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Cyclomorphosis of freshwater rotifers- A study of *Brachionus caudatus*

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Abstract
Cyclomorphosis is a change that occurs seasonally in the dimensions of certain appendages or of the body size in the clone line of a parthogenetically reproducing organism. In the present work cyclomorphosis was examined in species of *Brachionus caudatus*. The zooplankton samples were collected from Tighra Reservoir Gwalior by filtering 50 litres of reservoir water through a plankton collecting net made of bolting nylon cloth. Sampling was done from May 2012 to October 2012 in the last week of every month. The total length observed in the month of May was 0.210mm which decreased to 0.157mm in October. Similarly, the length of lorica was decreased from 0.150 mm to 0.120mm and the width of lorica decreased from 0.135 to 0.105 mm. In this species the cyclomorphosis was greatly controlled by the change in physico-chemical parameters of water particularly due to seasonal change in temperature.

Keywords: Cyclomorphosis, stage micrometer, rotifers, Tighra reservoir, ocular disc, zooplankton, *Brachionus*

1. Introduction
Various freshwater organisms display characteristic phenotypic changes in time. Regular seasonal change in morphology is known as cyclomorphosis, also termed as polymorphism or form variation. Such variation is common within the genus *Brachionus*, chiefly involving changes in body and spine lengths. Initially, cyclomorphosis was interpreted as an evolution of the mechanism allowing the organisms to float in the water column; this especially applied in the summer months as warm water viscosity is low. Subhasri and Susanta [1] from their study concluded that high temperature, availability of nutrients and turbulence of water triggered the cyclomorphic or polymorphic development of various species of Rotifers. As regards to the causes of cyclomorphosis in plankton require identifying both the external factors that stimulate morphological changes within a genetic line and the selective forces that operate within a given population. On the basis of extensive field and laboratory observations, Pejler [2] concluded that temperature, as well as food are the important factors influencing developmental rate. Nayar [3] discussing the role of physico-chemical characteristics of water has pointed out that pH, temperature, and oxygen may not have direct influence on the rotifers, but they together may create a good environment providing the required type of food for them. The form variation in rotifers, in the opinion of Arora [4] seems to be free from the influence of nutrients as his study was based on the specimen from organic matter rich sewage water.
The present study was conducted on *Brachionus caudatus,* because there was not much literature available about the form variation of this species. The main aim of the present study was to know the form variation in *B. caudatus* and to assess the influence of physico-chemical characteristics in form variation of this species

2. Materials and Methods
The zooplankton samples were collected from Tighra Reservoir Gwalior by filtering 50 litres of reservoir water through a plankton collecting net made of bolting nylon cloth. Sampling was done from May 2012 to October 2012 in the last week of every month. A subsample of 20ml was taken into the polyethylene bottle and preserved by adding 4-5 drops of 4% formalin and 2-3 drops of glycerine were also added for the softness of organisms. The zooplanktons were identified under the microscope by using various identification keys suggested by Edmondsons [5] and Battish [6].

The figures were drawn with the help of camera lucida adjusted on the compound microscope with the magnification power of 10X.15X. The measurements were taken by ocular disc duly calibrated with the stage micrometer. Thirty individuals of each species were measured every month. Following measurements were taken during our study as shown in figure 1.

1. Total length: It is the length of lorica including the length of anterior and posterior spine lengths.
2. Length of lorica: the length without length of spines.
3. Width of lorica
4. Length of various spines

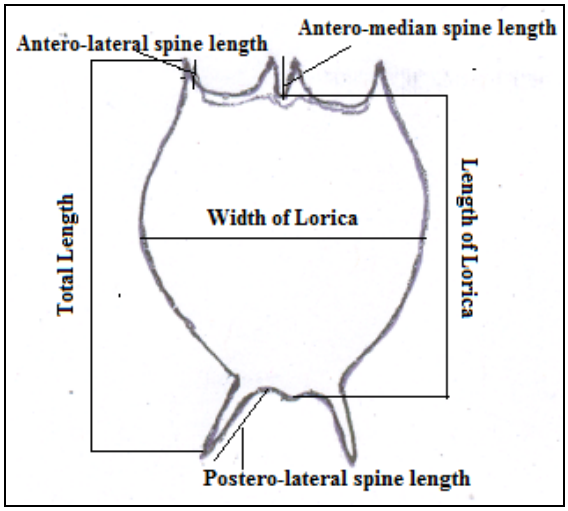

Fig 1: Various measurements of *Brachionus caudatus* taken during the course of study

3. Results

The present study was conducted on the species of *Brachionus*, viz., *Brachionus caudatus* a very common rotifer organism of water bodies' world over. The camera lucida images of the species are presented in figures 2. The total length observed in the month of May was 0.210mm which decreased to 0.157mm in October. The length and width of lorica has also shown a decreasing trend. The length of lorica in the month of May was 0.150 mm and it decreased to 0.120mm in the month of October. The width of lorica was 0.135 mm in May while in October it was recorded as 0.105 mm. In case of spines there was no change in anterior spines but the postero-lateral spine decreased from 0.045 mm in May to 0.022 mm in October (Table 1).

B. caudatus showed the significant positive correlation of the total length with the water temperature, dissolved oxygen, free carbon dioxide, total alkalinity, chloride and calcium. The depth, transparency, electrical conductivity, turbidity and pH exhibited a significant negative correlation with total length and there was the small positive correlation with the total hardness of water (Table 3). The length and width of lorica showed a significant positive correlation with the water temperature, dissolved oxygen, free carbon dioxide, total alkalinity, chloride and calcium, while there was significant negative correlation between length and width of lorica and depth, transparency, electrical conductivity, turbidity and pH and there was small positive correlation of length and width of lorica with total hardness (Table 3).. The length of anterior spines was constant throughout the study, but the length of postero-lateral spine showed a significant positive correlation with water temperature, dissolved oxygen, free carbon dioxide, total alkalinity and chloride and significant negative correlation with depth, transparency and electrical conductivity. Turbidity and pH showed a small negative correlation with length of postero-lateral spines and the calcium and total hardness showed small positive correlation with the postero-lateral spines (Table 3).

The physico-chemical characteristics included in the study are ambient temperature, water temperature, colour, depth, transparency, conductivity, turbidity, pH, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, chloride and calcium. The monthly values of the physico-chemical characteristics of the Reservoir water have been shown in Table 2.

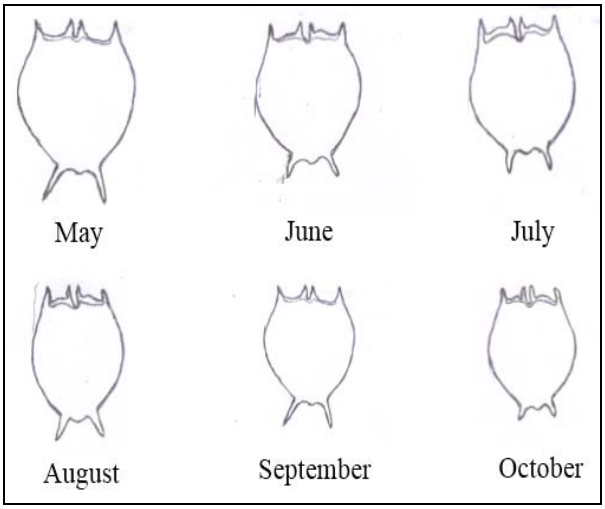

Fig 2: Camera Lucida images of *Brachionus caudatus* in different months.

Table 1: Various Morphometric Data of *Brachionus caudatus*

S. No.	Measurements	May	June	July	Aug	Sep	Oct
1	Total length	0.210	0.195	0.180	0.165	0.160	0.157
2	Length of Lorica	0.150	0.135	0.127	0.120	0.120	0.120
3	Width of Lorica	0.135	0.120	0.112	0.105	0.103	0.105
4	Length of Antero-median Spine	0.015	0.015	0.015	0.015	0.015	0.015
5	Length of Antero-Lateral spine	0.015	0.015	0.015	0.015	0.015	0.015
6	Length of Postero-Lateral Spine	0.045	0.038	0.038	0.030	0.026	0.022

Table 2: Mean values of physico-chemical characteristics of Tighra Reservoir during May 2012 to October 2012

S. No	Parameters	May	June	July	Aug	Sep	Oct
1	Amb. Temperature (°C)	36.08	33.4	32.5	32.8	31.1	29.6
2	Water Temperature (°C)	32.2	31.7	31.5	30.8	30.5	27.8
3	Colour	L.G	L.G	L.G	G	G	G
4	Depth (cm)	268.1	230.7	228.7	651.1	656.0	578.1
5	Transparency (cm)	103.7	114.4	112.7	110.0	166.2	185.0
6	Electrical conductivity (μScm^{-1})	156.8	126.0	162.4	184.8	170.8	162.4
7	Turbidity (NTU)	0.97	1.15	1.7	1.9	1.3	1.4
8	pH	9.27	8.45	9.8	10.22	9.4	9.4
9	Dissolved Oxygen (mgL^{-1})	7.09	7.6	6.8	5.68	4.7	3.7
10	Free Carbon Dioxide (mgL^{-1})	12.1	8.8	0.5	3.3	0.5	-
11	Total Alkalinity (mgL^{-1})	176.2	158.7	156.2	161.2	151.2	176.2
12	Total Hardness (mgL^{-1})	78.1	69.0	85.0	70.5	71.5	83.0
13	Chloride (mgL^{-1})	40.1	25.9	25.5	22.0	21.6	25.9
14	Calcium (mgL^{-1})	23.2	22.4	20.4	22.8	21.0	23.8

Table 3: Correlation coefficient of various lengths with different physico-chemical parameters in *Brachionus caudatus*

Parameters	Total length	Length of Lorica	Width of Lorica	Length of Postero-Lateral Spine
Water Temperature (°C)	0.99	0.93	0.93	0.98
Depth (cm)	-0.83	-0.71	-0.71	-0.87
Transparency (cm)	-0.68	-0.55	-0.55	-0.84
Electrical conductivity ($\mu S\ cm^{-1}$)	-0.65	-0.54	-0.54	-0.51
Turbidity (NTU)	-0.65	-0.76	-0.76	-0.39
pH	-0.54	-0.51	-0.51	-0.30
Dissolved Oxygen (mgL^{-1})	0.88	0.73	0.73	0.90
Free Carbon Dioxide (mgL^{-1})	0.89	0.90	0.90	0.74
Total Alkalinity (mgL^{-1})	0.79	0.85	0.85	0.77
Total Hardness (mgL^{-1})	0.26	0.25	0.25	0.47
Chloride (mgL^{-1})	0.88	0.96	0.96	0.82
Calcium (mgL^{-1})	0.51	0.54	0.54	0.41

4. Discussion

Cyclomorphosis has been recorded from all parts of the world. Several workers have attributed temperature as the major factor responsible for cyclomorphosis. The present study was conducted on *B. caudatus* for a period of six months. During the study period from May 2012 to October 2012, the maximum temperature was found in the month of May and it showed a decreasing trend upto the October. The total length, the length and width of lorica and the length of spines also decreased with decreasing temperature. Similar results were observed by the Wesenberg-Lund [7]; Ahlstrom [8] and Gallagher [9]. Edmondson [10] pointed out that calcium might have an effect on the cyclomorphosis. In the present study on *B. caudatus*, there was the insignificant correlation with the total length, length and width of lorica and the length of spines. Some workers like Arora [4] has shown that available nutrients do not seem to influence cyclomorphosis where as Diffenbach and Sachse [11] correlated the cyclomorphosis with available nutrients in the surroundings.

The length of spines in *Brachionus* had been found to increase in low temperature and low concentration of food [2]. But in case of *Brachionus caudatus* it showed an opposite relationship between temperature and length of spines. With the decreasing temperature, the length of spines decreased. Besides, the length of spines, total length, length and width of lorica also showed a decreasing trend. Korosi *et al.* [12] in his studies on bosmina reported that during high mortality risk (e.g., predation by larger invertebrates such as Chaoborus), longer mucros and increased carapace size increase prey-handling time and decrease the success rate of attacks. Subhasri and Susanta [1] from their study concluded that temperature, nutrient availability and turbulence of water triggers the cyclomorphosis of rotifers, while in the present study temperature showed a significant positive correlation with overall size of specimen and the turbidity showed little positive correlation with length and width of lorica and small negative correlation with length of spines.

Yali Ge *et al*. [13] showed that water temperature is responsible to influence the antero median and antero-lateral spine lengths and the posterior spine length of spined *Keratella cochlearis*. Similar results were obtained from the present study, the water temperature showed a significant positive correlation with the total length, length and width of lorica and the length of spines. Hence, from the above discussion it is found that the cyclomorphosis is highly controlled by various physico-chemical parameters of water among which temperature is the most important factor. Besides this, cyclomorphosis is also controlled by the predation pressure and dimenshining prey.

5. Conclusion

From the above work it is concluded that the cyclomorphic phenomenon is controlled by various environmental factors among which temperature is the most important. With increasing temperature the density of water decreases hence the size of body and spine length increases which let them float in the less dense water.

6. Acknowledgement

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7. References

1. Subhasri M, Susanta KC. Cyclomorphosis of fresh water rotifers from wetlands of contrasting ecological feature–seasonal analysis. J. Bidr. and Env. Sci. 2016; (8):155-163.
2. Pejler B. On the variation of rotifer *Keratella cochlearis* (Gosse). Zool. Bidr. Uppsala. 1962; (35):1-17.
3. Nayar CKG. Cyclomorphosis of *Brachionus calyciflorus* Pallas. Hydrobiologia. 1965; (25):538-544
4. Arora HC. Cyclomorphosis (Form variation) in some species of Indian planktonic rotatoria. Int. Rev. Ges. Hydrobiol. 1966; (51):623-632.
5. Edmondson WT. Ward and Whipple's Freshwater Biology, 2nd ed. John Woley and Sons, New York. 1959.
6. Battish SK. Freshwater zooplankton of India. Oxford and IBH Publishing Cooperation Private Limited, New Delhi. 1992.
7. Wesenberg-Lund C. Contribution to the biology and morphology of the genus *Daphnia* with some remarks on heredity. Mem. Acad. Roy. Sci. Lett. Denmark. 1926; (11):91-250.
8. Ahlstrom EH. A revision of the rotatorian genus *Keratella* with descriptions of three new species and 5-new varieties. Bull. Am. Mus. Nat. Hist. 1943; (80):411-457.
9. Gallagher JJ. Cyclomorphosis in the rotifer *Keratella cochlearis* (Gosse). Trans. Am. Microsc. Soc. 1957; (76):197-203.
10. Edmondson WT. Ecological applications of Lansing's physiological work on longevity in rotatoria. Science. 1948; (108):123-126.
11. Diffenbach H, Sachse R. Biologishe studien an pelagischen radertieren-Int. Rev. Ges. Hydrobiol. Hydrogr. 1911; (4):9-42.
12. Korosi JB, Kurek J, Smol JP. A review on utilizing *Bosmina* size structure archived in lake sediments to infer historic shifts in predation regimes. J. Plankton Res. 2013; (35):444-460.
13. Yali G, Yilong X, Jie M, Dandan X. Factors influencing morphological characteristics of *Keratella cochlearis* in Lake Tingtang. Proceedings of the National Academy of Sciences, India Section B: Biol. Sci. 2016; (1):1-8.