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Fungi Associated with Cellulose Decomposition in Natural Waters

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Quantitative and qualitative estimation of fungal population associated with the cellulose (Whatman No. 1 filter paper) exposed to two ponds and two streams was done. The fungal population was higher in streams than in the ponds. The rate of decomposition of cellulose was studied on weight loss basis using an exponential decay model. The decomposition rate in streams was appreciably higher than the ponds.

Key Words: Cellulose decomposition, Fungal population, Natural waters

Introduction

The importance of allochthonous organic matter in the metabolism of aquatic ecosystems has been greatly emphasized in the recent past (Hynes 1963, Jordon & Linkens 1975). The major component of extraneous nutrients of different lakes and streams is contributed by plant leaf litter, of which 60–70% is in the form of cellulose (Bellamy 1975). Schroeder (1978) has reported that cellulose decomposition rate is one of the best measure of the rate of digestion of plant litter. The Fungi are major decomposers on terrestrial habitats and they often dominate over bacteria (Anderson & Domesch 1975). Park (1972) has questioned the role of terrestrial fungi in the breakdown of organic matter in aquatic habitats and suggested the need for investigating their ecological role in aquatic systems. Relatively few studies are available on the mycoflora associated with the cellulose decomposition in natural waters (Park 1972, 1974a, 1974b, 1977, Egglishaw 1972). Since no such study is available in tropical and subtropical waters pertaining to cellulose decomposition in natural waters, the present investigation was undertaken.

Locality and Habitat Types

The present investigation was carried out in two still water-bodies and two running waters (table 1). The Fish Dale is a small reservoir of approx. 500m^2 surface area which is in use for fish culture. The Ward Lake is a big pond of 23800m^2 surface area and often used for recreational purpose. The stream was 0.25m and deep and 3m

Table 1 *Physico-chemical characters of different water bodies (Values are mean of 4 collections)*

Stations	Temp. (°C)*	*p*H	Depth (m)	Dissolved oxygen (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)
Fish Dale	21.50 14.0	6.80	0.50	7.20	2.60	2.80
Ward Lake	21.50 17.0	6.60	0.50	8.50	1.20	1.60
Stream	18.50 14.5	6.80	0.25	6.00	0.38	1.34
Sewage stream	19.0 14.0	6.50	0.25	1.25	5.75	7.23

*Temperature values are of first and last sampling dates

wide; it receives water from adjoining hillock, reaching an average flow rate of 50m/min. The same stream joins a small sewage outlet and therefore, becomes heavily loaded with nutrients; it, however retains almost the same size, depth and waterflow and was used as the fourth station.

The stations studied are situated in Shillong (India) at an altitude of 1460m, latitude 25.34N and longitude 91.52E.

Materials and Methods

Whatman No. 1 filter papers circles (diam. 20cm) were carefully packed in plastic bags (20cm × 20 cm) of 1mm pore size. Twenty five bags were tied at each stations with a thin nylon cord to which stones were tied to keep the bags in place. The bags were placed at the bottom in such a way that they were flat spread. Five bags were collected at each collection and the collection was done after 1, 3, 20 and 50 days from all the stations. In flowing water stations the current velocity was checked by putting stones as break towards the incoming current side so as to reduce the mechanical loss of materials due to current. The bags were collected aseptically into polythene bags and brought to the laboratory within 1 hr of collection. The bags were kept in refrigerator at 5°C and microbiological analysis was done within 3 hrs of collection.

The mycoflora was estimated by dilution spread plate method and direct plating method; Rose Bengal agar (Johnson & Curl 1972) was used as the growth medium. The *p*H was recorded by glass electrode electric digital *p*H meter and the water temperature by a mercury thermometer. The weight loss was calculated by taking the mean of three replicates, after excluding the ash content and other visible extraneous materials. Out of remaining two replicates, one was used for dilution spread plate method and the other for the particle plating method of mycoflora analysis. The culture plates were incubated at 25 ± 1°C for 7 days and fungi growing were identified. Direct observation of the filter papers was done under low power of light microscope using aniline blue stain for the presence of fungal mycelium growing on or in the filter paper. An exponential decay model was used to estimate

the rate of weight loss :

$$Wt = Wo^{e-kt}$$

where '*Wt*' is the dry weight at time '*t*', '*Wo*' is the original weight, '*t*' is time, '*k*' is a decomposition constant and '*e*' is the base of natural logarithms (Olson 1963).

Results and Discussion

The fungi isolated from filter paper circles exposed to the water bodies are listed in tables 2 and 3. Most of the fungi isolated belonged to the common terrestrial genera which is similar to the findings of Park (1974a). Park (1972, 1974a) had raised doubt concerning the active involvement of these fungi in the cellulose decomposition. This was in spite of the fact that most of his isolates exhibited cellulolytic activity in culture. A number of fungi could be isolated from the materials in 24 hr of exposure. The microscopic observations revealed that up to three days, circles did not show any mycelial growth on or in the filter paper tissue exposed in the Fish Dale and Ward Lake. But in the case of stream and sewage samples the mycelium of *Geotrichum* sp. were

Table 2 *Fungi isolated from various water bodies by plate culture method*

Fungi	Fish Dale	Ward Lake	Stream	Sewage Stream
Absidia spinosa Lendoner	—	—	+	—
Acremonium sp.	+	+	+	+
Aspergillus fumigatus Fres.	—	+	+	—
A. niger V. Teigh	+	+	+	+
A. nidulans Eidam. Wint	+	+	—	—
Aspergillus sp.	+	+	+	+
Cephalosporium sp.	+	+	+	—
Cladosporium herbarum (Pers.)	+	+	+	—
Fusarium solani (Mart) Sacc.	—	+	—	—
Geotrichum candidum Link ex Pers.	+	+	+	+
Mucor circinelloides V. Teigh	—	—	+	+
M. racemosus Fres.	—	+	+	+
Penicillium sp.	+	+	+	+
Phoma sp.	+	+	—	—
Rhizopus nigricans Ehrenberg	—	—	+	+
Trichoderma viride Pers Gray	+	+	+	+
Red yeast	+	+	+	+
Orange yeast	+	+	+	—
Sterile white mycelia	+	+	+	—

+ = present; — = absent

quite abundant even at the time of first collection.

The filamentous fungi did not show any definite pattern for quantitative variation in all the habitats which was probably because of the passive accumulation of spores which resulted into countable colonies on plate culture while the pattern of yeasts increased with time. It may be speculated that yeasts, being unicellular with active growth, have more important role in aquatic systems than the filamentous forms. The present study, therefore, is in conformity with the observations of Park (1974a). We have also noted that many plate culture fungi come through deposition of conidia or spores which is more reflected in direct plate method where only fast growing terrestrial forms could be isolated (table 3). But the same was not the case with yeasts and unicellular forms like

Table 3 *Fungi isolated from various water bodies by particle plating method*

Fungi	Fish Dale	Ward Lake	Stream	Sewage stream
Aspergillus niger	+	+	+	+
Cephalosporium sp.	+	+	+	+
Cladosporium herbarum	+	+	—	+
Fusarium solani	+	—	+	—
Geotrichum candidum	+	+	+	+
Mucor circinelloides	+	+	—	—
M. hiemalis Wehmer	+	+	+	+
M. racemosus	—	—	+	+
M. sp.	+	+	—	+
Penicillium sp.	+	+	+	+
Rhizopus nigricans	+	+	+	+
Trichoderma viride	+	+	+	+
Yeasts	+	+	+	+
Sterile white mycelia	+	+	+	+

+ = present; — = absent

Table 4 *Values of various decay parameters for different water bodies and percentage weight remaining after 50 days of exposure*

Stations	per day (k)	Half life (days)	95% Life (days)	% Weight remaining after 50 days
Fish Dale	0.0060	115.50	500.00	75.27 ± 4.6
Ward Lake	0.0061	113.61	491.80	73.88 ± 4.2
Stream	0.0309	22.43	97.08	15.20 ± 3.80
Sewage stream	0.0892	7.77	33.63	—

k = decay co-efficient; Half life = 0.693/k; 95% Life = 3/k

Geotrichum sp. which attain a high population level and therefore seems to be active in the degradation of cellulose.

The weight loss rate was appreciably slow in still waters of Fish Dale and Ward Lake in comparison to the flowing waters (table 4). Slowest decomposition was observed in Fish Dale and fastest in sewage stream. When exponential decay model (Olson 1963) was applied, it was found that while in sewage stream the 95% life is only 33.63 days, in Fish Dale it may prolong up to 500 days. It could be observed that probably the water current and invertebrate fauna were the most important factors which could have been responsible for the fast rate of decomposition in flowing waters.

In sewage stream, decomposition was faster than the stream which depicts that probably the high nutrient content and microbial population of the sewage stream might also be responsible for this, although the sewage fauna may also help towards high decomposition rate.

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