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On the Extra-Aquatic Fungi from Polluted and Unpolluted Water of River Kapila, Karnataka

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The results of a two-year ecological study on fungi of river Kapila are presented. An attempt has been made to correlate the physico-chemical factors of the habitat with the fungal number in unpolluted and polluted environments. Fungi as indicator of pollution are discussed.

Key Words: Fungi, Polluted and unpolluted water, Index organisms

Introduction

Seasonal fluctuations of various physico-chemical factors in aquatic systems play an important role in the distribution, periodicity, qualitative and quantitative composition of fresh water fungi (Manoharachary 1978, 1979 and Madhusudan Rao & Manoharachary 1981). Relatively few studies on extra-aquatic fungi in fresh water ponds, rivers, streams, sewage and other habitats exist (Becker & Shaw 1955, Church et al. 1972, Cooke 1963, 1976, Feldman 1955, Gareth Jones 1976, Harvey 1952, Hynes 1960, Noel 1973, Park 1972, Sladeck 1969 and Willoughby 1962, 1965). However, in India such studies are very few and mention may be made of Barauh and Bora (1979), Vishwe and Umalkar (1979), Manoharachary (1979) and Madhusudan Rao and Manoharachary (1981). In the present investigation, an attempt has been made to study the physico-chemical complex of the waters of the river Kapila in relation to the distribution of extra-aquatic fungi in polluted and unpolluted environments.

Material and Methods

River Kapila is one of the important rivers of Karnataka with a total length of 214 km. Monthly collection of samples was made for a period of two years (January 1979 to December 1980) from four stations (stretched over a distance of about 10 km near Nanjangud, 22 km from Mysore City) varying in degree of pollution.

Station 1 : Unpolluted upstream

Station 2 : Highly polluted station and it receives effluents from a textile factory situated in Nanjangud town and located at a distance of about 4 km away downstream from station 1

Station 3 : Located at about 2 km downstream the station 2

Station 4 : Situated down below station 3 and is about 2 km away from it, often it gets polluted through domestic wastes discharged from Nanjangud town.

Standard methods (APHA 1976) were employed for the collection, preservation and analysis of water samples. Samples for mycological examination were collected in sterile pyrex bottles and fungi were isolated following 'Willoughby's technique' (Willoughby 1962). Fungal number was estimated using Waksman dilution plate method (Johnson & Curl 1972), using potato dextrose agar and neopeptone dextrose aureomycin rose bengal agar.

Results and Discussion

I. *Physico-chemical factors*

In the present study following physico-chemical factors have been considered to assess the degree of pollution.

1. *Rainfall*

Average values of rainfall for the study period are given in figure 1. Maximum rainfall recorded during rainy season is about 214 mm.

2. *pH*

Monthly variations in *p*H values are given in figure 2. All the stations were characterised by alkaline *p*H and it was more at the polluted station 2. Hence, it is concluded that the fungi encountered in the present study can tolerate an alkaline *p*H (7.4–10.4).

3. *Temperature*

Water temperature did not show any significant variation at all the stations except at station 2 where it is little higher as compared to other stations (figure 1).

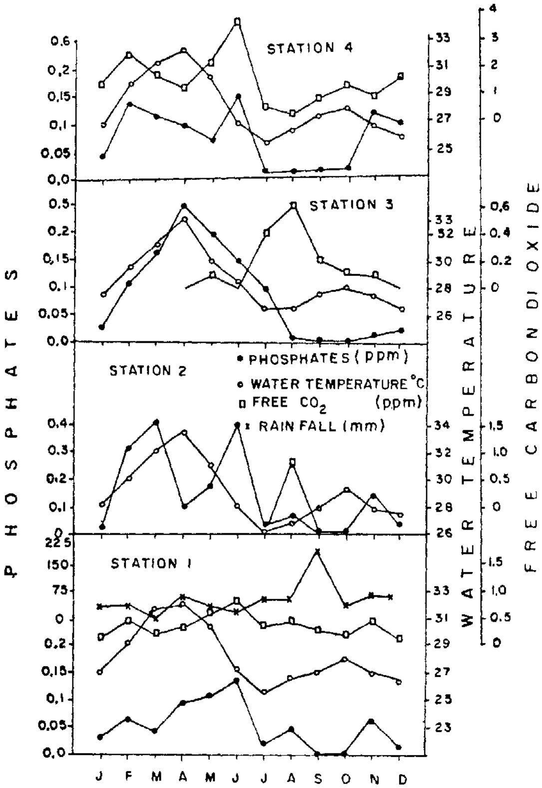

FIG 1

4. *Dissolved oxygen*

Dissolved oxygen is an important factor intimately associated with the biochemical changes and the metabolic activities of the organisms. Station 2 showed significant variation in dissolved oxygen content with respect to variation in effluent concentration and the discharge of water in the river. The maximum value was recorded (7.1 mg/l) during July and the minimum (1.6 mg/l) during February (figure 2).

5. *Oxidizable organic matter*

Unpolluted station 1 recorded lower amount (0.36 mg/l) of oxidizable organic

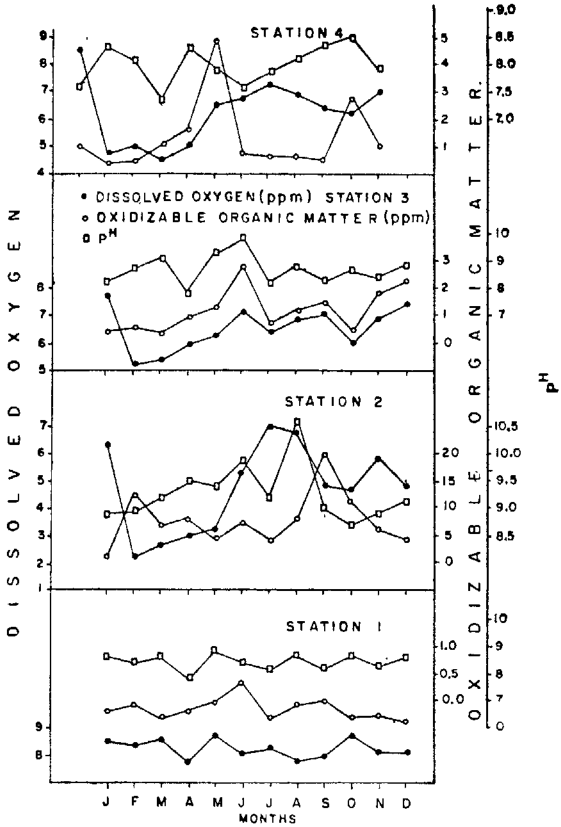

FIG. 2

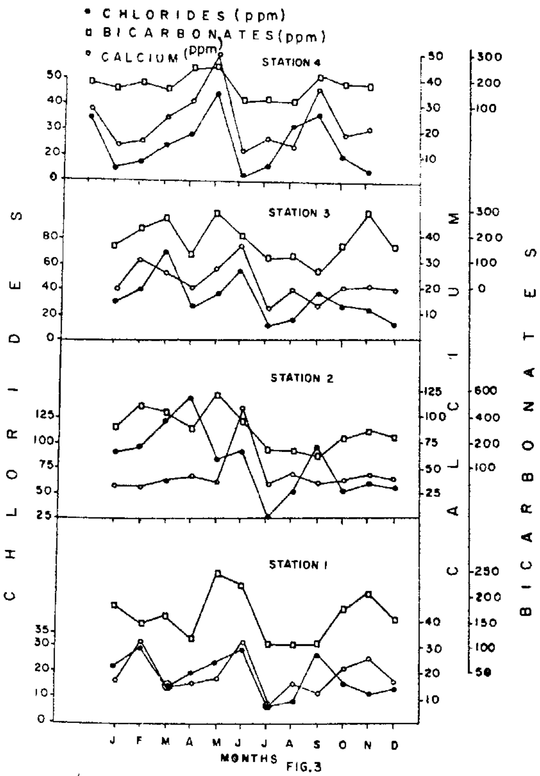

FIG. 3

matter while station 2 exhibited an average amount (4.82 mg/l). An inverse relationship between organic matter and dissolved oxygen has been established (figure 2) which was also recorded by Venkateswarlu (1969) and Warren (1971).

6. *Chlorides*

Significant variation in chloride concentration was observed at all the stations and there is a gradual increase in chloride concentration from the unpolluted station to the polluted stations (figure 1). Polluted station 2 always recorded higher chloride values.

7. *Free CO_2, Bicarbonates and Calcium*

An inverse relationship between free CO_2 and dissolved oxygen has been established (figures 1 & 3). In general, free CO_2 is maximum during rainy season and minimum during summer when the *p*H is higher. At all the stations except station 1 increase in bicarbonate content is accompanied by an increase in calcium concentration. Higher concentration of bicarbonates at station 1 could be attributed to the conversion of insoluble $CaCO_3$ to soluble bicarbonates in the presence of CO_2.

8. *Nitrogen complex*

Nitrate concentration of the river water at different sampling stations showed a narrow range of fluctuation (figure 4). Increase in nitrate concentration during April, June, October and November is probably due to heavy rains during the period of investigation.

Nitrite concentration in the water was low (figure 4). Comparatively little higher nitrite values were recorded at station 2.

Free ammonia, a product of decomposition of organic matter is associated with chlorides in polluted waters and for some stations an inverse relationship has been established between the two (figure 4).

9. *Phosphates*

Monthly variations in phosphate concentration for different sampling stations are given in figure 1. Stations 3 and 4 recorded higher values of phosphates and this is probably due to mixing up of domestic wastes with river water.

II. *Biological factor*

The fungal population at all stations showed marked seasonal variation with winter maxima and summer minima (table 1).

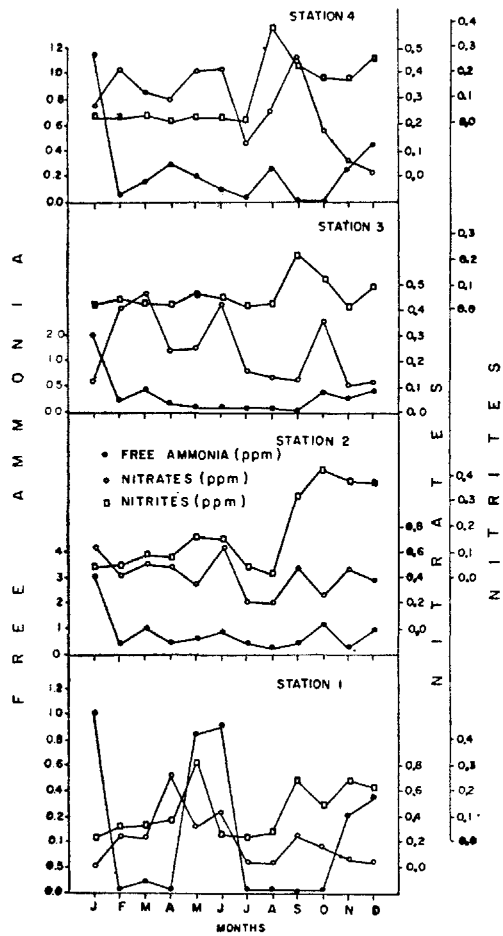

FIG. 4

Higher temperatures coupled with higher amounts of oxidizable organic matter and other nutrients (figures 1 & 2) are responsible for the paucity of fungi during summer. Similarly, low temperatures coupled with surface run off, arrival of soil particles, leachates and heavy rainfall are responsible for the abundance of extra-aquatic fungi during winter.

Polluted station 2 recorded the highest number of fungi as compared to lowest in unpolluted station 1. The variation is attributed to the difference in *p*H, temperature, oxidizable organic matter, dissolved oxygen and bicarbonate contents of water. This is in conformity with the observations of Barauh and Bora (1979) and Madhusudan Rao and Manoharachary (1981).

Tabak and Cooke (1968) have shown that at least 13 species of geofungi can survive in the absence of oxygen and many of them tolerate organic pollution. It is evident from the table 2 that a positive correlation exists between *p*H, dissolved oxygen, organic matter, chloride content of water and fungal number. It also shows that calcium, phosphates free and nitrate nitrogen have a role to play during their life cycle in the aquatic environment.

Barauh and Bora (1970), Cooke (1963), Manoharachary (1979), Park (1972), Vishwe and Umalkar (1979) and Willoughby (1962) have recorded the dominance of *Cladosporium*, *Mucor*, *Fusarium* and *Aspergillus* in polluted water. In the present study, *Aspergillus awamori*, *A. candidus*, *A. ochracious*, *Fusarium oxysporum*, *F. solani* and *Trichoderma viride* dominated the polluted water.

Table 1 *Monthly and seasonal counts of extra aquatic fungi (Average values for two years, in thousand/l)*

Months	Fungal number			
	Station 1	Station 2	Station 3	Station 4
January	45	78	70	68
February	24	43	44	30
March	20	31	26	28
April	10	20	15	14
May	21	33	30	26
June	48	69	51	48
July	37	60	50	41
August	53	74	61	60
September	35	63	57	44
October	42	58	63	48
November	82	114	93	81
December	54	86	71	60
Summer Mean	18.75	31.75	28.75	24.50
Monsoon Mean	43.00	64.80	56.40	48.20
Winter Mean	60.33	92.60	78.00	69.66
Total Mean	40.69	63.05	54.38	47.45

Table 2 *Correlation coefficients (r) between fungal number and the physico-chemical factors**

Physico-chemical factors	Stations			
	1	2	3	4
*p*H	0.483	0.556	0.497	0.567
Water temperature	0.162	—0.326	0.024	0.182
Dissolved oxygen	0.673	0.664	0.561	0.683
Free CO_2	0.430	0.543	—0.072	0.544
Oxidizable organic matter	0.529	0.713	0.684	0.541
Chlorides	0.460	0.486	0.560	0.557
Bicarbonates	0.080	0.389	0.418	0.362
Phosphates	0.505	0.383	0.393	0.992
Free ammonia	0.484	0.717	0.801	0.478
Nitrate Nitrogen	0.490	0.467	0.436	0.535
Nitrite Nitrogen	0.040	0.309	0.086	0.054
Calcium	0.410	0.403	0.436	0.453

* Significant if above + 0.500

Table 3 *Extra-aquatic fungi observed at different stations*

Sl No.	Taxa	Stations			
		1	2	3	4
1.	*Aspergillus awamori*	—	+	+	+
	A. candidus	—	+	+	+
	A. fumigatus	—	—	+	+
	A. flavus	—	+	+	+
	A. nidulans	—	—	+	+
	A. niger	+	—	—	—
	A. ochracious	+	+	+	+
	A. restrictus	—	+	+	—
	A. terreus	+	+	+	+
2.	*Cladosporium cladosporoides*	+	+	+	+
	C. herbarum	+	+	+	+
3.	*Acrophialophora fusispora*	—	+	—	—
4.	*Chaetophoma* sp.	—	+	—	—
5.	*Drechslera tetramera*	—	+	+	—
6.	*Botryodiplodia theobromae*	—	+	+	—
7.	*Fusarium decemcellularae*	—	+	—	—
	F. moniliforme	—	+	+	+
	F. oxysporum	+	+	+	+
	F. semitectum	—	+	+	+
	F. solani	+	+	+	+
8.	*Myrothecium roridum*	—	+	+	+
9.	*Penicillium chrysogenum*	—	+	—	+
	P. citrinum	+	+	+	+
	P. rubrum	—	+	+	+
10.	*Periconia byssoides*	+	+	+	+
11.	*Trichoderma viride*	+	+	+	+
12.	*Trichurus pillaris*	—	+	+	+
13.	*Verticillium glaucum*	+	+	+	+
	V. albo-atrum	—	+	—	—
14.	*Mucor luteus*	+	+	+	+
15.	*Rhizopus arrhizus*	+	+	+	+
	R. nigricans	—	+	+	+
16.	Yeasts	+	+	+	+

+, Present; —, Absent

Loudon (1972) has stressed upon the importance of fungi as indicators of pollution. *Aspergillus awamori*, *A. ochracious*, *A. terreus*, *Cladosporium herbarum*, *C. cladosporoides*, *Fusarium oxysporum*, *Trichoderma viride* and *Verticillium glaucum* were encountered throughout the period of investigation and are considered to be the index organisms of pollution.

Extra-aquatic fungi appear to play an important role in the digestion of organic matter and other pollutants (Cooke 1976). Altogether 30 species of fungi were identified from different stations (table 3). These fungi constitute mostly soil and aeromycoflora and are dominated by fungi imperfectii and are well established saprobes capable of decomposing the organic matter present in the environment and thus take part in the cycling of elements.

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