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Limno-biological study of Gofermeda reservoir in Hadiya zone, Southern Ethiopia-First report

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Abstract

Zooplanktons are aquatic pelagic invertebrates belonging to several phyla of Invertebrates. Freshwater zooplankton varies qualitatively as well as quantitatively. The present investigation is made to investigate species diversity of freshwater zooplankton in Gofer meda reservoir in Hosanna town, Southern Ethiopia. Field data and laboratory-based spatio-temporal scale study design was employed, from November 2020 up to May 2021, to determine the spatial distribution and temporal variation of Zooplankton species in the reservoir. Zooplankton samples were collected and preserved with appropriate procedures after field analysis

for further research in the Laboratory. The identification was made by compound research microscopes, the indices were enumerated with the help of the Sedgwick-Rafter counting chamber. Selected physicochemical parameters were studied to correlate the suitability of the water bodies for faunal abundance. Out of the recorded 37 genera of Zooplankton in genus level, 17 genera belong to order Rotifer, 8 genera belong to order Copepod, 7 genera belong to order Cladocera, and 3 belong to order Ostracodes and 2 Chironomida. Zooplanktons belonging to Rotifera constituted the most dominating contributing 46%, followed by Copepods contributing 21.6 %, Cladocera contributing 18.9 %, Ostracodes contributing for 8.1 % and 5.4% for Chironomids.

Key Words: *Cladocera, Copepod, Crustaceans, Diversity, Ostracoda, Rotifer*

INTRODUCTION

Aquatic biodiversity is wide-ranging term that comprises fresh water ecosystems with lakes, ponds reservoirs, rivers streams, ground water, wetlands and other part of aquatic biodiversity. Ethiopia among all the African countries unique for its geographic conditions, rich water recourses, extensive green fields, varied animal husbandry and over all diversity of flora and fauna. Although zooplankton research of Ethiopian lakes started already in the 1930's, but our understanding on zooplankton in east Africa has been slowly developing (Dagne et al., 2008).

The zooplankton of Ethiopian lakes is a mixture of species found throughout Africa and high diversified in the plankton, live at various depths in their own niches in defilement type of water bodies especially in and around eutrophic zone. The occurrence and abundance of a Zooplankton depends upon its productivity, which is influenced by physic-chemical parameters and the level of nutrients. Hence, qualitative and quantitative studies of zooplankton are important to understand environmental variations, such as water temperature, light, chemical composition particularly pH, Oxygen, salinity, food availability and prey- predator relationship. Zooplankton also serve as good indicator of the changes in water quality because they are strongly affected by environmental condition and respond quality to changes in water quality that in turn influences Zooplankton abundance, clustering and biomass.

The present investigation aimed to study the diversity, abundance of Zooplankton with relation to physic-chemical parametrs of Gofer Meda Reservoir in Hadiya Zone Hossana town, Southern of Ethiopia to establish a correlation for ascertaining water quality.

MATERIALS AND METHODS

The present study took place in Hossana town of Hadiya in the Southern Ethiopia located at an Elevation 2,177 above msl between Latitude N^0 $7^0$33'32.501" and Longitude E 037^0 51'55.187" using field data and

laboratory based spatio-temporal scale ranging for a period of 6 months. The surface area of the Gofer meda reservoir is approximately 196.445 hectares having an outlet. The reservoir serves as a vital source of water for a variety of purposes like recreation, washing clothes, bathing, and also fishing.

To study diversity of zooplankton, water samples collected from the various sample sites (3 sites) by a tow net of mesh size 70 µm made up of silk bolting cloth, about 1 foot in diameter and later analyzed in the laboratory. Regular weekly sampling was done four times in a month during early hours (6.00 AM to 8.00 AM morning) of the day at four different sites, selected based on topography and anthropogenic impact (Pattnaik, 2014). The volume of water filtered through the net varied in different localities depending on the plankton concentration. Quantitative analysis and identification was done by Sedgwick Rafter Counter by taking 1 ml sample and counting the best gridded cells. The variation in size and lengths was made by Occulometer (micrometer) and the photographs were taken using Swift microscope eyepiece camera of model: EC 5.0 MP.

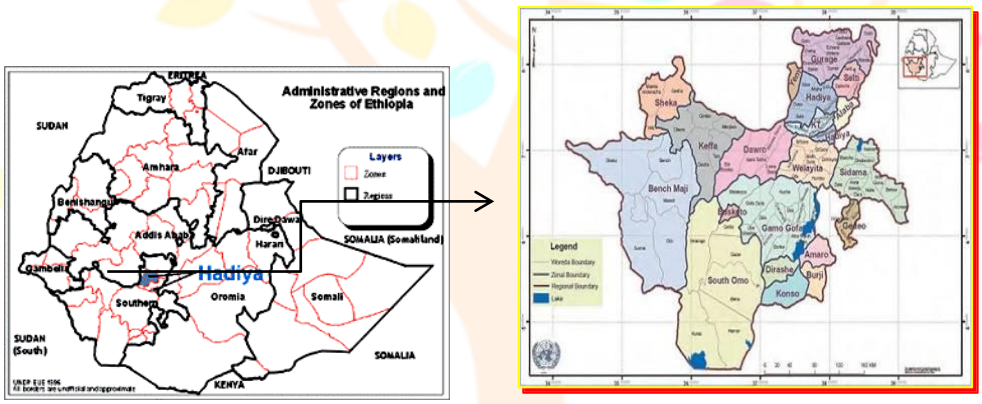

Fig. Site map of study area

The physico-chemical analyses done in the field and laboratories by using methods as described earlier. Various physic-chemical parameters taken into account e.g., water temperature, air temperature, pH, dissolved oxygen, Electrical conductivity (EC), Total dissolved solids (TDs). Zooplankton diversity was determined by using Shannon-Wiener's Index formula (Ludwig and Reynolds, 1988). Species dominance was calculated using Berger-Parker's Index formula (Berger and Parker, 1970).

For calculating the evenness of species, the Pielou's Evenness Index (J) was used (Pielou, 1975). Species Richness Index was determined using Margalef richness Index(d) (Margalef, 1958). Zooplankton identification and analysis was done using various standard literatures by observing the external carapace, lorica, outer appendages, ornamentation, spines and such. Interpretation of qualitative and quantitative data with the help of different statistical tools were used such as Pie charts, line graph, Bare graph, and also to compute diversity parameters such as Shannon-Weiner diversity index, Evenness, Richness, and Dominance.

RESULT & DISCUSSION

Variations in air temperature of the Gofermeda reservoir for the most frequent months (4) was given in Table-1. The maximum, air temperature recorded was 23.70ºc in December 2020 whereas the minimum air temperature recorded 21.70ºc in March 2021, fluctuating between 23.01ºc to 18.70ºc. The surface water temperature of all the four locations in the water body was relatively lower than the air temperature (Ganai, 2011 and Uzma, 2015). The pH of Gofer Meda reservoir, varied from maximum of 7.99 in March, 2021 to 7.50 minimum of in March, 2021 during study period. Moderately alkaline pH in the present study might be attributed by enhanced photosynthesis by the micro-phytoplankton and algae in the water bodies, thereby removing free CO_2 and result in increased alkalinity. Relatively lowest pH values in the might be due to lower photo synthetically active submerged micro-vegetation or algal aggregation in the Gofer-Meda reservoir due to flood nature of the reservoir.

Table- 1: Physicochemical parameters recorded at study sites

Sl NO	Date	Temperature in degrees		PH	DO in ml/L	TDS in ppm	EC in µs/cm
		Air Temp	Water Temp				
1	12/12/20	**23.7**	20.3	8.32	7.70	167.1	257.07
2	19/12/20	23.2	19.9	7.84	7.80	**180**	276.9
3	26/12/21	22.1	20.6	7.75	7.50	167	256.9
4	02/01/21	21.7	20.1	7.92	7.15	169	260.0
5	09/01/21	22.8	20.1	7.94	7.35	170	261.5
6	16/01/21	23.2	20.6	8.30	7.82	161	258.5
7	23/01/21	23.6	21.1	**8.56**	8.20	170	261.5
8	30/01/21	23.1	20.9	7.91	**9.44**	178	273.8
9	06/02/21	22.9	20.8	7.31	7.62	159	244.6
10	13/02/21	23.7	**21.8**	7.92	7.33	160	246.2
11	20/02/21	23.2	21.0	8.21	7.93	38.7	**246.2**
12	27/02/21	**19.0**	18.1	7.92	7.73	87.4	258.5
13	06/03/21	19.2	18.5	7.99	7.22	87.7	273.8
14	13/03/21	19.7	18.5	7.9	7.43	87.6	257
15	20/03/21	19.9	18.0	7.8	7.65	171.1	257
16	27/03/21	20.5	19.2	7.8	7.56	171.1	257

The maximum Dissolved oxygen (DO_2) recorded was 7.62 ml/l in March, 2021 and the minimum 6.50 ml/l in December, 2020. Among the six months, January and February were much colder, whereas December and March were relatively dry and sunny while April and May were the rainy. Increase in solubility of gases in liquid with decrease in temperature may be the reason for maximum values of DO during the cold months of January and February, 2021. Similarly the decline in dissolved oxygen content during dry months could be attributed to increasing water temperature leading to decrease in oxygen retention capacity of water.

The TDS values ranged relatively highest Total dissolved substance (180.00 ppm) recorded in December, 2020 and minimum of 38.70 ppm in February 2021, thus can be categorized as fresh water reservoir. The minimum and maximum average EC values were 276.90µs/cm in December 2020 and the minimum 244.60 µs/cm in February 2021; this could be correlated with the discharge of abattoir waste contaminants from nearby Hosanna town abattoir house, which might contain inorganic cat ions and anions

NO	Date	Sits	Species found				Parameters					
			Rotifera	Copepod	Cladocer	Ostracod	Air Temp in c°	Water Temp c°	PH	DO in ml/L	TDS in ppm	EC in µs/cm
1	12/12/20	S1	4	2	4	1	**23.7**	20.3	8.32	7.70	167.1	257.07
2	19/12/20	S2	2	1	2	1	23.2	19.9	7.84	7.80	180	276.9
3	26/12/21	S3	4	1	2	1	22.1	20.6	7.75	7.50	167	256.9
4	02/01/21	S4	3	1	3	2	21.7	20.1	7.92	7.15	169	260.0
5	09/01/21	S1	5	0	1	0	22.8	20.1	7.94	7.35	170	261.5
6	16/01/21	S2	6	2	3	0	23.2	20.6	8.30	7.82	161	258.5
7	23/01/21		6	2	2	0	23.6	21.1	8.56	8.20	170	261.5
8	30/01/21	S4	2	1	3	0	23.1	20.9	7.91	9.44	178	273.8
9	06/02/21	S1	4	1	2	0	22.9	20.8	7.31	7.62	159	244.6
10	13/02/21	S2	3	2	2	1	23.7	21.8	7.92	7.33	160	246.2
11	20/02/21	S3	5	0	3	2	23.2	21.0	8.21	7.93	38.7	246.2
12	27/02/21	S4	3	1	2	0	**19.0**	18.1	7.92	7.73	87.4	258.5
13	06/03/21	S1	3	2	2	1	19.2	18.5	7.99	7.22	87.7	273.8
14	13/03/21	S2	5	0	3	0	19.7	18.5	7.9	7.43	87.6	257
15	20/03/21		4	1	1	0	19.9	18.0	7.8	7.65	171.1	257
16	27/03/21	S4	3	1	2	0	20.5	19.2	7.8	7.56	171.1	257

Table 2: Number species found in four study sites months

Zooplanktons recorded in the Gofermeda reservoir

As a maiden attempt to understand the diversity, abundance and ecology of zooplanktons in the present study greater emphasis has been given to higher micro-invertebrates. In total 37 genera belonging to several zooplanktons were obtained from the present investigation of which 17 belonging to Rotifers, 07 to Copepods, 08 that of Cladocerans, 03 to Ostracoida and 02 belonging to Chironemata. The reservoir body also contains several other planktonic animals such as diatoms, algae, Cilliophorans, mastigophorans, larval forms of snails along with several algal and angiosperms. The zooplankton species found that recorded from four study sites Gofer-meda reserviour as follows-

Type of species	Rotifera (17)	Copepoda (07)	Cladocera (08)	Ostracoda (03)
Genera	*Brachiaunus forficula* *Brachionus bidentata* *Brachionus caudatus* *Brachionus quadridentatus* *Brachionus calyciferaous* *Brachiaunus angularis* *Brachinus budapestinensis* *Karatella tropica* *K. cochlearis* *Epiphanus clavulata* *Platyas patulus* *Rotaria rotatoria* *Rotaria vulgaris* *Filinia longiseta* *Cephalodella gibba* *Lacane bulla* *Lecane luna*	*Cyclops (02 Sp.)* *Diacyclops* *Mesocyclops* *Hetrocyclope* *Thermocyclops* *Nauplius larva*	*Daphnia sp.* Daphnia magna *Daphnia carinata* *Daphnia mendotae* *Moina (02 sp.)* *Bosmina* *Ceriodaphnia*	*Cypris* *Eucypris* *Centrocypris*

Analysis of Zooplankton diversity

The Shannon-Wiener index for present study had showed species value to be 1.863 for rotifer, 1.813 for copepod, 1.421 for Cladocera, 0.995 for Ostracoda indicating that the rotifer species were more diversified than another species. These values are slightly lower than the findings of Napiórkowski *et al*, 2019 but in agreement with the findings of Panwar and Malik, 2016. According to Wilhm (1970) a high value of diversity index (H') suggests a more healthy ecosystem, while a low value suggests a less healthy or degraded ecosystem.

The Simpson dominance index, a measure of biodiversity, is based on the probability that two individuals randomly selected from a sample will belong to same species (or some other category). Simpson's dominance index ranges from 0 (all taxa are evenly important) to 1.0 (one taxon dominate the community completely) (Uzma, 2015). In Zooplankton, Rotifer with Simpson's species dominance index 0.722 is less equal distributed than that of Cladocera, Ostracoda with the Simpson's species dominance index 0.65, 0.60 respectively where as Copopeda with Simpson's species dominance index 0.8025 is the least. The maximum values of species dominance during study might be described by availability of enough dissolved oxygen (DO) and favorability of pH of the water bodies, as these months were relatively rainy and cold while the sample was being collected.

Table 3: Number of species found in four month's study sites

NO	Date	Month	Sits	Species found			
				Rotifera	Copepoda	Cladocera	Ostracoda
1	12/12/20	December 2020	S1D	4	2	4	1
2	19/12/20		S2D	2	1	2	1
3	26/12/21		S3D	4	1	2	1
4	02/01/21		S4D	3	1	3	2
5	09/01/21	January 2021	S1N	5	0	1	0
6	16/01/21		S2N	6	2	3	0
7	23/01/21		S3N	6	2	2	0
8	30/01/21		S4N	2	1	3	0
9	06/02/21	February 2021	S1F	4	1	2	0
10	13/02/21		S2F	3	2	2	1
11	20/02/21		S3F	5	0	3	2
12	27/02/21		S4F	3	1	2	0
13	06/03/21	March 2021	S1M	3	2	2	1
14	13/03/21		S2M	5	1	3	0
15	20/03/21		S3M	4	1	1	0
16	27/03/21		S4M	3	1	2	0

Species richness is the simplest measure of biodiversity, and is simply a count of number of different species in a given area. This is commonly used along with other factors as a measure for determining the overall health of different biological ecosystems. High species richness for a given area indicates a high level of ecosystem stability, thus allow the ecosystem to better withstand natural or anthropogenic disturbances. The Margalef's species richness index (e) values for species richness was **5.886** in the study period. The values of Margalef's Species richness recorded in the present study are comparable to the findings of El-Sherbiny *et al*. (2011) but significantly larger than that of Olawusi-Peters and Ajibare (2014). From this finding, it can be said Gofermeda reservoir was species rich.

Table 4: Cross correlation between species and physico-chemical parameters.

Relation	Rotifera	Copopeda	Cladocera	Ostracoda	Air temper	Water temper	PH	DO	TDS	EC
Rotifera	---	0.055281346	0.041746467	-0.20939397	-0.2017884	-0.16825421	-0.49275317	0.12798015	-0.17329082	0.36481514
Copopeda	-0.055281346	---	0.16077679	-0.015937393	-0.20330224	-0.21942373	-0.36420967	0.02277259 7	0.33875949	0.00596 90725
Cladocera	0.041746467	0.16077679	---	0.36828145	-0.28185625	-0.27139111	-0.39343052	0.25127331	-0.19272172	0.00575 87235
Ostracoda	-0.20939397	0.015937393	0.36828145	----	-0.21256614	-0.28420557	-0.13641674	-0.29477649	-0.27546846	0.17681745
Air temp	0.20178849	0.20330224	0.28185625	0.21256614	----	-0.92155375	0.29430013	0.3353281	0.4206426	0.03584 1791
Water temperature	0.16825421	0.21942373	0.27139111	0.28420557	0.92155375	--	0.21016804	0.29458682	0.29394379	0.14958 397
PH	0.49275317	0.36420967	0.39343052	0.13641674	0.29430013	0.21016804	---	0.20518391	-0.13061753	0.15270 081
DO	-0.12798015	0.02277259 7	0.25127331	-0.29477649	0.3353281	0.29458682	0.20518391		0.15509796	0.47744 35
TDS	-0.17329082	0.33875949	-0.19272172	-0.27546846	0.4206426	0.29394379	-0.13061753	0.15509796	--	0.41054 412
EC	-0.36481514	-0.00596907 25	0.00575 87235	-0.17681745	0.03584 1791	-0.14958397	0.15270081	0.47744 35	0.41054 412	

Species evenness refers to equitability of each species among the sample matrix. This is relative distribution of individuals among taxonomic groups within a community (Ghosh and Biswas, 2015). The Pielou's species evenness index (J) is also a parameter which indicates relative awareness of the various species in a sample value is the number between 0 and 1. The closer the value of J to 0, the lower the species evenness and the higher the single species dominance in a sample, whereas the closer the value of J to 1, the higher the equity (evenness) of distribution of each individual species in the sample. In the present study, Pielou's species evenness values in Gofermeda reservoir were found to be 0.4957 in Rotifer, 0.7662 for Copepoda, 0.5916 for Cladocera and 0.9016 for Ostracod respectively with the average value of J found to be 0.5886.

Table-5 Diversity of Zooplanktons

Diversity metrics	Rotifer	Copepod	Cladocera	Ostracoda
Taxa	17	8	7	3
Individual	57	18	36	9
Dominance	0.088	0.1975	0.3503	0.4074
Simpson	0.91	0.8025	0.6497	0.5926
Shannon	2.625	1.813	1.421	0.995
Evenness	3.95	0.7662	0.5916	0.9016
Equitability	0.92	0.8719	0.7303	0.9057

This cross-correlation results of all the species indicated that strong negative relation with air temperature, water temperature and ionic concentration with equal regression value, where as positive relation with dissolved oxygen (DO) and total dissolved substance (TDS) and moderate relation with electrical conductivity (EC). Cross-correlation regressions also shows that species of Rotifera increased where as species Ostracodans decreased, while species correlation with the increase of rotifers diversity, resulted in decreasing diversity of Copepod, Cladocera and Ostracoda.

Table-6**: Z**ooplankton diversity indices in Gofermeda reservoir

Diversity Metrices	**value**
Taxa	30
Individual	138
Dominance	0.1064
Simpson	0.8936
Shannon	2.81
Evenness	0.5537
Equitability	0.8262
Margalef	5.886

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