FLORA AND FAUNA DOI:10.33451/florafauna.v23i1pp155-164
2017 Vol. 23 No. 1 PP 155-164 ISSN 0971 - 6920

POPULATION KINETICS AND SEASONAL FLUCTUATION OF ZOOPLANKTON OF DAH-REOTI (BALLIA)- AN OX- BOW LAKE

***A. K. JHA AND S. R. SINGH**

P. G. Department of Zoology,
S.M.M. Town (P. G.) College,
BALLIA (U. P.) 277001- INDIA
*Corresponding Author
Email : ashu_jha29@yahoo.co.in

Received : 15.03.2017; ***Revised*** : 14.04.2017; ***Accepted*** : 03.05.2017

ABSTRACT

The paper deals with the composition and seasonal variation of different groups of zooplankton as related to physico-chemical variables of water of an ox-bow lake - Dah Reoti, Ballia (U.P.) India. It was observed that Rotifera, copepoda and cladocera encountered in order of abundance (Rotifera>copepoda>cladocera) constituted the major groups of zooplankton. Protozoans and insect larvae were observed in negligible number hence not considered in the present study. Overall winter season provided the most propitious conditions for seasonal abundance (50.80%) probably owing to rich nutrient supply. Period from mid summer to mid monsoon was noticed tough period for zooplankton population owing to high silt load from tributary streamlets, fast wind action and increased pollution load.

Figure : 00 References : 21 Tables : 07
KEY WORDS : Ballia, Fluctutation, Ox-Bowlake, Water quality, Zooplankton,

Introduction

Zooplanktons are heterogenous assemblage of minute floating animal forms which constitute a major link in the energy transfer at secondary level in aquatic biotopes. They occupy an intermediate position in the aquatic food webs between autotroph and macroinvertebrates which in turn serve as food to fishes and aquatic birds. Zooplanktons are also effective tools in environmental biomonitoring of aquatic systems as they quickly respond to changes in water quality. Rotifera are the most sensitive bioindicators of water quality and their presence may be used as a reference to the quality of water. Zooplanktons are reported to accumulate chemicals through food intake and direct absorption of chemicals from water. A knowledge of their composition, abundance and seasonal variation is, therefore, an essential prerequisite for any successful aquaculture programme.

The present communication which is a part of an exhaustive ecological survey of an ox-bow lake Dah Reoti - deals with the population, structure and seasonal fluctuation of zooplankton community. The detailed morphometry of the lake, its water quality and the composition and seasonal fluctuation of phytoplankton have been described[8,9].

Material and Methods

Plankton and water samples were collected from 8 fixed stations between 8 A.M. to 11 A.M. at monthly interval during the period from October'04 to September'06. The methods for estimation of physico-chemical factors of water and the collection, preservation and enumeration of plankton have been described[8,9].

For the sake of convenience, the discussion revolves around overall monthly and yearly averages of the various physico-chemical variables of water as also the various groups of zooplankton.

Observation

Zooplankton formed only a mearge

TABLE-1 : Seasonal composition of Zooplankton Period : October 2004 to September 2006

Period	Cladocera (u/l)	Rotifera (u/l)	Copepoda (u/l)	Total (u/l)	Percentage of total Zooplankton
Winter (Nov.-Feb.)	174 (38.49)	1473 (60.0)	824 (42.10)	2471	50.8
Summer (Mar.-June)	126 (27.88)	441 (17.96)	564 (28.82)	1131	23.25
Monsoon (Jul.-Oct.)	152 (33.63)	541 (22.04)	569 (29.8)	1262	25.95
Yearly Total	452	2455	1957	4864	
Yearly Percentage	9.3	50.47	40.23		

Values given in parenthesis reflect percentage of seasonal abundance of different groups of zooplankton

percentage (4.26%) of the total plankton production of the lake. Its population during different months of the year, variated between 88u/l (June) and 941 u/l (December). They exhibited two pulses - a major in December and a minor one in April. The zooplankton population was comprised of mainly Rotifera, Copepoda and Cladocera in order of abundance. Protozoans and aquatic insects appeared in negligible number, hence have not been considered in the present study.

Rotifera

Rotifera formed the most important group contributing more than half (50.47%) of the zooplankton population (Table-1). They exhibited stunted population during hot summer months and early monsoon period. Their numerical increase was noticed from August onward till reaching the peak value in December/January. The population remained almost constant till February but in the following months they started dwindling touching the lowest ebb during hottest months of the year.

The species of *Brachionus, Keratella, Monostyla* and *Lecane* were dominant forms forming the bulk of rotifer population (Table-3).

Copepoda

With a contribution of 40.23%, the copepods stood only next to rotifers in the zooplankton population (Table-1).

The copepods showed bimodal pattern of flucuation exhibiting major pulse in December and a minor one in April. Both the peaks were followed by sharp falls. The months of February, May and June were observed tough period for copepods (Table-4).

The copepoda were represented by calanoid form *Phyllodiaptomus blanci* and the cyclopoid form *Mesocyclop*. The larval stages could not be identified seperately and were considered as a group only. The larval forms were permanent components of copepod population throughout the period of study and their maxima coincided with those of the adults.

Cladocera

The cladocerans exhibited an irregular pattern of fluctuation in the lake water. They were recorded in moderate number throughout the year and over all shared only 9.3% of the total zooplankton population (Table-1).

TABLE-2 : List of Zooplanktons encountered in the lake Dah-Reoti.

Rotifera	Copepoda
Brachionus angularis	*Mesocylop leuckarti*
B. forficula	*Phyllodiaptomus blanci*
B. caudatus	
B. calvciflorusk	
Keratella tropica	**Cladocera**
K. Prockurva	*Chydorus spaericus*
Monostyla sp.	*Ceriodaphia cormuta*
Lecane stichaea	*Dephnia lumholtzi*
L. hamata	*Sida crystallina*
L. closterocerca	*Simocephalus* sp.

Chydorus spaericus and *Ceriodaphnia cornuta* were the principal species occurring almost throughout the year. The other forms were scanty in number, low in percentage and were not even encountered throughout the year.

Zooplankton encountered in Dah-Reoti (Table-2) and the monthly variation in physico-chemical variables (Tables-5 & 6). The correlation coefficients for zooplankton (Table-7) are described.

Discussion

The dominance of rotifers both in forms and density was observed in the present study in accordance with the findings[1,8,11,14-18,21].

Contradictory statements exist on record dealing with the periodicity of rotifers. The periodicity of rotifers is greatly influenced by temperature[3]. Workers[6,13] have observed summer periodicity of rotifers where as other has reported peak population of rotifers during colder months of the year[18]. In the present study, though the early summer months were accompanied with considerable number of rotifers but they exhibited distinctive preference for colder months producing 60.0% of the yearly total of rotifer population during this season (Table-1). It appears that in a set of environmental conditions, temperature is generally not a limiting factor for the population growth of rotifers. A few rotifer species are strictly stenothermal, majority of them are eurythermal and can withstand wide thermal variations[16].

The rotifers provided with well developed lorica (*Brachionus* and *Keratella*) have been reported[11] to attain their peaks during summer months accompanied with high total alkalinity and temperature conditions. Contrary to this, the loricate forms in the present study which formed the bulk of rotifer population exhibited close affinity for low temperature though the values for alkalinity was reasonably high. The cause of survival and denser rotifer population to dissolved oxygen rather than temperature was reported[2]. In the present study, although the peak period of rotifers coincided with higher values of dissolved oxygen but it is difficult to believe that this factor alone could have caused the abundance of rotifers as the postmonsoon period, in spite of, being accompanied with high dissolved oxygen failed to bring a similar result. It

TABLE-3 : Important genera and their number/percentage contribution in the respective groups Period: Oct. 04 to Sept. 06

Planktonic group/ Genera	Yearly Total (u/l)	Percentage composition in Zooplankton	Percentage composition in the groups.
Rotifera	**203.5**	**50.55**	**-**
Brachionus spp	120.5	-	59.22
Keratella spp	60	-	29.48
Others	23	-	11.3
Copepoda	**161**	**40**	**-**
Mesocyclop sp	73.5	-	45.65
Phyllodiaptomus sp	17	-	10.56
Larval stages	70.5	-	43.79
Cladocera	**38**	**9.44**	**-**
Ceriodaphnia sp	9	-	23.7
Chydorus sp	11.5	-	30.26
Others	17.5	-	46.04

was observed that many rotifer species exhibiting maxima at the zones of even extremely diverse and unstable temperature and oxygen conditions[7].

Serveral workers have discussed the seasonal distribution of copepods[10-11,18-20].

The copepods in Dah-Reoti though showed minor pulses in the months of April and September but it recorded the major pulse in December. Entomologists[13,18] also have also observed major pulse of copepods in winter months though others have opined that the temperature is the controlling factor in the seasonal periodicity of copepods[4,5]. The indifferent behaviour of copepods to temperature observed in the present study is indicative of the fact that they are able to withstand wide thermal variations and various other physico-chemical variables of water as also the nutritional conditions might be responsible for copepod abundance.

The larval stages of copepods represented by *Naupliius* occurred significantly in the lake water

TABLE-4 : Monthly variation of different groups of Zooplankton (number / litre) Monthly averages for the period Oct. 04 to Sept.06

Months	Cladocera	Copepoda	Rotifera
Oct.	39 (8.64)	134(6.85)	195 (7.94)
Nov.	43 (9.51)	129 (6.59)	239 (9.73)
Dec.	48 (10.62)	469 (23.97)	424 (17.27)
Jan.	40 (8.85)	180 (9.20)	416 (16.94)
Feb.	43 (9.51)	46 (2.35)	394 (16.04)
Mar.	51 (11.28)	154 (7.87)	249(10.14)
April	51 (11.28)	312 (15.94)	114 (4.64)
May	12 (2.65)	65 (3.33)	35 (1.43)
June	12 (2.65)	33 (1.69)	45 (1.75)
July	24 (5.32)	57 (2.90)	60 (2.45)
Aug.	35 (7.74)	163 (8.33)	101 (4.12)
Sep.	54 (11.95)	215 (10.98)	185 (7.55)
Total	452	1957	2455

and their peaks coincided with the peaks of adults. Such coincidence of abundance of larval forms and the adults both at the same time might have occurred due to large hatch of the eggs from the sacs of females[12].

The cladocerans observed in moderate number throught out the year, failed to respond to changes operationg in the physico-chemical complexes of the lake water.

Table-1 reflects the seasonal population of different groups of zooplankton. The winter season (November to February) characterised in this region by clear but shorter days, lower intensity of sunlight, dry atmosphere and occasional rainfall supported more than half (50.80%) of the zooplankton. The summer (March-June) known for high atmospheric temperature, bright sunshine, longer days, dry air and fast winds exhibited the thinnest population of zooplankton where as the monsoon (July-October) accompanied with heavy rains, moderately high temperature, humid atmosphere, longer and cloudy days and frequent fast winds showed reasonably high density (25.95%) of zooplankton.

It appears apparently that the causative factor

TABLE - 5 : Seasonal Variations in physico-chemical conditions of water Period : October'04 to September'06

	Two Years Monthly Average Values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.
Depth (cm)	184.5	176.5	150.5	134.25	128.5	115.25	92.25	103.25	96.273	146	223	188.25
Transparency (cm)	81.5	88.25	97.95	119.5	108.5	99.75	85.5	72.5	65	60	52.75	72.5
Water Temperature (°C)	28.76	24.33	19.45	17.75	19.78	24.4	26.3	30.33	30.45	29.03	29.45	30
pH	8.81	8.67	8.6	8.27	8.89	8.8	8.48	8.47	8.4	8.5	8.2	7.95
Dissolved oxygen (mg/l)	12.9	10.14	8.2	9.82	9.95	9.1	7.97	8.03	8.98	11.88	11.75	12.33
Free Co_2 (mg/l)	0	0	0	0	0	3.95	2.85	11.98	10.3	8.28	8.25	7.68
Total Alkalinity (mg/l)	108.3	88.3	95.8	92.81	91.09	102.85	95.75	125	121	111	129.45	97.88
BOD (mg/l)	6.47	5.98	4.75	3.85	5.6	7.6	10.67	18.85	16.23	25.7	23.4	7.55
COD (mg/l)	18.7	12.7	11.05	11.2	9.9	13.7	15.5	14.5	20	20	19.2	19

160

TABLE - 6 : Variation in water quality of the lake (mean, standard deviation, standard error and coefficient of variation. Period: October' 04 to September'06

Factors	Units	Minimum	Maximum	Mean (x)	Standard Deviation s	Standard error	Coefficient of Variation (%)
Depth cm	76	224	144.88	40.66	8.3	28.06	
Transparency	cm	50	120	83.6	18.36	3.84	21.96
Water Temperature	**O**C	17	31	25.84	4.65	0.95	17.99
pH -	7.57	9.62	8.51	0.53	0.11	6.23	
Dissolved oxygen	mg/l	7.65	13.15	10.11	1.75	0.36	17.31
Free CO_2	mg/l	0	15.9	4.44	4.9	1	110.36
Alkalinity	mg/l	63.5	133.92	105.09	17.96	3.67	17.09
BODmg/l	3.4	19.85	9.35	4.99	1.02	53.37	
CODmg/l	8.4	25.2	15.45	5.19	1.06	33.59	

involved in poor density of zooplankters during the period from mid summer to mid monsoon is possibly due to high turbidity (Table-5) caused by silt load of tributary streamlets and to the summer-rain storms which resuspend the bottom deposits. Dah-Reoti is a shallow and open sheet of water liable to fast wind action causing stirring of the water columns and checking settling of the suspended particles. The suspended particles absorb a considerable amount of nutrient elements in their ionic forms making them unavailabe for plankton production. High turbidity caused by silt load also affects movement of many zooplankters.

The lake with reduced water level during this period also receives huge quantity of domestic sewage from Reoti town coupled with sewage from surrounding villages brought into the lake through early monsoon showers. The increased BOD contents might be another probable cause for limiting the population increase of zooplankters.

It appears that probably the nutritional supply did more than any other physico-chemical factor of water (within observed range) in seasonal fluctuation of zooplankters. It is a known fact that all species of phytoplankton do not constitute a direct source of food for zooplankton. The zooplankton are unable to utilize all species of phytoplankton with a diameter or length of cells of more than 20 m as such the entire net plankton including cells or colonies much larger than 20 m can be used by

TABLE - 7 : Correlation coefficient for Zooplankton

Dependent variable	Explainatory Variables	Correlation Coefficient (r)	Standard error of 'r'	Coefficient of determination (r^2)
	Depth	0.153	0.044	0.0234
	Transparency	0.662**	0.026	0.4382
Zooplankton	Water Temperature	0.6447**	0.019	0.4156
	pH	0.0817	0.003	0.6674
	Dissolved oxygen	0.2305	0.0024	0.0531
	Free Co_2	0.6739**	0.021	0.454
	Alkalinity	0.5352***	0.032	0.2864
	BOD	0.7607*	0.026	0.5786
	COD	0.1976	0.002	0.039

* Significant at 0.1% level

** Significant at 1% level

*** Significant at 5% level

zooplankton only after partial destruction, either as bacterial cells or as incompletely broken fragments of plant cells. Nannoplankton algae, bacteria and trypton contributing to the food of zooplankton communities was observed[7].

From increased BOD, the hot summer and early monsoon months might have resulted rich bacterial growth, yet the zooplankters failed to exhibit a richer population density probably owing to high silt and pollution load of the lake water.

During monsoon period the blue green algal form *Microcystis aeruginosa* blooms in the lake climaxing in the late monsoon period enjoying the lion share of the nutrients. However, with the start of winter, there is abrupt fall in the number of this algal form[4] thereby increasing the organic detritus, an important food item for sedimentators. It appears with all probabitity that during winter, when the silt particles settle down and the water becomes almost clear the decomposing organic matter enriches the water in biogenic salts which cause rapid growth of nannoplankton thus providing food for zooplankton and ultimately increasing their population densities.

Relatively poor abundance of cladocerans in the lake water seems to be of complex nature. Perhaps the cladocerans being larger and less mobile, fall easy prey to the fishes.

As stated above the zooplankton population in the lake constitutes even less than 5% of the total plankton. The blue green algal form *Microcystis aeruginosa* and the dinoflagellate *Ceratium hirundinella* which together contribute more than 90% of the total phytoplankton, do not form preferential food for the existing herbivorous fish stock of the lake. Naturally, the zooplankters are under heavy grazing pressure of the fishes and ultimately exhibiting thinner population.

References

1. ABDAR, M.R. (2015) Diversity of Zooplanktas in Mornalake, Estern Ghati, Maharastra. *Flora and Fauna* **21** (1) : 45-54.
2. ARORA, H.C. (1966) Responses of Rotifera to variations in some ecological factors. *Proc. Indian. Acad. Sci.* (B) **63** (2) : 57-66.
3. BYARS, J.A. (1960) A fresh water pond in Newzealand *Aust. J. Mar. Erishw. Res*. **2** (2) : 222-240.
4. CHEN, SHOUCHUNG (1965) Seasonal abundance of copepoda in lake Tunghu, Wu-chang, as shown by data obtained in the course of one year. *Acta Hydrobiol. Sin.* **5** (2) : 202-219.
5. GANAPATI, S. V. (1943) An ecological study of a garden pond containing abundant zooplankton. *Proc. Ind. Acad. Sci. (Botany)* **17** (2) : 41-58.
6. GEORGE, M.G. (1961) Diurnal variations in two shallow ponds in Delhi, India, *Hydrobiol*. **18** : 265-273.
7. GLIWICZ, Z. M. (1967) Zooplankton and temperature oxygen conditions of two alpine lakes of the Tatra mountains, *Polsk. Arch. Hydrobiol.* **14** (27) : 53-72.
8. JHA, A.K. AND SINGH, S.R. (2008) On the water quality of an Ox-bow lake Dah-Reoti in relation to fishery. *Ecol. Env& Cons.* **14** (1) : 191-198.
9. JHA, A.K., SINGH, S.P AND SINGH, S.R. (2007) Population Dynamics and seasonal abundance of phytoplankton in an ox-bow lake Dah-Reoti. *J.Appl.Biosc.* **33** (2) : 174-179.
10. MATHEW, P. N. (1972) 'Limnological investigations on the plankton of Gobindgarh lake and its correlation with physico-chemical factors, Primary productivity and fish production' *Ph. D. thesis of Agra Univeristy*.
11. MICHAEL, R. G. (1964) 'Limnological investigations on pond plankton, macrofauna and chemical constituents of water and their bearing on fish production' *Ph. D. Thesis, Univeristy of Calcutta*.

12. OLDEN, M. J. AND J. GREEN (1960) The hydrology and plankton of the river Sokoto. *J. Anim. Ecol.*, **29**(1) : 65-84.

13. PANDEY, B.N., HUSSAIN, S., JHA, A.K. AND SHYAMANAND (2004) Seasoanal fluctuation of zooplanktonic community in relation to certain physico-chemical parameters of river Ramjan of Kishanganj, Bihar. *Nature, Env. & Poll. Tech.* **3** (3) **:** 325-330.

14. PANNAK, R. W. (1955) Comparative limnology of eight Colorado mountian lakes. *Univ. Colo. Stud. Bio*l. **2** : 1-75.

15. PATEL, Y.E., SHAIKH, H.M. AND PATEL, N.G. (2015) Sesonal Variations in density and diversity of Zooplanktas of Waghur dam near Jalgaon (M.s.) India. *Flora and Fauna* **21** (1) : 24-30.

16. PEJLER, B. (1957) Taxaonomical and ecological studies on plankton Rotatoria from Northern Swedish Lapland. *Kungl. Sevenska Vetenskapsakademiens Hand Linger Fjarde Serien Bank.* **6** : Nr. **5** : 1-68.

17. SAHA, G. N., SEHGAL, K. L., MITRA, EVA AND NANDY, A.C. (1971) Studies on the seasonal and diurnal variations in physico-chemical and biological conditions of a perennial fresh water pond. *J. Inland. Fish. Soc. Ind.* **III.** 79-102.

18. SINGH, S. R. (1980) Limnological studies of Suraha lake (Ballia) III Periodicity of zooplankton. *Proc. Nat. Acad. Sci. India.***50** (3) : 198-210.

19. THAKUR, B. (1995) Studies on the hydrobiology of Poonkhud with reference to its fish and fishery potentials. *Ph.D. Thesis, C. C. S. Univeristy, Merrut. (India)***.**

20. TRIPATHI, B. M. (1996) Hydrological studies of Ramgarh lake in relation to plankton production, fish production and fish energetics. *Ph.D. Thesis, Univsresity of Gorakhpur, Gorakhpur, India***.**

21. YADAV, B.S. AND GARDE, R.P. (2016) Study of Zooplankton biodiversity of Chanakpur dam, Nasik District, Maharastra. *Flora and Fauna* **22** (**Special issue**) : 15-17.