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Impact of climatic changes on the diversity of ciliates: A study of the Panchakki aqueduct, Aurangabad (M.S.)

Shahjahan AS
Milind College of Science, Aurangabad, Maharashtra, India

Abstract
Global warming has a significant impact on the biodiversity of living organisms. The rise of temperature affects the biotic and the abiotic factors in nature. Ciliates being minute in size are sensitive to climate changes. In view of this the seasonal fluctuation of population density of ciliates in relation to some selected physic-chemical parameters were studied. The interplay of abiotic factors and its role in fluctuation and distribution is discussed. The representatives of the three major classes i.e. Kinetofragminophora, Oligohymenophorea and Polyhymenophora were represented. The seasonal fluctuations are discussed and correlated.

Keywords: diversity, ciliates and global warming

Introduction
Protists are the key components of ecosystems. Ciliates are minute in size, naturally are sensitive to climatic changes, especially to temperature. Climatic models predict an increase in average global temperature of 1.5 to 4°C over the century (David, *et al*., 2000) [9]. Global warming have temperature induced changes on species composition, however different species behave physiologically in unique ways. It is but needed to assess the influence of temperature on the biodiversity of an ecosystem. A large proportion of organic matter is produced through microbial including ciliates (Fenchel, 1987) [10]. Generally in waters with high nutrient levels, ciliates can be effective bacteriovorus (Porter, 1979) [12]. In view of this the fluctuation's in population density and species composition, with increasing temperature is studied from a perennial source of water during a period of June 2014-May 2015.

Material and Method
Sampling site
The Panchakki aqueduct is a perennial source of water, Originating from Ohar and Jatwada catchment area about 6 kilometers Northwest of Aurangabad. The water accumulating there is brought to Panchakki through aqueduct given an elevation of 20 feet height and dropped into a big Cistern. Wide variety of phytoplankton and zooplankton are harbor by this cistern. Ciliates like other microorganisms are sensitive to abiotic factors, hence studied and correlated with population of ciliates.

Method
The water samples for analysis were collected fortnightly on 1stAnd 15th of every month, around 9.00 a.m. The samples were collected 15 cm below the surface of water with planktonic mesh of 64 µm was used for sampling. The samples were transferred in plastic bottles and fixed in 4% formaldehyde. The study is stretched over a period of one year from June 2014 to May 2015. The abiotic factors were estimated with the help of (APHA- 2002, Mathur, 1982 and Thergaonkar, 1979) [11, 13] and identification of ciliated is based on (Bick, 1962 and Corliss 1979) [5, 7]. The data of temperature was collected from metrological department Chikalthana Aurangabad.

Result and Discussion
The physic-chemical parameters studied were, atmospheric temperature, water temperature, dissolved oxygen (D.O), Biological oxygen demand (B.O.D), chemical oxygen demand (C.O.D), Hydrogen-ion concentration (pH), Acidity, Alkalinity, Nitrogen and Total solids.
The seasonal fluctuations of these parameters during monsoon, winter and summer are shown in Table1

Table 1: Physico-Chemical Parameters (June 2014 to May 2015)

Sr.no	Parameters	Monsoon(june-sept)	Winter(oct-jan)	Summer(feb-may)
1	Atmospheric temperature	50.8°C	42.4°C	55.5°C
2	Water temperature	48.5°C	39.6°C	53.7°C
3	Dissolved oxygen (D.O)	07.6ppm	11.1ppm	09.4ppm
4	Biological oxygen demand (B.O.D)	04.0ppm	08.3ppm	06.4ppm
5	Chemical oxygen demand (C.O.D)	11.9ppm	09.4ppm	08.7ppm
6	Hydrogen-ion concentration pH	07.2pH	07.1pH	07.3pH
7	Acidity	0.3ppm	--------	05.0ppm
8	Alkalinity	63.4ppm	32.8ppm	95.6ppm
9	Nitrogen	03.1ppm	02.4ppm	01.8ppm
10	Total solids	265.3ppm	251.7ppm	272.6ppm

Table 2: Composition of Ciliates (June 2014- May2015)

Sr.No	Population Density (Ciliates) per/ml	Monsoon(June-Sept)	Winter(Oct-Jan)	Summer(Feb-May)
	Class: Kinetofragminophorea			
1	Litonotus fasciola	++	+++	-------
2	Dileptus anser	+++	+++	+
3	Lacrymaria olor	+++	++++	-------
4	Didinium nasutum	------	++++	++
	Class: Polymenophorea			
1	Paramecium caudatum	+++	++++	++
2	Frontonia accuminata	++	+++	+
3	Euplotes affinis	-------	+++	------
	Class: Oligohymenophorea			
1	Colpidium colpoda	------	+++	++
2	Vorticella microstoma	++	++++	+
3	Tetrahymena pyriformis	------	+++	++
4	Carchesium polypinum	+++	++++	+

Average of the season.
High (15/ml or more) ++++
Moderate (15/ml) +++
Less (10/ml) ++
Least (5/ml) +
Absent - ----

The atmospheric temperature was more (55.5°C) in summer, less in monsoon (50.8°C) and least in winter (42.4°C). The water temperature was consistently lower than atmospheric temperature by 1.8°C- 2.8°C in various seasons. Dissolved oxygen (D.O) was maximum in winter (11.1ppm), less in summer (09.4ppm) and least in monsoon (07.6ppm), Biological oxygen demand (B.O.D) was again more in winter (08.3ppm), less in summer (06.4ppm) and least in monsoon (04.0ppm). Chemical oxygen demand (C.O.D) however was more in monsoon (11.9ppm), less in winter (09.4ppm) and least in summer (08.7ppm). Hydrogen-ion concentration (pH) was alkaline throughout ranging from (07.1-07.3ppm). Acidity was maximum in summer (05.0ppm), much less in monsoon (0.3ppm) and there was no record in winter. Nitrogen was more in monsoon (03.1ppm), less in winter (02.4ppm) and least in summer (01.8ppm). Total solids have marginal fluctuations as in summer (272.6ppm) monsoon (265.3ppm) and in winter (251.7ppm).

Composition of ciliates

All the three classes of ciliates, Kinetofragmenophorea, polymenophorea and oligohymenophorea were represented during the present study. Class kinetofragmenophorea was represented by *Litonotus fasciola*, *Dileptus anser*, *Lacrymaria olor* and Didinium nasutum. The population density of *L. Faciola* was moderate in winter (15/ml), less in monsoon (10/ml) and there was no record in summer. *D.anser* was moderate in monsoon and winter least in summer. *L.olor* was high (more than 15/ml) in winter, less in monsoon, with no record in summer. *D.nasutum* was high in winter less in summer and was not present in monsoon.

Class Polymenophorea was represented by *Paramecium caudatum*, *Frontonia accuminata* and *Euplotes affinis*. Population-wise *P. caudatum* was high in winter, less in monsoon and least in summer *F.accuminata* was moderate in winter, less in monsoon and least in summer. *Euplotes affinis* was recorded with moderate density in winter; however there was no record in monsoon and summer.

Class Oligohymenophorea was represented by *Colpidium colpoda*, *Vorticella microstoma*, *Tetrahymena pyriformis* and *Carchesium polypinum*, *C.colpoda* in winter and summer respectively; however there was no record in monsoon. The population density of *V.microstoma* was high in winter, less in monsoon and least in summer. The population count of *T.pyriformis* was moderate in winter, least in summer and there was no record in monsoon *C.polpinum* was at its peak in winter, moderate in monsoon and least in summer.

Discussion

Atmospheric temperature plays a vital role in fluctuation of population density of organisms (Belehradek, 1926; Cossins and Bowler 1987)[4, 8]. Temperature in this region is more in summer less in monsoon and least in winter., pH was consistently alkaline throughout and dissolve oxygen was more in winter, less in monsoon and least in summer. The population density of ciliates was maximum in winter, minimum in summer and moderate in monsoon (Belehradek, 1926; Cossins and Bowler 1987; Weiss,1998; Ahmed Masood and Krishnamurthy, 1990, Ahmed Masood,1988; Chandra Rakash and Sharma,1996) [4, 8, 14, 2, 1, 6], recorded a similar pattern of seasonal fluctuations of population density of organisms, particularly of ciliates. Ciliate protozoans also play significant role in carbon flow in the freshwater plankton (Porter, 1979) [12].

Conclusion

Higher the temperature lowers the population count. However several abiotic and biotic factors of the environment have their own role to play in the diversity of organisms.

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