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Abiotic factors influencing the diversity and abundance of protozoans at two different stations of Devika stream in Udhampur district, J&K, India

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Abstract

Two different study sites of Devika stream were analysed for a period of one year (Oct, 2014 to Sept, 2015), in order to estimate the effect of various changing physico-chemical parameters on the diversity and abundance of inhabitant protozoans. During the present investigation, qualitatively, a total of 10 genera and 13 species viz. Centropyxis aculeata, C. ecornis, Paramecium aurelia, P. trichium, Vorticella sps., Epistylis plicatilis, Campanella umbellaria, Euplotes sps., Bursaridium schewakofii, Difflugia lebes, D. acuminata, Arcella vulgaris, Colpidium sps. were enlisted; out of which, only 6 genera showed their presence at Station II. Quantitative estimation revealed higher protozoan count at Station I (i.e:- 68.96%) than at station II. This may be attributed to the presence of comparatively higher levels of water temperature, free carbon-dioxide, sulphates, phosphates, nitrates, BOD as well as lower levels of DO at Station I. Furthermore, presence of some of the species like Epistylis plicatilis, Euplotes sps., Bursaridium schewakofii, Difflugia lebes and Arcella vulgaris at Station I infers to more anthropogenic influence at this station and also due to direct organic input. This organic load gets further diluted while travelling towards station II and seems less detrimental from the present data.

Keywords: Qualitatively, quantitative estimation, physico-chemical parameters, polluted state.

Introduction

Limnology is the study of fresh water-bodies including its abiotic and biotic components. Fresh-water ecosystems acts as life line for majority of the organisms, both micro and macro. They, not only acts as habitat for these species, but also helps in maintaining the hydrobiological cycles; in turn maintains the ecological equilibrium between the earth and the atmosphere. Both the abiotic and biotic factors are dependent on each other and hence, their interaction determines the quality of that particular water source as well as the diversity, seasonality and abundance of biotic fauna in that particular water-body.

In addition, biotic fauna includes zooplankton and benthos. Zooplankton are small, free-drifting, microscopic animalcules which rely on physical and chemical qualities of the water which they inhabits. They are the health indicators of a particular water-body because they not only use water bodies for habitat purposes, but also, their population structure and functioning changes according to the change in various abiotic factors of that water source because of their short life span[1,2]. Many of these zooplanktonic population highlights the shifting status of water-body from oligotrophic to mesotrophic and finally to eutrophic state[3].

Inspite of their immense importance, they are being deteriorated day by day due to various anthropogenic activities, which also results in the decline of few species and emergence of some pollution indicator species. Excessive pollution load in the form of sewage disposal from houses, factories and industries have also led to the decrement in the water quality by increasing the nutrient content[4] and emergence of various water-borne diseases.

Study area: Devika stream of Udhampur district, lies between 32°53'27"N latitude and 75°6'34"E longitude. This is a slow flowing, concrete embarked stream. Two study stations were selected; Station I (lotic stretch) and Station II (lentic stretch).

Material and methods

Monthly zooplankton sample was collected from the study area for the period of one year from Oct, 2013 to Sept, 2014. Concurrently, water sample was also taken for measuring the selected physico-chemical variables. Air temperature, Water temperature, Depth, DO and FCO_2 were done at the study site and rest of these abiotic parameters were determined in the laboratory[5].

For zooplankton samples, 50 litres of water was filtered using plankton net (Nytex 70µm mesh size). The filtered sample was transferred to glass vials and was preserved in 5% formalin. For their qualitative anlaysis, the methods given by various researchers[6-8] were used. For quantitative analysis, the drop count method was applied and the no. of zooplankton per liter of the concentrate was calculated by using the formula:

$$\text{Organism/l itre} = A \times \frac{1}{L} \times \frac{n}{V}$$

Where V= Volume of 1 drop (ml), A= Number of organism per drop (ml), n = Total volume of concentrated sample (ml), L= Volume of original sample (l).

Results and discussion

During the tenure of study period of one year, abiotic factors showed well-marked seasonal variations (Table-1) at both the study stations. Among all the abiotic factors presently investigated, water temperature, free carbon dioxide, phosphates, sulphates, nitrates and biological oxygen demand showed higher content at Station I than at Station II; whereas dissolved oxygen was comparatively lower at Station I than at Station II.

Qualitative and quantitative estimation of total protozoan population has been tabulated in Table 3-5. During the present investigation, it was recorded that the protozoan population was directly as well as indirectly get influenced by the fluctuating physico-chemical parameters. Furthermore, these abiotic factors showed seasonal variations and hence, influenced the diversity, abundance and seasonality of these different protozoan species.

Detailed research revealed the presence of a total of 10 genera and 13 species viz. *Centropyxis aculeata*, *C. ecornis*, *Paramecium aurelia*, *P. trichium*, *Vorticella* sps., *Epistylis plicatilis*, *Campanella umbellaria*, *Euplotes* sps., *Bursaridium schewakofii*, *Difflugia lebes*, *D. acuminata*, *Arcella vulgaris*, *Colpidium* sps. Out of all these, only 6 genera viz. *Centropyxis aculeata*, *C. ecornis*, *Paramecium aurelia*, *P. trichium*, *Vorticella* sps., *Campanella umbellaria*, *D. acuminata*, *Colpidium* sps. showed their presence at station II.

Critical analysis of the recorded data further highlighted the fact that protozoan species prefer to inhabit waters having high temperature[9]. Their preference for high BOD content have also been supported by workers[10]. Moreover, higher availability of food in the form of organic matter at Station I also supported the growth of larger quantity of protozoans at this particular station[11,12].

Table-1: Monthly variation in physico-chemical parameters at Station I.

Months / Parameters / Units	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Mean ± St. deviation
Air Temp, ^{o}C	18	15	15	13	21	22	20	28	32	29	27	25	22.08 ± 5.67
Water Temp, ^{o}C	17	17	16	12	17	20	19	27	28	26	25	24	20.66 ± 4.74
Velocity, m/sec	0.39	0.30	0.22	0.20	0.24	0.20	0.17	0.19	0.15	0.25	0.30	0.29	0.24 ± 0.06
Depth, cm	58	51	49	45	39	42	50	44	36	42	40	43	44.92 ± 5.62
pH	7.3	7.6	7.8	7.6	7.9	7.7	7.2	6.7	6.4	6.6	6.8	6.6	7.18 ± 0.49
DO, mg/l	5.0	5.8	4.2	3.8	4.8	4.0	3.6	3.4	3.0	3.6	4.2	4.0	4.12 ± 0.71
FCO_2, mg/l	32	32	28	24	24	28	30	36	48	40	36	40	33.16 ± 6.58
HCO_3^-, mg/l	273.28	294.6	294.6	273.28	283.56	268.4	268.4	244	231.8	244	268.4	256.56	266.74 ± 18.16
CO_3^{2-}, mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca^{2+}, mg/l	58.91	50.6	48.3	45.64	45.64	45.41	43.73	49.62	42.89	47.41	45.64	50.6	47.86 ± 3.95
Mg^{2+}, mg/l	32.48	35.46	39.69	39.69	39.93	28.82	30.35	23.49	24.68	27.51	30.59	28.62	31.77 ± 5.29
Cl^-, mg/l	60	54	46	39	35	48	52	44	32	42	49	54	46.25 ± 7.64
SO_4^{2-}, mg/l	0.00200	0.0018	0.0018	0.00194	0.00200	0.00186	0.00185	0.00200	0.00236	0.00194	0.00194	0.00202	0.00195 ± 0.00014
PO_4^{3-}, mg/l	0.010	0.095	0.056	0.028	0.036	0.034	0.038	0.177	0.177	0.035	0.010	0.016	0.05933 ± 0.0547
NO_3^-, mg/l	0.57250	0.57264	0.57258	0.57250	0.57250	0.57251	0.57249	0.57253	0.57254	0.57251	0.57246	0.57246	0.57252 ± 0.00005
BOD, mg/l	2.2	1.8	1.8	1.6	1.6	1.8	2.2	2.0	2.4	2.2	2.0	2.0	1.96 ± 0.23

Table-2: Monthly variation in physico-chemical parameters at Station II**.**

Months / Parameters Units	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Mean ± St. Dev.
Air Temp. °C	17	12	15	13	21	22	20	24	28	26	24	24	20.5 ± 4.77
Water Temp °C	18	18	19	15	21	20	18	22	23	20	22	21	19.75 ± 2.08
Velocity, m/sec	-	-	-	-	-	-	-	-	-	-	-	-	-
Depth, cm	69	67	64	64	59	60	56	54	50	59	60	58	60 ± 4.96
pH	6.4	6.4	6.7	6.5	6.7	6.6	6.4	6.2	6.0	6.4	6.4	6.5	6.43 ± 0.18
DO, mg/l	3.4	4.0	4.4	3.0	2.2	3.0	2.0	1.4	1.2	2.4	2.2	2.9	2.67 ± 0.89
FCO_2, mg/l	56	54	40	34	44	40	48	56	58	45	40	40	46.25 ± 7.36
HCO_3^-, mg/l	131.76	122	151.28	146.4	122	143.96	146.4	146.4	104.92	120.46	122	131.76	132.45± 13.30
CO_3^{2-}, mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca^{2+}, mg/l	43.41	39.4	33.64	36.4	33.64	42.05	42.05	32.79	31.95	39.4	38.68	33.64	37.25 ± 3.75
Mg^{2+}, mg/l	25.82	28.18	30.42	32.68	30.35	27.51	30.35	23.49	23.49	26.97	25.82	26.01	27.59 ± 2.66
Cl^-, mg/l	60	56	50	50	54	50	50	52	48	50	58	56	52.83 ± 3.55
SO_4^{2-}, mg/l	0.00194	0.0018	0.00172	0.0018	0.00200	0.00194	0.00186	0.00200	0.00213	0.00189	0.00184	0.00200	0.00191 ± 0.0001
PO_4^{3-}, mg/l	0.016	0.025	0.029	0.042	0.013	0.025	0.037	0.123	0.094	0.016	0.010	0.010	0.036 ± 0.032
NO_3^-, mg/l	0.57240	0.57248	0.57242	0.57254	0.57245	0.57250	0.57245	0.57250	0.57250	0.57242	0.57240	0.57242	0.57245 ± 0.00005
BOD, mg/l	0.8	0.9	0.7	0.8	0.8	0.9	1.0	1.0	0.8	0.8	0.9	0.8	0.85 ± 0.08

Table-3: Station-wise list of Zooplankton recorded at two stations of Devika stream**.**

Protozoa	Station-I	Station-II
Family Centropyxidae		
Centropyxis aculeata (Ehrenberg, 1838)	+	+
Centropyxis ecornis (Stein, 1857)	+	+
Family Paramecidae		
Paramecium aurelia (Hill, 1752)	+	+
Paramecium trichium (Hill, 1752)	+	+
Family Vorticellidae		
Vorticella sps. (Edmondson, 1992)	+	+
Family Epistylidae		
Epistylis plicatilis (Edmondson, 1992)	+	-
Campanella umbellaria (Goldfuss, 1820)	+	+
Family Euplotidae		
Euplotes sps. (Edmondson, 1992)	+	-
Family Bursariidae		
Bursaridium schewakofii (Pennard, 1922)	+	-
Family Difflugidae		
Difflugia lebes (Penard, 1902)	+	-
Difflugia acuminata (Leidy, 1879)	+	+
Family Arcellidae		
Arcella vulgaris (Leidy, 1879)	+	-
Family Frontonidae		
Colpidium sps. (Stein, 1857)	+	+

Table-4: Showing Protozoa composition at Station I.

Months / Organisms	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Family Centropyxidae												
Centropyxis aculeata	-	0.24	0.1	-	-	-	-	-	-	-	-	-
Centropyxis ecornis	0.16	-	-	-	-	-	0.18	0.28	-	-	-	-
Family Paramecidae												
Paramecium aurelia	0.28	-	-	-	0.88	-	0.56	1.23	-	-	-	0.36
Paramecium trichium	0.48	0.24	0.24	2.48	2.64	-	0.64	1.12	1.32	0.8	-	-
Family Vorticellidae												
Vorticella sps.	1.04	1.52	1.84	3.28	0.32	1.04	1.68	2.48	2.48	0.24	0.7	1.64
Family Epistylidae												
Epistylis plicatilis	-	2.98	1.5	-	0.32	-	-	2.4	3.22	-	-	1.44
Campanella umbellaria	-	-	-	-	-	-	-	0.16	-	-	-	0.74
Family Euplotidae												
Euplotes sps.	-	0.24	0.18	-	-	-	-	1.26	2.1	-	-	-
Family Bursariidae												
Bursaridium schewakofii	-	0.18	2.4	-	-	0.48	-	-	-	0.3	0.58	1.06
Family Difflugidae												
Difflugia lebes	-	-	-	-	-	0.08	0.32	0.08	-	-	-	-
Difflugia acuminata	-	-	-	-	-	-	-	-	0.18	0.16	-	-
Family Arcellidae												
Arcella vulgaris	0.4	-	-	0.1	-	-	-	-	-	0.22	0.1	0.16
Family Frontonidae												
Colpidium sps.	0.72	0.48	-	-	1.36	1.6	0.44	-	-	-	1.36	-
Total Protozoa Count	3.08	5.88	6.26	5.86	5.52	3.2	3.82	9.01	9.3	1.72	2.74	5.4

Table-5: Showing Protozoa composition at Station II.

Months / Organisms	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Family Centropyxidae												
Centropyxis aculeata	0.6	0.24	0.18	0.16	0.24	0.32	0.18	0.2	0.24	0.58	0.16	0.32
Centropyxis ecornis	0.7	0.32	0.3	0.34	0.08	0.16	0.12	-	0.1	0.24	0.1	0.16
Family Paramecidae												
Paramecium aurelia	-	0.16	-	-	-	-	0.18	0.7	0.88	-	0.32	0.3
Paramecium trichium	-	1.36	1.04	-	1.2	-	0.18	0.22	3.04	0.16	-	-
Family Vorticellidae												
Vorticella sps.	-	0.56	0.48	-	0.32	-	0.12	1.3	0.48	-	-	-
Family Epistylidae												
Epistylis plicatilis	-	-	-	-	-	-	-	-	-	-	-	-
Campanella umbellaria	-	-	-	-	-	-	-	-	-	-	1.1	-
Family Euplotidae												
Euplotes sps.	-	-	-	-	-	-	-	-	-	-	-	-
Family Bursariidae												
Bursaridium schewakofii	-	-	-	-	-	-	-	-	-	-	-	-
Family Difflugidae												
Difflugia lebes	-	-	-	-	-	-	-	-	-	-	-	-
Difflugia acuminata	-	-	-	-	-	-	-	-	0.1	-	-	-
Family Arcellidae												
Arcella vulgaris	-	-	-	-	-	-	-	-	-	-	-	-
Family Frontonidae												
Colpidium sps.	-	-	-	-	-	5.12	-	-	-	-	0.08	0.72
Total Protozoa Count	1.3	2.64	2.00	0.5	1.84	5.6	0.78	2.42	4.84	0.98	1.76	1.5

Conclusion

From the above discussion, it can be concluded that the protozoan diversity is not independent but depends on various physico-chemical factors like water temperature, FCO_2, NO_3^{2-}, PO_4^{3-}, SO_4^- and BOD. Their higher content favoured the growth of large number of protozoans at Station I whereas low DO content also supported their flourishment. Moreover, the presence of some of the species like *Epistylis plicatilis*, *Euplotes* sps., *Bursaridium schewakofii*, *Difflugia lebes* and *Arcella vulgaris* at Station I infers to more anthropogenic influence at this station.

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