ECOLOGICAL STUDY OF PONG DAM: A WETLAND OF HIMACHAL PRADESH, INDIA

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ABSTRACT

The present paper is a part of dissertation work carried out during the period from January 2002 to 1st May 2002 and an attempt has been made to study the salient ecological aspects of the wetland. During the study 22 sp. of phytoplankton, 17 sp. of zooplankton, 8 sp. of benthic fauna and 27 fish sp. were encountered. The limnological investigations conducted during the period showed that the water temperature and atmospheric temperature varied between 16^0C - 24^0C and 20^0C - 33^0C respectively. The hydrogen-ion-concentration (pH) was found to be in the alkaline range i.e. 8.0, DO content 8.8-9.2 mg/l, transparency varied between 200-240 cm. Phosphate and nitrate varied between 0.069-0.072 mg/l and 0.064 - 0.071 mg/l respectively. Among primary productivity values gross primary productivity ranged between 0.450-1.050, net primary productivity varied from 0.150-0.600 while community respiration rate showed variations from 0.150-0.750 gC/m^3/day. Based on the observations made during the study period it can be concluded that the physico-chemical and biological environment of the wetland is quite congenial for the well being of aquatic life and may be assigned as mild eutrophic status. Moreover, the reservoir needs more detailed limnological study for its better management and conservation.

INTRODUCTION

The establishment of reservoirs creates shallow water logged areas with unstable substrate and special plant and animal communities that characterized natural wetlands according to the definition by the (RAMSAR) Convention on Wetlands of International Importance (Crafter, *et al.*, 1992). During the past three decades, wetlands have received increasingly greater attention from both researchers and conservationists due to the intense human activities leading to deterioration of water quality affecting the aquatic life.

In India numerous studies have been made on many different kinds of wetlands and much effort has been devoted to create greater awareness about wetlands and their conservation. The Ministry of Environment and Forest set up a National Committee on wetlands in 1983 and has over the years developed a programme of wetland research and conservation. However, our knowledge of wetlands, their distribution, ecology, functions and values and even management remains far from satisfactory (Gopal, 1995).

Ecologically, wetlands are important ecotones that are transitional between open water and land endowed with definite structural, functional and performing specific ecological roles. The Ministry of Environment and Forests, Government of India has declared Pong Dam Reservoir as Wetland of National Importance.

STUDY AREA

In order to generate power and harness the water for irrigation purpose in the Shiwalik hills of Himachal Pradesh (30°-58'-30"N and 75°-50'- 0" E) the Pong Wetland came in existence by constructing a dam on river Bias, an important river of Indus valley, traveling a distance of 275 km in the east-west direction in Himachal Pradesh. Pong Dam reservoir is 97.84 meters deep at FRL having an area of 24000 hectares and enclosed by a catchment area of 12561 km^2 is one of the biggest manmade reservoir of India. Owing to its reservoir nature the water level fluctuates between 420 m and 370 m exposing an area of 50-220 km^2 periodically. Besides acting as an important habitat for both local and migratory birds it support a large population of fish and other major and minor flora and fauna. Besides precipitation, perennial rivers like Manaslu, Parbati, Sainj, Tithan and Uhi act as tributaries of Pong Reservoir. The state government has declared the lake as wild life sanctuary and renamed it as Maharana Pratap Sagar Lake.

MATERIALS AND METHODS

For the present study four locations of Pong Wetland were selected viz., (i) Dam site north (ii) Dams site south (iii) Dam site middle and (iv) Dam Site island (Fig. 1). Only surface water samples were collected from the four fixed sites during the period from January 2002 to May 2002. The collected samples were immediately processed for the parameter like pH and DO. Temperature and transparency were determined on the spot whereas the analyses of the chemical (nitrate and phosphate) and biological parameters (plankton, benthos) were done in the laboratory. The methods given by the APHA (1985) and A.D. Adoni (1985) were used for the assessment of physico-chemical parameters. For the study of primary productivity the "Light and Dark" bottles method was employed (Gaarder and Gran, 1927). The samples were incubated *in situ* for 24 hours. After incubation, dissolved oxygen was fixed in the field and estimated by modified Winkler's method. All oxygen values were converted to carbon values by multiplying by the factor 0.375 and productivity values are expressed as $gC/m^3/day$ (Megard, 1969).

RESULTS

Physico Chemical Characteristics and Primary Production of the Wetland

The data on physico-chemical features and primary productivity values of the Pong wetland has been tabulated in Table-1.

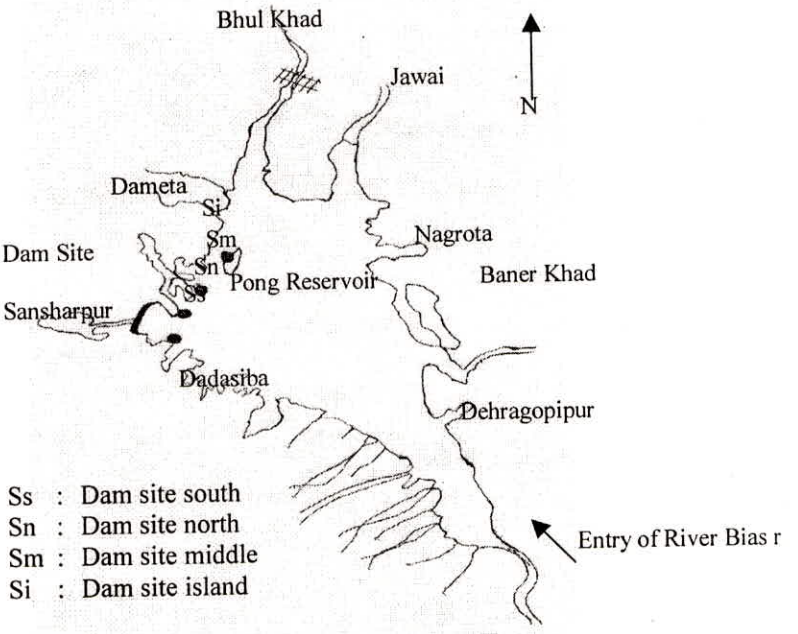

Fig. 1: Out line map of Pong reservoir showing sampling sites

Table 1. Physico-chemical parameters and primary productivity of Pong Dam Wetland

Parameter	Dam Site South	Dam Site North	Dam Site Middle	Dam Site Island
Temperature (°C)				
Air	20.0	23.0	22.9	33.0
Water	16.0	18.5	19.0	24.0
pH (units)	8.0	8.0	8.0	8.0
Transparency (cm)	220	225	240	200
Maxi. Depth (m)	50	53	46	49
Dissolved Oxygen (mg/l)	9.2	8.8	8.8	8.8
Nitrate (mg/l)	0.064	0.071	0.066	0.068
Orthophosphate (mg/l))	0.070	0.072	0.069	0.070
G.P.P. $gCm^{-3}d^{-1}$	0.750	1.050	0.450	0.750
N.P.P. $gCm^{-3}d^{-1}$	0.150	0.300	0.300	0.600
C.R. $gCm^{-3}d^{-1}$	0.600	0.750	0.150	0.150

Where,

G.P.P. = Gross Primary Productivity
N.P.P. = Net Primary Productivity
C.R. = Community Respiration

Temperature

The surface water temperature and atmospheric temperature varied between 16^0C (Feb.)- 24^0C (April) and 20^0C (Feb.) - 33^0C (April) respectively. The surface water temperature showed a close affinity with the atmospheric temperature. The maximum temperature observed in summer (April) and minimum in winter (Feb.).

Hydrogen-ion-concentration

The pH of the wetland at all the four sites was alkaline i.e. 8.0.

Transparency

The transparency ranged from 200 - 240 cm.

Dissolved oxygen

DO of surface water varied from 8.8 - 9.2 mg/l. The dissolved oxygen indicated higher concentration during winter and lower in summer.

Phosphates and nitrates

The Dissolved Phosphates concentration of pong wetland ranged from 0.069-0.072 mg/l whereas nitrate varied between 0.064-0.071 mg/l.

Primary production

Among the primary productivity values, gross primary productivity ranged between 0.450 - 1.050, net primary productivity varied from 0.150 - 0.600 while community respiration showed variations from 0.150 - 0.750 gC/m^3/day. Lower values of net primary productivity and higher values of community respiration rate were observed at Dam site south and Dam site north.

Biodiversity of the Wetland

Phytoplankton community

A total of 22 genera belonging to three major groups viz., Chlorophyceae, Bacillariophyceae and Cyanophyceae were collected during the study period. Chlorophyceae was the most dominant group with 10 sp. followed by Bacillariophyceae and Cyanophyceae.

Chlorophyceae

The group was represented by *Pediastrum simplex, Pediastrum duplex, Treubaria* sp., *Scenedesmus, Uronema* sp., *Spirogyra* sp., *Closterium* sp., *Gonatozygon* sp., *Arthrodesmus* sp., and *Ankistrodesmus* species. Within the group *Scenedesmus* was found in maximum number and *Arthrodesmus* with minimum.

Bacillariophyceae

The group was represented by *Navicula* sp., *Fragilaria* sp., *Melosira* sp., *Synedra* sp.,*Gyrosigma* sp., *Ghomphonema* sp., *Rhopalodia* sp. and *Coscinodiscus* species. *Navicula* sp. dominated with in the group.

Cyanophyceae

It was represented by *Microcystis aeruginosa, Oscillatoria* sp., *Spirulina* sp., and *Coelosphaerium* species. *Microcystis* sp. was found in maximum while *Spirulina* with minimum.

Zooplankton community

17 sp. of zooplankton were encountered which comprised Cladocera, Rotifera, Protozoa and Copepoda with almost even order of species abundance.

Cladocera

Cladocera was represented by *Bosmina longirostra, Daphnia* sp., *Collotheca* sp. *Scapholeberis kingi,* and *Alonella* species. *Scapholeberis kingi* was the dominant species.

Rotifera

The common species encountered were *Brachionus quadridentata, Brachionus angularis, Keratella cochlearis,* and *Trichocera.*

Protozoa

Protozoa was represented by 4 species viz., *Vorticella* sp., *Didinium* sp., *Paramecium* sp. *and Euglypha* species. *Vorticella* and *Paramecium* was the dominant species.

Copepoda

It was represented by *Mesocyclops,* Nauplius larvae, *Diaptomus* sp., *Limnocalanus* species. *Limnocalanus* sp. dominated with in the group. Copepods were noticed at Dam Site Island only.

Benthic Fauna of the Wetland

The benthic community plays an important role in the economy of natural waters. Considering its status in the trophic dynamics, several workers Raman, *et al.* (1975), Bose, *et al.* (1978) (cited by Yadava *et al.*, 1984) have studied the benthos of inland waters. In the productive capacity of water bodies, the importance of benthic organisms as a link in the energy flow from primary production to fish has been stressed by Alm (1922) (cited by Yadava *et al.*, 1984). The Pong Wetland was dominated by order Mollusca, Diptera and Oligochaeta. Among Mollusca, *Lymnaea, Viviparus, Corbicula, Gyraulus, Lamellidens* were recorded during the study period. Among all *Lymnaea* was the dominant species. *Chironomus* sp. and *Tanypus*

represented the order Diptera. *Chironomus* dominated the order Diptera and was present at all the four study sites, forming a good food for carnivorous fishes. Oligochaeta was represented only by *Lumbriculus* species.

Macrophyte community

All the study sites of the wetland does not support any kind of macrophytic vegetation which may be due to its higher levels of depth i.e. 97 meters at FRL and 53 meters as observed during the study period. Boulders that may also hinder the macrophytic growth occupy the littoral and sub littoral zones of the reservoir.

Ichthyofauna

A total of 27 fish sp. belonging to six families were recorded from Pong wetland. The commercially important species in order of abundance included *Labeo rohita, Mystus seenghala, Labeo calbasu, Tor putitora, Cirrhinus mrigala, Wallago attu, Cirrhinus carpio, Labeo dero, Catla catla and Channa* sp.(Kumar,1993-94).

DISCUSSION

The pH of the water was fairly constant at 8.0 (alkaline) is pretty good for fish production. Kumar (1984) remarked that acidic waters are distinctly undesirable and alkaline waters most productive. Hora and Pillay (1962) have shown that pH range of 7-8 is characteristic of good water for fish culture. Following the Wherle's classification (1927), the wetland according to its pH values can be categorized as alkaline. Factors affecting the transparency of water are various microscopic organisms and types of suspended organic matter. Based on average clarity values (except for monsoon period) i.e 221 cm, according to one classification scheme (Sharma and Durve, 1990) this reservoir can be assigned as mild eutrophic status.

The slightly lower values of oxygen was observed during summer which may be due to the fact that the rise in the atmospheric temperature in the post winter months leads to the warming of water and ultimately helps in the increase of the rate of mineralization of non-living matter which demands oxygen and also supports the law of solubility of gases. For supporting fish life there should be at least 3.0 ppm dissolved oxygen in water (Tarzwell, 1957). From this point of view the level of D.O. recorded in the present study was quite congenial for the well being of aquatic life.

The dissolved phosphates and nitrate-nitrogen does not show any pronounced variation and are within limits. The smaller concentration of these nutrients in the water body cannot definitely be pointed out as indicative of low productivity as this may also be because of their rapid utilization by phytoplankton and perhaps because of insignificant source of pollution. Welch (1952) as well as Ruttner (1953) has reported smaller amounts of phosphorus in waters free of contaminating effluents. Reid (1961) point out that in eutrophic lakes the nitrate concentration is typically decreased in the upper zone by plankton utilization. Sreenivasan (1968) classified Sathanur and Krishnagiri reservoirs as eutrophic inspite of the total absence of nitrates and phosphates in these reservoirs.

The lower values of net primary productivity and higher values of community respiration rate observed at Dam site South and Dam site North may be due to decrease in the phytoplankton population and an increase in the population of zooplankton. Same observations have been made by Nasar and Sharma (1980). Wetzel (1975) classified lakes on the basis of mean primary productivity values ranging from 50-300, 250-1000 and > 1000 $mgC/m^2/$ day as oligotroghic, mesotrophic and eutrophic respectively.

The plankton of Pong wetland was composed of typically eutrophic speices that indicates the enriched status of the water body. Swayer (1966) considered *Microcystis as* indicator of eutrophy. According to Palmer (1969) species like *Scenedesmus, Closterium, Ankistrodesmus, Navicula, Fragilaria, Melosira, Synedra, Gyrosigma, Microcystis aeruginosa, Oscillatoria, Coelosphaerium* and *Spirulina* are the indicators of eutrophication while *Pediastrum duplex, Rhopalodia, Coscinodiscus* are pollution indicator species. Among zooplankton the species that appear typical of eutrophic waters are *Bosmina, Brachionus* and *Trichocera* while *Daphnia, Limnocalanus* and *Diaptomus* species are found in oligotrophic waters (Gulati, 1983). Among the benthic fauna presence of *Chironomus* species at all the study sites also indicates the organic richness of the water body. According to Cole (1983), *Chironomus* can tolerate low oxygen tensions and found in eutrophic lakes.

CONCLUSION

The study forms a preliminary data base and on the basis of above results and discussion it can be concluded that the present environment of the wetland is quite congenial for the well being of aquatic flora and fauna and may be assigned as mild eutrophic status. Moreover, the wetland needs more detailed limnological study for its better management and conservation.

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REFERENCES

Adoni, A. D. (1985), Workbook on Limnology. Pratibha Publishers Sagar 1-212.

A.P.H.A. (1985), Standard methods for the examination of water and wastewater. 16th edition. Washington, D.C.

Cole, A. G. (1983), Textbook of Limnology (3rd edi.). St. Louis, Toranto and London. The C.V. Mosby Company: 369 pp.

Crafter, S. A., Njuguna, S. G. and G. W. Howard (eds) (1992), Wetlands of Kenya. Proceeding of the Kenya Wetlands Working Group. Seminar on Wetlands of Kenya 3-5 July 1991.

Gaarder, T. and H. Gran (1927), Production of Plankton in the Oslo Fjord. Raap. Proc. Verb. Cons. Perm. Int. Explor. 1-48.

Gopal, B. (1995), Handbook of Wetland Management. WWF - India, New Delhi. 1-267.

Gulati, R. D. (1983), Zooplankton and its grazing as indicators of trophic status in Dutch lakes. Environment Monotoring and Assessment (3) 343-354.

Hora, S. L. and T. V. R. Pillay (1962), Hand book on fish culture in the Indo-pacific regions. *FAO Fish. Biol. Tech. Pap.* 14

Kumar, K. (1984), Hydrobiological Investigations of a Fresh water Beel with special reference to its fish production. Ph.D. thesis, Bhagalpur University, Bihar.

Kumar, K. (1993-94), Limnological Reconnaissance and Fluctuations of Fishery in Pong reservoir H.P. 1-31.

Megard, R. O. (1969), Algae and Photosynthesis in Shagawa Lake, Minnesota. Int. Rept. S., Limnol. Res. Cent., Univ. Minnesota. 20 pp.

Nasar, S. A. K. and M. Sharma (1980), Primary productivity in relation to the abiotic factors in a temporary Freshwater Pond. *Acta hydrachim hydrobiol.* 8 (5): 435-442

Palmer, C. M. (1969), Alage and water pollution. Castle House Publication Limited. 123 p.

Reid, G. K. (1961), Ecology of Inland waters and Estuaries. Reinhold Publication Corporation, New York: 375 p.

Ruttner, F. (1953), Fundamentals of Limnology. Univ. Toranto Press. 242 pp.

Sharma, L. L. and V. S. Durve (1990), Water clarity of 26 waters of Rajasthan in relation to phytoplankton. Proc. The Sec. Asian, Fish. Forum, Tokyo, Japan: 915 - 918.

Sreenivasan, A. (1968), Limnology of Tropical Impoundments. IV. Studies of two hard water reservoirs in Madras State. *Arch. Hydrobiol.* , 65 (2): 205-22.

Swayer, C. N. (1966), Basic concepts of eutrophication. Sewage Indust. Wastes. 38 (5): 737.

Tarzwell, C. M. (1957), Water Quality Criteria for Aquatic Life. In: Biological Problems in Water Pollution. U.S. Deptt. of Health Education and Welfare, P.H.S. 246-272.

Welch, P. S. (1952), Limnology. New York, Toranto and London. Mac Graw Hill Book Co. Inc. 538 pp.

Wetzel, R. G. (1975), Limnology. Saunders College Publishing, Philadelphia: 526 pp.

Wherle, E. (1927), Studien under wasserstoffionen koenzentraati on sverhattnisse und Besiedung an Algenstandorten in der umgebung von Freiburg im Breisgau, Z. Bot., 19 : 207-287.

Yadava Y. S., Kolekar, V., Singh, R. K. and M. Choudhury (1984), Studies on the Macrobenthic Fauna of Dighali Beel (Assam). Proc. Nat. Acad. Sci. India 54, (B). III