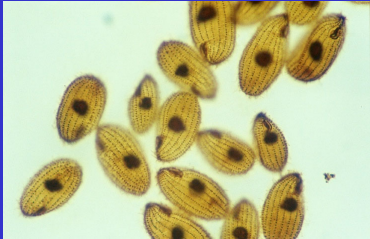


**BioMedical Parasitology**

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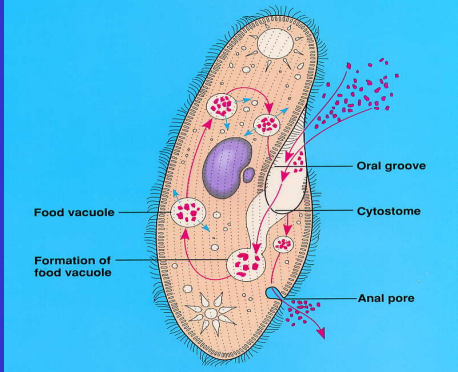
Protozoa  
Ciliates



Prof Peter O'Donoghue



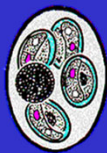

1

**CILIATES**  
(free-living/commensals/symbiotes/parasites)



4

**PROTOZOA**  
65,000 species  
(31,250 extant + 33,750 extinct)

flagellates	amoebae	sporozoa	ciliates
			
6,900 species	11,550 species	5,600 species	7,200 species
5,100 free-living 1,800 parasitic	11,300 free-living 250 parasitic	all parasitic	4,700 free-living 2,500 parasitic

2

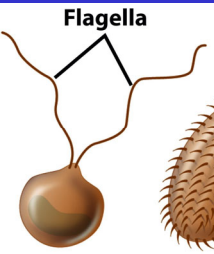
**Ciliate characteristics**

- possession of pellicular alveoli (hence Alveolata)
  - membrane-bound sacs beneath plasma membrane
- occurrence of nuclear dualism (Ciliophora only)
  - two types of nuclei (macronucleus + micronucleus)
- phenomenon of conjugation (Ciliophora only)
  - temporary fusion to exchange gametic nuclei
- possession of cilia (shared with many other eukaryotes)
  - hair-like extensions of cell (2+9 microtubular core)
  - but with complex infraciliature (inter-kinety system)


5

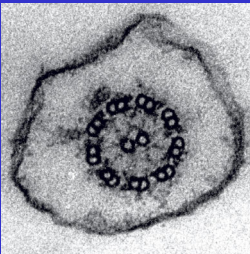
**UNDULIPODIA**

**Flagella**



**Cilia**



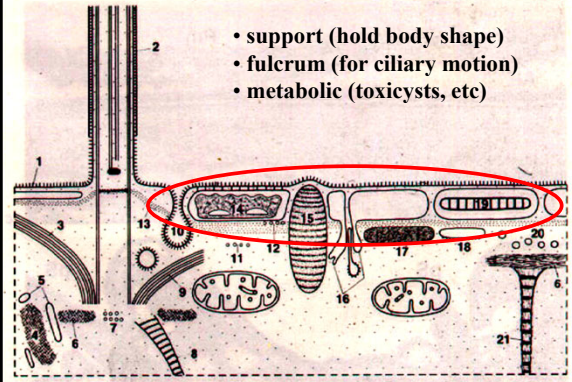


**2+9 microtubular core**

3

**Alveoli**

- support (hold body shape)
- fulcrum (for ciliary motion)
- metabolic (toxycysts, etc)



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### Nuclear dualism

- macronucleus - vegetative - fission
- micronucleus - reproductive - conjugation

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### Classification (on basis of oral/somatic ciliature)

#### CILIOPHORA

KINETOFRAGMINOPHOREA (“lower” holotrichs)	OLIGOHYMENOPHOREA (membrane-bearing holotrichs)	POLYHYMENOPHOREA (spirotrichs)
somatic whole body oral reduced lumen dwellers	somatic whole body oral specialized fouling organisms	somatic specialized oral highly specialized hunters

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### Conjugation

**KEY TO LABELS**

- Haploid ( $n$ )
- Diploid ( $2n$ )

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### Kinety ultrastructure

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### Ciliary ultrastructure

**cross-section**

- distal (9 doublets) (2 central)
- proximal (9 triplets) (cartwheel)

9

### Classification (on basis of kinetid ultrastructure)

12

## Ciliate classes

[Postciliodesmatophora]

- Karyorelictea ('surviving nucleus' - simple nuclear dualism)
- Spirotrichea ('coiled hair' - oral membranelles (polyhymenophoreans))

[Rhabdophora]

- Litostomatea ('simple mouths' - cytostome basket (rhabdos)\*)
- Prostomatea ('before mouth' - simple apical mouths)

[Cyrtophora]

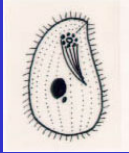

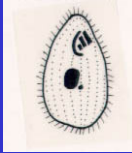
- Phyllopharyngea ('leaf throated' - cytopharyngeal phyllae (cyrtos))
- Nassophorea ('pot bearer' - cyrtos/nasse)
- Oligohymenophorea ('few membrane bearer' - three membranelles)
- Colpodea ('breast shaped' - curved body profile)

\**Balantidium*

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## CYRTOPHORA

Phyllopharyngea (‘leaf throated’) phyllae/cyrtos	Nassophorea (‘pot bearer’) cyrtos/nasse	Oligohymenophorea (‘few membranes’) three membranelles	Colpodea (‘breast shaped’) curved body
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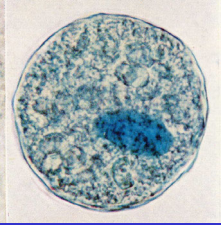
16

## POSTCILIODESMATOPHORA

<p><b>KARYORELICTEA</b> (‘surviving nucleus’) simple nuclear dualism</p> 	<p><b>SPIROTRICHEA</b> (‘coiled hair’) oral membranelles (polyhymenophoreans)</p> 
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### Parasite problem *Balantidium coli* (diarrhoea)

trophozoite  
in colon
cyst  
in faeces

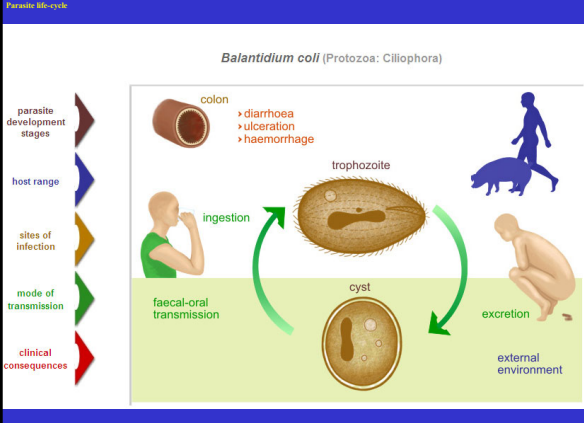
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## RHABDOPHORA

<p><b>LITOSTOMATEA</b> (‘simple mouths’) cytostome basket (rhabdos)</p> 	<p><b>PROSTOMATEA</b> (‘before mouth’) simple apical mouths</p> 
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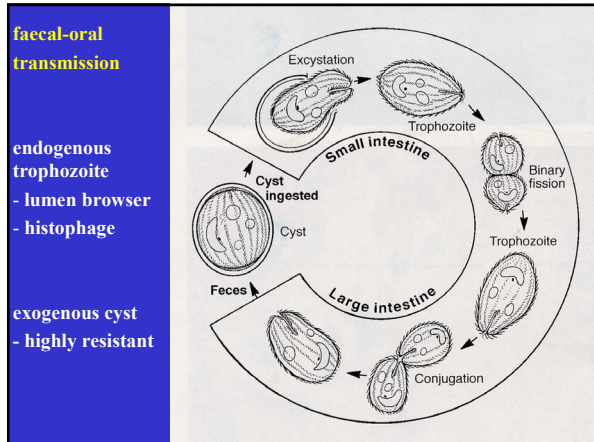
15

### Parasite life-cycle *Balantidium coli* (Protozoa: Ciliophora)



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**Control**

reduce human-pig contact (esp. in village situations)

- confine pigs (pens, intensive piggeries)
- prevent contamination (waste disposal)
- improve hygiene/sanitation

timely diagnosis

- coprology
- risk groups

effective treatment

- tetracycline
- diiodohydroxyquin
- metronidazole

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**Balantidiasis**

- infections in humans, monkeys and pigs, esp. in tropics
- most infections asymptomatic
- some cause dysentery-like syndrome (diarrhoea, tenesmus, nausea, vomiting, anorexia, headache, insomnia, weakness)
- some infections involve tissue invasion (mucosal sloughing, haemorrhage, abscess formation, necrosis)

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**Other parasites**

ciliates are swimmers  
very prevalent in aquatic environments  
some obligate/facultative parasites of fish/shellfish

skin diseases

- freshwater *Ichthyophthirius* (freshwater white spot)
- marine *Cryptokaryon* (marine white spot)

gill diseases

- congestion *Chilodonella*

tissue infections

- intraperitoneal *Tetrahymena* ('tet')

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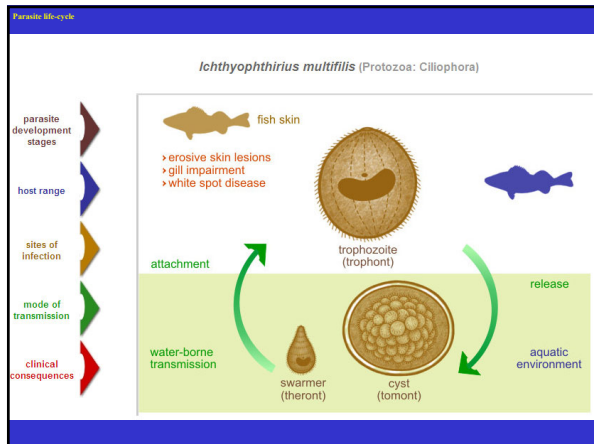
**Colonic ulceration**

mucosal sloughing, fluid loss, haemorrhage  
abscess formation, pus, necrosis

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**Ich (white spot)**

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## Endosymbiotes

greatest diversity in herbivores

- artiodactyls (ruminants wild and domestic)
- perissodactyls (equids)
- macropodids (kangaroos, wallabies and allies)

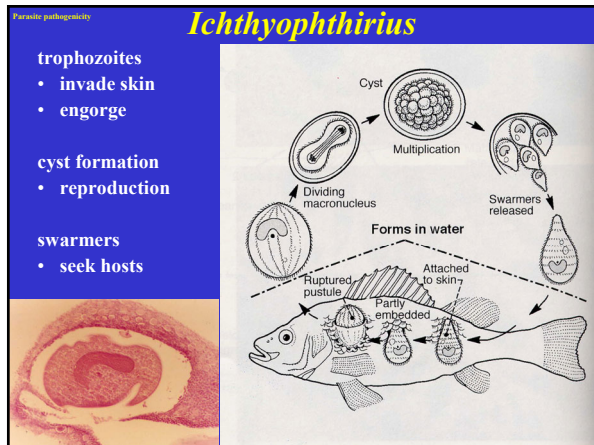
involved in fermentative digestion

- produce cellulases
- cycle microbial protein
- produce volatile fatty acids

unique organelles

- amitochondriate
- hydrogenosomes
- bacterial endosymbiotes

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## Mutualists

'rumen' ciliates

produce cellulases, VFA's

trichostomes

e.g. *Isotricha*, *Dasytricha*

- flexible bodies
- holotrichous ciliation

entodiniomorphids

e.g. *Entodinium*, *Cycloposthium*

- rigid bodies
- ciliary bands/tufts

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## Opportunists

<p><i>Tetrahymena</i></p> <p>opportunistic infections</p> <p>freshwater trout</p> <p>belly abrasions/needle-stick</p>	<p><i>Chilodonella</i></p> <p>opportunists?</p> <p>freshwater fishes</p> <p>gill congestion, hypoxia</p>
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## Fouling organisms

many ciliates attach to substrates (including aquatic organisms)

- posterior ends used for attachment
- anterior ends used to filter feed

peritrichs (left hand ciliary spiral to cytostome)

- sessilines (sessile, free-living)
  - loricate
  - stalked
- mobilines (mobile, ectobiotic)

suctoria (adults without cilia but with tentacles)

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***Lagenophrys***

sessiline peritrich  
 flat disc-like loricae  
 cemented to gill filaments of  
 decapod crustacea (yabbies)  
 associated with hypoxia

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**REVIEW**

ciliates constitute unique assemblage  
 considerable morphological complexity

- most free-living
- many symbiotes
- few parasites

good swimmers  
 feeding trophozoites

- invade tissues
- foul surfaces

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***Vorticella***

sessiline peritrich  
 zooids on contractile stalks  
 filter-feeding bacterivore  
 fouling organisms  
 attach to substrates,  
 including external  
 surfaces of aquatic  
 organisms

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***Trichodina***

mobile peritrich  
 disc-like attachment/holdfast organelle  
 attach to external surfaces of fish

- some species on skin cause erosive lesions
- some species on gills cause hypoxia

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