A Short Study of Zooplankton diversity in River Ganga in Patna Zone

Anuradha Singh[1], Prof. Sunita Kumari Sharma[2]
[1]*Research Scholar P.G Department of Zoology, Veer Kunwar Singh University, Ara*
[2]*Professor P.G Department of Zoology, Maharaja College Ara.*

***Abstract*—The Ganga Riverine System is a vital ecological hotspot that supports diverse habitats and sustains numerous species including zooplankton communities crucial for the ecosystem's functioning. However rapid urbanization industrialization and agricultural activities have led to substantial anthropogenic impact on this ecosystem, raising concerns about its ecological integrity and biodiversity. An investigation was led from July 2024 to December 2024 to examine variation in zooplankton with the physicochemical profile of River Ganga from Digha ghat to Gay ghat. Observations showed that during summer season water temperature, total alkalinity, hardness & chloride were observed more during summer season followed by raining season. There were 4 major group of zooplankton recorded in the selected sampling zones: - Cladocera (5 Genera) Copepoda(4Genera), Protozoa (3 Genera) & Rotifera(3 Genera). The density of zooplankton was more distinguished throughout the colder time followed by rainy season. Zooplankton density showed a positive relationship with pH, dissolved oxygen, nitrate and sulphur however a negative relationship with water temperature, chloride, total alkalinity and hardness. Moreover, habitat degradation, fragmentation and loss were observed, primarily associated with land use changes, urban expansion and agricultural intensification.**

***Index Terms*—Biodiversity, Cladocera, Copepoda, Rotifera, Zooplankton.**

I. INTRODUCTION

Zooplankton are the primary consumers of aquatic ecosystem. Zooplankton are the plankton consisting of small animals and the immature stages of larger animals. Zooplankton play an important role in food chain and also evaluates the ecological status of water bodies. Zooplankton are the bio- indicators of pollution and water quality. Present study reveals research on Zooplankton in Patna. Zooplankton are affected by many environmental factors such as pH, temperature, salinity; oxygen etc. Zooplankton play important role on food chain, energy transfer between primary and tertiary trophic levels. Due to their large densities they are being used as the indicator organisms of physical, chemical and biological process of aquatic system[1]. The orders of Zooplankton taken into consideration are Rotifera, Copepoda, Cladocera. Rotiferans are transparent, generally oval in shape and non-motile. Copepods have a segmented body and swim with their first antennae and frontal structures on its body, while Cladocerans have a distinctly visible compound eye, swim using second pair of antennae and migrate to surface at night[2].

II. MATERIALS AND METHODS

(i) Physico-chemical analysis of water: Two litres of water sample from Ganga River were taken in plastic containers. The physico-chemical parameters were measured using the protocol mentioned in APHA (1985). Turbidity was measured using a turbidometor. pH was measured with pH meter. Conductivity, salinity and TDS were measured with the help of multitester of EUTECH make. Calcium and hardness of water samples were detected by the EDTA titrometric method. Magnesium was calculated by subtracting Calcium from the total hardness, Nitrate was determined using Vernier Nitrate Ion selective electrode (ISE). Chloride was estimated by titrating the given sample with Silver Nitrate solution. Bicarbonate was calculated in the sample by the Sulphuric acid titrometric method[3].

(ii) Zooplankton diversity**:** Water samples from both the station were collected during early hours of the day (7am to 9am) on fortnightly

basis for the duration of six months i.e. July to December 2024. Water samples were collected with the help of Plankton net (having mesh size 77mesh per cm and net ring diameter 28cm), and a Borosil bottle of 15mI capacity was attached to the net. At first, the plankton-net was pulled through water horizontally for 4-5m (horizontal tow) such that less than half the diameter of ring was above water. This was followed by vertical tow which was about 2mm deep. The water sample containing Zooplankton got collected in the Borosil bottle attached to the plankton net. The water sample collected in the planktonic net bottle was transferred to air-tight, wide mouthed plastic storage bottles. To this, 4% formalin was added for fixation and preservation. The bottles were then kept safely at cool and dry place (temperature < 25°C). Stereoscopic microscope and Olympus FX 100 microscope were used to observe plankton and standard keys were used for identification. Sedgewick rafter was used for cell counting. The zooplankton density was quantified by Drop Count Methodology [4].

(iii) Results and Discussion

The Indian freshwater rivers usually carry contaminated water because of heavy pollution and industrial poisons that currently threaten the life once nurtured by these rivers. Hydrological parameters analyzed from the Ganga River, Patna showed spatial and temporal variations. The observed values of 262.4±10.7mg/L of total alkalinity and 318.8±11.52 mg/L of hardness were exceeding the standards. The water temperature was more in July and less in December due to depth of the river body (Table 1). Observed range of water temperature of 18.72-34.890C is suitable for culture of major carps. The lowest temperature is due to strong breeze and the highest value could be attributed to high solar radiation.[5] Increase in water temperature decreases the dissolved oxygen in water.[6] pH of water remained alkaline throughout the study period due to presence of carbonate and bicarbonate originating from the alkaline earth metals. pH of water was lowest during July and highest was on December (Table 1). pH ranged from 7.85 to 8.20 is good for fish life. Our results on pH of water is in close conformity with earlier finding.[7] Aquatic organisms are affected by pH of water because most of their metabolic activities are pH dependent [8.] Dissolved oxygen of water 5.0mg/L is desirable for good growth of fauna and flora. The low dissolved oxygen of water in July were possibly due to the lower oxygen holding capacity of water at high temperature and increase in its assimilation for biodegradable organic matter by microorganism. These results on dissolved oxygen of water supported the earlier finding. It has been explained that at low level of dissolved oxygen of water, decomposition of organic matters started.[9] Water temperature had a negative significant relationship with pH, dissolved oxygen however positive significant relationship with total alkalinity, hardness, chloride, nitrate and sulfate. pH and dissolve oxygen of water showed significant negative relationship with total alkalinity, hardness and chloride (Table 2).

Table 1: Physicochemical parameters of water of Ganga River, Patna 2024 (July to Dec)

WT (^{0}C)	pH	DO (mg/L)	TA (mg/L)	T H (mg/L)	Cl^- (mg/L)	NO_3^- (mg/L)	SO_4^{-2} (mg/L)
July 34.89±3.50	7.02±0.75	5.92±0.54	275.5±23.7	333.5±23.29	223.83±12.18	21.23±1.16	140.4±7.51
Aug 25.94±5.55	7.28±0.44	7.02±0.58	264.8±29.8	322.8±25.53	211.13±13.31	23.07±1.78	148.8±3.75
To Sept							
Oct - 18.72±4.74	7.21±1.03	7.53±0.43	259.4±31.0	317.1±27.57	208.57±11.82	21.10±1.19	134.9±5.65
Nov							
Dec 9.39±4.80	7.41±0.70	8.30±0.58	249.8±43.0	301.6±22.87	197.73±12.66	20.03±1.33	124.2±2.20
Average 22.23±9.37	7.23±0.14	7.19±0.86	262.4±10.7	318.8±11.52	210.32±9.28	21.36±1.09	137.08±8.93

Table 2: Correlation-coefficient of physicochemical parameters of water of Ganga River, Patna 2024 (July to Dec)

WT (^{0}C) pH DO (mg/L) TA (mg/L) T H (mg/L) Cl^- (mg/L) NO_3^- (mg/L) SO_4^{-2} (mg/L)

WT (^{0}C))	1.0	-0.893	-0.992	0.997	0.991	0.982	0.554[4]	0.772
pH		1.0	0.926	-0.924	-0.916	-0.961	-0.197	-0.481
DO (mg/L)			1.0	-0.998	-0.979	-0.992	-0.447	-0.690
TA (mg/L)				1.0	0.991	0.994	0.491	0.727
TH (mg/L)					1.0	0.985	0.561	0.784
Chloride (mg/L)		1.0					0.414	0.668
Nitrate (mg/L)							1.0	0.953
Sulfate (mg/L)							1.0	

Maximum values of total alkalinity of water in July might be due to increased photosynthesis leading to greater use of carbon dioxide, disposal of dead bodies of animals and urban discharge through open drains in the river. The highest total alkalinity of water during summer and the lowest during winter has also been reported earlier.[7] Total alkalinity of water was related with the fluctuations in the photosynthesis of phytoplankton. Water with alkalinity greater than 100 mg/L is productive and ideal for fish culture.[10] In this work, total alkalinity of water was found in the range of 249.8-275.5mg/L. Total alkalinity and hardness of water also showed significant positive relationships to chloride (Table 2). Chloride of water showed decline from July to December has also recorded earlier.[11] But, chloride level of water more than 100mg/L (192.34 to 228.65mg/L in this work) can burn the edges of the gills of fishes. Nitrate and sulfate of water was highest during the monsoon season. High value of nitrate during monsoon is due to the excessive entry of water from agricultural fields, decayed vegetable, animal matter etc. The high nitrate detected in the river can be attributed to the use of fertilizers, which leached and eroded in river bodies. Such findings on nitrate and sulfate of water were also reported.[12]

Table 3: Seasonal variation of zooplankton density (ind/m^3) of Ganga River, Patna 2024 (July to Dec)

Group	No. of genera	Representatives and their density	July	Aug - Sept Nov		Dec	Total
Protozoa	3	*Amoeba (37), Arcella (51),*	77	55	43	50	225
		Diffulgia (50), Vorticella (45)					
		and Paramaecium (42)					
Rotifera	3	*Asplanchna (51), Brachionus*	85	74	170	213	542
		(223), Cephlodella (52)					
		, Keratella(92) Lecane (68)					
		and Testudinella (56),					
Cladocera	5	*Bosmina (84), Chydorus (83),*	101	67	53	64	285
		Daphnia (44), Daphniosoma					
		(38) and Monia (36)					
Copepoda	4	*Heliodiaptomous (44),*	52	37	32	46	167
		Mesocyclops (35), Nauplius					
		(42) and Thermocyclops (46)					

Zooplankton is one of the most important biotic components influencing food chains, energy flow and cycling of matter of aquatic ecosystems because of its role of secondary consumer. An aggregate of 15 genera of zooplankton comprising 3 Rotifera, 5 of Protozoa, 5 of Cladocera, 4 of Copepods were

identified from the Ganga River (Table 3). These results were similar to earlier observation.[13] A total of 21 genera of zooplankton belonging to 5 major groups *viz.* Protozoa (7), Cladocera (5), Copepod (1), Rotifera (7) and Ostracod (1) have been reported from Tons River in Dehradun.[14] Earlier, out of 46 genera of zooplankton, 19 rotifera, 6 protozoa, 9 cladocera, 9 copepoda and only 3 Ostracoda was identified at Shershah Suri pond, Bihar, India. Besides, 38 genera of zooplankton having Copepoda with 17, Protozoa and larval forms of animals consisted of 5 genera and Ostracoda with 3 species at River Kali at Karwar, has been reported[15]. Dominancy of rotifers is the indicators of eutrophication and measures taken to minimize the aquatic pollution.[16] In this study also, maximum share in zooplankton composition was shown by Rotifers (43.60%) followed by Cladoceran (31.11%), Copepods (22.93), Protozoan (18.10) . Among these groups of zooplankton, Cladoceran and Copepods can be used as indicator of freshwater aquatic environments.[17] Abundance and dominance of rotifera is reported in several water bodies.[18,19] This pattern is common in many fresh water bodies like lakes, ponds, reservoirs, rivers or streams.[20]

Table 4: Correlation-coefficient of physicochemical parameters of water and zooplankton of Ganga River, Patna 2024 (July to Dec)

	WT (^{0}C)	pH	DO (mg/L)	TA (mg/L)	TH (mg/L)	Cl^- (mg/L)	NO_3(mg/L)	SO_4^{-2}(mg/L)
Protozoa	-0.817	-0.837	-0.854	0.819	0.834	0.817	0.124	0.356
Rotifera	-0.260	-0.347	-0.360	0.298	0.167	0.314	-0.497	-0.316
Cladocera	-0.870	-0.831	-0.827	0.888	0.896	0.883	0.041	0.280
Copepoda	-0.316	-0.327	-0.423	0.342	0.210	0.341	-0.371	-0.207

On quantitative share basis, species of *Arcella* (20%), *Diffulgia* (19.6%) and *Vorticella* (17.65%) were the most abundant among Protozoa. Among Rotifera, species of *Brachionus* (41.14%), *Keratella* (16.97%), *Lecane* (12.55%) and *Testudinella* (10.33%) were abundant. Abundance of *Brachionus* in freshwater water bodies is perhaps depend on physical and chemical nature of water.[21] Species of *Bosmina* (29.47%), *Monia* (29.12%), *Daphnia* (15.44%), *Diaphanosoma* (13.33%) were abundant among Cladocera. It has been reported that the density of Cladocera is determined by food supply as they are abundant when food supply to the water body is adequate.[22] *Thermocyclops* sp. (27.54%) among Copepoda. Abundance of species of *Vorticella, Brachionus, Keratella, Bosmina, Daphnia, Diapanosoma* and *Moina* were also reported also in Tons river at Dehradun.[14] *Bosmina sp* with 46.15 % in Chhariganga Oxbow Lake derived from the River Ganga in Nadia, WB has been reported.[23] These observations also resembles the earlier reports.[23] . In this study, the density of zooplankton showed temporal variation. The abundance of zooplankton is used to determine the conditions of aquatic environment. The numerical density of zooplankton fluctuated from 32 to 213 ind./L (Table 3). In a study, it was reported that numerical density of 12 taxa of zooplankton at Vasishti estuary was 10845/100m^3 to 23308/100m[24]. The maximum density of zooplankton was recorded during summer and minimum during post-monsoon. While analyzing seasonal dynamics of Rotifers in relation to physico-chemical conditions of River Yamuna made similar observations in increased densities of zooplanktons in summers and reduced densities in winters.[25] The highest count of Rotifers was recorded in the north-east monsoon season followed by winter and summer season at Yadigir, Karnataka.[26] According to an earlier report Ostracods and Protozoan was of maximum in summer months and minimum in monsoon months.[27] More numerical density of zooplankton more during summer and lowest during winter months was also reported.[28] Regular flash out of water, rain fall and perhaps cloudy sky during the monsoon seems a major cause of less plankton diversity because zooplankton prefer either the steady or the low water current.[29] The present study seems to resemble with these observations. The distribution of

zooplankton community depends on a complex of factors such as change of climatic conditions, physical and chemical parameters such as water temperature, pH, dissolved oxygen and nitrate.[30] In the present study, abundance and distribution of zooplankton was found to dependent on physical and chemical parameters of water at given point of time. Increase in water temperature can impact aquatic biodiversity, biological productivity, and the cycling of contaminants through the ecosystem. The density of zooplankton was found negatively correlated with water temperature, pH, dissolved oxygen, nitrate and sulfate. But, density of zooplankton was positively correlated with total alkalinity, hardness and chloride (Table 4).[31] However, a positive correlation between water temperature and zooplankton has also been reported.[32] The high zooplankton density of this river might be due to relatively stable environmental conditions like temperature and good standing crop of phytoplankton prevailing in that region.

Table 5 : Biodiversity indices of Zooplankton of Ganga River, Patna 2024 (July to Dec)

Phylum/ Group	Shannon-Weinner Index	Pielou Evenness Index	Simpson Dominance Index	Simpson Diversity	Simpson Reciprocal	Menhninick's Index	Margalef Richness Index
Protozoa	1.063	0.996	0.203	0.797	4.935	2.236	2.486
Rotifera	1.767	0.908	0.231	0.769	2.769	2.645	3.083
Cladocera	1.538	0.956	0.229	0.771	4.362	2.236	2.484
Copepoda	1.381	0.996	0.253	0.747	3.961	2.000	2.165

The value of Shannon Weinner index in the present observation (x of H' =1.473, range=1.063 to 1.767) showed heavy to moderately polluted water of the Ganga River. This means that H' of a maximum value of exp (2.4) has an equivalent diversity as a community with maximum of 4 equally- common species. Further, Margalef's richness index (x of d'= 2.407, range=2.165 to 3.083) also showed high diversity of this river. The value of d' is strongly dependent on sampling and highlighted genera/species richness of 2 to 3 genera/species. The values of H'from 0.44 to 3.4 and d'from 0.35 to 2.09 at Mumbai harbour.The maximum values of H' and d' were also calculated at Dhaula and Baigul.[33] Pielou evenness index (J') permits considerable refinement in diversity studies. The value of 0.908 to 0.996 of this index observed in this work showed similarities with earlier reports. The observation indicated moderate diversity and very even abundance of genera. Simpson indices take into account the representativeness of the species with the highest value of importance. Therefore, present observation (D'=0.653 to 0.797) showed moderate diversity with mature communities. Simpson dominance index (1-D') Its value of 0.203 to 0.253 observed in this work showed similarities and indicates moderate diversity. The value of The Simpson reciprocal index (1/D') of 2.769 to 4.935 shows conformity with the number of genera (3 to 5) observed in this study. An average of Margalef's Richness of 5, Pielou Evenness of 0.90, Shannon-Weiner Index of 1.42, Simpson diversity Index of 0.72 and Simpson dominance Index of 0.28 of different zooplankton species were observed in a River Ganga derived Chhariganga Oxbow Lake at West Bengal.[23] Thus, the present work corroborates the earlier findings. Margalef (d') and Menhninick's (M_d) Index richness provide an understandable and instantaneous expression of diversity. The Menhninick's Index is used for comparison of samples of different sizes. Earlier, it has been reported this index from 0.870 to 0.942 at Ramesar. A range of 1.732 to 2.645 of this work featured high diversity.[34] The mean values of H' > 2 and D' > 0.9 indicates the healthy diversity of the ecosystem.[35] Therefore, present work indicates some unhealthy diversity of zooplankton in this water body.

III. CONCLUSIONS

Depending on the limnological parameters, it may be concluded that the Ganga River, Patna seem to be suitable for fish culture because of physical and chemical parameters and type of zooplankton. The composition and biomass of zooplankton were evenly distributed and the physical and chemical parameters are of suitable range. The number of zooplankton was highest during July and lowest during post-

monsoon. The study indicates that temperature has an important role in the distribution of zooplankton in a freshwater habitat. The biodiversity indices indicated a moderate diversity of zooplankton, productive and moderately polluted condition of the Ganga River at Patna. The results depict that more monitoring of all the parameters is necessary.

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REFERENCES

[1] Meena K and Dube P. A Critical review of zooplankton studies of lentic water bodiesof India. International journal of environmental sciences. (2018) Vol. 7.No. Pp 79-83.
[2] Yasmin S, Kumari S, Sharon V, Rani K. Study of Zooplanton diversity in managed and unmanaged pond of Patna. Journal for young scientist (2016).
[3] Rani K. Comparative assessment of Zooplankton diversity in fresh water lentic ecosystem of Patna Bihar India. International Journal of fauna & Biological Studies (2023).
[4] SPandit D.N, Kumari P, Sharma S. K. Ecology an diversity of zooplankton of the river Ganga at Bihar, India in relation to water quality Current world environment 2020; 15(2).
[5] Santhanam P, Perumal P. Diversity of zooplankton in Parangipettai coastal water, southeast coast of India. J Mar Boil Ass India. 2003; 45(2):144–151.
[6] Perlman H. Water Density. In The USGS Water Science School. Retrieved from http:// ga.water.usgs.gov/edu/density.html. 2013.
[7] Ghosh B.B. Physicochemical analysis of pond water in Purba Barddhaman, West Bengal, India. Res J Environmental Sci. 2018; 7(2):54-59.
[8] Balakrishna D, Reddy T. R, Reddy K. V, Samatha D. Physico-Chemical Parameters and Plankton Diversity of Ghanpur Lake, Warangal, A.P. India. Inter J Zoo Res. 2013; 3: 44-48.
[9] Mahobe H, Mishra P. Study of Physico-Chemical Characteristics of Water Ponds of Rajnandgaon Town, Chhattisgarh. Internat J Sci Eng Res. 2013; 4(8):738-748.
[10] Alikunhi K. H. Fish culture in India. Bull Indian Council Agr Res. 1957; 20:1-150.
[11] Arya S, Kumar V, Raikwar M, Dhaka A. Physico-chemical Analysis of Selected Surface Water Samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India. J Exp Sci. 2011; 2(8):01-06.
[12] Kadam M. S, Nanware, Ambhore. Physicochemical status of water in Asana River, District Nanded. J Comp Toxical Physio. 2005; 2(I & II):13-17.
[13] Bhavan PS, Selvi A, Manickam N, Srinivasan V, Santhanam P, Vijayan P. Diversity of zooplankton in a perennial Lake at Sulur, Coimbatore, India. Internat J Edu Res. 2015; 5:31–44.
[14] Negi R. K., Mamgain S. Zooplankton Diversity of Tons River of Utarakhand State India. Internat J Zool Res. 2013; 3(2): 1-8.
[15] Shaikh N, Rathod J. L, Durgekar R. Zooplankton diversity in river Kali, Karwar, West coast of India. Internat J Engineer Develop Res. 2017; 5(3):495-500.
[16] Manickam N, Bhavan P. S, Santhanam P, Muralisankar T, Srinivasan V, Vijayadevan K, Bhuvaneswari R. Biodiversity of freshwater zooplankton and physico-chemical parameters of Barur Lake, Krishnagiri District, Tamil Nadu, India. Malaya J Biosci. 2015; 2(1):1–12.
[17] Saldeek V. Rotifers as indicators of water quality. Hydrobiologia. 1983; 100:167-201.
[18] Nogueira, M.G. Zooplankton composition dominance and abundance as indicators of environmental compartmentalization in Jaramirim Reservoir (Paranapanema River), Sao Paulo, Brazil. Hydrobiologia. 2001; 455:1-18.
[19] Kudari V.A., Kadadevaru G.G., Kanamadi D. Zooplankton composition in some ponds of Haveri District, Karnataka. Zoo's print. 2005 20 (12): 2094-2099.
[20] Neves I.F, Rocha O, Roch K.F. Pinto A.A. Zooplankton community structure of two marginal lakes of the River Cauba (Mato Grasso, Brazil) with analysis of rotifera and cladocera diversity. Brazil J Biol. 2003; 63 (3):329-343.
[21] Hutchinson G.E. A treatise on Limnology Limnoplancton. Wiley, New York. 1015, 1967.
[22] Singh S. P, Pathak D, Singh R. Hydrobiological studies of two ponds of Satna (M.P), India. Eco. Environ. Cons. 2002; 8:289-292.
[23] Ghosh D and Biswas J. K. Zooplankton Diversity Indices: Assessment of an Ox-Bow Lake Ecosystem for Sustainable Management in West Bengal. Internat J Adv Biotech Res. 2015; 16(1): 37-43.
[24] Nair N. B, Kumar K. K, Arunachalam M, Azis P. A, Dharmaraj K. Ecology of Indian estuaries:

Studies on the zooplankton ecology of Kadinamkulam Backwater. Proc Ani Sci. 1998; 93(6):573-584.
[25] Arora J, Mehra N. Seasonal dynamics of Rotifers to physical and chemical conditions of river Yamuna (Delhi), India. Hydrobiologia. 2003; 491:101-109.
[26] Basawarajeshwari I, Reddy R, Vijaykumar K. Zooplankton diversity in freshwater reservoir of Yadigir district, Karnataka state. Internat J Cur Innovat Res. 2015; 1(1):19-22.
[27] Mahor R. K. Diversity and seasonal fluctuation of zooplankton in fresh water reservoir Tighra Gwalior (M.P). Internat Res J. 2011; 2(19):24-25.
[28] Sadasivan S, Gurjar U. R, Shukla S. P, Jaiswar A. K, Shenoy L, Dshmukhe G. Zooplankton abundance and its seasonal distribution in Patalganga estuary, Maharashtra, India. J Ento Zoo Studies. 2019; 7(1): 1156-1160; 20 (12): 2094-2099.
[29] Bonner L. A., Walter W. J., Altiz R. Physical, hemical and biologicaldynamics of five temporary dystrophic forest pools in central Mississippi. Hydrobiologia, 1997; 357:77 – 89.
[30] Mahar M. A, Baloch W. A, Jafri S. I. H. Diversity and seasonal occurrence of planktonic rotifers in Manchharlake, Sindh, Pakistan. Pak J. Fisheries. 2000; 1(1):25–32.
[31] Sen S, Paul M. K, Borah M. Study of some Physico-Chemical Parameters of Pond and River water with reference to Correlation Study. Internat J ChemTech Res. 2011; 3(4):1802-1807.
[32] Varadharajan D, Soundarapandian P. Distribution and Abundance of Zooplankton along Tamil Nadu Coastal Water, India. Ecosys Ecograph. 2013; 3(4):1-4.
[33] Gholap A. B. Species diversity indices of zooplankton from Sadatpur reservoir, Ahmednagar, Maharashtra. Annals Biol Res. 2014; 5(4): 58-61.
[34] Davari N, Jouri M. H, Ariapour Ah Comparison of Measurement Indices of Diversity, Richness, Dominance and Evenness in Rangeland Ecosystem (Case Study: Jvaherdeh -Ramesar). J Rangeland Sci. 2011; 2:389-398.
[35] Srichandan S, Panda C. R, Rout N. C. Seasonal distribution of zooplankton in Mahanadi Estuary (Odisha), East Coast of India: A Taxonomical Approach. Internat J Zool Res. 2012; 9:17-31.