

DOCUMENT RESUME

ED 086 483

SE 016 646

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TITLE Handbook of Techniques and Guides for the Study of  
the San Francisco Bay-Delta-Estuary Complex, Part 2.  
Key to the Phytoplankton Phyla and Genera.  
INSTITUTION Alameda County School Dept., Hayward, Calif.; Contra  
Costa County Dept. of Education, Pleasant Hill,  
Calif.  
PUB DATE Feb 71  
NOTE 27p.  
EDRS PRICE MF-\$0.65 HC-\$3.29  
DESCRIPTORS Biological Influences; Ecological Factors;  
\*Environmental Education; Environmental Research;  
\*Guides; \*Instructional Materials; \*Marine Biology;  
Natural Sciences; Resource Materials  
IDENTIFIERS \*California; Phytoplankton; Project MER; San  
Francisco Bay

ABSTRACT

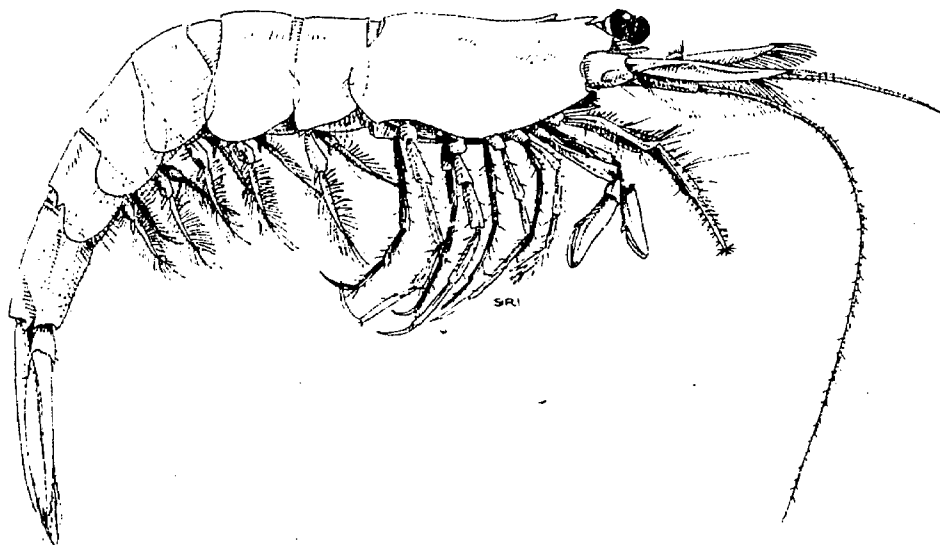
Project MER (Marine Ecology Research) is aimed at improving environmental education in the San Francisco Bay Area schools. This document is the second of a series of guides designed to help students and teachers gather data concerning the San Francisco Bay-Delta-Estuary Complex and to organize these data to make a contribution to the literature of science and to serve as the groundwork upon which knowledgeable decisions about the environment could be based. Presented in this guide is a key for identifying the phytoplankton phyla and genera organisms in the Bay. Physical descriptions of the organisms are accompanied by illustrations. Related documents are SE 016 645 and SE 016 647--SE 016 650, (JP)

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PROJECT M E R  
MARINE ECOLOGY RESEARCH

ED 086483



HANDBOOK OF TECHNIQUES  
and  
GUIDES FOR THE STUDY  
of the  
SAN FRANCISCO BAY-DELTA-ESTUARY COMPLEX

KEY TO THE PHYTOPLANKTON PHyla AND GENERA

PART II

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February 1971

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Prepared as a course of study for grades 9-14 in aquatic ecology.

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#### COVER

*Crango franciscorum*, the Bay Shrimp, was once the most prevalent shrimp in San Francisco Bay. Today, as the result of changes in Bay waters, it is no longer commercially important.

The line drawing of *Crango f.* was prepared by Margaret Lynn Siri, student of Ed Springer, at Kennedy High School.

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## FOREWORD

The phytoplankton of the San Francisco Bay - Delta - Estuary Complex have not received the attention necessary if one is to understand Bay ecology. Existing checklists of algae are too incomplete or unavailable for most biologists. In an effort to help gain more knowledge of these important forms, forms essential in the entire food-web, Jane Helrich has developed this Key to the Phytoplankton Phyla and Genera. In this key, great care has been taken to illustrate the forms and to use the least technical terms possible.

As you are monitoring at a field station, you will be identifying many of these forms. From the data you submit, it will become evident which algae are common in the Complex. Such information is vital to a complete understanding of the local food-web.

As you encounter species it is important that they be identified. Careful drawings of these species made by students will be incorporated in future revisions.

George J. Castellani  
Director, Project MER

MAJOR CHARACTERISTICS TO LOOK FOR IN COMMON PLANKTERS<sup>+</sup>

I. Grouping by Color

- a. Algae - blue-green
- b. Algae - green
- c. Diatoms - yellow to golden brown
- d. Pigmented flagellates - yellow green to dark brown

II. Gross Structure

- a. unicellular
- b. colonial type
- c. filamentous
- d. tubular
- e. strandlike
- f. membranous

III. Cell Structure

- a. protoplast
- b. cell wall
- c. outer matrix

IV. Size

- a. mesoplankton (net) over 3 mm. No. per 100 ml.
- b. microplankton between 60  $\mu$  and 3 mm. No. per ml.
- c. nanoplankton under 60  $\mu$  No. per ml.

V. Specialized Parts of Cells

VI. Specialized Parts of Multicellular Algae

+ Underlined terms defined in Glossary

TABLE I\*

COMPARISON OF FOUR MAJOR GROUPS OF PHYTOPLANKTON

Characteristics	Blue-Green Algae	Green Algae	Diatoms	Pigmented Flagellates
Color	Blue-Green to Brown	Green to Yellow-Green	Brown to Light Green	Green or Brown (Red)
Location of Pigment	Throughout Cell	In Plastids	In Plastids	In Plastids
Starch	-	+	-	+ or -
Slimy Coating	+	- in most	- in most	- in most
Cell Wall	Inseparable from slimy coating	Semirigid-smooth or without spines	Very rigid with regular markings	Thin, thick, or -
Nucleus	-	+	+	+
Flagellum	-	-	-	+
Eye Spot	-	-	-	+

\* From Algae in Water Supplies

- Absent  
+ Present

## CHARACTERISTICS HELPFUL IN IDENTIFICATION OF PHYTOPLANKTON<sup>+</sup>

### PHYLUM CHLOROPHYTA: May be fresh water or marine

Color: grass-green; usually referred to as the green algae.

chlorophylls A and B predominate - in chromatophores.

xanthophylls present, and A and B carotene.

Photosynthetic reserve is usually starch

Cellulose is almost always present in cell walls

Forms may be:

unicellular, or multi-cellular

micro or macro-scopic in size

motile or non-motile;

motile cells may have 2-4 flagella, equal in length, at the anterior end

Reproduction may be sexual or asexual

sexually reproductive forms may reproduce by isogamy, anisogamy, or cogamy.

### PHYLUM CYANOPHYTA: (Myxophyta) May be fresh water or marine

Color: blue-green

chlorophyll is not contained in specific plastids, but is diffused generally throughout the cytoplasm

chlorophyll A is present;

xanthophylls are present, and

Beta carotene; c-phycoyanin; c-phycoerythrin (responsible for masking other pigments, resulting in the usual blue-green color), but actually, every color in the spectrum is present somewhere in this group.

No distinct nucleus, but instead a central body which does not have a nuclear membrane, nor a nucleolus.

Photosynthetic reserve usually a carbohydrate; cyanophycean starch.

Forms are:

usually colonial or filamentous

some motile, but have no locomotor structure

Reproduction:

only asexual; by fission, fragmentation, and production of non-flagellate spores.

chlo' ro phyll  
xan' tho phyll  
chro ma' to phore  
car' o tene  
pho' to syn thet' ic  
cell' u lose

mac ro scop' ic  
mo' tile  
fla gel' la  
an ter' i or

i sog' a my  
an' i sog a my  
o og' a my

plas' tid  
cy' to plasm

nu' cle us  
nu cle o' lus

cy an o phy ce' an

co lo' ni al  
fil a men' tous

fis' sion  
fla' gel late

<sup>+</sup> Terms in margin are defined in the Glossary

PHYLUM PYRRROPHYTA: Dino-flagellates. Most are common in fresh water, but also make up an important and abundant part of marine phytoplankton.

Color: yellow-green to dark brown, due to chlorophylls A and C, being masked by several xanthophylls and B carotene.  
chlorophyll E present in members of one class.

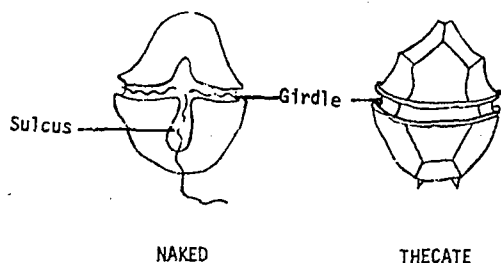
Photosynthetic reserves are starches and oils.

Forms are:

usually unicellular;  
usually motile, and with two flagella; one encircling the organism in a transverse groove (girdle)  
the other flagella is attached on a ventral-longitudinal axis in a groove (sulcus), so that it trails posteriorly.  
There are two forms, naked and thecate.  
Thecate walls are usually formed of ornamented polygonal plates. (See below)

*u' ni cel' lu lar*  
*trans verse'*  
*gir' dle*  
*ven' tral*  
*lon gi tu' di nal*  
*ax' is*  
*sul' cus*  
*pos ter' i or ly*  
*the' cate*  
*pol y gon' al*

Sexual reproduction is very rare.



PHYLUM CHRYSOPHYTA: Most are Diatoms (class Bacillariophyceae) common in fresh water or marine habitat. Conspicuous, important, and abundant part of phytoplankton, being the basis of the food chain.

Color: light green to golden brown.  
chlorophyll contained in specific plastids.  
all classes have chlorophyll A, and B, carotene, and a number of xanthophylls.

Photosynthetic reserves are oils and leucosin.

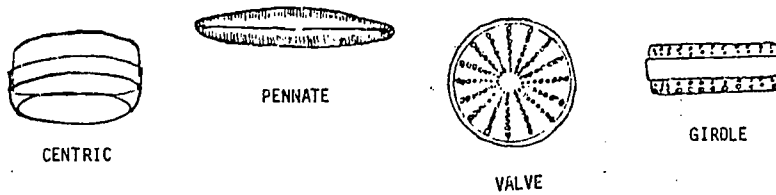
Forms are:

may be unicellular or in colonies.  
motile, but have no locomotor structure.  
(classes other than diatoms may have flagella)

+ Terms in margin are defined in the Glossary

Diatoms can be described as looking like a petri dish, having cell walls usually composed of two siliceous, overlapping halves.

*si li' ceous*



The more or less flattened surfaces are called valves.

The sides are called the girdle. (See above)

Classification is based on shape, and how the valves are decorated.

Order Centrales: have circular or elliptical valve outline, with markings not discernible, concentric, or in a radial pattern

*el lip' ti cal  
con cen' tric*

Order Pennales: have elliptical to rod-shaped outline; are bilaterally symmetrical, or asymmetric. (See above)

*bi lat' er al ly  
a sym met' ric,  
sym met' ri cal  
ra' phe  
pseu' do ra phe*

Some diatoms may have a longitudinal cleft on the valve, called a raphe; others may simply have only a space, called a pseudoraphe. (See below)

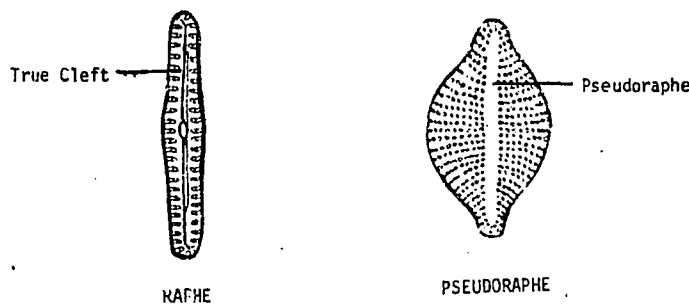
Reproduction:

Sexual reproduction can be isogamous, or autogamous.

Asexual reproduction of non-motile forms (diatoms) by flagellate or non-flagellate spores.

Statospore formation is unique to this phylum

*stat' o spore*



+ Terms in margin are defined in the Glossary

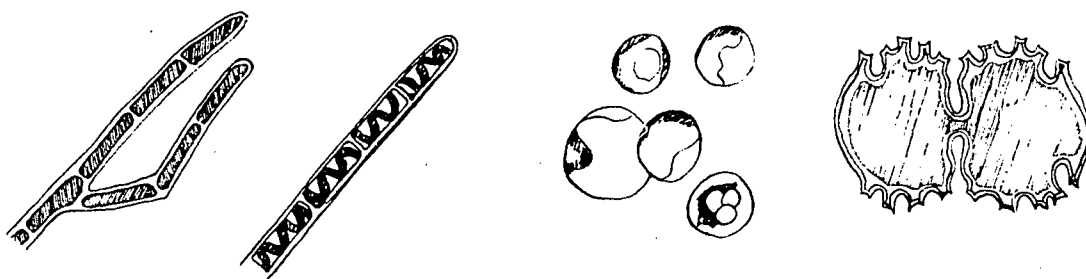


# KEY TO PHYTOPLANKTON

## PHYLA

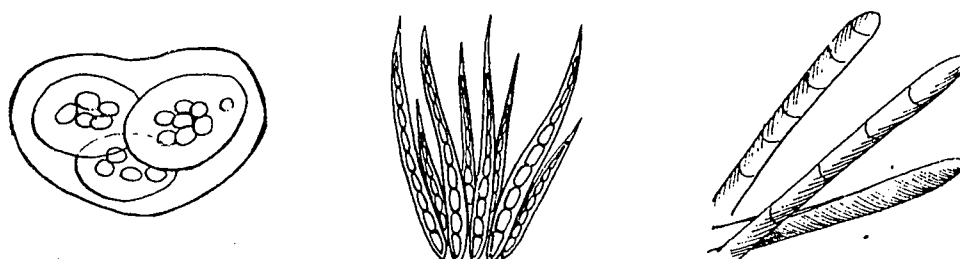
1. Pigments not contained in a plastid, but spread evenly throughout cell; color usually blue-green. Has slimy coating; nucleus absent.  
PHYLUM CYANOPHYTA...10

1. Pigments contained in a definite plastid; usually not blue-green; slimy coating usually absent; nucleus present..... 2

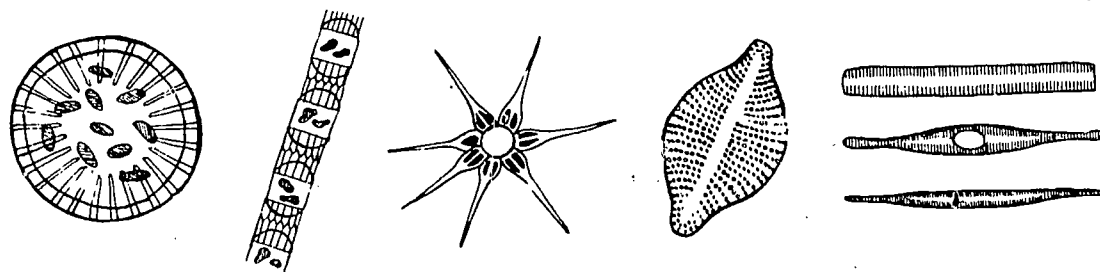


2. Non-motile; chloroplasts usually grass-green, and varied in shape; cell wall semi-rigid.  
PHYLUM CHLOROPHYTA.. 4

2. Motile or non-motile; chloroplasts yellow-green to brown; usually ovoid to spherical; cell wall very rigid or absent..... 3



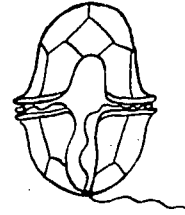
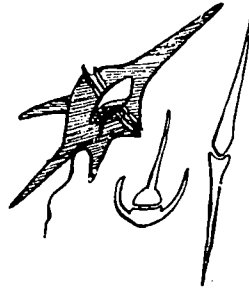
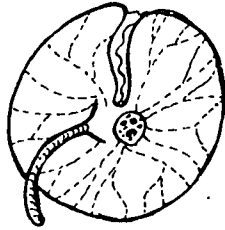
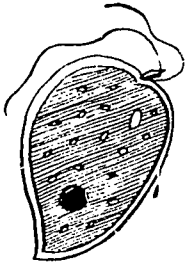
3. Chloroplasts yellow-green to golden-brown; cell wall rigid with regular markings, and usually made up of two overlapping halves (often impregnated with silica); motile or non-motile; single or in colonies.  
PHYLUM CHRYSOPHYTA...30



# KEY TO PHYTOPLANKTON

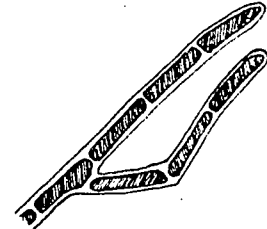
## PHYLA (Continued)

3. Chloroplasts yellow-green to dark brown (reddish); cell wall thin, thick or absent; usually two flagella, different in position and motion; has eye spot present; usually single, but may form in colonies. PHYLUM PYRRROPHYTA...17



## KEY TO GENERA OF CHLOROPHYTA

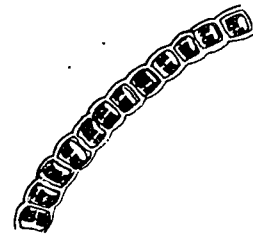
- 4. Cells in strandlike colonies.....5
- 4. Cells not in strandlike colonies.....7
- 5. Cells in branched, strandlike colonies.  
Cells a solid green chloroplast.      *Cladophora* (Fig. 1)



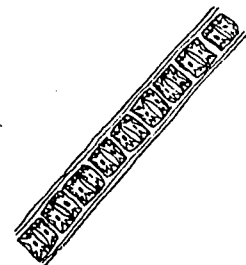
- 5. Cells in single strands, not branched;  
cells not solid green chloroplasts.....6
- 6. One or more spiral chloroplasts  
per cell.      *Spirogyra* (Fig. 2)



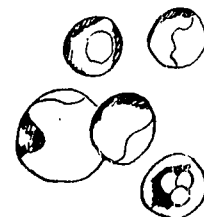
- 6. One collar-shaped chloroplast  
per cell.      *Ulothrix* (Fig. 3)



- 6. One or more star-shaped chloroplasts  
reaching to cell wall.      *Zygnema* (Fig. 4)

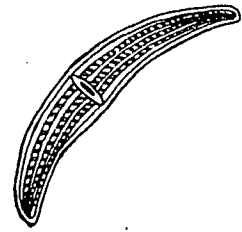


- 7. Cells consist of two semi-cells, with or  
without central constriction.....8
- 7. Cells with no semi-cells; no central  
constriction.      *Chlorella* (Fig. 5)



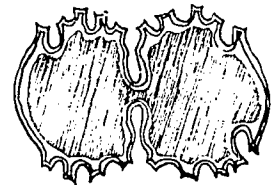
KEY TO GENERA OF CHLOROPHYTA  
(CONTINUED)

8. Cells of two semi-cells, without a deep constriction in the center; ends of cell bluntly pointed. *Closterium* (Fig. 6)

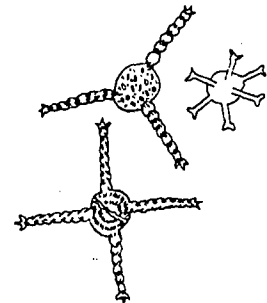


8. Cells of two semi-cells, having a deep constriction in the center, and margins of half-cells deeply incised.....9

9. Margins of cells deeply incised, and having short spines. *Microsterias* (Fig. 7)

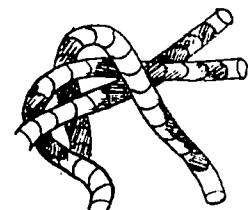
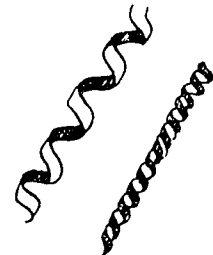
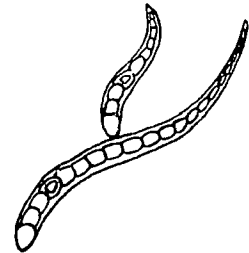
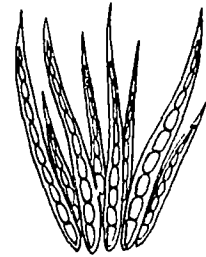
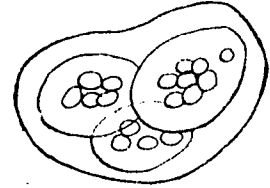


9. Margins of cells usually in three or more heavy spines; cell usually with processes extending in three dimensions. *Staurastrum* (Fig. 8)



## KEY TO GENERA OF CYANOPHYTA

- 10. Mature cells characteristically distinctly separated from one another by gelatinous matrix; cell division in three perpendicular planes. *Anacystis* (Fig. 9)
- 10. Cells characteristically not separated, but joined in filaments; cell division in two perpendicular planes.....11
- 11. Filaments conspicuously attenuated, tapering from base to apex (end).....12
- 11. Filaments not so.....13
- 12. Filaments fairly compact and radiate or parallel, forming distinct more or less globular, gelatinous mass. *Rivularia* (Fig. 10)
- 12. Filaments single, or loosely clustered, often with false branches; may unite with others to form micro--or macroscopic tufts. *Calothrix* (Fig. 11)
- 13. Filaments are without gelatinous sheaths, forming broad to narrow regular spirals. *Spirulina* (Fig. 12)
- 13. Filaments having definite or barely distinguishable gelatinous sheath, and not in regular spirals.....14
- 14. Filaments have conspicuous hyaline to yellow-brown individual sheaths, which extend beyond the filament; apical cells usually rounded. *Lyngbya* (Fig. 13)
- 14. Sheath not as above.....15



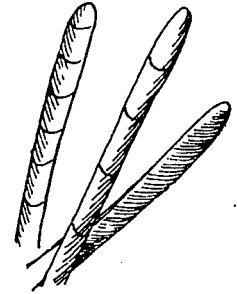
KEY TO GENERA OF CYANOPHYTA  
(CONTINUED)

15. Unbranched filaments, single to loose aggregations in watery mucous; cells spherical to barrel-shaped. *Anabaena* (Fig. 14)



15. Filaments not in watery mucous; cells not as above.....16

16. Unbranched filaments forming straight lines to irregular curves, occurring singly or in interwoven masses, attached or floating. Barely distinguishable sheath, or none; apical cell generally rounded. *Oscillatoria* (Fig. 15)



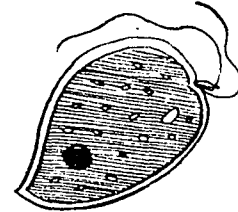
16. Unbranched filaments, straight or twisted, enclosed by loose gelatinous sheath commonly confluent with other sheaths forming a watery layer of filaments; apical cell variously shaped. *Phormidium* (Fig. 16)



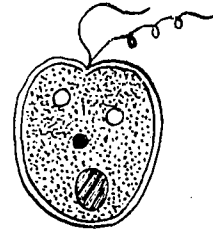
## KEY TO GENERA OF PYRROPHYTA

- 17. Girdle and sulcus lacking.....18
- 17. Girdle and sulcus present at some stage  
of life cycle.....19

- 18. Conspicuous spines at anterior end;  
thecate form. *Prorocentrum* (Fig. 17)

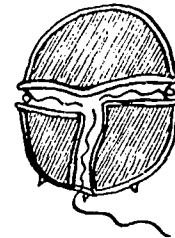


- 18. No conspicuous spines at anterior  
end; nonthecate form. *Haplodinium* (Fig. 18)



- 19. Body naked with thin pellicle (covering).....21
- 19. Body thecate (having decorative plates).....20

- 20. Theca separates into right and left halves.....27
- 20. Theca does not separate into right and  
left halves. *Glenodinium* (Fig. 24)

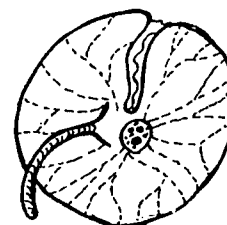


- 21. With ocellus (little eye--a small, rounded  
thickening.) *Nematodinium* (Fig. 19)



- 21. Without ocellus.....22

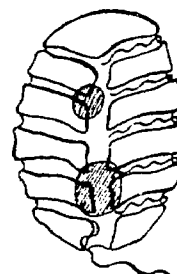
- 22. Cell large and spherical; single large  
tentacle at posterior end of sulcus. *Noctiluca* (Fig. 20)



- 22. Cell not thus, without large tentacle.....23

KEY TO GENERA OF PYRROPHYTA  
(CONTINUED)

23. With permanent colonial organization; with more than 1 girdle, and usually with two or more nuclei. *Polykrikos* (Fig. 21)

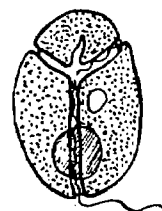


23. Without permanent colonial organization.....24

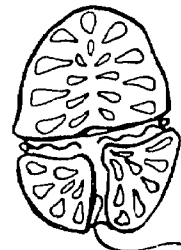
24. Ends of girdle not displaced, or displaced no more than 1/5 of the body length.....25

24. Ends of girdle displaced more than 1/5 of the body length.....26

25. Girdle close to anterior end, so that the epitheca is very small. *Amphidinium* (Fig. 22)



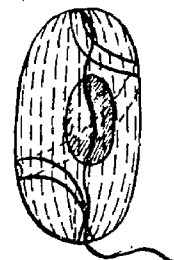
25. Girdle central to sub-central (mostly marine forms.) *Gymnodinium* (Fig. 23)



26. Sulcus almost straight. *Glenodinium* (Fig. 24)



26. Sulcus turned almost 1/2 the cell circumference. *Gyrodinium* (Fig. 25)



27. Epitheca very small and surrounded by the wide lips of the girdle (marine forms only.) *Dinophysis* (Fig. 26)

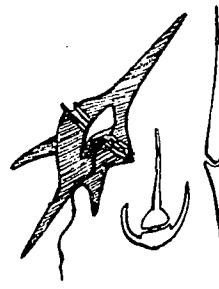


27. Epitheca usually larger. If small, not surrounded by lips of girdle.....28

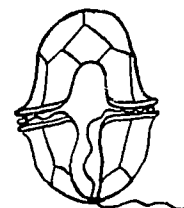


KEY TO GENERA OF PYRROPHYTA  
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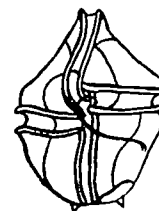
28. Apex of epitheca rounded or truncate,  
never acutely symmetrically pointed.....29
28. Apex of epitheca with an acute point,  
or definite horn, sometimes very long.  
Hypotheca with one to four horns, often  
strongly recurved. *Ceratium* (Fig. 27)



29. Epitheca rounded or truncate. Hypotheca  
may have two short spines. Sulcus often  
extends from hypotheca into epitheca.  
Fairly symmetric. *Peridinium* (Fig. 28)



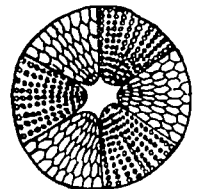
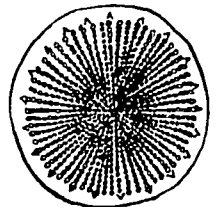
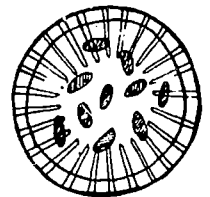
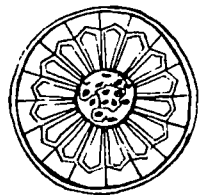
29. Body may be round or angular. Girdle  
usually equatorial. Spines very short,  
if any. One posterior intercalary plate.  
*Goniaulax* (Fig. 29)



# KEY TO GENERA OF CHRYSOPHYTA

## (DIATOMS)

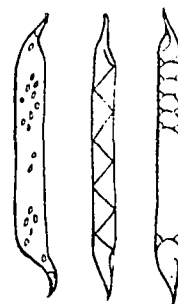
30. Valve outline circular; markings on valve usually in radial arrangement around a central point. ORDER CENTRALES... 31
30. Valve outline elliptical to rod-shaped; markings bilaterally symmetrical or asymmetric. ORDER PENNALES... 38
31. Single, cylindrical (round) cells, without horns or long spines..... 32
31. Not as above..... 35
32. Valve with wing-like expansion around margin of valve, supported by rays. *Planktoniella* (Fig. 30)
32. Valve without wing expansion..... 33
33. Valves with a striated margin. *Cyclotella* (Fig. 31)
33. Valves without a striated margin..... 34
34. Cells with inconspicuous, submarginal spines. *Coscinodiscus* (Fig. 32)
34. Cells without submarginal spines, and having valve divided into radial sections which are alternately arched inward and outward. *Actinoptychus* (Fig. 33)



# KEY TO GENERA OF CHRYSOPHYTA

(DIATOMS)  
(CONTINUED)

35. Valve with eccentric apex or hair-like spine. *Rhizosolenia* (Fig. 34)



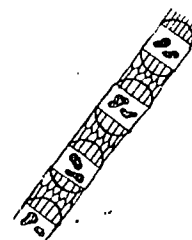
35. Valve not so.....36

36. Cells solitary with marginal crown of long spines. *Corethron* (Fig. 35)

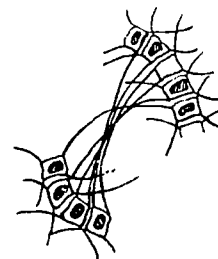


36. Cells not solitary, and without marginal crown of long spines.....37

37. Cells in chains, and held together by long, hollow spines. *Skeletonema* (Fig. 36)



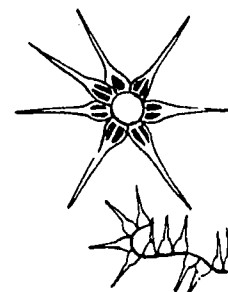
37. Cells in chains, with two setae per valve arising from the marginal corners. *Chaetoceras* (Fig. 37)



38. Valves without a raphe. A pseudoraphe usually present.....39

38. Both valves have a true raphe.....51

39. Cell with one end enlarged, forming star-shaped colonies. *Asterionella* (Fig. 38)

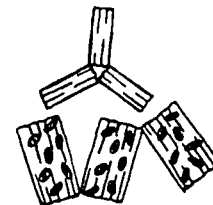
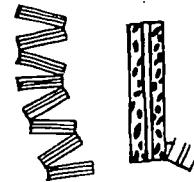
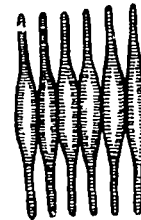
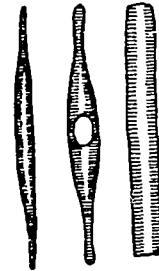
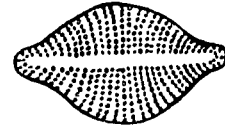


39. Cell not as above.....40

# KEY TO GENERA OF CHRYSOPHYTA

## (DIATOMS) (CONTINUED)

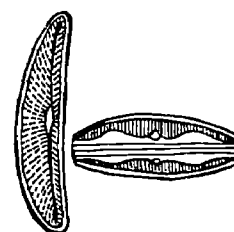
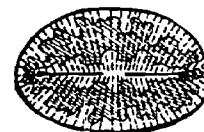
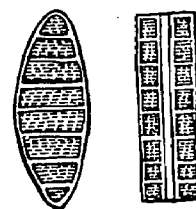
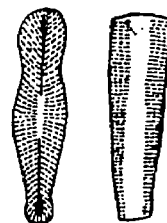
40. Pseudoraphe distinct.....41  
 40. Pseudoraphe indistinct or absent.....44
41. Striae (fine lines) usually radiate. *Rhaphoneis* (Fig. 39)
41. Striae usually transverse (going straight across.).....42
42. Cells elongate, usually many times longer than broad. *Synedra* (Fig. 40)
42. Cells not so; but united into bands by the entire valve side. *Fragellaria* (Fig. 41)
43. Cells long and narrow, cling in colonies.....44  
 43. Cells not long and narrow, do not cling in true colonies.....47
44. Colonies star-shaped or zig-zag.....45  
 44. Colonies not as above.....46
45. Cell with long valve, and having very small spines. *Thalassiothrix* (Fig. 42)
45. Cell with girdle view having four distinct longitudinal lines. *Tabellaria* (Fig. 43)



# KEY TO GENERA OF CHRYSOPHYTA

## (DIATOMS) (CONTINUED)

46. Cells very long, rounded on ends; slide over each other rapidly; at one time being end to end, and at another neatly arranged side to side. *Bacillaria* (Fig. 44)
46. Cells club or wedge shaped; longitudinally symmetrical, forming fan shaped colony. *Meridion* (Fig. 45)
47. Cells single; stalked or in gelatinous mass.....48
47. Cells not as above.....49
48. Valve symmetric but variable in shapes having conspicuous central and polar nodules. *Gomphonema* (Fig. 46)
48. Valve asymmetric; having a broad center, tapered at ends; girdle view rectangular. *Cymbella* (Fig. 47)
49. Girdle view quadrangular; valves elliptical to lance-shaped; cells may be in short chains. *Denticula* (Fig. 48)
49. Girdle view arched or bent; valves elliptical and rarely lance-shaped; does not occur in chains. *Cocconeis* (Fig. 49)
50. Valves crescent, elliptic, or somewhat boat-shaped; girdle view elliptic with flattened ends. *Amphora* (Fig. 50)
50. Valves not as above.....51

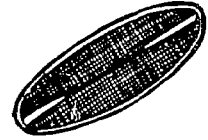


KEY TO GENERA OF CHRYSOPHYTA

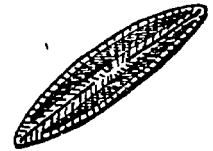
(DIATOMS)  
(CONTINUED)

51. Cell with definite central nodule.....52  
51. Cell without definite central nodule.....53

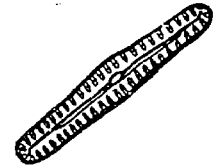
52. Cell with central nodule elongated to half the valve length or more, and then forking. *Amphipleura* (Fig. 51)



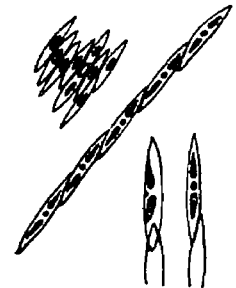
52. Cell with small central nodule and straight raphe; tapered at ends. *Navicula* (Fig. 52)



53. Valve linear, slightly inflated at center and rounded at ends. *Pinnularia* (Fig. 53)



53. Valve spindle-shaped, straight or slightly s-shaped; having a keel (keel of one valve diagonally opposite that of another valve.) *Nitzschia* (Fig. 54)



## GLOSSARY

anaerobic	a condition involving the absence of free oxygen in water or sewage.
anisogamy	sexual reproduction in which motile gametes are unequal in size.
anterior	the front or forward end of an organism that is capable of movement.
asymmetric	not symmetric - sides not alike.
autogamous	occurrence of fusion of two nuclei from same parent.
autotrophic	refers to nutrition type organism whose only food requirement is inorganic (organic materials are built up from inorganic by synthetic means.)
axis	the central line about which parts of an organism are symmetrically arranged.
benthic	aquatic organisms growing close to sub-strate.
bifurcate	divided into two branches; forked.
bilatera <sup>l</sup>	two-sided.
carbohydrate	any one of a group of compounds (sugar, starch, cellulose) containing carbon combined with hydrogen+oxygen in the form of an aldose or a ketose, essential in the metabolism of plants and animals.
carotene	a deep yellow or red hydrocarbon (crystalline) which acts as a plant pigment. It occurs also in various animal tissues (i.e., crayfish) and is changed in the body to vitamin A.
cellulose	an amorphous white carbohydrate, isomeric with starch, insoluble in all ordinary solvents and forming the fundamental material of plants.
chlorophyll	green photosynthetic pigment; present in plant cells, including the algae.
chloroplast	a color-carrying body (plastids) within a cell protoplast, containing the green coloring matter, chlorophyll.
chromatophore	a cytoplasmic structure (plastid) which acts as the seat of photosynthesis in holophytic nutrition, but whose color is yellow, brown, etc., instead of green.
cleft	an opening or division.
colonial	grouped or living together - in colonies.
concentric	circles, having a common center.
cyanophycean	bluish algae.
cytoplasm	all the protoplasm in a cell except that in the nucleus.

## GLOSSARY (Cont.)

diatom	cell walls of silica, and sculptured with striae and other markings; brown pigment associated with chlorophyll.
dinoflagellate	large flagellate.
elliptical	narrowly oval in form, with greater width across the middle than at the ends.
epitheca	the slightly larger half of a diatom; it fits as a flanged collar over the bottom half (hypotheca.)
filiform	in the shape of a thread
filamentous	having linear series of cells forming a thread, and held together by their cell walls or sheath.
fission	splitting or breaking apart
flagellate	motile algae and protozoa with a microscopic whip-like structure for locomotion.
fragmentation	breaking up of an organism into smaller pieces.
frustule	cell wall of a diatom.
fusiform	spindle-shaped.
gamete	either of two mature reproductive cells (ovum or sperm) which, in uniting, form a zygote.
girdle	the side of diatoms, showing the junction of the two valves (the hypotheca and epitheca.)
heterogamy	sexual reproduction wherein the gametes are of unequal size.
holozoic	animals whose nutrition is organic food (derived ultimately from plants) and taken into digestive cavity for absorption into the body.
hypotheca	the smaller, bottom half of a diatom, that fits inside the slightly larger top (epitheca.)



GLOSSARY (Cont.)

isogamy	sexual reproduction wherein the gametes are of equal size and all alike; no differentiation between male and female.
lateral	refers to sides, rather than ends, of an algae body or other organism.
leucosin	a simple protein.
locomotion	power of moving from one place to another
longitudinal	running lengthwise
lorica	rigid, wall-like covering around a motile cell, separated by a space from the protoplast or cell wall. An opening is present at the anterior end, through which the flagellum extends.
macroscopic	over 3 mm in size.
matrix	intercellular substance
membranous	a wide, thin, flat plant body; a partition or covering, like the permeable outer surface film of a protoplast.
micron	unit of linear measurement used for describing the size of micro-organisms. Equivalent to one one-thousandth of a millimeter. Defined by using the Greek symbol $\mu$ .
motile	free-swimming.
nannoplankton	unattached aquatic micro-organisms under 60 microns in size.
naviculoid	boat-shaped.
nodule	a small knot, lump or knob.
non-flagellate	not having a whip-like microscopic structure for locomotion.
nucleolus	a well-defined small nucleus often found within the nucleus of a cell.
nucleus	an organized, specialized body within the protoplast, and containing the chromatin.
oogamy	sexual reproduction in which the sperm is small and flagellate and the egg is large and non-motile.
organism	a plant or animal; a body that has developed as a result of being alive.

## GLOSSARY (Cont.)

pennate	a diatom which is elongate, not circular in the valve view; the ornamentation or pattern is arranged along the sides of the longitudinal axis rather than around a central point.
photosynthetic	ability of algae and other plants to manufacture sugar and other carbohydrates from inorganic raw materials, with the aid of light and chlorophyll.
phytoplankton	microscopic aquatic plant life.
pigmented	having color.
plankton	unattached micro-organisms (plants and animals) dispersed throughout the water.
plastid	a structure within a cell containing the pigments.
pollution	presence of foreign material in water, particularly that which interferes with its use.
polygonal	having many angles.
posterior	the hinder end of the body of a free-swimming organism.
protoplast	the mass of protoplasm within the cell wall.
pseudoraphe	a clear, narrow space along the longitudinal axis of some diatom valves.
radial	having lines or patterns extending from the center of a circle, and at right angles to tangents.
raphe	a furrow or cleft along the longitudinal axis of some diatom valves.
silica	silicon dioxide or other silicon compounds.
silicious	composed of silicon dioxide. Glossy.
spores	reproductive bodies in non-flowering plants; usually single-celled and capable of developing into an independent organism.
statospore	an asexual, non-motile spore with thickened cell walls.
strandlike	fibre or hairlike.
striae	fine lines; lines of pores (like dots) arranged in a regular pattern in the walls of diatoms.
sulcus	groove or furrow; ventral longitudinal groove in dinoflagellates.
symmetrical	regular; having the parts on one side of an organism identical to the other side.

GLOSSARY (Cont.)

thecate	having a cell wall (lorica) surrounding the organism.
transverse	lying across; placed along the long axis of a part.
truncate	with the end flat, squared off.
tubular	thread-like plant body, one cell wide, not divided into segments by cross-walls.
unicellular	one-celled.
valves	the more or less flattened surfaces of diatom cells.
ventral	underside; abdominal or vent side of an animal; lower side of a plant part - facing its center.
xanthophyll	a yellow pigment contained in plants, related to carotene.
zooplankton	microscopic aquatic animal life.

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