CHAPTER-5

GENERAL DISCUSSION

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Open-cast Coal mining and its ecological perspectives with emphasis to acid drainage and its impact on water bodies is a matter of great concern today as contamination of water and sediment with heavy metal altered the plankton and fish diversity is established in the present study. Similar investigations are also done in this field by worker notably Guha Roy (1992); Pentreath (1994); Weed and Rustschky (1971); Martin and Black (1998) and Das Gupta *et al.* (2002).

Quality of an ecosystem depends on the physico-chemical characteristics and biological diversity of the system (Tiwari and Chauhan, 2006). Table 3 and 4 depict the chemical variables of the water and sediment soil of the two wetlands selected for study. The study clearly showed that the productivity of the wetlands varied significantly depending upon the hydro-biological and soil qualities. Among the two selected water bodies, Patkai lake (Experimental) was found to be the most affected by mining activities. The entry of industrial effluents possibly contributed to the high levels of heavy metal concentration and low levels of dissolved oxygen was due to the decomposition of organic matter and AMD entering the Patkai lake. According to Dey (1996) some coal has high Arsenic level; and the Arsenic is emitted when the coal is burnt. The runoff from surrounding OCM fields and concentration of chemical constituents in partially dried up aquatic environment of Patkai were the possible cause for the deterioration of water quality. Patkai lake was further disturbed by unplanned developmental activities along the shorelines of the lake (Fig 9 &10) , which had its influence on the water quality. According to the Table 6 & 9 presence of Arsenic (As) and Iron (Fe) in the water and sediment soil of Patkai lake was beyond permissible level again may cause water pollution and makes it unsuitable for domestic usage. The relative limit of detection of Arsenic in the experimental water body, Patkai lake were in the range of 0.01–0.038 in water and 0.4–1.0 µg/ml soil (Bhagabati and Borkotoki, 2013). Concentration of metals in lakes viz., Copper, Zinc and Iron are all toxic to fish and amphibians (Freda, 1991; Lande and Guttman, 1973).

According to Table 3,4, 5 &6 physcico-chemical characteristics of Patkai lake revealed high pH and low Dissolved oxygen, poor alkalinity, high CO^2 level was least productive whereas Mota beel having normal pH, D.O. and alkalinity having favourable physicochemical conditions was highly productive. This is also supported by Zitko and Carson (1976); Pascoe *et al.* (1986). According to them the toxicity of pollutant may be increased or decreased by various water quality factors including pH, temperature, hardness and Dissolved Oxygen content of water. Smith and Heath (1979) also showed that several species of fishes that their Lc50 was decreased with increasing temperature. The pH of the experimental lake was found to be acidic in nature and other physico-chemical parameters and plankton analysis confirmed that the lake was polluted due to contaminants let into the lake, though the concentrations of the pollutants were found to be diluted possibly due to heavy monsoons. Thus the study indicates that the lake cannot be used as an alternative for drinking water supply.

The contamination of fresh water with a wide range of pollutants released from domestic, industrial and other anthropogenic activities has been reported by many workers over the last few decades (Vutukuru, 2005; Dirilgen, 2001; Voegborlo *et al.*, 1999; Canli *et al.*, 1998; Conacher *et al.*, 1993). Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms (Farombi *et al.*, 2007; Vosyliene and Jankaite, 2006). Among animal species, fishes are the inhabitant that cannot escape from the detrimental effects of these pollutants. It is also supported by Olaïfa *et al.* (2004); Dickman and Leung (1998).

Graph 16 & 17 shows Plankton diversity of the experimental water body namely Patkai lake was less. On the other hand, Mota beel (control) had higher diversity of zooplankton when compared to Patkai lake because of the sufficient nutrient input resulting in mesotrophic condition and lesser disturbance to the water quality which resulted in the rich fish diversity (Sharma, 2001).

The zooplankton analysis confirmed the poor water quality of Patkai lake. The lake had poor representation of the zooplankton community (Table: 6.3, 6.4) which is vital for the survival of the higher trophic levels. This had possibly let to various disorders in fishes eventually leading to the death of fishes in Patkai lake. In Tikak OCM region AMD and other anthropogenic activities i.e., bathing , washing of clothets etc. had altered the zooplankton community structure, which would influence the entire trophic structure of the lake (Fig: 4, 5, 6, 7, 9, 10, 18). It showed the less diversity of plankton in the lake.

The phyto- plankton diversity of Patkai wetland (Graph:17 & 18) reveals the less growth of algae. Similarly, presence of zoo-plankton like *Keratela, Daphnia, rotifers and cladoceran* in less amount indicates metal pollution in Patkai wetland. It is also supported by Chakrapani *et al.* (1996).

On the other hand, rich diversityof phytoplankton in the Mota beel indicated suitability of the water body of the beel for aquaculture.

The interrelationship between the physico-chemical parameters and plankton production of pond water and its relation with fluctuation of plankton are of great importance and basically essential in fish culture. Fishes are dependent on physico-chemical parameters. Any change of these parameters may affect the growth, development and maturity of fish (Jhingran, 1985). Sukumaran *et al.* (2008) also reported that phytoplankton is the major primary producers in many aquatic systems and is important food source for other organisms .

The present study reveals that Fish community structure in the experimental water body, Patkai lake revealed low fish diversity in comparison to the control, Mota beel during the study period. Characteristics of fish community structure can be considered as highly relevant end-point since they reflect the health of whole aquatic habital including water quality. A gradual decline in fish population in different water bodies throughout the globe had become a great concern in the recent years which is also reported by Myashita *et al.* (1990), Natarajan (1984) and Devi (2010).

Fish community structure has been widely used to assess the effect of human impacts on aquatic ecosystems including water quality deterioration and habit changes (Karr, 1981; Maret and MacCoy, 2002; Wolter *et al.,* 2000; Pirhalla 2004). Few studies however, investigated the effect of single specific stressor such as metal pollution on the structure of fish communities (Dyer *et al.,* 2000).

In the present study As, Cu, Ni, Zn were obtained as trace metal pose a serious threat to the aquatic ecosystem and might result in selective elimination of the most sensitive life stages of vulnerable fish species in Patkai lake which is supported by the low fish diversity of the lake. Chronic exposure of fish to sub-lethal trace metals causes, among others, disturbed ion regulation, reduced swimming speed, reduced growth and condition (Sorenson, 1991; Hollis *et al.,* 1999; Alsop *et al.,* 1999; Bervotes and Blust, 2003). As a consequence it can be expected that metal pollution also result in alteration in the fish community, both in species composition, richness and trophic composition. However it is very difficult to investigate fish community responses to metal pollution since a few aquatic systems can be found where heavy metal pollution is the only major anthropogenic impact. Heavy metal pollution in water and soil surface of Patkai wetland lower the fish diversity. Similar finding was also reported by Chen *et al.* (1997) ; Deka *et al.* (2005) and by Zhou (2000) in soil and fish.

Aquatic organisms including fish accumulate metals many times higher than present in water or sediments (Madhusudan *et al.,* 2003; Surec, 2003; Olaifa *et al.,* 2004) , thus causing an adverse effect on the aquatic organisms (Ohe *et al.,* 2004).

To confirm the effect of metal pollution on fishes, the Electron microscopic studies were carried out which revealed marked alterations at cellular level in the tissues of *C. batrachus* which can be used as indicators for the effects of various anthropogenic pollutants on organisms and reflects of overall health of the entire population in the ecosystem. It was also supported by Mohamed (2009). Various chemicals and metals viz. Cu, Zn, Cd, Pb, Ni, Mn, Mg etc. present in industrial effluents penetrate into the tissues of fishes and cause histopathological alternations (Eisler, 1971 ; Agarwal *et al.,* 1979; Gupta and Sharma, 1994; Maher *et al.,* 1999; Fernandes *et al.,* 2008). During ultra structural investigation of fish tissues it was observed that industrial effluents that were released from different sources of Tikak OCM located near the Patkai Lake affect the integument, gills, kidney and other organs especially liver of certain hardy fishes like *Clarias batrachus*, of the experimental wetland. Present study showed distinct alteration in the vital organs of tissue of *C. batrachus* namely gill, liver and Kidney of the experimental species.

In the present study among the heavy metal pollutants, arsenic that is present in the water of Patkai lake receives a special attention due to its potential health hazard to aquatic fauna and human life in particular. Maher *et al.* (1999) and Pazhanisamy *et al.* (2007) also reported the presence of arsenic in industrial wastes and its high toxicity along with considerable bioaccumulation in freshwater fishes make it a toxicant that should be given due consideration in aquatic toxicology.

Ultra structural alteration in Gill , liver and kidney of *C. batruchus* was may be due to accumulation of heavy metals (As, Cu, Ni and Zn) in tissues which have been well described by several investigators (Coombs, 1979; Windom *et al.,* 1987 ; Sorensen, 1991; Gupta and Sharma, 1994; Vincent and Ambrose, 1994; Rao *et al.,* 1998; Karuppasamy, 1999; Kalay *et al.,* 1999; Maher *et al.,* 1999; Rashed, 2001; Filazi *et al.,* 2003; Zydah, 2005; Calta and Canpolat, 2006; Fernandes *et al.,* 2008). They reported migration, hypertrophy, vacuolation, necrosis in the liver; lesion in the gills, thickening of primary lamellae, hyperplasia in cartilaginous rod and appearance of vacuoles in the gill rays; dissolution of epithelial cells of renal tubules exposed to various contaminants which are supportive to the study.

According to David and Ray (1960); Basak and Konar (1976); Ochiai (1995); Saxena (2002); Khadiga *et al.* (2002); Ohe *et al.* (2004) and Riba *et al.* (2005) some toxic chemicals released into the ponds, rivers and seas such as Pb, Cu, Zn, Hg, CN from acid mine discharge will cause the death of fish, algae and lesions in human beings even at very low concentrations. These are related to occupational hazards and constitute elements of environmental pollution especially Xenobiotic oxidants are discharged into water with the result that oxidative stress is imposed on aquatic organisms like fish, crab, prawn etc. (Adams *et al.,* 1989; Joshi ,2005) which was also supportive to the present study. The presence of heavy metals in water and sediment soil may be accumulated in the tissue of fishes which again may causes various physiological defects and mortality which was supported by the study of Torres *et al.* (1987); Stephen *et al.* (1987); Dirilgen (2001); Farombi *et al.* (2007) ; Ali and Fishar (2005). Most of the investigations pertaining to heavy metals contaminants in aquatic systems are dealt either with toxicity or with accumulation (Noel-Lambot *et al.,* 1978; Rushforth *et al.*, 1981; Das, 1990; Sorensen, 1991; Thiruvalluvan *et al.,* 1997; Nayak, 1999; Shrinivas and Balaparamaeswara, 1999; Kalay and Canli, 2000; Khadiga *et al.,* 2002; Datta *et al.,* 2007)

The present research effort is a logical initial step towards developing an idea about the status of the wetland situated near the mining region of Margherita sub-division with reference to the eco-biology of Patkai wetland near Tikak Open cast Mine. Pollution status of the water bodies determined by analyzing the phyto and zoo-plankton diversity showed less diversity of Plankton in Patkai lake which in turn reduced the growth of fish population. Ultra-structural analysis on fish which was carried out to confirm the impact of AMD also showed alteration in the cellular structure of fish which might be due to metal toxicity on fish fauna in the Patkai Lake.

Thus, the present study established direct correlation among the various parameters studied in the selected wetlands which showed altered physico-chemical characteristics in the water and sediment soil due to AMD in the Patkai lake. This again affected the Plankton composition as well as fish diversity and also leads to ultra-structural alteration in fish tissues which may be the cause of depletion of the aquatic organism in the Patkai wetland.