Studies on diatoms of river Gomati at Lucknow, Uttar Pradesh*

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The present paper describes Bacillariophycean members of river Gomati at Lucknow, U.P. A few physico-chemical parameters such as Water Temperature, pH, Total Alkalinity, Total Hardness, Calcium, Magnesium and Dissolved Oxygen were periodically analysed. A correlation of these parameters with diatom flora has been attempted at.

The micro-algal flora in form of Benthos, specially the Bacillariophyceae representing thirteen genera and fortyfive species have been systematically identified from several apparently polluted and unpolluted areas of the river course at Lucknow.

Key words: Diatoms, River Gomati, Lucknow, Uttar Pradesh.

INTRODUCTION

THE diatoms are one of the most ubiquitous phyco-aquatic organisms. The importance of diatom species lies in the sense that each species of this group believably occupies a different niche in that aquatic ecosystem and responds individually to the dynamics of its chemical and physical parameters. Pioneering work on these algae of the Indian region are those by Skvortzow (1935) on diatoms of Calcutta, Majeed (1935) on diatoms of Punjab and Biswas (1937) on diatoms of Loktak lake in Assam. Saxena (1968) has given a list of diatoms from Jammu and Kashmir. Venkataraman (1939) and Krishnamurty (1954) have described diatom flora of South India. Prasad and Singh (1982) and Kannan and Krishnamurty (1985) have highlighted diatoms as indicators of water quality. Gonzalves and Gandhi (1952, 1953, 1954) and Gandhi (1955), have worked on the diatoms of Bombay, Ahmedabad, Mysore, Kolhapur and adjoining areas of India.

Only a few workers have taken up the study of the diatoms of Uttar Pradesh notably by C.S. Singh (1961, 1962, 1963, 1964), Ahmad (1972), Saxena (1978), Y. Singh (1979) Prasad and Singh (1980, 1982), Verma (1990) and Tripathy and Pandey (1990).

Verma *et al.* (1992) surveyed the river Gomati at four selected stations at Lucknow and observed a number of characteristic features associated with water quality as well as micro-algal composition in form of diatoms.

Prasad and Singh (1980) emphasized upon the feasibility of using diatoms as the potential indicator of quality. Y. Singh (1979) while studying the ecology of river Gomati isolated nineteen taxa of diatoms which were found to be favoured by heavy sewage effluents.

MATERIALS AND METHOD

The water samples of the present study were collected in clean plastic containers at monthly intervals from four different locations from May, 1990 to April, 1991 inclusive of diatoms which were also collected simultaneously. The physico-chemical analyses of the water was done according to the Indian Standard Method of sampling and test for water used in industry I.S. 3025: 1964. The algal material was examined as soon as possible after bringing it to the laboratory in the living condition and later Bacillariophycean forms were identified up to generic level and then isolated. Such collection were preserved in 4% formalin solution for the purpose of systematic identification and documentation.

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For the preparation of slides of diatoms the method as suggested by Patrick and Reimer (1966, p. 94) was followed. The diatoms were identified with the help of standard literature particularly in form of monographs (Hendey, 1964; Hustedt, 1930; Vanderwerf, 1957-1974; Tiffany & Britton, 1952).

The following four stations were selected from the course of river Gomati, for the purpose of collection.

Station 1- This upstream station is situated in the outerskirts of Lucknow where the river enters the city. As the river water is pumped for municipal water works situated at Aishbagh, the name of this place is Gaughat pumping station.

Station 2- It is popularly called as Shaheed-Smarak, this station is situated near Residency Lucknow approximately six kilometers down stream from station 1.

Station 3 - Situated three kilometers away from Station 2 near Papermill at Nishatganj, Lucknow. The flow of water at this station is slightly slower.

Station 4 - This last station is situated where the river leaves the city. Now this area is known as Gomati Nagar after inhabitation and development.

OBSERVATION

A- Physico-Chemical Parameters

During the present course of study a total of seven physico-chemical parameters were selected which are: Water Temperature, pH, Total Alkalinity, Total Hardness, Calcium, Magnesium and Dissolved Oxygen (Table 3).

The minimum water temperature was 14°C at stations 2 & 3 during the month of January, 1991 and maximum water temperature was 34°C at station 2 during the month of May, 1990. The minimum pH was 7.5 at stations 1 & 2 during the months of May & December 1990. The minimum value of total alkalinity was 70.00 mg/l recorded at station 3 during the period of July, 1990 and maximum value was 312.00 mg/l during the month of February, 1991 at stations 3 & 4. The minimum value of total hardness 70.00 mg/l was recorded at stations 3 & 4 during the month of August, 1990 and maximum value of total hardness was 280.00 mg/l at station 1 during the month of May, 1990. Minimum value of calcium was 16.00 mg/l at station 1 during the month of May, 1990 and maximum was 56.00 mg/l at station 1 during the month of June, 1990. The minimum value of magnesium was 1.92 mg/l recorded at station 4 during the month of March, 1991 and maximum was 57.60 mg/l at station 1 during the month of May, 1990. The minimum value of dissolved oxygen 1.60 mg/l was observed during the month of April, 1991 at station 3 and maximum value was 15.50 mg/l at station 1 during the month of February, 1991.

B-Bacillariophyceae

Fortyfive different taxa of diatoms were observed from all the four stations of the river Gomati during present investigation (Figs 1-48). These diatom taxa belong to following thirteen genera (Table-2) and fortyfive species (Table-1).

1. *Gomphonema* - The eight taxa of *Gomphonema* were observed which are: *G.lanceolatum* var. *insignis* was recorded from stations 1&3 during the month of May, 1990. *G. magnifeca* was observed from stations 1 & 2 during the months of May & July, 1990. *G. gracile* was recorded during May & June 1990 at station 1. *G. sphaerophorum* was observed at stations 1, 2 & 3 during the months of May to December, 1990. *G. augur* was recorded from stations 1 & 4 during months of May, June, August & September, 1990. *G. subventricosum* was recorded from stations 1&2 during May & June, 1990. *G. parvulum* was observed from all the stations during May, June, July, September, October, November, 1990 and February, 1991. *G. montanum* var. *subclavatum* was observed at station 1 during May, November, 1990 & January, 1991 (Figs 2-10).

2. *Cymbella* - The six species of *Cymbella* were observed which are : *C. affinis* was recorded from stations 1, 2&3 during the months of May, June, November, December 1990 and January, 1991. *C. spicula* was observed at station 1 during May & October, 1990. *C. turgida* was recorded at stations 1 & 2 during May, June & September to November, 1990. *C. kappii* was at stations 1 & 2 during the May & December, 1990. *C. gracilis* var. *girodi* f. *curta* was observed at stations 1 & 2 during the months of May & June, 1990. *C. prostrata* was recorded from

Figures 1-48. 1. *Surirella tenera*, 2. *Gomphonema lanceolatum* var. *insignis*, 3. *G. magnifeca*, 4. *G. gracile*, 5. *G. augur*, 6. *G. augur* 7. *G. parvulum*, 8. *G. montanum*, 9. *G. subventricosum*, 10. *G. sphaerophorum*, 11. *Navicula cuspidata* var. *ambigua*, 12. *N. rhynchocephala*, 13. *N. simplex*, 14. *N. salinarum*, 15. *N. radiosa* var. *tenella*, 16. *N. cryptocephala* var. *subsalina*, 17. *Cymbella gracilis* var. *girodi f. curta*, 18. *C. spicula*, 19. *C. affinis*, 20. *C. prostrata*, 21. *C. turgida*, 22. *C. kappii*, 23. *Synedra ulna*, 24. *S. ulna*, 25. *S. gaillonii*, 26. *Nitzschia obtusa*, 27. *N. thermalis*, 28. *N. thermalis* var. *minor*, 29. *N. obtusa* var. *scalpelliformis*, 30. *N. capitellata*, 31. *Fragillaria construens* var. *binoidis*, 32. *F. costruens* var. *binoidis*, 33. *F. construens* var. *subsalina*, 34. *Synedra dorsiventralis*, 35. *Surirella tenera* var. *nervosa*, 36. *S.ovata*, 37. *S. ovalis*, 38. *Pinnularia interrupta*, 39., *P. subcapitata*, 40. *Surirella robusta*, 41., *S. linearis*, 42. *Rhopalodia gibba*, 43. *Epithemia zebra*, 44. *Cyclotella meneghiniana*, 45. *Rhopalodia musculus*, 46. *Cyclotella glomerata*, 47. *Cocconeis placentula*, 48. *Melosira granulata*

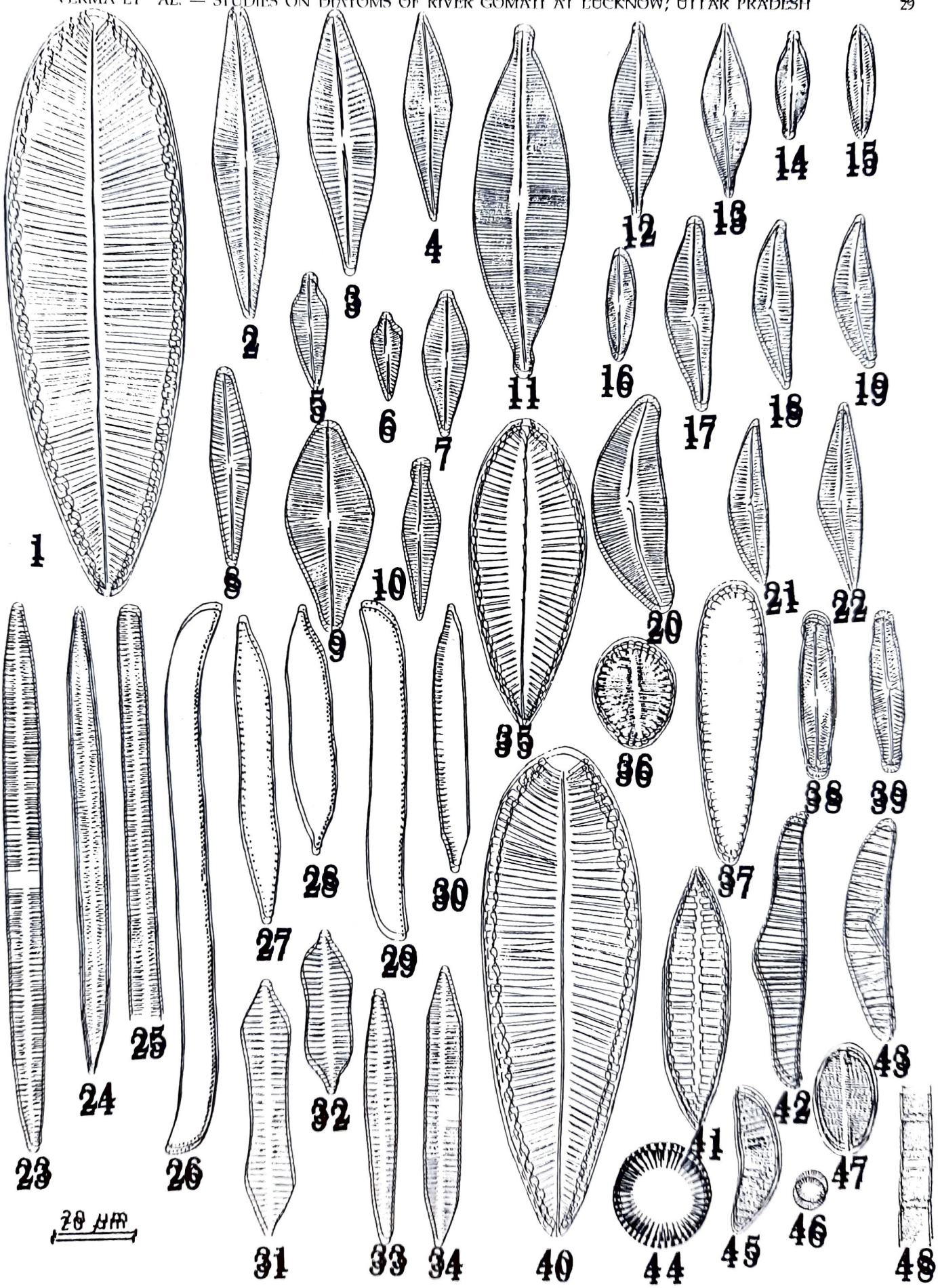
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Table-1: Details of occurrence of diatom species

S.No.	Name of Genus	No. of Species	Name of Taxa	Stations	Year and Months
1.	*Gomphonema*	8	*G. lanceolatum* var. *insignis*	1,3	May, Jul, 1990.
			G. magnifeca	1,2	May, Jul, 1990 & Jan, 1991.
			G. graciler	1	May, June, 1990
			G. sphaerophorum	1,2,3	May to Dec, 1990
			G. augur	1,4	May, June, Aug, Sep, 1990
			G. subventricosum	1,2	May, June, 1990
			G. parvulum	1,2,3,4	May, June, Jul, Sept to Nov, 1990 and Feb, 1991
			G. montanum var. *subclavatum*	1	May, Nov, 1990 and Jan, 1991
2.	*Cymbella*	6	*C. affinis*	1,2,3	May, Jun, Nov, Dec, 1990 and Jan, 1991
			C. spicula	1	May, Oct, 1990
			C. turgida	1,2	May, Jun, Sep, Nov, Dec, 1990
			C. kappii	1,2	May, Dec, 1990
			C. gracilis var. *girodi* f. *curta*	1,2	May, Jun, 1990
			C. prostrata	1,3,4	Jul, Nov, Dec, 1990
3.	*Nitzschia*	5	*N. obtusa*	1,2,3	May, Oct, Nov, Dec, 1990
			N. obtusa var. *scalpelliformis*	1,2,4	Jun, Nov, 1990 and Jan, Feb, 1991
			N. thermalis	1,2,4	May, Nov, Dec, 1990 and Jan, Feb, 1991
			N. thermalis var. *minor*	2,3	Jul, Aug, Sep, Nov, Dec, 1990 and Jan, Feb, 1991
			N. capitellata	4	Jun, 1990
4.	*Navicula*	6	*N. cuspidata* var. *ambigua*	2,3,4	May, Jun, Aug, Oct to Dec, 1990
			N. cryptocephala var. *subsalina*	1,2,3,4	May, Jul, Aug, Sep, Nov Dec, 1990 and Jan, Feb, 1991
			N. salinarum	4	Jun, 1990
			N. rhynchocephala	3,4	Jul, Sep, Oct, Nov, Dec, 1990
			N. simplex	3	Nov, 1990
			N. radiosa var. *tenella*	1,3,4	Jun, Nov, Dec, 1990
5.	*Surirella*	6	*S. tenera*	1	Dec, 1990
			S. tenera var. *nervosa*	1	Nov, 1990
			S. ovata	1	Jan, 1991
			S. ovalis	3	Oct, 1990
			S. robusta	1	Jan, 1991
			S. linearis	1	Nov, 1990
6.	*Synedra*	3	*S. ulna*	1,2,3	May, Jun, Sep, Oct, Nov, Dec, 1990 and Jan, Feb, 1991
			S. gaillonii	1, 3, 4	May, Nov, 1990, and Jan, Feb, 1991
			S. dorsiventralis	3	Oct, 1990
7.	*Cyclotella*	2	*C. glomerata*	1,2	Oct, 1990 and Jan, 1991
			C. meneghiniana	1,2	Jun, Oct, 1990
8.	*Fragillaria*	2	*F. construens* var. *binoidis*	3	Oct, 1990
			F. construens var. *subsalina*	4	Nov, 1990
9.	*Pinnularia*	2	*P. subcapitata*	2	Jul, 1990
			P. interrupta	4	Jun, 1990
10.	*Melosira*	1	*M. granulata*	1	May, 1990
11.	*Cocconeis*	1	*C. placentula*	1,2,4	Jul, Sep, Oct, Dec, 1990 and Jan, Feb, 1991
12.	*Epithemia*	1	*E. zebra*	1,2,3	Nov, 1990 and Jan, 1991
13.	*Rhopalodia*	2	*R. gibba*	1	Nov, 1990
			R. musculus	2	Nov, 1990

Table-2 : Distribution of Bacillariophyceae at Different stations

S.No.	Name of the Genus	Number of Taxa			
		Station-1	Station-2	Station-3	Station-4
1.	*Gomphonema*	8	4	3	3
2.	*Cymbella*	6	4	1	2
3.	*Surirella*	5	-	1	-
4.	*Nitzschia*	3	4	3	2
5.	*Navicula*	2	2	5	4
6.	*Cyclotella*	2	1	-	-
7.	*Synedra*	2	1	3	1
8.	*Cocconeis*	1	1	-	1
9.	*Epithemia*	1	1	1	-
10.	*Melosira*	1	-	-	-
11.	*Rhopalodia*	1	1	-	-
12.	*Pinnularia*	-	1	-	1
13.	*Fragillaria*	-	-	1	1
Total no. of taxa		32	20	18	15

stations 1, 3&4 during the July, November & December, 1990. (Figs. 17-22).

3. *Nitzschia* - Five species of *Nitzschia* were observed. *N. obtusa* was recorded from stations 1, 2&3 during May and October to December, 1990. *N. obtusa* var. *scalpelliformis* was observed at stations 1, 2&3 during the period of June, November, 1990 and January, February, 1991. *N. thermalis* was at stations 1, 2&3 during May, November, December, 1990 and January, February, 1991. *N. thermalis* var. *minor* was recorded from stations 2 & 3 during the period of July to December, 1990 and January, February, 1991. *N. capitellata* was observed at station 4 during June, 1990 (Figs 26-30).

4. *Navicula* - Six species of *Navicula* were recorded which are : *N. cuspidata* var. *ambigua* was observed from stations 2, 3&4 during May, June, August, October, November, December, 1990. *N.cryptocephala* var. *subsalina* was recorded during the months of May, July to September, November, December, 1990 and January, February, 1991 at all the stations. *N. salinarum* was observed at station 4 during June, 1990. *N. rhynchocephala* was found from stations 3 & 4 during July and September to December, 1990. *N. simplex* was observed at station 3 during November, 1990. *N.radiosa* var. *tenella* was recorded from stations 1, 3 & 4 during the period of June, November and December, 1990 (Figs 11-16.)

5. *Surirella*- The six species of *Surirella* were recorded which are : *S. tenera* was observed at station 1 during month of December, 1990. *S. tenera* var. *nervosa* and *S. linearis* were observed at station 1 during the month of November, 1990. *S. ovata* and *S. robusta* were observed at station 1 during January, 1991. *S. ovalis* was at station 3 during the month of October, 1990 (Figs 1&35-37 and 40, 41).

6. *Synedra* - Three species of *Synedra* were recorded. *S. ulna* was recorded from stations 1, 2&3 during the

Table-3. Mean Monthly Values of Physico-Chemical Variables.

S.No.	Physico-Chemical Parameters	Mean monthly variables			
		Station-1	Station-2	Station-3	Station-4
1.	Water Temp. (°C)	26.54	26.41	26.08	26.70
2.	pH	06.84	06.96	06.90	06.74
3.	Total Alkalinity (mg/l)	230.08	227.25	221.91	221.00
4.	Total Hardness (mg/l)	175.00	177.75	154.33	162.66
5.	Calcium (mg/l)	33.94	35.16	34.00	31.35
6.	Magnesium (mg/l)	20.20	19.73	15.36	15.73
7.	Dissolved Oxygen (mg/l)	10.82	05.56	05.70	06.39

month of May, June, and September, to December, 1990 and January, February, 1991. *S. salinoni* was observed during May & November, 1990 and January, February, 1991 at stations 1, 3&4. *S. dorsiventralis* was observed during October, 1990 at station 3 (Figs 23, 24, 25 & 34).

7. *Cyclotella*- Two species of *Cyclotella*, *C. meneghiniana* and *C. glomerata* were recorded from stations 1 & 2 during the months of June, October, 1990 and January, 1991 (Figs 44 & 46).

8. *Fragillaria* - Two species of *Fragillaria F. construens* var. *binodis* was recorded from station 3 during October, 1990 and *F. construens* var. *subsalina* was recorded from station 4 during November, 1990 (Figs 31-33).

9. *Pinnularia* - The two species of *Pinnularia* were recorded. *P. subcapitata* was observed during the months of July, 1990 at station 2 and *P. interrupta* was observed at station 4 during the month of June, 1990 (Figs 38 & 39).

10. *Melosira* - Single species of *Melosira granulata* was observed at station 1 during month of May 1990 (Fig. 48).

11. *Cocconeis* - Single species of *Cocconeis placentula* was observd at stations 1, 2 & 3 during the months of July, September, October, December, 1990 and January, February, 1991 (Fig. 47).

12. *Epithemia* - Single species of *Epithemia zebra* was observed during the period of November, 1990 and January, 1991 at stations 1, 2 & 3 (Fig. 43).

13. *Rhopalodia* - Only two species of *Rhopalodia* were recorded. *R. gibba* at station 1 and *R. musculus* at station 2, both species were observed during the months of November, 1990 (Figs 42 & 45).

RESULTS AND DISCUSSION

Monthly investigation of Physico-Chemical parameters of water of river Gomati and Diatom flora at each of the four selected stations was done. A total of fortyfive different taxa belonging to thirteen genera of Bacillariophyceae was finally identified from these stations of river Gomati. Out of fortyfive diatoms taxa thirty two were recorded from station 1, twenty from station 2, eighteen from station 3 and fifteen from station last. In the river Gomati, maximum growth of diatoms was recorded during both summer and winter seasons as compared to rainy season.

The genus *Gomphonema* and *Cymbella* were frequently recorded during month of May, 1990 at stations 1 & 2. Highest value of Dissolved oxygen was 15.50 mg/l at station 1 during the month of February, 1991. Genus *Surirella* was frequently recorded at station 1 during the winter season. *Surirella* was generally recorded from fresh and clean waters. At stations 1 water was seemingly unpolluted and uncontaminated as compared to remaining stations. The genus *Navicula* was frequently recorded from polluted and contaminated waters of river Gomati at stations 3 & 4 as compared to stations 1 & 2. The highest value of Total Hardness was 280.00 mg/l (mean value 175.00 mg/l) and Magnesium was 57.60 mg/l (mean value 20.20 mg/l) during the month of May, 1990 at station 1. The maximum value of Calcium was 57.00 mg/l (mean value 33.94 mg/l) during the month of June, 1990 at station 1. Total Alkalinity was highest 312.00 mg/l (mean value 221.91 mg/l) at stations 3&4 during the month of February, 1991 (Table-3).

Gomphonema parvulum was generally recorded from all the stations. *G. magnifica*, *G. subventricosum* were present at stations 1&2 *G. sphaerophorum* was observed at stations 1, 2&3. *G. lanceolatum* var. *insignis* was at stations 1&3, *G. augur* was found at stations 1 & 4. Six species of *Cymbella* were recorded. *C. affinis* was found at station 1,2 & 4, *C. gracilis* var. *giradi* f. *curta*, *C. kappii*, *C. turgida* at stations 1&2, *C. prostrata* was at stations 1, 3&4 and *C. spicula* only at station 1. (Table-1). *Navicula cuspidata* var. *ambigua* was commonly recorded from all the stations except station 1 but *Navicula* species were rare at stations 1 & 2 frequently at stations 3 & 4. *Cocconies placentula* was observed at all the stations except station 3. *Nitzschia* species was at all the stations but rare at station 4. *N. capitellata* was presented at station 4, *N. obtusa* and *N. thermalis* were observed at all the stations except at station 4. *N. obtusa* var. *scalpelliformis* was recorded from all the stations except station 1. *N. thermalis* var. *minor* was observed at stations 2&4. *Epithemia zebra* was recorded from all the stations except station 4. *Melosira granulata* was observed from station 1.

Synedra dorsiventralis was observed at station 3, *S. salinoni* was recorded from stations 1, 3 & 4, *S. ulna* was recorded from stations 1, 2 & 4. *Rhopalodia gibba* at station 1 and *R. musculus* at station 2. *Fragilaria construens* var. *binodes* was recorded at station 3 and *F. construens* var. *subsalina* at station 4. *Surirella* species was frequently found at station 1, *S. linearis*, *S. ovata*, *S. robusta*, *S. tenera* and *S. tenera* var. *nervosa* were observed at station 1 and only *S. ovalis* was recorded from stations 3. During the month of July, 1990 eleven genera of diatoms were presented. Diatoms were dominant at station 1 as compared to remaining stations. Diatoms specially *Gomphonema*, *Cymbella*, *Surirella* and *Melosira* were associated with high temperature, high oxygen concentration, low organic matters and unpolluted waters however, *Navicula*, *Nitzschia* and *Fragilaria* were

observed in low temperature, low oxygen concentration, high organic matters and polluted waters.

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