Ecology - based Fisheries Management in Chamera Reservoir (Himachal Pradesh)

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ECOLOGY-BASED FISHERIES MANAGEMENT IN CHAMERA RESERVOIR (HIMACHAL PRADESH)

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Foreword

Reservoirs form the most important inland fishery resources of India with immense potential to enhance the country's inland fish production. Keeping this aspect in view scientists of CIFRI investigated ecology and fisheries of Chamera reservoir in Himachal Pradesh. I am glad that the investigations made have brought out important limnological features of Chamera reservoir with useful recommendations for the development of fisheries therein.

I am hopeful that this document will greatly help in formulating guidelines for scientific management of said reservoir in particular and for other similar small water bodies in the state.

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INTRODUCTION

Since independence, dams are increasingly becoming characteristics components of various rivers in Himachal Pradesh because of a quantum jump in the development activities especially in the field of power generation, irrigation and flood control, leading to formation of several man-made lakes throughout the length and breadth of the state. The state is flurished by a number of rivers, the most important them being Chanab, Ravi, Beas, Sutlej and Yamuna. All the rivers are snow-fed and are perennial. The major impoundments created on the river Sutlej, Beas and Ravi are Gobindsagar (11300 ha), Pong (15000 ha) and Chamera (900 ha), respectively. These man-made lakes hold tremendous potential for inland fisheries development and offer ample scope for fish yield maximization through adoption of suitable management measures that requires study of ecological conditions and yield potential. Keeping this aspect in view, ecological investigations of Chamera reservoir were made on seasonal survey basis during three seasons; Post-monsoon (October, 1996), Winter (January, 1997) and Summer (May, 1997) and are presented herein.

LOCATION AND MORPHOMETERY

Chamera, an impoundment across the river Ravi near the village Chowrah is located in the district of Chamba in Himachal Pradesh. The reservoir came into existence in the year 1994 as a result of construction of a 140 m high concrete capacity arch dam by the National Hydroelectric Power Corporation for hydel purpose. It is linked with Pathankot town by a 97 km long road. Topography indicates the river basin lying mostly along the Himalayas and touching the Shivalik hills on the Southern fringe. The reservoir has a water-spread area of 900 ha and a catchment area of 4725 km^2. It has a gross capacity of 391.3 million m^3 and a mean depth of 43.5 m. It extends upto 11 km on Siul River beyond Sundla and upto 18 km on the Ravi river (Fig.1). The high C/A ratio (525) indicates more inputs of allchthonous nutrients through the catchments. The reservoir is mainly fed with snowmelt and warm monsoon run-off. The annual precipitation was 1100 mm. The reservoir level fluctuated by 2.72 m from a minimum of 746.96 to a maximum of 749.68 m.

LIMNOLOGY AND PRODUCTIVITY

a) Physico-chemical characteristics of soil

Basin soil of the reservoir was sandy loam and was slightly acidic (pH 6.6-6.7) in reaction. Values of organic carbon (1.52-1.62%), available phosphorus (5.6-5.8 mg/100 g) and available nitrogen (71.9-81.8 mg/100 g) reflected fertile status of soil. Enrichment of soil with organic matter indicates adequate flow of energy through allochthonous sources in addition to autochthonous source. Allchthonous form of energy thus becomes most important part of food chain and can be utilized by detritivorous fishes.

Table - 1 : Physico-chemical characteristics of Soil of Chamera Reservoir

Parameters	Pre-monsoon	Post-monsoon
Sand (%)	58.4	57.3
Silt (%)	22.9	24.4
Clay (%)	18.9	18.1
pH	6.7	6.6
Organic carbon (%)	1.53	1.62
Free $CaCO_3$ (%)	1.05	1.16
Available phosphorus (mg/100g)	5.6	5.8
Available nitrogen (mg/100g)	71.9	81.8
Sp. conductivity (µmhos/cm)	147.6	230.8

b) Physico-chemical characteristics of water

Observations on the physico-chemical features of water are presented in table 2. Water temperature is an important critical factor for the distribution of biological life in an ecosystem. The surface water temperature varied from 11° C in winter to 19° C in summer/post-monsoon, indicating temperate conditions of the reservoir. pH ranged between 6.6 in summer and 7.6 in post-monsoon indicating unfavorable conditions of water for fish growth in summer. Water transparency after monsoon (115 cm in summer) gradually increased (179 cm in winter) due to settling of suspended particles and coupled with lesser disturbances in water due to calm condition in the reservoir. Dissolved oxygen was in congenial range (8.1-8.8 mg/l). Free CO_2 was absent in post-monsoon and winter seasons while it appeared in summer (14.0 mg/l). Assesment of productivity based on the total alkalinity (av.64 mg/l) exhibited conduciveness of the water body for fish productivity. Total alkalinity correlated inversely with water temperature being low in summer (46 mg/l) and high in winter (84 mg/l).

Calcium (14.4-25.6 mg/l) and magnesium contents (4.9 mg/l) were favourable for promoting productivity. Total hardness (56-84 mg/l) followed a trend similar to that of alkalinity. Dissolved organic matter (3.2-4.0 mg/l) exhibited productive state of the reservoir. Specific conductivity was minimum in summer (95.0 µmhos/cm) and was maximum in winter (166.0 µmhos/cm). Low specific conductivity in summer is attributed to influx of snowmelt causing dilution in ions. Considering various limnological parameters especially water temperature, alkalinity, calcium and specific conductivity the Chamera reservoir is found suitable for production and propagation of cold-water fishes, particularly *T. putitora*.

Table – 2 : Physico-chemical characteristics of surface water of Chamera reservoir

Parameters	Ranges	Average
Water temperature (°C)	11.0-19.0	16.3
Transparency (cm)	115.0-179.0	147.3
pH	6.6-7.6	7.2
Dissolved oxygen (mg/l)	8.1-8.8	8.4
Free CO_2 (mg/l)	Nil-14.0	4.7
Total alkalinity (mg/l)	46.0-84.0	64.0
Dissolved organic matter (mg/l)	3.2-4.0	2.4
Hardness (mg/l)	56.0-84.0	70.0
Calcium (mg/l)	14.4-25.6	20.0
Magnesium (mg/l)	4.9	4.9
Chloride (mg/l)	11.36-14.2	12.7
Sp. conductivity (µmhos/cm)	95.0-166.0	132.3

Thermal and chemical stratification

Table - 3 : Depth Profile of Chamera Reservoir

Depth (m)	Water-temp. (°C)			pH			D.O. (mg/l)		
	Post-monsoon	Winter	Summer	Post-monsoon	Winter	Summer	Post-monsoon	Winter	Summer
S	19.0	11.0	19.0	7.6	7.3	6.6	8.3	8 8	8.2
5	19.0	11.0	18.5	7.5	7.3	6.6	8.3	8.8	8.0
10	18.0	10.0	18.2	7.4	7.4	6.7	7.7	8.0	8.0
15	18.0	10.0	18.0	7.4	7.5	6.8	7.7	8.0	8.0
20	18.0	10.0	17.5	7.4	7.5	6.8	6.7	7.2	7.7
Depth (m)	**Free CO_2 (mg/l)**			**Total alkalinity (mg/l)**			**Sp. conductivity (µmhos/cm)**		
	Post-monsoon	Winter	Summer	Post-monsoon	Winter	Summer	Post-monsoon	Winter	Summer
S	Nil	Nil	14.0	62.0	84.0	46.0	136.0	166.0	95.0
5	Nil	Nil	13.0	62.0	84.0	48.0	136.0	169.0	101.0
10	4.0	Nil	13.4	60.0	82.0	50.0	125.0	169.0	101.0
15	4.0	Nil	13.6	60.0	80.0	50.0	121.0	169.0	101.0
20	4.0	Nil	13.6	60.0	76.0	52.0	120.0	169.0	101.0

Contrary to the occurrence of thermocline generally in summer in temperate reservoir, Chamera reservoir did not show thermal stratification as variation in water temperature at surface to 20 m depth never exceeded by 1.5° C (Table3). One of the reasons for this deviation could be that the thermal stratification is broken by continuous influx of water due to snowmelt and regular discharge through spillway. Biogenic chemical stratification, an index of the productivity of the reservoir was rather weak. The value of dissolved oxygen was high (8.8 mg/l) at surface and dropped to 7.2 mg/l at 20 m depth during winter. pH varied from 7.6 at surface to 7.4 at 20m depths indicating narrow variation. Maximum variation in specific conductivity was observed in post-monsoon, ranging from 136 at surface to 120 µmhos/cm at 20 m depth showing weak chemical stratification.

c) Primary productivity

The gross carbon production fluctuated from 50 to 110 $mgC/m^2/hr$. Net production varied between 25 and 80 $mgC/m^2/hr$ (Fig.2). Higher rate of productivity in summer may be due to concentration of ions. The estimated potential fish yield of 56 kg/ha/y is good for unmanaged ecosystem.

BIOTIC COMMUNITIES

Plankton

The plankton abundance fluctuated from 114 u/l in winter to 198 u/l in post-monsoon (Fig.3) averaging 159 u/l. The plankton population was dominated by phytoplankton (80.2%). Bacillariophyceae constituted 56.1% of the total plankton and were mainly represnted by *Diatoma, Cymbella, Gyrosigma, Cyclotella, Melosira, Synedra, Hantzschia, Tabellaria, Meridion*, Frustulia and *Cocconeis*. Its major pulse was observed during post-monsoon (72.7%). *Oscillatoria* and *Spirulina* represented myxophyceae (5.3%). Chlorophyceae (17.8%) was composed of *Rhizoclonium, Pahycladon, Planktosphaeria, Scenedesmus and Pediastrum. Ceratium* represented the group dinophyceae (1.0%) in negligible quantity. Zooplanktons were mainly dominated by rotifers (12.8%) and were composed of *Colurella, Brachionus, Asplanchna, Hexarthra, Notholca and Keratella. Actinasphaerium* represented protozoan (4.6%) while copepods (2.6%) were constituted of *Cyclops* and *Diaptomus*.

The predominance of clean water species showed the environment to be free from pollution. The low abundance of plankton could be due to dilution of plankton because of continuous inflow from catchments and outflow through spillway. The cold water condition in the reservoir appeared to favour growth and dominance of diatoms.

Periphyton

Periphytic communities were rich in diatom population (80%) and were mainly represented by *Amphora, Fragilaria, Eucocconeis, Tabellaria, Frustulia, Navicula,*

Caloneis, Pinnularia, Hantzschia, Gyrosigma and *Cymbella*. Periphyton abundance ranged from 970 u/cm^2 in post-monsoon to 1261 u/cm^2 in summer (Fig.4).

Macrobenthos

The rocky and gravely substratum of the reservoir does not offer any sustenance for bottom biota.

Macrovegetation

The reservoir is devoid of aquatic macrophytes. Steep and rocky banks of the reservoir prevented the rooting of macrovegetation.

FISHERIES

It was reported that the Department of Fisheries, Himachal Pradesh has so far stocked the reservoir with the seed of *C.carpio*. The commercial fishing in the reservoir, however, is yet to start. *C.carpio* weighing upto 2 kg has been caught from the reservoir by hook fishing. Anglers have also reported occurrence of *T.putitora* in the reservoir.

MANAGEMENT GUIDELINES

Chamera is a small sized new impoundment of Ravi basin with low production potential. It has low plankton density. The water in the reservoir has good thermo-oxy conditions for cold-water fishes like *C. carpio, S. plagiostomus* and *T. putitora*. Considering the various ecological variables the sustainable development of Chamera reservoir can be achieved by an effective utilization of stock enhancement, species enhancement and environment enhancement as a management tool.

Stock enhancement

Stock enhancement is necessary to increase fish productivity. Reservoirs generally have unutilized or underutilized food niches that can support larger fish stock than the stock present. Hence augmentation of stock is essential and can be done by adopting a regular schedule of stocking fish with desirable stocking density. This requires determination of carrying capacity, ecological evaluation, logistics of seed production and transport and its economics. The planted species should also be fast growing and environment friendly. These aspects call plans for a schedule of number and ratios of the desired species to be introduced for the development of Chamera reservoir. Stocking of *C.carpio* and *T.putitora* @ 340 fingerlings per hectare will be useful. Since the thermal regime limits the very existence of fish species and other aquatic life which greatly alters the composition of biotic communities in the uplands, the Chamera reservoir is unfavorable for the natural growth, reproduction and recruitment of Indian major carps due to low water temperature conditions (11-19°C) prevailing in

the reservoir. Further the size at stocking is an important factor. Stocking of fingerlings (15-25 mm) leads to better production than the smaller seed.

Species enhancement

In Chamera reservoir, planting of fast growing economically important fish from outside with a view to utilize all the diverse niches of the biotope for obtaining maximum sustainable crop is of limited choice for species enhancement. Continuous stocking of *C.carpio* and *T.putitora* at least for three years with the objective of establishing their population and desired density in the reservoir is essential in view of recent filling of the reservoir. On the basis of temperature tolerance, *S. plagiostomus* is also suitable for species enhancement.

Environment enhancement

Environment enhancement has to be done with utmost care for which conservation may be given highest priority. The state government may undertake the conservation and commercial utilization of *T. putitora* depending on their potential to support a fishery and eco-tourism. To conserve the biodiversity of this fish the needed measures are as under.

i) Conservation of breeding grounds and creation of artificial breeding grounds are required.
ii) Illegal killing of mahaseer by dynamiting or any other means during their spawning run should be strictly prohibited. Use of small meshed nets below 40 mm be banned to avoid indiscriminate killing of mahaseer juveniles.
iii) Mahaseer as a game fish may be developed as sport fishing is creating interest among more and more people. The methods employed are spoon fishing and bait fishing.
iv) Establishment of a major hatchery for production of mahaseer seed at selected sites along the reservoir will be useful.
v) To conserve aquatic resources, awareness amongst local community may be brought in especially through educational programmes.

Besides environment enhancement, the fishing activities on commercial basis may commence after three years of continuous stocking. Fishing activities may be started under co-operative fold by involving rural unemployed youths. The members of co-operative societies be permitted for fishing in demarcated fixed beats of water bodies. This would provide direct and indirect employment to the local population besides improving socio-economic benefits including the quality of life of the local residents. Necessary training on fishing technology to licensed registered youths be imparted by the Department of Fisheries, H.P.

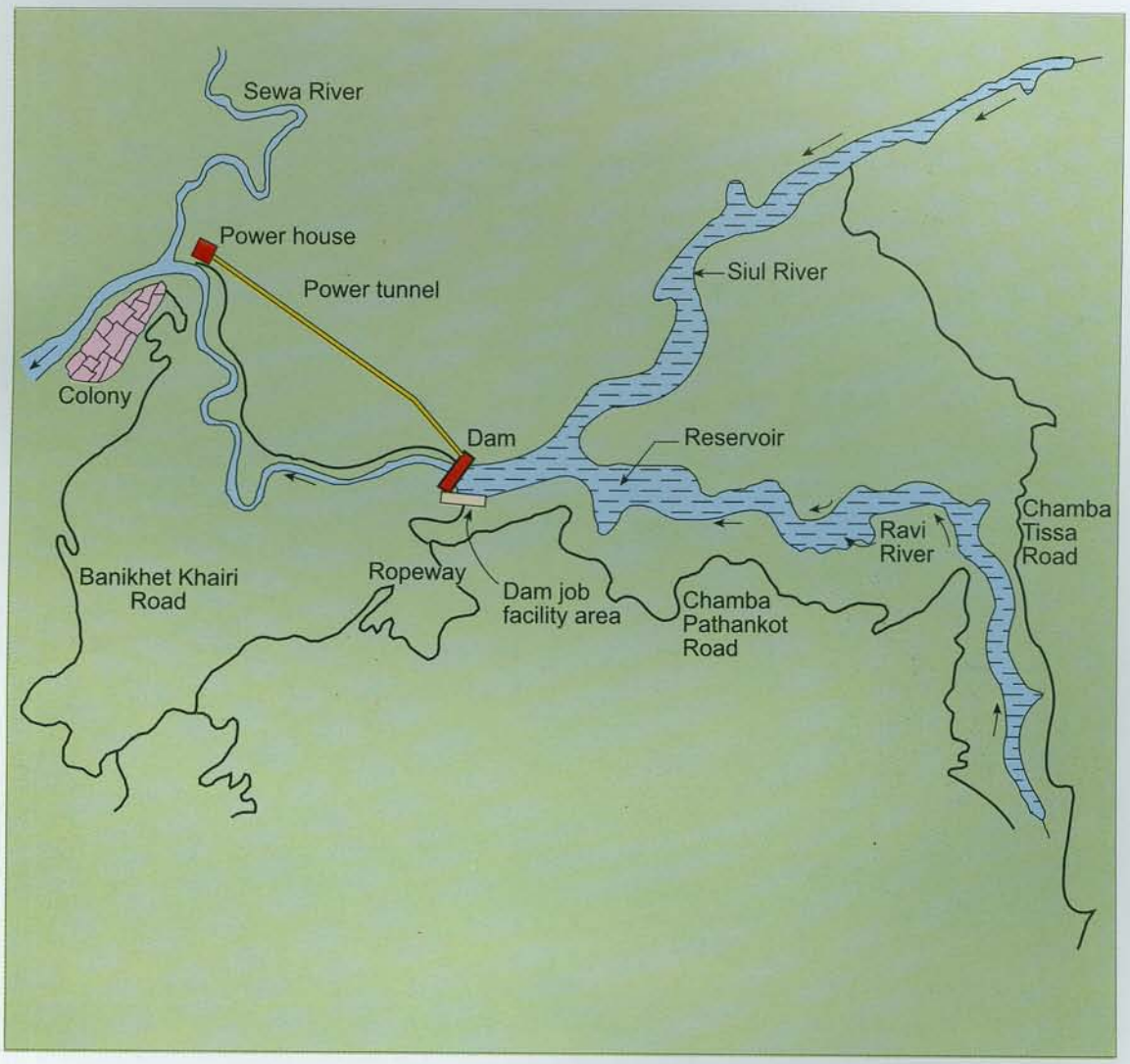


Fig.1 : Layout Plan of Chamera H.E. Project (Stage I)

Fig. 2- Primary production in Chamera reservoir

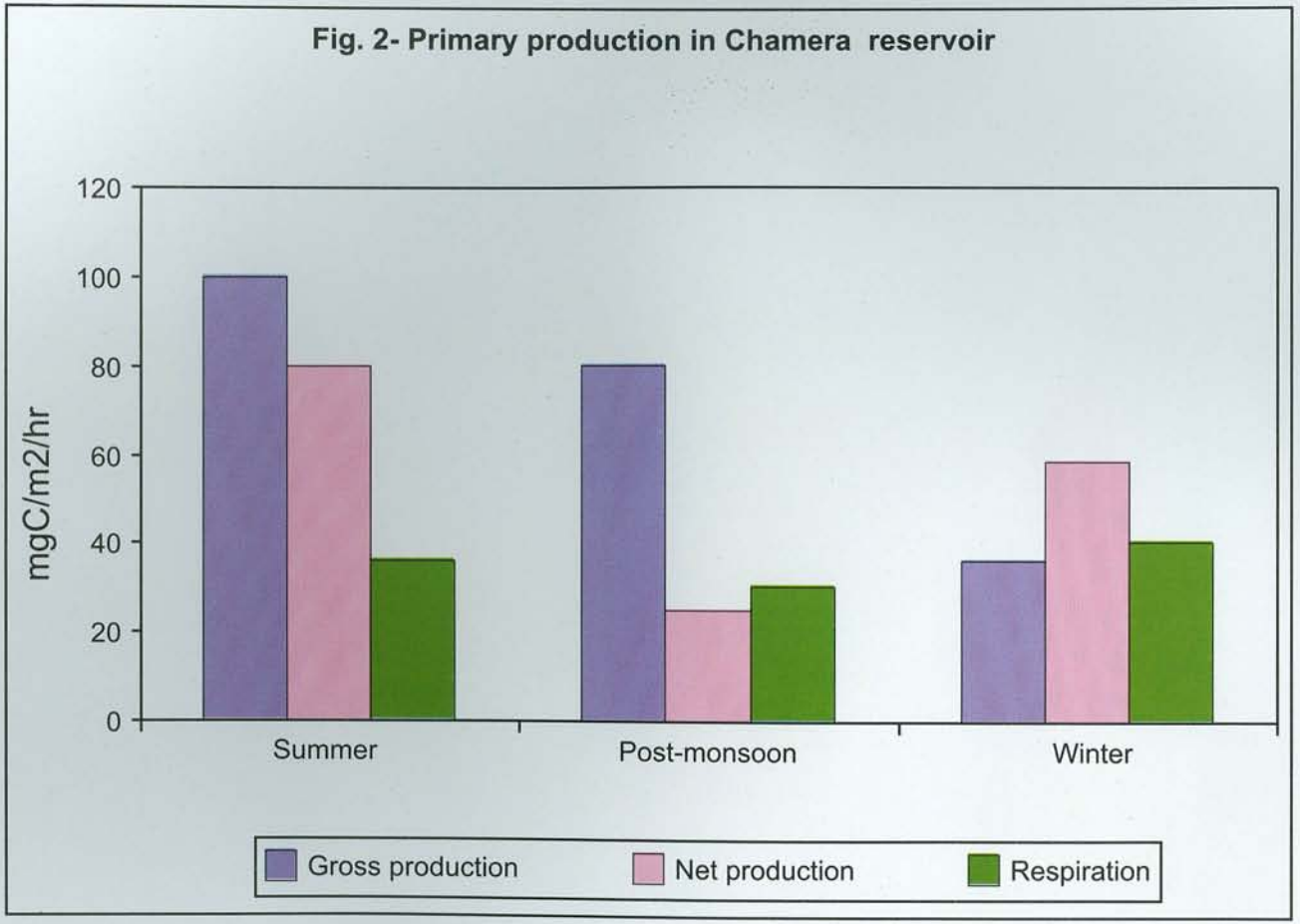


Fig. 3 - Composition of Plankton in Chamera reservoir

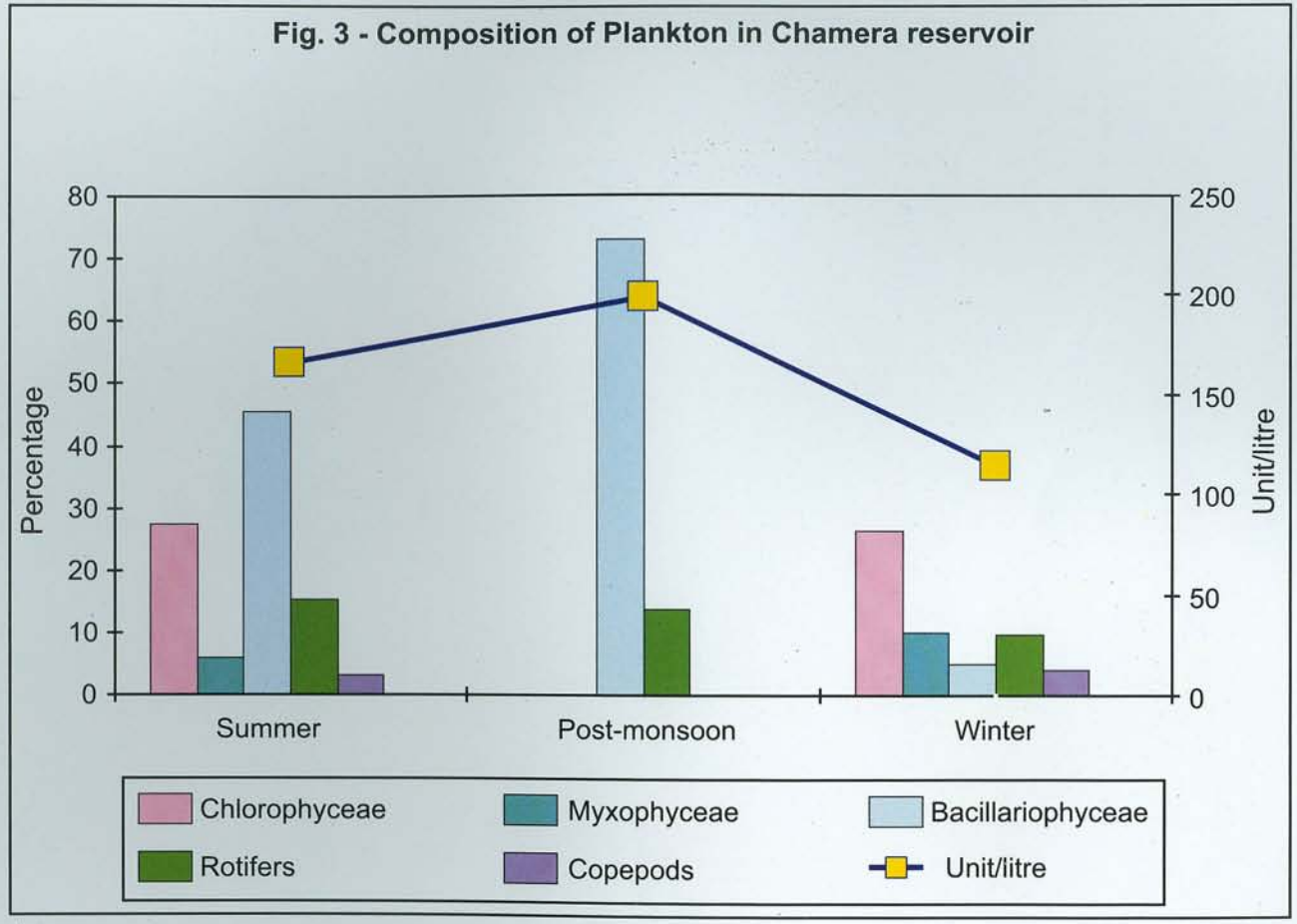
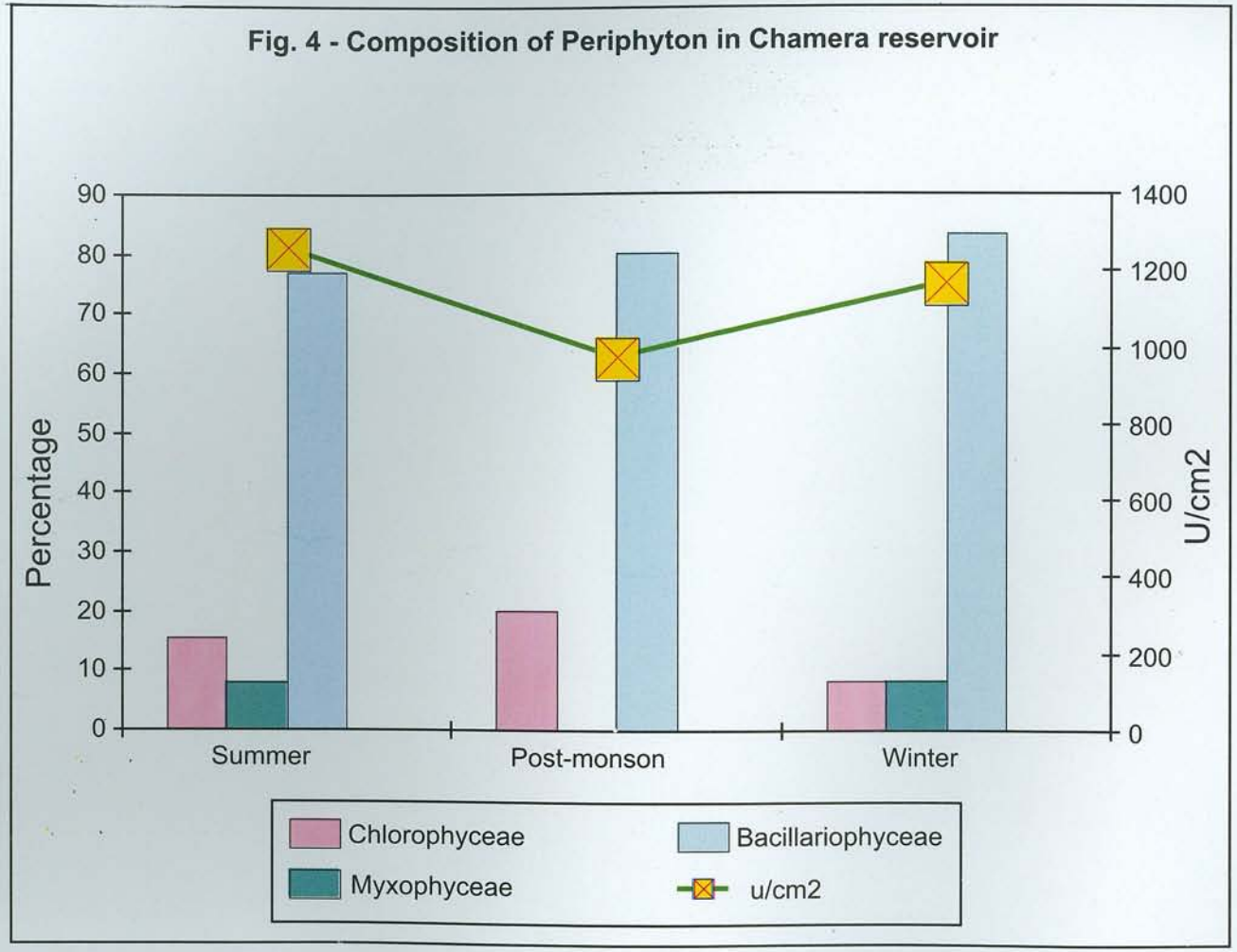
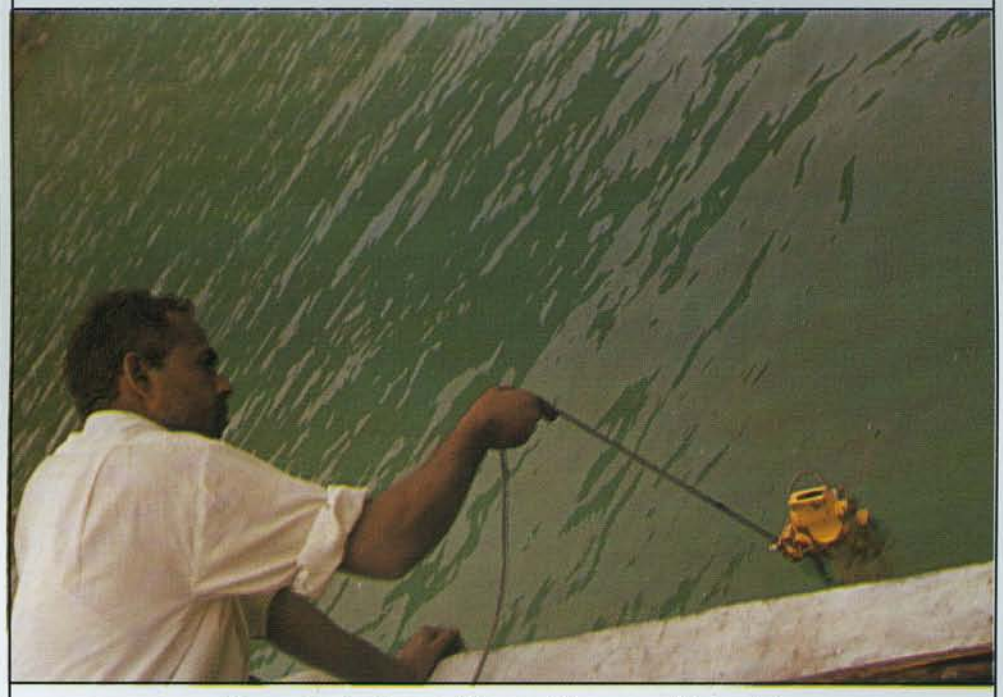


Fig. 4 - Composition of Periphyton in Chamera reservoir



A view of Chamera Reservoir



Limnological sampling in Chamera Reservoir