



*International Journal of Current Research
and Academic Review*

ISSN: 2347-3215 Volume 3 Number 9 (September-2015) pp. 171-175

www.ijcrar.com



Diurnal Fluctuations in Population Density of Ciliophora in Relation to Some Physical and Chemical Parameters from Hindudar lake of Markazi Providence, Iran

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KEYWORDS

Diurnal
fluctuations,
population
density,
Ciliophora,
physico - chemical
parameters
Hindudar
Lake

A B S T R A C T

Ciliophora are one of the biggest and oldest known Phyla of protozoans. Most ciliophora are free living, but some are commercial or parasitic, these small creatures are distributed all over of the world and can be observing in all fresh and marine waters on the earth. The ciliates are characterized by numerous cilia on the cell surface and possessing two kinds of nucleus, that is; macronucleus and micronucleus. In the present study we consider the diurnal fluctuations of ciliophora. The sampling was done in summer 2014, from a fixed point, 15 centimeter below the water surface at an interval of 6 h on the 10th of each month, from Hindudar Lake. The samples were subjected to some physico-chemical parameters (atmospheric and water temperature, dissolved oxygen, pH and total solid) and free living ciliophora density and diversity. Diurnal observation showed that the average minimum air and water temperature as well as dissolved oxygen and pH in six mornings, while the maximum for air, water and pH in 12 noon and dissolved oxygen in 18 evening respectively. Totally 943 ciliophora were counted, out of which only 601 number were identified. The ciliophora identified were represented by seven species, six genus, five family, three suborder, four order and three classes. During the present study the population density of identified species was in the following orders: *Carchesium polypinum*> *Didinium nasutum*> *Aspidisca costata*> *Paramecium bursaria*> *Paramecium caudatum*> *Vorticella microstoma*> *Coleps hirtus*. In the present investigation the minimum population density was recorded for *Coleps hirtus* which is an indicator for more polluted waters, while the other identified species are an indicator for less polluted water. Accordingly it's suggested that the water is characterized by less water pollution.

Introduction

The studies of diurnal fluctuations in biotic factors were carried out by Whitney (1942), Ganapati (1955), Verma (1964), Sarker *et al.* (1980) and Kippen and Kuczy (2001). Few works regarding fresh water protozoans and particularly ciliates, takes place in Iran. Ciliophora are one of the biggest and oldest known Phyla of protozoans, Leeuwenhoek in 1635 observed one of the members of the genus vorticela with the help of a very simple light microscope (Ahmed, 1990). Most ciliophora are free living, but some are commercial or parasitic, they have a great tolerance capacity of environmental pollutants (Ahmed, 1980). These small creatures are distributed all over of the world and can be observing in all fresh and marine waters on the earth (Bick, 1972). They are generally range from 10 μm to 3mm long (Hickman *et al.*, 2001). The free living ciliates can be characterized as zooplankton, and are acting as the second link of food chain; many scientists consider them as the Water indicator (Shayestehfar *et al.*, 2011). The ciliates are characterized by numerous cilia on the cell surface and possessing two kinds of nucleus, that is; macronucleus and micronucleus (Marshall and Williams, 1972).

Material and Methods

In Markazi province the climate is clearly marked in to four distinct seasons, viz., spring (April to Jun), summer (July to September), autumn (October to December) and winter (January to March). The present study covered four dial (24 h) periods of each month of summer 2014. The sampling was done 15 cm. below the water surface at an interval of 6 h on the 10th of every month from Hindudar Lake, located at 33°46' 58/9'' N, and 049°15' 15/5'' E (Fig. 1).

The samples were subjected to some physico-chemical analysis and free living ciliophora identification and counting. The atmospheric and water temperature ($^{\circ}\text{C}$), dissolved oxygen (ppm), and pH (%) were determined with the help of digital portable kit, the total solid (mg/l) was estimated using the methods outlined in standard methods for examination of water and waste water (APHA) 1980. The ciliates were studied and identified under light microscope (Olympus-BX51). The shape was drawing with the help of camera lucida, and were counted with the help of a counting chamber and calculated per liter. The method of preservation, count and identification was based on Ward and Whipple (1959) and Bick (1972) respectively.

Results and Discussion

The diurnal variation of physico-chemical parameters are shown in table 1.

The average maximum dissolved oxygen was recorded in September, while the minimum was observed in July and August respectively. pH is the measure of proton activities. The average maximum pH was recorded in July and then in August and September (7.62, 7.55 and 7.35) respectively. The average minimum total solid was recorded in July (186.62 mg/l), while the maximum average observed in September (289.25 mg/l) respectively. The total hardness showed a moderate rang during August 2014.

Diurnal observation showed that the average minimum air and water temperature as well as dissolved oxygen and pH in six mornings, while the maximum for air, water and pH in 12 noon and dissolved oxygen in 18 evening respectively (Table 1).

Totally 601 number of ciliophora were identified. The ciliophora identified were represented by seven species, six genus, five family, three suborder, four order and three classes. The species identified and their densities are named in table 2.

During the present study, the duration of day was high; the color of the water at sampling site was always greenish, which reflects the presence of some phytoplankton. The atmospheric temperature rises during the illuminated hours of day due to solar heat and drops down at night. During the day photosynthetic activity of phytoplankton raises the oxygen level. Dissolved oxygen concentration drops down at night especially between 24 to 6 hours, which may cause by consuming by photosynthetic plants, particularly phytoplankton, as well as other oxygen consumers organisms such as ciliophora. The abundance and distribution of ciliophora is guided by number of physico-chemical variables. Some attempts

were made to determine the optimum of physico-chemical variables for various species of ciliates. Such optimum may hardly be valid because of the possible effects of many uncontrolled factors. Ultimately the cumulative effect of physico-chemical variations seems to be responsible for the fluctuations in population density of ciliates. During the present study of the dial period, moderate water temperature, moderate concentration of dissolved oxygen as well as moderate pH appears to be responsible for the abundance of ciliophora in 6 and 18 hours.

Total solids are influenced by atmospheric temperature, more density of biotic organisms and A-biotic materials and rainfall. In the present study, Dryness (rain fall did not recorded since 5 months), abundance of biotic organisms lick ciliophora and high water evaporation may cause the more T.S. in September, moderate in August and low in July.

Table.1 Diurnal fluctuation of physical and chemical parameters of Hindudar dam (July to September, 2014)

	Time of sampling (Dial Hours)	Atmospheric temperature (°C)	Water temperature (°C)	Dissolved Oxygen (ppm)	pH (%)	T.S. (mg/l)
July	6	21	23.3	2.7	7.4	186.9
	12	32	27.6	3.9	7.9	186.6
	18	30.5	26	6.4	7.6	186.5
	24	27.8	25.4	5.7	7.6	186.5
August	6	23	23	2.5	7.2	235.5
	12	36.7	28.2	4.1	8.1	235.3
	18	32.8	27.1	4.8	7.5	235.5
	24	28	26.4	4.2	7.4	235.5
September	6	19.3	18.7	3.5	7.2	289.4
	12	29.5	27.4	5.2	7.6	289.2
	18	27.4	27.4	6.1	7.3	289.2
	24	24.6	26.8	5.5	7.3	289.2

Table.2 Diurnal fluctuation of population density of Hindudar dam (per liter) of ciliophora (July to September, 2014)

Diel hours → Months →	6			12			18			24		
	July	August	September	July	August	September	July	August	September	July	August	September
Total Phylum Ciliophora	70	32	137	39	22	52	60	34	92	21	13	29
Class Holotrichia	34	11	79	19	08	32	26	20	50	10	08	18
Order Gymnostomatida	34	11	79	19	08	32	26	20	50	10	08	18
Sub order Rhabdophorina	14	04	56	11	04	13	14	08	22	07	04	07
Family Colepidae	12	3	13	04	01	06	05	03	8	01	03	02
Sp.-Coleps <i>hirtus</i>	12	3	13	04	01	06	05	03	8	01	03	02
Family Didinidae	02	1	43	07	03	07	09	05	14	06	01	05
Sp.-Didinium <i>nasutum</i>	02	1	43	07	03	07	09	05	14	06	01	05
Order Hymenostomatida	20	07	23	08	04	19	12	12	28	03	04	11
Sub order Peniculina	20	07	23	08	04	19	12	12	28	03	04	11
Family Paramecidae	20	07	23	08	04	19	12	12	28	03	04	11
Sp.-Paramecium <i>caudatum</i>	15	05	16	02	03	08	08	07	12	00	02	07
Sp.-Paramecium <i>bursaria</i>	05	02	07	06	01	11	04	05	16	03	02	04
Class Peritrichia	26	17	41	15	07	18	16	08	28	07	04	09
Order Peritrichida	26	17	41	15	07	18	16	08	28	07	04	09
Sub order Sessilina	26	17	41	15	07	18	16	08	28	07	04	09
Family Vorticellidae	26	17	41	15	07	18	16	08	28	07	04	09
Sp.-Vorticella <i>microstoma</i>	11	6	18	08	04	08	06	03	11	01	02	06
Sp.-Carchesium <i>polypinum</i>	15	11	23	07	03	10	10	05	17	06	02	03
Class Spirotrichia	10	04	17	05	07	02	18	06	14	04	01	02
Order Hypotrichida	10	04	17	05	07	02	18	06	14	04	01	02
Family Aspidisca	10	04	17	05	07	02	18	06	14	04	01	02
Sp.-Aspidisca <i>costata</i>	10	04	17	05	07	02	18	06	14	04	01	02

Fig.1 Sampling site of Hindudar Lake



During the present investigation the maximum and minimum average of water temperature was recorded in August and September respectively, while it shows an inverse relationship with oxygen concentration, which is in agreement with

(Shayestehfar *et al.*, 2013). Less water temperature as well as more dissolved oxygen concentration in September may be the reason for maximum population density of ciliates in September and minimum in August.

During the present study the population density of identified species was in the following orders:

Carchesium polypinum> *Didinium nasutum*> *Aspidisca costata*> *Paramecium bursaria*> *Paramecium caudatum*> *Vorticella microstoma*> *Coleps hirtus*

The minimum population density was recorded for *Coleps hirtus* which is an indicator for more polluted waters, while the other identified species are biotic indicator for less polluted water (Bick, 1972). Accordingly it's suggested that the water is characterized by less water pollution.

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