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Golden Research Thoughts

SEASONALITY OF INVERTEBRATE FAUNA INHABITING LOWER SHIWALIK STREAM, PHILODINAVUS PARADOXUS- THE FIRST REPORT

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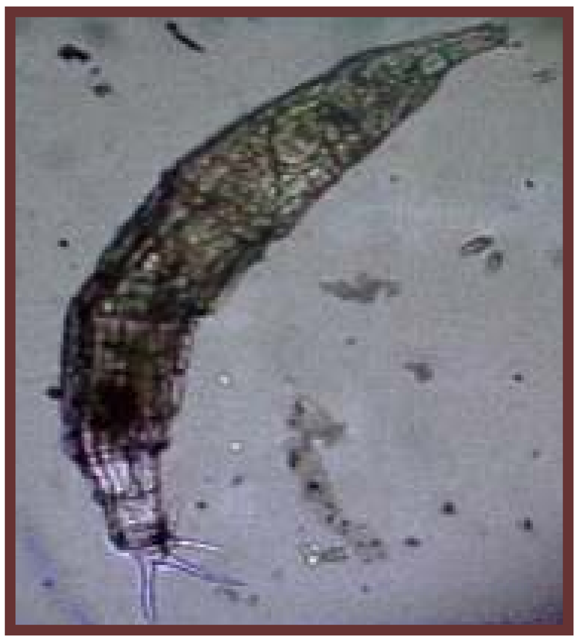

Abstract:-

The present contribution encompasses on few zooplankton groups and physico-chemical parameters as ecological indicator for identifying the ecological quality of Devika stream at Udhampur district, J&K. The seasonal variation of both these components were analysed for a period of one year (July, 2013– June, 2014). Fifteen physico-chemical parameters were analysed and a remarkable seasonal variation was recorded in them during the study period. Regading zooplankton, a total of 36 genera were recorded, out of which Protozoa was represented by 14 genera, Copepoda by 12 genera, Rotifera by 6 genera and Cladocera by 4 genera. Among these zooplankton, Rotifera showed its presence throughout the study period and the recorded data clearly showed well-marked seasonal fluctuation in zooplankton population with the presence of new rotifer sp. viz. Philodinavus paradoxus. The various kinds of indices such as Shannon-Wiener index, Simpson index, Margalef's index and Menhinick's index were also analysed.

Keywords:

Philodinavus, Ecological, Seasonal fluctuation, Margalef's index.

INTRODUCTION

Water is the prime neccessity for the existence of life apart from being the universal solvent. Water is available on earth as lotic and lentic aquatic sources as it provides habitat to a large number of microscopic and macroscopic communities. Thorough knowledge of physico-chemical conditions prevalent in a water-body provides assessment of water quality and also about the existence of biotic communities (Laal et al., 1986 & Nath, 2001). Moreover, there exists a close relationship between the hydro-biological parameters and the metabolism of aquatic organisms (Desmukh & Ambore, 2006).

Zooplankton, microscopic drifting animal-like aquatic invertebrates forms an important component of the biotic communities inhabiting the aquatic ecosystem. Ecologically, they play a useful role influencing all the functional aspects of the aquatic ecosystem viz. food chain, food web, energy flow/transfer and cycling of matter. The population dynamics and distribution of the inhabiting zooplanktons can be best understood by the prevalent physico-chemical factors. The complete study of both the organism and environment is, therefore, very essential and pre-requisite for understanding the various life history parameters of aquatic organisms (Welch, 1952). Suresh et al. (2011) reported that different environmental factors that determine the characters of water have great importance upon the growth and abundance of zooplankton.

Most of the zooplankton species are cosmopolitian in distribution. Their distribution depends on several factors, some of which are climatic conditions, physico-chemical factors and the availability of phytoplankton as food. Zooplankton play an important role in indicating the water quality, eutrophication status and productivity of any freshwater-body (Mikschi E, 1989). The abundance & distribution of these organisms can provide information regarding the health of water-body whether it is polluted or non-polluted Gajbhiye et al., 1981).

With this background, the present work was undertaken to analyse the physico-chemical parameters, seasonal abundance of zooplankton and also to know the relationship between the former and the latter.

STUDY AREA:

Devika stream, a lotic ecosystem of Udhampur district, lies between 32°53'27" N latitude and 75°6'34" E longitude. This is a slow flowing, concrete embarked stream.

MATERIAL AND METHODS:

Monthly zooplankton sample was collected from the study area for the period of one year from July, 2013 to June, 2014. Concurrently, water sample was also taken for measuring the selected physico-chemical variables. Air temperature., Water temperature., Water velocity, Depth, DO and FCO2 were done at the study site and rest of these abiotic parameters were determined in the laboratory (APHA, 1985).

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 Edmondson & Winberg (1971), Pennak (1978) and Adoni (1985) were used. For quantitative analysis, the drop count method was applied and the no. of zooplankton per litre of the concentrate was calculated by using the formula:

Organism/litre = A x 1/L x 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)

Various indices such as Shannon-wiener (H') index, Simpson index (I), Margalef's index (R1) and Menhinick index (R2) were used to analyze species diversity, richness.

RESULTS AND DISCUSSION:

A.PHYSICO-CHEMICAL PARAMETERS:

Monthly variations in the various physico-chemical parameters are shown in Table 1. All these factors showed wide range of fluctuations with changing seasons.

1.Temperature: Water temperature closely followed air temperature as earlier advocated by Sharma (2001), Sawhney (2004) & Shvetambri (2007). The rise in temperature (air & water) was primarily due to increased day length and sharp angle of incidence during summers. The decrease in temperature (air & water) may be because of reduced illumination, shorter day length (Sawhney, 2008 & Shindey et al., 2011) and less turbidity (Buttler, 1962).
2.Water velocity: This parameter showed its highest value during monsoons and lower value during summers. Higher water velocity coincides with the peak in water level caused by heavy rains and increase

in runoff (Sharma, 1999, Chowdhary, 2011 & Sharma, 2013).
3.Depth: The depth was found to be more during monsoons and less during summers. The maximum depth in monsoons was due to rains that caused frequent floods (Sawhney, 2008 & Chowdhary, 2011). The decrease in depth during summers was due to evaporation at high tempterature (Zutshi, 1992 & Sharma, 1999) and no extra addition from catchment areas.
4.pH: In winters, alkaline pH was recorded and during summers, acidic pH was recorded. Low pH in summers may be due to reduced level of water (Dutta & Patra, 2013) and high value of FCO2 (Langer et al., 2007). High pH in winters might be because of various additive factors as low water level (Pulugandhi, 2014) but less evaporation results in dilution even with the addition of domestic sewage (Bhandarwar & Bhandarkar, 2013).
5.DO: Concentration of DO is inversely proportional to tempt at a given time. Low DO during summer may be because of high tempt as its solubility decreases at higher tempt. (Dutta & Patra, 2013). Agitation of water due to heavy rainfall caused an increase in DO during monsoons (Chinnahiah et al., 2011). Higher DO during winters may be because of physical aeration rather than biological aeration (Hutchinson, 1957) and because of increased oxygen solubility at low tempt. (Bhandarkar & Bhandarkar, 2013).
6.FCO2: Most of the FCO2 comes from the decomposition of the organic matter and respiration of organisms (Singh, 1999). Increased decomposition of organic matter at high temperature and increased respiratory activities of aquatic organisms lead to the higher production of FCO2 during summers (Talling, 1957, Singh & Gupta, 2010 & Ahangar et al., 2012). Shorter photoperiod, slow decomposition due to low temperature made FCO2 lower in winters (Kumar et al., 1987 & Chowdhary, 2011).

7.BOD: The minimum BOD was recorded during winters due to decrease in temperature, which lead to decrease in microbial activity (Sachidanandamurthy & Yajurvedi, 2004). Increased microbial decomposition of dead organic matter with increase in water tempt. & decrease in water flow was responsible for higher BOD in summers (Das & Acharya, 2003 & Garg et al., 2009).
8.Bicarbonates: Low FCO2, reduced photosynthetic activities in winters resulted in decreased uptake of HCO3- as a source of carbon in photosynthesis, which lead its increase in winters (Sharma, 2013). Lower value of HCO3- in summers might be due to use of bicarbonates by the aquatic biota directly which lead to their depletion in water resulting in low value of total alkalinity (Harney et al., 2013).
9.Calcium: The uptake of Ca2+ for rich phytoplanktonic growth (Sawhney, 2008) and its decreased solubility at high tempt. (Abdel-Satar, 2005) might be responsible for its lower concentration in summers. High amount of Ca2+ in monsoons might be due to more leaching of Ca2+ containing rocks during rainy season and their subsequent entry into the water source along the runoff from catchment areas (Bhandarkar & Bhandrakar, 2013) and also due to rapid oxidation of organic matter (Pulugandi, 2014).
10.Magnesium: Decreased amount of Mg2+ might be due to its utilization by phytoplankton for chlorophyll molecules and enzymatic transformation (Wetzel, 2001 & Malik & Pandey, 2006). Leaching of Mg2+ bearing rocks in the catchment area might be responsible for its higher concentration during monsoons (Bhandarkar & Bhandrakar, 2013).
11.Chlorides: The higher level of Cl- was recorded during summers which might be the result of increased rate of evaporation (Shinde et al., 2011) and winter minima might be attributed to dilution effect and renewal of water mass (Shinde et al., 2011).
12.Sulphates: Lesser amount of sulphates in winter might be due to low temperature which resulted in reduced decomposition rate and conversion of sulphate to sulphides (Tripathy & Pandey, 1990 & Kaur, 2006). Sulphate maxima in summers might be due to high rate of evaporation and low flow of water (Bhandarkar & Bhandarkar, 2013).
13.Phosphates: High amount of phosphates in summers might be due to continuous addition of dead organic matter with sewage wastes (Saad & Antony, 1978 & Kaul, 2000) and low water level (Bhandarkar & Bhandarkar, 2013). Decline in its concentration during winters might be due to its utilization by algal and its co-precipitation with carbonates at high pH (Sawhney, 2008).
14.Nitrates: Influx of decaying organic matter and crematoria wastes (Chattopadhya et al., 2005) and influx of flood water (Shukla et al., 1989 & Sharma, 2013) might be responsible for its higher concentration during winters. Its minimum concentration in summers might be due to its uptake by natural phytoplankton and its reduction by denitrifying bacteria (Sabae & Abdel- Satar, 2001 & Sharma, 2013).

B.ZOOPLANKTON COMMUNITY:

Qualitatively and quantitatively, monthly and seasonal abundance of zooplankton for one year of investigation has been presented in Table 2 & 3. The zooplankton community of Devika stream consisted of 4 groups viz. Protozoa, Rotifera, Copepoda and Cladocera which showed a well-marked seasonal variation in accordance with physico-chemical factors.

a.Protozoa: In the present work, this group showed maximum abundance contributing 82.06% of total zooplankton population studied, with a peak in summer season and minima in monsoons. This group was represented by 14 genera viz. Centropyxis aculeata, Centropyxis ecornis, Centropyxis hemispherica, Vorticella sp., Bursaridium sp., Euplotes sp., Epistylis sp., Campanella sp., Paramecium Aurelia, Paramecium trichium, Paramecium caudatum, Colpidium sp., Euglypha sp. and Trachelomonas sp. Their maxima in summers might be due to due to availability of food and high rate of decomposition at high temperature (Wetzel, 1975 & Sharma, 2013). In monsoons, reduced amount of detritus caused by floods

and heavy rains caused a tremendous reduction in their number.
b.Rotifera: Rotifers followed Protozoa group contributing 10.89% and showed maxima during winters and minima during monsoons. This group was represented by 6 genera viz. Philodina sp., Rotaria sp., Euchlanis sp., Asplanchna sp., Trichocerca multicrinis and Philodinavus paradoxus. Their better development during cooler months coincides with the investigation of Heerkloss et al., 2005 and it might be due to higher oxygen content (Singh, 2004). A sharp decline in rotifer population was, however, recorded during monsoons which could be due to dilution of water resulting in lesser nutrients, reduced pH and DO level (Edmondson, 1965 & Sharma, 2013).
Characters of Philodinavus paradoxus: A new report of a rotifer species viz. Philodinavus paradoxus was made during the study period. This species reside in the littoral zone of the water-body under study (Fafioye & Omoyinmi, 2006) and has following characters: a. it is reptant, creeping with foot and rostrum b. Its corona is unspecialized c. its mastax is close to mouth d. it feeds by browsing and have a protrubale mastax which differs from that of other bdelloids in the structure and position of the trophy (Ricci & Melone, 1998).
c.Copepoda: This group stood at third rank in its abundance during the study period, contributing 6.91% of the total zooplankton. Their better development in warmer months (Heerkless et al., 2005) and the presence of rotifers which may serve as prey species for them might be responsible for their maxima in summers (Dieguez & Gilbert, 2002 and Sharma, 2013). The high water currents, increased water flow and other adverse conditions caused by the floods during monsoons might be responsible for their absence in monsoon season (Welcomme, 1975 & Ekpo, 2013).
d.Cladocera: This group contributed 0.41% of the total zooplankton population. This group showed its maxima in summers and total absence during monsoons. Their summer maxima might be due to low abundance of rotifers during this period as an inverse relationship between relative abundance of rotifers and cladocerans have already been reported by Larsen et al., 1996 & Singh, 2004. Their absence in monsoons might be due to drift by rapid water current and the turbidity caused by the surface runoff which interferes with the photosynthesis of phytoplankton, thus, inhibiting their multiplication and ultimately reducing their population due to food scarcity (Viroux, 2002 & Sharma, 2013).

From the correlation analysis between zooplankton and physico-chemical parameters (Table 4), it becomes clear that the protozoans, copepods and cladocerans were positively correlated with temperature. Protozoa showed positive correlation with FCO2, BOD, chlorides, sulphates and phosphates while rotifer showed positive correlation with pH and DO along with bicarbonates, sulphates and nitrates. Copepod population was positively correlated with FCO2, BOD, magnesium, chlorides and phosphates and cladocera with depth, FCO2, BOD, chlorides, sulphates and phosphates.

From the statistical analysis, various confirmations results were derived (Table 5). Shannon-wiener index revealed maxima for copepods and minima for Rotifers and Simpson index was higher for rotifers and minimum for copepods. The maximum and minimum values of species richness in terms of Margalef's index was of copepods and rotifers respectively and of Menhinick index was of cladocerans and protozoans respectively.

CONCLUSION:

The present study revealed that 36 genera of invertebrate fauna were recorded with abundance as Protozoa > Rotifera > Copepoda > Cladocera. This stream carried high biological productivity in terms of better population density of different zooplankton communities. In correlation to physico-chemical parameters, zooplankton existed under a wide range of environmental conditions, yet many species were limited by DO, pH and other physico-chemical factors. The presence of Philodina species throughout the study period indicates that the water-body is approaching towards eutrophication with the heavy inflow of organic pollutants. Also it is prevalent that zooplankton do have appearance and disappearance in different seasons of the year.

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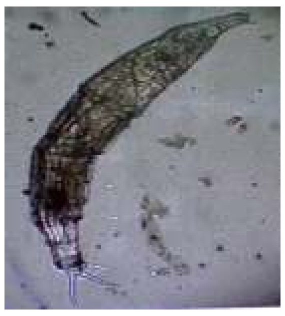
Diagram: showing new rotifer species from J&K



Philodinavus paradoxus

Table 1: Physico-chemical analysis of Devika stream (July, 2013-June, 2014)

S.No.	Months / Parameters	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1	Air tempt. (°C)	27	28	23	20	16	15	15	16	20	20	26	34
2	Water tempt. (°C)	26	26	22	19	17	16	17	17	18	18	21	26
3	Speed (m/sec)	.32	.38	.37	.49	.35	.28	.27	.30	.35	.32	.26	.22
4	Depth (cm)	55.5	55	51.3	47.1	40.4	37.7	36.7	41.7	46	45.3	42.7	36.5
5	pH	7.1	7.2	7.1	7.5	7.4	7.6	7.2	7.4	7.3	7.2	6.7	6.5
6	DO (mg/l)	4.6	4.9	4.6	4.7	6.5	6.8	5.3	5.6	5.1	5.5	4.4	3.9
7	FCO_2 (mg/l)	26	26	31.5	30.5	26	27.5	25.5	29.5	28.5	34.5	37.5	47
8	BOD (mg/l)	1.9	1.9	1.8	1.4	1.7	1.4	1.5	1.7	2.1	1.9	2.1	2.5
9	HCO_3- (mg/l)	227.75	197.03	219.11	206.92	220.82	232.19	222.16	206.18	201.6	194.71	187.38	179.33
10	Ca^{2+} (mg/l)	37.68	52.56	52.14	53.19	48.56	48.99	45.83	43.31	40.36	44.57	41.99	32.50
11	Mg^{2+} (mg/l)	127.59	178.73	159.83	182.07	168.7	165.09	159.86	156.48	127.44	131.66	168.29	162.1
12	Cl^- (mg/l)	48.25	44.5	47	43.5	46	45.5	42.5	38	42.5	52.25	60.5	58
13	SO_4^- (mg/l)	1.77	1.79	1.79	1.82	1.78	1.75	1.82	1.98	2.09	2.28	1.97	1.87
14	PO_4^{3-} (mg/l)	.085	.087	.059	.045	.034	.029	.039	.069	.123	.186	.137	.059
15	NO_3- (mg/l)	.57250	.57252	.57255	.57261	.57262	.57262	.57258	.57251	.57245	.57246	.57242	.57242

Table 2: Seasonal variation in the Zooplankton fauna of Devika stream (July,2013-June,2014)

S.NO.	Name of the organism	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	may	June
1.	*Centropyxis aculeata* (Ehrenberg, 1838)	+	-	+	+	+	+	+	+	+	+	+	+
2.	*Centropyxis ecornis* (Ehrenberg, 1841)	-	-	-	-	+	+	+	+	+	+	+	+
3.	*Centropyxis hemispherica*	-	-	-	-	-	-	-	-	-	-	+	+
4.	*Euglypha sp.* (Dujardin, 1841)	-	-	-	-	+	-	-	-	-	-	-	-
5.	*Bursaridium sp.* (Lauterborn, 1894)	-	-	-	-	-	+	+	+	+	-	+	-
6.	*Paramecium aurelia* (Ehrenberg, 1831)	-	-	-	-	-	-	+	+	+	+	-	-
7.	*Paramecium caudatum* (Ehrenberg, 1834)	-	-	-	-	-	-	-	-	-	-	+	+
8.	*Paramecium trichium* (Stokes, 1885)	-	-	-	-	-	-	-	-	-	-	+	+
9.	*Epistylis sp.* (Ehrenberg, 1831)	-	-	-	-	-	-	+	+	+	-	-	-
10.	*Colpidium sp.* (Stein, 1860)	-	-	-	-	-	-	-	-	+	+	+	+
11.	*Euplotes sp.* (Ehrenberg, 1830)	-	-	-	-	-	-	-	-	+	+	-	-
12.	*Trachelomonas sp.* (Ehrenberg, 1834)	-	-	-	-	-	-	-	-	+	+	-	-
13.	*Campanella sp.*	-	-	-	-	-	-	-	-	-	-	+	-
14.	*Vorticella sp.* (Ehrenberg, 1838)	-	-	+	+	+	+	+	+	+	+	+	+
15.	*Philodina sp.* (Hickernell, L.M., 1971)	+	+	+	+	+	+	+	+	+	+	+	+
16.	*Philodinavus paradoxus*(Murray, 1905)	-	-	-	-	-	-	-	-	-	-	+	+
17.	*Rotaria sp.* (Scapoli, 1777)	-	-	-	-	+	+	-	+	-	-	-	-
18.	*Trichocerca multicrinis* (Kellicott, 1897)	-	-	-	-	+	+	-	-	-	-	-	-
19.	*Euchlanis sp.* (Ehrenberg, 1832)	-	-	-	-	+	-	-	-	-	+	+	+
20.	*Asplanchna sp.*(Gosse, 1850)	-	-	-	-	-	-	-	+	+	-	-	-
21.	*Chydorus sp.* (Leach, 1843)	-	-	-	-	-	-	+	+	-	-	-	-
22.	*Ceriodaphnia sp.* (Dana, 1853)	-	-	-	-	-	-	-	-	-	+	+	+
23.	*Daphnia sp.* (O.F.Muller, 1785)	-	-	-	-	-	-	-	-	-	+	-	-
24.	*Alona sp.* (Birge, 1891)	-	-	-	-	-	-	+	-	+	+	-	-
25.	*Tropocyclop prasinus* (Fischer, 1860)	-	-	-	-	+	+	+	+	+	+	+	+
26.	*Macrocyclop albidus* (Jurine, 1820)	-	-	-	-	+	+	-	+	+	+	+	-
27.	*Macrocyclop sp.*	-	-	-	-	-	-	-	-	-	+	+	+
28.	*Cyclop magnus* (Marsh, 1920)	-	-	-	-	-	-	-	-	-	+	-	+
29.	*Cyclop scutifer* (Sars, 1863)	-	-	-	+	+	+	+	-	+	-	+	+
30.	*Cyclop bicolour* (Sars, 1863)									-			
31.	*Cyclop panamensis* (Marsh, 1913)	-	-	-	-	-	-	-	-	-	-	+	-
32.	*Mesocyclop leuckartii* (Claus,	-	-	-	-	-	-	-	-	-	-	+	-

Note: "+" indicates presence of organism
"?" indicates absence of organism.

Table 3: Group-wise monthly variation of zooplankton in Devika stream

S.No.	Months / Groups	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1	Protozoa	0.03	-	0.1	7.42	5.98	6.67	15.94	13.28	46.16	15.78	53.74	49.44
2	Rotifer	0.01	0.005	0.32	0.87	3.28	4.42	6.64	2.18	3.1	2.48	2.09	3.1
3	Copepod	-	-	-	0.35	1.65	1.92	2.54	1.44	0.99	2.04	3.53	3.61
4	Cladocera	-	-	-	-	-	-	0.03	0.03	0.03	0.12	0.06	0.07

Table 4: Correlation coefficient (r) between Zooplankton and various physico-chemical parameters

S.NO.	Parameters / Groups	Protozoa	Rotifera	Copepoda	Cladocera
1	Air temperature	0.48	-0.51	0.60	0.35
2	Water temperature	0.20	-0.62	0.61	0.25
3	Speed	-0.50	-0.52	-0.86	-0.05
4	Depth	-0.36	-0.86	-0.62	0.25
5	pH	-0.66	0.09	-0.84	-0.29
6	DO	-0.45	0.44	-0.38	-0.09
7	FCO_2	0.66	-0.02	0.65	0.51
8	BOD	0.73	-0.20	0.59	0.31
9	Bicarbonates	-0.80	0.16	-0.45	-0.54
10	Calcium	-0.62	-0.17	-0.65	-0.06
11	Magnesium	-0.56	-0.02	0.06	-0.25
12	Chloride	0.56	-0.08	-0.78	0.60
13	Sulphates	0.42	0.08	-0.01	0.63
14	Nitrates	-0.76	0.18	-0.53	-0.44
15	Phosphates	0.42	-0.23	0.15	0.68

Table 5: Different biodiversity indices for zooplankton in Devika stream

S.NO.	Indices / Groups	Protozoa	Rotifera	Copepoda	Cladocera
1	Total No. of species	14	6	12	4
2	Total no. of organisms	214.54	28.49	18.07	0.34
3	Shannon wiener (H')	1.61	0.34	1.80	1.09
4	Simpson index (I)	0.48	1.73	0.42	0.76
5	Margalef's index (R_1)	1.30	0.62	1.47	0.85
6	Menhinick index (R_2)	0.09	0.11	0.29	0.68

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