Dinoflagellates

- Commonly placed in Division *Pyrrophyta* Pascher, 1914, (botanical)
- Class *Dinophyacea* Fritsch 1929
- Also placed in Phylum *Dinophyta* (zoological)
- Diagnosis:
- Biflagellate, cell commonly covered with distinct cellulose plates, contain plastids (chromatophores), stores starch and oils in vacuoles, haploid reproduction, with equal-sized gametes.

Biological generalizations

- Produce red tides and bioluminescence (e.g. *Noctilucta* sp.)
- Both photosynthetic and heterotrophic
- Freshwater and marine, some are parasites and symbionts (e.g. *Zooxanthellae*)
- Contain numerous chromatophores (plastids) containing chlorophyll a and c, as well as carotenoids. May be brown or red, in addition to green.
- *Dinos* = whirling (not terrible)
- Reproduction is by alternation of generations (sexual and asexual)

- Most are armored (e.g. *Ceratium* sp., *Peridinium* sp., and *Goniaulax* sp.) , but several are naked (e.g. *Gymnodinium* sp.)
- "Cellular armor" of sporopollenin (polymer of CHON), a type of cellulose

Two life stages

1. Theca (typically disarticulates, no fewer than three plates. Plates commonly sculptured)
2. Cyst (cyst is fossilizable, sometimes filled with calcite and silica)

Discovery

- Ehrenberg (1836) described first fossils from Cretaceous cherts
- 1st living species described 187?

Geological Range

- Dinocysts—became abundant in Mesozoic and Cenozoic
- One Silurian species identified, yet acritarchs range from Proterozoic to recent

Morphology

- Biflagellate, with ventral flagellar pores
- One flagellum is transverse, positioned in cingulum (= girdle), origin in anterior flagellar pore
- One flagellum is longitudinal, positioned in sulcus, origin in posterior flagellar pore
- Archeopyle is hole used for excystment, sometimes covered with an operculum (= cover)

Anterior, apical	Ventral, dorsal	sulcus
Posterior, antapical	Epitheca, epicone	archeopyle
Cingulum, girdle	Hypotheca, hypocone	

Tabulation:

Kofoid (1909) tabulation used to describe thecal and cystal plates
Tabulation formula = shorthand method

- Preapicals = pr
- Apical = ‘ = touch apex
- Precingular = “ = anterior and touch cingulum
- Postcingular = “ ‘ = posterior and touch cingulum
- Antapical = “ “ = touch antapex or posterior
- Anterior intercalary = a
- Posterior intercalary = p
- Sulcal = s
- Cingular = c
- None = O
- X = more than

All plates numbered from left to right

4a = four apical plates

Example of Kofoid equation

Pr, ‘, a, “, c, “ ‘, p, “ “, s

Higher order taxonomy

- Paleontological taxonomy based on cyst (position of central spine = connection with thecal plate during encystment)
- Neontological taxonomy based on theca
- Over 130 living genera, 2000 marine species, 200 freshwater species
- Over 461 fossil genera divisible into 2536 species (Lentin et al, 1985)
- Number of species doubled in 10 years in early ‘70’s

Acritarchs (coined by Evit, 1963)

- *Akritos* = greek for “confused”
- *Arche* = greek for “origin”
- A problematic group of leftover cysts, characterized by central cavity, organic wall,