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Assessment of Culture Fisheries in Village Ponds: a Study in District Hisar, Haryana, India

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ABSTRACT: Present communication deals with the study of four village fish culture ponds (two wild and two managed ponds) from district Hisar of Haryana, India was undertaken, to correlate the water quality and biological cycles in ponds with fish production. Studies have revealed that the ponds are in good trophic status. Chlorides, total hardness, calcium, magnesium, biochemical oxygen demand (BOD), phosphates (o-PO_4) and ammonia were high whereas dissolved oxygen and fish growth/ yield was low in wild ponds in comparison to managed ponds. This may be due to high organic loads. The net primary productivity mg C L/d was high in the wild ponds in comparison to the managed ponds. And thus high fish growth /yield are not directly related with net primary productivity. The deterioration of water quality, as indicated by very high ammonia and BOD in wild ponds might have decreased the fish growth.On the other hand, grazing pressure might have decreased the Net Primary Productivity (NPP) but resulted in the high fish biomass. Thus, fish production appear to depend to lesser degree on the magnitude of primary production and therefore, universal relation between primary productivity and fish production could not be established and a variety of factors like organic load, ammonia production, nature/quantity of fertilizers influence such correlations. Management of water quality by managing the optimization of waste input in village ponds may help in enhancing the fish production through such small scale aquaculture.

Key words: Water quality, Physico-chemical characteristics, Fish yield, BOD, Ammonia, Fish

INTRODUCTION

The inland culture fishery sector in India has seen quantum growth over the last few decades and at present Haryana state stood second in fish production in the country. Pond water is considered as the major sources for augmenting fish production for the growing fish-eating population and also generating rural employment in the state. Aquaculture in such village ponds in Haryana, in general, utilizes poly carp culture and is practiced with the utilization of low to moderate and high levels of inputs, especially organic-based fertilisers and feed. The main problems faced by fish farmers are poaching, water availability/quality and credit. Even then, there has been a marked shift in the intensity of fisheries in some districts. Hisar (Lat. 29^{o}, 10'N; Long 75^{o}, 46'E) is one of the important district in the state which falls under semi-arid zone where rainfall is low and in some areas salinity is increasing. The consumption of fish in the region is increasing, and also there is an increasing demand for fresh fish from nearby cities and Delhi. This demand has led to sudden rise in the number of persons bidding for these ponds in the area, which is also seen in the rise in the lease amounts. Some of the fish farmers in the district are doing a good work of fish/fish seed production using tube-well/canal waters. However, there is ample scope for the improvement, if the proper technology is followed and regular monitoring of water quality is made. However, a balance model is required to promote aquaculture so that it can fulfil its potentials and contribute significantly to people's welfare.

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The details of pond ecosystem have been studied by a host of workers (Rahman *et al.*,1982; Mumtazuddin *et al.*, 1982; Islam *et al.*, 1998; Delince, 1992; Garg and Bhatnagar, 1999, Garg

and Bhatnagar, 2000; Bhatnagar and Garg, 2000) . It was observed that despite the intensification of pond culture, adequate accounts of limnological aspects are not available and no such studies on the pond fish culture in relation to water quality have been carried out in Haryana India. Therefore, the present studies have been undertaken to monitor water quality and fish food organisms in relation to fish growth/productivity from the fish culture ponds of one of the important district Hisar of Haryana.

MATERIALS & METHODS

Four fish culture ponds were selected in District Hisar (Lat. 29^{o}, 10'N; Long 75^{o}, 46'E) of Haryana, India, two are wild (where there is no restriction on cattle entry and sewage from non-point sources also enters in the pond) and two are managed and constructed ponds where cattle visit is limited and liming is a regular feature (See Table 1 for specific characteristics of ponds). Both types of ponds receive direct sunlight, the bottom soil of which contains clay.

Water samples were collected using plastic bottle of capacity two litres at bimonthly interval. The physico-chemical characteristics *viz*. temperature, dissolved oxygen, free CO_2 and alkalinity were analysed at the site itself, while parameters such as hardness, calcium, magnesium, chloride, orthophosphate and total phosphate were analysed in the laboratory in accordance with NEERI (1986) and APHA (1998) on the following 2-3 days during which samples were kept in cold storage. Multiline F-set 3 (E- Merck,Germany) was used for the determination of DO, pH, conductivity and salinity. BOD was estimated by seeding method. Water samples were diluted by adding distilled water and incubated for five days in BOD incubator (APHA, 1998).

Plankton samples were also collected by passing 25L of water taken from five different locations (5 L from each location) of each pond through plankton net (mesh size 50µm) at an interval of 60 days. The samples were then carefully transferred to a measuring cylinder and a volume of 50 ml with distilled water was made and preserved in small plastic bottles with 5 per cent buffered formalin (concentrated sample). Plankton numbers were estimated using Sedgwick Rafter cell. Identification of plankton to genus level was carried out using the keys of Ward and Whipple (1959), Prescott (1962) and Bellinger (1992).Plankton species diversity (d) was determined using the diversity index formula of Shannon and Weaver (Washington 1984).

$$d = - \sum (ni/N) \log_2 (ni/N)$$

Where, d = species diversity
n_i = no. of individuals of i^{th} species
N = total No. of individuals

Net and gross primary productivity (NPP and GPP) were determined using light and dark bottle technique following APHA (1998).

Fish were bulk weighed by repeated netting on bimonthly basis and specific growth rate and

Table 1. Selected stations on the and their characteristics

S.No	Characters	Wild ponds		Managed ponds	
		H-1	H-2	H-3	H-4
1	Pond site	Mugalpura	Jajanwala	Dabra	Satrod
2	Area(hectare)	2.0	2.0	0.6	1.2
3	Source of water	Natural/ tubewell	Canal /Natural	Tubewell	Tubewell
4	Species cultured	Three(C,R,M)	Four(C,R,M,CC)	Three(R,M,CC)	Four(C,R,M,CC)
5	Approximate Mortality* if any(%)	30%, during summer and cloudy weather low oxygen	15-18%, During high temp	Nil	Nil
6	Fertiliser used	No	No	Cow-dung, urea, SSP,MOC	Cow-dung ,MOC,Rice-bran
7	Medicine used	Lime , $KmNO_4$	Lime , $KmNO_4$	Lime , $KmNO_4$	Lime, KmNO4, Turmereic

C- Catla, R- Rohu, M-Mrigal, CC-Common carp, SC- Silver carp, GC- Grass carp, MOC Mustard oil cake,
***Mortality was calculated according to farmers report**

growth per cent gain in body weight was calculated. Fish yield was recorded at the time of harvesting by the actual harvests.The coefficient of correlation "r" between different water quality parameters was calculated using SPSS packages while group means were compared by student's't' test (Snedecor and Cochran, 1980).

RESULTS & DISCUSSION

Table 2 depicts the water quality characteristics of wild (H-1 & H-2) and managed (H-3 & H-4) ponds respectively.Water temperature followed the trend of atmospheric temperature being low during winter and high during summer pH was alkaline throughout the study period and was high in wild ponds in comparison to managed ponds Conductivity, alkalinity, hardness, calcium, chlorides, BOD, phosphates, ammonia and plankton population all were significantly high whereas DO was low in wilds ponds in comparison to managed ponds.

NPP was significantly ($P< 0.05$) high in wild ponds. Fish yield showed higher values in managed pond. Total fish production per year varies between 2900 and 5200 Kg per hectare in wild ponds and approximately 7166 kg per hectare in managed ponds (Fig. 1). Total fish yield from pond H-3 could not be reported because the harvesting was carried out before the scheduled date by the farmer. Fish growth showed a significant negative correlation with BOD ($r = - 0.362$, $P<0.05$) and ammonia ($r = -0.399$, $P<0.05$) showing that BOD and NH_4-N are the two important factors affecting the pond productivity.

Biological analysis of data further revealed that total plankton population was high in wild ponds, whereas species diversity was high in managed ponds in comparison to wild ponds (Table 2, Fig. 2).Sediment chemistry of the selected ponds (Table 3) also revealed that the pH is throughout alkaline. The accumulation of organic carbon and conductivity is high in wild ponds in comparison to cultivated/owned ponds. Nitrate mg Kg^{-1} dry weight also revealed a similar trend.

There have been a number of attempts at correlating the fish yields with limnological factors influencing the productivity of water bodies (Rawson, 1955; Northcote and Larkin, 1956; Ryder, 1965, Garg and Bhatnagar, 1999, 2000). In the present studies also high pH and alkalinity of the pond waters reveal that ponds are well buffered and in high trophic status. Water alkalinity

Table 2. Physico-chemical and Biological Characteristics of ponds (H-1-H- 4) waters in District Hisar

Parameters	Wild ponds		Managed ponds	
	H-1	H-2	H-3	H-4
Water Temp. ^0C	22.12±1.40	22.24± 1.36	23.57± 1.06	23.92±.90
p H	9.08± .09	8.19± .02	8.17±.08	8.12±.13
Conductivity µ S cm^{-1}	4201.94± 56.60	1618.33± 10.45	1023.44± 84.40	427.66±15.97
Salinity ppt	2.0	0.0	0.0	0.0
Dissolved oxygen mg L^{-1}	3.93± .08	6.26± .03	7.21±.05	7.51±.06
Free CO_2 mg L^{-1}	Absent	22.55±1.42	11.50±.95	13.10±1.55
Carbonates mg L^{-1}	57.21± 4.25	0.0	0.0	0.0
Biocarbonates mg L^{-1}	429.77± 25.64	382.83±14.67	240.55±9.16	168.16±2.34
Total alkalinity mg L^{-1}	486.98± 22.82	382.83±14.67	240.55±9.16	168.16±2.34
Total Hardness mg L^{-1}	543.72± 14.60	206.33± 6.6	234.83±28.21	172.11±3.24
Calcium mg L^{-1}	73.26± 10.65	41.57± 1.69	43.54±11.76	26.45±4.06
Magnesium mg L^{-1}	87.96± 8.88	25.04± 2.40	30.75±1.05	25.87±2.79
Chloride mg L^{-1}	221.26± 11.16	193.18± 13.04	115.65±22.55	9.42±.38
o-phosphate mg L^{-1}	2.30± .06	1.93± .04	0.74±.02	0.46±.02
Total phosphate mg L^{-1}	2.87± .10	2.54±.03	1.15±.05	0.63±.05
Total ammonia mg L^{-1}	2.05± .56	1.36±.35	0.52±.04	0.59±.11
BOD mg L^{-1}	2.70± .13	3.04± .10	2.45±.05	2.38±.10
Plankton Population L^{-1}	3780.00±193.2	3893.33±238.6	3520.00±208.6	3333.33± 156.8
Phytoplankton L^{-1}	2153.33±143.3	2076.66±172.7	2206.66±157.7	2083.33± 113.0
Zooplankton L^{-1}	1626.66±83.94	1816.66±151.1	1313.33±98.55	1037.33± 183.0

All values are mean ± S.E. of mean (n=24)

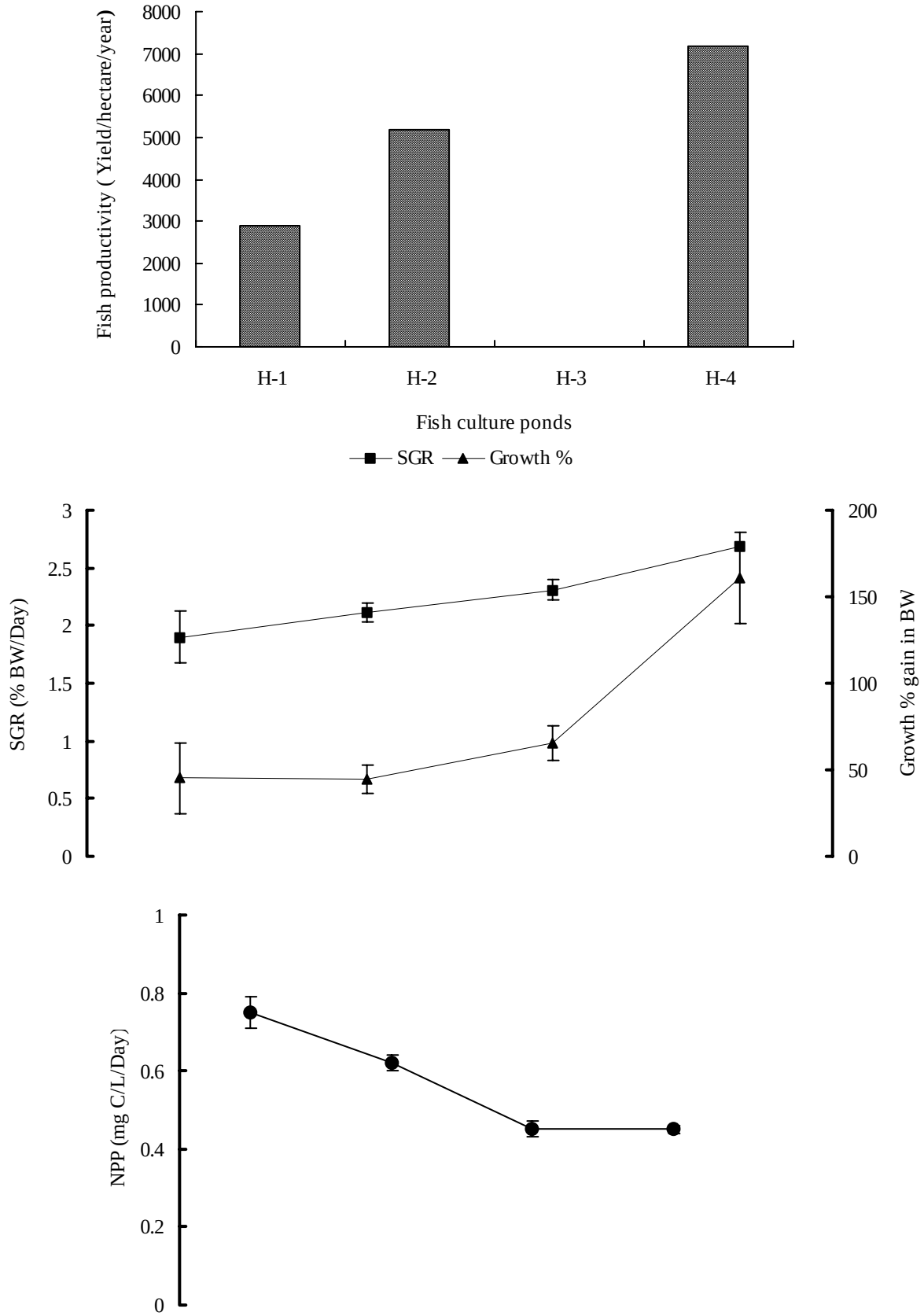

Fig. 1. Net primary productivity (NPP), fish growth (Specific Growth Rate –SGR and Growth per cent gain in Body weight) and production from selected ponds of District Hisar in Haryana. (Fish yield of H-3 could not be reported because the harvesting was carried put before the scheduled date by the Farmer)

Table 3 . Sediment Chemistry (Mean ± S.E.) of selected pond sites

Parameters	Wild ponds		Managed ponds	
	H-1	H-2	H-3	H-4
Moisture (%)	31.66±4.22	33.61±2.44	27.2±0.98	26.6±1.19
p H	8.26±0.01	8.31±0.06	7.16±0.04	7.41±0.06
Conductivity (μ S cm^{-1})	987.6±10.7	1319.9±38.9	992.8±64.54	563.0±21.54
Available phosphate (mg Kg^{-1} dry Wt.)	0.11±0.003	0.16±0.003	0.05±0.003	0.06±0.06
Nitrate (mg Kg^{-1} dry Wt.)	0.071±0.04	0.053±0.02	0.021±0.04	0.026±0.02
Organic carbon %	0.913±0.06	0.864±0.02	0.513±0.06	0.981±0.02

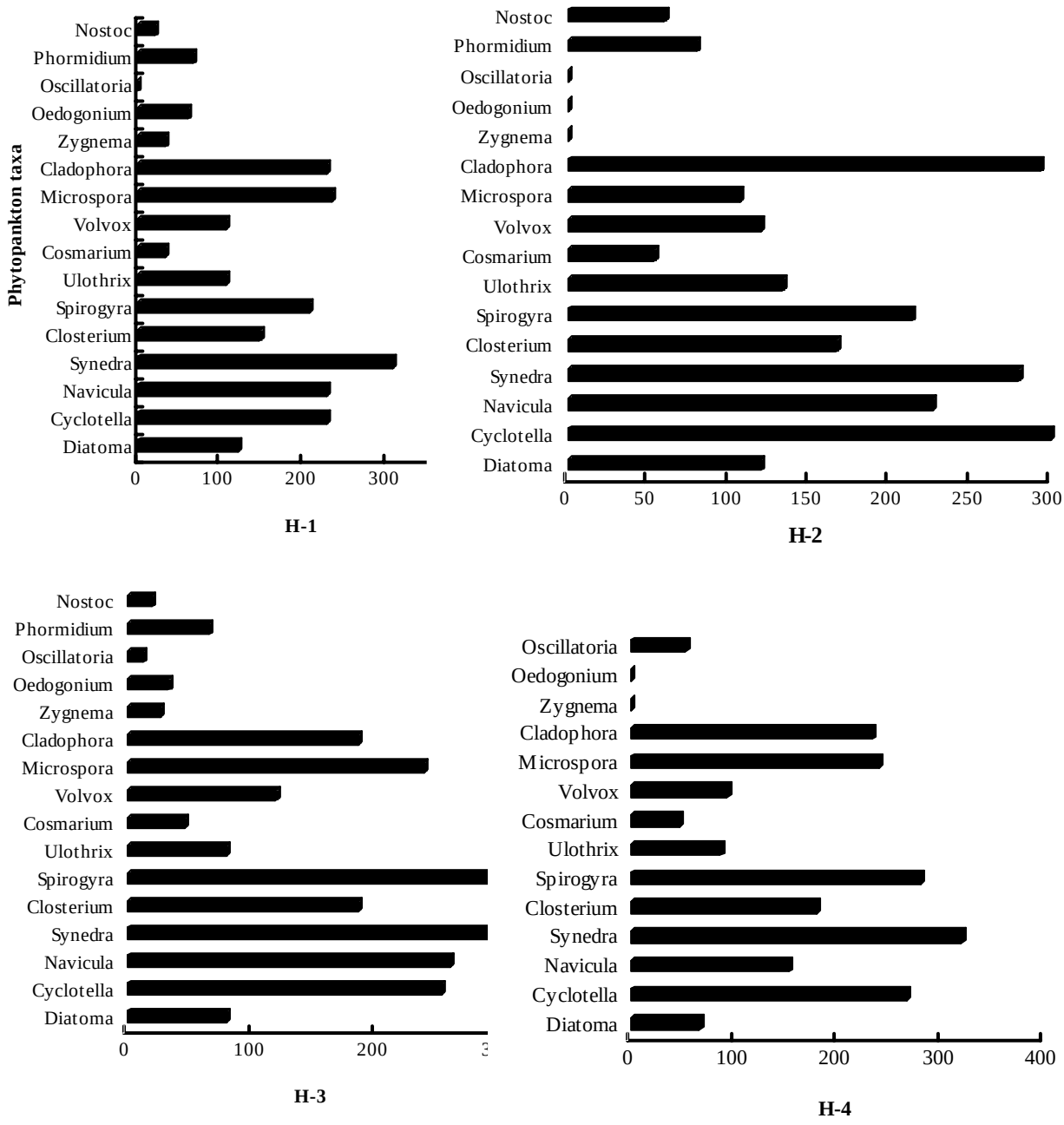

Fig. 2 . Planktonic community at selected sites (H-1 – H-4) in district Hisar (Continues)

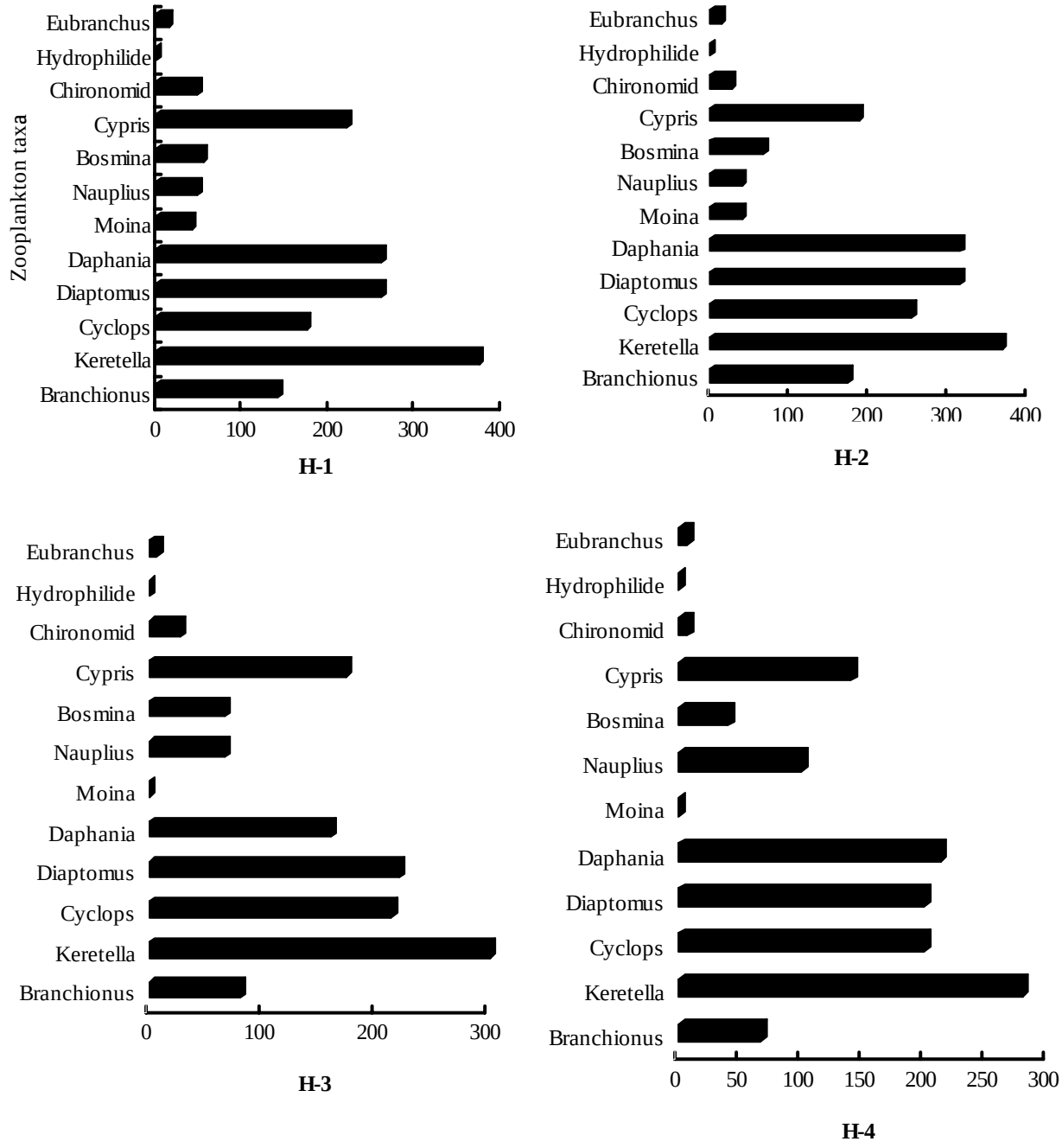

Fig. 2. Planktonic community at selected sites (H-1 – H-4) in district Hisar (Continuation)

is a measure of the buffering ability of the water this means that when pond water alkalinity is high, more acid substances are needed to decrease the water pH-value. However, the values were much high in wild ponds in comparison to managed ponds, where carbonate is the dominant ion and little carbon dioxide is made available by the buffer system, thus reducing photosynthesis (Boyd, 1972). No significant variation in electrical conductivity was observed between wild and managed ponds. Generally the values were high during summer may be because of high evaporation rates and salt concentrations (Talling and Talling, 1965). Chlorides, total hardness, calcium and magnesium were high in wild ponds in comparison to managed ponds may be because of unmanaged entry of cattle and domestic waste, since these parameters are usually taken as an index of pollution (Hansson, 1989 ; Bhatnagar and Sanghwan, 2009, and Bhatnagar *et al.*, 2009). Increased chloride

contents also indicate the pollution of animal origin. Chloride and hardness were much higher in wild pond (H-1) where water was saline (2.0 ppt) . In one of the wild ponds (H-2) free carbon dioxide was high according to Swingle (1955) free carbon dioxide at a concentration of more than 50 ppm is detrimental to fish life. According to Burggren (1979) high free carbon dioxide affect respiration of aquatic organism and slows the rate of metabolism in fishes. BOD, o-PO_4, total phosphate and ammonia were significantly high in wild ponds in comparison to managed ponds. High BOD indicates the presence of high biodegradable organic matter which consumes dissolved oxygen. Thus high organic load because of excess entry of cattle and domestic sewage from the non point sources in wild ponds may be responsible for high BOD. Similarly increase in phosphate in the wild ponds may also be attributed to high organic load in these ponds.

Ammonia concentration was also high in the wild ponds and is significantly and inversely related to fish growth ($r = -0.399$ $P<0.05$) and fish yields. According to Meade (1985), maximum limit of ammonia concentration for aquatic organisms is 0.1 mg L^{-1} and high value of ammonia causes ammonia toxicity resulting in osmoregulatory imbalance, kidney failure and damage to gill epithelium which leads to suffocation. In our studies although the values were low at station 1 yet they were higher than 0.1 mg L^{-1}. According to Harrison, (1978) high concentration of calcium, magnesium and phosphate ions also have a positive effect on ammonification, since ammonification is performed by heterotropic bacteria whose density is strongly dependent on organic substrate available (Barat and Jana, 1987). Therefore, high organic load in the wild ponds were also responsible for high ammonia in these ponds. No significant variation was observed in plankton population in wild as well as in managed ponds. Since plankton production depends upon carrying capacity of environment and nutrient factors, high nutrient availability and supply may have direct effect on production of fish food organisms. The phytoplankton dominant Taxa were *Cladophora*, *Spirogyra* (members of chlorophyceae), *Cyclotella, Synedra* and *Navicula* (members of bacillariophyceae). Among the zooplankton *Keretella*, (rotifer) *Cyclops*, *Diaptomus* (copepods) *and Daphania* (Cladoceran) were the dominant taxa (fig.2). Low zooplankton population was found in the ponds with highest fish growth rate (H-4). This decrease in plankton population may be attributed to grazing pressure exerted by the fishes (Delince, 1992). The phytoplankton-zooplankton interface is the crucial point where changes in the predators at the top of food web are translated to changes in the property of ecosystem such as primary productivity and nutrient recycling (Elser *et al*, 1990). In the present study the net primary productivity mg $L^{-1}d^{-1}$ was high in the wild ponds in comparison to the managed ponds. And thus high fish growth /yield is not directly related with net primary productivity, since fish release various waste products such as carbondioxide, ammonium and organic material containing nutrients while they remove oxygen and particulate, organic materials (plankton from the system). According to the effect of fish growth on water quality the positive effect is that they stablise the food web and maintain steady production and negative effect is that leading with increase biomass a decrease in net production factor is observed. In the present study also deterioration of water quality as indicated by very high ammonia and BOD in wild ponds, which might have decreased the fish growth, on the other hand, grazing pressure might have decreased the NPP in managed ponds but resulting in the high biomass van Rijn *et al.* (1986) have also reported similar results in poly culture manure ponds which shows low NPP at the end of the culture periods and high fish biomass.

CONCLUSION

Thus, the fish production efficiency varies over a wide range in the wild and the managed ponds. However, average conversion is more effective in managed pond. Therefore, by applying the simple management practices like management of water quality in terms of ammonia and BOD by managing the input of waste in water the production can be enhanced. The high fish production is actually the result of bacterial food chain, which has great importance in such organic waste loaded systems. The fish production appear to depend to lesser degree on magnitude of primary production and, therefore, universal relation between primary productivity and fish production could not be established and a variety of factors like organic load, ammonia production,

nature and quantity of fertilizers influence such correlations.

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