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RESEARCH ARTICLE

TROPHIC DYNAMICS AND ENERGY FLOW IN A SMALL IRRIGATION CUM FISH CULTURE RESERVOIR

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ABSTRACT

Present communication reveals that the phytoplanktonic energy is fixed and energy transformation by phytoplankton in Barnoo reservoir ranges in different season. The phytoplanktonic gross energy transformations were ranges between 27987 to 34232.5 Cal m-2 day-1 and net energy fixation were ranges between 1473.6– 30380.6 Cal m^{-2} d^{-1}. The fish production potential were estimated on the basis of 0.2% , 0.4%, and 1% of the net production energy and were in the range of 208 - 254.48 kg h^{-1} yr^{-1}; 416 – 508.96 kg ha^{-1} yr^{-1}, 1040 – 1272.4 kg h^{-1} yr^{-1} respectively. It means that the small reservoirs provide better scope for fisheries management and stock enhancement.

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INTRODUCTION

Barnoo reservoir: Location and Topography: For the purpose of study selected Barnoo reservoir as an experimental ground. It is a small irrigation reservoir located in Sihora tehsil of Jabalpur district (M.P.) at 80° 07' 10" E Longitude and 23° 20' 50" N Latitude. It is about 40 years old and was created by constructing an earthen dam of 322.50m. long and was completed during the year 1966-67. It was impounded on the rainy River Barnae. Total water spread area of the reservoir is 75.6 ha. at FRL , with a catchments area of 32.8 sq. km. Barnoo reservoir was adopted for fisheries purpose in 1980. For fishing it had been divided into 10-beats. The perennial region of the reservoir have uneven bottom and submerged trees (Mandloi *et al*, 2003 & Ojha, 2004). The basic principal source of energy for living organisms is sun, which releases energy and is captured by the photosynthetic organisms and transformed into potential chemical energy and stored as plant tissue. Aquatic ecosystem comprises abiotic factors intermingled with biotic components of producers (autotrophs), consumers (heterotrophs) and decomposers (saprophytes) where energy transformation takes place continuously and resulting in ultimate production of fish.

METHOD OF ESTIMATION OF PRIMARY PRODUCTION (APHA 1980)

Energy fixation: Rate of energy fixation by producers was calculated by multiplying carbon values (of primary production) with 9.82 (Pathak, 1997).

Primary productivity estimated through Oxygen method by measuring the changes in oxygen and Co_2 concentration i.e. Dark and Light bottle method. Taken 3-dark bottle and 3- Light bottle of narrow mouth ground glass stopper 250 ml. bottle and filled it with water sample of known depth and stopper tightly and hang all the six bottles at a depth from which the sample was collected. Before this adjustment determined the initial dissolve oxygen concentration by winkler's method. Exposure of bottles started in four hours intervals, eight hours intervals and twelve hours intervals. Bottle removes and determined the dissolved oxygen concentration immediately by winkler's method. Dissolved oxygen of Light bottle denotes as LB and Dark bottle dissolved oxygen denotes as DB. This method is applied in reservoir site and in natural condition for three seasons viz. winter, summer and monsoon season. After determined all the reading; calculation was made from the suitable formula.

OBSERVATION

Energy Transformation: Energy transformation and rate of energy fixation from light to chemical by producers were studied in Barnoo reservoir and noted seasonally interval. During the study period i.e. in summer season of the year 2001-2002; the Gross energy fixation and Net energy fixation were noted as 30933 Calm^{-2}hr^{-1}, 20622 Calm^{-2}hr^{-} respectively. In summer season of year 2002-2003; the Gross energy fixation and Net energy fixation were noted as 32630 Calm^{-2}hr^{-1}, 18413 Calm^{-2}hr^{-1} respectively. In summer season of year 2003 – Oct. 2003; the Gross energy fixation and Net energy fixation were noted as 33066 Calm^{-2}hr^{-1}, 18913 Calm^{-2}hr^{-1} respectively.

In monsoon season of year 2001-2002; the Gross energy fixation and Net energy fixation were noted as 29460 $Calm^{-2}hr^{-1}$, 14736 $Calm^{-2}hr^{-1}$ respectively. In monsoon season of year 2002-2003; the Gross energy fixation and Net energy fixation were noted as 33756 $Calm^{-2}hr^{-1}$, 30381$Calm^{-2}hr^{-1}$ respectively. In monsoon season of year 2003 – Oct. 2003; the Grass energy fixation and Net energy fixation were noted as 34233 $Calm^{-2}hr^{-1}$, 21211$Calm^{-2}hr^{-1}$ respectively. In winter season of year 2001-2002; the Gross energy fixation and Net energy fixation were noted as 27987 $Calm^{-2}hr^{-1}$, 17676 $Calm^{-2}hr^{-1}$ respectively. In monsoon season of year 2002-2003; the Gross energy fixation and Net energy fixation were noted as 30687 $Calm^{-2}hr^{-1}$, 20868 $Calm^{-2}hr^{-1}$ respectively.

RESULTS AND DISCUSSION

Energy transformation through primary production: In aquatic ecosystem the rate of energy transformation by chlorophyll bearing organisms i.e. phytoplanktons gives a dependable parameter for assessing their potential resource and maximum sustained energy that can be obtained from them as fish. Through photosynthetic process producer organisms synthesis organic compounds utilizing solar energy and nutrient material which is represented by basic equations (Pathak, 2003). In the water bodies like reservoir the energy transformation is mainly by phytoplanktons are the main primary producers and in Barnoo reservoir 61-sps. of phytoplanktons were identified which is the primary food for the fish. From ecosystem to ecosystem the rate of primary production are always differ and within the ecosystem it depends on various limno-chemical and meteorological conditions. Phytoplankton primary productivity along with related parameters like water quality can be used as indices of trophic status and fisheries resource potential (Henderson et.al. 1973; Melack, 1976; Oglesby, 1977). Though these parameters have been investigated in a number of reservoirs under different river system (Sreenivasan, 1972, Pathak, 1997; Kannan and Job, 1980; Birasal, 1996), due to the wide variations in their morphometry, nature and degree of watershed, climatic and human interference, the problem related to fishery management and their solution are location specific. In this study variability in gross and net production and nature of productivity profiles were analyzed on the basis of concurrent physico – chemical parameters. The primary productivity of a water body is the manifestation of its biological production.

Pathak (2003) studied on eight small reservoir and found differ in energy transformation from radient energy from chemical energy by the producers viz. 2428 $Cal/m^2/day$ (Umrang), 8780 $Cal/m^2/day$ (Thirumoorthy), 8781 $Cal/m^2/day$ (Bhavanisagar), 9547 $Cal/m^2/day$ (Bachhra), 12490 $Cal/m^2/day$ (Naktara), 13056 $Cal/m^2/day$ (Gularia), 13580 $Cal/m^2/day$ (Aliyar), 13970 $Cal/m^2/day$ (Bagala). Gessnor (1960) observed during the period of maximum growth that euphotic lakes in temperate regions have a gross energy fixation rate ranges from 1800 to 18400 $Cal/m^2/day$. In Lake Victoria the average daily production was estimate as 26054 $Cal/m^2/day$ (Talling, 1966). Ganapati *et al.*(1970) was recorded average daily production of 20,054 $Cal/m^2/day$ and 10598 $Cal/m^2/day$ in Amravati and Stanley, the two tropical reservoirs of south India. Such observation was reported in Barnoo reservoir. During the study the phytoplanktonic energy is fixed and energy transformation by phytoplankton in Barnoo reservoir ranges in different season. In Barnoo reservoir the phytoplanktonic gross energy transformation were ranges between 27987– 34232.5 Cal m-2 day-1 and net energy fixation were ranges between 1473.6–30380.6 Cal m^{-2} d^{-1}. In the present study the chemical energy fixed by producers compare well with the findings of the above workers.

Flow of energy from producers to consumers: Odum (1962) highlighted the importance of two types of chains the 'grazing food chain' consisting of herbivores which feeds on living plants to geather with their predators and the 'detritus food chain' consisting of detritivores which feed on dead plant material with their predators; such type of finding were reported in the present study. Odum (1957) and Teal (1957) working on different types of aquatic systems constructed energy flow models from which it is possible to calculate gross ecological efficiency or production efficiencies at any trophic level. Almost 90% of the potential energy is lost in passing from one level to the other.

Evaluation of fish production potential: The production potential of any water body depends directly on the efficiency with which producers transform and store solar energy into chemical energy. Odum (1975) and Mann (1968) applied energy flow approach for evaluating the fish production potential of lakes and reservoir keeping in view that in passing from one trophic level to the other almost 90% of the available energy is lost according to the second law of thermodynamics. Odum (1960 and 1962) felt than in natural systems like lakes and reservoirs which have wide range of fish spectrum belonging to various trophic levels that productivity potential can be taken as 1% of gross or 0.5% of net energy fixed at producer level. Natarajan and Pathak (1983) calculated the fish production potential of a number of reservoirs in the country by taking 0.5% of the net energy fixed by producers as energy available at fish level. The fish production potential estimated on the basis of 0.5% of the net production energy in several reservoirs was in the range of 43.6 to 382.5 kg/ha/yr. Such observation was reported during the present study. In Barnoo reservoir the fish production potential were estimated on the basis of 0.2% , 0.4%, and 1% of the net production energy in Barnoo reservoir and were in the range of 208 - 254.48 kg h^{-1} yr^{-1}; 416 – 508.96 kg ha^{-1} yr^{-1}, 1040 – 1272.4 kg h^{-1} yr^{-1} respectively. It means the small reservoirs and they provide better scope for fisheries management and fish stock enhancement.

Pattern of energy utilization: The pattern of energy utilization in Barnoo reservoir the energy harvest as fish was contributed by primary consumers (mainly by detritus feeders) and the main path of energy flow was through detritus chain. So, there is enough scope for increasing fish production (atleast 50% of the potential). Odum (1962) observed that fishes feeding directly on algae and macrophytes or detritus obtain maximum conversion efficiency from primary energy. Nikolsky (1963) stated that 'the nearer the useful end product (fish) stands to the first link in food chain (producers) the higher the yield from the water mass. Both these observations are in agreement that in Barnoo reservoir almost 90% of energy is lost in passing from one trophic level to the other.

CONCLUSION

Small reservoirs provide ideal situation for fish stock enhancement and getting maximum energy return by judicious stocking with desired species and taking care of energy loss from the system in flowing at higher trophic levels. In the study of Barnoo reservoir in respect of energy dynamics application of these investigations can be utilized for increasing fish production by stocking and building the desired fish stock.

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