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Algal Biodiversity in Selected Freshwater Aquatic Bodies in Bhubaneswar India

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Abstract: Algae are a very large and diverse group of organisms with huge significance, having many applications ranging from food products to biofuel production due to their ability to profitably accumulate huge content of beneficial macromolecules (such as, proteins, lipids, etc.). The city of Bhubaneswar in Khordha district of Odisha is in the east coast of India. It is recognised as the temple city and has a lot of ponds and other water bodies around, many of which are of religious significance. In the present study the algal species present in the water bodies dotting the city were identified up to the genus level. Eleven samples were collected from various freshwater habitats in the city. After microscopic observations of the samples the organisms were identified using relevant monographs under various algal groups. The algal species identified indicated that their growth was favoured by the hot and humid tropical savanna climate of the city. Such algal diversity analysis helps in indentifying the potential algal species that could be screened, isolated and their favored growth in such an agro-climatic condition can be capitalised for beneficial use.

Key words: Algae, Aquatic body, Bhubaneswar, Biodiversity, Limnology.

Introduction

Algae are a large and diverse group of simple, typically autotrophic unicellular to multicellular organisms. It is estimated that about 200,000-800,000 algal species exist of which about 35,000 species have been so far described [6]. They are a highly significant group of eukaryotic organisms, being the first organisms to conquer the land from the oceans and then evolving into plants [22]. Most are photosynthetic and lack many distinct cell organelles and cell organisation found in terrestrial plants. Algae constitute a polyphyletic group [17] since they do not include a common ancestor. Although their plastids seem to have a single origin from cyanobacteria [12], they were reportedly acquired in different ways.

The biodiversity of microalgae is enormous and they are still an almost untapped resource. Species-specific, they may contain high levels of carbohydrates, sugars and proteins, and can be used to produce animal feed and even human food [23]. Algae also contain large amounts of oil which is similar to other vegetable oils like rapeseed, soy, and canola, and can easily be transformed into biodiesel. Thus biofuel production from microalgae potentially offers great opportunities in a longer term [16]. Algae have appli-cations in fertiliser industry, bioremediation, pollution control. These are important in maintaining the equilibrium of aquatic ecosystems, and are also good bioindicators [4,5]. The algal growth in a habitat influences the ecosystem and responds rapidly to changes in the aquatic environment particularly in relation to nutrients. Their distribution and variation at different zones in a water body are influenced by its physicochemical status.

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India is a country with a rich aqua-floral biodiversity due to its water bodies, abundant sunlight and its typical tropical climatic conditions. The state of Odisha located in the east cost of India (Lat. 17° 48'-23° 34' N and Long. 81° 24'-87° 29' E) has an area of 1,55,842 km^2 and is rich in water bodies due to its several rivers, reservoirs, lakes, ponds and ditches, streams in the hilly terrain, and religious beliefs. Its capital city of Bhubaneswar is located in the Khordha district of Odisha (20.27°N 85.84°E) surrounded by rivers Mahanadi, Daya and Kuakhai, in the eastern coastal plains, along the axis of the Eastern Ghats mountains. It has an average altitude of 45 m (148 ft) above the mean sea level. Considerable works have been done in India about systematic survey, distribution, periodicity and ecology of algae in different habitats [2,7,8,9].

The algal diversity in the old Bhubaneswar regions was explored. In this study the algal species present in the eleven identified water bodies dotting the city were identified up to the genus level. Common prevalence of algae in these water bodies was studied which indicated the algal species whose growth is favored by the sunny, hot and humid tropical savanna climate of Bhubaneswar.

Materials and Methods

Sample collection

Water samples were collected from 11 different sites in Bhubaneswar (Figs 1,2; Table 1) by the water bodies by flask-scooping.

Centrifugation

The water sample was crude centrifuged to separate and concentrate the suspended in algal biomass. One ml of this was taken in a microcentrifuge tube and centrifuged **(Cole-Parmer 2012)** at 1000 rpm for two minutes in room temperature. This helps concentrate the algal sample for easier microscopic observation. The supernatant obtained was discarded and the desired biomass was used for the study.

Microscopy

The sample concentrate was observed microscopically using light microscope and microalgae were identified [10,18]. 20 microlitre of the sample was pipetted out from the microfuge tube and placed on glass slide. A cover slip was put over the glass slide so that the sample remains intact and free from other artefacts like dust particles, and the slide was observed under the microscope at 10X and 40X magnifications [1]. After studying their morphological features under the light mi-

Fig. 1. Respective photographs of the various collection sites

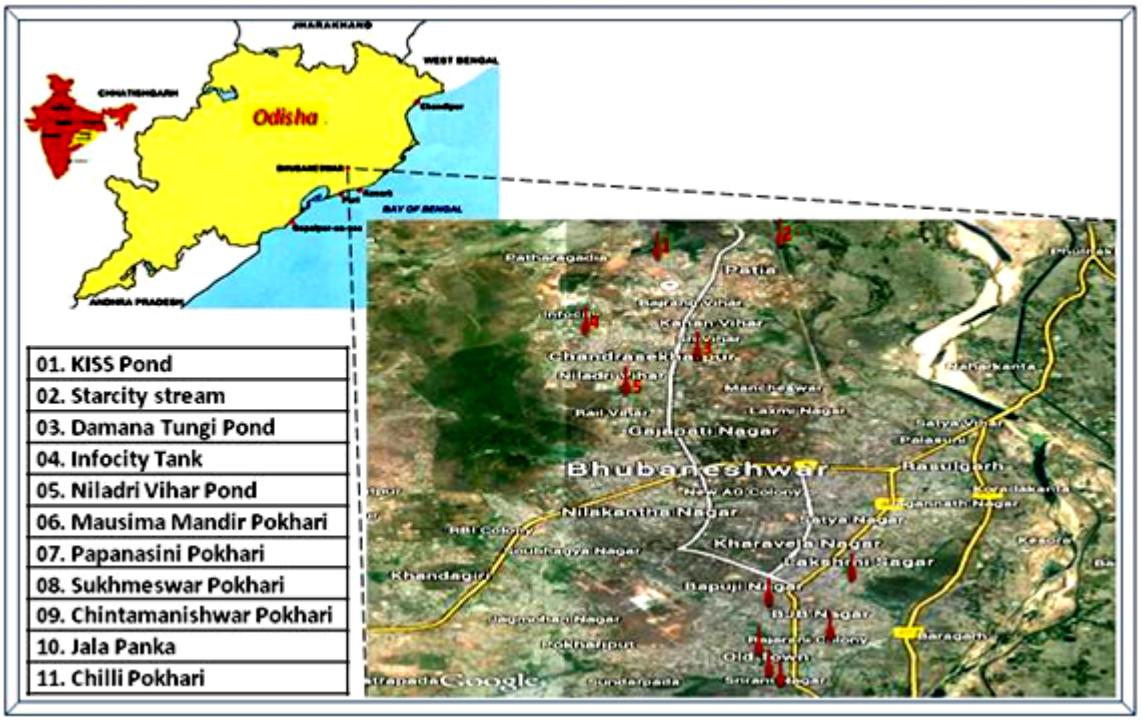

Fig. 2. Map of Bhubaneswar with the collection sites marked red (Source: Google Map)

Table 1. List of the sample collection sites with the latitude, longitude, and the habitat type

No.	Place of collection	Latitude	Longitude	Habitat type
1	KISS Pond	20°21’54.0"N	85°49’02.1"E	Pond
2	Starcity stream	20°22’11.0"N	85°49’55.4"E	Stream
3	Damana Tungi Pond	20°19’59.8"N	85°49’41.0"E	Pond
4	Infocity Tank	20°20’34.4"N	85°48’21.4"E	Ditch
5	Niladri Vihar Pond	20°19’16.4"N	85°48’42.9"E	Pond
6	Mausima Mandir Pokhari	20°15’13.1"N	85°50’06.7"E	Pond
7	Papanasini Pokhari	20°14’22.3"N	85°49’58.9"E	Pond
8	Sukhmeswar Pokhari	20°13’43.8"N	85°50’10.2"E	Pond
9	Chintamanishwar Pokhari	20°15’49.6"N	85°51’00.3"E	Pond
10	Jala Panka	20°13’58.9"N	85°50’02.9"E	Pond
11	Chilli Pokhari	20°14’37.1"N	85°50’47.3"E	Pond

croscope and preparing sketches, the organisms were identified using relevant monographs for various algal groups.

Results and discussion

The study made a survey of the algal biodiversity in and around Bhubaneswar. Algal samples from the sources identified are habituated to the climatic conditions of the city. It was observed that *Botryococcus* blooms mostly grew in water bodies in the old town area of Bhubaneswar, generally in the ponds beside the old heritage temples which dot the cityscape of the ‘old town’. It was seen as a pyramid shaped planktonic green microalga, generally found in colonies. Mostly, these water bodies with *Botryococcus* colonies did not harbor other algal species much. This may be due to the toxic effects of the free fatty acids exudates

of *Botryococcus* spp. [24]. Compared to other green algae species it had a relatively thick cell wall that is accumulated from previous cellular divisions.

Similarly, *Spirulina*, seen as tiny blue green algae in the form of a spiral coil, was identified from Chilli Pokhari and Jala Panka ponds. The genus *Tetraspora*, observed as a spherical structure embedded in some gelatinous matrix with cells scattered or arranged in groups of four or six, was identified in the samples of Mousima Mandir and Infocity ponds. Owing to the contiguous industrial growth leading to possible chemical contamination of Infocity pond, only a single species *Microspora* was observed a non-dominant species as an unbranched, filamentous green alga with cylindrical or swollen cells in Niladri Vihar and Damana Tungi ponds. *Microspora*, H-shaped cell structures forming a jelly like appearance, showed few brown bands between two cells when noticed carefully.

Damuna Tungi pond exhibited few boat-shaped *Navicula* (Table 2). The Star City stream sample was found to contain structurally filamentous spiral shaped alga *Spirogyra* and a few *Spirulina* species (Fig. 3). Oscilatoria, a blue green alga, was seen in Damana Tungi and KISS ponds as unbranched filamentous shaped structures occurring prominently either as individual cells or tangled in mats. The Damana Tungi pond was found to be most rich as a majority of the algal species identified was found surviving there (Table 3).

Oedogonium, a floating unbranched filamentous green alga, was observed in Damana Tungi pond sample. The presence of rings at the wider end of the species that arises as a consequence of cell division confirmed healthily growing *Oedogonium* cells. *Scenedesmus*, a green alga seen to form colonies of 4-8 cells arranged in rows, was also observed in the same sample. Among all the algal genera identified, the economic significance of the two is worth mentioning.

Table 2. List of the sites of collection showing the algal genus identified from them

Aquabody	*Botryococcus*	*Tetraspora*	*Microspora*	*Spirulina*	*Oscillatoria*	*Oedogonium*	*Naviculla*	*Scenedesmus*	*Spirogyra*
Damana Tungi			✓		✓	✓	✓	✓	
KISS					✓				✓
Star city				✓					
Chilli Pokhari				✓					
Chintamaneswar	✓								
Jala Panka	✓			✓					
Mousima Mandir		✓							
Niladri Vihar	✓		✓						
Papanasini	✓								
Sukhmeswar	✓								
Infocity		✓							

Botryococcus

With regard to its economic importance, *Botryococcus* is considered as the most important algal genus in the field of biotechnology particularly due to its photosynthetic efficiency accounting for high growth rate and faster biomass accumulation. Its

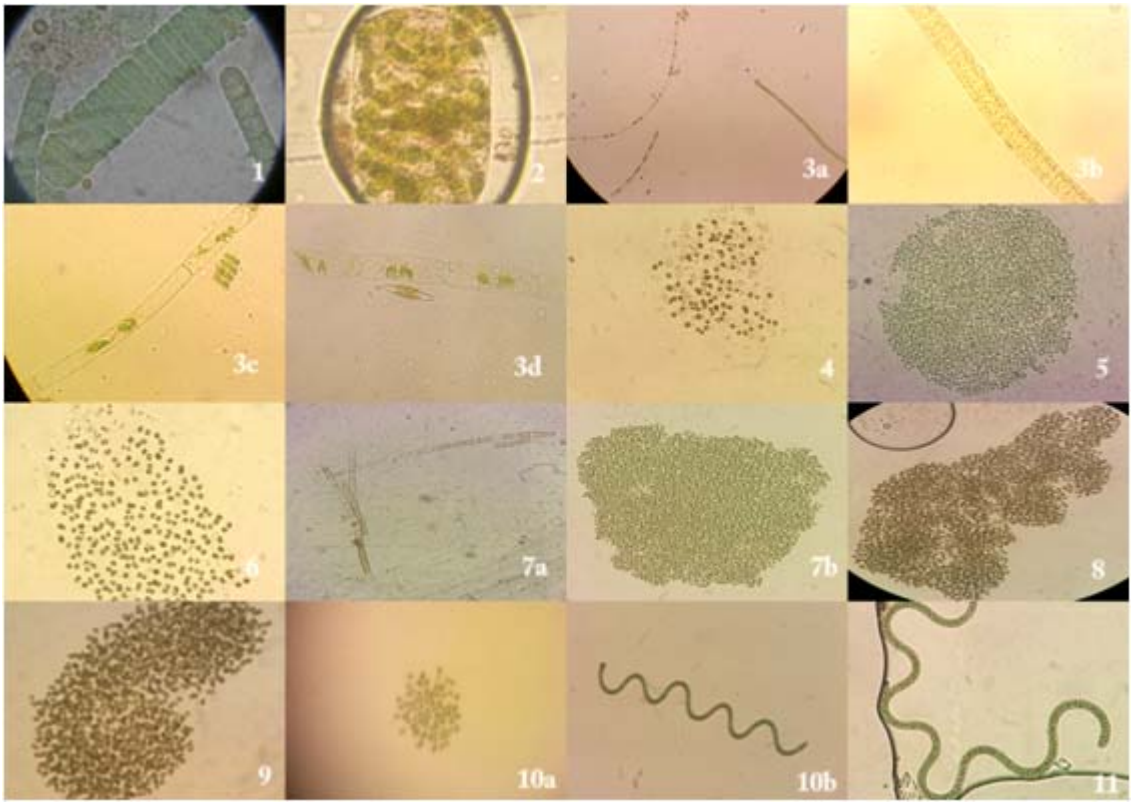

Fig. 3. Microscopic observations of the samples collected from the various sites mentioned

Table 3. Various dominant species found in various sampling points throughout the study period

No.	Sampling point	Dominant species identified
1	KISS	*Oscillatoria*
2	Starcity	*Spirogyra*
3	Damana Tungi	*Oedogonium, Microspora, Oscillatoria, Scenedesmus, Naviculla*
4	Infocity	*Tetraspora*
5	Niladri Vihar	*B. braunii*
6	Mausima Mandir	*Tetraspora*
7	Papanasini	*Microspora, B. braunii*
8	Sukhmeswar	*B. braunii*
9	Chintamanishwar	*B. braunii*
10	Jala Panka	*B. braunii, Spirulina*
11	Chilli Pokhari	*Spirulina*

most suitable growth conditions are freshwater ponds and lakes. India, with its tropical climate and large water bodies, provides ideal growth conditions. *Botryococcus* is constituted of 40-75 % hydrocarbons and polysaccharides by dry mass basis thereby making it a potential source for biofuel production.

These hydrocarbons have the ability to produce fuel with 90% efficiency for vehicles like cars and jets. Biodiesel from algae (oilgae) can be used to

recycle large amounts of CO_2 (carbon sequestration) through photosynthetic metabolism [3]. The oilgae is considered as the best sustainable alternate source of fuel with low combustion level thereby providing various environmental benefits [19]. It has emerged as an alternative to the extent that it can potentially replace conventional fossil fuels.

Spirulina

With respect to the economic importance, *Spirulina* is considered as the second most important algal genus. *Spirulina* is useful as dietary protein, B vitamins, and iron. Use of *Spirulina* potentially prevents weight loss, attention deficit hyperactivity disorder (ADHD), hay-fever, diabetes, stress, fatigue etc. as some of the diseases and/or symptoms. It contains all the essential amino acids and hence can be used as a nutraceutical [21].

Conclusion

A total of nine algal species were identified with variable abundance from eleven collection sites. Strains like *Botrycoccus braunii* with tremendous lipid contents could be ideal for biodiseal production. Likewise, strains like *Spirulina* which are rich in protein can be ideal for single cell protein production. This study leads to a comprehensive insight to developing a repository of local algal database which can aid in developing technologies for commercial and sustainable production of algal based products.

During the work, it was felt that there was a need for scientists and researchers to relate the algal strains to the ecology, their interactions, associations, their physiology and evolutionary studies in relation to the agroclimatic considerations. Bioprospecting algae in such algal biodiversity-wise rich region where no report of algal diversity is reported primarily could help a researcher to screen and collect the algae of interest from the identified ecological niche. Thus, one can easily make out the ecological environment where a particular dominant strain grows and it shall help to adapt the right culture techniques for mass cultivation of the algae of interest. A researcher in the region interested in pure cultures of the identified taxa may collect samples from the identified sources for further economic or industrial application studies.

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