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Fungi of Waste Water Environment in Relation to Pollution of the Hooghly River

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Forms and distribution of fungi in two sources each of industrial, town and village waste waters that are discharged to estuarine section of the river Hooghly in West Bengal were studied. Population values of fungi which were generally low increased with increaese in DO level and BOD/COD ratios of these waste water sources. Seventyone different species of filamentous and yeast fungi belonging to twentynine genera were obtained from all the sources together, of which twentytwo species were common to all sources. Diversity of fungal species was highest in the industrial waste waters with thirtyfive species exclusively occuring in the two sources studied. Species belonging to *Aspergillus-Penicillium*, *Fusarium-Acremonium*, *Phoma-Preussia*, *Trichoderma-Gliocladium* and *Trichosporon* predominated in these waste waters. In sedimented sludge samples population quantity was higher than that in respective waste waters but qualitative and quantitave distribution of the species was similar in both cases. It was revealed that 60—65% of the fungi isolated were lymaxenes, 25–30% were lymaphiles and the rest were casual invadors, all possibly were transported to the waste water environment with soil organic detritus.

Key words : Waste water environment, Pollution, Hooghly river, Fungi, Taxonomy

INTRODUCTION

The problem of pollution of the river Ganges is a matter of national concern today. The main mass of pollution today, as far as the river Ganges is concerned, is from the discharge of untreated sewage generated from human and industrial activities. In the estuarine part of the deltaic tidal section of the Hooghly river, 60—70% of waste water and total solids are contributed by domestic sources and the rest comes from industries (Dasgupta, 1984). The total volume of liquid waste discharged to the estuarine section of the river is

252 million gallons/day of which 77 million gallons/day is contributed by various industries. This large quantity of waste water, contaminated with a host of substances, find its way to the river and cause pollution. Fungi are important community segments of most waste water systems (Cooke, 1979) and play an important role in waste treatment and purification (Cooke, 1976 ; Ahmed, 1979 ; Stueit *et al.*, 1987). In the context of an investigation on self purification of waste waters discharged to the river Hooghly in West Bengal forms and distribution of fungi in different waste water sources and their taxonomic separation have been attempted.

MATERIALS AND METHODS

Two separate sources each of industrial (pulp manufacture), urban and village waste water drainage channels from approximately 10 km. stretch of the Hooghly river on its eastern side between Police Stations Kalyani and Naihati were selected for the study. Untreated waste water from these channels were being discharged to the river. Conventionally treated urban sewage water of a small city (Population ca 80,000) was also included in the study. Replicate samples of waste water and sludge were collected from various points of the drainage channels before their discharge to the river following standard method (Anonymous, 1975). Samples of river water were also collected from confluences points of drainage channels and approximate midpoints of the stream perpendicular to the discharge points of the channels. Water and sludge samples were analysed immediately for pollution parameters by standard methods of analysis (Anonymous, 1975 ; Hortwitz, 1980). Fungi were enumerated and isolated by conventional serial dilution plate count method in Dextrose-Peptone-Rose Bengal Aureomycin Agar medium (Cooke, 1954) using suitable replications and identified with reference to standard description of the species (Thom and Rapper, 1945 ; Raper *et. al.*, 1945 ; Lodder and Van Rij, 1970 ; Booth, 1971 ; Domsch *et al.*, 1980).

RESULTS AND DISCUSSION

Analysis of waste water samples (Table 1) from the different sources for common pollution parameters showed that reaction of untreated raw sewages of industries and towns were slightly alkaline and that of the river water and treated sewage were slightly acidic to neutral. The variations of pH among these sources were within tolerance limits of fungi. Dissolved oxygen status (Table 1) of raw sewages of industries and towns were characteristically very low due to a high content of oxidizable organic matter. Village effluents had a higher dissolved oxygen level than other sources. While BOD, COD ratios of industrial

Table 1 : *Organic pollution load and population count of total fungi in waste water samples discharged to the river Hooghly*

Parameters	Untreated Industry		Sewage Town		from Village		Town Sewage primary treatment	(4) after secondary treatment	Sewage Mixed with river water			River Water median Line
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(3)	(6)	
DO (ppm)	0.50	0.25	0.50	0.28	4.80	2.80	0.80	1.20	5 20	8.70	9.70	10.1
BOD (ppm)	186.0	243.0	164.0	247.0	28.2	47.4	193.0	167.0	21.0	11.4	17.4	1.8
COD (ppm)	268.0	370.0	220.0	330.0	14.4	18.2	292.0	248.0	74.0	58.0	5.2	1.0
BOD/COD	0 60	0.60	0.75	0.74	1.9	2.6	0.66	0.67	0.2	0.2	3.3	0.8
pH	7.8	7.8	7.0	7.8	7.0	7.2	7.0	6.5	7.0	6.5	6.5	6.5
Total Count. ($ml^{-1} \times 10^2$)	2.0	1.4	2.6	1.8	27.5	11.0	4.6	13.0	0.8	1.1	0.8	0.06

and town sewages were low (less than 1) the same for village sewages were high (more than 1). The total fungal population of the raw sewage was generally low and there was an apparent relationship between populations of fungi and BOD/COD ratio and DO status of sewages (Table 1). Population values of fungi of the sewages increased with increases in both DO and BOD COD ratios. Although the BOD/COD ratio of town sewage remained unaltered between two treatments, populations count of fungi increased only after secondary treatment probably due to a higher level of dissolved oxygen. A considerable dilution effect of flowing river water was also apparent from the data (Table 1).

A large and varied population of filamentous and yeast fungi were obtained from these waste water sources (Table 2). Quantitativerly, among the filamentous fungi, *Aspergillus* and *Penicillium* followed by *Fusarium.Acremonium*, *Trichodema-Gliocladium* and *Phoma-Preussia* predominated in these waste water sources. Yeasts, particularly *Trichosporon* spp., occcured in significantly high quantity in these waste waters. Treatment of town sewage by conventional method marginally altered the proportional distribution of different fungi. Populations of *Cladosporium* and *Phialophora* were very distinctly increased in town sewage after treatment (Table 2).

Table 2 : *Species population of fungi in waste water environment*

Organism	Population as % total				
	Raw effluents of Industry	Town	Village	Town Primary treatment Sewage	after Secondary treatment
Aspergillus spp.	26.3(14)	29.4(8)	25.8(4)	19.5	16.4
Penicillium spp.	14.3(15)	21.3(4)	23.1(5)	11.3	12.8
Fusarium spp.	9.1(3)	11.7(1)	14.5(1)	10 5	5.6
Acremonium spp.	5.9(3)	1.6(1)	1.2(1)	3.2	1.5
Preussia spp.	3.4(3)	2.0(1)	1.8(1)	5.6	2.6
Phoma spp.	1.2(3)	1.4(1)	1.3(1)	1.6	1.2
Cladosporium spp.	1.2(1)	1.5(2)	3.2(2)	10.3	14.4
Trichoderma spp.	4.2(4)	2.4(1)	2.2(1)	2.1	4.8
Gliocladium spp.	1.2(2)	0.8(1)	0.8(1)	1.1	2.7
Geotrichum sp.	1.0(1)	1.7(1)	2.8(1)	3.2	4.6
Humicola spp.	1.0(2)	2.2(1)	1.8(1)	5.4	6.2
Bahupaathra spp.	0.8(1)	—	—	—	—
Paecilomyces sp.	0.4(1)	—	—	—	—
Nigrospora sp.	0.4(1)	0.8(1)	1.2(1)	—	—
Phialophora sp.	0.8(1)	2.8(2)	3.7(2)	9.6	10 8
Other species	3.0(13)	4.2(5)	4.5(6)	2.0	2.2
Unidentified (sterile)	—	0.6	0 9	3.0	4 5
Yeast	25.4(1)	15.6(1)	11.2(1)	11.5	9.7

Figures within parenthesis represent number of separate species obtained from the respective sources

Table 3 : *Distribution of different species of fungi to different waste water sources*

Fungi common to all waste sources	Fungi common to industrial and town wastes	Fungi common to industrial and village waste	Fungi common to town and village wastes	Fungi occuring exclusively in industrial wastes
Trichosporon custaneum, Aspergiilus terreus, Aspergillus sydowii, Aspergillus niger, Aspergillus flavus, Penicillium funiculosum, Penicillium veriabile, Fusarium solani, Acremonium strictum, Phoma nebulosa, Preussia terricola, Trichoderma harzianum, Gliocladium virens, Humicola grisea, Geotrichum candidum, Nigrospora oryzae, Hyalodendron sp., Phialophora sp. (1) Cladosporium cladosporioides, Mucor hiemalis, Rhizomucor pusillus and Syncephalastrum racemosum. (Total-22)	Aspergillus tamarii, Aspergillus versicolor, Emericella nidulans, Emericella fruticuosa, Penicillium nigricans, Penicillium wortmanii and Sphaeropsis sp. (Total-7)	Penicillium oxalicum, Penicillium vinaceum, Penicillium chrysogenum, Absidia corymbifera and Curvularia verruculosa. (Total-5)	Phialophora sp. (2) and Cladosporium sp. (Total-2)	Aspergillus foetidus, Aspergillus clavatus Aspergillus ochraceus, Aspergillus phoenicis, Aspergillus japonicus, Fennellia flavipes, Penicillium spiculisporum, Penicillium fellutarum, Penicillium stipitatum, Penicillium janthinellum, Penicillium citrirum, Penicillium vermiculatum, Penicillium sp. Eupenicillium sp., Fusarium merismoides, Fusarium ventricosum, Acremonium persicinum, Acremoniun curvulum, Trichoderma viride, Trichoderma koningii, Trichoderma sp., Gliocladium roseum, Preussia dispersa, Preussia multispora, Phoma capitulum, Phoma leveillei, Myrothecium roridum, Asteromella sp., Bipolaria sorokiniana, Bahupaathra samala, Sporotrichum pruinosum, Humicala sp., Paecilomyces lilachinus, Leptosphaerulina trifolii and an arthrospor'c anamorph of basidiomycete. (Total-35)

Excluding the sterile fungi which remained unidentified seventy one different species of fungi were obtained from all the sources (Table 2). Diversity of species was highest in industrial waste water and sixtynine different species of fungi were obtained altogether from the two sources studied (Table 2). Among the seventyone species, twenty two species were common to all the sources (Table 3). Besides these, there were seven, five and two species common to industry and town, industry and village and town and village sources respectively. While there were only two species exclusive to both village and town sewages, while the industrial sewage had thirty five species exclusive to it (Table 3).

Sedimented sludge samples (Table 4) of these waste waters when compared showed a very high population of fungi in industrial and town sewages. Lower fungal population in village sewage sludge probably was related to its lower

Table 4 : *Population of fungi in sludge samples of different waste waters*

	Sludge Samples of		
	Industry	Town	Village
Organic Carbon (%)	3 5	2 94	0.441
pH	7.5	6 2	6.0
Total count, $gm^{-1} \times 10^5$	7.2	9.8	0.4
Organisms	Population as %		Total
Aspergillus spp.	32.8	16.4	21.6
Penicillium spp.	16.7	12.8	13 8
Fusarium spp.	10 5	5.6	19.6
Acremonium spp.	4.8	2 0	0.8
Preussia spp.	7.8	2.6	1.2
Phoma spp.	1.2	5.6	1.6
Cladosporium spp.	2.2	14.4	2.2
Trichoderma spp.	4.3	3.6	1.8
Gliocladium spp.	3.0	2.2	3.8
Geotrichum spp.	1.3	4.8	16.4
Humicola spp.	2.1	4.2	4.0
Nigrospora sp.	0.4	1.2	0.8
Phialophora sp.	—	3.4	2.1
Other species	0.4	8.4	2.7
Unidentified (sterile)	2.6	4.1	2.2
Yeast	10.0	8.7	4.4

organic matter content (Table 4). Quantitatively, species composition of fungi (Table 4) in sewage sludge samples was similar to that of the respective waste

waters with a very characteristic reduction in the population of yeasts in the former. There was no fungal genus or species exclusive to sludge samples. Taxonomic separation of the seventyone identified species showed the dominance of filamentous hyphomycetes in waste waters (Table 5).

Table 5 : *Proportional distribution of waste water fungi to different taxonomic groups*

Class	Proportional distribution (%)
Zygomycetes	5.56
Plectomycetes	5.56
Loculoascomycetes	8.33
Blastomycetes	2.78
Hyphomycetes	70.83
Coelomycetes	6.94

The fungi isolated from the waste waters were all soil fungi common to most environments. They were possibly transported from the surrounding soil to the waste water habitat through detritus matter. No characteristic lymabionts or typical aquatic fungi were isolated possibly due the medium used was not suitable for their separation. Apart from the casual invadors like *Bipolaris sorokiniana*, *Leptosphaerulina trifolii* etc., majority were either lymaxenes (60-65%) and lymaphiles (25-30%). Some of the lymaphiles like *Paecilomyces*, *Phoma*, *Hyalodendron*, *Phialophora*, *Sporotrichum* etc. were not obtained from the surrounding soil through where the channels passed. Among the yeasts there were a few known human or animal pathogens (eg, *Trichosporon cutaneum*). Excluding a few species which are ecologically consumers or sugar fungi, several species known for their decomposer functions for plants structural polymers including soft wood lignin (eg, *Trichoderma*, *Sporotrichum*, *Humicola*, *Paecilomyces*, *Gliocladium*, etc.) were present in the waste waters. Among the typical consumers like *Aspergillus*, *Fusarium*, *Acremonium*, *Phialophora* and *Cladosporium* etc. there were some species known for their degradative potentials for not only the plant structural polymers but also of synthetic hydrocarbons and aromatics (Domsch *et al.*, 1980).

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