

# Environmental Status of Gandhisagar Reservoir

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A study on the limnology, biota and productivity of Gandhisagar reservoir (Chambal river, Madhya Pradesh) was conducted. Gandhisagar reservoir was observed to have moderate nutrient concentrations conducive to fish growth. The qualitative abundance of planktonic population was high. The dominant phytoplankton, zooplankton, macrozoobenthos and microzoobenthos are presented in the text. Average primary productivity values for 12 months period were 40.83, 36.75 and 37.00 mgC /m<sup>3</sup>/h respectively at surface, 2.5 m and 12 m depth.

Life in water is influenced directly or indirectly by the physical, chemical and biological factors. The fish form an important constituent of the aquatic ecosystem and the multipurpose reservoirs provide an excellent biotope for the aquatic organisms, particularly fishes. Limnological and biological aspects of several fresh water ecosystems in India have been studied (Alikunhi, 1952; Chacko & Krishnamoorthy, 1954; Chacko & Sreenivasan, 1955; George, 1964, 1968, 1969 & 1973; Sreenivasan, 1966; David *et al.*, 1969; Vasishth & Gulati, 1972; Sharma, 1980; Khan & Zutschi, 1980; Khan & Ejike, 1984; Unni, 1985) Such information is either lacking or insufficient for several reservoir systems in India. The present study is an effort towards a better understanding of hydrobiological status and primary productivity of Gandhisagar reservoir of Chambal river, Madhya Pradesh.

## Materials and Methods

Transparency was measured using a standard Secchi disc. Physico-chemical parameters were estimated as per the methods given in APHA, 1975. Plankton collections were made by filtering 40 litres of water through a bolting silk cloth net having 172 meshes per linear 2.54 cm length. The material was preserved immediately in

5% formalin and also in Lugol's solution. Counting of plankton was done by transect method (Vollenweider, 1973). Floatation technique using sugar solution (300 g/l) was employed for identification of microzoobenthos (protozoa) live samples collected and fixed in formol alcohol. The macrozoobenthos were collected by using Suber's sampler, Eckman Grab and Vanveen sampler at the dam site area. The materials were screened through No.30 standard sieve and organisms were hand sorted and stored in formol alcohol fixative.

Gross primary productivity studies were conducted at the surface, 2.5 and 12 m depth by using light and dark bottle technique (Vollenweider, 1969). The dissolved oxygen was estimated by the modified Winkler's method.

## Results and Discussion

The physico-chemical characteristics of Gandhisagar reservoir are given in Table 1. The highest temperature was recorded in July (39°C) and lowest in January (19°C). The transparency values ranged between 70 cm in August and 330 cm in December and are less than that of Iduki reservoir (Khatri, 1987) and Bhavanisagar reservoir (Sreenivasan, 1966).

The Gandhisagar reservoir waters are alkaline and the pH value ranged from 8.00

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Table 1. *Monthly fluctuation of physico-chemical parameters at Gandhisagar dam site area. 1985-86*

Parameters	Oct. 85	Nov. 85	Dec. 85	Jan. 86	Feb. 86	Mar. 86
Temperature, °C	Air	28	27	22	19	27
	Water	25	24	20	18	20
Transparency, cm	110	180	330	310	280	210
Hardness, mg/l	72	72	88	92	96	100
Conductivity, µmohs	230.65	232.30	233.80	229.10	266.47	285.17
pH	8.40	8.20	8.00	8.30	8.60	8.50
Dissolved oxygen, mg/l	8.00	7.20	7.30	8.00	8.40	10.80
Carbonate, mg/l	3.50	4.20	5.80	7.20	8.40	8.60
Bicarbonate, mg/l	110.20	121.80	130.80	143.40	148.90	153.40
Nitrate, mg/l	0.16	0.12	0.06	0.04	0.05	0.05
Phosphate, mg/l	0.06	0.01	0.02	0.03	0.02	0.035
Calcium, mg/l	20.04	20.84	23.25	24.05	26.45	29.65
Chloride, mg/l	18.99	17.99	16.99	16.99	17.99	18.99
Silicate, mg/l	9.90	9.70	9.50	10.00	10.10	10.20
Parameters	Apr. 86	May 86.	June 86	Jul. 86	Aug. 86	Sept.86
Temperature, °C	Air	28	32	36	39	27
	Water	20	30	30	31	25
Transparency, cm	240	270	270	230	70	75
Hardness, mg/l	95	94	93	93	71	70
Conductivity, µmohs	284.30	285.10	282.50	283.50	230.40	230.20
pH	8.20	8.20	8.20	8.10	8.40	8.40
Dissolved oxygen, mg/l	6.80	9.20	9.20	7.60	8.40	7.20
Carbonate, mg/l	9.00	-	-	-	-	-
Bicarbonate, mg/l	170.50	195.00	210.50	111.20	100.30	99.50
Nitrate, mg/l	0.05	0.06	0.04	0.12	0.25	0.20
Phosphate, mg/l	0.035	0.08	0.095	0.14	0.18	0.05
Calium, mg/l	29.20	26.50	26.00	24.50	20.25	20.50
Chloride, mg/l	18.45	18.50	18.40	18.50	17.90	17.90
Silicate, mg/l	10.10	10.00	10.00	10.10	10.9	9.80

Table 2. List of phytoplankton and zooplankton detected in Gandhisagar reservoir

## A. Phytoplankton

## Myxophyceae

- |                            |                           |
|----------------------------|---------------------------|
| 1. <i>Merismopedia</i> sp. | 6. <i>Nostoc</i> sp.      |
| 2. <i>Microcystis</i> sp.  | 7. <i>Arthrospira</i> sp. |
| 3. <i>Oscillatoria</i> sp. | 8. <i>Spirulina</i> sp.   |
| 4. <i>Anabaena</i> sp.     | 9. <i>Phormidium</i> sp.  |
| 5. <i>Lyngbya</i> sp.      |                           |

## Chlorophyceae

- |                              |                               |
|------------------------------|-------------------------------|
| 1. <i>Edorina</i> spp.       | 11. <i>Dispora</i> sp.        |
| 2. <i>Pandorina</i> spp.     | 12. <i>Pediastrum duplex</i>  |
| 3. <i>Volvox</i> spp.        | 13. <i>Pediastrum simplex</i> |
| 4. <i>Scenedesmus</i> spp.   | 14. <i>Actinastrum</i> spp.   |
| 5. <i>Cosmarium</i> spp.     | 15. <i>Oedogonium</i> spp.    |
| 6. <i>Ulothrix</i> spp.      | 16. <i>Spirogyra communis</i> |
| 7. <i>Zygnema</i> spp.       | 17. <i>Scenedesmus acutus</i> |
| 8. <i>Microspora</i> spp.    | 18. <i>Scenedesmus quad-</i>  |
| 9. <i>Closteridium</i> spp.  | <i>ricauda</i>                |
| 10. <i>Stichococcus</i> spp. | 19. <i>Chlorella vulgaris</i> |

## Bacillariophyceae

- |                            |                            |
|----------------------------|----------------------------|
| 1. <i>Pinnularia</i> spp.  | 8. <i>Melosira</i> spp.    |
| 2. <i>Bacillaria</i> spp.  | 9. <i>Cyclotella</i> spp.  |
| 3. <i>Navicula</i> spp.    | 10. <i>Cocconeis</i> spp.  |
| 4. <i>Amphipleura</i> spp. | 11. <i>Cymbella</i> sp.    |
| 5. <i>Synedra</i> spp.     | 12. <i>Gomphonema</i> spp. |
| 7. <i>Nitzschia palea</i>  | 13. <i>Diatomella</i> spp. |

## B. Zooplankton

## Rotatoria

- |                               |                            |
|-------------------------------|----------------------------|
| 1. <i>Keratella quadrata</i>  | 7. <i>Trichotria</i> spp.  |
| 2. <i>Keratella tropica</i>   | 8. <i>Brachionus quar-</i> |
|                               | <i>dridentatus</i>         |
| 3. <i>Polyarthra vulgaris</i> | 9. <i>Brachionus-</i>      |
|                               | <i>calyciflorus</i>        |

- |                             |                                |
|-----------------------------|--------------------------------|
| 4. <i>Filinia longiseta</i> | 10. <i>Brachionus falcatus</i> |
| 5. <i>Monostyla</i> spp.    | 11. <i>Brachionus rubens</i>   |
| 6. <i>Asplanchna</i>        | 12. <i>Philodina</i> spp.      |
| <i>brightwellii</i>         |                                |

## Cladocera

- |                              |                              |
|------------------------------|------------------------------|
| 1. <i>Daphnia carinata</i>   | 9. <i>Alona rectangula</i>   |
| 2. <i>Daphnia pulex</i>      | 10. <i>Diaphanosoma</i>      |
|                              | <i>branchyurum</i>           |
| 3. <i>Daphnia lumholtzi</i>  | 11. <i>Diaphanosoma</i>      |
|                              | <i>sarsia</i>                |
| 4. <i>Alonella dentifera</i> | 12. <i>Macrothrix</i>        |
|                              | <i>montana</i>               |
| 5. <i>Alona quatata</i>      | 13. <i>Macrothrix rosea</i>  |
| 6. <i>Alona affinis</i>      | 14. <i>Simocephalus</i> spp. |
| 7. <i>Alona quadran-</i>     | 15. <i>Polysphemus</i> spp.  |
| <i>gularis</i>               |                              |
| 8. <i>Ceriodaphnia</i> spp.  |                              |

## Ostracoda

- |                         |                          |
|-------------------------|--------------------------|
| 1. <i>Cypris obensa</i> | 2. <i>Cypris candona</i> |
|-------------------------|--------------------------|

## Copepoda

- |                                 |                              |
|---------------------------------|------------------------------|
| 1. <i>Ectocyclops</i>           | 8. <i>Ergasilus</i> spp.     |
| <i>phaleratus</i>               | 9. <i>Allodiaptomus raoi</i> |
| 2. <i>Eucyclops</i>             | 10. <i>Heliodiaptomus</i>    |
| <i>serrulatus</i>               | <i>vidus</i>                 |
| 3. <i>Cyclops vicinus</i>       | 11. <i>Paradiaptomus</i>     |
|                                 | <i>greeni</i>                |
| 4. <i>Microcyclops</i>          | 12. <i>Synecella</i>         |
| <i>varicans</i>                 | <i>calanoides</i>            |
| 5. <i>Macrocyclops</i>          | 13. <i>Argulus japonicus</i> |
| <i>distinctus</i>               | 14. <i>Diaptomus</i> spp.    |
| 6. <i>Mesocyclops</i>           | 15. <i>Nauplius</i> larvae   |
| <i>hyalinus</i>                 |                              |
| 7. <i>Mesocyclops leuckarti</i> |                              |

to 8.60. Being alkaline the reservoir waters are favourable to biological process in general and fish production in particular. Ellis (1937), pointed out that pH ranges between 6.70 and 8.40 are generally favourable

to freshwater fishes. The values of dissolved oxygen varied from 7.20 mg/l in November and December to 10.80 mg/l in March. The carbonate values were 3.50 mg/l in October and 9.00 mg/l in April. The bicarbonate

value ranged from 99.50 mg/l in September to 210.50 mg/l in June and the pattern of fluctuation is similar to other north Indian water bodies (David, 1963; Pahwa & Mehrotra, 1966). The hardness values ranged between 70-100 mg/l.

Table 3. List of microzoobenthic and macrozoobenthic organisms

#### Microzoobenthic organisms:

##### Protozoa

- |                            |                             |
|----------------------------|-----------------------------|
| 1. <i>Diffugia</i> spp.    | 7. <i>Carchesium</i> spp.   |
| 2. <i>Arcella</i> spp.     | 8. <i>Colpodium</i> spp.    |
| 3. <i>Nebalia</i> spp.     | 9. <i>Frontonia</i> spp.    |
| 4. <i>Actinophrys</i> spp. | 10. <i>Opercularia</i> spp. |
| 5. <i>Stentor</i> spp.     | 11. <i>Metopus</i> spp.     |
| 6. <i>Vorticella</i> spp.  |                             |

#### Macrozoobenthic organisms:

##### Oligochaeta

- |                                 |                                    |
|---------------------------------|------------------------------------|
| 1. <i>Nais communis</i>         | 6. <i>Aulophorus tonkinensis</i>   |
| 2. <i>Dero</i> spp.             | 7. <i>Tubifex tubifex</i>          |
| 3. <i>Chaetograster limnaei</i> | 8. <i>Limnodrilus hoffmeisteri</i> |
| 4. <i>Stylaria</i> spp.         | 9. <i>Branchiura sowerbyi</i>      |

##### 5. *Pristina menori*

##### Hirudinea

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1. <i>Glossiphonia complanata</i> | 2. <i>Hemiclepsis</i> spp. |
|                                   | 3. <i>Barbonia</i> spp.    |

##### Diptera

- |                           |                               |
|---------------------------|-------------------------------|
| 1. <i>Pentaneura</i> spp. | 6. <i>Chironomus tentanus</i> |
| 2. <i>Tanytarsus</i> spp. | 7. <i>Antocha</i> spp.        |
| 3. <i>Simulium</i> spp.   | 8. <i>Tripula</i> spp.        |
| 4. <i>Tabanus</i> spp.    | 9. <i>Palpomyia</i> spp.      |
| 5. <i>Culicoides</i>      | 10. <i>Psychoda</i> spp.      |

##### Coleoptera

- |                         |                            |
|-------------------------|----------------------------|
| 1. <i>Berosus</i> spp.  | 5. <i>Ectopria</i> spp.    |
| 2. <i>Enochrus</i> spp. | 6. <i>Psephenus</i> spp.   |
| 3. <i>Agabinus</i> spp. | 7. <i>Dineutus indicus</i> |

The present study showed a conductivity fluctuation between 230.65  $\mu$  mohs in October and 285.17  $\mu$  mohs in March and this is less when compared to other reservoirs. (Sharma, 1980; Khan & Zutshi, 1980).

- |                        |                            |
|------------------------|----------------------------|
| 4. <i>Gyrinus</i> spp. | 8. <i>Hydrophilus</i> spp. |
|------------------------|----------------------------|
- Ephemeroptera

- |                                 |                           |
|---------------------------------|---------------------------|
| 1. <i>Paraleptophlebia</i> spp. | 4. <i>Heptagenia</i> spp. |
| 2. <i>Stenonema</i> spp.        | 5. <i>Baetis</i> spp.     |
| 3. <i>Ameletus</i> spp.         |                           |

##### Trichoptera

- |                            |
|----------------------------|
| 1. <i>Hydropsyche</i> spp. |
| 2. <i>Hydroptila</i> spp.  |

##### Hemiptera

- |                                   |
|-----------------------------------|
| 1. <i>Notonecta</i> spp.          |
| 2. <i>Ranatra filiformis</i> spp. |

##### Odonata

- |                             |
|-----------------------------|
| 1. <i>Enallagma</i> spp.    |
| 2. <i>Progomorphus</i> spp. |

##### Lepidoptera

- |                         |
|-------------------------|
| 1. <i>Elophila</i> spp. |
|-------------------------|

##### Mollusca

- |                                |
|--------------------------------|
| 1. <i>Bellamya bengalensis</i> |
| 2. <i>Lymnaea acuminata</i>    |
| 3. <i>Thiara scabra</i>        |
| 4. <i>Thiara lineata</i>       |
| 5. <i>Corbicula striatella</i> |
| 6. <i>Perreysia caerulea</i>   |
| 7. <i>Diagnostostoma</i> spp.  |

##### Nematoda

- |                               |
|-------------------------------|
| 1. <i>Prismatolaimus</i> spp. |
| 2. <i>Torbillus</i> spp.      |
| 3. <i>Goffartia</i> spp.      |

The nitrate content was in the range 0.04 mg/l in January to 0.25 mg/l in August. The maximum value of nitrate was recorded in monsoon months and might be due to natural enrichment and reduction of consuming agency, the phytoplankton. Venkateswarulu (1969 a,b) made similar observation during the study on river Moosai in Hyderabad. The phosphate value showed a fluctuation of 0.01 mg/l in November to 0.18 mg/l in August. Pahwa & Mehrotra (1966) and Chakraborty *et al.*, (1959) recorded phosphate ranges 0.05 to 0.21 mg/l and 0.03 to 0.09 mg/l respectively, in rivers Ganga and Yamuna. The seasonal fluctuation pattern is in confirmation with the trend observed in river Chambal (Dad, 1981). The calcium content ranged between 20.04 and 29.65 mg/l. The chloride values ranged from 16.99 mg/l in December and January to 19.99 mg/l in October and these values are too low compared to other Indian reservoirs; 11.90 to 42.10 mg/l to Tungabhadra reservoir (David *et al.*, 1969); 27.00 to 35.00 mg/l in Sagar lake (Mishra & Yadav, 1978); 50.00 to 70.00 mg/l in Nilang lake (Khan & Zutshi, 1980). From the study it is clear that the Gandhisagar reservoir has moderate nutrient concentration and is conducive to fish growth. Unni (1985) reported that Gandhisagar is eutrophic in nature.

The dominant phytoplankton and zooplankton recorded under different groups are shown in Table 2. The qualitative abundance of planktonic populations is quite high in Gandhisagar reservoir.

The micro and macro zoobenthos recorded are shown in Table 3. The quantitative data pertaining to macrozoobenthos and constituent groups have been estimated and presented in Table 4. Insect larvae were the dominant faunal component having a count of 339.46/m<sup>2</sup> and represented 34.79% of the total population followed by

Gastropods 33.60%, Oligochaetes 21.97% and bivalves 9.64%. Among the Gastropods *Lymnaea* and *Vivipara* were the main constituents, *Chironomus* represented the dominant insects and the population of Oligochaeta consisted of *Tubifex*, *Limnodrilus* and *Branchiura*.

The monthly variations of macro zoobenthic population at Gandhisagar dam indicated that maximum mollusc population occurred in January and February and least in September. The largest quantity of Chironomids were recorded in September while July and April formed the lean period. The Oligochaetes were dominant in the month of May.

Details of gross productivity are presented in Table 5. Productivity at the surface was the highest in April followed by May and June and the values were 7862 & 62 mgC/m<sup>3</sup>/h respectively. Productivity

Table 4. Macrozoobenthos per square meter at the dam site

Group	Count/m <sup>2</sup>	Percentage composition
Gastropods	327.96	33.60
Bivalves	94.05	9.64
Insects	339.46	34.79
Oligochaeta	214.34	21.97
Total	975.81	100.00

value at three levels were more or less the same in the month of March and the average productivity values for 12 months period were 40.83, 36.75 and 37.00 mgC/m<sup>3</sup>/h respectively. The primary productivity values at different levels ranged from 22-78, 15-102 and 12-106 mg C/m<sup>3</sup>/h respectively for surface, 2.5 and 12 m depth. The present productivity values showed same trend as reported by Sharma & Durve (1985) in establishing Gandhisagar reservoir as a low productivity reservoir.

Table 5. Monthly fluctuation of primary productivity at Gandhisagar dam site during 1985-86

Month	Surface	2.5 m	12 m
	mgC/m <sup>3</sup> /h	depth 3 mgC/m <sup>3</sup> /h	depth 3 mgC/m <sup>3</sup> /h
April 85	78	102	84
May	62	48	106
June	62	48	30
July	30	16	18
August	22	20	12
September	30	54	46
October	48	32	38
November	48	32	24
December	32	15	16
January, 86	24	30	16
February	30	22	30
March	24	22	24
Average value	40.83	36.75	37.00

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