RESEARCH PAPER:

Morphological variations in chlorophyceae(green algae) due to polluted water of Damodar river running through Kathara area (Dist. Bokaro) Jharkhand

ARPANA SHARMA AND RADHA SAHU

Asian Journal of Environmental Science (December, 2009 to May, 2010) Vol. 4 No. 2 : 231-234

See end of the article for authors' affiliations

Correspondence to :
ARPANA SHARMA
Algal Biotechnology Laboratory, University Department of Botany, Ranchi University, RANCHI (JHARKHAND) INDIA

SUMMARY

The present communication elucidates morphological variations in Chlorophyceae (green algae) in relation to water quality of Damodar river along Kathara area. Damodar river is well known for establishment of coal based industries along its basin area. Kathara area of Bokaro district is one of the most productive coal mines. Mining activities like open cast mining, underground mining and coal washery have been conducted here. These mining activities release several kinds of pollutants like coal dust, ashes, oils and grease, floatation agents, flocculation agents etc. per day. All these effluents are directly added to river without recycling resulting in the change of physico-chemical characters of water and soil leading to morphological variation of algae.The study area has been divided into three sites as per quality of pollutants and their locations. Water as well as algal specimens were collected regularly from the above three sites for consecutive years 2005-07. Parameters taken were pH, Temperature, TSS, TDS, oils and grease, ammonical nitrogen, BOD, COD, arsenic, hexavalent Cr, fluoride and sulphide and estimated by standard procedure as prescribed by APHA(1985). Altogether 50 species of chlorophyceae belonging to 14 genera were recorded and studied. Morphological variations were clearly observed especially in species of *Ulothrix, Stigeoclonium, Oedogonium, Bulbochaete* etc. Severe morphological variations were observed in all the above genera during study. Cultural studies were also conducted in the laboratory in different culture media.

Key words :
Chlorophyceae, Damodar river, Morphological variation, Physico-chemical water analysis

Accepted :
August, 2009

Damodar river is one of the largest river of Eastern India and Jharkhand state. It originates from Chandwa village of Palamu district on the Chotanagpur plateau in Jharkhand and merges in the river Hooghly in West Bengal. Major catchment area of the river falls in the coal mining belts of Jharkhand. Kathara is one of the most productive mines of C.C.L(Central Coalfield Limited). It is surrounded from all the three sides by Damodar river and its tributaries as shown in the map. All the three types of mining activities like open cast mining, underground mining and coal washery is being conducted here throughout the year releases several tones of solid (raw coal stones, carbonaceous shale), liquid (oils and grease, flocculation agents, acid mine drainage) and gaseous (fly ashes, coal dust, fumes of organic and inorganic impurities like phenol, hexavalent Cr, SO_2 and NOx etc.) pollutants are released. There is no management system of recycling of pollutants and are directly added to the river and environment. The physico-chemical and biological qualities of water, air and soil get changed at all the points where effluents are added.

MATERIALS AND METHODS

The study area:

Site-I : Jarangdih open cast mines with huge coal dumping yards and heaps of raw coal stones.

Site-II: Jarangdih underground mines with small puddles for siltation and railway siding for transportation of coal.

Site-III: Kathara washery having large ashes and slurry ponds along the river side.

For physico-chemical water analysis, water samples were collected regularly from the above three sites for the years 2005-07 as per APHA(1985).

– For physico-chemical analysis water samples were collected from a depth of 0.5m from all sides in natural glass containers up to the top and precaution was taken to maintain the temperature during transit period.

– For heavy metal analysis water samples were collected in plastic sample container and rinsed with 1+1 nitric acid then redistilled water before use. Then added 5 ml conc. HNO_3 to minimize absorption of metals on the container walls.

The algal specimens were also collected

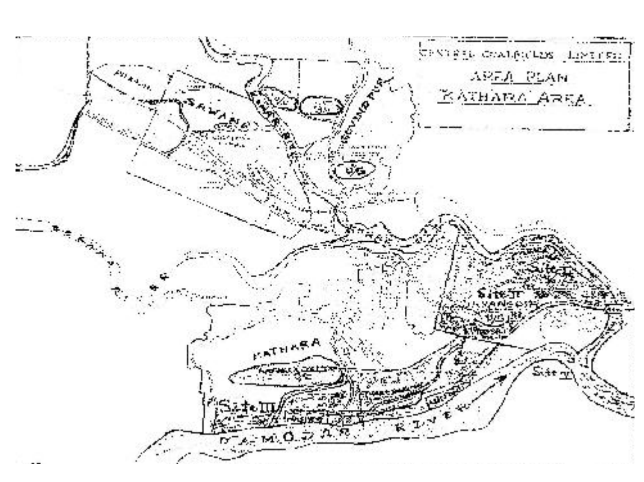

Fig. 1 : Area plan Kathara area

regularly from the study area with the help of planktonic net in wide mouthed bottle and were preserved in 4% formalin and brought to the laboratory. The specimens were observed in standard research microscope. Micrometric measurement was done, cameralucida drawings were made, microphotographs were also taken and identified with the help of standard monographs and research articles.

The cultural studies were conducted in the laboratory following different culture media:

– Godward's inorganic solution
– Habitat water and
– Tap water

Morphologically deformed species were placed in separate culture media under 12 hrs. artificial tube light and 12 hrs. darkness in a culture cabinet. Slides were made and observed under the standard microscope with a regular interval of 6 days. Growth rate pattern was drawn with the help of cameralucida drawings and microphotographs were also taken.

RESULTS AND DISCUSSION

Range and annual mean values of different physico-chemical parameters were collected from CMPDI, Ranchi given below in Table 1.

Altogether 50 species of chlorophyceae (green algae) belonging to 14 genera has been recorded during the years 2005-06-07 listed in Table 2 given below.

During the study, Physico-chemical water analysis reveals higher values of all the parameters at every sites especially pH, TDS, BOD, fluoride, hexavalent Cr and phenol as per table no.1. All the parameters studied were increased sharply during summer and winter while abruptly coming down during monsoon.

Present biosurvey showed wide range of morphological variations in chlorophyceae (green algae)because they are very sensitive and have ability to adopt towards adverse ecological factors and disturbance to their habitat (Tripathy, 2009).

Hydrodictyon reticulatum, *chlorella vulgaris* were collected only once from site-I when there was increased values of BOD, COD and sulphideas as reported by Gorrie (2004). They showed morphodeformities like hypertrophoid cells, uneven meshes due to irregular swelling of the coenocytes, chlorosis were prominent etc. (Table 1 and 2).

Several species of *Scenedesmus* like *S.qadricauda,*

Table 1 : Annual mean value of parameters at different sites

			Different years →								
			2005			2006			2007		
Sr. No.	Parameters	MAL	Site-I	Site-II	Site-III	Site-I	Site-II	Site-III	Site-I	Site-II	Site-III
1.	pH	7.5	9.0	8.16	8.19	9.1	8.18	8.11	9.2	8.5	8.21
2.	Temp.(°C)		30.0	23.1	20.25	31.0	20.0	22.16	32.0	23.0	21.12
3.	TSS	4.5	7.5	6.0	7.0	8.0	7.2	7.63	8.5	7.6	7.69
4.	TDS	275	545	490	496	600	602	500	610	524	540
5.	Oils and grease	0.01	1.25	1.0	1.12	1.15	1.0	1.13	1.5	1.32	1.43
6.	Ammonical nitrogen	0.01	3.0	2.18	2.13	3.10	3.0	2.17	3.12	3.0	2.92
7.	BOD	25.0	50.1	45.5	46.10	51.0	52.3	50.27	60.0	52.0	53.24
8.	COD	8.5	16.1	10.0	12.62	20.0	11.1	12.95	23.0	19.0	21.61
9.	Arsenic	0.001	2.0	1.5	1.42	2.57	1.5	2.12	3.5	2.0	2.31
10.	Hexavalent Cr	0.001	2.5	1.5	1.30	3.0	1.25	2.10	3.4	2.1	2.0
11.	Fluoride	0.001	1.15	1.0	1.10	2.0	1.63	1.59	2.11	1.12	1.0
12.	Sulphide	0.001	1.1	1.0	1.0	1.3	1.1	1.1	1.1	1.0	1.1

All parameters are in mg/l
MAL = Maximum Allowable Limit

Table 2 : Algal specimens recorded during study

Sr. No.	Name of the taxa	Site-I	Site-II	Site-III
1.	*Hydrodictyon reticulatum* Lag.	+	-	-
2.	*Chlorella vulgaris* Bej.	+	-	-
3.	*Scenedesmus quadricauda* Turp.	+	+	+
4.	*Scenedesmus obliqus* Kuetz.	+	+	+
5.	*Scenedesmus dimorphus* Smith	+	+	+
6.	*Scenedesmus bijugatus* Kuetz.	+	+	+
7.	*Scenedesmus priesmaticus* Bru.	+	+	+
8.	*Ulothrix oscillarina* Kuetz.	+	-	+
9.	*Ulothrix moniformis* Kuetz.	+	+	-
10.	*Ulothrix cylindricum* Kuetz.	+	+	+
11.	*Ulothrix aqualis* Kuetz.	+	-	+
12.	*Ulothrix teanissima* Kuetz.	+	-	+
13.	*Ulothrix tenerrima* Kuetz.	+	+	+
14.	*Ulothrix subtiliense* Rabenh.	+	-	+
15.	*Microspora amoenae* Kuetz.	-	+	-
16.	*Microspora tumidula* Hazen	-	-	+
17.	*Microspora williense* Lager.	-	+	-
18.	*Microspora membranaceae* Wang.	+	-	-
19.	*Stigeoclonium teanue* Hazen	+	+	+
20.	*Stigeoclonium attenuatum* Hazen	+	+	+
21.	*Stigeoclonium farctum* Hazen	+	+	+
22.	*Stigeoclonium aestivales* Hazen	+	+	+
23.	*Oedogonium texans* Tiff.	+	-	+
24.	*Oedogonium punctatostriatum* Tiff.	+	+	+
25.	*Oedogonium nanum* Wittr.	+	+	+
26.	*Oedogonium paloense* Britt.	+	+	+
27.	*Oedogonium ilsteri* Skuja	+	+	+
28.	*Oedogonium dowsonii* Britt.	+	+	-
29.	*Oedogonium canadense* Tiff.	+	+	+
30.	*Oedogonium reticulosporum* Mroz.	+	+	+
31.	*Bulbochaete monile* Wittr.	+	+	+
32.	*Bulbochaete rectangularis* Wittr.	+	+	-
33.	*Bulbochaete nana* Gonz.	+	+	-
34.	*Bulbochaete nitidia* Jao.	+	+	+
35.	*Bulbochaete mirabilis* Wittr.	+	-	+
36.	*Bulbochaete randhawae* Gonz.	+	+	-
37.	*Rhizoclonium profundum* Br.	-	+	-
38.	*Rhizoclonium hieroglyphicum* Br.	-	-	+
39.	*Zygnema pectinatum* Ag.	-	+	+
40.	*Zygnema czurdae* Ran.	-	+	+
41.	*Sirogonium sticticum* Kuetz.	-	-	+
42.	*Spirogyra inflate* Kuetz.	+	+	+
43.	*Spirogyra bruneae* Kuetz.	+	+	+
44.	*Spirogyra flavescence* Kuetz.	+	+	+
45.	*Spirogyra singularis* Kuetz.	+	+	+
46.	*Closterium acerosum* Nag.	+	+	+
47.	*Closterium moniliferum* Nag.	+	-	-
48.	*Closterium parvulum* Nag.	+	-	+
49.	*Closterium cicularae* Nag.	+	+	+
50.	*Cosmarium subimpressulum* Brg.	-	-	+

'+' connotes presence and '-' connotes absence

S.dimorphus, S.bijugatus, S.priesmaticus; Ulothrix species e.g *U.oscillarina, U.tenerrima, U.aqualis, U.teanuisimma*, U.zonata species of *Stigeoclonium* e.g *S.tenaue, S.farctum,S.aestivales,S.attenuatum* were dominant at all the sites may be due to higher values of oils and grease , hexavalent chromium ammonical liquor (Hagen 2006) .

Species of *Oedogonium* e.g *O. texans, O. punctatostriatum, O. nanumO. paloense,O. ilsteri, O.dowsonii, O. canadense, O. reticulosporum; Rhizoclonium species, Bulbochaete species like B. monile, B. rectangulari, B. nitidia, B. mirabilis, B. randhawe*; *Spirogyra* species e.g *S. inflatae, S. bruneae, S. flvescens, S. singularis* were dominant at all the sites throughout the year growing in much deformed forms. They were collected when the parameters like pH, TDS and arsenic were higher as reported by Tripathy (2009) Table 1 and 2.

Interestingly the cultured specimen showed healthy and normal growth in Godward's inorganic solution as well as in tap water but in habitat water no proper growth was seen and finally the specimen disintegrate and maximum growth was seen in Godward's inorganic solution as compared to the tap water medium. It proves that the morphological variations are due to the pollution load of mining activities in the river water.

Fig. 2 show below showing the total percentage of pollution tolerant species at different sites *i.e. Bulbochaete> Oedogonium> Scenedesmus> Ulothrix > Closterium> Spirogyra.*

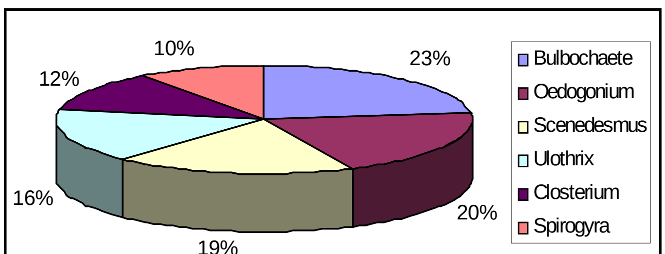

Fig. 2 : Percentage composition of dominant chlorophycean members at three different sites of the study area

Conclusion:

Chlorophyceae (green algae) are very sensitive to change in the water quality by toxic chemicals, heavy metals, organic and inorganic impurities. Due to the presence of these pollutants, some of the genera survive in a deformed stage loosing their normal morphology called as morphological variations. These genera e.g *Ulothrix, Stigeoclonium, Oedogonium, Bulbocheate, Spirogyra, Closterium* etc. are established as pollution tolerant species and also act as pollution indicators.

Authors' affiliations
RADHA SAHU, Algal Biotechnology Laboratory, University Department of Botany, Ranchi University, RANCHI (JHARKHAND) INDIA

REFERENCES

APHA (1985). *American water pollution control Federation*: Standard methods for the examination of waste water, 19th edition, New York,U.S.A

Gorrie, R.M. (2004). Forely development in upper Damodar valley 15th years scheme, D.V.C. Kolkata, pp. 3-192

Hagen, H.D. (2006). Environmental Governance in mining areas, East-West publishers, New Delhi.