Protozoa

Objective:

- **To know the basic cytology and characteristics of protozoa.**
- **Understand their importance in the ecology of water treatment and significance as pathogens in water supply.**

References

Sleigh, M. ***Protozoa and other Protists***

Curds, C.R. ***Protozoa in the Water Industry***

Mitchell, R ***Environmental Microbiology***

Gray, N F ***Biology of Wastewater Treatment***

Outline

Introduction, Classification, Characteristics, Water Ecology, Water Pathogens.

Protozoa - Introduction

- **Members of Protista kingdom**
- **Eukaryotic mostly Unicellular**
- **Reproduce - sexually (Conjugation)**
  asexually (Binary Fission)
- **Motile (not all)**
  – swimming, gliding, crawling
- **May have Plastids (Algae?)**
  – these can be lost
- **Size 5 μm - > 500 μm**
- **Extremely Diverse Morphology**
  – c.f. bacteria, fungi

Morphology

- **Nucleus in nuclear membrane**
  - 1 or 2 nuclei
- **Cytoplasmic Membrane**
  - Present in all
- **Organelles often present**
  - mitochondria, golgi, Chloroplasts!
- **Cell Wall - Absent**
- **Cell Coat / Shell**
  - Pellicle
  - Test
  - Lorica
- **Cilia, Cirri**
- **Flagella**
- **Contractile Vacuole**
  - in free-living protozoa

Feeding

- **Autotrophs (Phototrophic)**
  - **Primary producers like Algae**
- **Heterotrophs**
  - **Saprobic - dead and decaying matter**
  - **Holozoic - whole live organisms**
    - bacteria, algae, other protozoa
- **Raptorial Feeding**
  - **Actively seek prey (*Didinium)***
- **Filtration**
  - **Cilia beat, cilia trap (*Vorticella)***
  - **Buccal Cavity (Mouth region)**
  - **Cytostome - Phagocytosis**
- **Stick to Prey**
  - **Suctoria tentacles with haptocyst (*Acineta)***
  - **suck contents of cell**
- **Pinocytosis - cell drinking**
  - **soluble organics**

Sarcomastigophora

Mastigophora subphylum having flagellum

- **Phytomastigophora**
  - – phototrophic flagellates
  - – can lose chloroplasts
  - – e.g. *Euglena, Peranema*
- **Zoomastigophora**
  - – animal-like flagellates
  - – e.g. *Bodo, Oikomonas*
  - – some parasitic e.g. *Giardia*,Trypanosoma**

Sarcodina subphylum having pseudopoda

- **Rhizopoda**
  - – move by pseudopoda
  - – **Naked -** *Amoeba, Entamoeba**
  - – **Testate -** *Arcella*
- **Actinopoda**
  - – planktonic
  - – Radiolaria
    - – radial axopoda, siliceous skeleton.

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Apicomplexa

Sporozoea

- simple , resistant spores and oocysts
- parasitic
- e.g. *Cryptosporidium**
  Plasmodium (malaria)*
  Toxoplasmosis*

Microsporidia
Myxosporidia

Obligate intracellular parasites

in vertebrates, invertebrates, protists

e.g. *Nosema* disease in Honey bees

Ciliophora

The major Phylum in terms of diversity and actual numbers in Aquatic Environments.

A number of sub-classes, all have cilia or ciliary organelles. Most are free-living. Four types are of most interest.

1. Suctoria

- **Predatory on other protozoa, sessile.**
- **no cilia, but have tentacles.**
- **e.g.** ***Acineta,***
  Podophyra

2. Peritrichia

- **Sessile usually stalked.**
- **Bell-shaped pellicle, some have lorica.**
- **Cilia bands.**
- **e.g.** ***Vorticella***
  Carchesium
  Opercularia

Ciliophora

3. Holotrichia

- free-swimming
- body covered in cilia
- some predatory
- e.g. *Paramecium*
  Chilodonella
  Colpidium

4. Spirotrichia

- cilia in rows, sheets, tufts, - i.e. Cirri
- Crawl on surfaces
- e.g. *Aspidisca*
  Euplotes

Ecological Function

- **Surface waters**
- **Sewage treatment**

  - **primary feeders**
    - holozoic - bacterial predation
  - **particulate ingestion (detritus)**
  - **uptake of dissolved BOD**
  - **Benefits**
    - Purification
    - Clarified effuents
    - Pathogen Removal

Ecological Factors Affecting Protozoa

- **Water**
  - **essential, Encyst when shortage.**
- **Temperature**
  - **Survive extremes by spores or cysts.**
- **Oxygen**
  - **free-living species mostly aerobic**
  - **gut parasites, symbionts anaerobic.**
- **Carbon Dioxide**
  - **high conc. toxic to many species**
  - ***Paramecium, & Bodo* tolerant, find them with pollution.**
- **Salinity**
  - **Strong effect on water uptake by cell.**
  - **Contractile vacuole compensates.**
  - **most species either fresh- or saltwater.**

Saprobic Zones - Protozoa

scheme of Kolkwitz & Marsson (1902)

- **1. Polysaprobic** **(large numbers small diversity)**

  BOD (10 - 50 mg/l) **Bodo, Oikomonas, Paramecium**

- **2. Mesosaprobic** **(greater diversity, + pigmented flagellates)**

  α- BOD (5 - 10 mg/l) **β- BOD (2.5 - 5 mg/l)**

  Chladydomonas (pigmented flagellate)

  Chilomonas (flagellate)

  Colpidium (ciliate)

  Arcella (amoebae)

- **3. Oligosaprobic** **photosynthetic protozoa**

  BOD (< 2.5 mg/l) **Dinobryon**

  Ceratium

  + ciliates and amoebae

(limited application due to the lengthy identification process)

Protozoal Diseases

Giardiasis - *Giardia lamblia*

- flagellate, symmetrical organelles
- waterborne epidemics, 10^6 cases/yr giving diarrhoea, nausea, cramps.
- adhesive disc attaches to gut wall
- animals and humans
- transmission through faeces
- cysts resistant to chlorination
- 10^8 cysts/g faeces
- infectious dose 25 cysts
- Filtration best method for removal

Cryptosporidiosis -*Cryptosporidium sp.*

- only recently identified epidemiology
- Sporozoan oocysts
- Cow faeces (177days 40% viable)
- 1989 Reading outbreak
- 1993 Milwaukee 419,000 infected.
- filtration best prevention

Protozoal Diseases

Trypanosomes

flagellates

- ***T.cruzi*** **Chagas Disease**
  - South America
  - animals and man
  - Bugs faeces entersInfants Eyes
  - fatal
- ***T. brucei*** **African Sleeping Sickness**
  - Tsetse fly vector
  - invade cerebrospinal fluid and brain
  - fatal

Amoebic Dysentery

- Rhizopod *Entamoeba histolytica*
- mild infection (gut lumen)
- severe (gut wall)
- abscess, metastases in liver
- warm climates increase incidence of the latter condition.

Protozoal Diseases

- **Malaria *Plasmodium malariae***
  - **Sporozoan**
  - **Complex life cycle Mosquito vector, liver cells and blood cells.**
  - **Synchronised erythrocyte lysis**
  - **72 hourcycle of fever**
  - **Prophylactic drugs for blood cells**
  - **Liver infection resistant - recurrent**
- **Leishmanias (flagellates)**
  - **Oriental Sore - Sand Fly vector**
    - –local abscess
  - **Kala-azar**
    - –tissue parasite
    - –liver, spleen, bone marrow
- ***Naegleria fowleri***
  - **Primary Amoebic Meningoencephalitis PAM**
    - –Watersports, Roman Baths + sewage contamination
    - –death 7 days , headaches, fever, encephalitis
  - **Can harbour *Legionella* in water tanks**