JABU JOURNAL OF ALGAL BIOMASS UTILIZATION
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# Biodiversity of Microalgae and Cyanobacteria from freshwater bodies of Jodhpur, Rajasthan (India)

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## ABSTRACT

Biodiversity of microalgae and cyanobacteria from different freshwater bodies of Jodhpur, Rajasthan (India) was studied and compared their variations in terms of physicochemical and diversity indices . In all eighty four forms were observed in just twenty five samples that were collected from 7 water bodies. There were 26 green algae belonging to 16 genera, 9 morphotypes of diatoms and 48 morphotypes of 13 cyanobacterial genera. Indicating that generic diversity was high in green algae but morphotypic diversity in cyanobacteria. Shannon and Weaver's Biodiversity Index (H') varied from 0.655 to 1.189.

**Key words: Biodiversity, Rajasthan, Jodhpur, Microalgae, Cyanobacteria, Diversity index,**

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INTRODUCTION:

Microalgae and Cyanobacteria (blue-green algae) are capable of both carbon assimilation and $N_2$ fixation, thereby enhancing productivity in variety of environments. Apart from fixing atmospheric $N_2$, they secrete a number of biologically active substances. Tropical conditions such as those in India provide favourable environment for the luxuriant growth of these organisms in the natural ecosystems such as different types of soil, freshwater bodies, oceans, saline backwaters, estuaries, and also hyper saline saltpans (Subbaramaiah, 1972; Srivastava & Odhwani, 1992; Thajuddin & Subramanian, 1992; Thajuddin *et al.* 2002; Rajkumar, 2004; Chellappa *et al.* 2004; Goyal S.K, 1962,1964; Bhatnagar and Bhatnagar 2005; and Bhatnagar *et al.* 2008; Makandar and Bhatnagar 2010). Microalgae and cyanobacteria, until recently in oblivion, uncared for and unrecognized, have shot into fame and popularity owing to a host of their innate properties that make them ideal organisms for use in a variety of ways to meet our needs and to promise us a bright future (Thajuddin and Subramanian, 2005). Besides their ecological significance, offer a grate potential tool as an organisms for the biotechnological interest such as mariculture, food, feed, fuel, fertilizer, medicine and combating pollution (Mitsui *et al.* 1981; Venkataraman 1981, Venkataraman, 1983; Kannaiyan, 1985; Borowitzka, 1988; Gustafson *et al.*, 1989; Prabaharan & Subramanian, 1995; Subramanian & Uma, 1996). The present work was carried out to understand the diversity of microalgae and cyanobacteria from different

freshwater bodies of Jodhpur city as an initiative study for exploiting their innate potentials.

## MATERIAL AND METHODS

*Study area and sampling*

The Jodhpur district is located in the western Rajasthan of India. The district is bounded on the north by Bikaner District, on the northeast by Nagaur District, on the southeast and south by Ajmer District, on the southwest by Pali District, and on the west and northwest by Jaisalmer District. The district stretches between 26 00' and 27 37' at north Latitude and between 72 55' and 73 52' at East Longitude. This district is situated at the height between 250–300 meters above sea level. There are several natural and artificial fresh water bodies are distributed more frequently in and around Jodhpur city with seasonal algal blooms.

Visible and planktonic samples were collected from various freshwater bodies by dipping sterilized sampling bottle to 0.5-1 ft. Opened to collect water and recapped there itself. Samples were transported in a box containing ice and were preserved at $4^{o}$C. An aliquot of 100 ml homogenized sample was separated for studies on the live organisms and then 4 % formalin was added to rest of the of the amount for longer preservation.

Water samples were also taken from each site for analyzing physico-chemical by using standard methods (APHA, 1975).

*Morphotypic Diversity*

Diversity of total and diazotrophic morphotypes in normal water samples

was determined by enrichment culture technique as described below:

*Sterilization*

The glassware were rinsed with chromic acid and washed in running tap water. Before use, these were rinsed twice with tap water and thrice with distilled water and were dry sterilized at 160$^{o}$ C for 2 hr in a hot air oven. Culture medium was sterilized at 15 lb pressure (121$^{o}$ C) for 20 minutes in an autoclave.

*Enrichment*

Ten ml of water sample were inoculated in 50 ml sterilized standard BG-11 medium with and without nitrate nitrogen in 100 ml Erlenmeyer flasks in triplicates for the diversity studies of total and diazotrophic morphotypes.The flasks were shaken well and incubated in growth room maintained at 29 ±1$^{o}$C and 12:12h::L:D cycle. Illumination of 1100-1300 Lux was provided using two cool white fluorescent lamps (40 W) in each rack.

*Incubation and Identification*

The cultures were incubated till the appearance of good growth (20 days in BG -11 +N, 30 d in BG-11 -N) algal and cyanobacterial morphotypes appearing in the enrichment cultures were examined microscopically and identified using taxonomic keys after Smith (1950), Prescott (1982), Desikachary (1959), Geitler (1932) and Starmach (1966).

*Abundance Pattern*

The abundance pattern of cyanobacterium or microalga was marked in the field of view. Five fields were observed for each of the three replicates and rated as Very Rare (VR), Rare (R), Fairly Common (FC),

Common (C), Very common (VC) and Dominant (D), based on the imaginary total area under view that could be covered if the cells of a morphotype were grouped together.

VR R FC C VC D

*Ecological parameters and statistical treatment*

Shannon and Weaver's index ($H_{T'}$) for total and diazotrophic morphotypes ($H_{D'}$), frequency and species richness ($SR_T$ and $SR_D$ for +N and -N enrichment respectively) were determined for each site of sampling. Performance index (PI) for each form was then calculated as proportional presence of morphotype x sum of abundance pattern of the morphotype. Standard skewness and standard kurtosis for populations of $SR_T$, $SR_D$, $H_{T'}$ and $H_{D'}$ were used to find out if they were normally distributed. Kolmogorov Smirnov test was used to compare distributions of populations. Student's t-test to determine if the difference in population means was statistically significant and F-test to compare the standard deviation.

**RESULT AND DISCUSSION**

Water samples drawn from seven freshwater bodies were studied, so as to compare their microalgal and cyanobacterial diversity. Freshwater bodies other than Fidusar Chopar (water from lime stone quarry) had neutral to slightly alkaline pH (Table 1.0). Conductivity ranged from 357 to 927µS $cm^{-1}$ and water soluble cations viz. $Na^+$, $K^+$ and $Ca^{2+}$ were less than 50 ppm each.

**Table 1.0 Physicochemical properties of freshwater samples from Jodhpur (Rajasthan )**

| Site | pH | Conductivity ($\mu S\ cm^{-1}$) | Na (ppm) | K (ppm) | Ca (ppm) |
|---|---|---|---|---|---|
| Meherangarh Fort pond, Jodhpur | 7.01 | 927 | 39.3 | 38 | 47 |
| Jaswant Thada, Jodhpur | 7.71 | 437 | 31.5 | 5.8 | 30.7 |
| Kailana lake Jodhpur | 7.13 | 357 | 13.6 | 51.2 | 21.6 |
| Fidusar Chopar | 8.4 | 536 | 16.8 | 40.6 | 32.2 |

***Microalgal Biodiversity***

Biodiversity of microalgae and cyanobacteria was estimated in terms of Shannon and Weaver's Biodiversity Index (H') it varied from 0.655 to 1.189 (Table 2.0). Results of enrichment in BG 11+N medium also were as depictive as of the original sample observed directly under microscope. However there was poor representation of diazotrophic forms.

**Table 2.0 Diversity indices of microalgae and cyanobacteria in some fresh water bodies of Jodhpur (Rajasthan)** ($H_o$ : Original sample, $H_t$: Total on enrichment, $H_d$: Diazotrophic)

| Sampling site | $H_o$ | $H_t$ | $H_d$ |
|---|---|---|---|
| Maherangarh Fort pond Jodhpur | 1.001 | 1.007 | 0.301 |
| Kailana lake Jodhpur | 0.655 | 0.655 | 0.292 |
| Pink stone quarry, Fidusar Chopar | 0.781 | 0.573 | 0.297 |

| | | | |
|---|---|---|---|
| Mandore Temple Pond Jodhpur | 0.793 | 0.537 | 0.292 |
| Arjunpura tube well storage tank | 1.189 | 0.552 | 0.283 |
| Kesarpura tube well storage tank | 0.876 | 0.581 | 0.279 |
| Ajmer university Tube well storage | 0.995 | 0.621 | 0.302 |
| **Mean** | **0.8985** | **0.693** | **0.294** |
| **Standard deviation** | **0.1774** | **0.2151** | **.0035** |

In all eighty four forms were observed in just twenty five samples that were collected from 7 water bodies. There were 26 green algae belonging to 16 genera, 9 morphotypes of diatoms and 48 morphotypes of 13 cyanobacterial genera. Indicating that generic diversity was high in green algae but morphotypic diversity in cyanobacteria. Amongst green algae, a maximum of 5 morphotypes were that of *Scenedesmus*, followed by *Cosmarium* (3) while amongst cyanobacteria *Oscillatoria* (8), *Chroococcus* (6) and *Lyngbya* (5) had more representatives than *Phormidium*, *Nostoc* and *Gloeocapsa* that showed 4 morphotypes each. The most frequent genera were *Scenedesmus* > *Oscillatoria* > *Chroococcus* > *Gloeocapsa*, *Phormidium* > *Chlorococcum* > *Cosmarium* > *Chlorella* and *Plectonema*. A genus being very frequent might not contribute sufficiently in terms of biomass or activity to its habitat as it might have low dominance pattern in samples. Therefore performance of each genus was indexed based on their importance value each sample and the overall frequency. It was seen that Performance Index was high for *Scenedesmus* (4.89), *Chlorococcum* (2.8) and *Navicula* (1.93) although except the

first the rest were comparatively infrequent (Fig. 1.0 and 2.0).

**Fig. 1.0 Generic Contribution of cyanobacteria to morphotypic diversity in some fresh water bodies of Jodhpur (Rajasthan)**

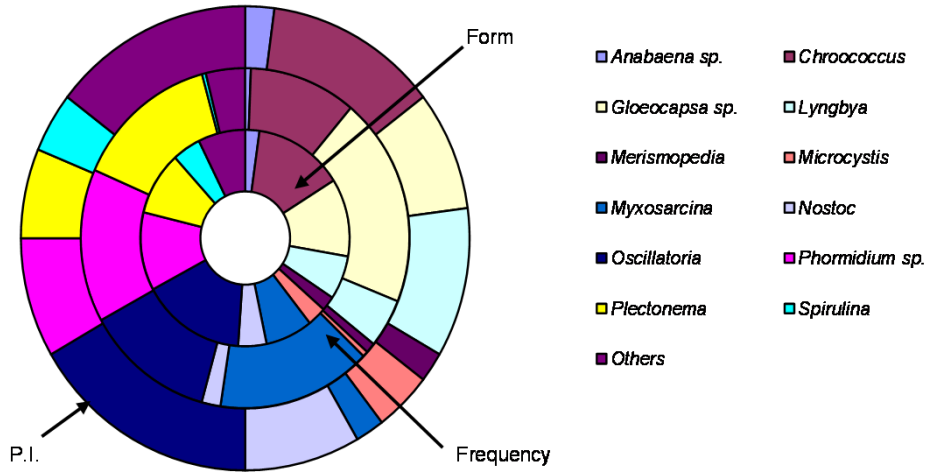
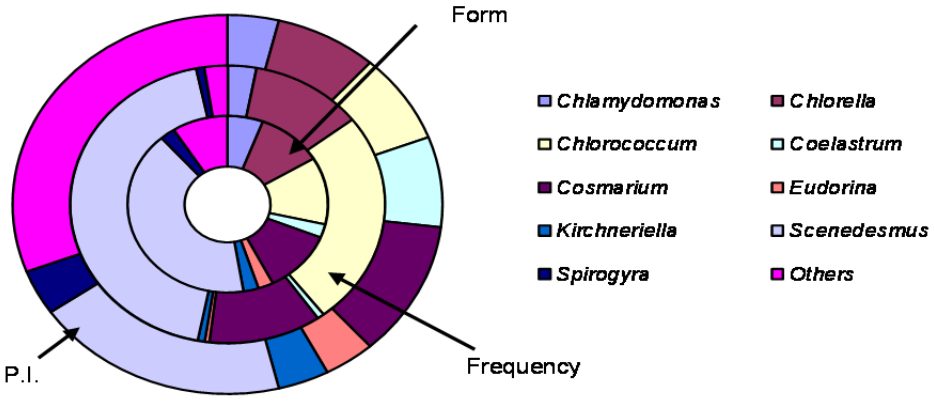



**Fig. 2.0 Generic contribution of Microalgae to morphotypic diversity in some fresh water bodies of Jodhpur (Rajasthan)**



There were morphotypes, which were seen only in one sample. These constituted 33.33% of the total 84 forms. *Scenedesmus dimorphus, Chlorococcum humicola, Navicula* sp., *Scenedesmus quadricauda* and *Myxosarcina burmensis* were the most frequent morphotypes, however performance wise *Chlorococcum humicola* was the best followed by *Scenedesmus dimorphous, S. quadricauda, Navicula* sp., *Chlorella* sp. and *Myxosarcina burmensis* respectively (Table 3.0).

| **Table 3.0 Frequency and Performance Index of various morphotypes of microalgae and cyanobacteria observed in some fresh water bodies of Jodhpur (Rajasthan).** Morphotypes | **Freq.** | **PI** |
|---|---|---|
| *Anabaena* sp., *Aulosira* sp., *Chroococcus giganteum West, C. turgidus (Kutz.)Nag., Lyngbya* sp., *L. cryptovaginata Schk.,* *Nostoc* sp., *N. commune (Vaucher), Oscillatoria sp, O. granulosa Martenes, Spirulina subtilissima (Kutz.)* | 4.00 | 0.00 |
| *Gonium* sp., *Pandorina* sp., *Gloeocapsa gelatinosa Kutz. , Lyngbya rivularianum Gom.* *Nostoc sphericum Vaucher, Nostochopsis* sp. | | 0.01 |
| *Achnanthes* sp., *Cymbella* sp. | | 0.02 |
| *Pediastrum* sp., *Microcystis pulvarea(Wood) Forti , Phormidium* sp. | | 0.04 |
| *Oedogonium* sp. | | 0.05 |
| *Coelastrum microporum* Nägeli | | 0.07 |
| *Gloeothece palea (Kutz.)* | | 0.09 |
| *Calothrix* sp., *Pediastrum biradiatum* Meyen, *Scenedesmus obliquus* | | 0.11 |
| *Coelastrum* sp., *Synechococcus* sp. | 8.00 | 0.01 |
| *Ankistrodesmus falcatus* (Corda) Ralfs, *Chroococcus versicolor, Hapalosiphon* sp. | | 0.02 |
| *Chrococcus gomonti Nygaard, Protococcus* sp. | | 0.03 |
| *Anabaena khannae* Skuja, , *Oscillatoria limosa* Ag., *O. Terrebriformis Ag.,* | | 0.04 |
| *Cymbella alpina* Grunow. | | 0.05 |

| | | |
|---|---|---|
| *Rhizoclonium* sp. | | 0.06 |
| *Chlorococcum* sp. | | 0.07 |
| *Lyngbya taylorii, Oscillatoria formosa Bory.,* | | 0.09 |
| *Ulothrix* sp. | | 0.10 |
| *Gloeocapsa gigas* West., | | 0.14 |
| *Cosmarium* sp. | | 0.21 |
| *Oscillatoria agardhii* Gomont, | | 0.03 |
| *Eudorina* sp. | | 0.05 |
| *Scenedesmus quadricauda longispina* (Chodat). | 12.00 | 0.06 |
| *Amphora* sp., *Merismopedia glauca* (Ehr.) Naegeli | | 0.07 |
| *Kirchneriella obesa West.,* | | 0.08 |
| *Cosmarium ocellatum* Eichler & Gutwinski, *Spirogyra* sp. | | 0.09 |
| *Nostoc punctiforme (Kutz.)* | | 0.11 |
| *Oscllaoria subbrevis Schmidle.* | 12.00 | 0.13 |
| *Plectonema purpureum* Gomont. | | 0.20 |
| *Microcystis aeruginosa (Kutz.)* | | 0.33 |
| *Chlorella vulgaris* Beijerinck | | 0.14 |
| *Lyngbya borgerii* Lemmermann | 16.00 | 0.21 |
| *Phormidium innundatum* Kiltz. | | 0.25 |
| *Stauroneis* sp. | | 0.29 |
| *Gloeocapsa* sp. | | 0.10 |
| *Phormidium tenue* (Menegh). | | 0.17 |
| *Spirulina* sp. | 20.00 | 0.26 |
| *Chroococcus dispersus* (Keissler) Lemmermann. | | 0.21 |
| *Pinnularia* sp. | | 0.31 |
| *Scenedesmus bijuga* (Turpin) Lagerheim. | | 0.46 |
| *Plectonema nostocorum* Bornet ex Gomont. | 24.00 | 0.38 |

| | | |
|---|---|---|
| *Nitzschia* sp. | | 0.39 |
| *Phormidium angustissimum* West. | | 0.55 |
| *Synedra ulna* (Nitzsch) | | 0.64 |
| *Chlamydomonas* sp. | 28.00 | 0.33 |
| *Plectonema notatum* Schmidle | | 0.60 |
| *Chroococcus minor (*Kützing) Nägeli | 32.00 | 0.46 |
| *Oscillatoria obscura* Brühl et Biswas | | 0.54 |
| *Gloeocapsa aeruginosa* Kützing | | 1.12 |
| *Cosmarium taxichodriformis* | 36.00 | 0.98 |
| *Chlorella* sp. | | 1.16 |
| *Myxosarcina burmensis* Skuja | 40.00 | 1.05 |
| *Scenedesmus quadricauda (*Turp.) de Breb | | 2.03 |
| *Navicula* sp. | 48.00 | 1.93 |
| *Chlorococcum humicola* (Naeg.) | 52.00 | 2.73 |
| *Scenedesmus dimorphus* (Turp) Ktz. | 125.00 | 2.23 |

Five fresh water bodies at Jodhpur lie within 40 km distance from each other in and around the city. Yet there were striking differences in terms of microalgal biodiversity. The difference was also remarkable as sampling at Meherangarh, Kailana and Mandore was done during August and at Fidusar Chopar in the September month of the same year, i.e. 2004, indicating that observed variation was not a result of climate but of actual water chemistry.

Only *Microcystis aeruginosa* and *Scenedesmus quadricauda* were the common inhabitants at Meherangarh fort pond and Mandore Tank. *Oscillatoria obscura* and *Chlorella* sp. were found at

Meherangarh fort pond and amongst the lithophytes of the seeping water at stone quarries of Fidusar Chopar. Rest of the forms were specific to each of the aquatic body. A maximum of thirteen forms (excluding diatoms) could be observed at Meherangarh (mostly on enrichment in BG 11+N medium) whereas the least (4 species) were found at Kailana lake. Some of the forms were observed by Goyal (1964) and Thajuddin et al., (2007) at Jodhpur and Thanjavur respectively were suit the present study. In any ecosystem, not a single species grows independently and indefinitely, because all the species are interlinked and has cyclic transformation of nutrients. The physicochemical changes in the environment may affect particular species and induce the growth and abundance of other species, which leads to the succession of several species in a course of time. Amongst the observed parameters, conductivity and cations appear to be the factors affecting occurrence of different algae. Hence the present study concluded inspite of the fact that the Microalgae and cyanobacteria are ubiquitous, their population dynamics are often influenced by the available nutrients and the physico-chemical conditions of the ecosystem.

**Acknowledgements**

We thank the Department of Biotechnology, Government of India for financial support.

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