Algae Identification

Background

Algae are photosynthetic organisms that have a relatively simple structure compared to vascular plants. The main characteristic that distinguishes algae from other plants is sexua reproduction. Unlike in higher plants, where the multicellular sex organs are only partially fertile, in algae either the whole unicellular organism functions as a gamete, or, if there are multicellular reproductive structures, they are 100% reproductive.

Algae are nearly ubiquitous, and may grow in waters of varying salinity, in intertida regions, in soils, on buildings, living mutualistically within other organisms, or even on desiccated sand and rocks in deserts and on the snowy slopes of mountains. Limnologists are most concerned with phytoplankton, which may live in the open water or on mud and surfaces on the bottom. The presence of different types of pigments is one main characteristic used to classify the different types of algae. All algae contain chlorophyll a, along with other accessory pigments. The accessory pigments absorb different wavelengths of light, allowing the algae to capture more of the sun’s energy for use in photosynthesis. The major groups of algae are Divisions (equivalen to Phyla in animals) Cyanophyta, Chlorophyta, Cryptophyta, Chrysophyta, Pyrrophyta, Bacillariophyta, Euglenophyta and Rhodophyta.

All members of Division Cyanophyta, the “blue-green algae”, are prokaryotic cells with no organized nucleus and no mitochondria or chloroplasts. Members of all other algal divisions are eukaryotic. Blue green algae contain phycobilins (phycoerythrin or phycocyanin) as accessor pigments to chlorophyll a. It is the presence of the blue pigment phycocyanin in man Cyanophyta that gives them their characteristic blue-green color. Some blue-greens can fix molecular nitrogen and are often responsible for the “pond scum” on eutrophic lakes.

Division Chlorophyta consists of the “green algae”. These phytoplankton have chlorophylls a, b and sometimes carotenoids. This is a very diverse division and typically abou half of the species of phytoplankton in a lake will be chlorophytes. Much evidence, including similarities in pigments, suggests that vascular plants arose from algae of the Division Chlorophyta.

The presence of chlorophylls a and c characterizes members of the Division Cryptophyta. These phytoplankton are often unicellular and motile and are common in the Laurentian Grea Lakes. Some members of this division are mixotrophic, meaning they can take up organic compounds in addition to producing them through photosynthesis.

The chrysophytes, or golden-brown algae, contain chlorophyll a, β-carotene, and sometimes chlorophyll c. They are often flagellated and many are mixotrophic. Some members have siliceous scales or cysts.

Members of the Division Pyrrophyta, also known as dinoflagellates, contain chlorophylls a and c, and may be armored with plates known as theca. They are strong swimmers and have two flagella in grooves. Dinoflagellates are responsible for toxic red tides in oceans and estuaries.

The diatoms, members of the Division Bacillariophyta, contain chlorophylls a and c and xanthophylls. They have an external covering, or frustule, made of Si $_2$. There are two major orders of diatoms, the centric diatoms, which have radial symmetry, and the pennate diatoms, which have bilateral symmetry. Diatoms are often important components of spring blooms.

There are a few planktonic members of the Division Euglenophyta. They contai chlorophylls a and b and are flagellated unicells with no cell wall. Similarly, there are only a few freshwater representatives of the Division Rhodophyta, or “red algae”. They are predominantly colonial, have chlorophylls a and c, β-carotene and some xanthophylls. Members of the Division Rhodophyta never have flagella or flagellated gametes.

Phytoplankton are generally sampled using water bottles, such as a Van Dorn, or wit small pumps. Many species of phytoplankton are too small to be retained by even the finest mesh nets. Unless there is a dense algal bloom, phytoplankton cells have to be concentrated to obtain sufficient numbers for statistically reliable counts. For a good summary of collection, concentration, and counting techniques see exercise 10 in Wetzel and Likens.

Exercises

You will look at several preserved samples which have been collected and concentrated, some live cultured phytoplankton, and some live phytoplankton which have been collected fro local lakes or streams.

Prescotts' "How to Know the Freshwater Algae" will be used for phytoplankt identification. A copy of "Introduction to the Algae" by Bold and Wynne will also be available. Several EPA posters for identifying algae are a good place to start when trying to determine to which division or major group an unknown phytoplankton belongs.

(1) Look at algae from each of the live samples, cultures and preserved samples. Identify each alga you find to genus and record the genus and division of the algae you find in each sample. You should be able to find species from **at least** three different divisions. Make simple line drawings of each.

(2) It is often useful to know which species are dominating the phytoplankton assemblage, not simply what species are present. There are several methods for quantifying phytoplankton in a sample. Specialized slides which hold a known volume of sample, such as Sedgewick-Rafter, Palmer-Maloney, and hemocytometer cells, are often used for precise work. We will use simplified techniques that do not require specialized equipment, but the methodology is much the same. Concentrated samples of preserved phytoplankton will be available for enumeration.

   (a) Place one drop (0.05 ml) of the concentrated sample on a microscope slide and gently cover with a coverslip (coverslip is 22 mm x 22 mm). Seal the edge of the coverslip with nail polish to retard drying.

   (b) By moving the mechanical stage, you will be able to look at the whole slide in a systematic fashion. Begin at one edge of the coverslip. Proceed counting all algae in the microscope field as you move the stage toward the other edge of the coverslip. Scan a complete track across the sample, keeping tally of the different taxa and the number of each taxon observed. When organisms lie partially within the field of view, count only those in the upper half of the field as lying within the field.

   (c) At the end of a complete track, if you have observed greater than 100 of a given taxon, you may disregard counting that alga on subsequent scans. Counting one hundred individuals of each major taxon provides sufficient statistical accuracy for mos purposes (see table in Wetzel and Likens 1991 pg. 148). Record the number o individuals of each type for each track counted. Calculate the number of tracks required to count greater than 100 members of each taxon.

   (d) Once you have either counted 100 individuals of all taxa or scanned the entire slide, compute the numerical density of each species using the following formula

$$D_i = [N_i / (V \times C)]\ [A / (S_i)\ (Df)\ (L)]$$

D_i - density of algal species i (number/ml)
N_i - number counted of species
V - volume of sample (0.05 ml
C - concentration factor of sample
S_i - number of scans needed to obtain > 100 algae of the species i, or total number o scans for species
Df - diameter of microscope optical field in
L - length of scan (length of cover slip) (22 mm)
A - area of cover slip (22 mm x 22 mm)

(e) To determine the diameter of the microscope optical field (Df), place a stage micrometer on the stage, and focus on the ruler using the magnification you used t count the phytoplankton. Adjust the ruler so that it passes through the center of the field, and record the length of the field diameter.