Chapter 6

Conclusions

The underlying essences are the major conclusions that have been drawn from the study:

- Research study for the present Ph.D. dissertation was initiated to generate baseline information pertaining to the diversity, distribution, seasonal dynamics, community interaction of benthic fungi in different stretches of Subarnarekha river, West Bengal, India with a holistic approach to take into consideration of the entire freshwater lotic ecosystem and analyzing its different structural components (abiotic and biotic).
- Three contrasting study sites were selected based on the contrasting ecological features (SI – Industrial zone; SII– agricultural zone; SIII – brackish water zone) in a long stretch of Subarnarekha, a trans-boundary river of eastern India. The contrasting eco-zones mainly focused on the ecological inputs of the respective study sites and the outcome of their interactions in the form of different biodiversity assemblages and also different water quality parameters during the study period July, 2012 to June, 2014.
- The present dissertation has not only included detailed biodiversity studies giving special emphasis on fungal diversity but also attempted to utilize the outcome of such studies for proper and sustainable eco-management of the aquatic ecosystem.
- The seasonal population dynamics and community interaction patterns have been determined in relation to prevailing ecological parameters (water quality and soil parameters) in temporal and spatial scales using several statistical tools.
- Water quality parameters exhibited different forms of fluctuations mostly under the influence of three important meteorological parameters – temperature, rainfall and flow of water at different study sites in different seasons (monsoon- July to October; post-monsoon – November to February; and Premonsoon – March to June).
- Water quality parameters viz. alkalinity, dissolved oxygen, chloride content, total phosphate phosphorus, coliform bacteria were found to exhibit maximum values during

monsoon whereas parameters such as temperature, pH, hardness, biological oxygen demand etc. displayed their higher results during monsoon season. All those variations have established the roles of respective parameters in respect of their seasonal dynamics.

- Maximum fungal diversity was found during monsoon periods in all the three study sites and in two consecutive years followed by post-monsoon and pre-monsoon for the study sites S-I to S-II while pre-monsoon ranked second position after monsoon at S-III.
- Experimental investigations were conducted for predicting the bioremediation efficiency of heavy metals in different physical conditions. Out of all isolated fungi, five types of fungi were screened for their tolerance to three types of heavy metals (Cd II, Pb II and Hg II) in a PDA medium containing heavy metal from 50-1000 ppm.
- The fungus *Aspergillus penicillioides*, (F12) has been isolated from the bottom soil of Subarnarekha river estuary which used to receive effluents of several industries. This strain was also found to tolerate high concentration of Cd (II) and Pb (II) up to 1000 ppm level but Hg (II) up to 200 ppm. Both biomass and EPS have been able to remove aqueous Pb and Cd which have been optimized in the batch culture process.
- Interestingly EPS was found to be the most efficient than biomass in order to facilitate heavy metals bioaccumulation. The affinity of EPS was tended to be higher to Pb (II) than Cd (II) when both of them supplemented equally at mixed concentration.
- Therefore, strain F12 is supposed to offer a selective advantage for simultaneous Pb (II) and Cd (II) but also Hg (II) removal efficiencies in the aqueous system especially loaded with industrial discharge.
- The fungal species have exhibits flocculation, emulsification, antibacterial activities that may be used for the sustainable waste water treatment process.

In view of the above mentioned research findings, following hypotheses can be proposed:

- The first hypothesis explains the ecological changes in an riverian system operate temporally and spatially after being determined by the combined effect of an array of physical, geological, chemical and biological parameters which are in turn are influenced by two mode of factors: anthropogenic activities (industrial, deforestation, mining, fishing, tourism, transportation etc.) and also natural calamities such as flood, cyclones etc. which are evident from the present study by the development of three contrasting eco- zones (i) site –I with lot of industrial activities; (ii) site-II mostly having agricultural and mining activities and (iii)site –III with ecotourism and fishing activities.
- It is also be hypothesized that out of so many bio-diversified components, benthic fungi by virtue of their sensitiveness and power of tolerance against ecological perturbations can play as bio-indicator organism in the changing of ecological conditions from upstream to downstream of the river. The 28% fungi at site I (chemical pollution rich) and 29% species at Sonakonia but 43% found at Talsari (capable of withstanding brackish water influence). This observation is also substantiated by the intensity of heavy metal pollution in the study sites that S-I has experienced maximum heavy metalsload followed by S-III and S-II.
- It is also hypothesized that tolerant fungal strain in the studied riverine tract (*Aspergillus penicillioides* (F12) could withstand the heavy metal stress and showed maximum bio remedial activities of some selected heavy metal resistant fungi (*Penicilium sp., Aspergillus sp., Pythium sp., Fusarium sp., Rhizopus sp., and Tricoderma* sp.) by virtue of processing biochemical entities such as EPS. The findings which have appeared to open up new vistas in waste water treatment process by understanding mass culture of such fungi and their ready uses for the removal of heavy metals from the contaminated water body.

- ❖ It is also hypothesized that out of several screened and identified fungal strains, a number of benthic fungi have exhibited the power of antibacterial activity as their inoculation in cultural media with pathogenic bacteria tend to cause the depletion of bacterial counts.

Those entire hypotheses have led to the conclusion that the different fungal species, a gift of nature as wonderful aquatic biodiversity components have been struggling within an increasing stressful ecological setup and survive after sustaining seasonal ecological odds. They are now in need of immediate sustainable eco-management of the entire aquatic ecosystem for their existence in the earth.