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Study of Freshwater Algal Biodiversity in and around of Bhawanipatna, Kalahandi, Odisha

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ABSTRACT

The Algal study is a very useful tool for the assessment of water quality of any type of water body and also contributes to understanding of the basic nature and general economy of the aquatic system. Change in season, temperature, wind, precipitation pattern and nutrient cycle influence the dominance of algae. Most algae were abandoned in early spring and summer. The main aim of the research was to find the biodiversity of algae in Bhawanipatna. Many samples of different kinds of algae were collected from different sites of Bhawanipatna. Further the samples were taken to the laboratory of the department of Botany and centrifuged samples were analysed using an optical microscope. Further algal taxa were identified according to their morphological characteristics. Species richness between sampling sites was also identified. Total 20 species were collected from five different sites of Bhawanipatna. *Spirogyra* sp., *Navicula* sp. and *Closterium* sp. were found in abundant population, while *Oedogonium* sp. and *Chlorella* sp. were relatively less in population.

Key words: Algae, *Spirogyra sp.*, *Navicula sp,* algal bloom, biofuel

Introduction

Algae are originated in the fossil record courting back to nearly three billion years in the Precambrian. An approximate count suggests there are around 72,500 species of algae. Among these, names for approximately 44,000 have likely been officially published, with 33,248 names already processed (1). Algae represent a crucial group of eukaryotic organisms. They hold great significance as they were among the pioneering life forms to transition from marine environments to land, subsequently evolving into the diverse array of plants we see today (2). The majority of algae are photosynthetic and exhibit simpler cellular structures and organelles compared to terrestrial plants. Algae form a polyphyletic group, meaning they don't share a common ancestor. While their plastids likely originated from cyanobacteria, the process of acquisition appears to have varied among different algal groups (3). Microalgae boast tremendous biodiversity and remain largely untapped as a resource. Each species may possess distinct characteristics, potentially harbouring abundant carbohydrates, sugars, and proteins. These qualities render them valuable for producing both animal feed and even food for human consumption (4). Algae are rich sources of oil, comparable to vegetable oils such as rapeseed, soy, and canola. This oil can be readily converted into biodiesel. Therefore, harnessing microalgae for biofuel production holds significant long-term potential (5). Algae find applications in the fertilizer industry, bioremediation, and pollution control. These roles are vital for preserving the balance of aquatic ecosystems and serve as valuable bioindicators. The growth of algae within a habitat significantly impacts the ecosystem and swiftly reacts to alterations in the aquatic environment, especially concerning nutrient levels. Their distribution across different zones within a water body is influenced by its physicochemical conditions (6,7).

India possesses abundant aquatic and floral biodiversity, thanks to its extensive water bodies and ample sunlight, coupled with its characteristic tropical climate. The state of Odisha, situated along the east coast of India (Latitude 17° 48'-23° 34' N and Longitude 81° 24'-87° 29' E), covers an area of 155,842 square kilometres. Odisha has 30 districts, among them Kalahandi, rich with great biological diversity. Its abundance of water bodies stems from numerous rivers, reservoirs, lakes, ponds, ditches, and streams, particularly in its hilly terrain, alongside cultural and religious significance (8).

Materials and Methods

Sample collection site: Kalahandi spans between latitudes 19.3 N and 21.5 N, and longitudes 82.20 E and 83.47 E, encompassing the southwestern region of Odisha. It shares its borders with Balangir and Nuapada districts to the north, Nabarangpur, Koraput, and Rayagada districts to the south, and Rayagada, Kandhamal, and Boudh districts to the east. With an area of 8,364.89 square kilometers, Kalahandi ranks seventh among Odisha's 30 districts in terms of size. Bhawanipatna, the headquarters of Kalahandi district in Odisha, India, is located approximately between 19.9025° N latitude

and 83.1664° E longitude at the centre of the district (9). The Kalahandi district comprises two distinct physiographic regions: plains and hilly tracts. The hilly areas are primarily situated in the southwestern part of the Bhawanipatna Subdivision. Bhawanipatna, the district headquarters, is the second-largest city in South Odisha. Renowned for its numerous Hindu temples dedicated to various deities, the city derives its name from the presiding deity Bhawani-Shankar, combined with "Patnam," meaning place in Odia. The Bhawanipatna municipality oversees the city's administration, divided into 20 wards, each containing sub-areas known as "pada." Originally inhabited by diverse communities, these padaas have gradually become more homogeneous over recent decades. Bhawanipatna boasts over 45 padaas and stands as one of the largest urban centers in southern Odisha (10, 11). Total five sites were selected for the research of algal samples. The first site selected was Raja Bondh. It has stagnant water. It was located in latitude 19.90313, longitude 83.167193Then second site selected was Pepel naal behind green paradise, it has flowing water, latitude 19.916059, Longitude 83. 182216. Third site selected was Kantabanji devisagar bondh it has stagnant water and its latitude is19.936272 and longitude is 83.177148. Fourth site selected was Pengsur; it has running water Algae was found in rock surface, its latitude is 19.901146And longitude 83.210258. Fifth site selected was San Bandh, its latitude is 19.91521And its longitude is 83.17236.

Sample collection: Water samples were collected from total five sites of Bhawanipatna (Raja Bondh, Pepel naal, behind green paradise, Kantabanji devisagar bondh, Pengsur, San Bandh with sterile zip lock polythene bags.

Centrifugation: According to Shuvra Shekhar Roy et.,al (2015) with some modification The water sample underwent crude centrifugation to separate and concentrate the suspended algal biomass. Subsequently, one milliliter of this concentrated sample was transferred into a microcentrifuge tube and centrifuged at 10,00 rpm for 3 minutes at room temperature. This process aided in concentrating the algal sample, facilitating easier microscopic observation. The resulting supernatant was then discarded, and the desired biomass was utilized for the study (12).

Microscopy: The concentrated sample was examined microscopically using a light microscope to identify microalgae. 20 microliters of the sample were pipetted onto a glass slide from the microfuge tube. A cover slip was then placed over the glass slide to maintain the integrity of the sample and prevent contamination from dust particles or other artifacts. The slide was observed under the microscope at both 10X and 40X magnifications. After observing their morphological features and creating sketches, the organisms were identified using appropriate monographs specific to various algal groups.

Result and discussion

The study made a survey of the algal biodiversity in Bhawanipatna, algal samples from the sources identified are habituated to the climatic conditions of the city. It was observed that spirogyra mostly grew in water bodies in the area of Bhawanipatna generally in the ponds of the town. Total numbers of 20 algal spp. were found in 10 samples from the material Collected at five investigated sampling sites.

Biodiversity differed between sampling sites, however a large variation in species composition was found even within a single sample. It has been documented from the stagnant water close to the Raja Bandh area. From the above sample, different dominant algal taxa were found; these are *Navicula sp., Cymbella sp*. and *Closterium sp*. Similarly, to running Water, samples exhibited a dominant alga *Spirogyra sp.* and *Oedogonium sp.* were most abundant. Large amounts of *Spirogyra sp.* and *Spirulina sp., Oscillatoria sp., Oedogonium sp., Chlorella sp*., *Chlamydomonas sp*. were found in the San Bandh. *Spirogyra sp.* were abundantly found in the San Bandh, in Kantabanji Devisagar Bandh and near Pengsur Dam Further two more samples were collected from a local area in which the flow of water is steady, where *Navicula sp., Oscillatoria sp.* and *Spirogyra sp.* was found. At last, from the site Peepal Naal with *Gomphonema sp., Lepocinclis sp. Oedogonium sp.*, were found, where *Spirogyra sp.* is found to be dominated. *Pacus acuminatus sp.* and *Pinnularia sp*., *Rhizoclonium sp.* were also found in. From the above results all species were found in all collection sites, among these both Species *Spirogyra* and *Navicula sp*. found nearly 90% dominant. The study in different water bodies of Bhawanipatna store is about the diversity of algal belonging to various classes.

The most abundant species are *Spirogyra* and *Navicula,* the details of both the species were describe as follows: *Spirogyra* is a multicellular green alga characterized by long, filamentous chains composed of cells linked end-to-end, often extending several centimeters in length. These chains from the vegetative structure known as a thallus, consisting of unbranched filamentous strands with multiple cells. Each cell within the filament typically measures between 10 to 100 micrometers in length and exhibits a cylindrical shape. With the exception of the terminal cells at both ends, which are attached to a single cell, each cell is connected to two neighboring cells along its width. In certain species, such as *Spirogyra longata*, the terminal cell may lack chlorophyll and is referred to as a holdfast. Additionally, some species may feature root-like rhizoids originating from the holdfast, aiding in anchoring the filaments to the substrate. *Spirogyra* serves as a primary producer in aquatic food webs, providing food and habitat for various organisms such as small invertebrates and larvae (12, 13). *Navicula* species, while not abundant, was frequently found in small quantities alongside other diatoms and blue-green algae in soil and water samples. Upon collection, the cells appeared pale olive in color and contained numerous oil droplets, along with two large oil globules on each side of the nuclear bridge, a characteristic feature of this genus. These organisms are unicellular but can form colonies, and their cell wall is composed of silica, referred to as a frustule. The cell length ranges from 27.5 to 82.5 µm, and the cell width varies from 7.5 to 17.5 µm at the broadest central part. *Navicula* diatoms are utilized as bioindicators in water quality assessment and environmental monitoring programs. Changes in *Navicula* populations can indicate shifts in water chemistry, nutrient levels, and pollution levels, aiding in the management and conservation of aquatic ecosystems (14).

Conclusion

Algae are a varied cluster of aquatic organisms that can carry out photosynthesis and also yield oxygen. They need moisture to survive, and habitats is cosmopolitan in distribution. Our study resulted in the algal communities forming at the Bhawanipatna areas consisting of at least 20 species. Out of the 20 species reported *Lipocinclis sp., spirogyra sp., Navicula sp. and Closterium sp.* are found to be abundant in the area. Some taxa like *Chlorela sp.* and *Oedogonium sp.* Were found to be least abundant. 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 requirement for researchers to narrate the algal strains to the ecology, to know their physiology and evolutionary studies in relation to the agro-climatic considerations. Bioprospecting algae in such algal biodiversity rich regions 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. So, it can be classified as a complex and species-rich Microbial community. In conclusion, the biodiversity of algal species in the majority of the studied sites might be higher than reported in this study, because some Species have not yet been determined. Furthermore, future sampling of the sites at Bhawanipatna areas will undoubtedly bring new species because there are numerous ecosystems diversities varying in ecological conditions. This is Promising for future studies on biodiversity of algae in Bhawanipatna areas. By this research work we came to know about various sites of Bhawanipatna with high algae population. We can find more similar kinds of sites in Bhawanipatna which may include some useful algae which can be used in future for various Commercial purposes like cosmetic industry, biofodder, biofuel etc.

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Table 1: General characteristics of sampling sites of different part of Bhawanipatna.

Locality No.	Sampling Site	Geographical Coordinates	Habitat	Date of Collection
1	Raja Bandh	(Latitude)19.91637	Static Water	06.02.24

		(Long)83.180475		
2	Peepal Nal	(Latitude)19.916059 (Long)83.182216	Flowing Water	05.02.24
3	Kantabanji Devisagar Bandh	(Latitude)19.93627 (Long)83.177162	Static Water	05.02.24
4	Pengsur	(Latitude)19.901146 (Long)83.210258	Flowing Water	28.01.24
5	San Bandh	(Latitude)19.915207 (Long)83.172344	Static Water	27.01.24

Table 2: Show the abundance of the algae in different site in Bhawanipatna.

Sl. No.	**Algae**	**Site-A**	**Site-B**	**Site-C**	**Site-D**	**Site-E**
1	*Chlamydomonas sp.*				+	
2	*Oedogonium sp.*	+		+		+
3	*Gomphonema sp.*		+			
4	*Navicula sp.*	+	+	+	+	+
5	*Oscillatoria sp.*	+	+			
6	*Pinnularia sp.*		+			
7	*Spirogyra sp.*	+	+	+	+	+
8	*Rhizogonium sp.*	+				
9	*Euglena.sp*	+	+		+	+
10	*Phacus acuminatus sp.*		+			
11	*Lepocinclis sp.*	+		+	+	
12	*Closterium sp.*		+	+	+	+
13	*Cladophora sp.*	+	+			
14	*Cymbella sp.*	+				
15	*Closterium praelongum*				+	
16	*Chlosterium parvulum*	+				
17	*Chlosterium acerosum*	+				
18	*Chlorela sp.*	+				
19	*Chara sp.*			+		

+ denotes the presence of algae

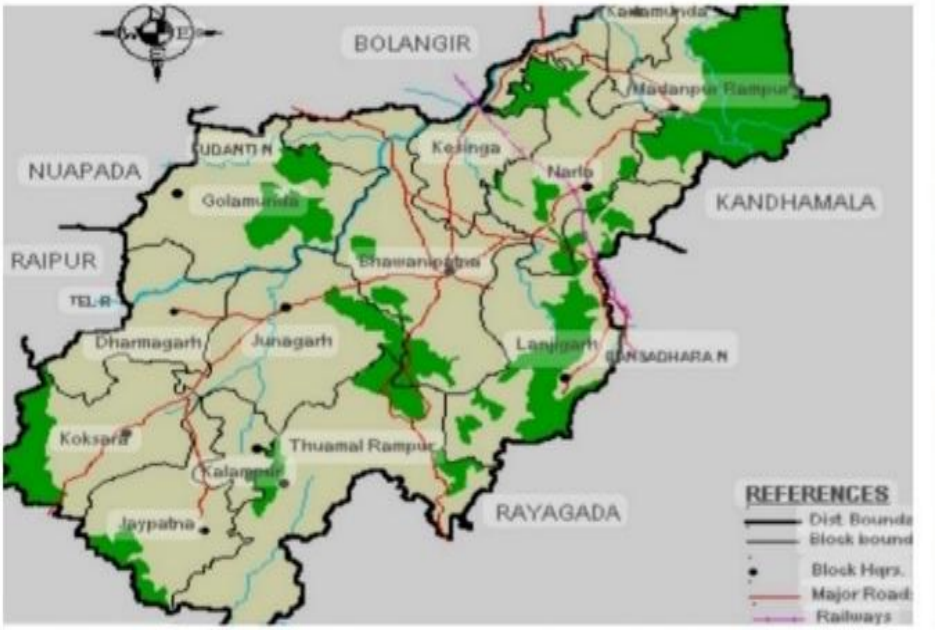

Fig. 1: Map of Bhawanipatna, Kalahandi district, Odisha.

Fig. 2: Sampling Site located at different site of Bhawanipatna (a) Raja Bandh, (b) Peepal Nal, (c) Kantabanji Devisagar Bandh, (d) Pengsur Dam, and (e) Saan Bandh.

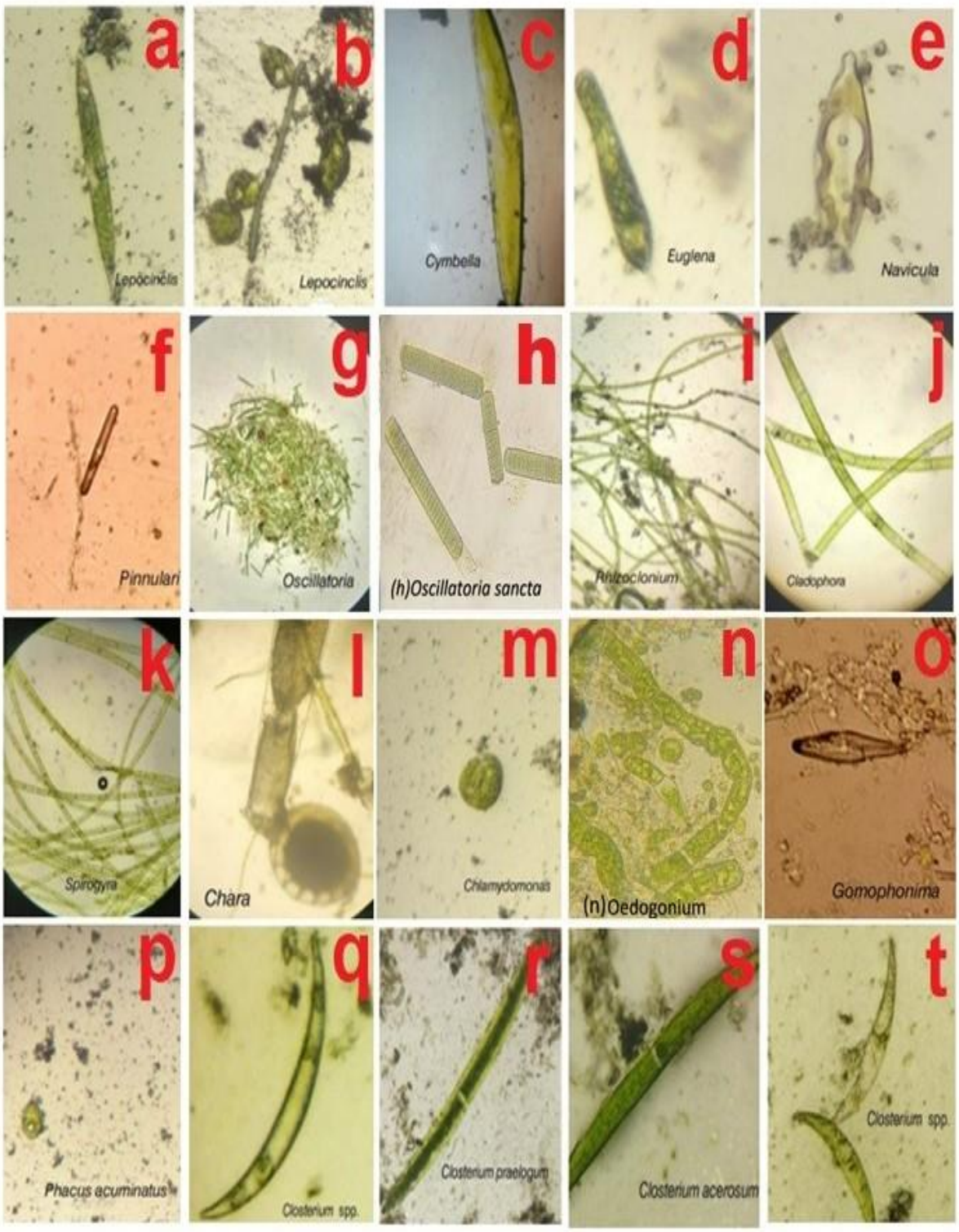

Fig. 3: Photograph of algae species i.e. *Lipocinclis* Sp. (a), *Lipocinclis globulus* (b), *Cymbella lanceolata* C. Agradh (c), *Euglena gracilis* (d), *Navicular trivalis* (e), *Pinnularia viridis* (f), *Oscillatoria abscura* (g), *Oedogonium* sp. (h), *Rhizoclonium riparium* (i), *Cladophora fascicularis* (j), *Spirogyra aequinoctialis* (k), *Chara* Sp (l), *Chlamydomonas allensworthi* (m), *Odedogonium* sp. (n), *Gomphonema reimeri* (o), *Phacus acuminatus* (p), *Closterium Venus* (q), *Closterium praelogum* (r), *Closterium acerosum* (s), and *Closterium* Sp. (t).

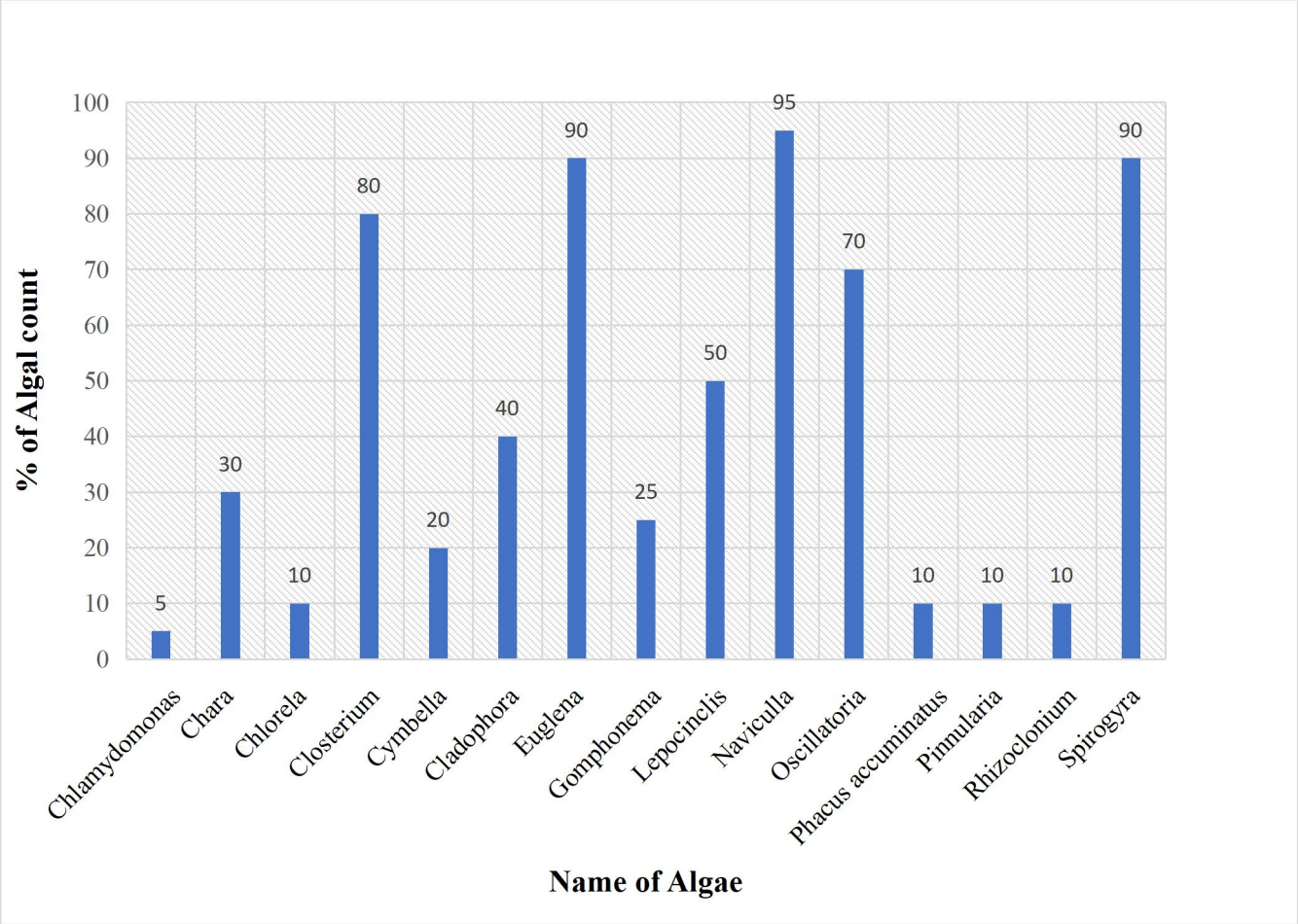

Fig. 4: Showing the percentage of algal contribution from the study sites.