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Original Article

Brachionus falcatus and *Platyias patulus* indicating organic pollution in Ouémé River's basin, Republic of Benin

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Abstract: Zooplankton is a biological compartment widely used in the bio-monitoring of aquatic ecosystems. It allows early detection of environmental disturbances even before reaching the upper compartments of interest to humans. The present study evaluated the ability of two rotifer species *Brachionus falcatus* and *Platyias patulus* to indicate organic pollution in the Ouémé River basin. Sampling was done between October 2014 and September 2015. Plankton net of 20 µm mesh size was used. Parameters such as NH_4^+, NO_2^- and PO_4^{3-} were measured in water and used for the calculation of the Organic Pollution Index (IPO). The results showed that the occurrence of *B. falcatus* and *P. patulus* was 96.66% and 81.11%, respectively. Both species were particularly abundant in sites such as Kaboua and Vossa as well as downstream of the basin (Agonlin-lowé and Bonou). These strong abundances are linked to a very strong organic pollution in Kaboua and Vossa then to a high organic pollution at downstream. The least organically polluted station (Kpassa) had the lowest abundance of both species. *B. falcatus* and *P. patulus* are therefore two indicator species of organic pollution in the Ouémé River's basin in Benin.

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Introduction

Aquatic ecosystems are invaluable, contributing substantially to a country's economy. But human activity generally affects their integrity. Thus, there is change in the general functioning of these ecosystems and consequently a significant drop in productivity. Ouémé River in Benin is the first aquatic ecosystem in terms of occupied area. Throughout its basin, there are sources of disturbance e.g. agriculture, industry, urbanization. Simeonov et al. (2003) reported that anthropogenic influences such as urban, industrial and agricultural activities degrade surface waters that become hazardous to drinking water, industrial use, and agricultural use as well as for other types of use. These sources of disturbance at upstream of a stream are drained along the basin (Calandre and Jacono, 2006) and lead to a greater alteration at downstream and in the receiving water body (Arimoro, 2009). Ouémé River basin is thus impacted from upstream to downstream in evolving dynamics other time.

To preserve the richness of the Ouémé river ecosystem, it is necessary to be able to follow the evolution of its ecological status so that management decisions will be made at the right time. Biological monitoring is a comprehensive integrating method to assess both the quality of the ecosystem and its impact on biocenosis. Zooplankton is one of the most important biological compartments for ecological processes. They are good environmental indicators that can express different responses to different disrupters (Houssou et al., 2017a). These responses are also very variable between the component species of the zooplankton community. Some species are known to be common to eutrophic environments while others are very sensitive (El-Enany, 2009). Eutrophication affects the zooplankton composition shifting the dominance of large species (copepods) to the smaller species (rotifers) (El-Shabrawy, 2000). It is therefore a very appropriate community for the monitoring of environmental changes.

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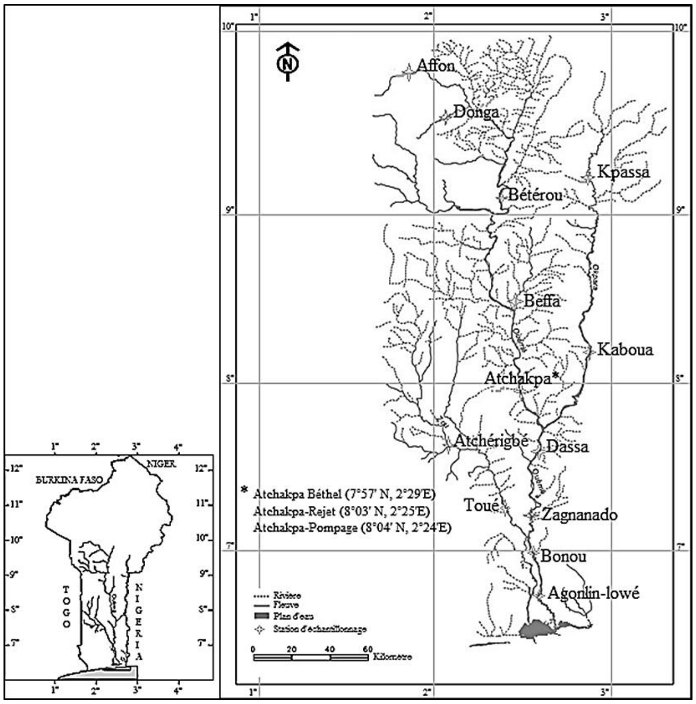

Figure 1. Geographical map of sampling sites in Ouémé River's basin.

Brachionus falcatus and *Platyias patulus* are both rotifers species of the family of Brachionidae. They are among the most abundant species in the Ouémé basin (Houssou et al., 2017b). Mola (2011) showed that rotifers of Brachionidae family are indicators of eutrophication; A phenomenon resulting from organic pollution and the mineral charge of water. The present study therefore assessed the ability of *B. falcatus* and *P. patulus* to indicate organic pollution in the Ouémé river basin in Benin.

Materials and Methods

The study was conducted in the Ouémé river basin in Benin. The catchment area (Fig. 1) extends between 6°51' and 10°11' north latitude and 1°29' and 3°24' east longitude. It covers an area equivalent to half of the territory of Benin republic (i.e. more than 50000 km²). Fifteen sampling sites were selected from upstream to downstream and taking into account the main tributaries of the river (Okpara, Zou, Beffa and Donga rivers) (Fig. 1). The variability of habitats and anthropization in the basin were key factors in the choice of sites.

Sampling of zooplankton was done monthly over a 12-month period (October 2014 to September 2015).

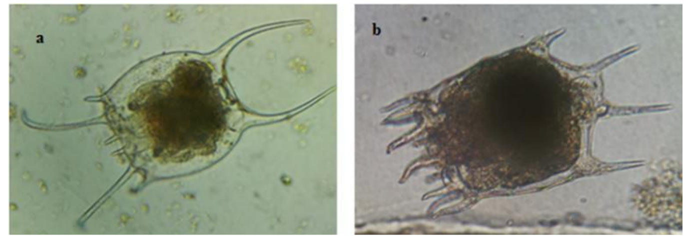

Figure 2. (a) *Brachionus falcatus* and (b) *Platyias patulus*.

A 20 µm mesh plankton net was used with a combination of vertical and horizontal sampling techniques. Samples were fixed *in-situ* with 5% formaldehyde. In laboratory, the samples were treated under a photonic microscope. Both rotifer species (*B. falcatus* and *P. patulus*) were identified and counted. The Ahlstrom (1940) guide was used for identifications. The count was made milliliter per milliliter over the entire volume of the samples by using a four-grid enumeration cell of Burker turk. A photograph of the species (Fig. 2) was also made.

A sample of water was collected biweekly at each station for determined parameters such as NH_4^+, NO_2^- and PO_4^{3-} (Houssou et al., 2017c). Standards methods (APHA, 2005) were used for determination of these parameters.

The presence/absence of the two species was studied in the different stations and over time. The distribution profile of the abundances in the different sites was studied with the attribute symbol plot in Canoco for windows v.4.5 software. Then, the organic pollution in the different sites was evaluated with the Organic Pollution Index (IPO) of Leclercq and Vandevenne (1987) modified by Leclercq (2001). This index is based on the classification of parameters such as ammonium, nitrite and orthophosphate into pollution classes which mean gives the IPO. The classification grid is presented in Table 1. The distribution spectrum of the mean abundance of species in the various status of organic pollution was established and the Tukey test was used to test the difference between the statuses. The Spearman correlation was also calculated between the species and the organic pollution index.

Results and Discussion

Spatial and temporal distribution of species: The two

Table 1. Classes limits of parameters including in IPO calculation (Leclercq, 2001).

Classes	NH_4^+ (mg.L^{-1})	NO_2^- (µg.L^{-1})	PO_4^{3-} (µg.L^{-1})
5	< 0.1	< 5	<15
4	0.1-0.9	6-A0	16-75
3	1-2.4	11-50	76-250
2	2.5-6	51-150	251-900
1	>6	>150	>900

IPO = mean of classes numbers of the three parameters; IPO = 5.0-4.6: No organic pollution; IPO = 4.5-4.0: Less organic pollution; IPO = 3.9-3.0: Moderate organic pollution; IPO = 2.9-2.0: Strong organic pollution; IPO = 1.9-1.0: Very strong organic pollution.

Table 2. Spatial and temporal distribution of *Brachionus falcatus* and *Platyias patulus* in the Oueme River basin.

Sites	Site code	Oct-14		Nov-14		Dec-14		Jan-15		Feb-15		Mar-15		Apr-15		May-15		Jun-15		Jul-15		Aug-15		Sep-15	
		B	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*	*B*	*P*
Agonlin-Lowé	Ag-L																								
Bonou	Bon																								
Zagnanado	Zag																								
Toué	Tou																								
Atchérigbé	Atch																								
Dassa	Das																								
Atchakpa-Béthel	Atch-B																								
Atchakpa-Rejet	Atch-R																								
Atchakpa-Pompage	Atch-P																								
Kaboua	Kab																								
Vossa	Vos																								
Kpassa	Kpa																								
Bétérou	Bét																								
Donga	Don																								
Affon	Aff																								

B- Brachionus falcatus, P- Platyias patulus. The colored boxes show the present of the species.

species had a perfect distribution between December and then May and in June and July for *B. falcatus* (Table 2). *Platyias patulus* was also found in all stations in November. In September, it was absent in the basin while it was present only at Agonlin-lowé and Bonou in October. *Platyias patulus* was absent in Zagnanado in August, in Kpassa in June, July and August and then in Donga in June and August. As for *B. falcatus*, it was not found in Vossa in October and November and then in Kpassa in August, September, October and November. This distribution confers an occurrence of 96.66% to *B. falcatus* and 81.11% to *P. patulus*. They are therefore constant species in the Ouémé basin (Dajoz, 2000) and are characteristic of its ecosystem. The two species being cosmopolitan with a preference for warm waters, their strong presence in the Ouémé basin is justified. They have already been found in Beninese waters Houssou et al. (2015 and 2016). The rarity of *P. paltulus* during the months of September and October (high water period) shows that it is strongly affected by the volume of water. It was only observed in October at the two stations in downstream (Bonou and Agonlin-Lowé). The topography of the basin giving a relatively high stability to the downstream water compared to the upstream zone, favored the maintenance of the species in downstream even if water volume is high. The water flow is therefore a strongly limiting factor in the distribution of *P. patulus* in the Ouémé basin.

Species abundance distribution: The abundance of *B. falcatus* and *P. patulus* in the study sites is shown on Figure 3A and B, respectively. The two species presented a perfectly equivalent profile of their abundances. The growth/decline of one is systematically followed by that of the other. *Brachionus falcatus* appeared most abundant with densities between 209 ind.m^{-3} and 927 ind.m^{-3}. For *P. patulus*, the densities ranged from 39 ind.m^{-3} to 185 ind.m^{-3}. The two extremes of density of each species were observed on the Okpara River (Kaboua and

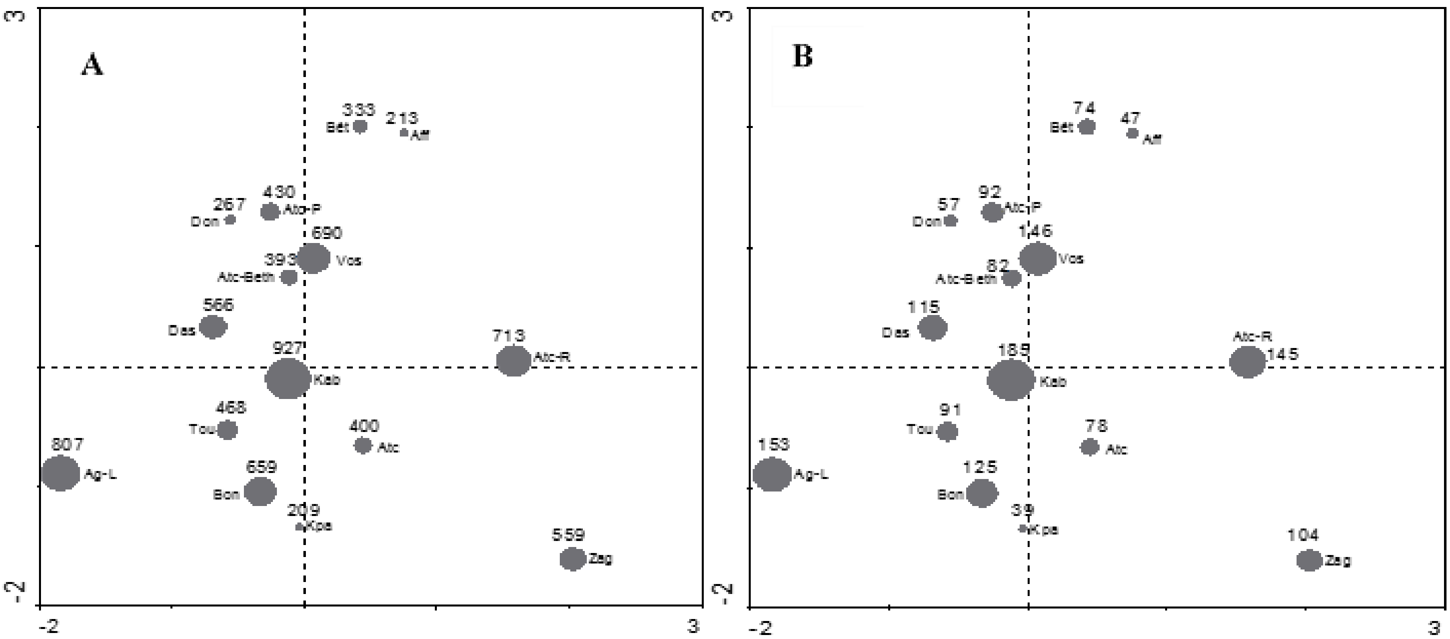

Figure 3. Plot of *Brachionus falcatus* (A) and *Platyias patulus* (B) abundances throughout sampling sites. Sites codes are same as in table 2.Values represents species abundances (ind.m^{-3}).

Kpassa station respectively for the highest and lowest abundance). The stations of Agonlin-lowé, Atchakpa-Rejet, Vossa and Bonou also had high densities of both species.

The Okpara River, which is the main tributary of the Ouémé River, gave in this study the lowest and highest density of the two studied species. Both species being primary consumers, their development is strongly linked to that of phytoplankton. Phytoplankton in tropical condition is limited by the mineral charge; the insolation being mostly sufficient. Thus the Okpara River respectively in the Kpassa and Kaboua sites had the lowest and highest mineralization. At the Kpassa sites (low mineralization), a hydrological dam is set up for the production of drinking water for Parakou city. The pollutant discharges into this site are therefore very limited. As for the Kaboua sites, located further downstream and in a forest area, it is a border between Benin and the Federal Republic of Nigeria. It is therefore highly used for trade between the two countries. At the mineral level, this station reflects not only the directly induced pollution but also the load of the whole river from the upstream under the influence of the transfers (Calandre and Jacono, 2006). During the low-water periods, there was a strong phytoplankton production coinciding with the bloom of the two studied species of rotifer. The removal of water during the dry season therefore created the conditions for multiplication of the two species (Zébzé-Togouet et al., 2005).

Organic pollution: In terms of organic pollution in the basin, three statuses were observed (Table 3). Moderate pollution has been observed in sites such as Zagnanado, Toué, Atchérigbé, Dassa, Atchakpa-Béthel, Atchakpa-Pompage, Kpassa, Bétérou, Affon and Donga. A status of strong pollution was then observed at Agonlin-lowé, Bonou and Atchakpa-Rejet. The stations of Kaboua and Vossa were very strongly polluted. Ammonium, nitrites and phosphates which have been used for the determination of organic loading are products of mineralization of organic matter in water (Leclercq, 2001; Wang et al., 2006; Abai et al., 2014). Their concentration in water therefore indicates the degree of organic pollution. The organic inputs in the Ouémé basin are from various sources. Agriculture is currently the most important source of inputs, crop residues and processing waste. Increasing urbanization in the Ouémé basin places domestic wastewater as the second most important source of organic matter in the surface waters of the basin. The industry also

Table 3. Organic pollution level of studied sites.

Stations	Parameter's classes			IPO	Pollution level
	NH_4^+	NO_2^-	PO_4^{3-}		
Agonlin-lowé	2	3	2	2,33	Strong
Bonou	3	3	2	2,67	Strong
Zagnanado	4	3	3	3,33	Moderate
Toué	3	3	3	3,00	Moderate
Atchérigbé	4	3	3	3,33	Moderate
Dassa	4	3	3	3,33	Moderate
Atchapka-Bethel	3	3	3	3,00	Moderate
Atchakpa-Rejet	2	2	2	2,00	Strong
Atchakpa-Pompage	4	2	3	3,00	Moderate
Kaboua	2	1	1	1,33	Very strong
Vossa	3	1	1	1,67	Very strong
Kpassa	4	3	3	3,33	Moderate
Bétérou	4	3	3	3,33	Moderate
Affon	3	3	3	3,00	Moderate
Donga	3	3	3	3,00	Moderate

Table 4. Spearman's ranks correlation between species and IPO value.

Species	IPO
Brachionus falcatus	-0,676*
Platyias patulus	-0,707*

contributes in some places to the organic pollution of water.

At stations with moderate organic pollution (such as Affon, Donga, etc.), urbanization is less and domestic waste is not an important source of pollution. The organic matter in the water of these sites comes mainly from agriculture. Particularly in Atchakpa-Betehel, the organic load could have been more important than moderate. Self-purification between Atchakpa-Rejet (the discharge point of the "Sucrerie du Complant du Benin (SUCOB)" plant) and this station by macrophytes, mainly *Eichhornia crassipes*, contributed to the reduction of pollution (Kone, 2002). In the discharge station of SUCOB where pollution is high, the main source of organic pollution is therefore the sewage from the sugar production plant. As for the other two sites (Bonou and Agonlin-lowé) with strong organic pollution, they are in downstream of the basin, thus presenting an accumulation of the pollutant load from upstream. These are also areas with significant urbanization. The direct anthropogenic impact is therefore important. The station of Kaboua for the reasons mentioned above and the station of Vossa have a very high organic pollution. Anthropization and agriculture are the two sources of organic matter in the station of Vossa.

Ecological spectrum of species: The distribution spectrum of the abundance of the two species in the three statuses of organic pollution observed shows an increase in both species with the increase in pollution (Fig. 3). For each of the two species, the density in the moderate pollution status was significantly smaller than in the other two status ($P<0.05$). A significant correlation ($P<0.05$) is observed between the IPO and the abundance of the two species (Table 4). The Spearman correlation was -0.676 for *B. falcatus* and -0.707 for *P. patulus*. Brachionidae rotifers are known to be strongly linked to water eutrophication (Serafim-Junior et al., 2010; Mola, 2011). The phenomenon of eutrophication is a strong biological multiplication thanks to an enrichment of water in organic and mineral matter. Thus the profile of the two species of Brachionidae (*B. falcatus* and *P. patulus*) in the present study shows that they are strongly related to eutrophication. Since organic pollution is the main source of eutrophication parameters, the two species perfectly indicate the organic load in the basin of the Ouémé basin.

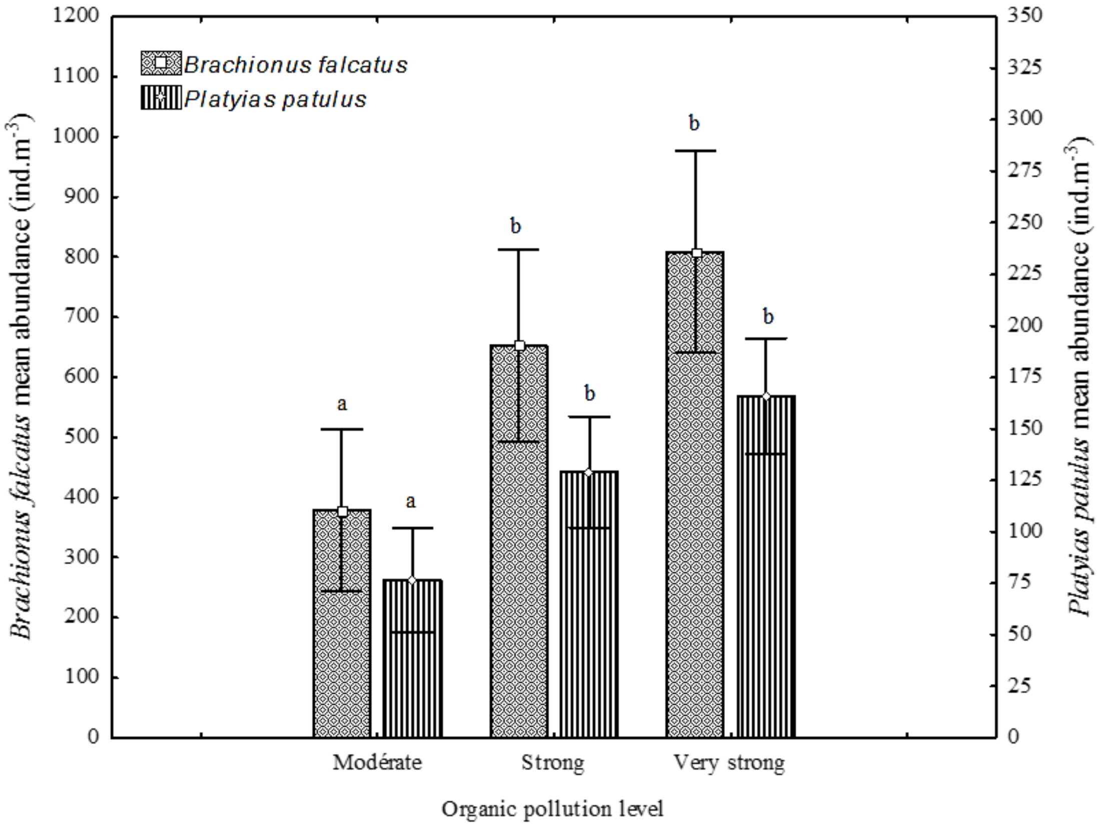

Figure 4. Ecological spectrum of *Brachionus falcatus* and *Platyias patulus* relative to organic pollution. For the same species, plots headed with different letter are significantly different ($P<0.05$).

Conclusion

Rotifers *B. falcatus* and *P. patulus* both from the family of Brachionidae have a profile strongly related to organic pollution in the Ouémé River basin. Their maximum density is associated with the very strong organic pollution in the sites of Kaboua and Vossa. The two species are therefore interesting bioindicators of organic pollution in the Ouémé river basin.

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References

Abai E.A., Ombolo A., Ngassoum M.B., Mbawala A. (2014). Suivi de la qualité physico-chimique et bactériologique des eaux des cours d’eau de Ngaoundéré, au Cameroun. Afrique Science: Revue Internationale des Sciences et Technologie, 10(4): 135-145.

Ahlstrom E.H. (1940). A revision of the Rotatorinan genera *Brachionus* and *Platyias* with descriptions of one new, species and two new varieties. Bulletin of the American Museum of Natural History, LXXVII(II): 143-184

APHA. (2005). Standard methods for examination of water and wastewater, 21st ed., APHA, AWWA, WPCF, Washington DC, USA.

Arimoro F.O. (2009). Impact of rubber effluent discharges on the water quality and macroinvertebrate community assemblages in a forest stream in Niger Delta. Chemosphere, 77: 440-449.

Calandre P., Jacono D. (2006). Protection et gestion des rivières du secteur seine-aval. Bassin Seine-Normandie, Chapitre 3: Fonctionnalités des Rivières, 31-40.

Dajoz R. (2000). Précis d’écologie. Edition Dunod, Paris. 615 p.

El-Enany H.R. (2009). Ecological studies on planktonic and epiphytic microinvertebrates in Lake Nasser, Egypt. PhD thesis, Zoology Department, Faculty Science, Benha University.

El-Shabrawy G.M. (2000). Seasonal and spatial variation in zooplankton structure in Lake Nasser. II-costal area of the main channel and main Khors. Journal of Egyptian Academic Society for Environmental Development, 1(1): 19-44.

Houssou A.M., Agadjihouédé H., Montchowui E., Bonou C.A., Lalèyè P. (2015). Structure and seasonal dynamics of phytoplankton and zooplankton in Lake Azili, small Lake of the pond of River Ouémé, Benin. International Journal of Aquatic Biology, 3(3): 161-171.

Houssou A.M., Yaovi R., Ahouansou Montcho S., Bonou C.A., Montchowui E. (2016). Diversity and seasonal variation of zooplankton of Lake Hlan, Republic of Bénin (West Africa). Journal of Applied Biosciences, 102: 9723-9737.

Houssou A.M., Daguégué E.J., Montchowui E. (2017a). Lethal and sub-lethal effects of cypermethrin and glyphosate on the freshwater's copepod, Acanthocyclops robustus. Invertebrate Survial Journal, 14: 140-148.

Houssou A.M., Montchowui E., Bonou C.A. (2017b). Composition and structure of zooplankton community in ouémé river basin, republic of Benin. Journal of Entomology and Zoology Studies, 5(6): 336-344.

Houssou A.M., Ahouansou Montcho S., Montchowui E. Bonou A.C. (2017c). Spatial and seasonal characterization of water quality in the Ouémé River basin (Republic of Benin, West Africa). Egyptian Journal of Chemistry, 60(6): 1077-1090.

Kone L. (2002). Epuration des eaux usées par lagunage à microphytes et à macrophytes en afrique de l'ouest et du centre: état des lieux, performances épuratoires et critères de dimensionnement. Thèse de Doctorat des Sciences Techniques. École polytechnique Fédérale de Lausanne, Suisse. 170 p.

Leclercq L., Vandevenne L. (1987). Impact d'un rejet d'eau chargée en sel et d'une pollution organique sur les peuplements de diatomées de la Gander (Grand-Duché de Luxembourg). Cahiers de Biologie Marine, 28(2): 311-318.

Leclercq L. (2001). Les eaux courantes: caractéristiques et moyens d'étude, dans Les zones humides. Actes des colloques organisés en 1996 par le Ministère de la Région Wallonne dans le cadre de l'Année Mondiale des Zones Humides, Jambes, Région Wallonne, DGRNE. pp: 67-82.

Mola H.R. (2011). Seasonal and spatial distribution of Brachionus (Pallas, 1966; Eurotatoria: Monogonanta: Brachionidae), a bioindicator of eutrophication in lake El-Manzalah, Egypt. Biology and Medicine, 3: 60-69.

Serafim-Juunior M., Perbiche-Neves G., de Brito L., Ghidini A.R., Casanova S.M.C. (2010). Variaçao espaço-temporal de Rotifera em um reservatorio eutrofizado no sul do Brasil. Iheringia, 100(3): 233-241.

Simeonov V., Stratis J.A., Samara C., Zachariadis G., Voutsa D., Anthemidis A., Sofoniou M., Kouimtzis T. (2003). Assessment of the surface water quality in Northern Greece. Water research, 37(17): 4119-4124.

Wang S., Jin X., Bu Q., Zhou X., Wu F. (2006). Effects of particle size, organic matter and ionic strength on the phosphate sorption in different trophic lake sediments. Journal of Hazardous Materials, 128(2): 95-105.

Zébazé-Togouet S.H., Njiné T., Kemka N., Nola M., Foto-Menbohan S., Monkiedje A., Niyitegeka D., Sime-Ngando T., Jugnia L.B. (2005). Variations spatiales et temporelles de la richesse et de l'abondance des rotifères (Brachionidae et Trichocercidae) et des cladocères dans un petit lac artificiel eutrophe situé en zone tropicale. Revue des Sciences de l'Eau, 18(4): 485-505.