Proc. Indian natn. Sci. Acad. B50 No 2 pp 203–210 (1984)

Temporal and Depth-wise Distribution of Terrestrial Fungi in a Freshwater Lake

*B K TIWARI and R R MISHRA**
**Department of Botany, St. Anthony College, Shillong 793001*
***Department of Botany, School of Life Sciences, North-Eastern Hill University, Shillong 793014*

(Received 28 July 1983; after revision 29 March 1984)

Temporal and depth-wise variation in the population of terrestrial fungi was studied in a small freshwater lake for a period of two years on monthly intervals. The population showed a marked seasonality. However, the pattern was not same during both the years.' The number of propagules/ml of lake water ranged from < 10 to 600. The fungal flora was dominated by the forms producing high number of spores. The significance of these fungi in the lake community has been discussed.

Key Words: Freshwater lake, Seasonality, Terrestrial fungi

Introduction

Representatives of almost all subdivisions of fungi are found in natural waters (Sparrow 1968, Cooke 1976). Although the term aquatic fungi include all the "fungi living in water" (Ainsworth & Bisby 1963) the motile zoospore producing phycomycetes (Sparrow 1960) and non-motile tetraradiate spore producing deuteromycetes (Ingold 1942, 1976) have been generally considered as true aquatic forms. Most of the dominant soil and litter fungi have been isolated from natural waters (Cooke 1976, Park 1972). These so-called 'geofungi' have been found to be actively involved in the leaf litter decomposition (Kaushik & Hyne 1968, 1971, Padget 1976). They utilize oxygen and dissolved nutrients from water and successfully compete with the autochthonous heterotrophic populations of the system (Cooke 1966, 1967). Quereshi and Dutka (1974) pointed out the possibilities of the use of terrestrial fungi as a potential indicator of water pollution and the degree of eutrophication. They also emphasized the need of more qualitative and quantitative information on the population of terrestrial fungi in the natural waters.

Temporal variations and spatial distribution of the terrestrial fungi was studied in a small freshwater lake for a period of two years.

Study Area

The study was conducted in Wards Lake, Shillong, India (alt. 1460 m, lat. 25°34″N, Long. 91°52″E). The slopes surrounding the lake are covered with dense managed grasses and scattered trees, predominantly of pine (*Pinus kesiya* Royle ex. Gordon). The lake receives water inflow throughout the year and has a surface outlet which allows the excess water to flow out during rainy seasons. Throughout the year the water level does not change appreciably except during January-February when the level drops approx. 30 cm. The bathymetric map and general morphometry of the lake is given in figure 1. The stations are shown by bold numbers 1–5.

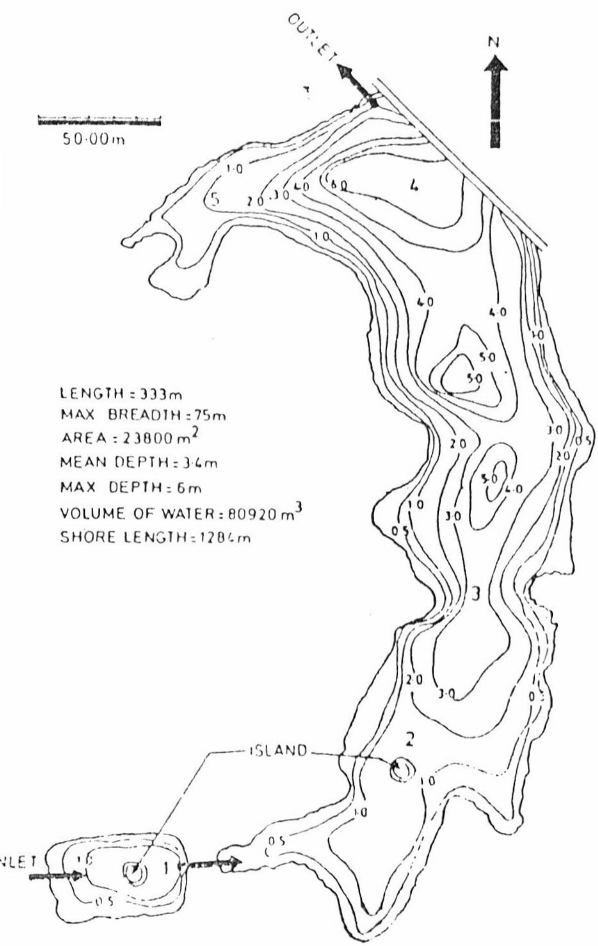

Figure 1 Bathymetric map and general morphometry of Wards Lake, Shillong. Stations are shown by numbers 1 to 5

The Station 1 was 0.80 m deep and comparatively richer in nutrient concentrations (Tiwari 1980). This station has a silt bottom and profuse submerged growth of *Hydrilla verticillata* (Linn F) Royle. The Station 2 was 0.5 m. deep and the water was comparatively clearer than Station 1. Station 3 was situated in the main body of the lake where water depth was 3 m. This station was characterized by the rocky bottom covered with gravels and the space between the gravels was occupied by a thin layer of coarse sand particles. Station 4 was situated in the deepest part of the lake and nearest to the outlet. The lake bottom at this station was silt with a cover of semi-decomposed plant litters composed mainly of pine needles. The water depth at this station was 6 m. Station 5 was situated at the next corner of the lake where the depth was 0.5 m. The observations of this station were deleted as they did not differ appreciably when compared with the Station 2. The informations collected on Station 5 were, however, used when the data were compiled for the whole lake.

Methods

The water samples from various depths were collected between 10.00–12.00 hours using a JZ sampler (Zobell 1941). The surface water samples were collected in sterilised bottles avoiding the surface film. The bottles were maintained in a dark chamber and transported to the laboratory within half an hour of collection.

Viable fungal propagules were estimated by spread plate method. 0.5 ml of the lake water was inoculated on the surface of freshly poured Rose Bengal Streptomycin Agar (Martin 1950). The inoculum was uniformly spread on the agar and the Petriplates were incubated 25±1°C for 7 days. The total number of fungal colonies was counted to calculate the number of viable fungal propagules per ml of water.

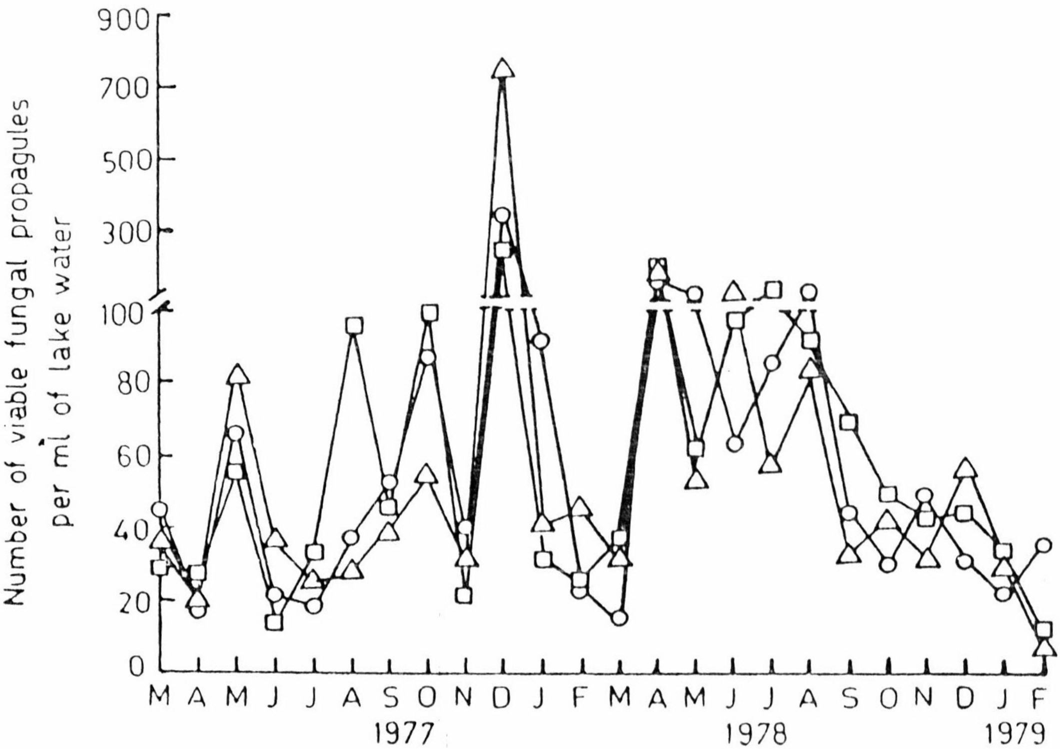

Figure 2 Monthly variation and depth-wise distribution of terrestrial fungi at Station 1. Circles: surface water; triangles: mid-depth water (0.40m); squares: bottom water (0.80m)

Results

A perusal of the data presented in figures 2, 3, 4 and 5 suggests that the planktonic fungal population showed a marked seasonal variation. However, all the stations did not show the same pattern of seasonality. The Stations 2, 3 and 4 showed almost similar trend of population variation while Station 1 showed altogether different trend. Station 2, 3 and 4 showed a spring and autumn peaks during the first year of study, but this trend was not repeated in the subsequent year. The Station 1 showed an increase in fungal population from spring to winter during the first year while in the second year of study a decrease was noted. The depth-wise distribution of fungal population did not vary significantly although qualitative differences in the population were observed.

The fungal forms isolated from the lake water mostly belong to the terrestrial group of fungi. *Pythium monospermum*, *Aureobasidium*

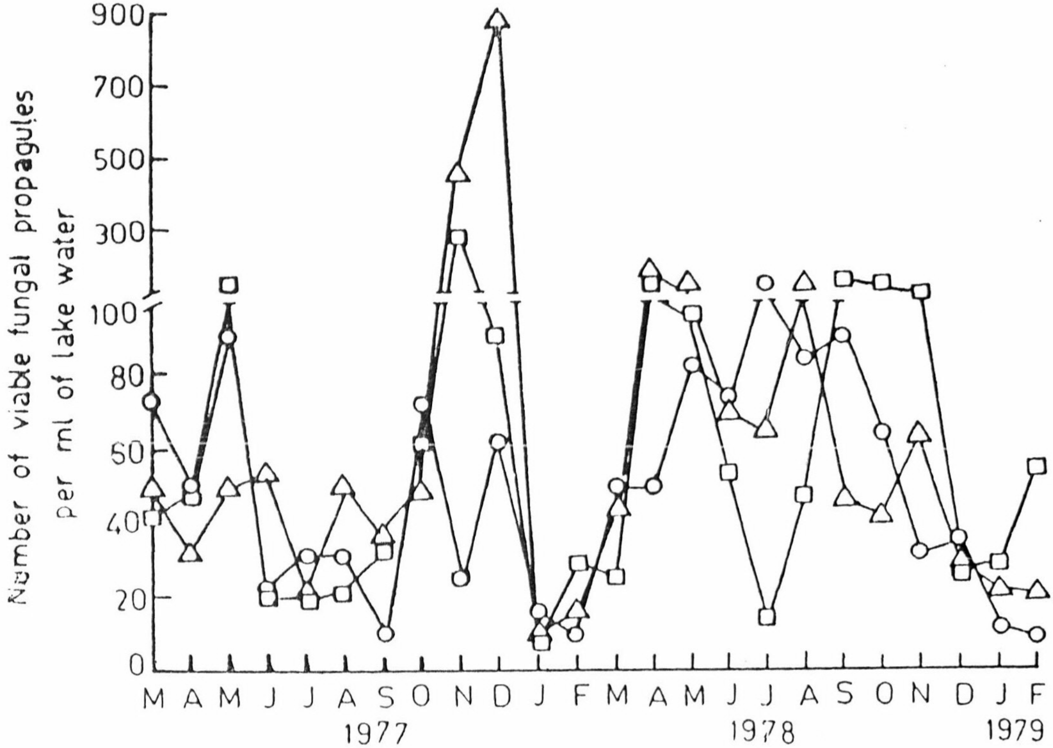

Figure 3 Monthly variation and depth-wise distribution of terrestrial fungi at Station 2. Circles: surface water; triangles: mid-depth water (0.25m); squares: bottom water (0.50m)

pullulans, *Rhodotorula* sp., *Sporobolomyces* sp., *Trichosporon* sp., *Aspergillus fumigatus*, *Cladosporium herbarum*, *Geotrichum candidum*, *Penicillium* spp., *Phialophora* sp. and *Trichoderma* sp. were the most commonly isolated forms. The percentage occurrence of various fungi throughout the study considering all the stations together are given in figure 6. A perusal to the percentage occurrence values of the dominant forms suggests that unicellular yeasts and filamentous fungi producing small unicellular spores in large numbers dominate the fungal flora.

A general look at the representation of various groups of fungi reveal that the majority of the fungi belong to the class deuteromycetes. Other classes are represented by very few species. Quite significantly the class ascomycetes is represented by only one genus. The monthly variation in species composition of fungi isolated by plate culture method did not show any marked variation. To some extent, however, it appears that a few species of yeasts were more in number during winter months. Most of the filamentous forms were isolated throughout the year. However, the site of occurrence varied. The differences in the number of propagules of different species did not show any pattern of seasonality though the total number of fungal propagules per ml of lake water ranged from below 10 to 800.

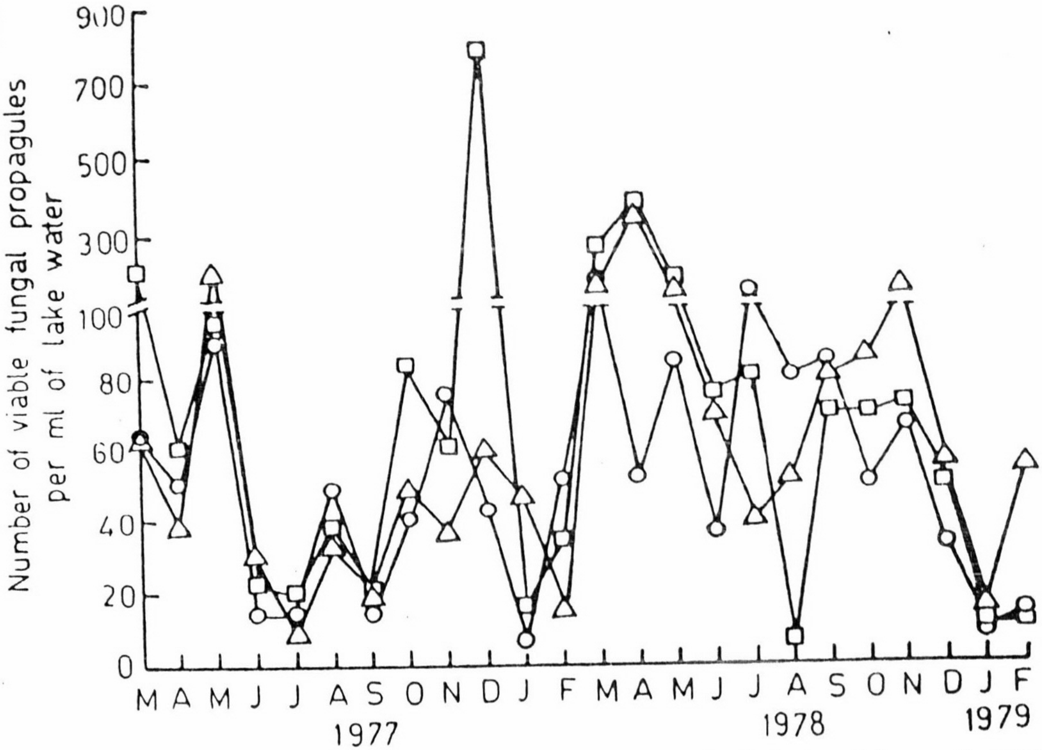

Figure 4 Monthly variation and depth-wise distribution of terrestrial fungi at Station 3. Circles: surface water; triangles: mid-depth water (1.50m); squares: bottom water (3.0m)

Discussion

The results on seasonality and occurrence of fungi suggest that the fungi constitute an important component of planktonic community and the lake harbours a sizeable population of fungi throughout the year. Our studies (Tiwari 1980, Mishra & Tiwari 1983) on decomposition of extraneous litters in this lake clearly demonstrate that fungi colonize the pine and teak leaf litters and take active part in their decomposition. Most of the fungal species isolated have also been reported from other aquatic habitats (Cooke 1976) and many of them from the terrestrial habitats of this region (Das 1980).

The dominance of fungal flora by yeasts and yeast-like forms suggests that probably they can remain free-floating in the lakewaters and their sedimentation rate is slower as compared to the forms producing large sized spores. Secondly, such forms are probably better adapted to reproduce and multiply in the aquatic habitat and therefore, they may be regarded as the resident populations of the habitat. It may be speculated that among planktonic fungi the unicellular forms are more important and mycelial forms grow only when they get a suitable organic substrate. The positive correlation between fungal population and particulate organic carbon noted by Chryzanowski and Stevensen (1979) also strengthens the speculation. The occurrence of most of the species throughout the year may be because of the longevity of the

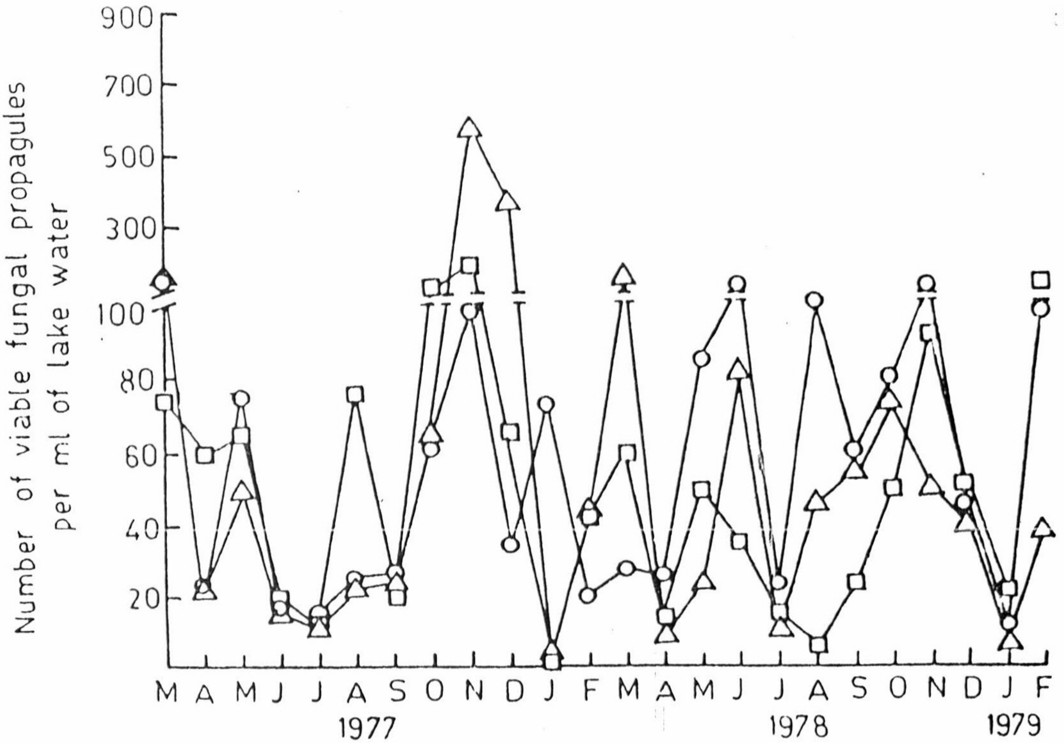

Figure 5 Monthly variation and depth-wise distribution of terrestrial fungi at Station 4. Circles: surface water; triangles: mid-depth water (3.00m); squares: bottom water (6.0 m)

fungal propagules (spores and conidia) which once produced, may remain suspended in viable state for longer periods (Sussman 1968). This is in contrast to the saprolegniaceous zoospores whose active phase of life is often limited to less than 24 hours (Clausz 1974).

These fungi have been variously classified by mycologists with respect to their activity in the system (Dick 1971, 1976). The active involvement of these fungi in the aquatic ecosystem processes has been a matter of controversy for a long period of time. While Park (1972) believes that they are passively accumulated on the substrates, Cooke (1962, 1963, 1967) believes that they are actively involved in the ecosystem processes.

The actual origin of the terrestrial fungi in lakewaters has not been fully worked out (Clausz 1974) but their population variations show that they enter the lake through run-off, rain water, streams and air and they become 'active alien' in these environments (Dick 1976). Very few isolations of ascomycetes may be attributed to the lack of suitability of the medium for the growth of these fungi because many ascomycetes do not grow on the routine plate culture media. Similar may be the case with the basidiomycetes which are very rarely found in the aquatic habitats (Ingold 1976).

Acknowledgement

The authors are thankful to the University Grants Commission, New Delhi for financial assistance.

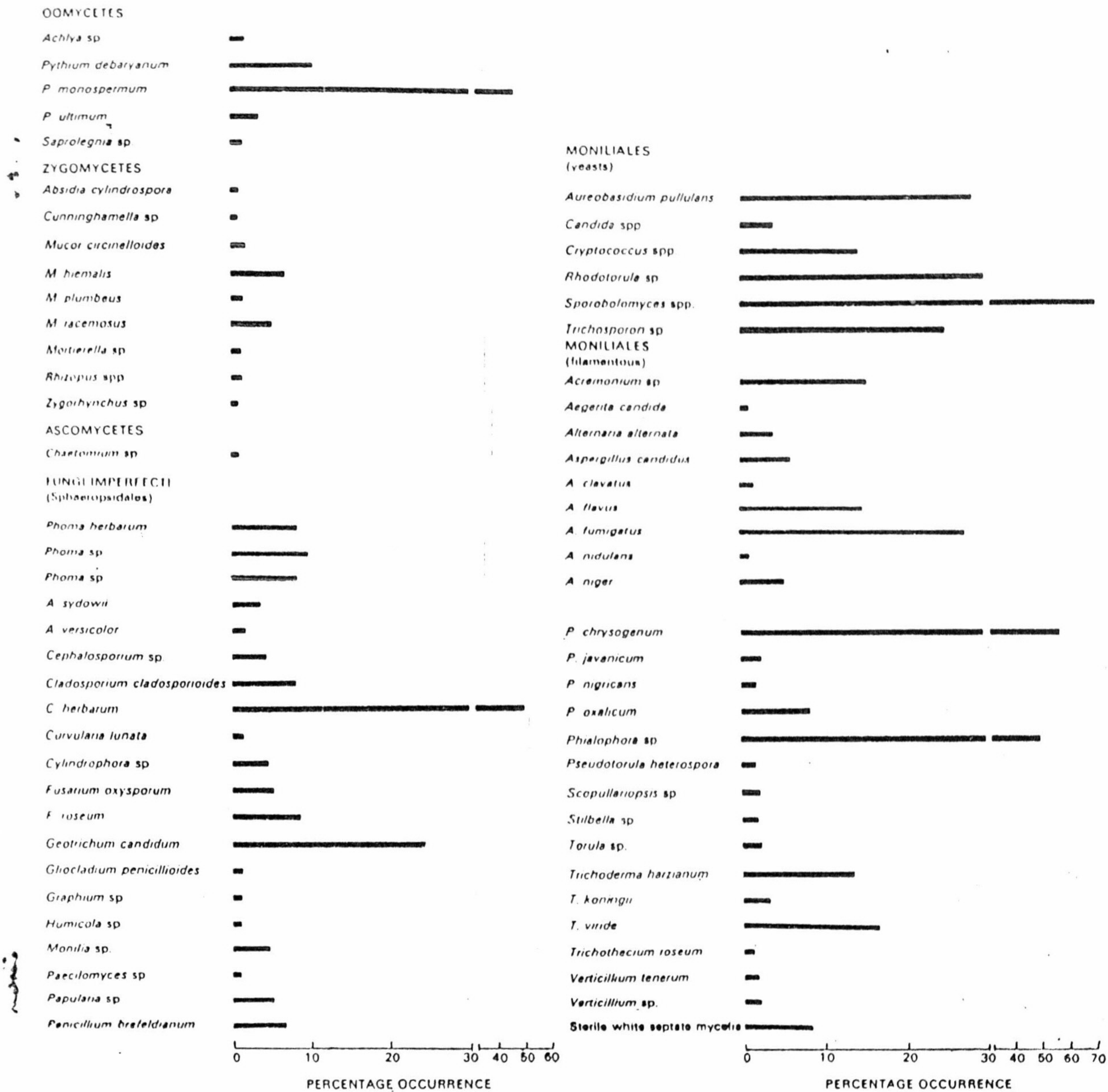

Figure 6 Percentage occurrence of terrestrial fungi in the lake water. Calculated on the basis of the data (360 samples) collected from all the stations and depths. Percentage occurrence $= \frac{\text{No. of samples of occurrence} \times 100}{360}$

References

Ainsworth G C and Bisby G R 1963 *Dictionary of Fungi* (Kew, Surrey: Commonwealth Mycological Institute)

Chryzanowski T K and Stevensen L H 1979 Material fluxes through the north-inlet marsh system: short term temporal fluctuations of fungi and related parameters; *Mycologia* **71** 958–967

Clausz J C 1974 Periods of activity of water molds in a North Carolina Lake; in *Phenology and Seasonality Modelling* pp 191–203 ed. H Lieth (New York: Springer-Verlag)

Cooke W B 1962 The role of fungi in environmental sanitation; *Devl. Indus. Microbiol.* **3** 313–318

—— 1963 *A Laboratory Guide to Fungi in Polluted Waters Sewage and Sewage Treatment Systems* (Cincinnati: Public Health Service Publ.) 132 pp

—— 1966 The occurrence of fungi in acid mine drainage; *Produe Univ. Proc. 21st Industrial Water Conf.* pp 258–274

—— 1967 Some fungi of the Cache La Poudre River Colorado; *Rep. U.S. Dept. Interior Cincinnati* pp 361–372

—— 1976 Fungi in sewage; in *Recent Advances in Aquatic Mycology* pp 389–434 ed. E B G Jones (London: Eleck Science)

Das P K 1980 Microbial Decomposition of Pine (*Pinus kesiya.*) Litter: An Ecological Study; Ph.D. Thesis North-Eastern Hill University, Shillong, India

Dick M W 1971 The ecology of saprolegniaceae in lentic and littoral muds with a general theory of fungi in the lake ecosystem; *J. Gen. Microbiol.* **65** 325–337

—— 1976 The ecology of aquatic phycomycetes; in: *Recent Advances in Aquatic Mycology* pp 513–542 ed. E B G Jones (London: Eleck Science)

Ingold C T 1942 Aquatic hyphomycetes of decaying alder leaves; *Trans. Br. Mycol. Soc.* **25** 339–417

—— 1976 The morphology and biology of freshwater fungi excluding phycomycetes; in *Recent Advances in Aquatic Mycology* pp 335–357 ed. E B G Jones (London: Eleck Science)

Kaushik N K and Hynes H B N 1968 Experimental study on the role of autumn-shed leaves in aquatic environments; *J. Ecol.* **56** 229–243

—— and —— 1971 The fate of the dead leaves that fall into streams; *Arch. Hydrobiol.* **68** 465–515

Martin J P 1950 Use of acid, rose bengal and streptomycin in the plate method for estimating soil fungi; *Soil Sci.* **69** 215–232

Mishra R R and Tiwari B K 1983 Fungi and bacteria associated with pine (*Pinus kesiya* Royle) needles and teak (*Tectona grandis* L.) leaf litters during processing in a freshwater lake; *Hydrobiologia* **102** 123–129

Padget D E 1976 Leaf decomposition by fungi in a tropical rainforest stream: *Biotropica* **8** 166–178

Park D 1972 Methods of detecting fungi in organic detritus in water; *Trans. Br. Mycol. Soc.* **58** 281–291

Quereshi A A and Dutka B J 1974 A preliminary study on the occurrence and distribution of geofungi in Lake Ontario near Niagara river; *Proc. 17th Conf. Great Lakes Res.* 653–662

Sparrow F K Jr 1960 *Aquatic Phycomycetes.* 2nd Revised Edition (Ann Arbor: University of Machigan Press) 1187 pp

—— 1968 Ecology of freshwater fungi; in *The Fungi An Advanced Treatise* Vol. III pp 41–93 eds. G C Ainsworth and A S Sussman (New York: Academic Press)

Sussman A S 1968 Longevity and survivality of fungi; in *The Fungi An Advanced Treatise* Vol. III pp 447–486 eds. G C Ainsworth and A S Sussman (New York: Academic Press)

Tiwari B K 1980 Studies on Microflora of a Freshwater Lake: An Ecological Approach; Ph.D. Thesis, North-Eastern University, Shillong, India

Zobell C E 1941 Apparatus for collecting water samples from different depths for bacteriological analysis; *J. Mar. Res.* **4** 173–188