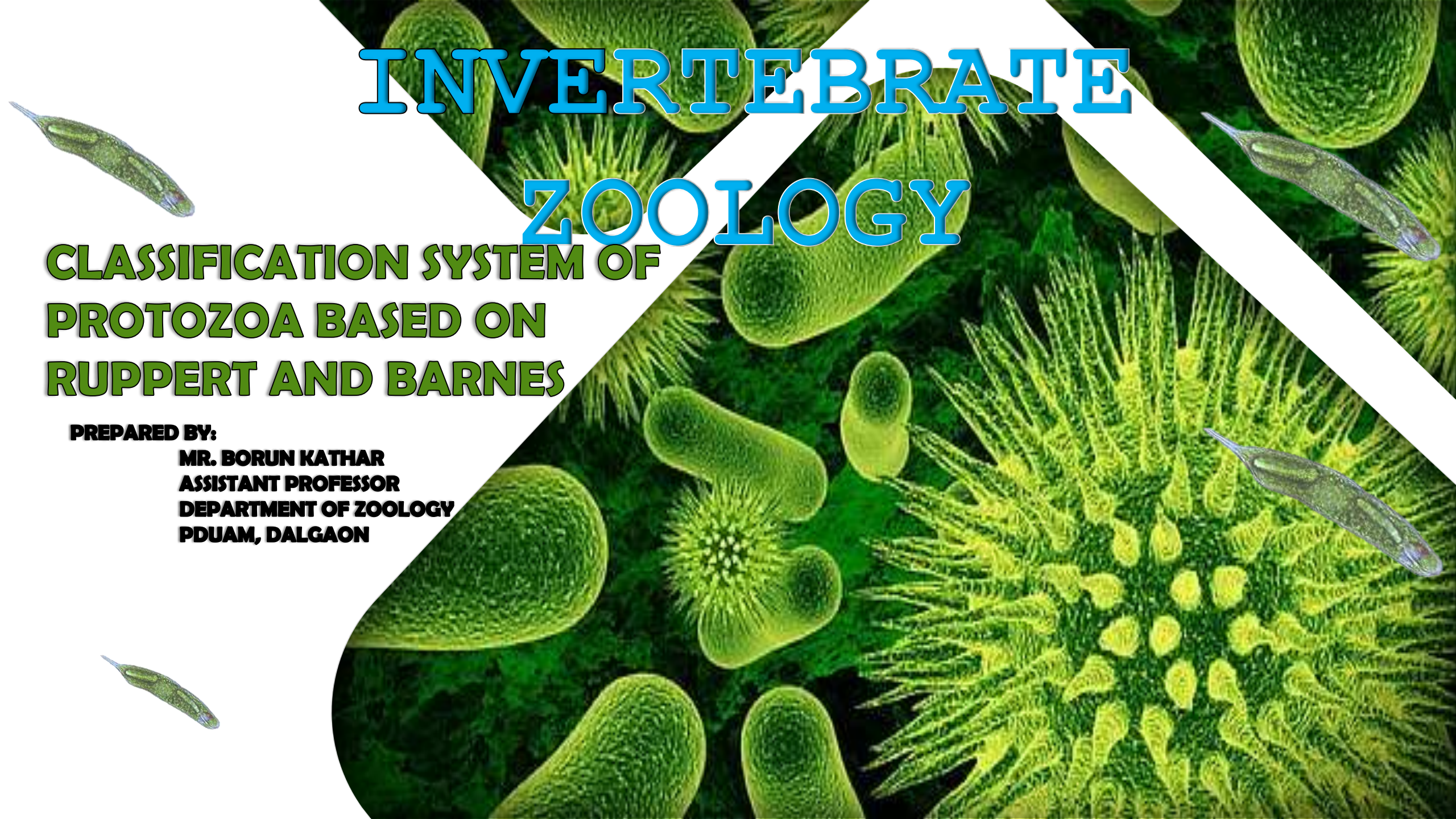




INVERTEBRATE ZOOLOGY

CLASSIFICATION SYSTEM OF PROTOZOA BASED ON RUPPERT AND BARNES

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PROTOZOA

Protozoa are now regarded as a diverse, polyphyletic group of single-celled, eukaryotic organisms, typically classified under the Kingdom “Protista” (or as Protists). The unicellular eukaryotes have a membrane-enclosed nucleus, which exhibits itself as a complete organism adapted to meet the challenges of life, but some form colonies of cells

Formerly known as infusoria or animalcules, protozoans are motile, eukaryotic, unicellular organisms. Historically, protozoa included nearly every group of what we now consider Protista- fungus-like, animal-like, plant-like, and other unicellular eukaryotes. The name Protozoa means “first animal”



PROTOZOA

It has now been established that the collared flagellates (**Choanoflagellates**) is the only protozoan taxon, that is the sister taxon of Metazoa and truly qualifies as the “first animal”. Metazoa is split into two main branches: Parazoa (Sponges & Placozoans, which lacks true tissue) and Eumetazoa (all other animals, which possess true tissues and organs)

The remaining protozoan taxa are either unique groups with no significant multicellular descendents or they are related closely to plants or fungi.

Remarkably, one protozoan taxon, **Myxozoa** (formerly Myxosporidia), is actually a group of animals related to Cnidarian (Anemones and Jellyfishes)

Protist exhibit astounding diversity and play a significant ecological role. The nearly 2,15,000 described species equal in number the vascular plants and are 10 times more plentiful than the bacteria and virus species combined.



PROTOZOA

Of the total number of **Protist** species, slightly less than half (around 92,000) are **Protozoans**, one-quarter of which live as symbionts of other organisms like protozoan parasites in humans, livestock, poultry, fish and wildlife.

The **Protist** as a whole, including the photosynthetic **Protozoa**, account for 40% of global primary productivity.

Protozoans can be categorized based on its body form like- Flagellates protozoan, Ciliates protozoans, Amoeboid protozoans,& Sporozoite protozoans.



DIVERSITY OF PROTOZOA

PHYLUM: EUGLENOZOA

CLASS:

EUGLENOIDEA

KINETOPLASTIDA



CLASS :

- The euglenoid species of *Peranema* and *Euglena* are among the most familiar of all flagellates

- * The body is elongate with an invagination, the reservoir, at the anterior end.
- * The cytostome lies at the base of the reservoir and joins a cytopharynx.
- * It has a contractile vacuole, two flagella, each bearing a row of mastigonemes, arise from the reservoir wall.



CLASS :

EUGLENOIDEA

- In *Euglena*, one flagellum is very short and terminates at the base of the long flagellum.
- * A pigmented eyespot, or stigma, shades a photosensitive bulge, the paraflagellar body, at the base of the long flagellum.
- * In the colourless heterotroph *Peranema*, both flagella are long, but one tails backward and can be used to catch food or temporarily attach to something.



CLASS :

EUGLENOIDEA

- Approximately two-third of the 1000 species of the marine and freshwater *Euglenoida* are colourless heterotrophs and one-third are green photoautotrophs, such as the species *Euglena*.

* The chloroplasts of photosynthetic species contain chlorophylls *a* and *b*.

The species such as *Euglena* store food energy as a unique starch like carbohydrates called paramylon, which is synthesized in the specialized region, the Pyrenoid, of the chloroplast, but stored as free granules in the cytoplasm.



CLASS :

KINETOPLASTIDA

- Kinetoplastids flagellates are colourless heterotrophs

★ A few of the 600 species are free living, but most are important parasites.

All share the flagellar paraxial rod with their euglenoid relatives, but uniquely have a conspicuous mass of DNA, called a **Kinetoplast**, located within a single, large mitochondrion.

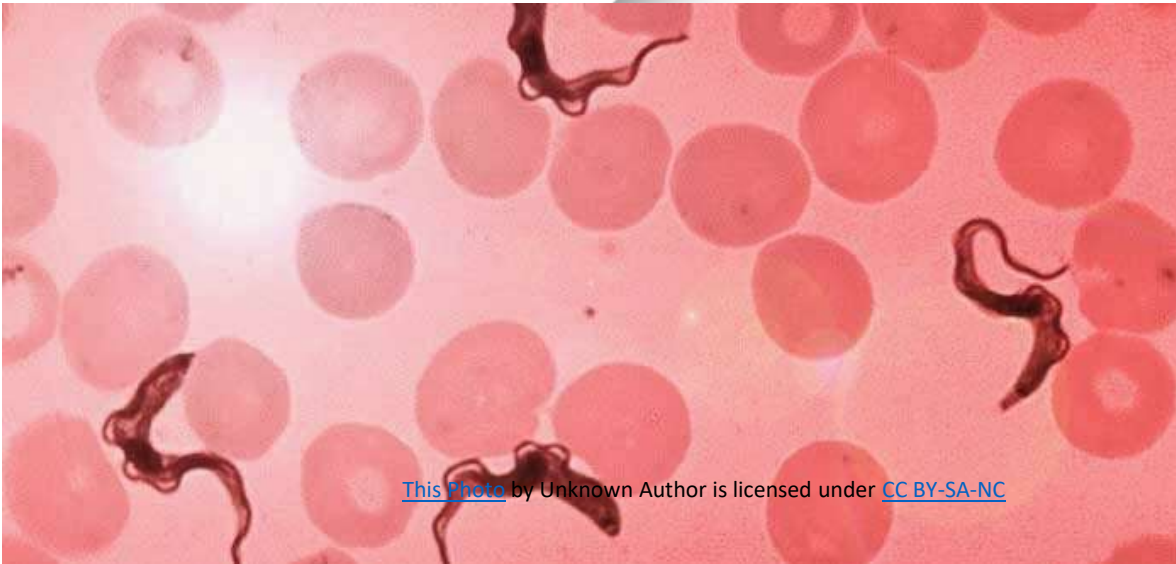
Species of the free living biflagellates *Bodo* commonly are found in brackish and fresh water and in soil, where they feed on bacteria.



CLASS :

KINETOPLASTIDA

- The Trypanosome Kinetoplastids flagellates are gut parasites of humans and insects (Tse tse fly) causing African sleeping sickness disease in human.



CLASS :

KINETOPLASTIDA

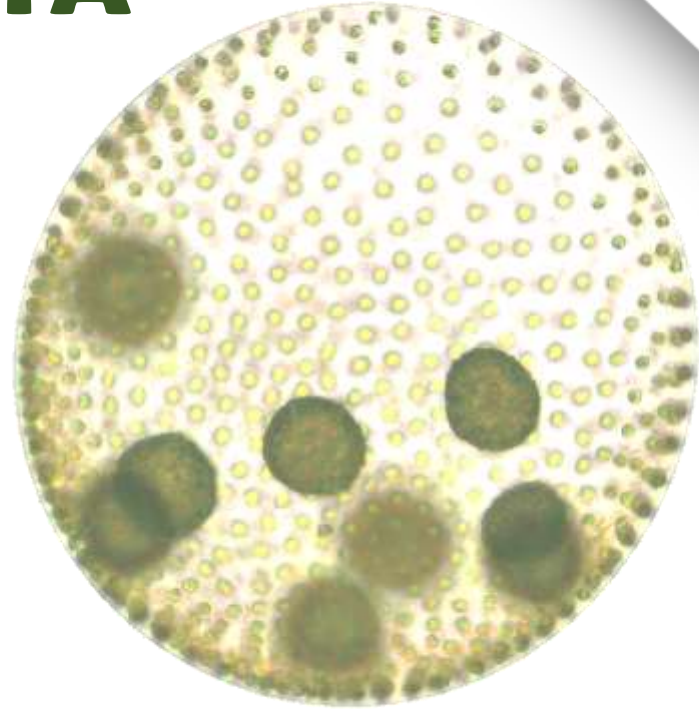


DIVERSITY OF PHYLUM: PROTOZOA CHLOROPHYTA

ORDER:



VOLVOCIDA



Order:

Volvocida is a taxon of green algae (chlorophyta), in which the large cup-shaped chloroplasts contain chlorophylls a and b and a pyrenoid that synthesizes starch (amylopectin) as a food storage product.

Many chlorophytes are non motile marine and freshwater algae, such as the filamentous spirogyra of freshwater.

The cells of volvocida, however, are permanently flagellated: each cell bears two, four, or occasionally eight flagella lacking mastigonemes. An eyespot and two contractile vacuoles also may be present.

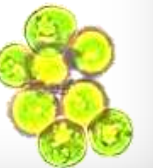
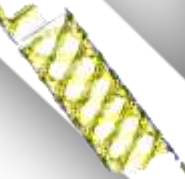
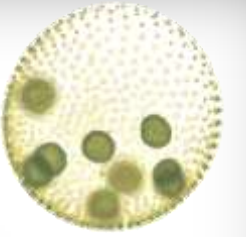
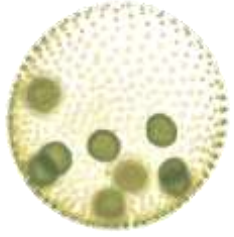
The cells are enclosed in a gel matrix composed of glycoproteins and glycoamyloglycans and are interjoined by cytoplasmic bridges.

Order:

Among the flagellated species, some are solitary, such as *Chlamydomonas* and others are colonial. The colonies of *Gonium* are flat plates of 32 to 40 cells, but other genera form hollow spheres: *Pandorina* (16 to 32 cells), *Eudorina* (32 cells), *Pleodorina* (64 to 128 cells), *Volvox* (2000 to 6000 cells).

Chlamydomonas reproduce clonally by longitudinal binary fission. In *Volvox*, only specialized, large aflagellate cells (gonidia) are capable of asexual and sexual reproduction.

Although closely related to plant and not to animals, *Volvox* nevertheless illustrates how multicellular might have evolved in the first animals



DIVERSITY OF PROTOZOA

PHYLUM:

CHOANOFLAGELLATA

Choanoflagellates are thought to be the sister taxon of animals (metazoan).

Both choanoflagellates and primitive monociliated animal cells bear a single flagellum, which bears a bilateral vane of mastigonemes- like filaments and is surrounded by a cylindrical collar of microvilli.

This synapomorphy, along with support provided by rDNA sequences, unites the choanoflagellates and metazoans as sister taxa in a monophyletic taxon.

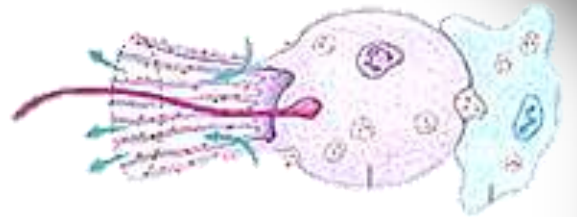
Phylum : Choanoflagellata

The 600 species of choanoflagellates are mostly tiny and inconspicuous, usually not in excess of 10 μm in diameter.

While feeding, the flagellum creates a water current from which the collar filters bacteria and organic particles. Bacteria trapped on the collar are ingested by phagocytosis.

Choanoflagellates may be solitary or colonial, attached or free swimming. Some sessile species are attached by a stalk, part of a vase like test.

Colonial planktonic form: *Proterospongia*

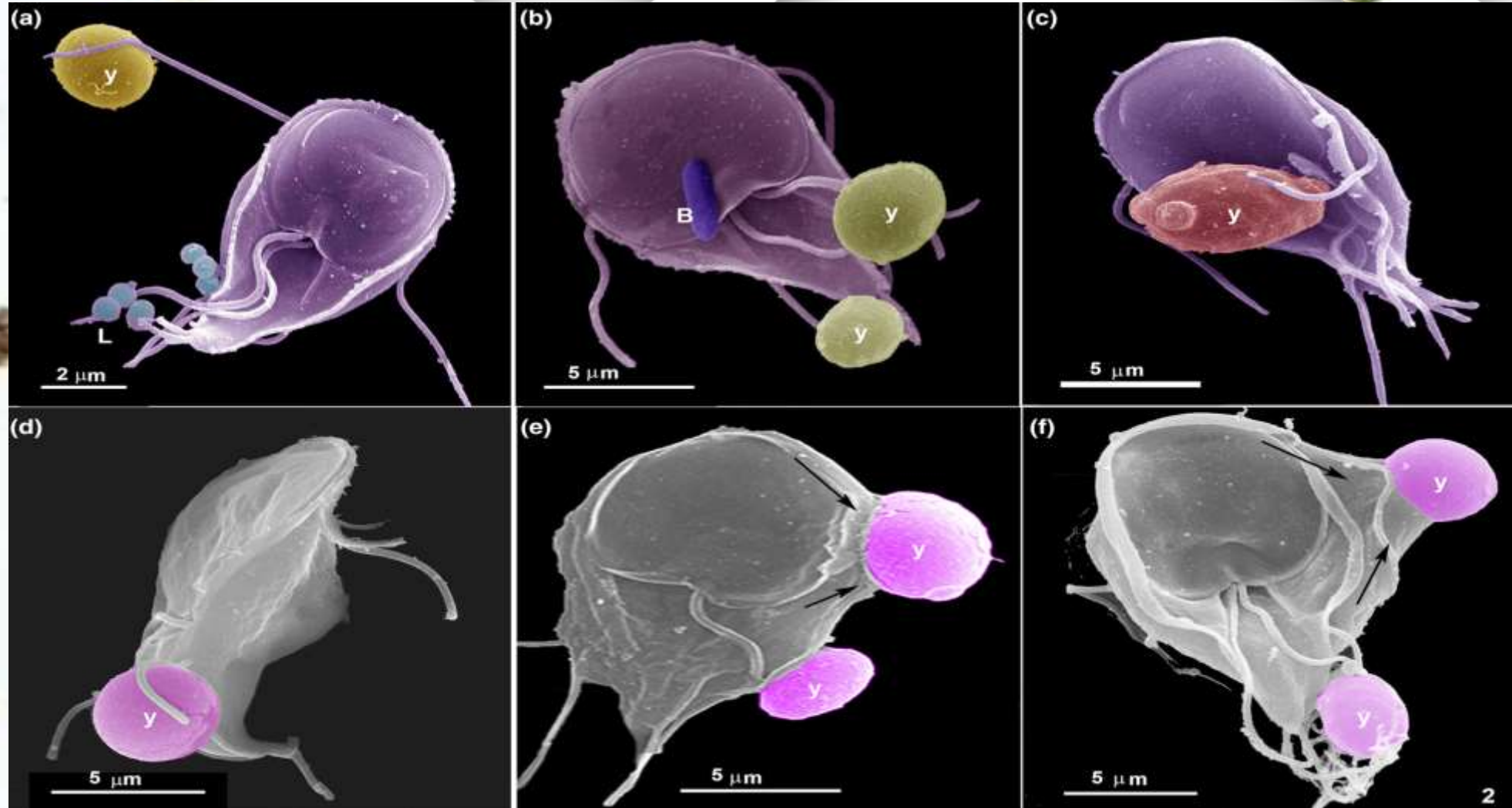


Phylum : RETORTAMONADA and AXOSTYLATA

These two taxa of heterotrophic flagellates have from four to thousands of flagella organized in functional groups. A few of the 700 species are free living (*Hexamita*) in anoxic habitats, but most live anaerobically in the guts of vertebrates and insects, especially wood roaches and termites.

Retortamonads such as *Giardia lamblia*, have four pairs of flagella, one of which trails behind the leading three and the cell body. *Giardia lamblia* causes bloody diarrhea, is a common intestinal parasites

Phylum : RETORTAMONADA and AXOSTYLATA



Phylum : RETORTAMONADA and AXOSTYLATA



DIVERSITY OF RETORTAMONADA

CLASS:

Retortamonadea

Two or four anterior flagella, one of which is associated with the cytostome. Example: *Chilomastix sp.* Cause diarrhea in humans, and *Retortamonas* in poultry.

Diplomonadea

Cell with eight flagella, two cytostomes, two nuclei, mitochondria are absent. Example: free living- *Hexamita* and parasitic- *Giardia sp.*

Phylum: AXOSTYLATA

Axostylates have a bundle of microtubules called the axostyle that extends the length of the cell.

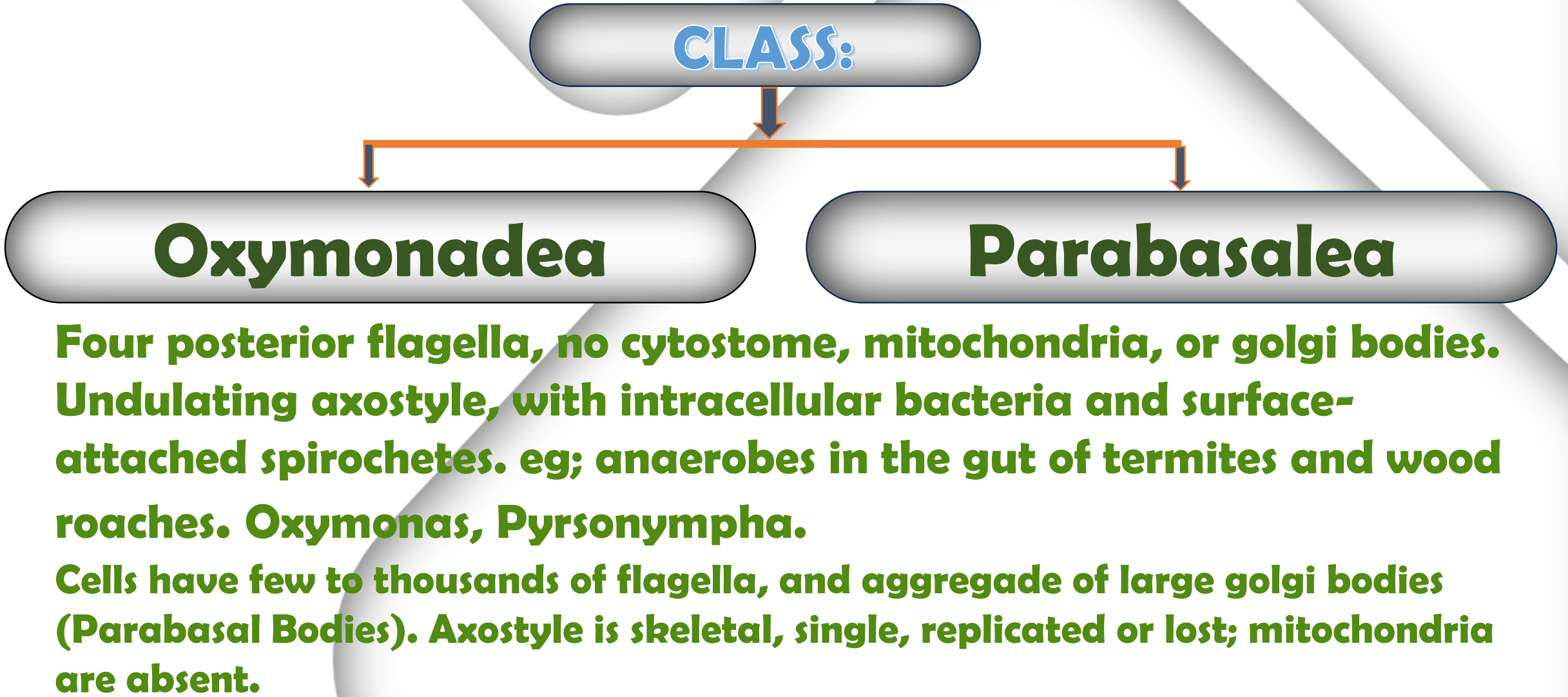
In most species, it is skeletal in function, like an intracellular backbone, but in some primitive species, it undulates and imparts a long snaky whip to the cell motion.



Example: Trichonympha campanula

DIVERSITY OF AXOSTYLATA

CLASS:



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graph TD; A[DIVERSITY OF AXOSTYLATA] --> B[CLASS:]; B --> C[Oxymonadea]; B --> D[Parabasalea]; C --> E[Four posterior flagella, no cytostome, mitochondria, or golgi bodies. Undulating axostyle, with intracellular bacteria and surface-attached spirochetes. eg; anaerobes in the gut of termites and wood roaches. Oxymonas, Pyrsonympha. Cells have few to thousands of flagella, and aggregade of large golgi bodies (Parabasal Bodies). Axostyle is skeletal, single, replicated or lost; mitochondria are absent.]; D --> F[Cells have few to thousands of flagella, and aggregade of large golgi bodies (Parabasal Bodies). Axostyle is skeletal, single, replicated or lost; mitochondria are absent.]
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Oxymonadea

Four posterior flagella, no cytostome, mitochondria, or golgi bodies. Undulating axostyle, with intracellular bacteria and surface-attached spirochetes. eg; anaerobes in the gut of termites and wood roaches. Oxymonas, Pyrsonympha.

Cells have few to thousands of flagella, and aggregade of large golgi bodies (Parabasal Bodies). Axostyle is skeletal, single, replicated or lost; mitochondria are absent.

Parabasalea

CLASS: Parabasalea

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graph TD; A[CLASS: Parabasalea] --> B[Order: Trichomonadida]; A --> C[Order: Hypermastigida];
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Order: Trichomonadida

Has two to six flagella, a recurrent flagellum forms an undulating membrane; axostyle projects posteriorly to form the attachment site.

Eg: *Trichomonas* and *Mixotricha paradoxa*

Order: Hypermastigida

Cell has many flagella at the anterior end of the cell. Most have surface- attached symbiotic bacteria. In the gut of termites and wood roaches. *Barbulanympha*, *Lophomonas*, *Trichonympha*.

PHYLUM: ALVEOLATA

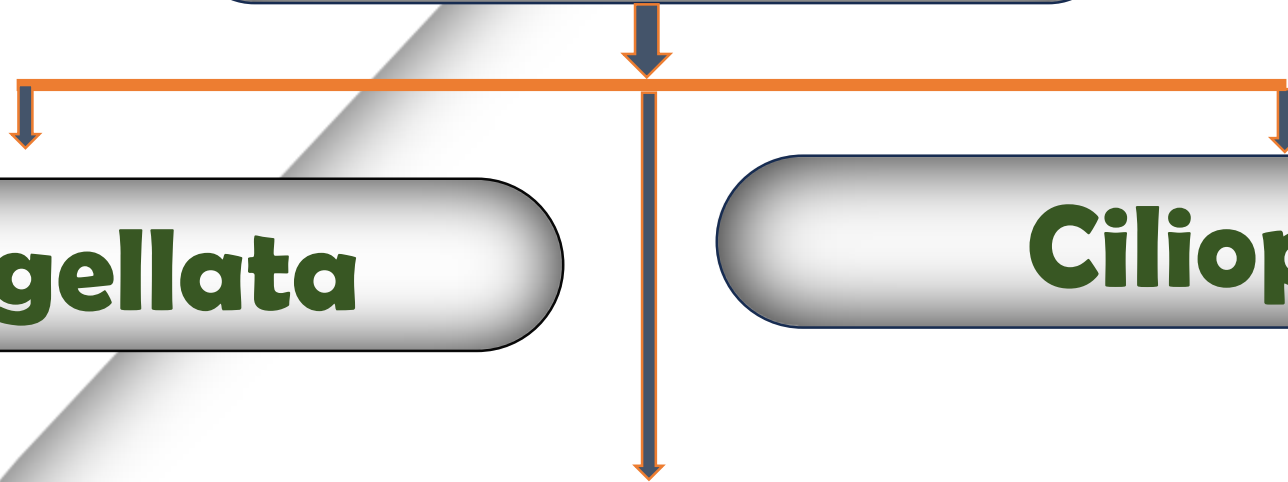
Three taxa, Dinoflagellata, Ciliophora, and Apicomplexa (Sporozoa) constitute the Alveolata. Alveolates are united on the basis of having similar ribosomal DNA sequence and pellicular alveoli.

SUB-PHYLUM:

Dinoflagellata

Ciliophora

Apicomplexa



SUB-PHYLUM: DINOFLAGELLATA

Approximately one-half of the 4000 marine and freshwater species of dinoflagellates have chloroplasts and are important primary producers, especially in the sea.

The xanthophyll pigment peridinin colours them red-brown or golden-brown. Their chloroplasts have three membranes and have chlorophyll a and c, but lack chlorophyll b.

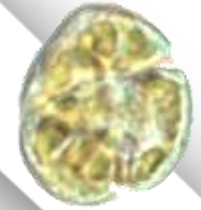
Heterotrophic dinoflagellates lack plastids and are colourless. A few dinoflagellates are endoparasites of other protozoans, crustaceans, and fishes.

Typical dinoflagellates have two flagella. Dinoflagellates have a complex skeleton, or theca, which often contains deposit of skeletal cellulose in alveoli. Dinoflagellates are either pigmented photoautotrophs or colourless heterotrophs,, but some pigmented species exhibit both modes of nutrition.

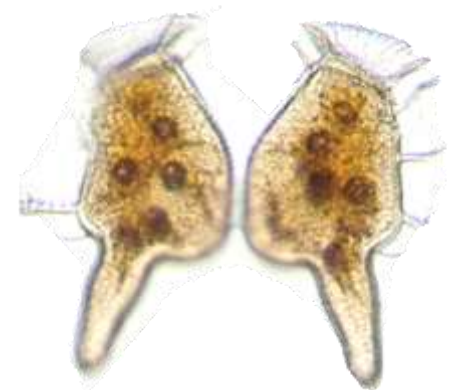
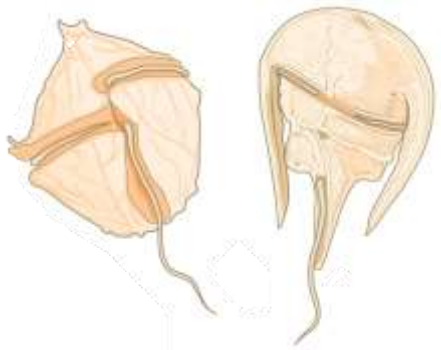
SUB-PHYLUM: DINOFLAGELLATA



★ Some dinoflagellates capture their prey with pseudopodia and ingested through an oral opening associated with the longitudinal flagellar groove. Eg. *Noctiluca*.



★ Dinoflagellates undergo longitudinal binary fission. Cyst are formed in many flagellates groups, including dinoflagellates.



SUB-PHYLUM: CILIOPHORA

(CILIAE PROZOANS)

Ciliophora is a monophyletic taxon of extremely or unusually small animals having cilia on their body and have sophisticated cellular organelles and complexity in their behaviour. The 8000 + described species are widely distributed in freshwater, the sea, and swamps, waterlogs etc.

Diverse body forms occur among the ciliates and, despite their motility and fixed anterior-posterior polarity, most are asymmetric. A few, however, are radially symmetric with an anterior mouth.

Most ciliates are solitary and motile, but some species form colonies and are sedentary. Ciliate cell size range from 10 μm to 4.5 mm.

SUB-PHYLUM: CILIOPHORA
(CILIATE PROZOANS)

DIVERSITY OF CILIOPHORA: CLASS

1. KARYORELICTEA

Freshwater and marine. All highly contractile. Macro and micro nuclei both diploid.
Ex. Loxodes, Remanella

2. SPIROTRICHEA

Ciliates with oral membranelles (polykinetids) that wind clockwise to the cytostome. Somatic dikinetids or polykinetids

Sub-Class:

a. Heterotrichia
Ex: Stentor

Sub-Class:

b. Oligotrichia
Ex: Halteria

Sub-Class:

c. Strichotrichia
Ex: Stylonychia

Sub-Class:

d. Hypotrichia
Ex: Aspidisca

3. LITOSTOMATEA

Somatic monokinetids

Sub-Class:

a. Haptoria
Ex. Dileptus

Sub-Class:

b. Trichostomatia
Ex. Balantidium

4. PROSTOMATEA

Oral region imilar with Litostomates, but some polykinetids are also present.
Ex. Coleps

5. PHYLLOPHARYNGEA

6.