ON THE POSSIBILITIES OF ECO-RESTORATION OF WETLANDS OF NORTH-BIHAR WITH NOTES ON THEIR STRUCTURE AND FUNCTION

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INTRODUCTION

Wetlands (flood plains, marshes, swamps and chaus) are one of those lentic waters which form links between terrestrial and aquatic ecosystems and play an important role in eutrophication. Such ecosystems will have a community structure intermediate between the open water and forest types and in such environment the autotrophic-heterotrophic stratification is very less. According to Odum (1962) the most productive ecosystems of the ecosphere are those in which autotrophic-heterotrophic strata lie close together, thus, ensuring efficient nutrient regeneration and recycling.

In the region of North-Bihar districts (24º20'10" to 27º31'15" NL and 83º99'50" to 88º17'40" EL) many such types of wetlands exist (Fig. 1). The eco-restoration of such wetlands for sustainable use of resources is of utmost significance. Therefore, the objective of present study is to investigate the structure and function of these wetlands and to explore the possibilities of their ecological restoration for the sustainable development taking into account the aquaculture and pisciculture.

MATERIALS AND METHODS

Study area

The wetlands under study includes three typical swampy ecosystem wetlands of North-Bihar, that have been described in the text by the names of Hyacinth, Makhana and Chaur swamps.

ABSTRACT

The paper describes the analysis of the physico-chemical and biological parameters of the different swamps (Hyacinth, Makhana and Chaur) of North-Bihar apart with the suggestions for the restoration of degraded wetlands based upon ecological principles. It was observed that out of these three wetlands the chaur ecosystem has higher DO$_2$ content while the doped (Hyacinth) ecosystem has lower DO$_2$ content and higher detritus production. The Makhana ecosystem is intermediate between these two ecosystems. The doped or Hyacinth swamps has immense potential energy resources in the form of detritus which can be tapped for maximum energy return through culture of detritivore fishes. The eco-restoration of such wetlands can be done by manipulating the animals assigning lower trophic levels of the food chain.

KEY WORDS

Polluted (Hyacinth) swamp
Makhana swamp
Wetlands
Eco-restoration

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These three different types of swamps were selected for seasonal observations of certain physico-chemical factors of water. The first two swamps were perennial in nature while the third one (Chaur) was seasonal, as it completely dried up during summer months (March to July). The pH, DO$_2$, FCO$_2$, CO$_3^{2-}$, HCO$_3^{-}$ were studied every months for two years from January, 2001 to December, 2002 along with free H$_2$S, Si$^-$ and Cl$^-$ content following APHA (1981) and Welch (1948). The standing crop of periphyton, phytoplankton, zooplankton, macro-invertebrates and fishes was studied using different sampling devices and taxa were identified in the laboratory by the standard literature available in their respective fields.

**RESULTS AND DISCUSSION**

The result of physico-chemical factors of three different types of swamps under study have been shown in Tables 1 to 3 respectively.

**Physico-chemical conditions of swamps and wetlands**

Generally, there is higher dissolved oxygen and less FCO$_2$ concentration in Chaur swamps than in Makhana and Hyacinth swamps. The Hyacinth swamp has also been called polluted or doped swamps. Low pH of water together with high atmospheric and water temperatures, heavy accumulation of organic matter and hypoxic conditions of soils and water are responsible for the production of major decomposition products viz., hydrogen sulphide, methane, free ammonia, etc. more in the Hyacinth swamps and the Makhana swamp (Table 3). Gas envelopes have been constructed for different types of swamps. Such envelopes were represented graphically by plotting all the monthly measurements of DO$_2$ and FCO$_2$ within a particular swamp and enclosing these data with a polygon. More steep envelope in Makhana (Eurale ferox) swamps was evident of hypercarbic environment but it was flatter than the gas envelopes of chaur swamp which was infested with emergent Cyperus reeds with a combination of sufficient submerged macrophytes (Fig. 2). There was comparatively more DO$_2$ and less FCO$_2$ concentration in Chaur swamp than Makhana and Hyacinth swamps. The concentrations of FCO$_2$ in swamps control the pH, bicarbonate-carbonate alkalinitis.

As in such systems only air-breathers and supplemental air-breathers are colonized, because of low DO$_2$ contents and high amount of FCO$_2$. In Hyacinth swamps the DO$_2$ content was found below 3.00 ppm indicating anaerobic conditions and no obligate water breathers were present in such conditions. Therefore, autotrophic biomass exceeds greatly heterotrophic production in these environments. As such there is accumulation of autotrophic production in the system showing successional stage from aquatic to terrestrial environments (Roy, 2007). In Chaur swamp the shape of the envelope was vertically steep showing higher DO$_2$ content and lower FCO$_2$ content while in Hyacinth swamps the shape was horizontally flatter showing lower DO$_2$ content and higher FCO$_2$ content in such environment. The Makhana swamp was intermediate between Hyacinth and Chaur.

**Biotic components**

The biotic components mainly include macrophytes, phytoplankton, periphyton, zooplankton, macro-invertebrates,
The rotiferan population always dominate over other zooplankton communities in these swamps.

**Periphyton:** The periphyton communities of the swamps mainly include algae and testaceous rhizopods (e.g., Euglypha, Diffugia, Centropyxis, Arcella etc). Usually the periphytic species prefer highly eutrophic conditions with rich DO₂ high pH and more alkaline medium (Brown and Austin, 1973). Hard testaceous shells of rhizopods were mainly composed of fine sand particles of silica and decomposed diatoms cells. The abundance of Bacillariophyceae and silicate contents of water thus, control the testaceous rhizopod population. In the present study the silicate was found to be absent from July to December 2001 and from March to June 2002. A such periphytonic communities showed inverse relationship with the silica content of water in these wetlands.

**Phytoplankton:** The phytoplankton communities of swamps were mainly represented by three groups of algae – Cyanophyceae, Chlorophyceae and Bacillariophyceae. Bacillariophyceae dominated among the phyto-planktonic communities through out the years during the present study.

**Zooplankton:** Zooplankton communities of swamps belonged to Rotifera, Cladocera, Ostracopoda and Copepoda.

The rotiferan population always dominate over other zooplankton communities in these swamps.

**Macrophytes:** There is general agreement that the freshwater swamps have higher macrophytic productivities than any other natural community (Leith, 1975; Thompson, 1976). The ratio of P/R > 1, showing autotrophic community and such environments are on the way of succession (Singh, 1992).

Four characteristic vegetational communities were recognized in these swamps. These were (i) free-floating type e.g., Eichhornia crassipus, Trapa bispinosa, (ii) bottom rooted-floating type e.g., Euryale ferox, (iii) submerged type e.g., Hydrilla verticillata, Potamogeton crispus, Najas graminea, Ceratophyllum demursum etc. and (iv) emergent type e.g., Cyperus sp (Singh, 1992).

**Macro-invertebrate diversity:** The macro-invertebrate fauna belong to following three invertebrate phyla – Annelida (Limnodrilus sp.), Mollusca (Lamellidens marginalis, Pressiya sp.) and Insecta (Belostoma, Ranatra, Corixa sp., Hydrophilus, Berosus).

Comparative studies on annual averages of total number and percentage of macro-invertebrates per meter square area in different swamps revealed that the Makhana swamp form the most favourable habitat for annelids, molluscs and insects. (Roy, 2007; Roy et al., 2008).

**Eco-restoration of Hyacinth swamps**

Hyacinth and doped swamps were rich in nutrients and have immense potential energy sources, which can be tapped for maximum energy return through detritivore fishes (Kumar, 2007). Fishes feeding on different trophic levels provide enough scope for energy manipulations. The release and deposition of organic matters after death and decay of macrophytes, contributed significantly to the richness of the bottom soil of doped swamps. The low concentration of nutrients in the water phase may be due to the locking of nutrients for longer period by macrophytes. In water bodies the energy fixation at primary
level is contributed both by phytoplankton and macrophytes. In the wetlands the abundance and dominance of macrophytes favour detritus production.

Kumar (2007) has suggested that the water bodies with profuse aquatic macrophytes decompose and silt get deposited at the bottom after their death, which play an important role in the aquatic food web. These water bodies have very high rate of detritus production. The doped swamps can be restored by manipulating detritus feeder fishes in these environments. Thus, the stocking and culture of detritivore fishes in such ecosystem (e.g., *Cirrhinus mrigala*) will be useful for removal of detritus particles through the natural food chain.

**CONCLUSION**

(i) Wetlands are unstable ecosystems where P/R > 1.0.

(ii) They may change with season, rate of siltation and nutrient flux.

(iii) They are on the way of succession.

(iv) There is operation of complex hydrological and biogeochemical cycle.

(v) Due to siltation, eutrophication of wetlands and human habitations surrounding the water systems, there is terrestrialisation of the large wetlands and chaus in the region of North-Bihar.

(vi) Integrated aquaculture programme will help in conservation of these wetlands.

(vii) Eco-friendly and eco-tourism programmes will be useful for the conservation and management of the wetlands of Bihar.

**REFERENCES**


