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Full Length Research Paper

Seasonality in Abundance and Composition of Zooplankton of Shesher and Welala Floodplain Wetlands, Lake Tana Sub-Basin, Ethiopia.

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Abstract
The study was conducted at eastern side of Lake Tana in Shesher and Welala floodplain wetlands from July, 2009 to May, 2010 for four seasons (rainy, post-rainy, dry season and pre-rainy season). The study aimed to investigate the spatial and temporal dynamics of Zooplankton. Zooplankton community of Shesher and Welala was highly dominated by rotifers which contributed 83 and 90%, respectively. Brachionus spp and Keratilla spp were the most prominent in the rotifer community in both wetlands. Copepods were the second dominant group next to rotifers and were best represented by Cyclopoids. Cladocera were the least abundant and were comprised of Moina spp. In general, the highest density and composition of zooplankton was recorded during the dry season, concurrently with highest phytoplankton abundance.

Keywords: *Abundance; composition; floodplain; spatial and temporal; zooplankton.*

Introduction

Zooplankton is an important component in the food-chain as a major contributor of the food base for larval fish stocks and some adult fish species (Mavuti and Litterick, 1981). Zooplankton studies provide information for a better understanding of the trophic relationship in the lake (Bollens and Frost, 1989). It is an important link between primary production and planktivorous fish. Zooplankters play an important role in trophic dynamics of planktonic ecosystems as they transfer energy from primary productivity to higher trophic levels (Davis, 1996). In addition, they have a potential as bioindicators of water quality in ecosystems function (Suzanne and Jeffery, 1997; Ferdous and Muktadir, 2009).

Zooplankton can have the potential to be used as one of water quality monitoring strategies. He proposed integration of two strategies to have a better water quality and lower cost /benefit ratio in the management of water resources. These are: 1) strategy of reducing the external load of nutrients, toxic substances, organic matter or acid precipitation. 2) The strategy of controlling internal ecological processes. If one consider the second solution, it is clear that zooplankton grazing is one of the internal dynamics regulating water clarity (Bendorf, 1988).

Zooplankton also has a significant role in Lake Ecosystem through transferring energy from primary producers to predators and by suppressing the abundance of phytoplankton. When their grazing is intense, zooplankton can substantially reduce total phytoplankton biomass and productivity, producing clear-water phase (Lampert *et al*., 1986). Zooplankton also can affect the relative abundance of phytoplankton species, both by direct grazing (top-down) and by nutrient recycling (bottom-up) processes.

Nutrient transfers in the water and the aquatic biota (bacteria, protozoa, fungi, plants, and animals excluding fishes) both in floodplains and backwaters are similar to those described for other systems, with the addition of pronounced seasonal effects (Junk, 2002). The nutrients channeled to the sediments can be released by being mineralized or buried. Nutrients that pass through the trophic web to fish can be removed from the system by harvest or migration.

Several studies have been made on the community structure of zooplankton in various East African Lakes and reservoirs (Talling and Lemoalle, 1998); however, seasonal floodplain reservoirs were rarely studied. This is also true for Ethiopia. The Shesher and Welala Wetlands are highly exposed to degradation because of unsustainable farming activities by local farmers such as drainage for recession agriculture (Atnafu et al., 2011). The largest potential threat, however, is a huge irrigation project on Ribb River, which is under construction (Getahun *et al*., 2008; Alemayehu *et al*., 2010). The aim of this study was to assess spatial and temporal segregation of Zooplankton of these two wetlands.

Materials and Methods

Study-Area

Lake Tana located at an altitude of 1830 m and is situated on the basaltic Plateau of the north-western highlands of Ethiopia covering an area of about 3050 km^2. It is the source of the Blue Nile River (Great Abbay), with a catchment area of 16, 500 km^2. Seven large permanent rivers feed the lake as well as ca. 40 small seasonal rivers. The main tributaries to the lake are Gilgel Abbay (Little Blue Nile), Megech River, Gumara River and the Ribb River. The Blue Nile is the only outflowing river. This shallow lake is Ethiopia's largest lake, containing more than half the country's freshwater resources and the third largest in the Nile Basin (Fig. 1).

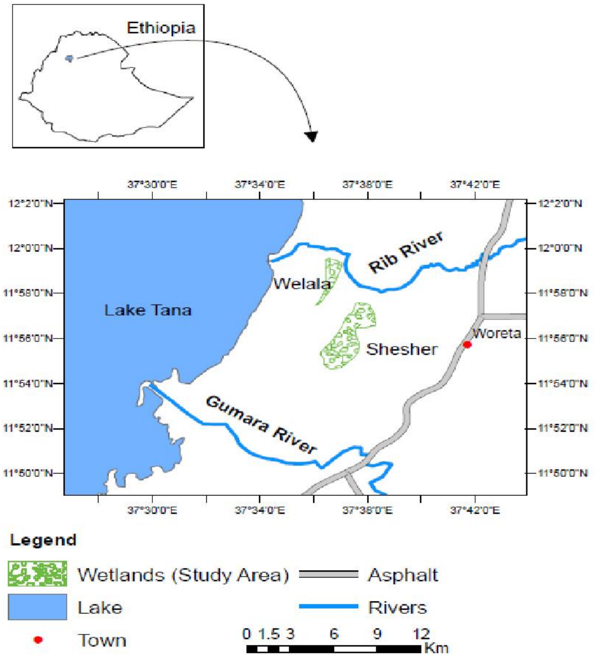

Fig. 1. Map of Lake Tana, Ribb River and Gumara River, and associated Shesher and Welala floodplain Wetlands (after Atnafu *et al.*, 2011)

Shesher and Welala floodplain Wetlands are located on the eastern side of Lake Tana within Amhara Regional State, South Gondar Zone of Fogera Woreda (Fig. 1). The local community gets benefits from these Wetlands in the form of fishing, grazing for cattle and small scale irrigation. Most of the eastern portions of the Shesher and Welala floodplain Wetlands are cultivated for recession agriculture when the water shifts ("Bahir Shesh") and canals are made for irrigating field crops. Rice farming is important in the area. During the period of this study ca. 30% of the land is used for rice cultivation (Atnafu, 2010).

Shesher and Welala Wetlands are also spawning and nursery habitats for the African Catfish, *Clarias gariepinus* (Anteneh *et al.*, 2012) and they harbor a large diversity of bird species including internationally endangered and threatened ones (Bendorf, 1988). The Wetlands are very shallow, maximum depth of Shesher is 1.75 m, whereas the maximum depth of Welala is 2.5 m during main rainy season. Shesher dries up usually during February-March and Welala during April or May. During the years with much precipitation and much overflow from Ribb River, Welala does not dry up at all (Anteneh *et al.*, 2012).

Sufficient water inputs are vital for maintaining an ecological connection with Lake Tana. During the rainy season (July-October), the two Wetlands are charged with overflow from Ribb River, overflow from Lake Tana, overflow from Gumara River, catchment runoff and direct precipitation. Before 2009, overflow from Ribb River was the most important water source (Atnafu *et al.*, 2011). However during the rainy season of 2009 we observed that the overflow from Ribb River was reduced because of the construction of a dike along the bank of the River constructed by local people and facilitated by local officials to minimize over flooding of the nearby villages (Fig. 1).

This research was conducted from July 2009 to May 2010 in four seasons. There were four sampling sites, two in each Wetland, one in the littoral and one in the open water region of each Wetland. GPS was used to define the sites.

Climate

The mean annual rainfall of the area is ca. 1200 mm and ranges from 1103 to 1336 mm. In the study area the air temperature ranges from 22ºC to 29ºC (Kebret, 2008). The climate around L. Tana is characterized by four seasons: 1) a main-rainy season with heavy rains during July-September, 2) a dry season during December–April, 3) a pre-rainy season during May-June and 4) a post-rainy season during October-November. After the main-rainy season, there are the two cropping seasons.

Physico-Chemical Parameters

Table 1. Mean value of physico-chemical parameters of Shesher and Welala Wetlands during the study period

Parameters	Shesher	Welala
T (ºC)	24.38	25.26
DO(mg/l)	7.25	5.8
Conductivity (µs/cm)	181.83	162.64
pH	7.46	7.03
Secchi Depth(cm)	8.56	9.19
NO_3-N (mg/l)	1.2	0.92
PO_4-P (mg/l)	0.4	1.18
SiO_2 (mg/l)	2.31	5.03

Zooplankton Sampling

At each sampling site, the Zooplankton was sampled with a Van Dorn water sampler at different depths. Subsamples from different depths, representing equal volumes, were pooled and filtered through 80 µm plankton net. Then concentrated to a volume of 50 ml and preserved in 4-5 % formaldehyde and sucrose. Speciements were sorted and counted under Olympus type microscope (10x) using gridded glass counting chambers. Identification of zooplankton was done using the monographs and key as indicated in (Fernando, 2002) and (Korinek, 1999). Abundance was computed as individual per liter, following Wetzel and Likens, (2001) and all calculations were a mean of triplicates taken at each site. To evaluate the significance of spatial and temporal variations of zooplankton in the two wetlands the Kruskal-Wallis test was performed. Data presentation was performed by using tables and abundance percentage.

Results and Discussion

Zooplankton taxa were identified in to three groups such as Rotifers, Copepods and Cladocerans. The most diverse group was rotifer which accounted 9 genera/species and others constituted only one third of the total composition which were 2 genera/species of copepods (Cyclopoida and Calanoida) and 4 genera/species of Cladoceran (*Ceriodapinia spp, Diaphanosoma spp, Macrothrix spp and Moina spp*. (Table 2).

Table 2. Taxa of Zooplankton identified in Shesher and Welala Wetlands and their average abundance (%) during the study period

Groups	Taxa	%Abundance (Shesher)	%Abundance (Welela)
Rotifers	*Ascomorpha sp.*	0	0.01
	Asplanchna sp.	1.43	0.69
	Brachionus sp.	59.61	31.27
	Filinia sp.	4.56	12.2
	Keratella sp.	16.89	44.44
	Lecane sp.	0.02	0.19
	Pedalia/hexathra sp.	0.02	0.14
	Polyathra sp.	0.47	0.37
	Trichocerca sp.	0.32	0.2
Copepods	*Calanoida*	3.15	1.59
	Cyclopoida	8.73	5.49
Cladocerans	*Ceriodapinia sp.*	0.01	0.13
	Diaphanosoma sp.	0.4	0.05
	Macrothrix sp .	0.01	0.1
	Moina sp.	4.38	3.2

Rotifer Species

Rotifers were the dominant of all taxa of zooplankton in Shesher and Welala Wetlands and followed by *Copepods* and *Cladocera* throughout the study period (Table 2). This might be rotifers do well in water with high food threshold and small size water bodies because of their low filtration rates. In addition, Rotifers might have ability to select in feeding algae in turbid water. Therefore, in turbid reservoirs, Rotifers are favored than Cladocerans (Cuker and Hundson, 1992; Kirk, 1991; Kirk and Gilbert, 1990). This series of dominancy was similar to that of Lake Babogaya (Belay, 2007) and opposite to Lake Tana (Copepods, Rotifers and Cladocerans in their order of dominancy; Wondie, 2006). The over dominancy of Rotifers to that of Cladocerans and Copepods might be the ability of Rotifers to reproduce fast parthenogenetically (asexually) enables them to react quickly to unfavorable and favorable environmental conditions (Pennak, 1978). Therefore, they have the shortest life span (12 days) than Cladocerans (50 days) and Copepods (which have only sexual reproduction, require longer periods to increase their population levels), and can reach their peak reproductive level in about 3.5 days (Allan, 1976).

Brachionus spp. were the most prominent species in Shesher which contribute 60 % where as in Welala *Keratella* spp. which made about 44.4% of the total abundance. The next abundant species were *Keratella* spp. in Shesher and *Brachionus* spp in Welala however other species were found rarely. Moreover, *Brachionus* and *Keratella* species were more dominant in Shesher during the dry season (85% of the total *Brachionus* and 54% of the total *Keratella* recorded). *Branchionus spp.* were the most abundant followed by *Keratella* species. The possible reason could be the slight alkaline nature of the wetlands (**Table 1**) which favor for their great quantitative importance than some of other genera (Hutchinson, 1967). Gilbert (1967) suggested that *Brachionus spp.* populations may develop various levels of posterolateral spines that decrease predation by *Asplancha spp.* In similar fashion, Mengisto *et at*., (1991) reported that *Branchionus* and *Keratella* species have contributed more than 50 % of the rotifer assemblage of Lake Awassa. There has been temporal significance variation in both wetlands ($P<0.05$) in abundance of rotifers.

Generally, in post rainy season the diversity of the rotifer species was high although their abundances were less as compared to dry season. In dry season the species richness were more or less similar to post rainy season and their abundances were very high. The species composition and abundance were very low during the main rainy season in both ponds.

Copepod Species

Copepods covered over 7-12% of the total zooplankton composition (Table 2) and the Cyclopoids were dominant. Maximum numbers of Cyclopoids were recorded at Shesher in dry season and at Welala in pre-rainy season. The cyclopoids were numerically denser in Shesher than Welala. *Calanoids* were less abundant in all season during the study time and more pronounced at pre rainy and main rainy season.

Calanoid and Cyclopoid Copepods were not proportionally abundant at the studied sites. As compared with Lake Tana where Calanoids were dominant (Wondie, 2006), the Cyclopoids in Shesher and Welala dominated in numerical density. The abundance of copepods over the study period in Shesher and Welala varied from 0.00 to 119.78Ind/l and 0.00 to 428 Ind/l, respectively (Table 3). As compared to Lake Tana (maximum peak av. 90.64 Ind/l; Wondie, 2006), the copepods in Shesher and Welala were denser. There was temporal significance variation in both wetlands ($P<0.05$). The minimum amounts of Copepods were recorded at main rainy season following the dynamicity of phytoplankton (Wondmagegne *et al*., 2012). The Cyclopoids were more abundant at dry season in Shesher (60 %) and Welala (94%). This may be related to availability of primary producers and nutrients (Wondmagegne *et al*., 2012). The other reason may be the reduction of predator migratory birds associated with the shrinkage of the water level. The Calanoids were numerically abundant in both Shesher and Welala at post rainy season which contributed from their total population about 94% and 90, respectively. This might be the availability of nutrients combined with relatively high temperature which favored the Calanoids to have high numeric density in the post rainy season.

Cladoceran Species

The Cladoceran species were the least abundant species collected during the study period and were represented by four species (namely*: Ceriodapinia spp. Diaphanosoma spp, Macrotrix spp and Moina spp*., Table 2). Among them *Moina spp* were the dominant species in numerical density and persisted throughout the study period in both Shesher and Welala wetlands. The cladocerans in both wetlands were highly represented by *Moina spp* which accounted over 90% in numerical density. However, the other three species were rarely found in the whole sites and season during the study period; and were totally absent in the dry and pre-rainy season (Table 3).

Generally, Cladocerans community contributed less when compared to the numerical density of Rotifers and Copepods. This may be due the hydrodynamics and turbidity (Table 1) of the ponds as (Threlkeld, 1986) and (Kirk KL, 1992) stated that Cladocerans can be reduced during flooding events when abundant silt particles overwhelm algal particles in the water column which are markedly influenced by hydrodynamics of the reservoir. Cladocerans had positive correlation with rotifers which indicating that the predation among the assemblage was not principally important factors for the reduction of their abundance but the hydrodynamics. The anthropogenic effect (canalization for irrigation) and farm activity (following the shrinkage) as well as natural factor (evaporation) reduce the water volume and level as a result the water bodies experience fast hydrodynamic trend with short period of time.

The number of Cladocerans in both wetlands showed irregular fluctuation patterns in the dry season (Table 3). This pattern, however, was changed during the wet and mixing periods when the number increased considerably at all sampling sites. The Cladocerans community was observed in high numbers during the wet season (August, 2009; Table 3). The increase in density of Cladocerans during the wet season might be associated with allochthonous organic matter input into the ponds that is favoring the growth of some phytoplankton. Consequently, phytoplankton species in the wetlands may be shifted to edible phytoplankton by filter-feeder Cladocerans. The dominant phytoplankton during this season was small size diatoms (Hutchinson, 1967), which are edible by filter feeder Cladocerans. In addition, the particulate organic matter serves as a medium for the growth of bacteriophytes that are a good source of food for Cladocerans (Belay, 2007).

Cladocerans are desirable fish prey since they have high caloric value and are readily consumed by most fry. Therefore, cladocerans populations usually decline rapidly when subjected to predation in line with high fish population of the ponds (Geiger *et al*., 1985; Geiger, 1983). On the other hand, copepods, because they are speedy and powerful swimmers are better able to maintain their populations than cladocerans during the later stages of a culture season (Geiger and Turner, 1990).

Table 3. Major Zooplankton species and seasonal changes in their abundance recorded (average values) from Shesher and Welala Floodplain Wetland (August, 2009 to May, 2010), S= Shesher Wetland, W=Welala Wetland, MRS= Main Rainy Season, PORS= Post Rainy Season, DS= Dry Season, PRS, Pre-Rainy Season, Ind/L= individual per litter, - = absent

Groups	**Taxa**	**MRS**		**PORS**		**DS**		**PRS**	
		S (Ind/L)	**W (Ind/L)**	**S (Ind/L)**	**W (Ind/L)**	**S (Ind/L)**	**W (Ind/L)**	**S (Ind/L)**	**W (Ind/L)**
Rotifers	*Ascomorpha sp.*	-	0.15	0	0.075	-	-	0.35	-
	Asplanchina sp.	-	-	3.6	2.025	67.125	7.775	4.1	1.6
	Brachionus sp.	8.4	4.5	15.3	47.925	2661.325	389.825	436.7	77.425
	Filinia sp.	0.4	1.4	34.2	65.025	189.95	111.025	14.525	25.25
	Keratella sp.	-	1.05	121.05	225.675	761.525	468.725	1.75	33.075
	Lecane sp.	0.3	2.90	0.45	0.225	-	-	0.35	-
	Pedalia/Hexathra sp.	-	-	0.375	2.1	1	0.6	-	-
	Polyathra sp.	1.1	3.4	0.9	0.75	21.2	3.85	1.55	-
	Trichocerca sp.	-	-	11.25	1.875	5.55	1.5	0.4	-
Copepods	*Calanoid*	0.55	-	24.98	148.33	0.98	16.575		0.35
	Cyclopoid	34.05	7	8.33	5.33	119.78	428.15	37.1	16.5
Cladocerans	*Ceriodapinia sp.*	0.4	0	0	0.15	-	-	-	-
	Diaphanosoma sp.	0.2	0	22.65	18.9	-	-	-	0.35
	Machrothrix sp.	-	-	0.15	0.15	-	-	0.4	-
	Moina sp.	3.8	4.4	49.8	50.25	93	246.15	7.2	4

Conclusion

Zooplankton abundance in Shesher and Welala varied significantly among the seasons. But, there is no significant variation between sampling sites. Rotifers accounted for most of zooplankton abundance in Shesher and Welala Wetlands. The maximum abundance of Rotifers was observed during the dry period and declined at the rainy season. Copepods followed the Rotifers in terms of abundance. They were represented only by two groups (Calanoids and Cyclopoids) where maximum abundance coincides with maximum phytoplankton abundance in dry season. The cladocerans were the least abundant of the zooplankton taxa in all sites of Shesher and Welala which was represented by *Moina spp* along with four genera (i.e., *Ceriodapinia*, *Diaphanosoma*, *Macrothrix* and *Moina*) that were recorded during the study period. The maximum abundance of cladocerans was found during wet and mixing periods, while the lowest abundance was found in the dry periods.

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