



(RESEARCH ARTICLE)



Some green algae of Ajodhya hills and forest area of Baghmundi (Purulia district, West Bengal)

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International Journal of Science and Research Archive, 2023, 09(01), 598–607

Publication history: Received on 08 May 2023; revised on 18 June 2023; accepted on 21 June 2023

Article DOI: <https://doi.org/10.30574/ijrsra.2023.9.1.0475>

Abstract

Fresh water resources are depleting at a fast rate throughout the world affecting diverse aquatic flora and fauna. Algal flora responds to the adverse changes in habitat which is reflected by their morphotaxonomical deformation and occurrences of pollution tolerant taxa in the changed habitat. Based on the findings of more than five decades, it has been established that such taxa are labeled as bioindicator because of their pollution tolerance. Taking into account, these attributes; a systematic enumeration of phytoplanktons of all the five dams of Ajodhya hills viz. Upper dam, Lower dam, Marvel Lake, Kestobazar lake and Murguma dam was carried out. During the systematic investigations on morphotaxonomy of green algal flora of Ajodhya hills and forest area altogether 15 taxa of green algae were studied. These taxa belong to Volvocales, Chlorococcales and Zygnematales. These taxa come under the genera *Eudorina*, *Gonium*, *Pandorina* (Volvocales), *Hydrodictyon*, *Pediastrum*, *Scenedesmus* (Chlorococcales), *Spirogyra*, and *Zygnema*, (Zygnematales).

Out of these members of Zygnematales were found to be abundant reflecting the optimum nutrient and atmospheric condition supporting their growth. The collections of algal samples were made periodically (during 2020 to 2022) and characteristic features were studied and identification was done based on standard literatures.

However, the part of the Murguma dam which is affected by anthropogenic activity. The algal population showed the abundance of pollution tolerant taxa and the water quality of that particular part of dam showed organic pollution in physicochemical analysis of the water taken up during the studies.

Keywords: Pollution tolerant; Bio indicator; Phytoplankton; Water quality

1. Introduction

Green algae are the largest and most diverse group of algae, with about 8000 species known (Guiry, 2012). They are ecologically important as they are major produce in the fresh water ecosystem. Numerous taxonomic studies on algae have been carried out in the world. Contribution made by Griffith (1849), Wallich (1860), Lagerheim(1888), Turner (1892), West & West (1902), Bruchl & Biswas (1926), Fritsch & Rich (1937), Scott & Prescott (1961), Komarek (1983), Kouwets (1987), Stastny (2010), Matthews (2016) etc. for the algal flora of different parts of the world are acknowledgeable. Although significant works were done by Biswas(1925), Pal & Santra (1993), Mukherjee & Srivastava (1993), Sarma & Keshri (1993), Satpati & Pal (2011), Chakraborty et al.(2010), Sikdar et al (2012), Halder (2013), Barman & Pal (2013), Singh & Pal (2015), Bose et.al (2016), Nandi et al.(2017) from different place at different times in West Bengal. But till date no record of green algal flora of this region has been recorded. This is the first attempt to study the green algae of the water bodies of studied areas. Green algae constitute an integral part of fresh water bodies

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specially the tropical oligotrophic water bodies as found in the study and rich variety of desmids are encountered. Hence, present venture was made to morphotaxonomic study of green algal flora.

2. Material and methods

2.1. Study Area

Present study area includes five water bodies namely Upper dam, Lower dam, Marvel Lake, Kestobazar lake, and Murguma dam which have been selected for the present study. Upper and Lower dam are mainly used for hydro-electric power project. Marvel Lake adds to aesthetic beauty of the tourist, the lake was created by cutting stones when constructing the upper and lower dam. Kestobazar Lake is an impoundment used by local people for various purposes and Murguma dam is being used for irrigation and drinking purposes. These serene water bodies make the place an attractive tourist spot. All the dams are source of fish fauna. The details of the five (5) water bodies are given below-

Table 1 Five water bodies and their coordinate and Area/Depth

Sl. No.	Site	Latitude	Longitude	Altitude	*Area of water bodies	*Water Depth
1	Site- I (Upper Dam)	23.2017090N	86.0957660E	(494-516) mMSL	82900 square meters	22 Meters
2	Site-II (Lower Dam)	23.1931470N	86.0873500E	(300-337) mMSL	1266000 square meters	37 Meters
3	Site-II (Marvel Lake)	23.2127180N	86.0868950E	465 mMSL	300 square meters	21 Meters
4	Site-IV (Kestobazar Lake)	23.1866110N	86.0873340E	350 mMSL	500 square meters	6 Meters
5	Site- V (Murguma Dam)	23.3156800N	86.0493500E	(339.4-347.14) mMSL	Approx. 2000 square meters.	22 Meters

*Data source: Purulia Pumped Storage Project, Irrigation Div.(Saharjore Project), Purulia,W.B

2.2. Algal Collection and Identification

Collection of green algae along with other algal flora from selected five areas was made for three consecutive years (during 2020 to 2022). Monthly collection of samples from surface water was made. The samples were brought to laboratory and examined under Levenhuk Biological Microscope (Magnification 40x to 1200x). Photographic analysis of objectives was performed with Microscope Digital Camera (Model No.SCMOS00350KPA, TOUPCAM) for morphotaxonomical studies. Both fresh and preserved (4% formalin) samples were studied and micro measurement was taken. Identification was made following The Fresh Water Algal Flora of British Isles, Algae of the Western Great Lake Area, Fresh Water Algae of Eastern India, Algal Flora of Jharkhand, Algal flora of Bihar, and other relevant literatures.

3. Results

3.1. Water Analysis

Three consecutive years (2020, 2021 and 2022) observations and analysis water quality from the five different surface water bodies of Ajodhya hills have been done.

The physicochemical parameters were analyzed according to the method of APHA (1995) and Trivedy and Goel (1986) and BIS. At each site, water samples were collected from five different locations for monitoring. Samples results of those five locations have been recorded (Table: 1.). A total of 17 parameters were studied. These are – water Temperature, pH, Alkalinity, Phosphate, Nitrate, Chloride, Dissolved Oxygen, Chemical Oxygen Demand, Calcium, Sodium, Silicate, Potassium, Magnesium, TDS, TSS, Biological Oxygen Demand and Turbidity. The Temperature ranges from (08 – 35) °C, pH value ranges from 6.8 to 8.1. Diversity of alkalinity was found. The value of alkalinity ranges from 84-112 ppm. Phosphate value ranges from 1.30 mg/L- 4.5 mg/L. Nitrate concentration ranges from 0.150 ppm – 0.60 ppm, Chloride content varies from 12 ppm – 27 ppm. Dissolved oxygen ranges from 5.3 ppm to 7.1 ppm., Biological Oxygen Demand

ranges from 2.1 mg/l to 6.2 mg/l, Chemical Oxygen Demand varied from 2.9mg/l to 5mg/l, Turbidity ranges from 0.35 NTU to 0.80 NTU, calcium (hardness) varied from 48 mg/l to 71 mg/l, sodium value varied from 3.2 mg/l to 4.2 mg/l, potassium value varied from 1.2 mg/l to 1.7 mg/l, magnesium hardness value ranges from 45 mg/l to 61 mg/l, total solids value ranges from 79 mg/l to 118 mg/l. (Table:2.) (Dey and Sharan, 2022).

Table 2 Summer and winter variation of 17 parameters of five water bodies.

Sl. No.	Parameter	Different Sites									
		Site- I		Site- II		Site- III		Site- IV		Site- V	
		Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
1	Water Temperature (°C)	33	17	38	19	34	18	33	21	35	21
2	pH	8.1	7.1	8.1	7.1	6.8	7.4	7.3	7.1	7.1	7.3
3	Alkalinity (ppm)	112	90	84	96	110	100	110	101	108	97
4	Phosphate(mg/L)	1.8	1.31	1.4	1.4	2.9	1.4	1.3	2.1	2.5	2.0
5	Nitrate (mg/L)	0.40	0.50	0.15	0.20	0.15	0.60	0.20	0.40	0.15	0.60
6	Chloride(ppm)	25	18	20	13	27	17	26	12	26	20
7	Dissolved Oxygen (ppm)	5.5	5.9	5.3	7.1	5.2	6.9	5.2	7.0	5.0	7.1
8	Chemical Oxygen Demand(COD)	3.0	5.0	2.9	4.3	3.2	4.4	2.9	5	3.0	4.6
9	Calcium (Mg/L)) Hardness	48	70	59	65	61	67	66	71	65	70
10	Sodium (mg/l)	85	84	84	81	80	84	84	83	82	80
11	Silicate(mg/L)	5	7	10	9	8	9	11	10	10	11
12	Potassium(mg/L)	74	70	75	76	74	74	72	75	78	75
13	Magnesium(mg/l)	100	98	98	97	97	96	98	98	94	98
14	TDS(mg/L)	500	490	495	494	500	500	497	498	498	500
15	TSS(mg/L)	140	135	135	140	140	140	135	136	138	140
16	Biological oxygen demand(ppm)	3.2	4.1	3.2	3.3	3.2	3.5	3.2	3.6	5.7	6.2
17	Turbidity(NTU)	0.49	0.35	0.60	0.55	0.50	0.45	0.75	0.80	0.70	0.75

3.2. Taxonomic Description

Collected specimens were identified by standard literatures. After identification systematic parts are given below

3.2.1. Systematic enumeration

ORDER: VOLVOCALES

- *Gonium pectoral* Mueller (Figure. 1. a.)
 - (Prescott, 162 p.75, 663, plate.1, fig.21)
 - 16 celled, ellipsoid cells are 12µm in dia., closely arranged in a flat, quadrangular plate. Cells are enclosed by individual Sheath.
 - Date of Collection: 03.09.2021
 - Place of Collection: site-I, II, V
 - Collection No.: P-D 26

- *Pandorina morum* (Mueller) Bory(Figure.1. b.)
 - (Prescott,162 p.75,663,plate.1,fig.23)
 - Colony ovate,16 celled ,220 µm in dia., cells are(15x17) µm, crowded.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,V
 - Collection No.: P-D 25
- *Eudorina elegans* Ehrenberg(Figure 1. C.)
 - (Prescott,162 p.76,663,plate.1,fig.24-26)
 - Colony spherical,16 celled, cellsize (15x17)µm,disposed within a gelatinous envelope.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,II,V
 - CollectionNo.: P-D 26
- *Eudorina illinoisensis* (Kofoid) Pascher (Figure 1.d..)
 - (Protist.i.hoset.ac.jp and C.A.Kofoid,1898)
 - Colony composed of 16 celled, spherical in measurements with (180 x150) µm.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,II,V
 - CollectionNo.: P-D 27

ORDER: CHLOROCOCCALES

- *Scenedesmus arcuatus* Lemmermann (Figure 1. e.)
 - (Samad and Adhikary,2008,p.95,pl.1,fig.7)
 - Colony 16 celled,curved,cell oblong, cell wall smooth, cell sizes (5x12)µm
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,V
 - Collection No.: P-D 28
- *Scenedesmus quadricauda* (Figure 2.a.)
 - (Rath and Adhikary, 2005,p.51,pl.7.fig.120)
 - 4 celled, oblong –cylindrical with rounded ends and arranged in a linear series, cells are (7x18) µm in size and poles of cells with long spine.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,V
 - Collection No.: P-D 29
- *Scenedesmus acuminatus*(Lagerheim) Chodat (Figure 2. b.)
 - (Rath and Adhikary,2005,p.52,pl.7.fig.14 and Nordicmicroalgae.org)
 - Colony curved usually 8 fusiform cells with sharp pointed ends, interior cells forming a flat plate and other cells lunate.Cell wall smooth, cells 5µm broad and20µm in length.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,V
 - CollectionNo.: P-D 30
- *Pediastrum boryanum* (Turpin) Menegh. *Var. brevicorne* A.Braun (Figure 2.c.)
 - (Pasztaleniec and Poniewozik,2004,p.40-41, fig.3)
 - Circular coenobium with 16 celled with 58µm in dia.dimensions of cells:(10x12)µm , cell wall granular incision in shape of U.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,V
 - CollectionNo.: P-D 31
- *Pediastrum duplex* Meyen var. *reticulatum* Lagerheim (Figure 2. d.)
 - (Rath and Adhikary,2005,p.55,pl.7.fig.21)
 - Cells are more or less H-shaped, intercellular spaces are available, cells are 15µm in diameter.
 - Date of Collection: 03.09.2021
 - Place of Collection:site-I,II,III,V
 - CollectionNo.: P-D 32
- *Pediastrum simplex*(Meyen) var.*echinulatum* Wittr. (Figure 2. e)
 - (Pasztaleniec and Poniewozik,2004,p.42-43, fig.10)
 - Coenobium circular composed by 8 cells, central part hollow covered by 8 cells which are (15x25)µm in dimension.
 - Date of Collection: 03.09.2021

- Place of Collection:site-I, V
- Collection No.: P-. D 33
- *Pediastrum tetras* (Ehrenberg) (Figure 3. a.)
 - (Pasztaleniec and Poniewozik,2004,p.41-42 fig.7)
 - Coenobium without holes,8 celled, cell dimensions (6x12)µm. All smooth walled cells have verynarrow linear incision.
 - Date of Collection: 04.09.2021
 - Place of Collection:site-I, V
 - CollectionNo.: P-.D 34
 -
- *Hydrodictyon reticulatum*(L.) Lagerheim (Figure 3. b.)
 - (Halder, 2015, p.169, fig. A-B)
 - Macroscopic grass green saccate reticulum, like cylindrical net with hexagonal, cells are elongate,cylindrical,50µm long,10µm broad, reticulate chloroplast, pyrenoids many.
 - Date of Collection: 04.09.2021
 - Place of Collection:site-I,V
 - CollectionNo.: P-. D 35

ORDER: CONJUGALES

- *Spirogyra corrugata* Transeau (Figure 3. c)
 - (Kargupta and Jha,2004, p.75, figs. 39-44)
 - Vegetative cells (40x132)µm,plane cell wall,chloroplast-3,reproduction scalariform, fertile cell solitary,zygospores ovoid,42x75µm, double layered,outer layer corrugated,inner yellow brownish, finely reticulated.
 - Date of Collection: 04.09.2021
 - Place of Collection:site-I,II,V
 - CollectionNo.: P-. D 36
- *Spirogyra fluviatilis* Hilse in Rabenhorst (Figure 3. d)
 - (Prescott,1962, p.314, pl.73, figs. 4-5)
 - Filaments of rather stout cells, 45µm in dia,cell wall smooth,chloroplast 4, scalariform conjugation by tubes from both gametangia, zygospore ovate,pitted with(42x 59)µm dimension.
 - Date of Collection: 04.09.2021
 - Place of Collection:site-I, V
 - CollectionNo.: P-. D 37
- *Zygnema insigne* (Hassall) Kuetzing (Figure 3. e)
 - (Kargupta and Jha,2004, p.156, figs. 24-25)
 - Vegetative cells (28 x32) µm, stellate chloroplast 2, conjugationscalariform, zygosporesglobose,(27x30) µm, smooth walled and yellow brown in color.
 - Date of Collection: 04.09.2021
 - Place of Collection:site-I, III, V
 - Collection No.: P-. D 40

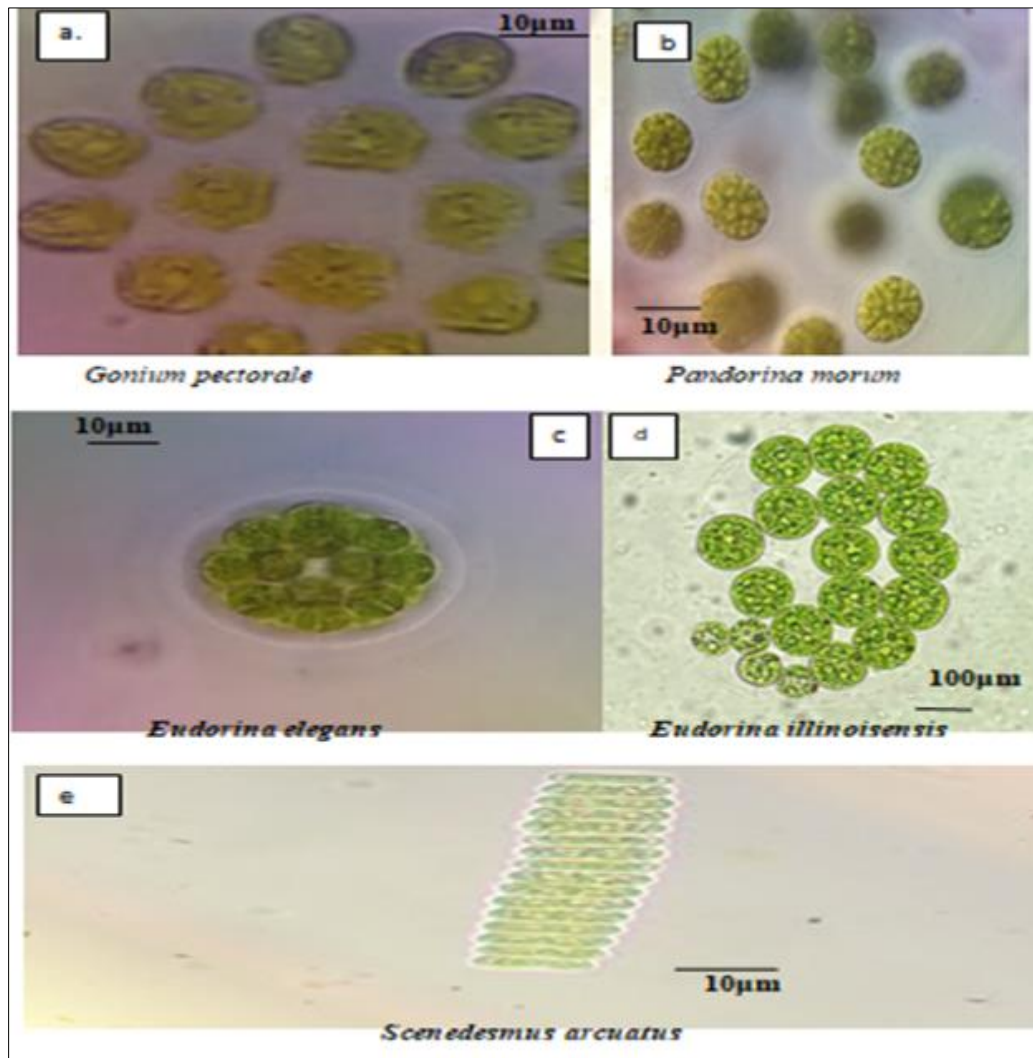


Figure 1 Micro photographs of a.*Gonium*, *Pandorina*, b: *Pandorina morum*, c: *Eudorine elegans*, d: *Eudorina illinoisensis*, e: *Scendesmus arcuatus*

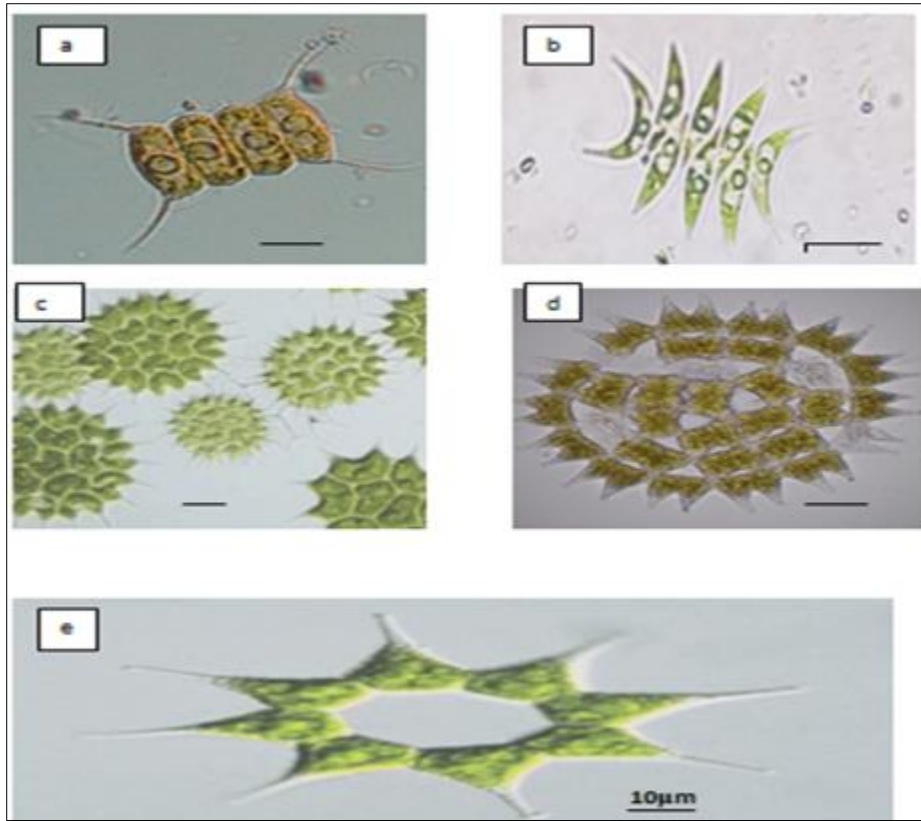
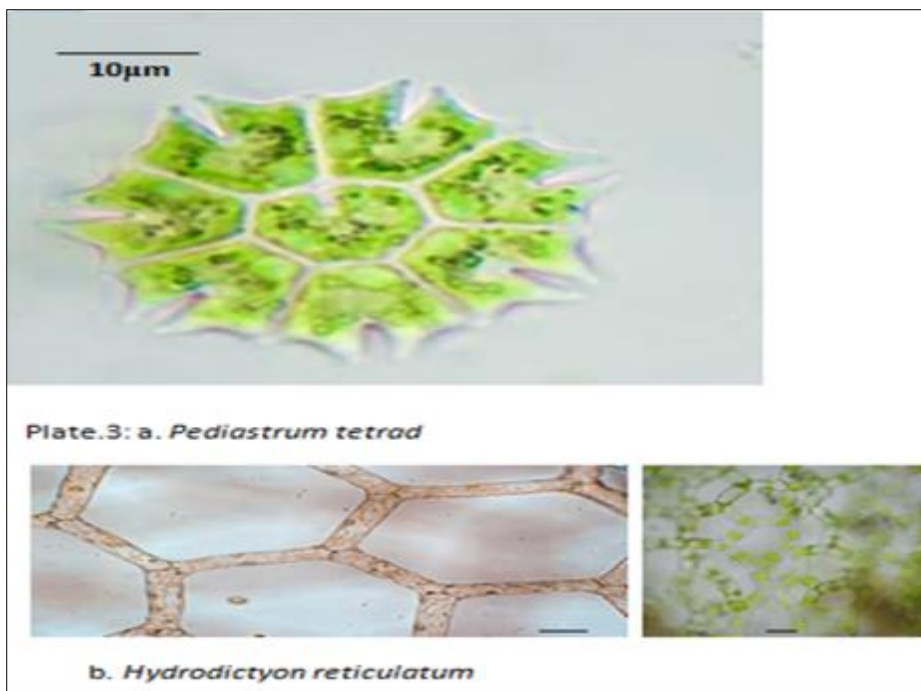


Figure 2 Micro photographs(scale bar 10 μm) of a: *Scenedesmus quadricauda*; b: *Scenedesmus ocuminatus*; c: *Pediastrum boryanum*; d: *Pediastrum duplex* var. *reticulatum*; e: *Pediastrum simplex* var. *echinulatum*



Figures 3 a: *Pediastrum*, tetrad; b: *Hydrodictyon reticulatum*

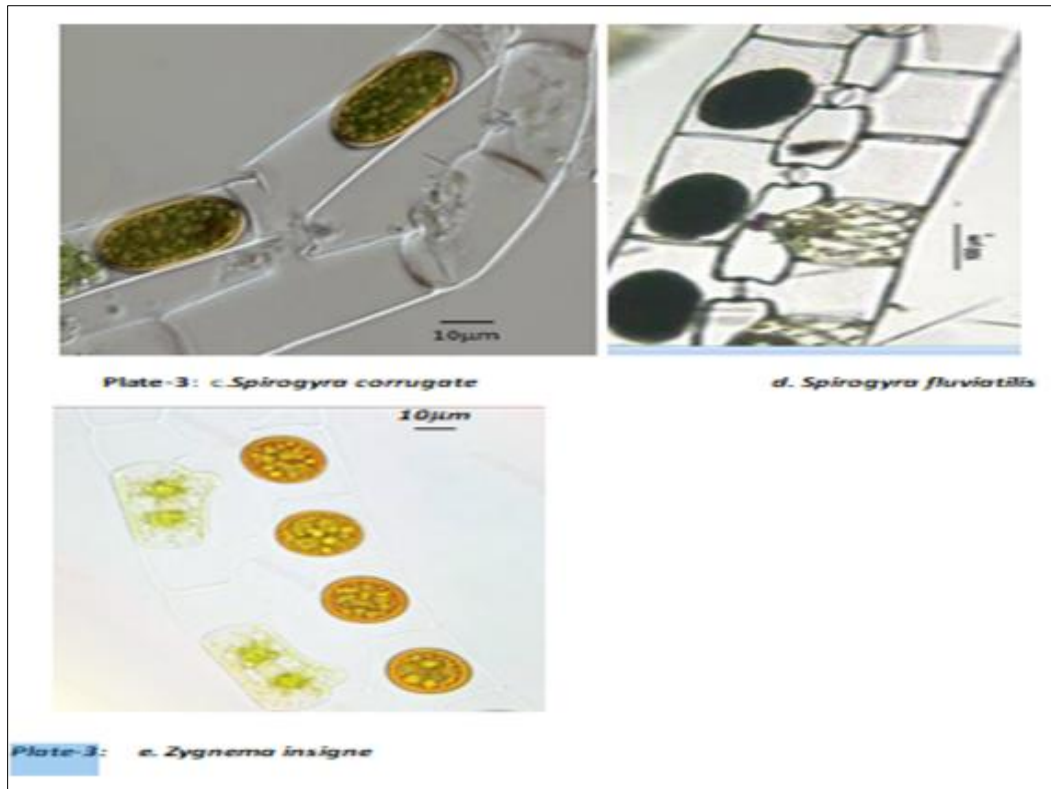


Figure 3 Micro photographs of c.: *Spirogyra corrugate*; d: *Spirogyra fluviatilis*; e: *Zygnema insigne*

4. Discussion

Taxa of some green algae are taken as a good bio- indicator of clean, unpolluted fresh water and they responded to changes in the environment and occurrences of pollution tolerant taxa only in the changed habitat. According to Palmer (1969) there are about 60 most pollution tolerant genera and 80 most pollution tolerant species of algae. Algae tolerances to organic pollution algal genera are rated on a scale 1 to 5. The diversity of species have been found to increase with the improvement in water quality. (Mollie Magner, 2022). Lowest number of taxa was found in Murguma and Kestobazar dam. Certain portion of these water bodies are used by few local people of the neighboring for various purposes like washing clothes, utensils, bathing, domesticated livestock washing etc. and these boarder areas have been avoided for collection. The collections were made from the undisturbed part of areas. Maximum numbers of taxa were found in Upper dam followed by Lower dam, undisturbed part of Murguma dam, Mable Lake. Maximum number of taxa were collected in the month of September. The occurrence of diverse desmids flora is further supported by oligotrophic nature as reported by the authors previously.

5. Conclusion

Present paper described a total 15 taxa of green algae. This study showed that wetland of Ajodhya hills is rich in algal diversity along with other groups of algae. This study highlights importance of the knowledge regarding the green algal flora of Ajodhya of Purulia district. The value of different physic-chemical parameters were found permissible limit prescribed by WHO and optimum condition for algal growth in these studied water bodies. This work will provide valuable information for hydrobiology and algal taxonomy. Water reservoirs show oligotrophic water quality in physicochemical analysis and also supported by the algal samples having genera like *Spirogyra*, *Zygnema* and different colonial green algae like *Pandorina*, *Gonium*, *Eudorina* etc. During the present study; pollution tolerant algal genera were recorded like *Pediastrum*, *Pandorina* etc.

Compliance with ethical standards

Acknowledgments

The authors would like to thank Prof. Dr. Jay Prakash Keshri, Dept. of Botany, Burdwan University for valuable information and suggestions. The authors are truly grateful to Prof. Dr. Kunul Kandir, Dean & H.O.D, University Dept. of Botany, Ranchi University, Ranchi for her kind co-operation and encouragement.

Disclosure of conflict of interest

No conflict of interest.

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