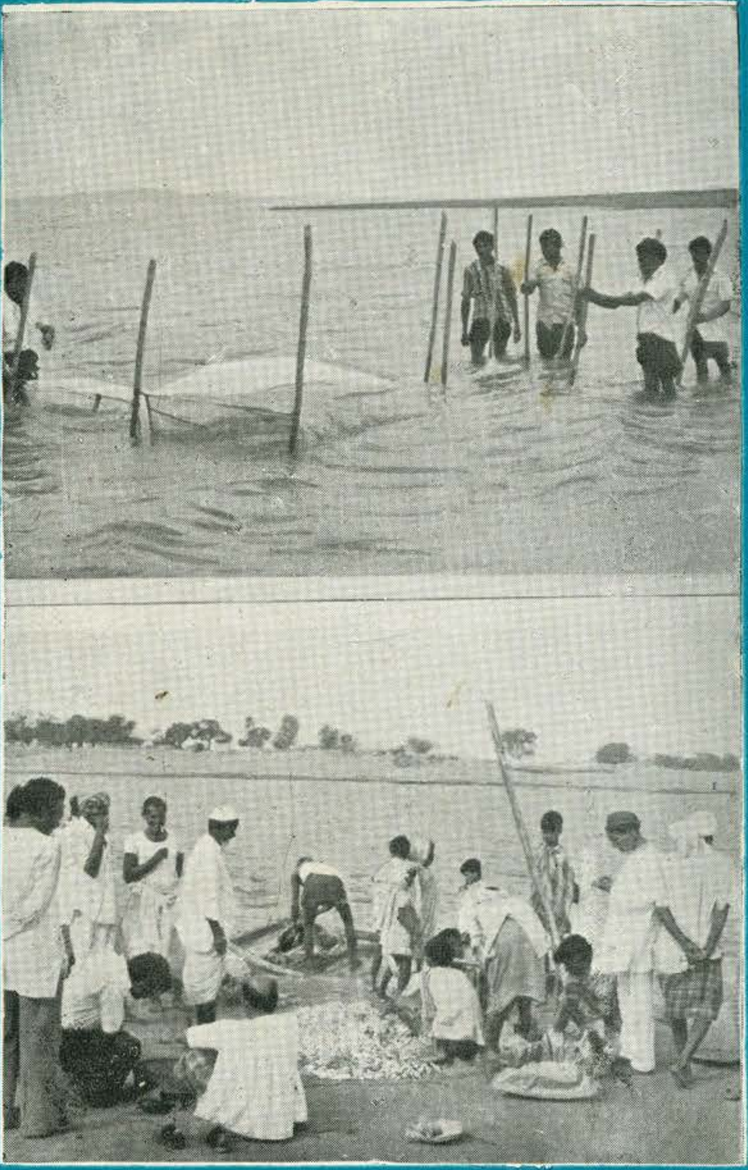

1971-81

FINAL REPORT

ALL INDIA CO-ORDINATED RESEARCH PROJECT

ECOLOGY AND FISHERIES OF FRESHWATER RESERVOIRS

GETALSUD

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FINAL REPORT

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON ECOLOGY AND FISHERIES OF FRESHWATER RESERVOIRS

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ALL INDIA COORDINATED RESEARCH PROJECT ON ECOLOGY AND FISHERIES OF FRESHWATER RESERVOIRS

FINAL REPORT

1973-1981

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FOREWORD

The Getalsud Reservoir was taken up as one of the reservoirs under All India Co-ordinated Research Project on Ecology and Fisheries of Freshwater Reservoirs launched during the year 1971 as Institute-based Project by ICAR. The reservoir was located in the Chhotanagpur plateau of South Bihar across the river Subarnarekha near Ranchi. Detailed studies on ecology of the river water particular reference to morphometry, water inflow-outflow, physico-chemical features of water, soil, productivity studies including primary production, trophic structure including plankton, benthos, periphyton, ichthyofauna etc., biology of economic species including breeding and recruitment, experimental fishing were some of the numerous aspects that were covered during the period of study.

The Klinograde profile and other physico-chemical parameters of water reveal productive character of the reservoir. But the study shows that there is hardly any breeding or recruitment of Indian major carps and emphasises the need for stocking. Similarly the study focuses on the selective fishing of carp minnows which breed profusely and compete with major carps.

It is hoped that the State would give due consideration to various recommendations, the implementation of which would enhance the fishery of the reservoir manifold.

15.10.85

A.V. Natarajan
Director

Barrackpore.

CONTENTS

1 INTRODUCTION

Soon after independence, a number of reservoirs came into being as a result of the completion of various river valley projects initiated with a view to controlling floods, generating power and increasing irrigation facilities. These reservoirs were also used for fish production but the yields from such man-made lakes were invariably very low and did not exceed 6 to 7 kg/ha/year (Jhingran and Tripathi, 1978). In order to increase the yields and formulate general principles for increasing fish productivity of man-made lakes, an All India Coordinated Research Project on the Ecology and Fisheries of Freshwater Reservoirs was initiated in 1971 with three centres in the country. Later, with a view to develop the economy of predominantly tribal regions, a few reservoirs in such areas were also taken up for scientific studies. Getalsud, located in the Chhotanagpur plateau of South Bihar, is one such reservoir.

Considerable work has been done on the man-made lakes of Bihar (Fig. 1). Among the earliest works, studies on the fish and fisheries of the Damodar basin (Job and David, 1952) provide useful basic information. Gul-badamov (1961 and 1962) experimented on improved fishing techniques in Maithon and Panchet reservoirs. The fisheries of the four reservoirs - Tilaiya, Maithon, Konar and Panchet - in the Damodar Valley as well as the effects of dams on the fisheries of the river system as a whole have been critically evaluated by Pantulu et al. (1966). The fisheries of DVC reservoirs in relation to stocking were further assessed by Jhingran and Natarajan (1978). Further work on these reservoirs includes studies on parasitic diseases of fishes (Pal & Gopalakrishnan, 1978), spawning of carps (Gopalakrishnan & Pal, 1978, Govind and Khan, 1978 and Parameswaran et al., 1978) food of trash fishes (Natarajan et al., 1975), thermal and chemical stratification (Sarkar, 1979), and studies on the itchthyofauna (Ramakrishnaiah, 1979 a). The fishery trends in Tilaiya and Konar reservoirs have again been reviewed recently (Roy and Banerjee, 1979; Ramakrishnaiah, 1979 b). Among other hydrology of Nalkari reservoir has been described by Sarkar et al. (1979) while problems of fisheries development in the same reservoir has been dealt by Natarajan (MS). Shetty (1967) reviewed the work on spawn prospecting in Badua reservoir while Ghosh and Rao (1978) discussed the problems of fisheries development in newly constructed reservoirs in South Bihar with special reference to Badua.

Published work on Getalsud reservoir is so far restricted to periphyton (Jha, 1979), planktonic cycle and primary production (Singh and Gupta, 1979) and cage culture (Banerjee and Govind, 1979).

2 MORPHOMETRY

Getalsud dam is located on latiatude 23°27.3'N and longitude 85°33.5'E across Subernarekha river near Getalsud village, 40 km east of Ranchi in Ranchi district of Bihar. The impoundment came into existence in 1971 when construction of the dam was completed. The objectives of the multipurpose Subernarekha Project are (i) supplying much needed water to Ranchi town, Heavy Engineering Corporation and other industries, (ii) generating about 130 MW of power in its two power houses (iii) regulating the flow in the river Subernarekha for use at Jamshedpur and (iv) fisheries development in the reservoir.

The river Subernarekha originates at Nagari, in the Chhotanagpur plateau of South Bihar, about 50 km upstream of Getalsud dam and flows through the districts of Ranchi and Singhbhum in Bihar before it centres West Bengal and Orissa to drain into the Bay of Bengal (Fig. 1). The river has a catchment area of about 15,540 sq km in Bihar of which 716.8 sq m exist at the damsite. The river depends upon rains and ground water seepage for its flow which varies from 10 cusecs during the summer to one lakh cusecs in the rainy season.

The dam can be divided into two parts viz., the earth dam and the spillway. The earth dam is made of locally available impervious and semipervious earth. The upstream slope of the earth dam is protected by pitching with heavy stone. The downstream slope is provided with good turf.

The spillway, constructed of stone masonry in cement mortar, is located in the river portion and designed to pass 3 lakh cusecs of flood discharge. It has seven vents fitted with 12.5 m X 12.2 m gates with a bridge at the top. The spillway is anchored to the earth dam with 90 m of non-overflow transition blocks on either side. It has two one metre diameter undersluices with a total discharging capacity of 1200 causecs.

The total length of the dam is 5907.8 m. Its maximum height is 35.36 m and it has a 7.62 m wide roadatthe top. The major rock types at the damsite are coarse grained biotites gneiss and angen gneiss. The left bank at damsite is hilly and wooden while the right bank is a moderately undulating to flat country.

The power channel for the first turbine located near village Sikidiri takes its water supply from the reservoir through an intake structure in the left earth dam which has a discharge capacity of 2,000 cusecs. The water discharging from the intake structure is led through a 4,989 m long channel to the first turbine which generates 65 MW of electricity.

The water coming out of the tail race of the first turbine is again led through a similar channel about 2454 m long and through two tunnels having a total length of 865 m before it reaches the second turbine to generate another 65 MW of power. The water coming out of the second turbine discharges again into the Subernarekha just below the Hundru falls.

Getalsud reservoir has a shore line of 80 km shore development of 3.85 and a volume development of 0.6839 (Fig. 2). It has a mean depth of 8.46 m. Other morphometric data are as follows:-

1	River bed level at damsite	:	563.09 m MSL
2	Outlet levels		
	(a) River sluices	:	568.01 m MSL
	(b) Canal sluices	:	581.55 m MSL
	(c) Spillway crest	:	583.40 m MSL

3 Area and capacity

	Level (m)	Area (ha)	Capacity (ha. m.)
Minimum draw down	584.63	986.97	5795.1
Maximum sub-mergence	595.70	3459.50	28852.2

4	Average annual water level fluctuations	:	11.07 m
5	Maximum length of the reservoir	:	11.2 km

6	Catchment Area reservoir	: 716.80 sq km
7	Mean annual rainfall in catchment	: 838.45 mm
8	Maximum depth of the reservoir	: 32.62 m

INFLOW, OUTFLOW AND RESERVOIR LEVEL

Data pertaining to 8 years from 1973-74 to 1980-81 are presented in Fig. 3. Yearly outflow varied from 38,104 hectare-metres (1974-75) to 2,07,585 hectare-metres (1977-78). Outflow was through the spillway and/or intake gate to the canal which carried water to the power houses. Inflow and outflow both were normally maximum in the months of July, August and September. Reservoir level was normally maximum almost always in the month of June before the onset of floods. Yearly average reservoir level was minimum (584.50 m) in the year 1973-74 and maximum (587.19 m) in 1976-77. Water level fluctuation within a year was minimum in 1975-76 (1.34 m) and maximum in 1978-79 (9.39m).

METEOROLOGICAL OBSERVATIONS

Data on meteorological observations at Getalsud for 8 years from 1973-74 to 1980-81 are given in Fig. 4. Air temperature varied from 4.9°C (January '75) to 40.3°C (May '80). It was maximum in the first quarter (April-June) and minimum in the fourth quarter (January -March). Wind velocity was highest in the first quarter of the years 1973-74, 1977-78, 1979-80, and 1980-81 and in the second quarter of 1974-75, 1975-76, 1976-77, 1978-79.

Yearly rainfall at damsite varied from 997 mm (1979-80) to 1975 mm (1977-78). Rainy season starts in June and continues upto September. Maximum rain in one month was seen in September 1979 (522mm), August 1977 (516 mm), September 1978 (485 mm) and July 1977 (466 mm). In general it may be stated that wind velocity was high during the rainy season.

CHEMICAL CHARACTERISTICS OF THE SOIL

Studies on the chemistry of soil and water conducted from 1975 to 1980 are described here :

For the purpose of various studies, Getalsud reservoir was divided into three sectors namely lotic, intermediate and lentic (Fig. 2). Each sector was further divided into three regions namely littoral, sub-littotal and profundal. Soil samples were collected at random with the help of Ekman dredge from every 12.9 sq km in the three sectors during April-May and November-December for chemical analysis. Studies during 1975 to 1980 in premonsoon months revealed that pH of the soil increased from 5.7 in 1975 to 6.2 in 1977 but an irregular trend was observed thereafter. Organic carbon decreased from 0.6 in 1975 to 0.3% in 1977 and no clear pattern was noticed in the later years. Available nitrogen showed a continously decreasing trend from 52.1 in 1975 to 13.9 mg/100 g soil in 1978 but thereafter an increase in the value was observed upto 1980. Available phosphorus also decreased from 12.1 in 1975 to 1.1 mg/100 g soil in 1977 with an irregular pattern in the later years. During postmonsoon seasons of 1975 to 1980, not much change in the pH value (6.1 to 6.3) was observed. Organic carbon, available nitrogen and phosphorus did not show any clear trend.

Studies on the soil of the three sectors indicated that organic carbon was below a verage but available nitrogen and phosphorus were fairly high in the basin soil (Table I). The soil was acidic in nature (pH 6.0 to 6.3). Lotic sector was low in organic carbon, available nitrogen and phosphorus than lentic and intermediate sectors. It was also observed that organic carbon, available nitrogen and phosphorus values were high in premonsoon than the post monsoon season.

6 PHYSICO-CHEMICAL FEATURES OF SURFACE WATER

Surface water samples were collected from the three regions of each sector. Depth sampling was done in the profundal region of each sector with the help of Nansen reversing water sampler. The parameters like water temperature, water transparency, pH, dissolved oxygen, carbon dioxide, carbonate, bicarbonate were determined at the work spot. While calcium, magnesium, nitrate, phosphate, silicate, iron, organic matter and specific conductivity determined in the laboratory.

6.1 Physical features

6.1.1 Water temperature (Fig.5): Water temperature in lentic sector varied from 16 (Winter) to 28.5°C (Summer). In the intermediate sector, it varied from 16°C to 28.3°C, being low in January and high during June. In the lotic sector the water temperature fluctuated between 16.5° to 28.4°C being low in January and high during May.

6.1.2 Water transparency (Fig.6): Water transparency in lentic sector varied from 14 to 176 cm being low in August and high during March. In intermediate sector, water transparency ranged from 13 cm (July) to 112 cm (March) and was low than in the lentic sector. In lotic sector, water was most turbid and ater transparency ranged from 10 to 86 cm being low in July-August and high during February.

This revealed that water transparency was mainly influenced by the seasonal influx of flood waters.

6.2 Chemical features

Chemical features of surface water presented in Table II. Dissolved oxygen varied from 5.8 to 9.6 ppm. There was a general tendency for its value to decrease in monsoon months (5.8 - 7.2 ppm) due to decrease in that dissolved oxygen was the highest in spring (7.7 to 9.6 ppm) followed by winter (6.4 to 7.9 ppm), summer (6.4 to 7.3 ppm) and monsoon months (5.8 to 7.2 ppm). pH was high but carbon-di-oxide was low during summer due to high photosynthetic activity during the period.

Bicarbonate alkalinity ranged from 29.5 to 52.6 ppm with an average of 40.7 ppm indicating low productive water body. Specific conductivity representing total soluble salts varied from 163.7 to 306.0 micrombos with an average of 218.3 micromhos indicating low to medium productive reservoir. It was further observed that bicarbonate alkalinity and specific conductivity almost followed the same trend (Fig. 7). High values of these parameters were noted during summer and low in monsoon months.

Calcium was in the range of 5.3 to 18.8 ppm with an average values of 11.1 ppm and is indicative of low productive water. Magnesium varied from 3.5 to 8.8 ppm. Organic matter ranged from 1 to 4.3 ppm being low in summer and high in monsoon months as it is brought in large quantities by flood waters.

6.3 Nutrient features of the reservoir

This reservoir is very poor in respect of major nutrients like phosphate and nitrate. But silica concentration is fairly high.

In lentic sector, phosphate concentration varied from 0.001 to 0.12 ppm, nitrate traces to 0.34 ppm, silica 2.6 to 12.0 ppm, and iron traces to 0.62 ppm. In intermediate sector, phosphate ranged from 0.001 to 0.03 ppm, nitrate traces to 0.29 ppm, silica 3.2 to 14.0 ppm and iron nil to 0.66 ppm. In lotic sector, phosphate varied from 0.001 to 0.04 ppm, nitrate traces to 0.36 ppm, silica 2.8 to 18.2 ppm and iron traces to 0.61 ppm. High values of phosphate and nitrate were noted mostly during flood season (July-September) but in other seasons, its pattern was not clear. Iron was high during floods but low in other seasons. Silica concentration was high during January to May but thereafter a continuous decline was observed. Seasonal variations in iron and silica are shown in Fig. 8. Almost negligible variations in these nutrients occurred between surface and bottom waters.

7 VERTICAL PATTERN OF PHYSICO-CHEMICAL PARAMETERS

7.1 Thermal stratification

Pronounced thermal stratification was observed in the profundal region of lentic sector during April (Fig. 9). In April 1974, the temperature at surface was 25.5°C and at bottom 20.2°C giving a difference of 5.3°C. Thermocline got formed between 10 (22.8°C) and 11 m (20.8°C).

In April 1975, the temperature difference between surface and bottom was of 7°C. It was the highest record during the period under investigation. Thermocline developed in between 8 m (24.1°C) and 9 m (22.7°C) depth.

In April 1978, the temperature difference between surface and bottom was of 5°C. The thermocline developed in between 9 and 10 m depth where a difference of 1°C was noted.

In April 1980, the temperature difference between surface and bottom was of 5.5°C. The thermocline formed in between 8 and 9m depth where temperature difference was 2°C.

Further, Getalsud reservoir sometimes developed more than one thermocline in the depth profile and is therefore unique in this respect, Two thermoclines were observed during May in 1974 and 1975 (Fig. 10).

During May 1974, the difference between surface and bottom temperature was 5.7°C. The first thermocline developed in between 8 and 9 m depth where temperature drop was 1.3°C and the second thermocline was in between 11 and 12 m depth with temperature of 1.3°C.

Similarly during May 1975, the difference between surface and bottom temperature was 6.7°C. The first thermocline developed in between 5 and 6 m depth with temperature drop of 1.5°C and the second was in between 10 and 11 m depth with decrease in temperature of 1.3°C.

It was interesting to observe that because of the development of two thermoclines during May 1974 and May 1975, the depth of epilimnion got reduced than what it was in the previous months of April in 1974 and 1975 when only one thermocline was recorded.

7.2 Chemical stratification

Getalsud reservoir was observed to stratify chemically in the summer months which broke thereafter due to influx of flood water into the reservoir. The data pertaining to stratification of chemical constituents in the depth profile during the year 1975 are presented in Table III. A similar pattern of stratification was recorded in the subsequent years also. A steep fall in dissolved oxygen content from surface to bottom in summer indicating klinograde oxygen curve (Fig.11) was noticed which is suggestive of a productive reservoir. In the other months of the year the variation in dissolved oxygen from surface to bottom was much less. The free carbon-di-oxide was high at the bottom layers and its increase at and near the bottom was always associated with decrease of oxygen suggesting rapid utilisation of oxygen for the decomposition of bottom organic sediments. The accumulation of carbon-di-oxide in the bottom layers as a result of decomposition of bottom sediments increases hydrogenious resulting in fall of pH. The bottom accumulation of carbon-di-oxide and decline in pH are suggestive of a productive reservoir.

The relationship of bicarbonate and specific conductivity in the depth profile during July 1975 and 1978 is shown in Fig. 12.

PRIMARY PRODUCTION

Primary production experiments were conducted in the surface water of the three regions of each sector and depth wise in the profundal region of each sector. The light and dark bottles technique was employed for this study.

Surface primary production studies in profundal, sub-littoral and littoral regions of the three sectors revealed that the rate of primary production was much higher in littoral followed by sub-littoral and profundal region in lentic and intermediate sectors. In lotic sector this rate was much higher in sub-littoral followed by littoral and profundal regions (Fig. 13).

Depth profile primary production studies made during 1977-80 in the profundal region of lentic, intermediate and lotic sectors show that carbon production rate decreased considerably during flood season (July-September). In lentic sector, the production was quite high in October-December during 1978 and 1979 and in April-June during 1980. In intermediate sector, a similar pattern was noted. In lotic sector, the peak period was January-March during 1978 and 1979 and April-June in 1980 (Fig. 14).

The average gross production was 289.85 and net production 154.44 mg C/m^2/ day in lentic sector; the average gross production 257.85 and net production 137.12 mgC/m^2/day in intermediate sector and the average gross production 295.53 and net production 150.64 mgC/m^2/day in lotic sector (Fig. 15). The average gross and net production for Getalsud reservoir was 281.07 and 147.40 mgC/m^2/day. The rate of respiration of gross production was 47.56%. Thus, the average carbon production of this reservoir was the lowest among the reservoirs studied under the All India Coordinated Research Project on the Ecology and Fisheries of Freshwater Reservoirs.

From limnological studies the reservoir has a fish potential of 50 kg/ha/yr. This is based on the autochthonous primary production only. How ever, reservoir gets allochthonous organic matter from the catchment if this be included the potential will be still higher. Against this the present fish harvest from the reservoir is very poor.

9 PLANKTON

Monthly collections of plankton were made from the littoral, sub-littoral and profundal regions of the three sectors namely lotic, intermediate and lentic of Getalsud reservoir by the vertical haul method. In this way nine plankton samples were examined every month. The plankton net was made of bolting silk No. 25. Settling volume of plankton was taken by using a hand operated centrifuge machine, the number of revolutions being kept constant. Numerical enumerations were done with the help of a plankton counting cell. Plankton abundance by volume in the three sectors is depicted in Fig.16.

9.1 Lotic Sector

1976-77 : This sector showed maximum plankton production with average monthly abundance of 2.176 ml/m^3. This was maximum in May (8.43ml/m^3) and minimum during August (0.362 ml/m^3). Summer and winter pulses were observed in May (8.43 ml/m^3) and December (1.31 ml/m^3) respectively, the latter being of lesser magnitude.

Total plankton crop was highest in June (5,57,76,773 units/m^3) and lowest in August (1,07,892 units/m^3) with an average of 52,27,509 units/m^3. This was made up of 93.52% phytoplankton and 6.48% zooplankton was dominated by Chlorophyceae (88.24%). Next in abundance was Myxophyceae (4.23%), whose greatest availability was in May (7,71,767 units/m^3).

Zooplankton was dominated by Rotifera (3.12%) and Copepoda (2.53%). The highest abundance of both these groups was recorded in April (6,71,654 units/m^3, 7,91,858 units/m^3), whereas the lowest was in September (3,752 units/m^3, 2,502 units/m^3). As a whole, phytoplankton dom dominated over zooplankton.

1977-78 : Average plankton production was 2.02 ml/m^3 which was maximum in May (6.71 ml/m^3) and minimum in August (0.300 ml/m^3). Summer and winter pulses were observed in May (6.71 ml/m^3) and December (3.52 ml/m^3) respectively.

Average plankton abundance was 22,74,987 units/m^3 which was highest during February (1,88,76,305 units/m^3) and lowest during June (82,421 units/m^3). This abundance was made up of 81.34% of phytoplankton and 18.66% of zooplankton. Phytoplankton was dominated by Bacillariophyceae (76.94%) whose bloom was observed in February (1,85,54,690 units/m^3) whereas minimum abundance of this group was recorded in September (2,045 units/m^3). Next groups in order of dominance were Myxophyceae (2.15%) and Chlorophyceae (1.73%), whose greatest abundance was observed during July (1,85,356 units/m^3) and January (1,31,488 units/m^3) respectively.

Zooplankton was dominated by Rotifera (7.65%) and Protozoa (6.05%), which were in greatest magnitude during November (11,04,849 units/m^3 and 10,41,368 units/m^3 respectively). Copepods (3.58%) was the next group on order of abundance and was in greatest availability during May (3,65,567 units/m^3). Phytoplankton dominated over zooplankton.

1978-79 : This sector had an average monthly abundance of 1.223 ml/m^3 which was maximum in October (3.090 ml/m^3) and minimum during September (0.118 ml/m^3). Four maxima were recorded in April (0.629 ml/m^3), July (0.738 ml/m^3), October (3.090 ml/m^3) and February (2.396 ml/m^3).

Total plankton abundance was 4,14,748 units/m^3, which was maximum during November (12,36,383 units/m^3) and minimum during September (45,257 units/m^3). This abundance was made up of 72.14% of phytoplankton and 27.86% of zooplankton. Phytoplankton was dominated by Myxophyceae (67.12%) whose greatest occurrence was observed in November (11,02,851 units/m^3). Nest groups in order of abundance were Chlorophyceae (2.78%) and Bacillariophyceae (1.67%) whose maximum availability was recorded in October (33,187 units/m^3) and July (13,447 units/m^3) respectively.

Zooplankton was dominated by Copepoda (12.46%) which was maximum in July (1,19,536 units/m^3). Next group was Rotifera (8.81%) which was observed in greatest numbers during October (77,395 units/m^3). Cladocera (4.43%) also made a significant contribution (47,593 units/m^3 in February).

Zooplankton dominated during April, May and July, while phytoplankton dominated during the other months. On the whole, phytoplankton dominated over zooplankton.

1979-80 : Average plankton production was 0.771 ml/m^3, which was highest in June (1.852 ml/m^3) and lowest during July (0.267 ml/m^3). Two maxima were seen in June (1.852 ml/m^3) and October (1.224 ml/m^3).

Numerically total plankton production was 15,68,093 units/m^3 which was maximum in January (1,19,56,660 units/m^3) and minimum during July (27,629 units/m^3). This was composed of 94.60% of phytoplankton and 5.40% of zooplankton. Phytoplankton was dominated by Bacillariophyceae (68.57%), which formed a bloom in January (1,07,28,455 units/m^3), the least abundance of the same being in June (388 units/m^3). Next group in order of abundance was Myxophyceae (25.57%) which was in bulk during January (10,89,932 units/m^3).

Zooplankton was dominated by Copepoda (2.62%) which was maximum during October (77,554 units/m^3). Next group was Rotifera (1.68%) whose greatest availability was observed in December (62,936 units/m^3), Cladocera contributed 0.52% and was in highest magnitude during October (23,462 units/m^3).

9.2 Intermediate sector

1976-77 : This sector had monthly average plankton abundance of 1.108 ml/m^3, which was maximum in April (4.00 ml/m^3) and minimum during September (0.186 ml/m^3). Three planktonic peaks were observed in April (4.00 ml/m^3), July (1.126 ml/m^3) and December (1.11 ml/m^3).

The average plankton crop was 3,10,137 units/m^3, which fluctuated from 63,019 units/m^3 (September) to 7,27,946 units/m^3 (April). This was shared by 70.44% of phytoplankton and 29.56% of zooplankton. Phytoplankton was dominated by Myxophyceae (63.07%), which was in greatest occurrence during April (3,78,049 units/m^3) and was followed by Chlorophyceae (3.24%) and Bacillariophyceae (2.76%). Chlorophyceae was recorded in the highest number during April (26,266 units/m^3), while Bacillariophyceae was the most abundant in June (60,041 units/m^3).

Zooplankton was dominated by Rotifera (12.29%) and Copepoda (12.26%), which were in highest abundance during April (1,26,547 units/m^3 and 1,20,244 units/m^3). Cladocera followed with 2.38% contribution, which was also recorded in bulk during April (15,223 units/m^3). As a whole phytoplankton dominated over zooplankton.

1977-78 : During this period, average plankton production was 0.96 ml/m^3, which was maximum in October (2.91 ml/m^3) and minimum during August (0.33 ml/m^3). In general, two pronounced planktonic pulses were observed in June (0.95 ml/m^3) and October (2.91 ml/m^3).

Numerical plankton abundance was 2,00,437 units/m^3, which was maximum in October (7,00,959 units/m^3) and minimum in September (55,126 units/m^3). This abundance was contributed by 71.27% of phytoplankton and 28.73% of zooplankton. Phytoplankton was dominated by Myxophyceae (50.96%) and was followed by Chlorophyceae (5.33%) and Bacillariophyceae (2.55%). Maximum occurrence of Myxophyceae was recorded in October, (6,26,085 units/m^3), whereas Chlorophyceae and Bacillariophyceae were at their peak abundance during January (60,615 units/m^3) and February (20,342 units/m^3) respectively.

Zooplankton was dominated by Copepoda (12.42%) and Rotifera (10.87%), being maximum during June (41,032 units/m^3) and January (52,320 units/m^3) respectively. Cladocera was maximum in April (10,649 units/m^3) and contributed 3.36%. Phytoplankton dominated over zooplankton.

1978-79 : Intermediate sector had an average plankton abundance of 0.818 ml/m^3 which varied from 0.308 ml/m^3 (September) to 2.880 ml/m^3 (October). Three plankton peaks were recorded in June (0.929 ml/m^3, October (2.880 ml/m^3) and January (0.835 ml/m^3).

Avera ge plankton abundance was 4,36,760 units/m^3 which was highest in October (11,71,154 units/m^3) and lowest in July (80,361 units/m^3). This crop was formed of 84.10% of phytoplankton and 15.90% of zooplankton. Phytoplankton was dominated by Myxophyceae (78.54%), which experienced its maximum occurrence in October (9,69,786 units/m^3). Chlorophyceae (4.37%) followed Myxophyceae and was in bulk in December (1,23,073 units/m^3).

Zooplankton was dominated by Copepoda (7.33%) and Rotifera (5.63%). Greatest density of Copepoda was recorded in October (1,21,700 units/m^3) whereas Rotifera was maximum in June (66,315 units/m^3), Cladocera formed only (1.63%). Phytoplankton dominated over zooplankton.

1979-80 : During this period, this sector had an average production of 0.679 ml/m^3. August (0.188 ml/m^3), was the least productive month whereas June (1.925 ml/m^3) showed the maximum productivity. Two plankton peaks were recorded one in June (1.925 ml/m^3) and the other in October (0.679 ml/m^3).

Plankton abundance in numerical terms was 8,09,048 units/m^3 which was macimum in January (43,74,776 units/m^3) and minimum during August (16,950 units/m^3). This abundance was composed of 94.27% of phytoplankton and 5.73% of zooplankton. Phytoplankton was dominated by Myxophyceae (50.68%) and Bacillariophyceae (43.17%). Highest availability of Myxophyceae was observed in June (8,70,211 units/m^3), whereas Bacillariophyceae was maximum in January (34,69,153 units/m^3).

Sooplankton was dominated by Copepoda (3.25%), which was in greatest numbers during June (54,735 units/m^3) and was followed by Rotifera (1.28%) which was also maximum in June (27,316 units/m^3). Cladocera formed only (0.71%). As a whole phytoplankton dominated over zooplankton.

9.3 Lentic sector

1976-77 : This sector had an average plankton production of 1.185 ml/m^3 which ranged from 0.186 ml/m^3 (September) to 4.749 ml/m^3 (April). Three plankton pulses in general were seen in April (4.749 ml/m^3), December (1.110 ml/m^3) and March (1.291 ml/m^3).

This had 3,36,569 units/m^3 of total plankton which was maximum in April (9,63,533 units/m^3) and minimum in September (62,949 units/m^3). The abundance was composed of 77.71% of phytoplankton and 22.29% of zooplankton. Myxophyceae (68.98%) dominated the phytoplankton, whose highest availability was recorded in April (8,00,820 units/m^3) followed by Bacillariophyceae (5.94%) and Chlorophyceae (1.58%). The mamima for the two groups were in June (2,09,967 units/m^3) and February (22,130 units/m^3) respectively.

Zooplankton was dominated by Copepoda (11.59%), which was in highest a bundance in March (1,03,470 units/m^3). Rotifera (8.08%) followed the a bove group, whose highest availability was recorded in June (1,00,490 units/m^3). Cladocera contributed 1.49%. Phytoplankton dominated over zooplankton.

1977-78 : This sector had an average plankton abundance of 0.630 ml/m^3, which was maximum in June (1.040 ml/m^3) and minimum during A ugust (0.17 ml/m^3) . Three plankton peaks were recorded in June (1.04 ml/m^3), September (0.85 ml/m^3) and January (0.95 ml/m^3).

Average numerical abundance during this period was 1,28,726 units/m^3 which was maximum in June (2,51,533 units/m^3) and minimum during August (15,051 units/m^3). This abundance was composed of 54.56% of phytoplankton and 45.44% of zooplankton. Phytoplankton was dominated by Myxophyceae (45.70%) whose maxima was recorded in November (1,17,426 units/m^3). Chlorophyceae (5.12%) followed in order of abundance and was in highest numbers during October (19,857 units/m^3). Dinophyceae (1.58%) made almost the same contribution.

Zooplankton was dominated by Copepoda (18.61%) and Rotifera (18.56%). The maxima of both these groups fell in June (65,087 units/m^3 and 90,847 units/m^3). Cladocera contributed 4.29%. Phytoplankton dominated over zooplankton.

1978-79 : Average plankton production was 0.473 ml/m^3 which fluctuated from 0.166 ml/m^3 (September) to 0.936 ml/m^3 (November). Two pronounced peaks were recorded in July (0.730 ml/m^3) and November (0.936 ml/m^3). March (0.487 ml/m^3) was also quite productive.

Average total standing crop of this sector was 1,79,838 units/m^3 which was in highest number during November (5,83,125 units/m^3) and lowest in August (17,413 units/m^3). This crop was made up of 80.42% of phytoplankton and 19.58% of zooplankton. Phytoplankton was dominated by Myxophyceae (71.27%) whose highest abundance was recorded in November (5,18,110 units/m^3). Chlorophyceae (7.65%) followed in order of abundance and was in highest density during January (60,335 units/m^3). Bacillariophyceae (1.13%) was meagerly represented.

Zooplankton was dominated by Copepoda (10.48%), whose maxima was recorded during November (41,413 units/m^3). Rotifera (5.78%) was next group in order of dominance, which was in greatest availability during September (29,879 units/m^3). Cladocera (1.64%) and Protozoa (1.46%) did not make much of a contribution. Phytoplankton dominated zooplankton.

1979-80 : This sector had an average plankton abundance of 0.896 ml/m^3 which ranged from 0.225 ml/m^3 (December) to 2.092 ml/m^3 (February). Four plankton peaks were observed during June (1.519 ml/m^3), August (1.427 ml/m^3), October (1.058 ml/m^3) and February (2.092 ml/m^3).

Average numerical abundance was 4,45,699 units/m^3 which was highest during October, (14,45,605 units/m^3) and lowest during July (47,963 units/m^3). This was made up of 87.79% of phytoplankton and 12.21% of zooplankton. Phytoplankton was dominated by Myxophyceae (85.39%), whose maxima was observed during October (13,53,673 units/m^3). Bacillariophyceae (1.83%) made only a meager contribution.

Zooplankton was dominated by Copepoda (6.32%), which was maximum in October (58,959 units/m^3). Rotifera (3.82%) was the next group which observed its maxima in November (59,388 units/m^3). Cladocera contributed 1.48% and was maximum during February (23,647 units/m^3). Phytoplankton dominated over zooplankton.

In all the sectors, phytoplankton dominated over zooplankton. The most dominant groups among phytoplankton were Chlorophyceae in the lotic and Myxophyceae in the intermediate and lentic sectors during 1976-77. During 1977-78, lotic sector was dominated by Bacillariophyceae and intermediate and lentic sectors by Myxophyceae. During 1978-79, Myxophyceae was the most dominant group in all the three sectors. During 1979-80, lotic sector was dominated by Bacillariophyceae and intermediate and lentic by Myxophyceae.

Among zooplankton, Rotifera and Copepoda were the dominant groups during 1976-77 in all the three sectors. During 1977-78, Rotifera and Protozoa were the dominant groups in lotic sector whereas Rotifera and Copepoda were the dominant groups in intermediate and lentic sectors. Copepoda had also considerable contribution in lotic sector during 1977-78. During 1978-79 and 1979-80, Copepoda and Rotifera were the dominant groups in all the three sectors.

The summer maxima of plankton were normally observed from April to June and this coincided with high value of biocarbonate and specific conductivity. Monsoon months of July to September were least productive.

This was the period when bicarbonate and specific conductivity were low. The plankton minima were also due to the dilution by inflowing flood water and an increase in turbidity.

Based on the yearly average plankton production, lotic sector was the most productive followed by the intermediate and lentic sectors. Littoral and profundal in all the sectors as a whole. In general, plankton productivity of all the sectors decreased from 1976-77 to 1979-80. Lentic sectors was however, the exception during 1979-80 when production was more than in 1978-79 (Fig. 16).

Taking the average of all the three sectors, plankton productivity in terms of ml/m^3 continuously decreased from 1976-77 to 1979-80 (Table IV).

A classified list of plankters encountered in Getalsud is given below :

Myxophyceae	Microcystis, Merismopedia, Oscillatoria, Anabaena, Spirulina.
Chlorophyceae	Botryococcus, Pediastrum, Oedogonium, Spirogyra, Hormidium, Volvox, Ankistrodesmus.
Bacillariophyceae	Diatoma, Tabellaria, Surirella, Synedra, Navicula, Melosira, Stauroneis, Cymbella, Attheya, Anomoeneis, Nitzschia, Rhizosolenia.
Desmidiaceae	Closterium, Desmidium, Cosmarium, Staurastrum, Arthrodismus, Microsterias, Sphaerozosoma.
Dinophyceae	Ceratium
Rhodophyceae	Lamanea and Batrachospermum
Protozoa	Difflugia, Pleodorina, Centropyxis, Vamphyrella, Vorticella, Dinobryon.
Rotifera	Polyrthra, Triarthra, Filinia, Trichocerca, Keratella, Brachionus, Lecane, Platyas, Conochilus, Asplanchna, Hexarthra, Pleurotbochus.
Cladocera	Daphnia, Diaphnosoma, Bosmina, Chydorus, Moina.
Copepoda	Diaptomus, Cyclops and nauplii

10 EFFECT OF EFFLUENTS ON WATER QUALITY AND PLANKTON OF SUBERNAREKHA RIVER

Surface water and plankton samples were collected from the four points (Fig. 17) upstream of Getalsud reservoir to determine any possible adverse effects of Heavy Engineering Corporation factory effluents and town sewage on water quality and plankton. The factory effluents and township sewage are discharged into the Subernarekha river between point I and II. The effluents contains mainly oil, phenol and coaltar. Ranchi city's sewage water joins the river between points III and IV. The water quality and plankton availability at four points are discussed below:-

Point I : This is in Hatia reservoir which contains unpolluted water. The data shows that water was well oxygenated (Dissolved oxygen 7.2 to 9.8 ppm) with pH 7.5. The plankton was made up of 185 units /l of phytoplankton and 20 units/l of zooplankton. The poor plankton concentration was perhaps due to downward migration because of direct sunlight at noon when collections were made and while the water transparency was high (Table V).

Point II : This is the point where dissolved oxygen decreased to a great extent (Dissolved oxygen 4.4 to 4.8 ppm) which may be due to pollution. Here total plankton was only 300 units/l and was mostly phytoplankton mainly composed of diatoms.

Point III : At this point the water quality showed a better value of chemical constituents. Plankton concentration also improved. The same was 10,430 units/l, comprising 10,360 units/l of phytoplankton and 70 units/l of zooplankton. Diatoms were the dominant plankters.

Point IV : Here the water quality improved further and showed high values of chemical constituents. There was tremendous incbease in the plankton population which was 52,680 units/l composed of 52,600 units/l of phytoplankton and 80 units/l of zooplankton. Here also diatoms were the most conspicous group.

The study therefore suggests that the water quality gets much improved before the Subernarekha joins the Getalsud reservoir.

11 BOTTOM BIOTA

Macrofauna

Bottom biota collections were made with the help of Ekman's dredge at depth intervals of 2 m upto 10 m and after that at 5 m depth interval. Three hauls were taken. Ther frequency of collection from all the three sectors was once in a month but after September, 1976, only one secton was sampled each month.

With regard to bottom conditions obtaining in the three sectors of Getalsud reservoir the bottom in litic sector is soft with considerable dead organic matter in the form of dead vegetation but during monsoon season heavy amount of silt is deposited in this region. This sector has a maximum depth of 10 meters. The bottom in intermediate sector towards and near lotic sector is comparable to the lotic but it differes towards lentic sector. This sector is upto 15 meters deep. Lentic sector has sandy bottom but the shallow region towards shore has soft muddy bottom. The maximum depth varies from 20 to 25 meters.

Lotic Sector (Fig. 18)

1975-76 : Bathymetric distribution of bottom macrofauna indicated that benthos abundance ranged from 727 units/m^2 (6 m) to 2689 units/m^2 (4m) for the depths varying from 2 m to 8 m. The same was 1253.60 mg/m^2 (6 m) to 3826.69 mg/m^2 (4 m) in terms of weight. Thus 4 m depth was most fertile both by number and weight. Yearly average abundance was 1693 units or 2530.08 mg/m^2.

1976-77 : Depth of 2 meters was most productive both by number and weight. The abundance varied from 529 units/m^2 (0 m) to 1675 units/m^2 (2 m) for depths upto 8 m. By weight this abundance was 401.15 mg/m^2 (0 m) to 2110.72 mg/m^2 (2 m). The yearly average benthic abundance was 1149 units or 1349.74 mg/m^2. Thus, there was a fall in benthic production from 1975-76 to 1976-77.

1977-78 :

The yearly benthic abundance was 1237 nos. or 4749.83 mg/m^2, which was maximum at 6 m (1837 $units/m^2$) and minimum at 8 m depth (303 $units/m^2$). But by weight a difference picture was observed since benthos was highest at 0 m (15993.50 mg/m^2) and lowest at 8 m (435.78 mg/m^2). 0 m depth productivity is attributed to the presence of live molluscs. Thus, benthos production by numbers did not vary much but it was more productive by weight as compared to the previous year.

1978-79 :

The yearly benthos abundance was 460 $units/m^2$ or 504.48 mg/m^2 by weight. This abundance fluctuated from 77 $units/m^2$ (0 m) to 1148 $units/m^2$ (10 m) or 75.99 mg/m^2 (4 m) to 1240.97 mg/m^2 (10 m) for depths upto 10 m. Thus, 10 metre depth was most productive both by numbers and weight. There was considerable fall in production from the preceeding year.

1979-80 :

The benthos abundance was 38 $units/m^2$ (0 m) to 808 units/ m^2 (6 m) or 29.82 mg/m^2 (0 m) to 698.40 mg/m^2 (6 m) by weight. Yearly average abundance was 353 units or 308.47 mg/m^2, which was lower than in 1978-79.

Intermediate sector (Fig. 19)

1975-76 : This sector had an yearly average benthos abundance of 75 units or 39.99 mg/m^2 which ranged form 34 units/m^2 (2 m) to 113 units/m^2 (10 m) but by weight this abouhdance was 21.58 mg/m^2 (2 m) to 52.28 mg/m2 (6 m). Thus, the most productive depth by numbers was 10 m and by weitht was 6 m.

1976-77 : The aboundance of this sector fluctuated form 86 units/m^2 (4 m) to 696 units/m^2 (15 m) or 36.20 mg/m^2 (2 m) to 237.35 mg/m^2 (15 m). Thus, 15 metre depth was most productive numerically as well as gravimetrically. Yearly average aboundance was 200 units or 88.98 mg/m^2, indicating an increase in productivity than in 1975-76.

1977-78 : Average benthos production was 348 units or 339.31 mg/m^2, which varied form 195 units/m^2 (2 m) to 617 units/m^2 (0 m). By weight the production was 147.18 mg/m^2(4 m) to 615.44 mg/m^2 (2 m). There was an increase in benthic production then earlier years.

1978-79 : This sector had an yearly average aboundance of 183 units or 200.61 mg/m2, which ranged form 58 units/m^2 (15 m) to 472 units/m^2 (0 m) or 25.97 mg/m^2 (15 m) to 776.33 mg/m^2 (8 m). Thus, the highest benthic production by numbers was at zero m whereas by weight it was at 8 m. The least productive depth was 15 m both by weight and numbers. There eas a fall in benthos production.

1979-80 : Yearly average benthos abundance was 280 units or 355.25 mg/m^2 during this period which varied from 24 units/m^2 (2 m) to 957 units/m^2 (0 m.). Highest and lowest benthos aboundance by weight were at 15 m (809.09 mg/m^2) and (6 m) (129.86 mg/m^2) respectively. Thus, like the proceeding year, highest aboundance by number was at 0 m but by weight this was at 15 m. There was once again an increase in benthos production as compared to the previous year.

Lentic sector (Fig. 20)

1975-76 : This sector had an average benthos production of 81 units or 56.66 mg/m^2 which fluctuated form 57 units/m2 (10 m) to 115 units/m^2 (20m, 25 m), the same was 34,86 mg/m^2 (6 m) to 95.20 mg/m^2 (8 m) by weight. In general, higher depths(20, 25m) were more productive by numbers.

1976-77 : The benthos aboundance ranged form 70 units/m^2 (10 m) to 288 units/m^2 (25 m) by number and 25.12 mg/m^2 (10 m) to 98.10 mg/m^2 (25 m) by weight. Thus, maximum benthic production was at 25 metres both by numbers and weight whereas (10 m) depth was least productive. Annual average benthos aboundance was 168 units or 70.37 mg/m^2.

1977-78 : Average production was 98 units or 40.01 mg/m^2 which ranged form 46 units/m^2 (10 m) to 250 units/m^2 (20 m). By weight, this was 14.42 mg/m^2 (0 m) to 68.30 mg/m^2 (20 m). Thus, the maximum production both by weight and numbers was at 20 metres. There was a decrease in production ocer the preceeding year.

1978-79 : Benthos aboundance fluctuated form 32 units or 28.14 mg/m^2 (2 m) to 476 units or 300.14 mg/m^2 (25 m). Thus both by number and weight, benthos production was highest at 25 metres, indicating higher depths to be more productive like in the preceeding year. Annual average benthos production was 110 units or 92.96 mg/m^2 which showed an increase as compared to the previous year.

1979-80 : Yearly average benthos aboundance was 127 units or 76.45 mg/m^2, which ranged form 29 units/m^2 (15 m) to 289 units/m^2 (20 m). By weight also production was minumum at 15 m (27.41 mg/m^2). No regular trend of bathymetric distribution was observed.

Diptera and aquatic Oligochaeta were the dominant groups of macrofauna. Diptera (Fig. 21) preferred depth range of 6 to 10 m in lotic sector, whereas maximum availability was recorded at 0 m, 6 m and 15 m in intermediate sector and at 6 m, 15 m 20 m and 25 m in lentic sector. Thus normally higher depths were preferred by dipterans. Aquatic Oligochaeta (Fig. 22) were in highest aboundance at depths 2 m to, 8 m in lotic sector, 0 m, 8 m, 10 m, and 15 m in intermediate sector and at 10m, 15 m and 20 m in lentic sector. Trichoptera (Fig. 23) favoured depths not exceeding 8 m in all the three sectors being mostly aboundant in 2 m depth. Molluscs (Fig. 24) were found mainly in lotic sector. These occurred at 4 m, 8 m and 10 m.

Benthos aboundance in lotic sector decreased in 1976-77 over 1975-76 but there was improvement during 1977-78. From 1977-78 onwards there was a continuous decrease in benthic production upto 1979-80.

In intermediate secror, there was a contimuous increase in benthos aboundance upto 1977-78 with a fall in 1978-79 but benthic production once again increased during 1979-80.

In lentic sector, there was a continuous increase in benthic production upto 1979-80 by units/m^2 except during 1977-78 but this trend differed by weight, which showed a drcrease during 1977-78 over the preceeding two years and during 1979-80 than in 1978-79.

In general, lotic sector was the richest in benthos production followed by intermediate and lentic sectors.

The following benthic organisms were encountered in the reservoir.

Aquatic oligochaeta - Tubifex abd Nais Culicoides,
Diptera - Culicoides, Dixa, Chironomus & Chaoborus

Anisoptera - Aphylla

Trichoptera - Philopotamus

Mollusca - Carbicula, Pisidium, Goniobasis, Sphaerium and Gyraulus

Collembola - Spring tail

Coleoptera - Promoresia

11.2 Periphyton

Periphyton of Getalsud reservoir was studied form April 1978 to March 1979. For this purpose monthoy smaplings were made from the three sectors by hanging glass slides from slightly below the surface water to slightly above the bottom mud. Each slide was fitted in beyween two wooden corks and tied with a galvanised iron wire. The slides were so adjusted on the G.I. wire that then immersed they occupied a vertical position with reference to water surface. The distance between two adjacent sampling levels was kept constant
at one

at one meter. A sinker at the bottom end of the G.I. wire was used to prevent the slides form drifting by wave acyion. A depth upto 18 meters was thys sampled.

After the slides remained immersed in water for a certain number of days the string with slides at different levels was pulled up slowly. The slides were removed and kept in 4% formalin in specimen tubes, after giving a gentle bath in enamel trays to remove the loosely attached organisms.

One side of each of these slides was wiped clean while the other side was examined under the microscope after placing cover slips at random. To avoid air space between the slide and cover slip a few drops of tap water were also added prior to placing the cover slips. The qualitative and quantitative evaluation of the periphyton, thus encountered, was made. The quantity of the population was expressed interms of units/sq. cm as described by Edmondson (1969).

A regular study of periphyton of lotic and intermediate sectors could not be carried out due to certain practical difficulties and hence the lentic sector is described in some detain;

The average periphyton pupulation of different depths showed a trimodal pattern of annual fluctuations. The primary maximum was observed during December followed by secondary in March and tertiary in August-September. April, May and July were the lean months (Table VI) as far as periphyton deposits were concerned.

The periphytic community of the reservoir was largely deminated by different groups of algal flora followed by animalcules (protozoans) and so the sequence, in terms of abundance, may be stated as - Bacillariophyceae, Chlorophyceae, Myxophyceae, animalcules, Euglenophyceae, Xanthophyceae and Dinophyceae. Since the individual contribution of the last four groups was minor, these are grouped under the term "miscellaneous". Watermoulds were also encountered at times and these too are included under the miscellaneous category.

The primary peak, onserved during December, was mainly composed of diatoms and among these Navicula, Hantzschia, Gomphoneis, Fraqilaria and Melosira were the most dominant followed by green algae like Phyllobium, Oocardium, Chaetophora and Cosmarium. Difflugia and Epipyxis represented animalcules and miscellaneous groups respectively, which contributed significantly to the formation of this pulse.

The secondary peak of March again showed the dominance of Bacillariophyceae followed by Chlorophyceae and animalcukes. However, during this period, as compared to the primary peak in December, the animalcules (Vorticella , Vampyrella, Centropyxis) were observed in greater aboundance. Amoung the diatoms Navicula, Melosira, Diploneis and Gomphoneis were the dominant forms. Navicula was recorded upto 5 metres depth while the other genera were more abundant towards the bottom. Stioeoclonium and Phyllobium were the dominant green algae which contributed a major share in the formation of this peak. The former genus was mostly confined to upper strats of the water column upto a depth of 3 metres while Phyllobium was present in the entire water columb upto a depth of 18 metres. Anabaenopsis was the only blue green alga observed during the period growing more vigorously towards the peripheral end of the water column.

The tertiary peak of August-September was much smaller in size. The trend of this peak was also smilar to the other two peaks, with the difference that here the blue green algae and the miscellaneous group showed better proliferation. Mastogloia, Cyclotella, Fragillaria, Ambhora, Synedra and Gomphonema were the dominant diatoms followed by Stigeoclonium Oocardium, Phyllobium and Cosmarium (green algae). Anabaena, Phormidium, Phacus, Peridinium, Epiphysis, Vorticella, Difflugia were the other important organisms observed.

The percentage composition of different groups of algal flora and animalcules varied form month to month and depth to depth. The overall percentage composition of Bacillariophyous group was observed to be ranging between 28.73-61.19%, 12.88-40.70%, 1.3-20.77%, 4.07-32.52% and 1.09-22.38% respectively.

The vertical distribution of periphyton in this reservoir was largely governed by the availability of diatoms. The highest deposition of organisms was generally observed upto a depth of 2 meters. However, on certain occasions, their aeailability extended upto 5 metres (December-January, February-March). Generally a regular pattern of fluctuations of the periphytic community was recorded form surface to a depth of 8 metres beyond which a gradual decline in the population was observed (Table VII). Bacillariophyceae and Chlorophyceae (Cosmarium, Phyllobium) were the only two groups of algae consistently recorded form every depth of the water column. The rest of the forms showed erratic distribution. A clear cut differentiation of stratification in terms of qualitative aboundance of the organisms was also evident because it was observed that certain forms prefer to grow towards the peripheral ends while the others grow more vigorously in deeper waters.

The distoms were the important organisms in lotic and intermediate sectors also but in case of the former the green algae especially chaetophorales and conugales grew more vigorously while in the intermediate sector the miscellaneous group was the most prominant.

The periphyton population of Getalsud reservoir comprised a large number of organisms and among them the algal florawere highly dominant. Among the animalcules, protozoans were the most important. The large number of other forms which were recorded form the glass slides may not all be considered as truely epiphytic. It is just possible that at least some of these organisms become opiphytic during some stage of their life cycle.

Phyllobium, Chaetophora, Aphanochaete, Dermatophyton, Stigeoclonium, Cladophora, Oocardium, Oedogonium, Gomphonema, Amphora, Cymbella, Gomphoneis, Diplonesis, Navicula, Epipyxis, Difflugia, Vorticella etc., are the true attached forms and hence recorded in sizeable numbers during the course of investigation. The other dominant forms recorded during the course of study were Hantzschia, Melosira, Cyclotella, Fragilaria, Synedra, Mastogloia, Spjaerocustis, Cosmarium, Vampyrella, Actinosphaerium and Centropyxis but these are in fact planktonic in nature. The presence of such planktonic forms in sizeable quantities on the slides is suggestive of partial periphytic tendency of these organisms. It is possible that the duration of their attachment is short. The blue green algae like Oscillatoria, Anabaena, Lyngbya, Merismopedia, Coccochloris etc., can attach themselves over any submerged substratum due to the presence of a mucilaginous sheath and hence these may be treated as truely periphytic in habitat. The dominance of diatoms among the observed periphyton, corroborates the findings of Fritsch (1935) who suggested that the attachment of diatoms is effected with the help of mucilage often secreted by them.

The fluctuations of organisms over the glass slides varied considerably according to the season and the depth of the water column. This variation may be due to many physicochemical factors like sunlight, temperature, wave action, rainfall, turbidity and chemical characteristics of water. The absence or decrease of green algae (except Phyllobium and Cosmarium) towards greater depths may be coreelated with the low light intensity and temperature. The abundance of diatoms at almost all the depths of the water column suggests that this group is able to withstand variable range of light intensity and temperature. However, it was observed that the verical distribution of diatoms showed conspicuous qualitative stratification and forms like Merosira, Cyclotella, Mastogloia and Diploneis dominated towards the bottom. Similar was the case with blue green algae like Metismopedia, Coccochloris, Anabaena, Oscillatoria etc., which were recorded more towards peripheral end of the water column. The stratification of animalcules was also more towards the bottom.

11.3 Benthic algae

For studying the soil algae, bottom mud samples form various depths were collected by using Ekman dredge. Soil was kept in glass jars, tap water added to it and the contained algae allowed to proliferate under diffuse sunlight at room temperature. The organisms observed after 4 days of growth are listed below: (next page)

Scenodesmus, *Cosmarium*, *Euglena*, *Amphithrix*, *Nitzschia*, *Rhoicospenia*, *Cymbella*, *Cyclotella*, *Mastogloia*, *Aphanotheca*, *Pinnularia*, *Navicula*, *Caloneis*, *Surirella*, *Closterium* and *Pediastrum*.

12 LARGER AQUATIC PLANTS

Concentration of hydrophytes was more in the lotic followed by the intermediate and lentic sectors. Water hyacinth, *Eichhornia crassipes*, was the most common weed observed in all the sectors. Cyperus occupied the next position in respect of abundance. *Ipomea* was observed only in the lotic and intermediate sectors and was restricted to the shallow marginal regions. *Marsilea*, *Nelumbium* and *Ceratophyllum* were confined to the lotic sector only.

13 FISH FAUNA

A full classified list of the fishes of Getalsud reservoir is given below. These belong to 6 orders and 12 families. The classification and nomenclature is after Day(1958) and Menon (1974).

Class Teleostomi

Sub-class Actinopterygii

I Order Osteoglossiformes sub-order Notopteroidei

i) Family Notopteridae

1 *Notopterus notopterus* (Pallas)

II Order Cyprintiformes

Division Cyprini

Sub-order Cyprinoidei

ii)Family Cyprinidae

Sub-family Abramidinae

2 *Chela cachius* (Hamilton)

3 *Salmostoma bacaila* (Hamilton)

4 *S. phulo* (hamilton)

Sub-family Rasborinae

5 Barilius barila (Hamilton)

6 Dabio (Brachydanio) rerio (Hamilton)

7 Esomus danricus (Hamilton)

8 Rasbora daniconius (Hamilton)

9 Amblypharyngodon mola (Hamilton)

10 Catla catla (Hamilton)

11 Cirrhinus mrigala (Hamilton)

12 C. reba (Hamilton)

13 Cyprinus carpio var. communis (Linnacus)

14 Garra gotyla gotyla (Gray)

15 Hypophthalmichthys molitrix (Valenciennes)

16 Labeo bata (Hamilton)

17 L. boggut (Sykes)

18 L. calbasu (Hamilton)

19 L. Dyocheilus (McClolland)

20 L. pangasia (Hamilton)

21 L. rohita (Hamilton)

22 Osteobrama cotio cotio (Hamilton)

23 Puntius sarana (Hamilton)

24 P. sophore (Hamilton)

25 P. ticto (Hamilton)

iii) Family Cobitidae

26 Lepidocephalichthys guntea (Hamilton)

27 Noemacheilus botia (Hamilton)

Division Siluri

Sub-order Siluroidei

iv) Family Siluridae

28 *Ompok bimaculatus* (Bloch)

29 *O. pabda* (Hamilton)

v) Family Bagridae

30 *Mystus cavasius* (Hamilton)

31 *M. vittatus vittatus* (Bloch)

iv) Falily Clariidae

32 *Clarias batrachus* (Linnaeus)

vii) Family Heteropheustidae

33 *Heteropneustes fossilis* (Bloch)

III Order Mugiliformes
Sub-order Mugiloidei

viii) Family Mugilidae

34 *Rhinomugil corsula* (Hamilton)

35 Sicamugil cascasia (Hamilton)

IV Order Channiformes

ix) Family Channidae

36 *Channa gachua* (Hamilton)

37 *C. punctatus* (Bloch)

38 *C. striatus* (Bloch)

V Order Perciformes
Sub-order Percoidei
Super family Percoidae

x) Family Centropomidae

39 *Chanda nama* (Hamilton)

40 *C. ranga* (Hamilton)

Sub-order Gobioidei

xi) Family Gobiidae

Glossogobius giuris (Hamilton)

VI Order Mastacembeliformes

xii) Family Mastacembelidae

42 Mastocembelus armatus (Lacepede)

43 M. pancalus (Hamilton)

It may be noted that major predators like Mystus seenghala, M. aor, Wallago attu, Bagarius bagarius etc., do not infest the reservoir. That may at least partly explain the dominance of small sized fishes in it.

14 EXPERIMENTAL FISHING

Experimental fishing by gill nets was started in Getalsud reservoir during the year 1977-78. This work was done mostly in the intermediate and lentic sectors. The lotic sector is quite narrow and there were some practical difficulties in fishing in this sector. The manging coefficient of the nets was 0.5. Species composition and catch per metre square for various mesh bars during different years are giving in Tables VIII and IX.

1977-78 : Fishing was done for 20 days only in the months of February and March 1978. A total of 8 to 13 nets of length 322 to 896 metres and area 1030 to 2986 sq. metres were operated. The nets were of 13 mesh bars viz., 20,30,35,40,45,60,90,105, 110,120,130,145 and 150mm. The total catch during the year was 35.010 kg. Catla catla formed 50.70% of the catch followed by Cirrhinus mrigala (25.02%). The most effective mesh bars were 120 mm (63.53 gm/m^2) and 90 mm (38.88 gm/m^2).

1978-79 : Fishing was done for 24 days only during the year in the months of May, June, February and March. Seven to 16 nets of 13 mesh bars viz., 20,25,30,35,40,45,60,90,105,110,120,145 and 150 mm were used on the days fishing was done. Their length varied form 374 to 733 metres and area form 1524 to 2663 m^2. The total fish catch was 52,843 kg, the most important species in the each being Labeo bata (49.97%) and C. mrigala (29.73%). The effective mesh bars were 35 mm (8.33 gm/m^2) and 60 mm (6.97 gm/m^2).

1979-80 : Fishing was done for 63 days form April to November and in February and March. Nine to 12 nets of length 937 to 1290 metres, area 3202 to 5016 M^2 and of mesh bars 20,25,30,35,40,45, 50,55, and 130 mm were operated on fishing days. The total catch during the year was 212.064 kg. C. mrigala (23.79%), Puntius sarana (16.97%) and Labeo calbasu (14.84%) being the dominant species. Mesh bars which proved to be more effective than others were 40 mm (6.26 gm/m^2) and 54 mm (4.94 gm/m^2).

1980-81 : Fishing was done on 54 days during the year spread over the months of May, June, November, January, February and March. Nine to, 12 nets of mesh bars 20,25,30,35,40,45,50,55, 65,75,80,85,90,120,130, and 150 mm were used. The length of nets operated each day varied form 937 to 1604 m and area form 3202 to 9932 m^2. Total catch during the year was 171.675 kg. The most important fishes caught were C. mrigala (31.17%) followed by Catla catla (13.08%), C. reba (10.25%) and Labeo rohita (10.22%). The most effective mesh bars were 150 mm (9.46 gm/m^2), 90 mm (8.34 gm/m^2), 40 mm (7,53 gm/m^2) and 75 mm (5.49 gm/m^2).

Though the data are meagre, it may be said that mesh bars of 20 to 40 mm are effective in catching small and medium sized fishes while for majro carps mesh bars of 90 to 150 mm should be used.

Mesh selectivity :

The relevent data are presented in Table X. Catla catla ranging in length form 493 to 729 mm was caught in mesh bars of 50 to 150 mm. Cirrhinus mrigala (201 to 549 mm) appeared in almost all mesh bars of 20 to 90 mm. Mesh bars of to 75 mm were effective in catching Labeo calbasu ranging in length form 141 to 479 mm. Labeo rohita (487 to 668 mm) was caught in bets of mesh bar 30 to 85 mm. Smaller mesh bars of 20 to 55 mm proved effective in catching fishes such as Notopterus notopterus, Salmostoma bacaila, Cirrhinus reba, Labeo bata, L. dyocheilus, Osteobrama cotio cotio, Puntius saraaa, Ompok pabda, Rhinomugil corsula, Channa punctatus, Glossogobius giuris and Mastocembelus armatus.

15 COMMERCIAL FISHING

Commercial fishing in Getalsud reservoir by the use of gill nets was initiated by the Fishreies Department of the State Governmenr in the year 1976-77 and continued upto June 1979. The reservoir was then auctioned on 1st July 1979 for a period of 3 years amd a private contractor started fishing operations in it.

The contractor is fishing with gill ahd drags hets. For operating gill nets he normally employs 4 parties, each having 4 men on one boat. Each boat has some 40 nets, each of 30 m length. In this way some 4,800 m of gill nets are used. The mesh bar varies form 70 to 150 mm. Major carps are mostly caught by gill nets.

Drag netting is done by 4 to 7 parties each having a country boat and a drag net (200 m x 6 m). This type of fishing is done at night form 9 P.M. to 4 A.M. Drag netting is reported to be much more profitable in Getalsud reservoir as large quantities of small sized fishes are caught by this method.

Fishing is continued in the reservoir till the returns are considered adequate after which the contractor with his men and equipment moves to some other reservoir. The fish catch is first brought to Ranchi and then handed over to retailers. As per information supplied by the State Fisheries Department, the catch by commercial fishing in various years is as follows :-

1976-77	:::	481.300 kg
1977-78	:::	2620.250 kg
1978-79	:::	7659.550 kg
1979-80	:::	2595.550 kg
1980-81	:::	5980.000 kg

16 EFFECT OF IMPOUNDMENT ON REPRODUCTION AND RECRUITMENT

About 50 km upstream of Getalsud, the Subernarekha is dammed resulting in the formation of Hatia reservoir. Jamuar is a tributary of the Subernarekha which joins it upstream of Getalsud but downstream of Hatia. There is a dam across the Jamuar also. It is therefore obvious that when the South West Monsoon starts, the two reservoirs upstream of Getalsud are filled up first before the extra flood waters are allowed to flow down towards Getalsud. The two dams thus exercise on adverse effect on the spawning of fishes in Getalsud reservoir. It may also at least partly be due to the two dams upstream of Getalsud that the floods in the Subernarekha are frequent during the rainy season through of short duration.

Spawn collection work was done in the months of July and August near village Jorar on the Subernarekha (Fig. 2) in the years 1975 to 1979 and in 1981 on the Jamuar. At Jorar mostly fertilised eggs of minor carps and a few young ones of Cirrhinus mrigala were collected in the year 1975. The eggs on rearing in plastid pools were found to be those of Cirrhinus reba.

In the years 1976 & 1977 also only fertilised eggs were collected at the Jorar site. The composition of various species after rearing in 1976 was Cirrhinus reba - 45.10%, Labeo pangusia - 39.21%, Puntius sophore - 9.80%, P. sarana 2.62%, Chada nama - 2.62% and Glossogobius giuris - 0.65%. The same in the year 1977 was Amblypharyngodon mola -23.40% Puntius sophore - 29.78%, P. ticto - 12.77%, P. sarana- 17.02, Salmostoma bacaila -4.26% and Esomus danricus - 12.77%.

Shooting nets operated at Jorar in 1978 collected only a few fertilised eggs and early fry of Chanda nama. The eggs later died during the process of rearing. During 1979 rains failed and the flooding was very poor and perhaps due to that very few eggs could be collected.

The first indication of a gangetic major carp breeding during the flood season was got during the year 1981 when 28.6% of the reared hatchlings were found to be that of Labeo calbasu and the rest of minor carps.

Shore collections were also made around the yerø by operating small meshed drage nets in various parts of the reservoir though no young ones on major carps were ever collected, hatchlings of minor carps and trash fishes were caught in aboundance during the rainy season.

BIOLOGY OF FISHES

17.1 Food and Feeding Habits :

Fishes of Gelalsud reservoir were collected every month for study of their biology. This work was done form November 1977 to September 1980. For the study of food the fishes were grouped differently for various species, i.e., 21-40 mm and 41-60 mm for Esomus danricus; 15-35 mm for Danio(Brachydani) rerio; 21-50 mm and 51 mm and above for Puntius ricto, Puntius sophore, Salmostoma bacaila, Amblypharyngodon mola, Osteobrama cotio cotio, Rhinomugil corsula, Chanda nama and Glossogobius giuris.

The specimens after nothing down the length and weight (Table XI) were cut open and gut contents taken into a petridish. The contents of entire gut were examined under a miscroscope and the percentage of various food items assigned by eye estimation. The percentage of various food items in gested by different s species of fish is depicted in Fig. 25.

Puntius ticto : The fish feeds mainly in sand and mud (33.5%), secayed organic matter (9.5%0, Bacillariophyceae (30.0%), Chlorophyceae (15.0%), Myxophyceae (5.5%), insects and insect larvae (2.5%), Copepoda (2.5%) and Cladocera (1.5%). The food composition is almost the same for the two size groups.

Puntius sophore : The specimens below 50 mm mainly fed on sand and mud (53.5%) decayed organic matter (15.)%), Bacillariophyceae (24.0%), Chlorophyceae (6.5%) and Myxophyceae (1.0%). In P. Sophore also there is not much change in the larger groups, Dinophyceae represented by Ceratium was observed. A high percentage of sand and mud (55.5%) was observed in the guts of adult P. sophore, other food items being decayed organic matter (15.0%), Bacillariophyceae (20.0%), Chlorophyceae (6.5%), Dinophyceae (2.0%) and Myxophyceae (1.0%).

Esomus danricus : The gut contents of E. danricus of size range 21-40 mm mainly comprised phytoplankton i.e. Chlorophyceae (50.0%), Bacillariophyceae(30.0%), Myxophyceae (8.0%), Desmidiaceae (3.0%), snad and mud (6.0%) and decayed organic matter (3.0%). The specimens longer than 41 mm showed similar feeding habits except that percentage of sand and mud and decayed organic matter increased in their gut contents. The gut contents of E. danricus above the size of 41 mm were composed for sand and mud (30.6%), Chlorophyceae (30.0%), Bacillariophyceae (28.5%), Myxophyceae (3.5%), Desmidiaceae (2.0%) and decayed organic matter (5.5%).

Salmostoma baciala : The gut contents of speciments between the length range of 21-50 mm comprised Bacillariophyceae (45.5%), Chlorophyceae (25.5%), Copepoda (20.0%), Cladocera (7.5%) and Rotifera (1.5%), Specimens above 50 mm fed on animal matter (50.5%), insect and their larvae (30.0%), Copepoda (8.0%), Cladocera (3.5%), Rotifera (4.5%), Bacillariophyceae (2.0%) and Chlorophyceae (1.5%). This shows that the young ones of S. bacaila consume much more of phytoplankton but as the fish grows in size, it switches over the insects and zooplankton.

Amblypharyngodon mola : In A. mola there is not much of a difference in the food of juveniles and adults. The food items of this fish were represented mainly by sand and mud (63.5%), decayed organic matter (13.5%) and Bacillariophyceae (13.0%) followed by Chlorophyceae (4.5%), Desmidiaceae (3.0%) and Myxophyceae (2.5%).

Osteobrama cotio cotio : The food of O. cotio cotio of size range 21-50 mm was composed of sand and mud (44.0%), decayed organic matter (35.5%), insects and their larvae 3.5%); Copepoda (2.5%), Cladocera (2.0%), Bacillariophyceae (7.0%), Chlorophyceae (3.0%), and digested animal matter (2.5%).

The food of O. cotio cotio above 50 mm comprised sand and mud (30.5%), decayed organic matter (22.5%), insects and their larvae (25.0%), digested animal matter (10.0%), Copepoda (3.0%), Cladocera (2.0%), Bacillariophyceae (3.0%), Clorophyceae (2.0%), and Myxophyceae (2.0%). This indicates that intake of animal matter increases as the fish grows in size.

Rhinomugil corsula : This fish subsists mainly on snan and mud (28.0%), decayed organic matter (25.5%), Bacillarriophyceae (40.0%), Desmidiaceae (2.5%), Chlorophyceae (2.5%) and Myxophyceae (2.0%).

Chanda nama : Specimens of total length 21-50 mm feed mainly on zooplankton i.e., Copepoda (65.5%) and Cladocera (25.0%), while fish and insects and their larvae contributed 7.5%) and 2.0% respectively. In specimens of 51 mm and above insects and their larvae, young prawns, and fish increased, while zooplankton decreased, the percentage of various items being insects and their larvae (69.5%), young prawns (5.5%), fish (15.0%), Copepoda (7.5%) and Cladocera (2.5%).

Glossogobius giuris : Smaller fishes upto 50 mm in length fed mainly on zooplankton and insects and their larvae i.e., Copepoda (59.5%), Cladocera (24.5%), insects and their larvae (8.5%), digested animal matter (5.5%) and fish (2.0%).

The larger specimens above 50 mm mainly feed on fish and prawns constituting 40.5% and 35.5% respectively while insects and their larvae form 16.0% of gut contents. Besides these, Copepoda (2.5%), Cladocera (2.0%) and digested animal matter (3.5%) also constituted the food of G. giuris.

Danio (Brachydanio) rerio : The gut contents of D. (Brachydanio) rerio showed phytoplankton as the major food comprising Chlorophyceae (32.5%), Desmidiaceae (25.0%), Bacillariophyceae (17.5%), Myxophyceae (3.5%), and decayed organic matter (2.5%) and also zooplankton such as Copepoda (10.0%), Cladocera (7.0%) and Rotifera (2.0%).

Detailed studies on the food of minor carps and other small sized fishes of Gotalsud reservoir thus show that most of these feed on phytoplankton, the only exceptions being Chanda nama and Glossogobius giuris which feed on zooplankton (Copepoda and Cladocera) also. However, the percentage of zooplankton is more in their early stages as compared to the same in the adults. In the adult condition it was observed that both these fishes prefer insects and their larvae as the major item if food. Zooplankton also forms the food of the young ones of S. bacaila, O. cotio cotio, D. (Brachydanio) rerio as well as the adults of P. ticto. The above six species consume more of Copepoda and less of Cladocerans. Among the Copepoda, Diaptomus, Cyclops and nauplii and among the Cladocerans, Daphnia, Ceriodaphnia, Diaphanosoma and Moina were the more abundant forms.

Rotifers do not constitute an important food of fishes. The fishes that utilise totifers and Danio (Brachydanio) rerio and Salmostoma bacaila. Keratella, Filinia and Polyarthra are frequently found in the guts. Keratolla was the most impoortang rotifer which formed the food of fishes.

Phytoplankton constituted the main food of the fishes of Gotalsud reservoir except C. nama and G. giuris. Among phytoplankton Bacillariophyceae, Chlorophyceae and Desmidiaceae were the most dominant groups. Bacillariophyceae was represented by Navicula, Cymbella, Pinnularia, Amphora, Gyrosigma, Surirella, Achnanthes, Gomphonema, Nitzschia, Synedra, Cyclotella, Meridion, Melosira, Fragilaria, Frustulia Tabellaria, Cocconeis and Caloneis. The fishes that prefer Bacillariophyceae as the major food item are Rhinomugil corsula, Puntius ticto, Puntius sophere and Amplypharyngodon mola.

Chlorophyceae was represented by Microspora, Ulothrix, Oedogonium, Botryococcus, Eudorina, Pleodorina and Pandorina. The fishes that consume Chlorophyceae as the main item of food are Esomus danricus and Danio (Brachydanio) rerio.

Myxophyceae was represented by Anabaena, Nostoc, Oscillatoria and Merismopodia. Desmidiaceae was represented by Cosmarium, Closterium, Netrium, Staurastrum, and Penium. Desmids formed the second most important food of R. corsula and D. (Brachydanio) rerio. Dinophyceae was represented by Ceratium and was consumed only by Puntius sophere.

Insects were represented by Chaoborus, Chironomus, Philopotermus and their larvae. Insects and their larvae were the most important food item of adult Glossogobius giuris, Chanda nama, Oteobrama cotio coito and Salmostoma Bacaila.

17.2 Length-weight Relationship: The logarithmic form of the relationship in respect of various species is as follows:

Puntius ticto	Log W = 2.6864 Log L - 1.2912
Puntius sophore	Log W = 3.1635 Log L - 2.1802
Esomus danricus	Log W = 2.4516 Log L - 1.2357
Salmostoma bacaila	Log W = 2.7829 Log L - 1.90899
Amblypharyngodon mola	Log W = 2.4945 Log L - 1.0845
Osteobrama cotio cotio	Log W = 3.5489 Log L - 3.0961
Rhinomugil corsula	Log W = 2.8165 Log L - 1.6634
Chanda nama	Log W = 2.5756 Log L - 1.3378
Glossogobius giuris	Log W = 2.4466 Log L - 1.0389
Danio (Brachydanio) rerio	Log W = 1.7341 Log L - 0.3182

Where L is total length in mm and W is weight in mg.

Catla catla	Log W = 3.0107 Log L - 4.8463
Labeo rohita	Log W = 3.1528 Log L - 5.8463
Labeo calbasu	Log W = 2.7123 Log L - 4.2017
Cirrhinus mrigala	Log W = 2.9426 Log L - 4.8481
Hypophthalmichthys molitrix	Log W = 3.277 Log L - 5.8053

Where L is total length in mm and W is weight in g.

The relationship normally showed a greater tendency to deveate form the cube law in fishes which attain a small size.

17.3 Age and Growth : The age of major carps in Getalsud reservoir was determined by examining their scales (Plate I) with the helop of a simple projector. The von Bertalanffy's growth equations for the four species are given below:-

Catla catla $I_t = 1484.99\ (I-e^{-0.1068\ (t+0.605)}$

Labeo rohita $It = 1517.90\ (I-e^{-0.0769\ (t+1.098)}$

Labeo calbasu $I_t = 628.85\ (I-e^{-0.2052\ (t+0.7705)}$

Cirrhinus mrigala $I_t = 1595.50\ (I-e^{-0.0544\ (t+1.2873)}$

The asymptotic length IL oo) for Catla catla, Labeo rohita, L. calbasu and Cirrhinus mrigala was 1485,1518,629,1595 mm respectively. The same was computed by using mathematical derivation corresponding to Walford's graphical analysis.

Lengths at age derived form scale reading and application of von Bertalanffy growth equation and other growth data pertaining to the major carps are as follows:-

Age in years	Lengths scale (mm)	estimated by growth equation (mm)	Calculated wt. (g)	Increment in Length (mm)	Increment in Weight (g)
1	2	3	4	5	6
Catla catla					
1	234	232.11	193	-	-
2	362	362.64	720	128	527
3	473	469.41	1611	111	891
4	577	575.29	2929	104	1318
Labeo rohita					
1	226	224.50	101	-	-
2	321	323.90	321	95	220
3	410	415.80	705	89	384
4	493	490.10	1184	83	479
5	568	569.20	1899	75	715
Labeo calbasu					
1	192	190.10	98	-	-
2	275	283.70	260	83	162
3	336	346.30	447	61	187
4	393	397.50	684	57	237
Cirrhinus mrigala					
1	187	180.40	69	-	-
2	263	262.80	187	76	118
3	331	327.90	369	68	182
4	398	401.60	634	67	265
5	462	459.80	983	64	349
6	522	526.00	1409	60	426

17.4 Maturity and Fecundity : The ova diameter frequency polygons of ripe specimens of various species are depicted in Fig. 26. The first mode is formed by immature ova while the maturing and mature ones form two modes in all the fieses studied. The nature of the polygons is such that it shows that the various fishes have a prolonged spawning season. This is also borne out by a stydy of condition factor * with (K_2) and without (K_1) gonads during different months of the year (Fig. 27). A decline in condition indicates the onset of breeding. The various fishes exhibit two or more such decline during the course of a year which indicates a prolonged breeding season.

* Condition Factor, $K = W \times 10^5/L^3$, where W is weight of fish and L is total length.

Puntius ticto : Mature specimens were found in the months of January to April and in November . Stray mature fishes were also seen in August and September. Fecundity varied from 628 to 3127 for fishes 62 to 74 mm in length (Female gonado-somatic index, GSI **, varyied from 3.31 to 20.11). Females in running condition were seen in February and spent ones in January to March and in August.

Puntius sophore : The fish was observed to mature mainly in February and November . Stray mature individuals were found in April to June, August and October. Fecundity varied from 584 to 2380 for fishes 70 to 101 mm in length (GSI of females from 4.30 to 9.94). Spent females were seen in March. April, June, September and November. The fish therefore starts breeding even before the onset of floods.

Esomus danricus: Mature specimens were seen in May, August and September. Fecundity varied from 298 to 635 for fishes of total length 40 to 57 mm and GSI 3.19 to 9.09 . Spent females occurred in May, August and September. The fish therefore breeds mainly during the South-West monsoon.

Salmostoma bacaila : Mature specimens were available during May to September. Fecundity varied from 340 to 6263 in fishes of length 62 to 150 mm (GSI 3.71 to 22.07). Spent females were caught from July to October thereby showing that the main spawning takes place during the flood season.

Amblypharyngodon mola : The fish matures in June, July and August. A few mature specimens were caught in May and September. Fecundity was found to vary from 425 to 1846 in specimens measures 48 to 68 mm. Gonado somatic index of mature specimens was 5.82 to 19.54 . Spent females were found in August and September thereby indicating that the fish breeds mainly during rainy season.

Osteobrama cotio cotio : Mature fishes were seen from April to September. Stray individuals were caught as early as February and sometimes in October. Spent females were seen in the months of July to September . This shows that the fish has a prolonged breeding season. The main spawning, however, appears confined to the rainy season. The gonado somatic index of females varied from 3.28 to 14.00 and the Fecundity from 625 to 4120 in fishes measuring 60 to 112 mm.

** Gonado Somatic Index, GSI= Wt of gonad x 100/wt. of fish.

Chanda nama : Mature females having GSI of 3.09 to 8.98 were found from April to October . A few such specimens were captured in February and November . Spent females were noticed in July to September. This fish also therefore has a prolonged breeding season. The bulk of the spawning, however, is restricted to the flood season. Fecundity varied from 429 to 1676 for females varying in length from 40 to 80 mm.

Glossogobius giuris : Mature females of GSI 2.14 to 4.94 occurred in February , April and June. Fecundity of fishes 64 to 122 mm in length varied from 1436 to 5675. Spent females were not observed.

Mature females of Rhinomugil corsula and Danio (Brachydanio) rerio were not encountered. Maturity stages II & III of R. corsula were, however, observed in January and February. Spent females were seen in April and so from such observations it may be inferred that R. corsula spawns in March.

The above account shows that while breeding does occur in mon-monsoon months, the flood season constitutes the main spawning period of these fishes. This is further corroborated by the easy availability of their hatchlings in the reservoir during the mon-soon season.

The relationship of total length and fecundity was found to be curvilinear. The logarithmic form of this relationship for various species is given in the following formulae :

Puntius ticto	Log F = 3.7235 Log L - 3.6892
Puntius sophore	Log F = 2.4841 Log L - 1.6750
Amblypharyngodon Mola	Log F = 3.7109 Log L - 3.5802
Osteobrama cotio cotio	Log F = 2.5719 Log L - 1.8843
Chanda nama	Log F = 1.3258 Log L - 0.6096
Glossogobius giuris	Log F = 2.0415 Log L - 0.5664

Where L is length of the female in mm and F is fecundity.

The data pertaining to Esomus danricus and Salmostoma bacaila were too meagre to permit calculation of their length- fecundity relationship.

17.5 Food and Growth of Silver Carp : An experimental consignment of 2680 fingerlings of the exotic silver carp (*Hypophthalmichthys molitrix*) was stocked in Getasud reservoir in March 1974. A number of recoveries were made. The fish registered a net growth of 4.3 kg in just 2 years 4 months. One of the recoveries showed even a higher growth of 4.7 kg in 27 months as shown in Table XII. The growth rate varied from 0.82 to 1.67mm /day and increment in weight ranged from 2.20 to 5.79 g /day. These observations indicate the potential role of silver carp in the development of fisheries in Getalsud reservoir. It is also significant that the silver carp in the reservoir fed mostly on phytoplankton and particularly on *Micropcystis*.

18. RESERVOIR MANAGEMENT

Stocking of Getalsud reservoir by major carp fry and fingerlings was started in the year 1974-75 by the Bihar State Fisheries Department. A total of 31, 42, 066 young ones of Gangetic major carps were stocked in the seven year period from 1974-75 to 1980-81. Incidental stocking of minor carps and miscellaneous fishes during this period was 2,08,015. Considering the average area of the reservoir to tbe 2210 hectares, the average stocking rate of major carps was 203 fingerlings per hectare per year. Details of stocking as supplied by the State Fisheries Department are given below :-

Year	Major carp	Minor carp	Misc.	Total
1974 - 75	98,784	-	-	98,784
1975 - 76	1,59,700	19,832	248	1,79,780
1976 - 77	7,15,000	-	-	7,15,000
1977 - 78	8,49,975	-	86,775	9,36,750
1978 - 79	7,57,495	1,01,160	-	8,58,655
1979 - 80	2,81,112	-	-	2,81,112
1980 - 81	2,80,000	-	-	2,80,000
Total	31,42,066	1,20,992	87,023	33,50,081

19. CAGE CULTURE

An experiment in cage culture was started in August 1974 in Getalsud reservoir to examine the feasibility of rearing carp spawn in floating cages. The cages were fabricated of thick bamboo which is lighter than water, and fixed in a reservoir pochet near the dam with a view to lessor wind and wage action on the cage . Synthetic floats were fixed to the cage and adjusted in such a manner that the cage remained submerged in water to a depth of 1.10 m to 1.2 m. The cages were anchored by sufficiently long ropes to allow them to rise up with increase in reservoir water level. Each cage was provided with an inner liming of synthetic 'hapa'. In the initial stages of rearing, hapas of 1/20 mesh were used but later as the size of fry increased, hapas of 1/8" mesh were used for raising fingerlings.

Fry of major and medium carps were stocked in the cages at a maximum density of 2500/cage or 700/sq.m. This works out to 70, 00000 per hectare and is much more than in conventional nurseries. The length of fry at the lime of stocking varied from 10-31 mm. In the subsequent experiments the rate of stocking was reduced to 300 to 2200/cage of 7,50,000 to 52,50,000 per hectare.

During the first two months after stocking the rate of growth of fry was quite good, the average being 17 mm/month for Cirrhinus mrigala, 25 mm/month for Catla catla and 20 mm/month for Labeo rohita. The growth was poor in the ensuing winter months but started picking up in subsequent months. In past winter months the growth rate was 14 in C. mrigala, 30 in Catla, 17 in rohu, 19 in Labeo bata and 22 in Cirrhinus reba per month.

Artificial feeding is necessary under conditions of such heavy stocking in addition to the natural food like plankton which the stocked fish get from the reservoir. The composition of feed was MOC, GOC and RB in the ratio of 3:1:1. The young ones were fed at the rate of 30% body weight for 3-4 days which was later reduced to 20%. Artificial feeding was then gradually reduced to 4% during winter months and again increased to 10% during summer months when water temperature was 28° to 34°C. Feeding was done twice daily in morning and afternoon.

Production achieved during the year of rearing was 22.5 kg/ cage.

The culture experiment undertaken in Getalsud reservoir, thus shows that in the absence of nurseries and rearing ponds near the reservoir, spawn can be reared in cages to fingerlings size before release in the reservoir.

20 TECHNICAL SUMMARY

Getalsud reservoir is situated on the upper reaches of Subernarekha river which flows independently into the Bay of Bengal. It is a medium sized reservoir having a water-spread area of 3440 hectares at the full reservoir level of 595.7 m.

Yearly outflow varied from 3 lakh to 17 lakh ac. ft. Inflow and outflow were normally maximum in July, August and September.

Reservoir level was normally maximum in September, October and November. The lowest level was almost always in the month of June before the onset of floods. Water level fluctuations within a year varied from 1.2 to 9.5 m.

Air temperature varied from 5 to 40°C in a year. Wind velocity was high in summer. Yearly rainfall at damsite varied from 975 to 1950 mm. Rainy season starts in June and continues upto September.

Organic carbon in basin soil was below average but available nitrogen and phosphorus fairly high. Soil was acidic (pH 6.0 to 6.3). Pre-monsoon season registered high values of organic carbon available nitrogen and available phosphorus as compared to the post-monsoon season.

Water temperature fluctuated by 12.5°C between summer and winter months. Water transparency varied from 10 to 176 cm. The low transparency was due to influx of flood waters during monsoon season. The change in season showed marked effect on the chemical features of water. The reservoir is poor in respect of major nutrients like phosphates and nitrate though silica is fairly high.

Getalsud reservoir gets thermally stratified mostly during April, May and June.

Chemical stratification in the reservoir was noticed in respect of dissolved oxygen, pH, carbon-di-oxide, bicarborate and specific conductivity during the summer months. Though an increase in carbondioxide and a decrease in oxygen contents in the bottom layers indicated its productive nature a decrease in bicarbonate and specific conductivity indicated its poor productivity.

Heavy Engineering Corporation factory effluents do not seem to adversely affect the water quality of the river before it joins the reservoir.

The rate of energy fixation by primary producers was normally high in the littoral followed by sublittoral and profundal regions. The rate of carbon production was low. The average gross carbon production was 281.07 mg $C/m^2/day$ and not 147.40 mg $C/m^2/day$.

Plankton production was high in the lotic sector followed by the intermediate and lentic sectors. The plankton maxima were normally recorded in a year - one in summer and the other in winter.

Phytoplankton generally dominated over zooplankton. Myxophyceae was the most dominant group among the phytoplankton and copepods and rotifers among the ooplankton. Total plankton concentration varied from 1,28,726 units/m^3 to 52,27,509 units/m^3 or 0.118 ml/m^3 to 8.43 ml/m^3.

Lotic sector was the richest in benthos production followed by the intermediate and lentic sector. Benthic concentration varied from 66 units/m^2 to 1693 units/m^2 or 40 mg/m^2 to 4.75 gm/m^2. Dipterans and aquatic oligochaetes formed the dominant components of benthos. Normally deeper regions (8-20 m) were more productive.

Three periphyton maxima were observed in an year, the primary maximum being in December, secondary in March and tertiary in August- September. The periphytic community was dominated by various groups of algae. Concemtration of periphyton was the highest upto a depth of 2 metres and sometimes even upto 5 metres. Periphyton deposits varied from 62 units/ cm^2 to 2593 units/cm^2

Algae found on the bottom mud are mainly Seconedesmus, Cosmarium, Euglena, Nitzschia, Cymbella, Pinnularia, Navicula, Surirolla, Closterium and Pediastrum.

Hydrophytes are common in Getalsud reservoir in all the sectors. Their concentration was more in the lotic sector than in all the sectors. Other aquatic plants found in the reservoir are Cyperus, Ipomea, Marsilea, Nelumbium and Ceratophyllum.

The fish fauna of the reservoir includes gangetic major carps, medium and small-sized carps, catfishes, murrels and a few other air breathing forms, fresh water mullets, featherbacks and porches. Major predators like Mystus seenghala, M. aor, Wallago attu, Bagarius bagarius etc., do not infest the reservoir.

Experimental fishing data indicate that mesh bars of 20 to 40 mm are effective in catching small and medium sized fishes while 90 to 150 mm mesh bars should be used for gangetic major carps. Catla catla varying length from 493 to 729 mm was caught in mesh bars 50 to 150 mm. Cirrhinus mrigala (201 to 549 mm) appeared in almost all mesh bars of 20 to 90 mm. Mesh bars of 20 to 75 mm were effective in catching Labeo calbasu ranging in size from 141 to 479 mm. Labeo rohita (487 to 699 mm) was caught in nets of mesh bars 30 to 85 mm.

The reservoir is auctioned to a contractor for undertaking Commercial fishing operations who uses gill nets for major carps and drag nets for small-sized fishes. Commercial landings are composed of mainly small-sized fishes. According to the records of the State Fisheries Department, a little over 19 metric tonnes of fish was caught in the five years since 1976-77.

Gangetic major carps have not yet started breeding in the reservoir first indications of the spawning of L. calbasu have been recorded during 1981.

Most of the minor carps and small-sized fishes of Getalsud reservoir feed on phytoplankton, the only exceptions being Chanda nama and Glossogobius giuris which feed on zooplankton. However, the percentage of zooplankton is more in their early stages as compared to the same in the adults.

In the adult condition, both these species prefer insects and their larvae as a major item of food. Zooplankton also forms the food of the young ones of S. bacaila, O. cotio cotio, D. (Brachydanio) rerio as well as the adults of P. ticto. The above six species consume more of Copepoda and less of Cladocers.

Rotifers do not constitute an important food of fishes. Diatoms, green algae and blue-green algae form the dominant food of phytoplankton feeders.

The species that prefer diatoms as a major food item are Rhinomugil corsula, Puntius ticto, P. sophore and Amblypharyngodon mola.

The fishes that prefer green algae are Esomus danricus and Danio (Brachydanio) rerio.

Fishes which feed on blue green algae include Puntius ticto and Esomus danricus.

Insects and their larvae form the most important food of adult Glossogobius giuris, Chanda nama, Osteobrama cotio cotio and Salmostoma bacaila.

Piscivorous fishes were Glossogobius giuris and Chanda nama.

Length-weight relationships of 10 minor carps and small sized fishes, 4 gangetic major carps and the exotic silver carp are given. The relationship normally showed a greater tendency to deviate from the cube law in small-size fishes.

Ageing of major carps of Getalsud reservoir was done by examining scales.

Length-weight relationship of Catla catla is given by Log W=3.0107 Log L-4.8463. The fish attained lengths of 234, 362, 473 and 577 mm at the end of 1 to 4 years respectively. The von Bertalanffy growth equation was calculated to be $l_t = 1484.99 (1-e^{-0.1068 (t+0.605)})$. Fishes of lengths 500 to 860 mm were common in the landings.

Length-weight relationship of Labeo rohita was calculated to be Log W = 3.1528 Log L - 5.4085. The fish attained lengths of 226, 321, 410, 493 and 568 mm at the end of 1 to 5 years respectively. The growth equation was computed to be $l_t = 1517.90 (1-e^{-0.0769 (t+1.098)})$. Fishes normally caught were 420 to 580 mm in length.

Length-weight relationship of Labeo calbasu was LogW= 2.7123 Log L - 4.2017. The lengths at ages 1 to 4 were 192, 275, 336 and 393 mm. The growth equation is $l_t = 628.85 (1-e^{-0.2052 (t+0.7705)})$. The fish caught normally varied in length from 220 to 460 mm.

Length -weight relationship of Cirrhinus mrigala was Log W = 2.9426 Log L - 4.8481. Lengths attained at the end of first 6 years of life were 187, 263, 331, 398, 462 and 522 mm respectively, von Bertalanffy growth equation was computed to be $l_t = 1595.50 (1-e^{-0.0544(t+1.2873)})$. Fish landed was normally of length 300 to 660 mm.

The asymptotic lenfth (L_∞) for Catla catla, Labeo rohita, L. calbasu and Cirrhinus mrigala found to be 1485, 1518, 629 and 1595 mm respectively. The growth rate of all these major carps is slower in Getalsud reservoir as compared to the same in other similar bodies of water for which are available.

Spawning frequency of minor carps and other small sized fishes was determined by a study of the ova diameter frequency & condition factor with and without gonads and were found to have a prolonged breeding season. While breeding does occur in non-monsoon months, the flood season constitutes the main spawning period . This is further corroborated by the easy availablity of their hatchlings in the reservoir during the monsoon season.

Date on fecundity of eight minor carps and small-sized fishes are given. Relationship of length and fecundity was found to be curvilinear. The logarithmic form of this relationship in respect of 6 species is given.

The exotic Silver carp, Hypophthalmichthys molitrix was introduced in Getalsud reservoir in March 1974. A number of recoveries were made at a later date. The fish registered a net growth of 4.3 kg in 2 years 4 months.

Another recovery showed even a higher net growth of 4.7 kg in 27 months. This indicates the potential role of silver carp in the development of fisheries in the reservoir. Silver carp in this reservoir significantly fed mostly on phytoplankton and particularly on Microcystis. The Length-weight relationship of this fish was calculated to be Log W = 3.2777 Log L - 5.8053.

A total of about 31.5 lakh young ones of Gangetic major carps were stocked in the Getalsud reservoir in the seven year period starting 1974-75. Considering the average area of the reservoir to be 2210 hectares, the average stocking rate of major carps was 203 fingerlings per hectare per year.

Experiments on cage culture in Getalsud reservoir indicate that spawn can be reared in cages to fingerling size before release in the reservoir.

1. RECOMMENDATIONS FOR DEVELOPMENT AND CONSERVATION OF FISHERIES OF GETALSUD RESERVOIR

1. The Gangetic major carps, catla, rohu and mrigal, stocked in the reservoir have not yet started breeding. Their stocking is therefore to be continued. Spawning of Labeo calbasu during the South West monsoon of 1981 has been observed for the first time but its natural recruitment is still somewhat low and hence stocking of this species is also to be continued. However, it needs to be ensured that fingerlings of a proper size (100 mm) are stocked and their species-wise record maintained.

2. The proportion of major carps in the catches in still somewhat low and to stocking rate may be increased to 400/ha/year the ratio of Catla, mrigal, calbasu and rohu being 10:5:4:1.

3. The reservoir abounds in trash fishes and this abundance is partly due to the absence of major catfishes from the reservoir . Trash fish population can be put under some control only by large scale drage netting round the year.

4. The exotic common carp was stocked in the reservoir but did not form a Fishery. Further stocking of this fish may therefore be stopped.

5. Molluscan fauna at the bottom remains largely unutilised at present. It is suggested that Pangasius pangasius may ve transplanted to utilise this food resource. In this purpose about 5000 P. pangasius fingerlings are stocked per year.

6. Observations on the growth of silver carp have indicated that the species would be a welcome addition to the existing fauna of the reservoir. Since subernarekha river constitutes a small, independent, river system drainging directly into the Bay of Bengal, there is no risk of this exotic fish entering into other important systems. It is therefore suggested that silver carp may also be transplanted in the reservoir at the rate of 5 to 6 per hectare. The stocking may be done regularly at 20,000 fingerlings/year for a period of 5 years. A total ban on its exploitation during the first three years may also be imposed to enable it to establish itself in the reservoir. Introduction of silver carp will also help in the utilisation of Microcystis which abounds in the reservoir but which at present remains largely unutilised as food of fish.

7. The present method adopted for commercial fishing is by auctioning the fishing rights to a contractor who is not willing to part with the data on catches. Since data on commercial catches are required for an assessment of the fisheries , some other suitable method which ensures a study of the entire catch before disposal may be adopted. It is therefore strongly recommended that the present mode of exploitation be changed as early asp possible.

8. Based on results of experimental fishing gill nets of the following mesh bars are suggested for exploitation of different species of fish.

Species	Mesh bar (mm)
Catla catla	80-1[illegible]
Cirrhinus mrigala	50- 90
Labeo calbasu	40- 75
Labeo rohita	40- 90
Minor carps a trash fishes	20- 55

9. The gangetic major carps of the reservoir migrate up-stream beyond the lotic sector during the first few floods and are killed indiscriminately by the local population. Action may be taken to prevent this destructionly declaring closed season and strictly following the same.

10. The reservoir has a good tribal population all along its periphery who indulge in poaching. They need to be organised into cooperation and entrusted fishing rights. This would help establish them and improve their economic lot.

11. The adverse effects of Heavy Engineering Corporation and other factories in the area as well as that of the city sewage which are discharged into the river before it joins the reservoir, are not noticeable at present. The same however are to be periodically monitored and remedial action taken if necessary.

12. Fry may be reared to fingerling size, before release in the reservoir, in cages if the existing facilities at Maheshpur fish farm and considered inadequate for this purpose. The enumeorous packets on the right bank of the reservoir in the lontic zone near domestic are suitable for fixing cages.

22. Suggestions for future work

It is suggested that work on the following programmes may be taken up to enable assessment of its fisheries in future.

1. Collection of data on total and specieswise catch of all commercially important species during different months and catchsper unit of effort.

2. Length frequency of all commercially important species of fish.

3. Determination of spawn quality and quantity above the lotic zone where the Subernarekha joins the reservoir.

4. Study of biology of the stocked gangetic major carps with particular reference to age and growth, gonadal development, fecundity and spawning.

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25. PUBLICATIONS

Based on the work done under the Project, the following manuscripts are now reader for publication :

Bhatnagar, G.K., S.N. Singh and A.K. Ekka
Ichthyofauna of Getalsud reservoir.

Bhatnagar, G.K. and A.K. Ekka
The food of trash fishes of Getalsud reservoir.

____
On some aspects of the biology of trash fishes of Getalsud reservoir.

Gupta, B.P. and J.N. Pal
Occurrence of thermocline in Getalsud reservoir of Bihar.

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Hydrology of Getalsud reservoir of Bihar.

Gupta, B.P.
Studies on primary production Getalsud reservoir of Bihar.

Singh, S.N.
Seasonal and sectoral variations in plankton population of Getalsud reservoir, Ranchi Part-I. Phytoplankton.

____
Seasonal and sectoral variations in plankton population of Getalsud reservoir, Ranchi. Part- II. Zooplankton.

____
Observations on macro-benthos abundance in Getalsud reservoir, Ranchi.

TABLE - I

Chemical characteristics of soil of Getalsud reservoir
1975 - 1980

	PRE-MONSOON Sector			POST-MONSOON Sector		
	Lentic	Intermediate	Lotic	Lentic	Intermediate	Lotic
pH	6.0	6.0	6.1	6.2	6.3	6.2
Organic carbon %	0.60	0.58	0.46	0.53	0.52	0.35
Available Nitrogen (mg/100 g)	32.35	33.71	31.08	35.06	28.92	24.38
Available phosphorus (mg/100 g)	5.21	7.06	3.52	3.73	6.08	2.45

TABLE - II

Chemical features of surface water of Getalsud reservoir

Seasonal quarters	Dissolved oxygen (ppm)	pH	Free CO_2 (ppm)	Calcium (ppm)	Magnesium (ppm)	Organic matter (ppm)
Oct'77-Dec'77	7.4	7.3	3.4	5.3	4.1	1.8
Jan'78-Mar'78	9.6	7.7	3.9	8.6	3.5	1.8
Apr-Jun	7.0	7.9	2.0	11.1	3.5	1.4
Jul-Sept	6.9	7.6	2.3	7.8	4.6	4.3
Oct-Dec	7.8	7.6	2.3	10.2	4.1	2.9
Jan'79-Mar'79	8.7	7.6	2.4	7.8	6.6	1.6
Apr-Jun	7.3	8.2	2.1	14.3	6.2	1.0
Jul-Sept	7.2	7.5	5.2	12.0	4.9	1.4
Oct-Dec	7.9	7.8	3.6	12.3	5.9	-
Jan'80-Mar'80	7.7	7.7	4.5	8.9	4.1	-
Apr-Jun	6.4	8.2	0.6	18.8	8.8	2.5
Jul-Sept	5.8	7.4	15.1	13.3	8.6	3.0
Oct-Dec	6.4	7.4	9.4	14.5	7.5	2.7

TABLE - III

Chemical stratification during summer months in Getalsud reservoir

Depth (m)	APRIL 1975					MAY 1975					JUNE 1975				
	D.O. (ppm)	pH	CO_2 (ppm)	HCO_3 (ppm)	Sp.cond. (micro-mhos)	D.O. (ppm)	pH	CO_2 (ppm)	HCO_3 (ppm)	Sp.cond. (micro-mhos)	D.O. (ppm)	pH	CO_2 (ppm)	HCO_3 (ppm)	Sp. Cond (micro-mhos)
S	8.8	7.6	3.0	40.0	119.9	6.8	7.2	2.0	43.0	125.9	5.6	7.2	9.0	42.0	105.0
1	8.4	7.6	3.0	40.0	119.9	6.8	7.2	2.0	43.0	125.9	5.6	7.0	9.0	42.0	105.0
2	8.3	7.6	3.5	40.0	119.9	6.6	7.2	3.0	43.0	125.9	5.6	7.0	9.0	42.0	105.0
3	8.0	7.6	4.0	40.0	119.9	6.6	7.2	3.0	43.0	125.9	5.6	7.0	9.0	42.0	105.0
4	8.0	7.5	4.5	39.0	119.9	6.4	7.2	3.0	43.0	125.9	5.4	7.0	9.0	42.0	105.0
5	8.0	7.4	4.5	39.0	119.9	6.4	7.2	3.0	43.0	119.9	5.4	7.0	9.0	40.0	102.7
6	8.0	7.2	5.1	38.0	119.9	4.8	7.0	5.0	43.0	119.9	5.2	7.0	10.0	40.0	102.7
7	7.8	7.2	5.1	38.0	119.9	4.8	7.0	5.0	40.0	119.9	5.2	7.0	10.0	40.0	102.7
8	7.5	7.1	5.1	38.0	119.9	4.8	7.0	5.0	40.0	119.9	3.2	7.0	10.0	40.0	102.7
9	6.0	7.0	5.1	38.0	110.6	4.8	7.0	5.0	40.0	119.9	3.2	7.0	12.0	40.0	102.7
10	5.5	7.0	5.1	38.0	110.6	4.8	7.0	5.0	39.0	119.9	3.2	6.8	12.0	40.0	102.7
11	5.0	7.0	5.1	38.0	110.6	2.4	7.0	6.0	39.0	117.9	1.2	6.8	12.0	40.0	102.7
12	4.8	7.0	5.1	38.0	110.6	2.4	7.0	6.0	39.0	117.9	1.2	6.8	12.0	40.0	102.7
13	4.8	7.0	5.1	38.0	110.6	2.4	7.0	6.0	39.0	117.9	1.0	6.6	14.0	40.0	102.7
14	4.8	7.0	5.1	38.0	110.6	2.4	6.8	7.0	39.0	117.9	1.0	6.6	14.0	40.0	102.7
15	4.8	7.0	5.1	38.0	110.6	2.4	6.8	7.0	39.0	117.9	0.9	6.6	16.0	40.0	102.7
16	4.8	7.0	5.1	37.0	110.6	2.4	6.8	7.0	39.0	117.9	0.8	6.6	16.0	38.0	102.7
17	4.8	7.0	6.0	37.0	110.6	2.0	6.8	7.0	39.0	117.9	0.8	6.6	16.0	38.0	102.7
18	4.8	7.0	6.1	36.0	110.6	2.0	6.6	8.0	36.0	116.9	0.8	6.6	16.0	38.0	102.7
19	4.8	6.9	6.1	36.0	110.6										
20	4.8	6.9	6.1	36.0	110.6										
21	4.8	6.8	6.1	36.0	110.6										

TABLE - IV

Year-wise average plankton production (ml/m^3) in different sector of Getalsud reservoir, Ranchi

Sector	1976-77			1977-78			1978-79			1979-80		
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Lotic	8.430 (may)	0.362 (Aug)	2.176	6.710 (may)	0.300 (Aug)	2.020	3.090 (Oct)	0.118 (Sept)	1.223	1.852 (Jun)	0.267 (Jul)	0.771
Intermediate	4.000 (Apr)	0.186 (Sept)	1.108	2.910 (Oct)	0.330 (Aug)	0.960	2.880 (Oct)	0.308 (Sept)	0.818	1.925 (Jun)	0.188 (Aug)	0.679
Lentic	4.749 (Apr)	0.186 (Sept)	1.185	1.040 (Jun)	0.170 (Aug)	0.630	0.936 (Nov)	0.166 (Sept)	0.473	2.092 (Feb)	0.225 (Dec)	0.896
Reservoir as a whole			1.490			1.203			0.838			0.782

TABLE - V

Effect of effluents of Heavy Engineering Corporation Factory on water quality of Subernarekha River

	Hatia Reservoir I	Hatia bridge II	Burning ghat III	Namkum bridge IV
Dissolved oxygen (ppm)	7.2- 9.8	4.4- 4.8	7.4- 8.0	8.0- 8.4
pH	7.5	7.1- 8.2	7.2 8.5	7.2- 8.1
Free CO_2 (ppm)	3.0- 4.6	2.6- 8.0	0.0- 4.6	1.8- 9.0
Total alkalinity (ppm)	30.0- 36.0	58.0- 62.0	46.0- 56.0	53.0-56.0
Organic matter (ppm)	0.5- 1.7	2.6- 4.8	0.8- 6.0	2.0- 7.0
Silica (ppm)	3.4- 7.0	4.2- 6.0	3.6- 7.0	3.6- 7.6
Specific conductivity (micro-mhos)	106.9-126.3	220.5-232.5	231.6-330.6	278.0-315.9

TABLE - VI

Average monthly fluctuations in Periphyton of Getalsud reservoir

Groups	MONTHS										
	Apr	May	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Myxophyceae	20.77	5.31	10.61	6.90	6.25	2.97	2.25	2.14	1.33	-	5.60
Chlorophyceae	12.88	38.41	40.70	30.45	27.04	21.65	37.13	20.84	24.11	24.73	22.32
Bacillariophyceae	61.99	47.95	33.70	28.73	34.41	53.65	42.46	34.26	53.37	42.40	51.98
Animalcules	4.07	7.47	10.41	32.52	9.92	16.55	15.09	20.42	13.69	19.32	16.20
Miscellaneous	1.09	0.86	4.58	1.40	23.38	5.18	3.07	22.34	7.50	13.55	3.90
Average unit/cm^2	690	848	873	1056	1063	715	1235	1745	1045	1069	1732

TABLE - VII

Seasonal abundance of periphyton and its vertical distribution per sq cm in Getalsud reservoir

Depth (m)	Summer Apr-Jun	Monsoon Jul-Sept	Post-monsoon Oct-Nov	Winter Dec-Jan	Spring Feb-Mar
S	1650	1978	2143	2530	2550
1	939	2009	2060	2313	2231
2	1200	1707	1852	2340	2335
3	1282	994	1139	2593	2102
4	1103	983	1118	1703	1789
5	706	911	1014	1641	1721
6	1025	880	939	1160	1883
7	1206	749	824	944	1234
8	1825	835	848	878	944
9	546	343	616	770	958
10	99	310	372	411	535
11	62	137	406	450	494
12	237	-	411	473	370
13	234	-	385	-	-

TABLE - VIII

Species composition of the catch landed during experimental fishing in Getalsud reservoir (1977-78 to 1980-81)

Species	1977-78		1978-79		1979-80		1980-81	
	Landings (kg)	%	Landings (kg)	%	Landings (kg)	%	Landings (kg)	%
Notopterus notopterus	0.760	2.17	1.050	1.99	3.560	1.68	1.630	0.95
Salmostoma bacaila	-	-	-	-	0.345	0.16	0.620	0.36
Catla catla	17.750	50.70	2.000	3.78	7.750	3.66	22.450	13.08
Cirrhinus mrigala	8.760	25.02	15.710	29.73	50.445	23.79	53.505	31.17
C. reba	0.890	2.54	2.200	4.17	23.706	11.18	17.590	10.25
Labeo bata	2.630	7.51	26.405	49.97	31.475	14.84	4.700	2.74
L. calbasu	0.700	2.00	3.200	6.05	21.335	10.06	13.840	8.06
L. dyocheilus	-	-	-	-	-	-	1.300	0.75
L. rohita	0.800	2.28	0.325	0.61	3.900	1.84	17.550	10.22
Osteobrama cotio cotio	-	-	0.128	0.24	14.022	6.61	6.245	3.64
Puntius sarana	0.310	0.89	0.550	1.04	35.990	16.97	13.265	7.73
Ompok pabda	2.110	6.03	1.225	2.32	14.926	7.04	13.130	7.65
Rhinomugil corsula	0.300	0.86	-	-	1.220	0.57	0.545	0.32
Channa punctatus	-	-	-	-	-	-	0.875	0.50
Glossogobius giuris	-	-	0.050	0.10	1.130	0.53	0.365	0.21
Mastocembelus armatus	-	-	-	-	2.260	1.07	4.065	2.37
Total	35.010		52.843		212.064		171.675	

TABLE - IX

Catch (in g)/ meter square of net/day in different mesh during 1977-78 to 1980-81

Mesh bar (mm)	Catch/m^2 in grams			
	1977-78	1978-79	1979-80	1980-81
20	9.79	0.41	1.08	1.03
25	-	3.53	1.47	1.70
30	6.65	2.23	1.25	1.54
35	2.17	8.33	1.51	1.77
40	1.14	1.07	6.26	7.53
45	3.46	1.92	4.94	2.66
50	-	-	2.32	3.21
55	-	-	2.29	2.37
60	6.86	6.97	-	-
65	-	-	-	2.24
75	-	-	-	5.49
85	-	-	-	1.64
90	38.88	-	-	8.84
105	8.45	2.20	-	-
120	63.53	-	-	-
150	-	-	-	9.46

* Nets in which no fish was caught have not been taken into consideration.

TABLE - X

Size of major carps and ohter fishes caught in various mesh bars during experimental fishing in Fetalsud reservoir from 1977-78 to 1980-81

Mesh bar (mm)	Length range (mm)				Other fishes
	C. catla	C. mrigala	L. calbasu	L. rohita	
20	-	201-273	141.296	-	C.reba, O.pabda, O.cotio cotio, G.giuris, M.armatus, S.bacaila, C.punctatus,
25	-	200-283	233-320	-	C.reba, L.bata, S.bacaila, G.giuris, L. dyocheilus
30	-	341-494	172-355	487	O.pabda, N.notopterus, L.bata, C.reba, P. sarana, M.armatus, L.dyocheilus, C.punctatus,
35	271-	300-513	225-395	251-415	L.bata, O.pabda, C.reba, N.notopterus, P. sarana,
40	-	320-401	250	-	O.pabda, R.corsula, N.notopterus, L. bata
45	-	301-657	245-290	330-339	L.bata, N.notopterus, O.pabda, R.corsula, P. sarana
50	493	331-601	294-435	490	L. bata
55	396-551	362-623	328-395	318-582	Nil
60	500	401-577	375	-	Nil
65	-	365-535	-	-	"
75	-	403-652	471-479	560-633	"
85	668-704	634	-	578-668	"
90	678	405-549	-	-	"
105	400-511	-	-	-	"
120	683-720	-	-	-	"
150	729				"

TABLE - XI

Size and number of fishes examined for study of biology

Sl. No.	Species	No. examined	Total length Range (mm)	Weight Range (gm)
1	Puntius ticto	245	22- 83	0.550- 8.187
2.	Puntius sophore	352	28-105	0.676-16.741
3.	Esomus danricus	299	23- 60	0.153- 1.582
4.	Salmostoma bacaila	365	21-155	0.050-14.784
5.	Amblypharyngodon mola	293	19-120	0.150-18.091
6.	Osteobrama cotio cotio	531	25-112	0.500-14.850
7.	Rhinomugil corsula	192	25-164	0.208.43.052
8.	Chanda nama	804	20-130	0.078-19.474
9.	Glossogobius giuris	137	20-160	0.147-35.552
10.	Danio (Brachydanio) rerio	138	18- 33	0.050- 0.600

TABLE - XII

Growth rate of Silver carp stocked in Getalsud reservoir, Ranchi

Date of capture	Length on the day of capture (mm)	Wt. on the day capture (gms)	Increase in size (mm)	Increase in Wt. (gm)	Period of growth (days)	Growth rate (mm/day)	Growth rate (gm/day)
10.9.74	375	400	298	393.2	178	1.67	2.20
23.8.75	583	2100	506	2093.2	525	0.96	3.98
12.6.76	750	4750	673	4743.2	819	0.82	5.79
25.7.76	785	4280	708	4273.2	862	0.82	4.95
29.7.76	785	4250	708	4243.2	866	0.82	4.89
29.7.76	792	4550	715	4543.2	866	0.82	5.24

Date of release of Silver carp in Getalsud reservoir = 15.3.1974

Average { Initial length = 77 mm; Initial weight = 6.8 gm } at the time of release

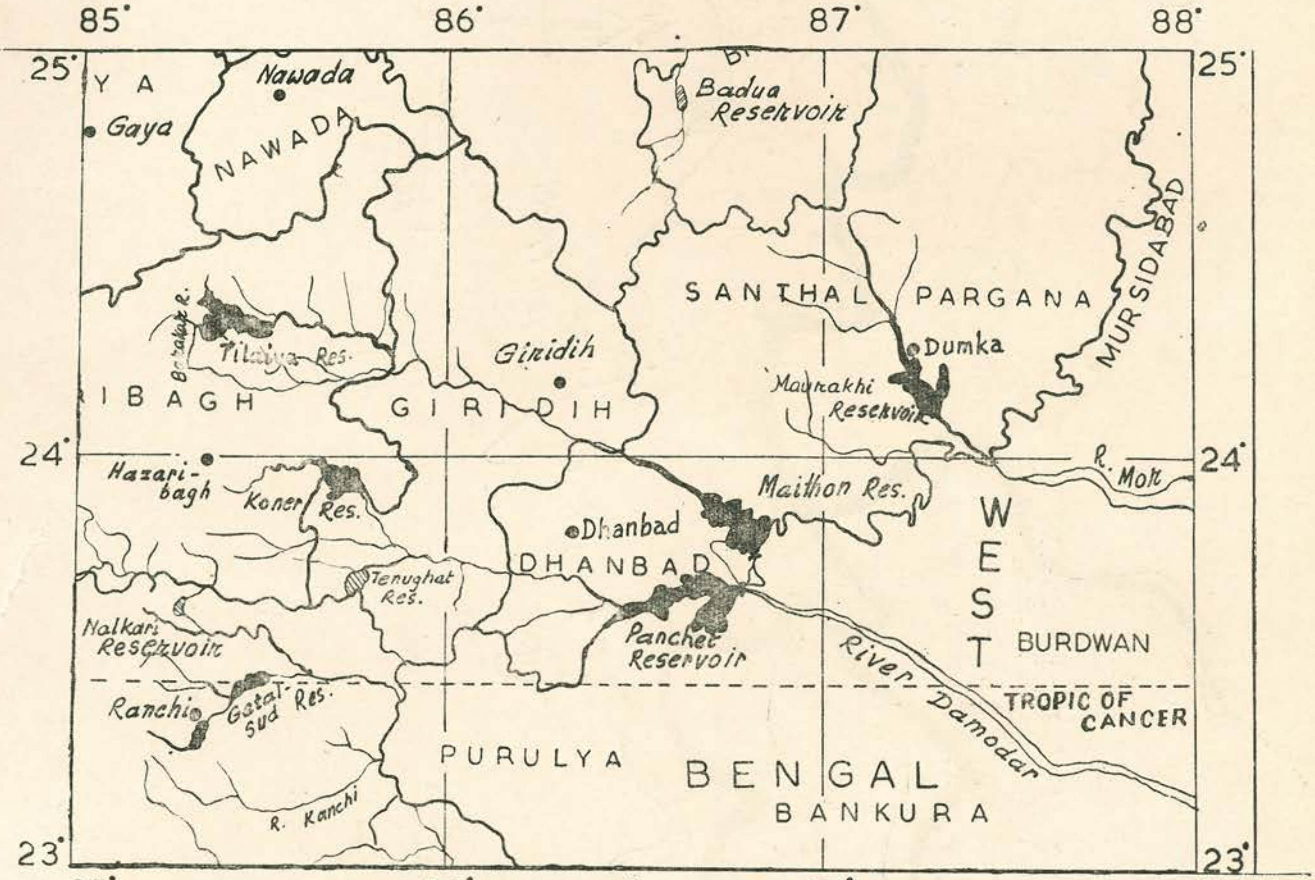


Fig. 1. Map showing the man made lakes in Bihar

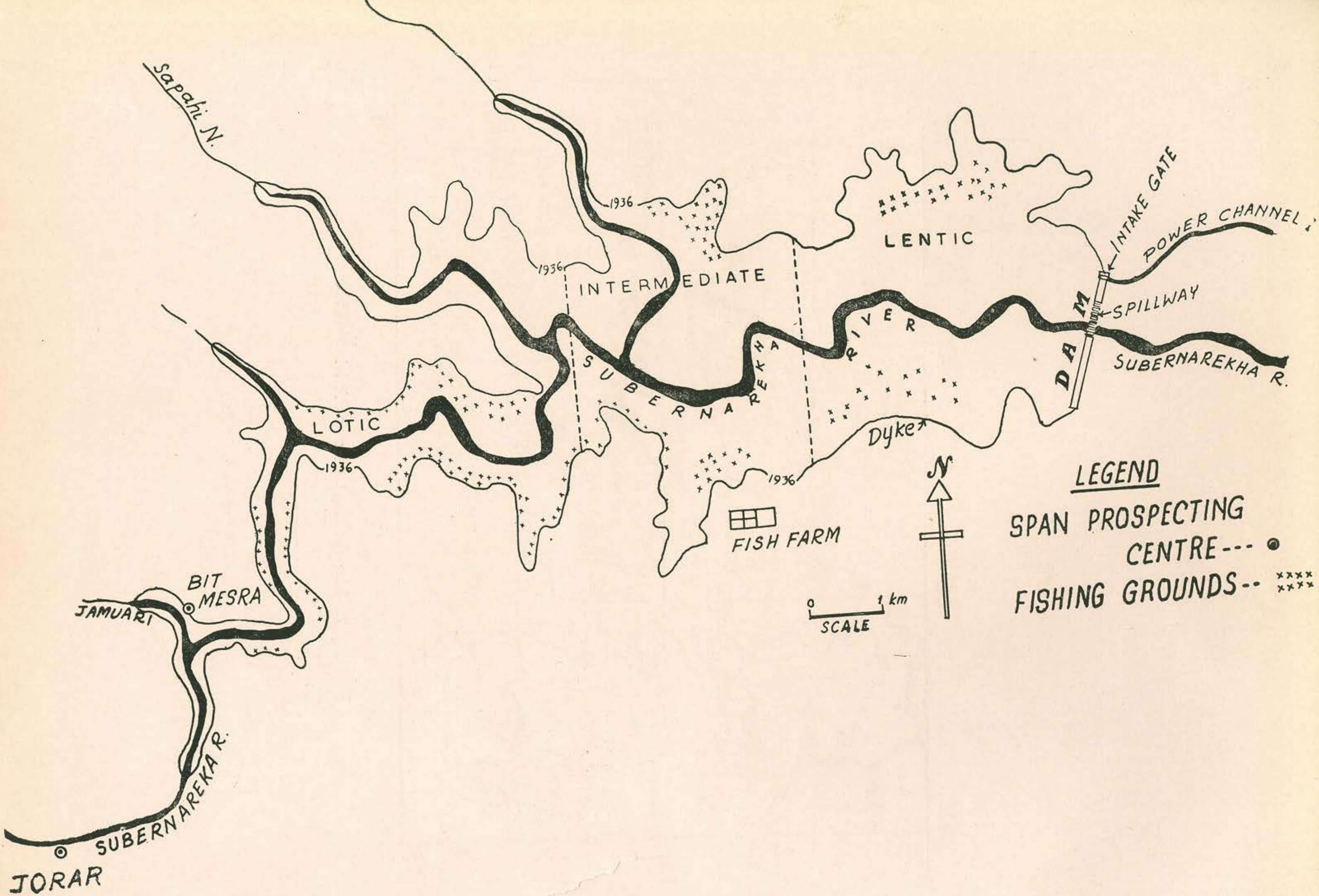


Fig. 2. Outline map of Getalsud Reservoir.

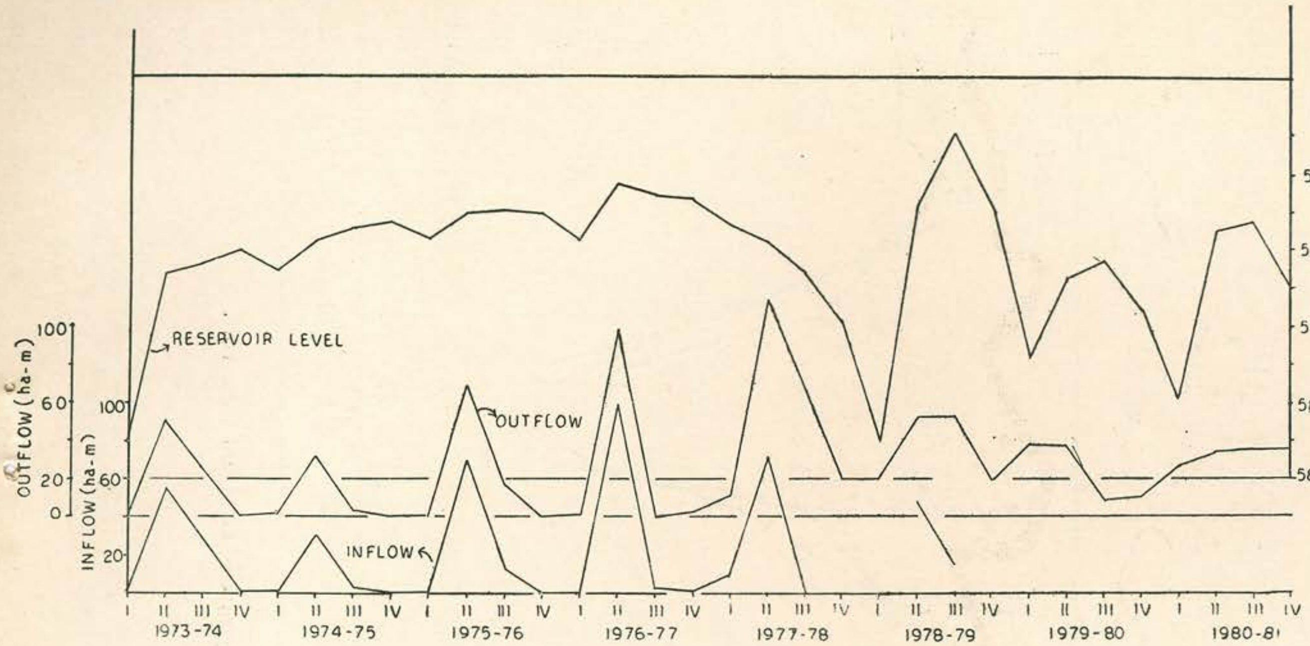


Fig. 3. Inflow (ha-m) outfall (ha-m) and reservoir level (meters above MSL) of Getalsud Reservoir during different quarters of the years 1973-74 to 1980-81. The first quarter is April to June.

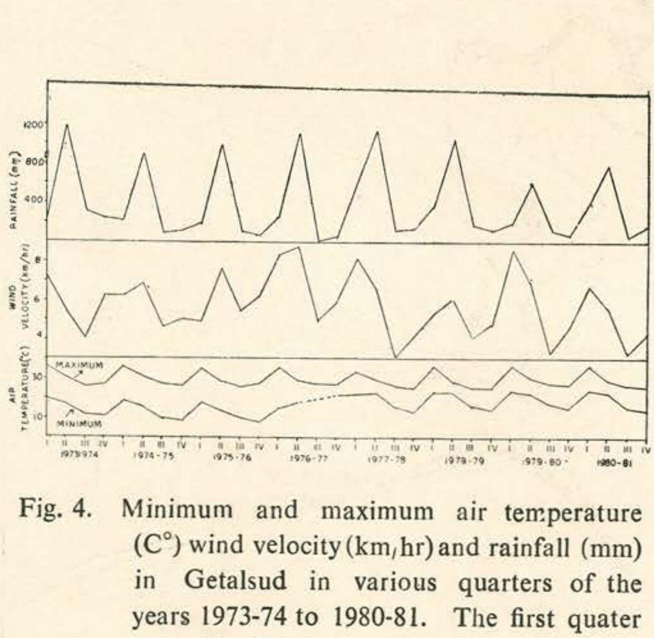


Fig. 4. Minimum and maximum air temperature (C°) wind velocity (km/hr) and rainfall (mm) in Getalsud in various quarters of the years 1973-74 to 1980-81. The first quater is April to June.

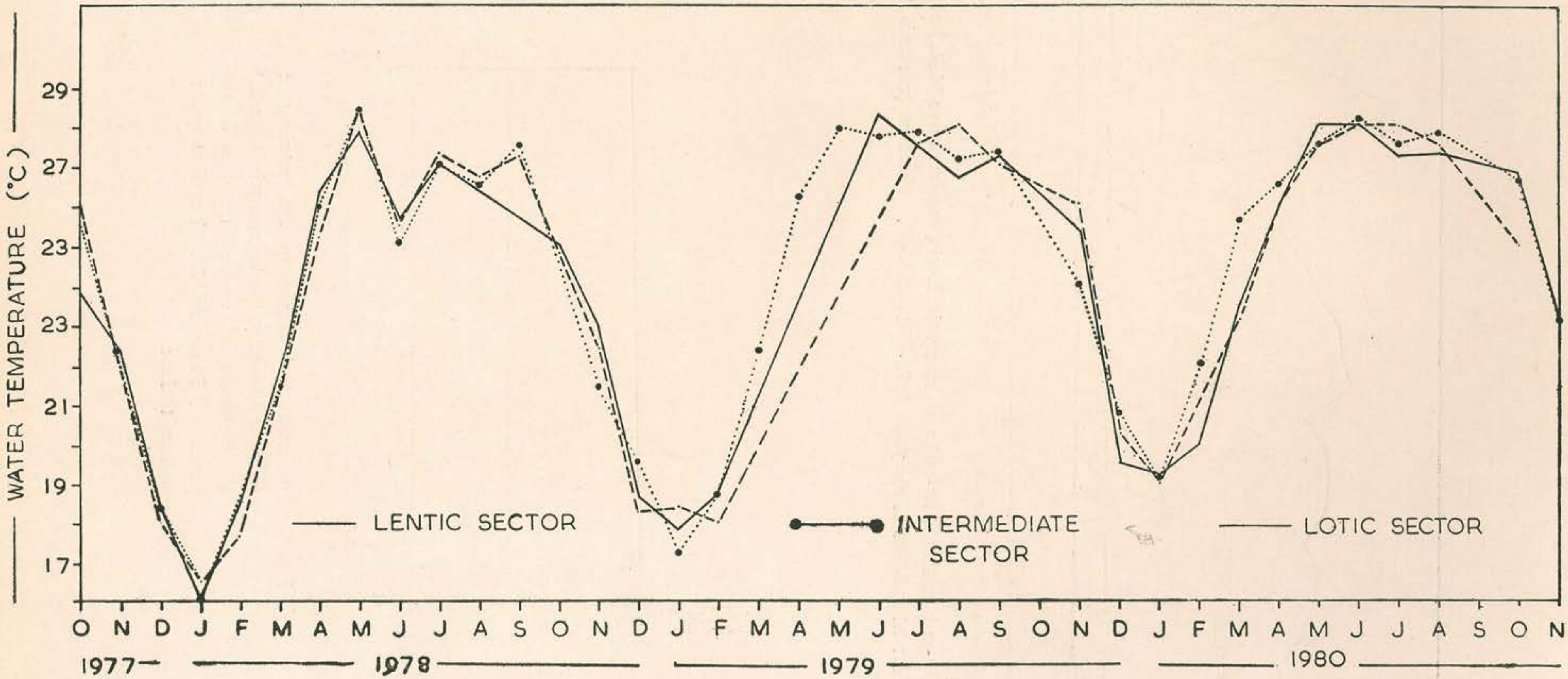


Fig. 5. Variations in surface water temparature in different sectors of Getalsud Reservoir.

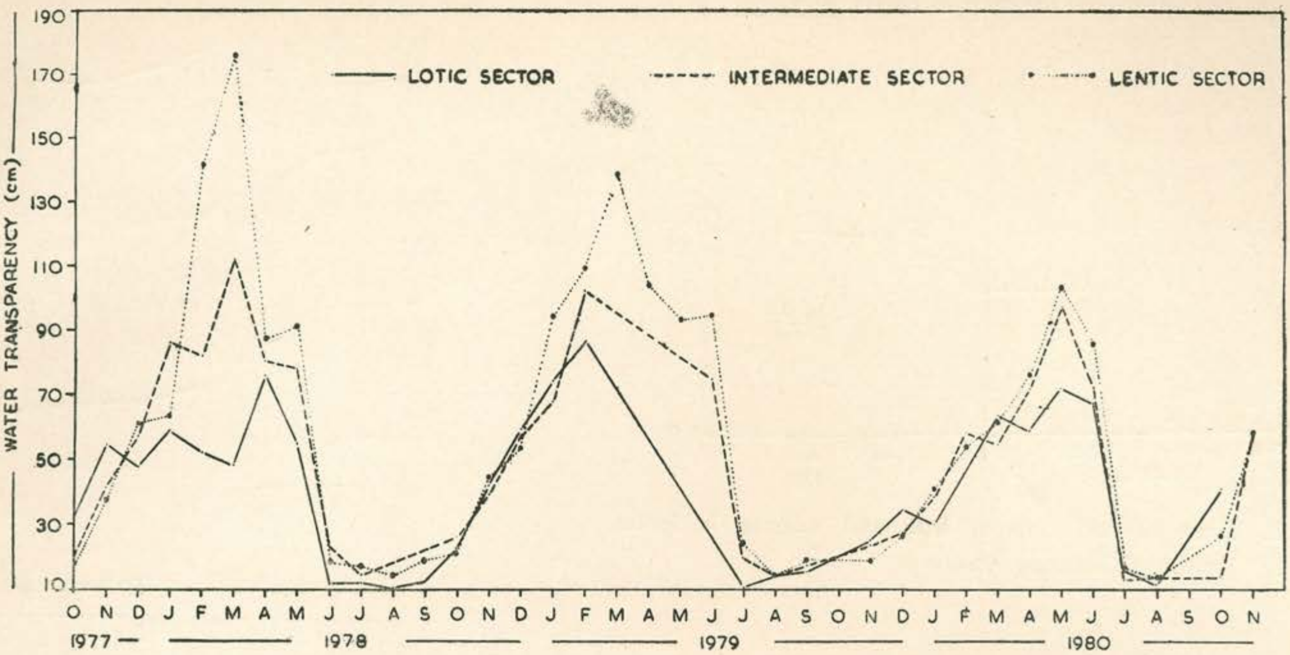


Fig. 6. Water transparency in different sectors of Getalsud Reservoir.

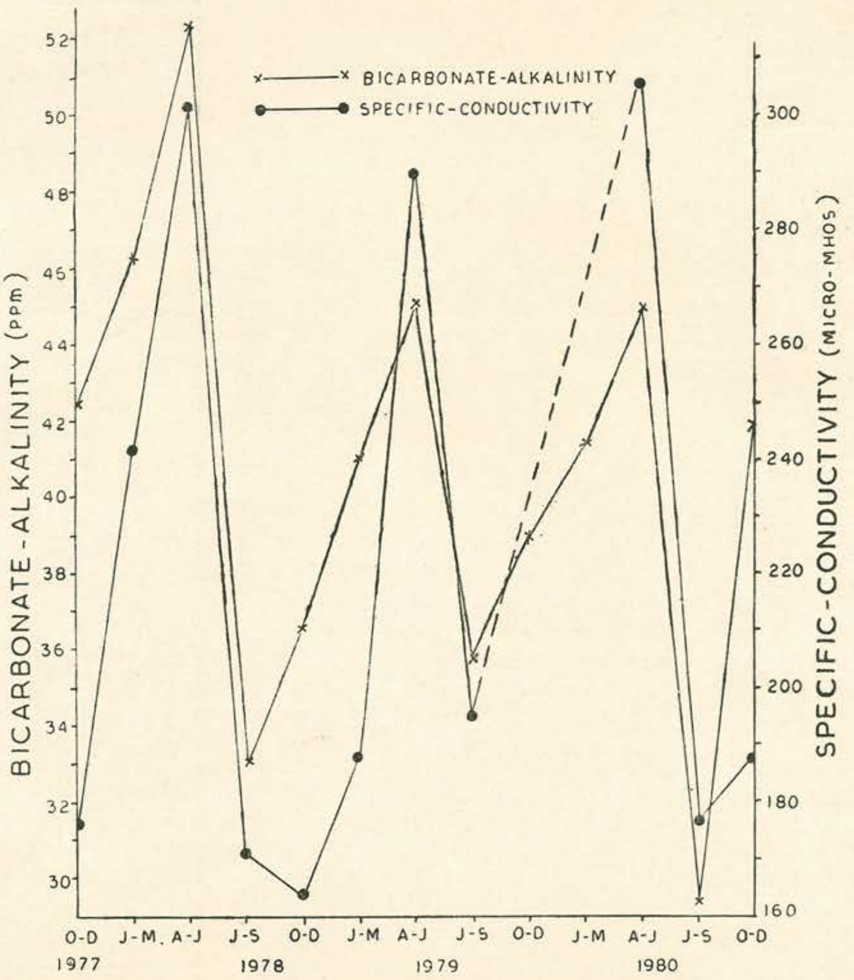


Fig. 7. Bicarbonate and specific conductivity relationship in different seasons in Getalsud Reservoir.

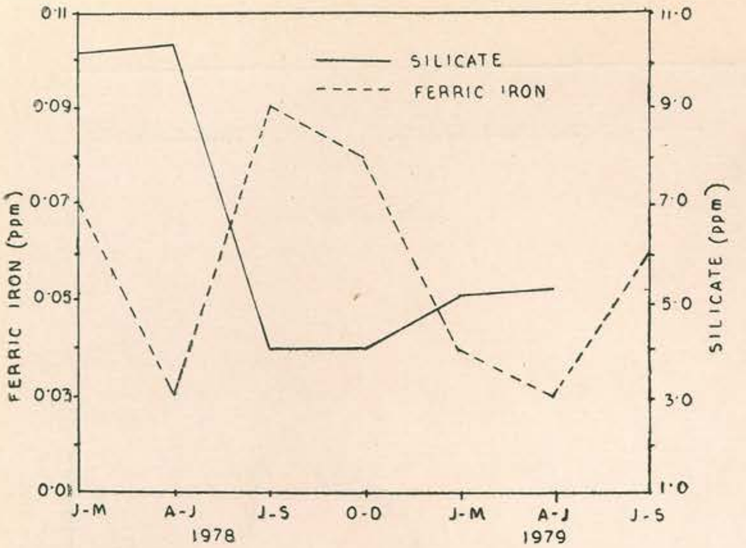


Fig. 8. Seasonal variations in iron und silicate in lentic sector of Getalsud Reservoir.

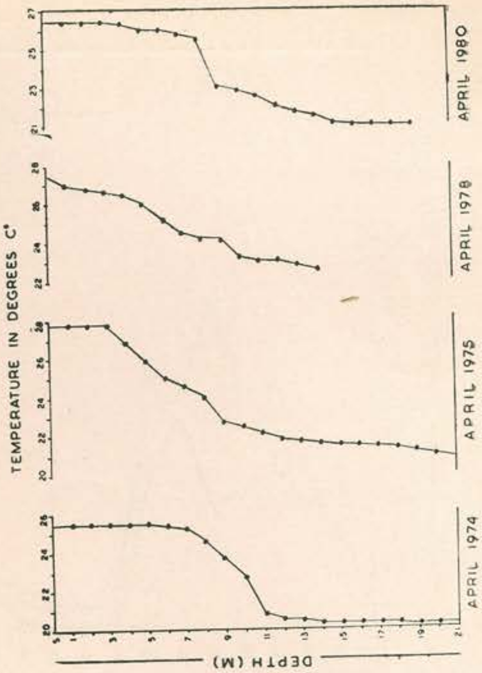


Fig. 9. Thermal strtification in Getalsud Reservoir.

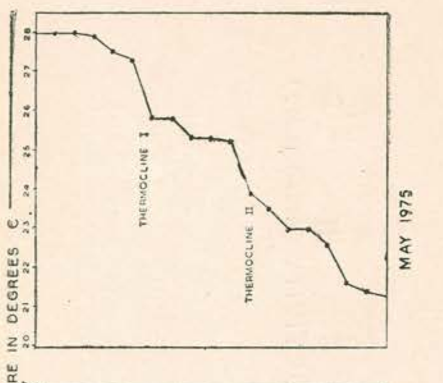


Fig 10. Two thermo clines in depth profile of Getalsud reservoir.

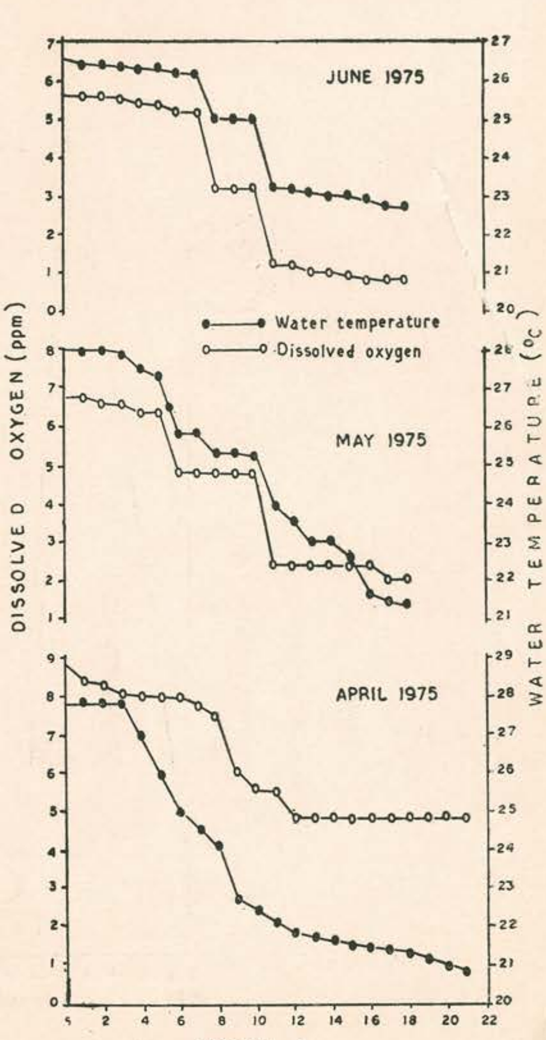


Fig. 11. Klinograde Oxygen curve of Getalsud Reservoir.

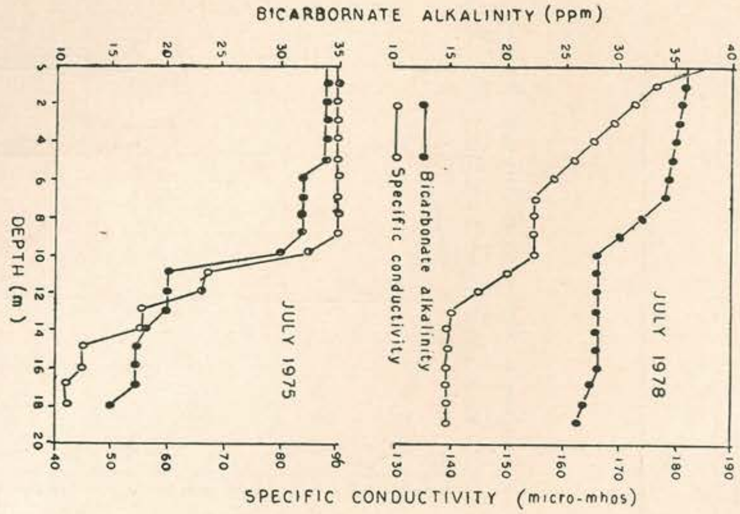


Fig. 12. Depthwise distribution of bicarbonate and specific conductivity in Getalsud Reservoir.

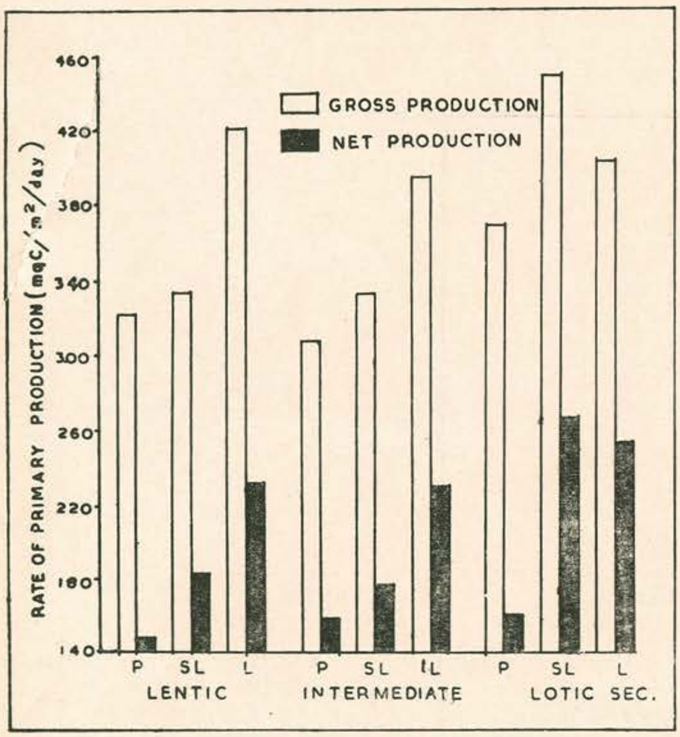


Fig. 13. Primary productivity in profundal (P) Sub-littorab (SL) and littoral (L) regions of the three sectors of Getalsud Reservoir (average value from Oct. 1977 to Dec. 1980.

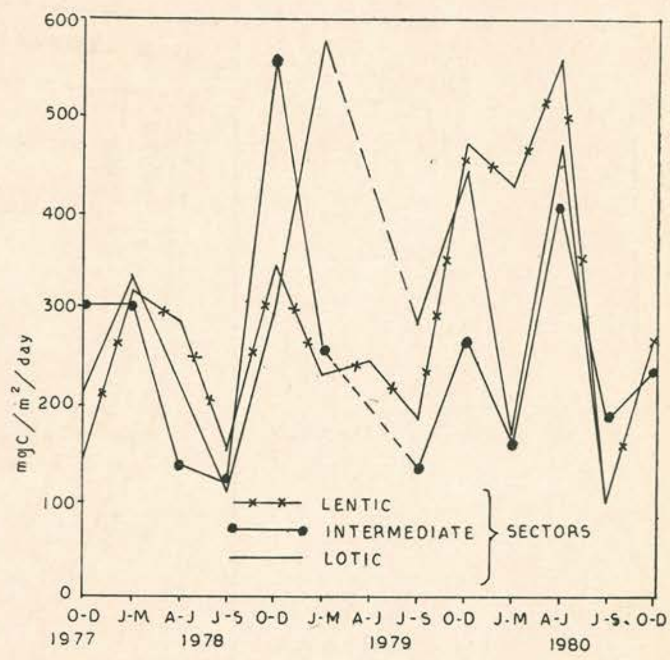


Fig. 14. Primary production in different seasons in Getalsud Reservoir.

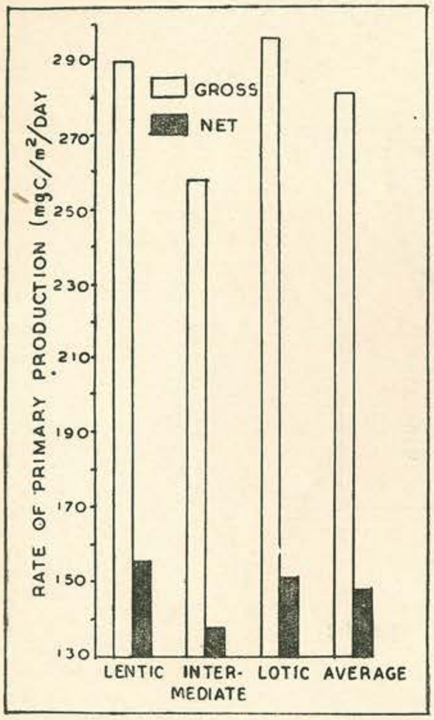


Fig. 15. Sectorwise primary production in Getalsud Reservoir (Average value from Oct. 1977 to Dec. 1980).

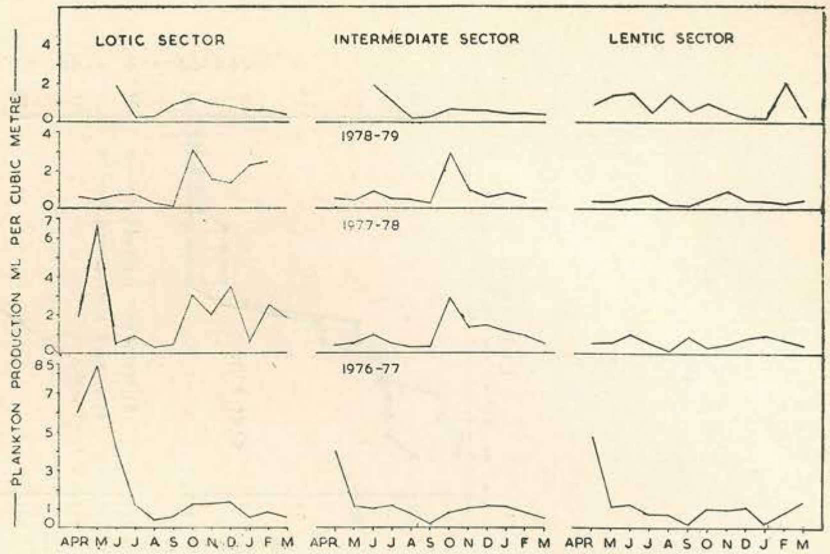


Fig. 16. Plankton density (ml/cum) in lotic and lentic sectors of Getalsud Reservoir for the period 1976-80.

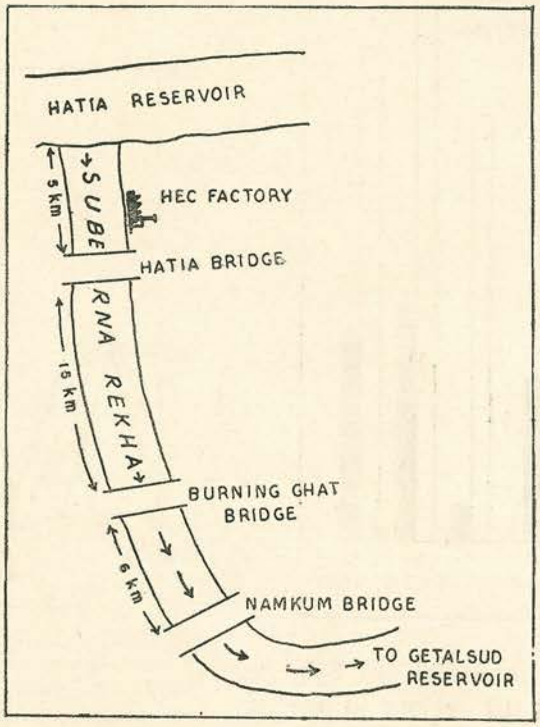
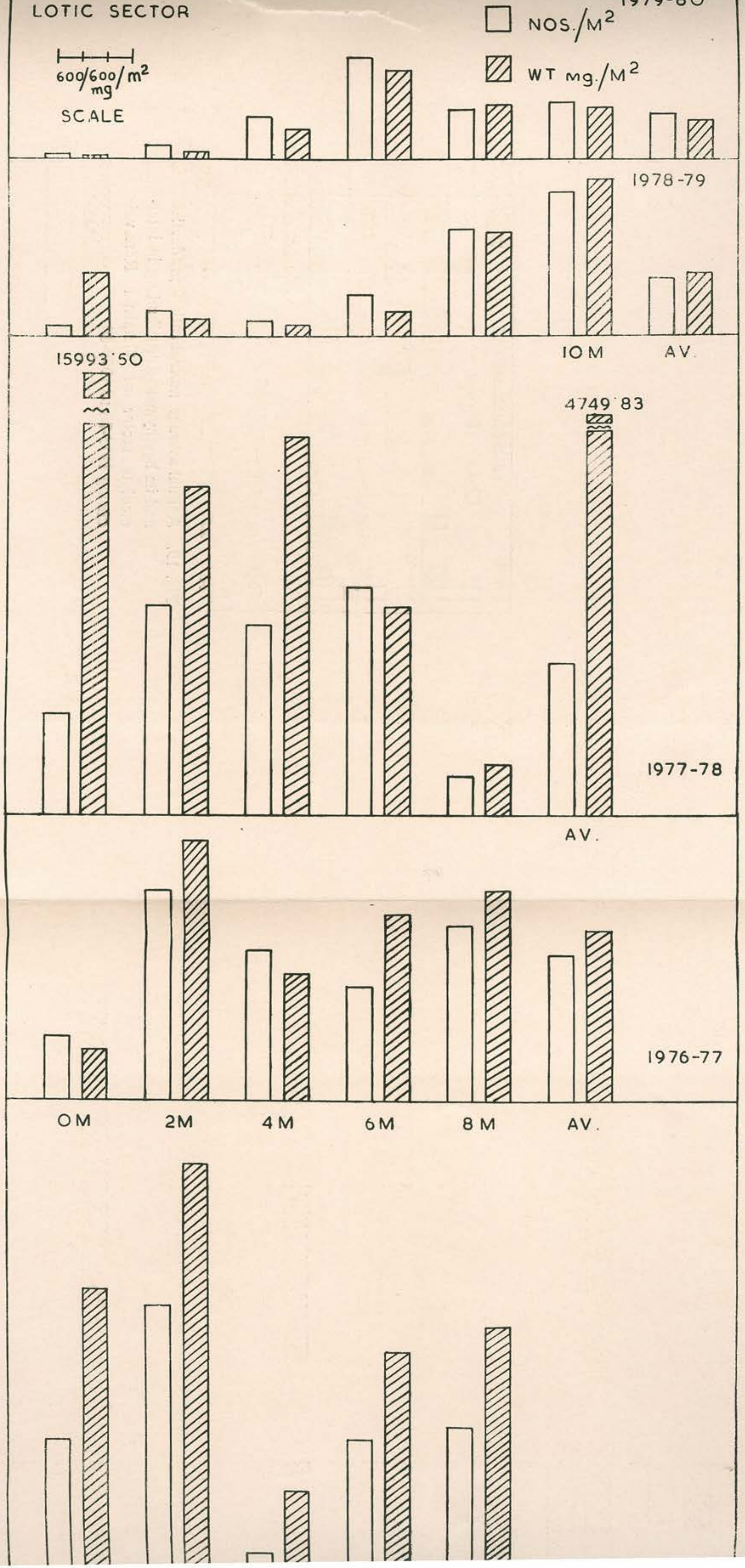


Fig. 17. Diagrammatic sketch showing the four points on subernareka riner where pollution study was done (not to scale).


LOTIC SECTOR
NOS./M²
WT mg./M²
1979-80
600/600/m² mg
SCALE
1978-79
10 M
AV.
15993·50
4749·83
1977-78
AV.
1976-77
OM
2M
4 M
6 M
8 M
AV.

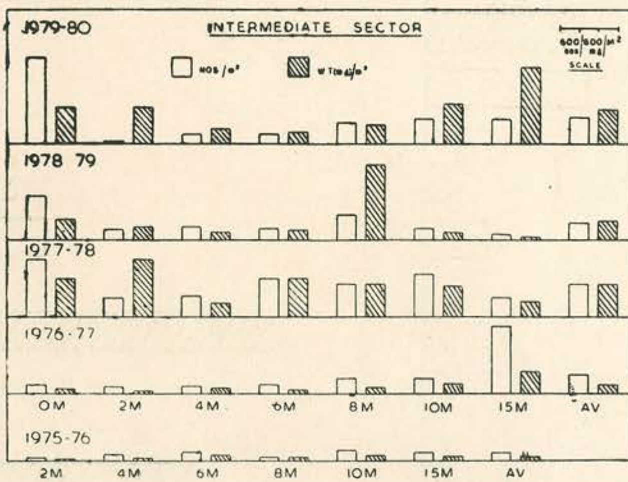


Fig. 19. Annual average macrobenthos production and its beathymetric distributions in intermediate sector of Getalsud Reservoir during 1975-76 to 1979-80.

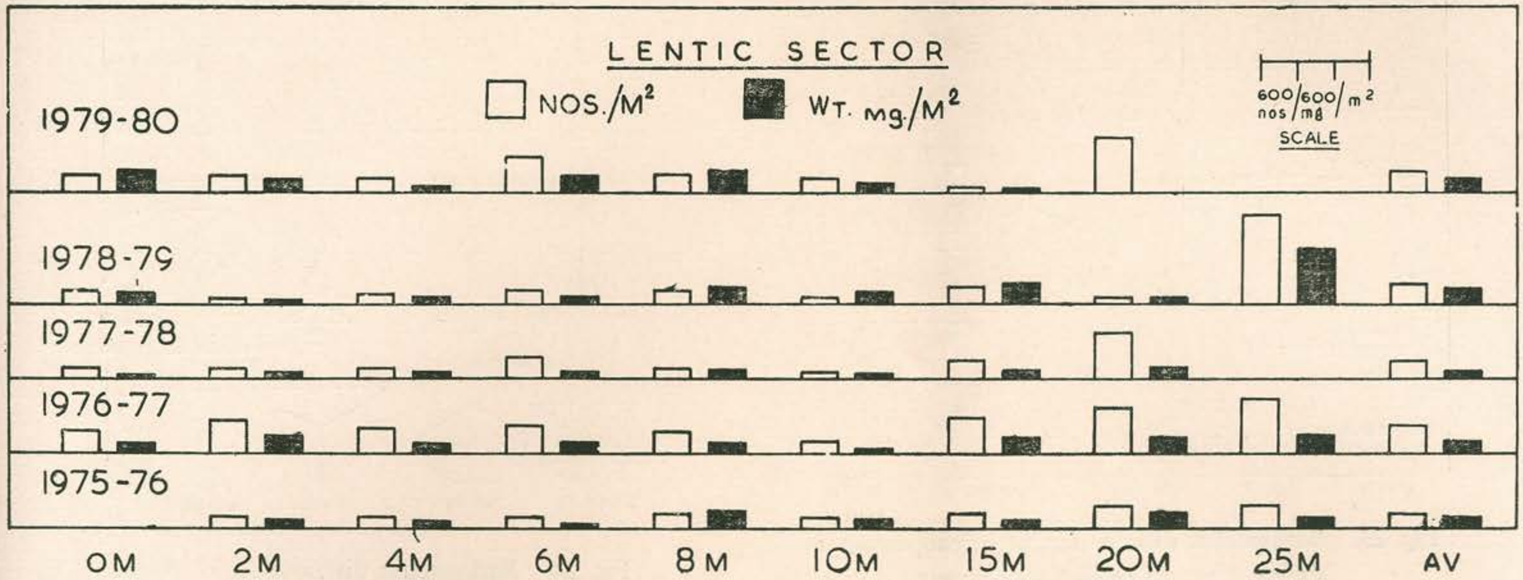


Fig. 20. Annual average macrobenthos production and its bathymetric distribution in lentic sector of Gentalsud Reservoir during 1975-76 to 1979-80.

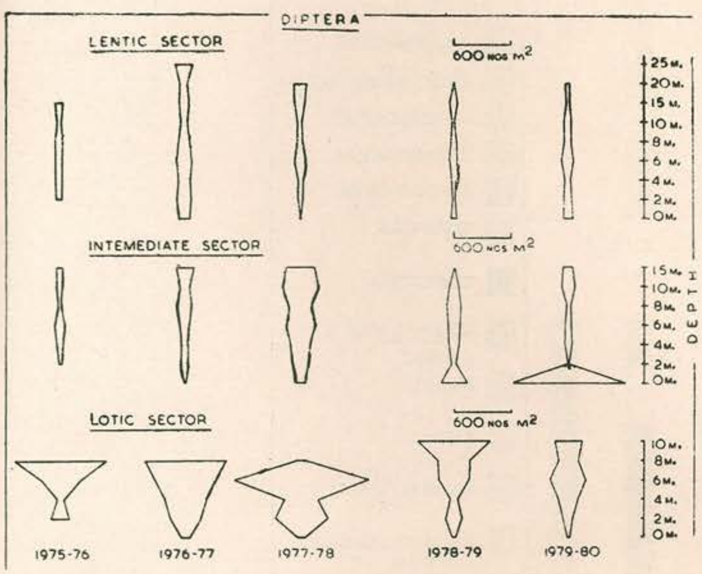


Fig. 21. Bathymetric distribution of dipteran population in different sectors of Getalsud Reservoir during 1975-76 to 1979-80.

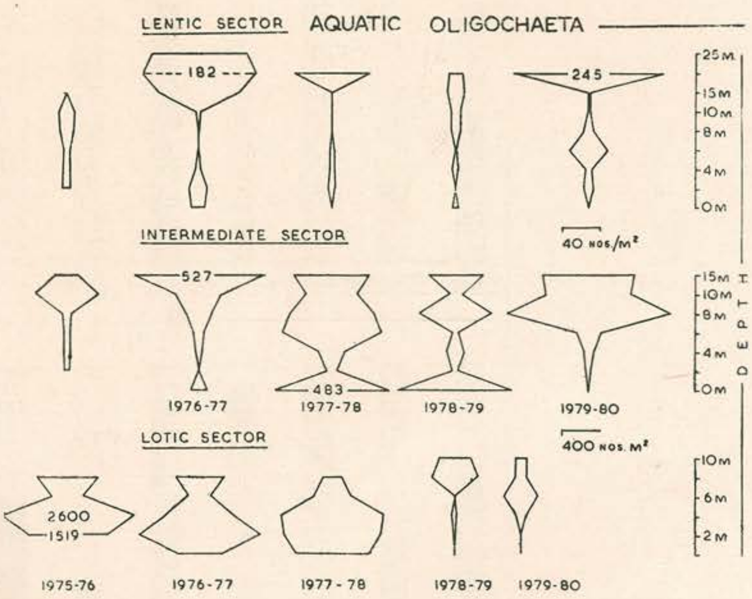


Fig. 22. Bathymetric distribution of aquatic oligochactes in different sectors of Getalsud Reservoir during 1975-76 to 1979-80.

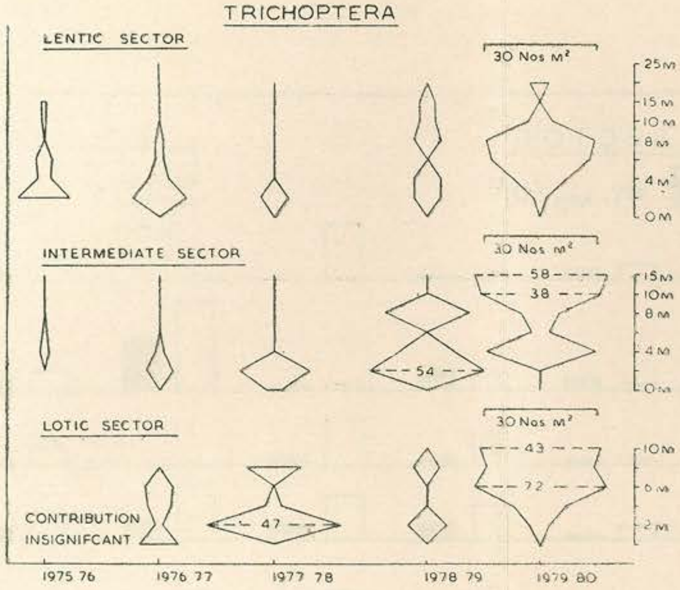


Fig. 23. Bathymetric distribution of trichopterans in different sectors of Getalsud Reservoir.

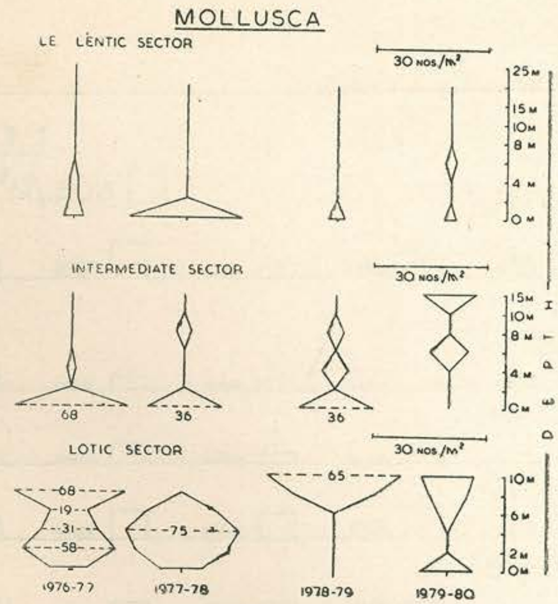


Fig. 24. Bathymetric distribution of Molluscans in different sectors of Getalsud Reservoir during 1975-76 to 1979-80.

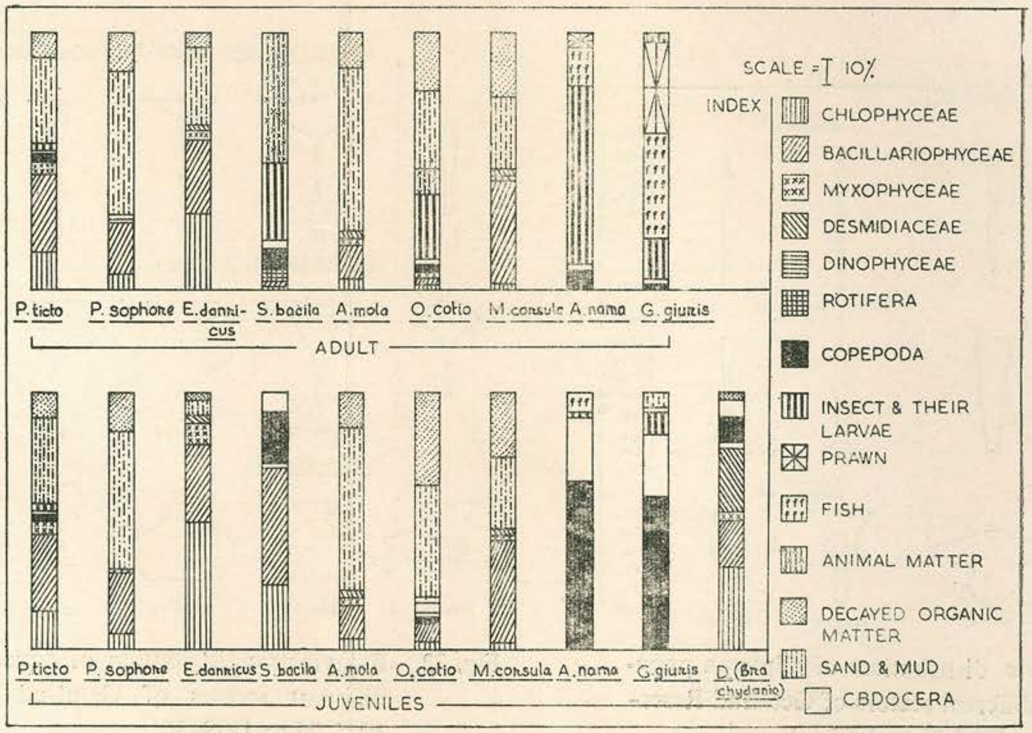


Fig. 25. Food Composition of fish of Getalsue Reservoir.

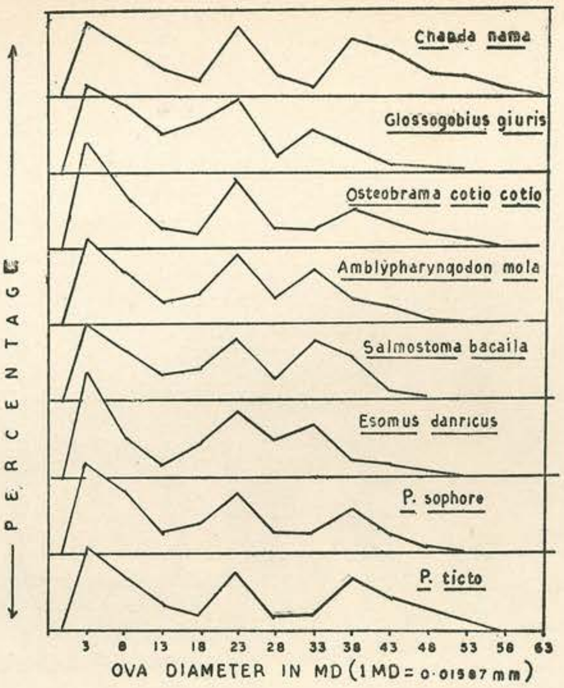


Fig. 26. Ova-diameter frequency polygons of the fishes of Getalsud Reservoir.

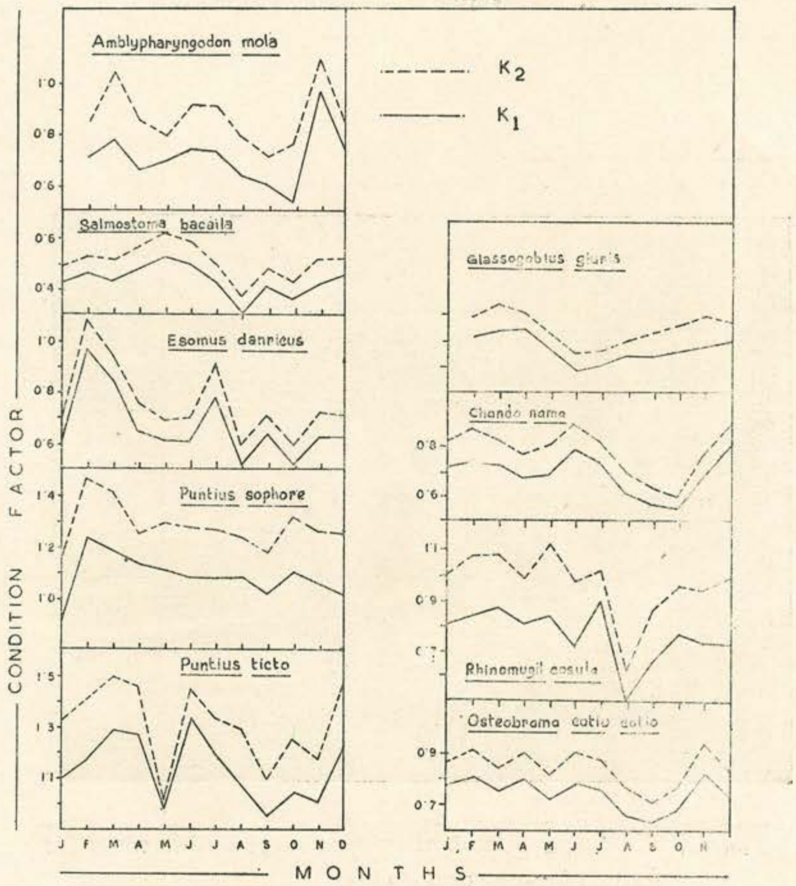


Fig. 27. Condition factor of the fishes of Getalsud Reservoir.

Plate 1. Measurement of water temperature

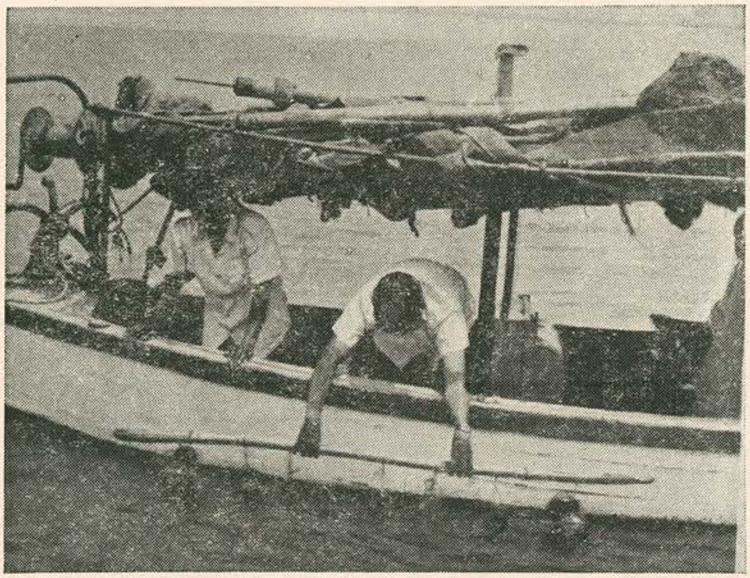


Plate 2. Dark and white bottles being suspended in water for pıimary production studies.

Plate 3. Fish being examined for length frequency analysis.

Plate. 4. Experimental fishing