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DB IndAlgae: an on-line resource of marine algae from India identified on the basis of molecular and morphological features

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DbIndAlgae is a free on-line database of marine algae from India. It provides information about the geographical distribution, morphological characteristics and most importantly, sequence data of marine algae collected from different coasts. It is the only database which contains molecular data of the algal species from India. Identification of the species is based on both morphological as well as molecular information. The database also serves as an interface to the herbarium maintained at the Centre for Plant Sciences, Central University of Punjab, Bathinda. So far the database lists 45 marine algal species. Some algal species have been identified for the first time from India, but have already been reported from places other than India, whereas new species are those which have been identified by us for the first time as a part of this study and have never been reported elsewhere.

Keywords: Database, marine algae, molecular and morphological features, *Ulva paschima*.

IDENTIFICATION, naming and cataloguing of different species of plants and animals form the basis for many conservation efforts such as Statutes and Acts, evolutionary studies, as well as commercial exploration. In India, the database DB IndAlgae (http://bit.ly/db-ia) is the first step in identifying and cataloguing marine algae. DB IndAlgae is an effort by us at the Marine Phycology Laboratory, Central University of Punjab, Bathinda. No previous attempts have been made in this regard to make information available on-line for easy access and effective dissemination. The data available at DB IndAlgae are the result of our ongoing research at the above-mentioned laboratory. The algal species listed in our database have been identified using both morphological as well as molecular features. Earlier plant taxonomists used only morphological features to distinguish different species but in some phyla where phenotypic plasticity occurs frequently, such as algae, mere morphology-based study can cause ambiguities, including misidentification of a taxon. The advancement in molecular phylogenetics and DNA barcoding has played a major role in remedying ambiguities in algal phylogeny[1]. Marine algal taxonomy used in this communication and in DB IndAlgae is according to AlgaeBase[2].

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Previously constructed databases for algae have catalogued them, solely on the basis of morphology, resulting in ambiguity in certain groups[1], e.g. *Pseudochlorodesmis*[3]. The major algal databases which have gained attention in this field are:

Index Nominum Algarum (INA): A card file and online reporting system maintained at the Silva Center for Phycological Documentation of the University Herbarium, University of California, Berkeley, USA. It includes nearly 200,000 names of algae.

World Register of Marine Species (WoRMS): An open-access catalogue of marine species developed by Flanders Marine Institute (VLIZ), Belgium, which originated from European Register of Marine Species. WoRMS is associated with over 100 databases in order to provide consistent and assured quality information about valid and invalid names, and synonyms of most of the marine species[4].

Ocean Biogeographic Information System (OBIS): An on-line portal containing primary data of marine species from all the oceans. It has various nodes and works in collaboration with other databases, thus becoming the largest provider of global marine biodiversity information combined with bio-geographic data like ecological patterns, species dispersion and many more. The major limitation of this portal is the selective sampling which is mostly limited to surface waters and temperate zones[5].

AlgaeBase: A digital repository developed in 1996 at the University of Ireland, Galway. It provides information on the economically important marine algae to emphasize the sustainable use of algal resources globally. Initially, it covered marine algae of Ireland, Britain and Atlantic coast of France obtained from the 'The Species Directory of the Marine Fauna and Flora of the British Isles and Surrounding Seas'. At present, the database lists around 8000 species based on their morphological characteristics[2].

Harmful Algal Event Database (HAEDAT): A database that contains records of harmful algal events, management of harmful algae and monitoring systems globally. It works in collaboration with WoRMS, International Council for Exploration of Sea (ICES), North Pacific Marine Science Organization (PICES), and International Society for Study of Harmful Algae (ISSHA)[6].

Other region-specific databases: Besides these, a few other regional databases are available, which catalogue algae in specific geographic locations. For instance, the Australian Marine Algal Name Index (AMANI) provides information about taxonomy and distribution of Australian marine algae and some protists. Hawaiian Algal database (HADB) is an on-line portal for Hawaiian Archipelago algae providing taxonomic information, photographs, micrographs and standardized DNA sequence data. ANSP is an algae image database providing light micrographs of various algal samples from USA. AIDI is an algae image database providing interactive images of various algal samples found in India[7–9].

India is among the 12 mega-biodiversity countries and includes 4 out of 35 hotspots[10] and highly endangered eco-regions of the world. It has an extensive marine, coastal environment, with its coastline stretching to about 8000 km. A wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes and coral reefs characterized by unique biotic and abiotic properties and processes occur. Marine algae constitute a vital part of the biotic component of the ecosystems[11]. With the initiation of 'Drugs from Sea' programme by the Government of India, marine algae have gained a lot of attention. According to the latest data on distribution of marine algae along Indian coasts, there are 212 taxa of 46 genera in 19 families of Chlorophyta, 211 taxa of 50 genera in 13 families of Phaeophyta, and 442 taxa belonging to 138 genera in 33 families of Rhodophyta[12].

As part of an ongoing study, we carried out algal sample collection from the coastal states of Goa, Karnataka, Kerala, Tamil Nadu, West Bengal, Andaman Islands, Gujarat and Andhra Pradesh. This study aims at cataloguing morphological and phylogenetic diversity of marine algae

Table 1. Macroalgae coverage incorporated in DB IndAlgae based on sample collection

State	Number of days of sampling	Marine algal taxa		
		Number of species (number of genera)		
		Rhodophyceae	Chlorophyceae	Phaeophyceae
Goa	2	1(1)	2(2)	–
Karnataka	2	–	2(1)	–
Kerala	4	9(5)	4(2)	3(2)
Tamil Nadu	3	5(3)	6(3)	4(3)
West Bengal	2	–	1(1)	–
Andaman Islands	2	3(3)	4(4)	2(1)
Gujarat*	3	20(16)	15(8)	12(7)
Andhra Pradesh*	5	8(5)	11(5)	5(3)
Total		46	45	26

*Isolates will be updated to the database as soon as the morphological and molecular identification is complete. The data provided are based on preliminary identification.

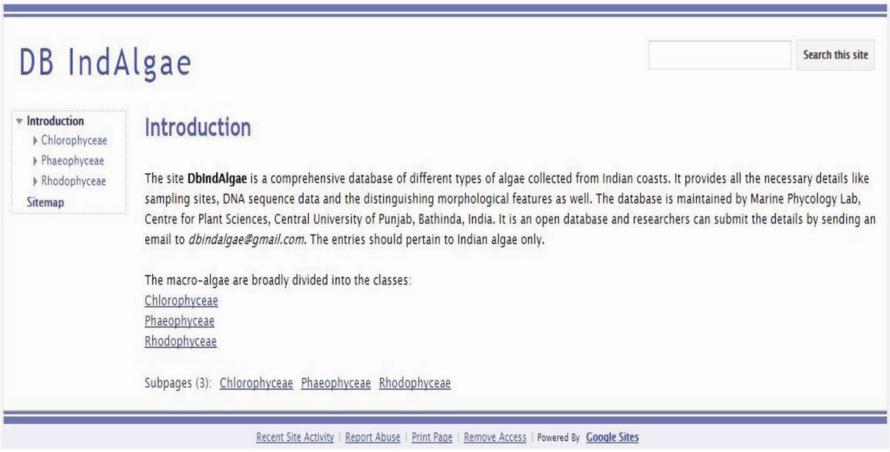

Figure 1. Home page of DBIndAlgae.

Figure 2. Snapshot of a page from DB IndAlgae showing salient features of the database.

distributed along the Indian coasts. Techniques like DNA barcoding are being used to understand the cryptic diversity of marine algae. Sample collection from Goa (four locations), Karnataka (four locations) and Kerala (seven locations) was undertaken in May 2012, and from Tamil Nadu (six locations) in July 2012. Coasts of Andaman Islands (three locations) were covered in January 2014 and those of West Bengal (two locations) were covered in May 2014. Sample collection from Gujarat (three locations) and Andhra Pradesh (five locations) was conducted in November and December 2015 respectively. Table 1 provides details of algal diversity and days of sampling

from these states. Further studies will include sampling other coastal regions as well.

As of 1 March 2016, DBIndAlgae lists around 45 different marine algal species belonging to 28 genera identified from the Indian coasts divided into three classes, viz. Phaeophyceae, Chlorophyceae and Rhodophyceae. Many of the species are new to Indian coasts, e.g. *Ulvella leptochaete* (Ulvalaceae, Chlorophyceae)[13] and some are new holotypes, e.g. *Ulva paschima* (Ulvaceae, Chlorophyceae)[14], *Cladophora goensis* (Cladophoraceae, Chlorophyceae)[15]. More than 50 new isolates are being processed and will be updated as soon as their identification is complete. All the 45 species are listed under their respective classes and assigned an individual webpage.

Each webpage features different sections (Figures 1 and 2).

Unique user ID (UUID): This is given to each sample. The three letters refer to the geographical location while the numerals represent serial numbers of the respective samples.

Classification: Taxonomic position of the species.

Distribution: Sampling sites with GPS coordinates.

Image: Photograph of thallus taken either in the laboratory and/or at sampling site and a picture of herbarium sheet.

DNA sequence data: Details of markers with NCBI accession numbers if submitted/received.

Description: Morphological features of the algae as observed.

Key references: List of the latest important scholarly articles of the same alga.

Only marine algae have been listed in the database; however, in future we plan to include terrestrial algae as well as phytoplankton which would broaden the scope of the database.

The main purpose of creating this database is to ensure that the specimens and their associated data are available to researchers. For further study, researchers can visit the facility to observe specimen herbaria and stored samples, and or can also loan them for studies. Person requesting loan should justify the request and give a valid reason to keep the sample, if loan is not to be returned. Borrowed specimen should be maintained in the same condition as received, unless permission is obtained to manipulate the same.

Thus DBIndAlgae is a web-searchable, open-access, live database where algae found in Indian coastal areas are catalogued based on their molecular as well as morphological features. This database will serve as a useful tool to researchers in knowing about algal biodiversity in India and their ecological, physiological and evolutionary parameters. The database is freely available on-line at http://bit.ly/db-ia. The intent is to add more samples and sampling regions as the study progresses. More extensive analyses on the incorporated species will be done and information about the available synonyms and life cycles can be added. The database is open to all researchers to submit their entries pertaining only to the Indian algae. For this, they can contact us via e-mail (dbindalgae@gmail.com).

Conflict of interest: Authors declare that there is no conflict of interest.

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