

Copepod Diversity, Status and Effect of Pollution

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ABSTRACT

Copepods are important component of zooplanktonic community of any freshwater ecosystem (Arak and Mokashe, 2012). Present attempt has been to enlist the copepod diversity of two freshwater ponds. Overall presently a total of 6 genera were reported; 5 genera with 9 species belonging to family Cyclopida and 1 genera with 1 species belonging to family Diapotomidae. Of the all it was presently recorded that quantitatively *Cyclop bicolor* was seen dominating in both the water bodies. Statistical analysis so applied revealed that there exist both interspecific and intraspecific competition both the water bodies.

1. Introduction

Zooplankton richness and diversity is the result of combination of various factors, range of habitat, intra and inter specific competition and the food availability in the form of primary and secondary productivity in the aquatic habitat. Hydroperiod is another aspect affecting the zooplankton richness (Frisch *et al.*, 2006). About 120 species of freshwater free living copepods are known from India (Uttangi, 2001). Freshwater copepods are one of the major zooplankton communities that are present in fresh water bodies. The copepods comprise of groups like Calanoids, Cyclopoids and Harpacticoids. Copepods are hardy and strongly motile as compared to other zooplankton because of the presence of tough and strong exoskeleton. Indirect development is seen with the presence of larval stages (nauplius). Copepods inhabit almost all types of lentic water bodies and are easily found in littoral and limnetic zones (Arak and Mokshee, 2012). Copepods are mostly predators and feed on protozoans, rotifers but also feed on algae and detritus, and in turn becomes prey to fishes, thus are an important interlace in aquatic food web.

2. Materials and methods

For the present study monthly sampling was done for the qualitative analysis of zooplankton by filtering water through plankton net (made of bolting silk with mesh size 70µm). 50 liters of water was filtered through planktonic net and the filtrate was collected in 100 ml plastic bottles and preserved in 5% formalin. The identification using the help of standard books and manuals viz: Edmondson (1992), Adoni(1985), Pennack(1989) was done. The quantitative estimation was done by using the formula: $N = \frac{A \times 1}{L} \times n/V$

Where: N= Zooplankton no. per litre of water, A= Total no. of zooplanktons counted per drop,

V= Volume of a drop (ml)

L= Volume of original sample in litres.

n= Total volume of concentrated sample

Two water bodies were selected i.e Talpad pond (station 1) and the Jonu pond (station 2). Station 1 is domestic pond located at about 25 km away from the main Udhampur city with

a muddy bottom and here water on little agitation becomes turbid. It is located at 32° 51' 38" N (latitude), 75° 11' 40" E (Longitude) and at an elevation of 675 m from sea level. Station 2 (Jonu pond) is about 28 km away from the main city and has cemented embankment. The bottom is not so muddy because of more gravel content at the base, so water is clear for most of the seasons. It is located at 32° 51' 06" N (latitude), 75° 12' 19" E (Longitude) and at an elevation of 757 m from sea level.

3. Results and Discussions

The 6 Genera of Copepoda presently recorded belong to Order Eucopepoda representing 2 Families viz. Cyclopida and Diapotomidae (Table 1,2,3). Seasonal analysis of data revealed dominance of Copepods during summers at both the study stations with 28.08 no./l and 16.04 no./l respectively (Table 9). Monthly analysis showed that copepods were maximum in the month of June at both the stations with 9.04 no./l and 12.66 no./l respectively (Table 1,2). The Copepod dominance in summer months could be due to their preference to warm conditions (Dar *et al.* 2009). The absence at station 1 or rare presence at station 2 in the month of January showing negative correlation with cold water. (Langer *et al.*, 2007).

Coming to the species dominance, quantitatively the ruling specie was *Cyclop bicolor* followed by *Halicyclop* species and *Tropocyclop prasinus* at station 1 while the least presence was shown by *Mesocyclop leuckartii*. *Cyclop bicolor* was present for the maximum period of 9 months while *Halicyclop* species for a period of 8 months in a year. At station 2 quantitatively the maximum contribution has been by *Cyclop bicolor* followed by *Mesocyclop tenius* and *Halicyclop* species. While *Tropocyclop prasinus* was present for the maximum period of 10 months followed by *Mesocyclop tenius* and *Halicyclop* species for a period of 9 months in a year. The least number was of *Diaptomous* species.

Comparative qualitative analysis of station 1 and station 2 revealed that all species were present at station 2 but at station 1 *Diaptomous* sp. and *Mesocyclop* sp. were absent.

Ecology of copepods reveals that vegetation provides a good habitat for these copepods and thus helps them in flourishing (Dutta and Verma, 2010). Absence or least presence of adult copepods in the month of January could be due to the diapause at egg stage which is an adaptive feature in copepods to avoid the harsh winters (Gyllestrom and Hansson, 2003; Dahms.1994).

Statistical analysis of the data was also done and Pearson correlation was applied. For station 1, indicated Cyclop sps., *C. scutifer* showed a positive correlation with dissolved oxygen indicating their association with well aerated waters while *Mesocyclop tenuis* showed positive correlation with the nitrates and free carbon-dioxide respectively. This indicating that *Mesocyclop tenuis* can tolerate the good amount of increasing FCO₂ and the other major elements in the water body i.e. tolerate the pollution to some extent. *Halicyclops* sps. showed a negative correlation with magnesium (Table 5). Within copepods the analysis highlighted a significant positive correlation of *C.bicolour* with *Halicyclops* sp. while *Eucyclop agilis* to *Tropocyclop* sp. and *Halicyclops* sp. (Table 6).

Similarly Pearson correlation was applied for copepods at station 2 revealed that significant positive correlation was seen among *Cyclop bicolour* and water temperature, *Mesocyclop*

tenuis and depth, *Eucyclop agilis* with phosphates and sulphates (Table 7). *Mesocyclop tenuis* showed positive correlation with both depth and free carbon-dioxide as with increase in depth the amount of carbon dioxide increases and amount of oxygen decreases. Significant positive correlation was seen between *Tropocyclop prasinus* and *Mesocyclop* sp. (Table 8). Analysing both the statistical correlation indicates interspecific competition among majority of the copepod species present at station 1 and 2. Various biodiversity indices were calculated for both the stations which are shown in table 4. This clearly indicates that the station 1 is richly diversified than station 2.

4. Conclusions

From the above discussion we can conclude that seasonal dynamics is well prevalent in copepod population. From the correlation tables of both the stations it is reflected there is extreme interspecific as well as intraspecific competition. Physico-chemical parameters played a significant role in the survival and the establishing of the species which was seen throughout the year.

Table 1: Showing seasonal abundance (no./litre) of zooplankton sps. at station-1

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	TOTAL
SUB-CLASS : COPEPODA													
ORDER : EUCOPEPODA													
FAMILY : CYCLOPIDA													
<i>Cyclop</i> sp.	-	1.32	-	-	-	-	-	-	-	-	-	-	1.32
<i>C. bicolour</i>	-	-	1.72	1.04	0.5	3.28	0.42	0.2	0.7	-	0.22	1.92	10.0
<i>C. scutifer</i>	-	2.94	-	-	-	-	-	-	-	-	-	-	2.94
<i>Halicyclops</i> sp.	-	-	1.56	-	-	1.3	0.64	0.04	0.26	0.34	0.34	1.24	5.72
<i>Mesocyclop. leuckartii</i>	-	-	-	-	0.22	-	-	-	-	-	-	0.12	0.34
<i>M. tenuis</i>	-	0.54	-	-	-	-	-	-	1.58	-	-	-	2.12
<i>Tropocyclop prasinus</i>	-	0.8	0.76	-	0.14	0.98	0.5	-	0.28	-	-	-	3.46
<i>Eucyclop agilis</i>	-	-	0.49	-	-	0.78	-	-	-	-	-	-	1.27
Nauplius larva	-	0.44	-	1.32	0.16	2.7	-	-	0.18	0.6	-	-	5.4
Total	0.00	6.04	4.53	2.36	1.02	9.04	1.56	0.24	3.00	0.94	0.56	3.28	32.57

Table 2: Showing seasonal abundance (no./litre) of zooplankton sps. at station-2

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
SUB-CLASS : COPEPODA													
ORDER : EUCOPEPODA													
FAMILY : CYCLOPIDA													
<i>Cyclop</i> sp.	-	0.28	-	-	-	0.52	0.02	-	-	0.88	-	-	1.7
<i>C. bicolour</i>	-	-	1.34	0.06	0.84	6.48	1.44	1.82	-	0.12	-	0.1	12.2
<i>C. scutifer</i>	-	0.38	-	-	-	-	-	-	-	-	0.66	0.24	1.28
<i>Halicyclops</i> sp.	0.22	-	-	1.16	0.22	1.16	1.08	-	0.54	0.34	0.8	1.2	6.72
<i>Mesocyclop</i> sp.	-	-	1.58	0.30	-	0.34	0.26	0.32	0.54	0.06	-	1.98	5.38
<i>M. leuckartii</i>	-	-	-	0.10	0.38	0.14	0.1	0.14	-	-	-	-	0.86
<i>M. tenuis</i>	-	-	-	0.10	0.06	0.74	0.12	3.02	0.68	0.96	0.94	0.54	7.16
<i>Tropocyclop prasinus</i>	0.04	-	1.34	0.6	0.36	0.14	0.42	0.2	0.32	-	0.56	0.32	4.3
<i>Eucyclop agilis</i>	-	-	-	0.58	0.32	0.24	0.14	-	-	0.16	-	0.1	1.54
Nauplius larva	-	0.14	1.42	1.12	0.22	2.58	0.6	0.42	0.88	-	1.28	0.88	9.54
FAMILY DIAPOTOMIDAE													
Genus: <i>Diapotomus</i> sp.	-	-	-	-	-	0.32	0.2	-	-	-	-	-	0.52
Total	0.26	0.80	5.68	4.02	2.40	12.66	4.38	5.92	2.96	2.52	4.24	5.36	51.20

Table 3: showing list of copepods at station 1 and 2

COPEPODA	Station 1	Station 2
1. <i>Cyclop</i> sp.	+	+
2. <i>Cyclop bicolour</i>	+	+
3. <i>Cyclop scutifer</i>	+	+
4. <i>Diaptomous</i> sps.	-	+
5. <i>Eucyclop agilis</i>	+	+
6. <i>Halicyclop</i> sp.	+	+
7. <i>Mesocyclop</i> sp.	-	+
8. <i>Mesocyclop tenuis</i>	+	+
9. <i>Mesocyclop leuckartii</i>	+	+
10. <i>Tropocyclop prasinus</i>	+	+
11. Nauplius larva	+	+

Table 4: showing various diversity indices for station1 and 2

Diversity indices	Station 1	Station 2
Simpson index	0.1784	0.1838
Dominance index	0.8216	0.8162
Shannon-wiener index	1.913	1.897
Menhinick index	0.2081	0.1864
Equitability index	0.8708	0.7912

Table 5: Showing correlation between Physico-chemical parameters and the copepod sps. at station 1

	Air temp.	Water temp	depth	ph	DO	FCO ²	CO ₃	HCO ₃	Ca	Mg	Cl	PO ₄	SO ₄	NO ₃
<i>Cyclop</i> sp.	-.006	.141	-.006	.166	.707*	-.280	0	-.102	-.313	.524	-.109	-.236	.489	-.272
<i>C.bicolour</i>	.539	.290	-.527	-.335	-.273	.551	0	-.224	.232	-.374	.576	-.278	.021	-.092
<i>C.scutifer</i>	-.006	-.141	-.006	.166	.707*	-.280	0	-.102	-.313	.524	-.709	-.236	.489	-.272
<i>Halicyclop</i>	.261	.058	-.308	-.291	-.016	.255	0	.330	.443	-.686*	.521	-.134	.016	.002
<i>M.leuckarti</i>	.085	-.228	-.271	.234	-.080	.150	0	.050	.056	.346	-.028	-.105	-.270	-.113
<i>M.tenuis</i>	-.221	.010	.402	-.311	.168	-.220	0	-.436	.199	.049	-.210	.00	-.021	-.725**
<i>Tropocyclop</i> sp.	.558	.372	-.548	-.401	.102	.404	0	.106	-.138	-.209	.545	-.422	.331	-.225
<i>Eucyclop agilis</i>	.565	.357	-.544	-.341	-.294	.554	0	.198	.055	-.402	.538	-.194	.121	-.291
<i>Nauplius</i> larvae	.471	.440	-.556	-.238	-.448	.711**	0	.080	.080	.009	.486	-.083	-.076	-.227

Table 6: showing pearson correlation among copepod species at station 1

	<i>Cyclop</i> sp.	<i>C.bicolour</i>	<i>C.scutifer</i>	<i>Halicyclop</i>	<i>M.leuckarti</i>	<i>M.tenuis</i>	<i>Tropocyclop</i> sp.	<i>Eucyclop agilis</i>	<i>Nauplius</i> larvae
<i>Cyclop</i> sp.	1								
<i>C.bicolour</i>	-.261	1							
<i>C.scutifer</i>	1.00**	-.261	1						
<i>Halicyclop</i>	-.261	.799**	-.261	1					
<i>M.leuckarti</i>	-.128	.074	-.128	-.030	1				
<i>M.tenuis</i>	.244	-.127	.244	-.202	-.168	1			
<i>Tropocyclop</i> sp.	.432	.512	.432	.510	-.236	-.137	1		
<i>Eucyclop agilis</i>	-.131	.830**	-.131	.727**	-.185	-.171	.738**	1	
<i>Nauplius</i> larvae	-.004	.662*	-.004	.231	-.190	-.104	.456	.676	1

Table 7: Showing correlation between Physico-chemical parameters and the copepod sps. at station 2

	Air temp.	Water temp.	depth	pH	DO	FCO ₂	CO ³⁻	HCO ³⁻	Ca ²⁺	Mg ²⁺	Cl-	PO ₄	SO ₄	NO ₃
Cyclop sp.	-.147	.141	-.080	.270	.207	-.053	-.157	.005	.262	.094	.411	-.170	-.022	.158
C.bicolour	.483	.666*	-.106	.076	.117	-.069	-.173	.193	-.043	-.142	.929**	-.072	.417	.463
C.scutifer	-.315	-.238	-.178	.110	.020	-.100	-.157	-.120	.278	.295	-.168	-.273	-.334	-.397
Halicyclop sps.	.138	.244	-.306	.250	.521	-.030	-.217	-.270	.149	-.004	.433	.350	.140	.029
Mesocyclop sp.	.186	-.082	-.054	-.043	-.017	-.147	-.217	-.233	.064	-.237	-.059	-.036	.100	-.098
M.leuckarti	.480	.389	.005	-.318	-.034	.304	-.199	-.058	-.461	-.296	.266	.052	.512	.552
M.tenuis	.106	.340	.876**	-.316	.388	.342	-.221	-.333	.492	-.404	-.035	-.028	-.393	.049
Tropocyclop sp.	-.001	-.219	-.097	.140	.006	-.193	-.180	-.288	.233	-.147	-.138	-.106	-.047	-.282
Eucyclop agilis	.351	.186	-.314	-.132	.372	-.551	-.225	-.411	-.493	.159	.263	.595*	.686*	.416
Nauplius larvae	.356	.404	-.314	-.030	-.392	.079	-.375	-.180	-.025	.064	.746**	.266	.492	.271
Diapotamous sp.	.413	.689*	-.240	.261	.166	-.255	-.131	.294	-.037	-.101	.873**	-.090	.241	.424

Table 8: showing pearson correlation among copepod species at station 2

	Cyclo p sp.	C.bicolour	C.scutifer	Halicyclop sp.	Mesocyclop sp.	M.leuckarti	M.tenuis	Tropocyclop prasinus	Eucyclop agilis	Nauplius larvae	Diapotamous sps.
Cyclop sp.	1										
C.bicolour	.309	1									
C.scutifer	-.113	-.295	1								
Halicyclop sp.	-.018	.265	.086	1							
Mesocyclop sp.	-.260	.002	-.064	.197	1						
M.leuckarti	-.133	.328	-.344	-.019	-.291	1					
M.tenuis	.082	.197	-.007	-.173	-.072	.055	1				
Tropocyclop prasinus	-.175	-.176	-.117	.368	.871**	-.223	-.082	1			
Eucyclop agilis	.090	.583	-.333	.498	-.148	.521	-.262	-.012	1		
Nauplius larvae	.018	.718**	.052	.543	.315	-.009	-.006	.102	.195	1	
Diapotamous sps.	.297	.865**	-.226	.522	-.09	.211	-.051	-.180	.185	.621*	1

Table 9: showing no./l of copepod species at station 1 and 2

No. of copepods/litre	Station 1	Station 2
Summers	28.08	16.04
Monsoons	5.95	15.78
Winters	13.34	10.97
Total	47.37	42.79
Mean	15.79	14.26
Std. Deviation	11.26	2.85

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