

A computerized image database for freshwater algae recorded in Turkey

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Abstract: A computer-based image database for freshwater algae recorded in Turkey has been established. A separate page was prepared for each algal taxon and each page includes images and taxonomic and ecological information related to the taxon. Algal images were obtained mainly from authors of algal studies previously carried out in various freshwater bodies in Turkey. Data were then standardized in accordance with that of the central database of Turkish herbaria and a database for Turkish freshwater algae, which were previously established through TÜBİTAK projects. The database program Access was used to enter data, as this program recognizes Turkish characters. A total of 627 data with images were installed in the database. These belonged to Bacillariophyta (202 data), Chlorophyta (255 data), Chrysophyta (3 data), Cryptophyta (2 data), Cyanophyta (87 data), Dinophyta, (12 data), Euglenophyta (61 data), Prasinophyta (1 datum), Rhodophyta (1 datum), and Xanthophyta (3 data).

Key words: Image database, freshwater algae, Turkey

1. Introduction

Previously, 3 approaches were used for coding plants (Pignatti, 1976), and there were only a few systems (Ceska and Roemer, 1971; Llyod et al., 1972; Cunningham and Peruwal, 1983) that were developed especially for numerical coding of algae. Klasvik (1974) used abbreviations for each half of a binomial, with 4 letters reserved for the genus and 3 for the species, e.g., *Chamaesiphon fuscus* was coded as CHAM FUS, while making computer analyses of the periphyton of 2 Swedish rivers.. A somewhat similar system for collating records of freshwater algae in British Columbia has been adopted (JR Stein, personal communication). Even with only 37 species, Klasvik (1974) met with the difficulty that 2 different binomials, *Nitzschia palea* and *N. paleacea*, would have the same abbreviation unless the coding convention was modified; the 2 species were in fact coded as NITZ PAL and NITZ PAA, respectively. A simplified version of this system for coding the more common freshwater algae in the British Isles was published (Whitton et al., 1978); an extension of the same system for other aquatic photosynthetic plants was given by Holmes et al. (1979). However, systems based on letters lead to a variety of practical problems such as those caused by synonyms and changes in nomenclature (Pignatti, 1976). A computer-orientated numerical coding system for algae was

introduced by Whitton et al. (1979), who developed a system for coding freshwater algae numerically in a form suitable for the recording and subsequent analysis of data with the use of a computer. In more recent years, computer-based databases with or without images have become common for many kinds of organisms, since they are useful for the rapid and accurate identification of organisms and also for reaching data related to their taxonomy and distributional records with a computer.

The number of projects and studies on the biological diversity of Turkey has increased in the last 30 years. Most of the projects were supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK) and early projects were concerned mainly with the establishment of computerized databases for seed or flowering plants (Phanerogamae) and animals, encompassing taxonomic properties and distributions of the species. Recently a computerized database for freshwater algae occurring in Turkey was completed as a TÜBİTAK project by Şen et al. (2006), in which 6130 pieces of data belonging to Bacillariophyta, Charophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Dinophyta, Euglenophyta, Prasinophyta, Rhodophyta, and Xanthophyta were uploaded. However, all these databases were composed mainly of taxonomic properties and distributional records of organisms. It is worth mentioning that no images were added.

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In fact, image database projects have unfortunately been neglected in Turkey despite a number of studies concerned with taxonomy and ecology of freshwater algae (Akçaalan Albay et al., 2014; Koçer and Şen, 2014). Nevertheless, there are numerous image databases in use belonging to various kinds of plant and animal groups all over the world (e.g., <http://protist.i.hosei.ac.jp>, <http://www.utex.org>, <http://www.dr-ralf-wagner.de>, <http://www.catalogueoflife.org/>, <http://www.algaebase.org>, http://cumuseum.colorado.edu/Research/Diatoms/diatom_databases.html, <http://rbg-web2.rbge.org.uk/ADIAC/db/adiacdb.htm>, <http://fcelter.fiu.edu/data/database/diatom/index.htm>).

The present image database is the first for the freshwater algae recorded in Turkey. The database brings together information on the ecological characteristics of freshwater algae with their most recognizable images. A separate image page was prepared for each taxon and each page includes images and taxonomic and distributional information related to the taxon. The present paper summarizes the principles of the new image database for algae recorded in freshwater bodies in Turkey, which will be of great help towards the identification of algal taxa when access is given to users by TÜBİTAK.

2. Materials and methods

The first phase of the project involved data collection and selection of data types, including images available for freshwater algal species. Such data were obtained mainly from authors and algal studies already carried out in various freshwater bodies in Turkey. The data were then standardized, and after trials to enter the data into a preliminary image database, the most suitable master image database system was

selected. The database program Access was finally decided to be used for data entry, as this program recognizes Turkish characters. In addition, Access is a type of image database management system that provides users with the software tools needed to organize data in a flexible manner and also includes facilities to add, modify, or delete data from the database. Moreover, it asks questions (or queries) about the data stored in the image database and produces reports summarizing selected contents. Algaebase was used for the taxonomy of algal taxa.

3. Results

A total of 627 data were uploaded to the image database, belonging to Bacillariophyta (202 data), Chlorophyta (255 data), Chrysophyta (3 data), Cryptophyta (2 data), Cyanophyta (87 data), Dinophyta, (12 data), Euglenophyta (61 data), Prasinophyta (1 datum), Rhodophyta (1 datum), and Xanthophyta (3 datum). Data were split into the 2 major groups of diatoms and other algae in order to enable users to access them rapidly when the image database is in use. Algal data were entered into database in the following order: class, order, family, genus, species, synonym(s), description, locality. Abbreviations such as L (lake), DL (dam lake), R (river), S (stream), and M (marsh) were used to indicate the localities in which algae were recorded. The examples of data pages for each algal group as installed in the Turkish Freshwater Algae Image Database are shown in Figures 1–9.

Acknowledgment

This project was supported by TÜBİTAK (TBAG-Ç.SEK/14 (102T105) 2007).

Class: **Euglenophyceae**
 Order: **Euglenales**
 Family: **Euglenaceae**
 Genus: ***Euglena*** Ehrenberg
 Species: ***Euglena acus*** Ehrenberg
 Synonym(s):

Description:

Species: 50-175 µm long, 8-18 µm wide; body long spindle or cylindrical, with a sharply pointed posterior end; numerous discoid chloroplasts; several paramylon (paramylum) bodies; nucleus central; stigma distinct; flagellum short, about one-fourth the body length.

Locality:

Adana Seyhan R, Sarıçam R
Ankara Çubuk-I DL, Mogan L, Bayındır DL
Antalya Köprüçay R
Elazığ Selli S, Keban DL
Isparta Akyatan Lagoon, Aksu S
İstanbul Riva S, Büyükçekmece L
Kayseri Sultan M
Kocaeli Sapanca L
Manisa Marmara L
Samsun İncesu S, Bafra Fish L, Cernek L
Sinop Sarıkum L

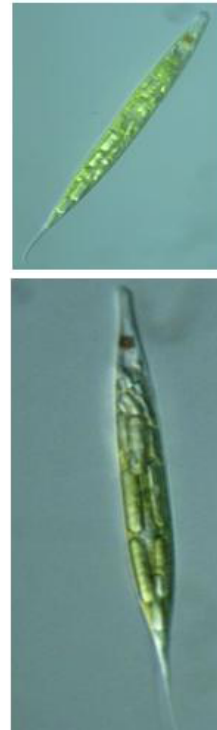


Figure 1. An example of Euglenophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Bacillariophyceae**
 Order: **Pennales**
 Family: **Naviculaceae**
 Genus: ***Cymbella*** Agardh 1830
 Species: ***Cymbella lanceolata*** (Ehrenberg) Kirchner 1878
 Synonym(s): ***Cocconema lanceolatum*** Ehrenberg 1838

Description:

Length, 60-220 µm. Breadth, 18-32 µm. Striae dorsal 9-10 at 10 µm.

Locality:

Ankara Çubuk R, Mogan L, Kirmir S
Ankara Çamlidere DL, Karagöl L
Adana Seyhan R
Adapazarı Sapanca L
Afyon Karamik L
Balıkesir Akıntidere S
Erzurum Tortum L
Erzincan Tercan DL
 İzmir Karagöl L
 İstanbul Riva S
Kırşehir Hirfanlı DL
Konya Akşehir L
Muğla Köyceğiz Dalyan L
Düzce Melen S
Erzurum Karasu R
Eskişehir Porsuk R, Yeşilirmak R, Sakarya R

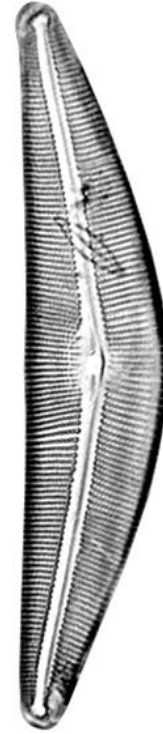


Figure 2. An example of Bacillariophyta data installed in the Turkish Freshwater Algae Image Database.

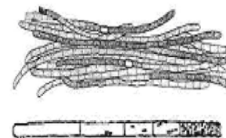
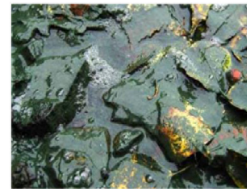
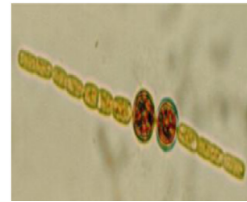
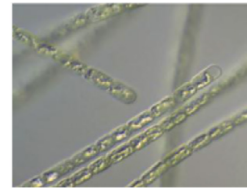
Class: **Cyanophyceae**
 Order: **Nostocales**
 Family: **Nostocaceae**
 Genus : ***Aphanizomenon*** [Morren 1838]
 Bornet et Flahault 1886
 Species: ***Aphanizomenon flos-aquae*** [(Linnaeus 1753)
 Ralfs 1850] Bornet & Flahault 1886
 Synonym(s): ***Byssus flos-aquae*** Linnaeus

Description:

Trichomes straight, aggregated in bundles or flakes to form macroscopic colonies of a few or hundreds of trichomes; single trichomes may also occur. Ends of trichomes usually showing slight tapering, with the cells towards the end slightly longer than those in the middle. Cells 5-6 µm wide, 5-15 µm long, with gas vacuoles; end cell conical. Heterocyst 5-7 µm wide, 7-20 µm long. Akinete cylindrical, 6-8 µm wide, 40-80 µm long; wall smooth, colourless.

Locality:

Elazığ Keban DL
Eskişehir Porsuk R
Kocaeli Sapanca L
Manisa Marmara L
Samsun Bafra Fish L



30 µm

Figure 3. An example of Cyanophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Dinophyceae**
 Order: **Peridinales**
 Family: **Peridiniaceae**
 Genus: **Peridinium** Ehrenberg
 Species: **Peridinium cinctum** (O.F.Müller) Ehr.

Synonym(s): *Peridinium westii* var. *aureolatum* Lemmermann
Peridinium cinctum f. *angulatum* (Lindemann) Lefèvre

Description:

Cells rounded to ovoid, sometimes dorsiventrally flattened, 35-73 µm wide, 40-78 µm long; hypotheca shorter than epitheca, separated by narrow, winged, cingulum offset by one cingular width; sulcus with narrow wings extending about one-third length of epitheca, descending to antapex of hypotheca; cell wall consists of thick thecal plates with coarsely net-like ornamentation, each reticulation surrounding 1-3 pores and in older cells ornamentation extending to small spines,- plate formula: 4', 3a, 7", 5c, 5s, 5", 2"', narrow striated intercalary bands, antapical plates frequently uneven in size; apical pore absent; chloroplasts numerous, dark brown and arranged around periphery of cell; eyespot absent; resting stage having a thickened 'warty' wall and enlarged, striated intercalary bands.

World-wide; found in plankton of pools, lakes, ponds and reservoirs; predominant in winter and spring.

Locality:

Samsun Suat Uğurlu DL, Hasan Uğurlu DL, Bafra Fish L
Afyon Karamık L
Ankara Çubuk-I DL, Kurtboğazi DL, Bayındır DL, Beytepe & Alap P
Konya Hotamış M
Elazığ Keban DL

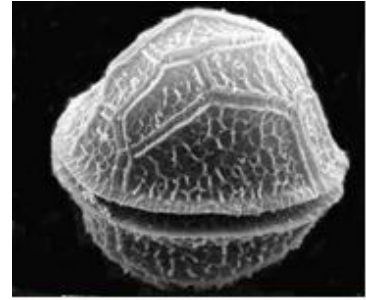


Figure 4. An example of Dinophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Zygnematophyceae**
 Order: **Zygnematales**
 Family: **Desmidiaceae**
 Genus: **Cosmarium** Ralfs
 Species: **Cosmarium botrytis** Meneghini ex Ralfs

Synonym(s):

Description:

Genus: Unicellular; variable in shape; a constriction at the center of the cell body; mostly longer than wide; flattened; each semicell hemispherical, spherical, ellipsoidal, rectangular, pyramidal or kidney-shaped; no apical indentation. 65-90 µm long; 51-68 µm wide.

Locality:

Adana Sarıçam R
 Afyon Karamık L
 Ankara Mogan L
 Balıkesir Akıntıdere
İzmir Gölcük L, Barutçu L
 Kayseri Sultan M
 Sivas Hafik L
 Trabzon Uzungöl L



Figure 5. An example of Chlorophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Chrysophyceae**
 Order: **Chromulinales**
 Family: **Dinobryaceae**
 Genus: ***Dinobryon*** Ehrenberg
 Species: ***Dinobryon sertularia*** Ehrenberg
 Synonym(s):

Description:

Genus: Solitary or colonial; individuals with vase-like, hyaline, but sometimes, yellowish cellulose lorica, drawn out at its base; one to two lateral chromatophores (chloroplasts); usually with a stigma; in colonial forms daughter individuals remains attached to the inner margin of aperture of parent lorical and there secrete new loricas.

Species:

Colonies planktonic, branched; lorica base-like, with wide opening; lateral margins of lorica smooth, slightly swelled; 24-45 µm long, 8-14 µm wide. Lorica 30-45 µm long, 10-15 µm wide.

Locality:

Afyon Karamik L
Ankara Beytepe & Alap P
Ankara Çubuk-I DL, Bayındır DL
Elazığ Keban DL
Samsun Suat Uğurlu DL
Sinop Sarikum L
Sivas Hafik L



Figure 6. An example of Chrysophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Cryptophyceae**
 Order: **Cryptomonadales**
 Family: **Cryptomonadaceae**
 Genus: ***Cryptomonas*** C.G. Ehrenberg
 Species: ***Cryptomonas ovata*** Ehrenberg
 Synonym(s):

Description:

Genus: Elliptical body with a firm pellicle; dorsal side convex, ventral side slightly flat; "cytopharynx" with granules; two lateral chromatophores (chloroplasts) vary in color from green to blue-green, brown or rarely red; 1-3 contractile vacuoles anterior. Cell body elongated ovoid or elliptical; cytopharynx conspicuous; three rows of ejectosome (trichocysts).
 Species: Cell body 16-20 µm long, 8-10 µm wide; two almost equal flagella; color, dark amber to dark brown. 20-30 µm; reservoir distinct; yellow to brownish-green chloroplasts; starch granules. 30-60 µm long, 20-25 µm wide.

Locality:

Ankara Mogan L, Bayındır DL, Çubuk-I DL
Ankara Kurtboğazi DL, Beytepe & Alap P
Elazığ Keban DL
İstanbul Büyükçekmece L, Riva S
İzmir Barutçu L
Kocaeli Sapanca L
Samsun Cernek L



Figure 7. An example of Cryptophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Prasinophyceae**
Order: **Dunaliellales**
Family: **Polyblepharidaceae**
Genus: **Tetraselmis** F.Stein
Species: **Tetraselmis cordiformis** (N. Carter) S.F.N. Stein
Synonym(s): *Cryptoglena cordiformis* N. Carter

Description:

Genus: Cell body ellipsoidal-ovoidal with cell wall; Four equal-length flagella arising from an anterior depression of the cell body; chloroplast cup-shaped with a pyrenoid at the bottom; a single stigma; large two contractile vacuoles at the base of flagella.

Species:

Cell body ovoidal, 16-23 µm in diam.; anterior depression 1/5-1/6 of the body length; a single circular stigma located at the equatorial line.

Locality:

İzmir Gölcük L
Manisa Marmara L
Isparta Eğirdir L



Figure 8. An example of Prasinophyta data installed in the Turkish Freshwater Algae Image Database.

Class: **Xanthophyceae**
Order: **Vaucheriales**
Family: **Vaucheriaceae**
Genus : **Vaucheria** de Candolle
Species: **vaucheria sessilis** (Vauch.) De Candolle
Synonym(s): *Ectosperma sessilis* Vaucher 1803

Description:

A pair of oogonia and a single, curved antheridium.

Dimension(s): cells about 35-135 µm wide.

Locality:

Balıkesir Akıntidere S

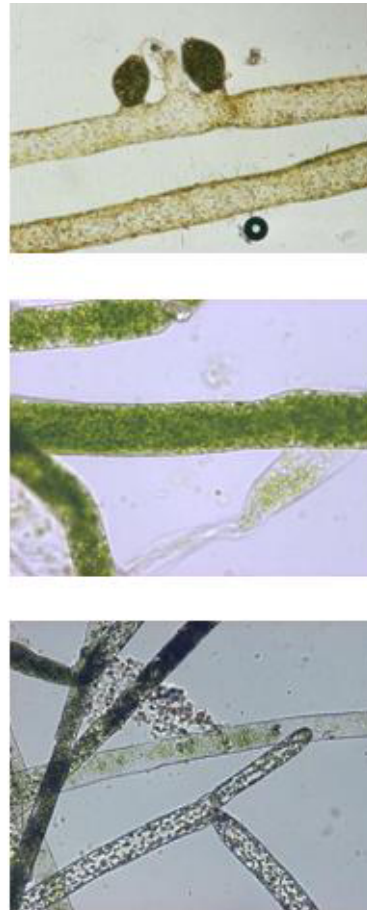


Figure 9. An example of Xanthophyta data installed in the Turkish Freshwater Algae Image Database.

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