Морфология и локомоция жгутиконосцев

Внешняя морфология монад: количество и расположение жгутиков

биконт

уникон

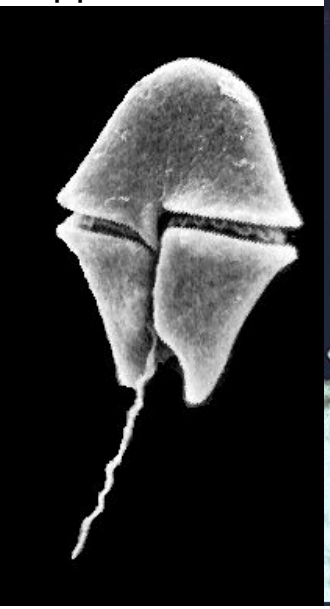
анизоконт

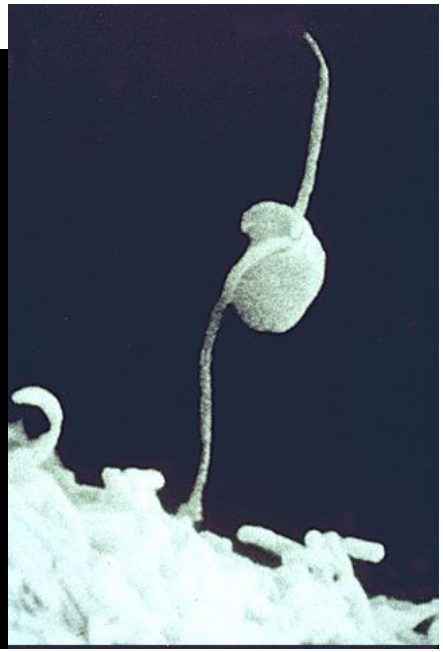
изоконт

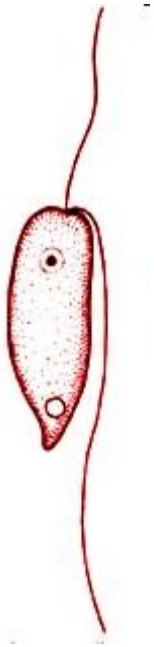
анизоконт с апикальным положением жгутиков

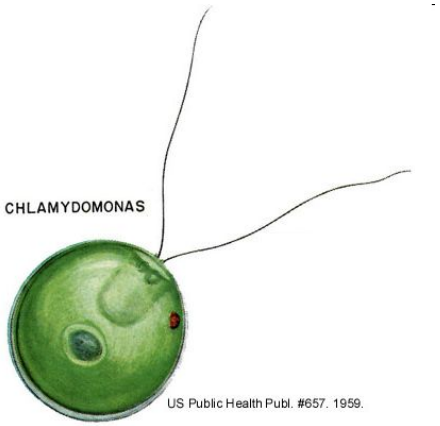
анизоконт с латер. полож. жгутиков

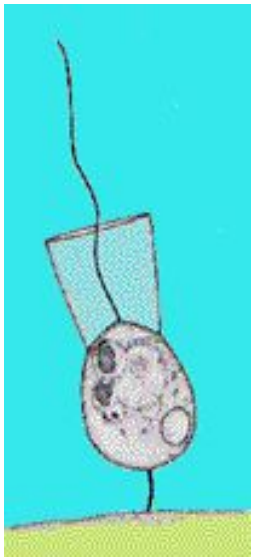
динокон











Жгутики анизоконта:
Моторный = передний
Рулевой = задний = рекуррентный

Dinoflagellata

Большинство таксонов

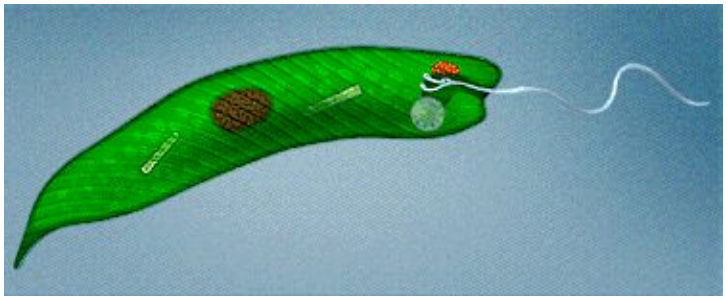
Chlorophyta

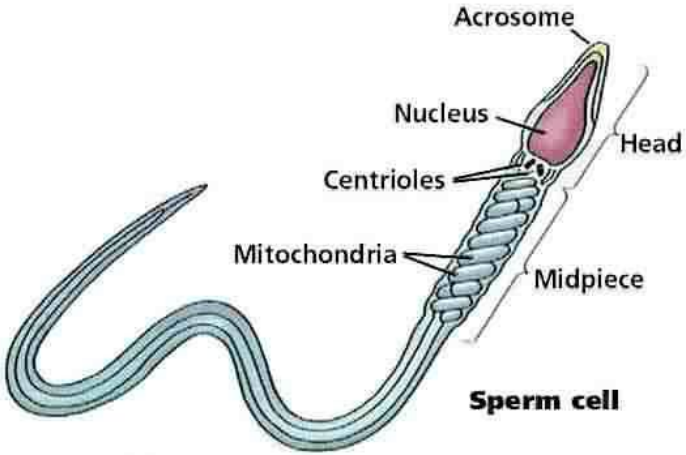
Choanoflagellata

Направление перемещения

choanoflagellate

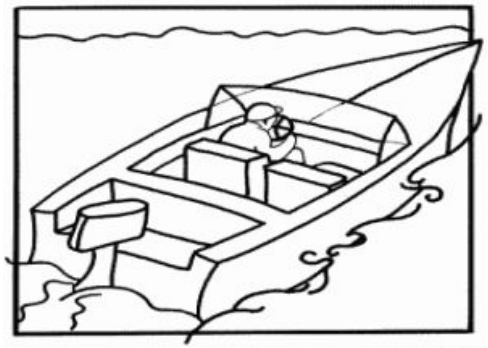
Euglena





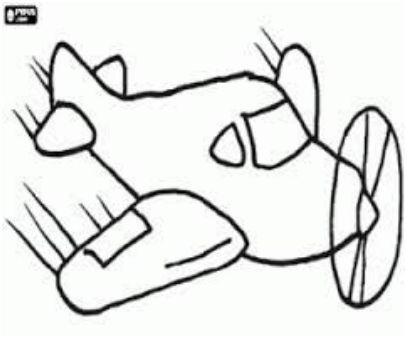
mammalian sperm cell

Chytrid zoospore

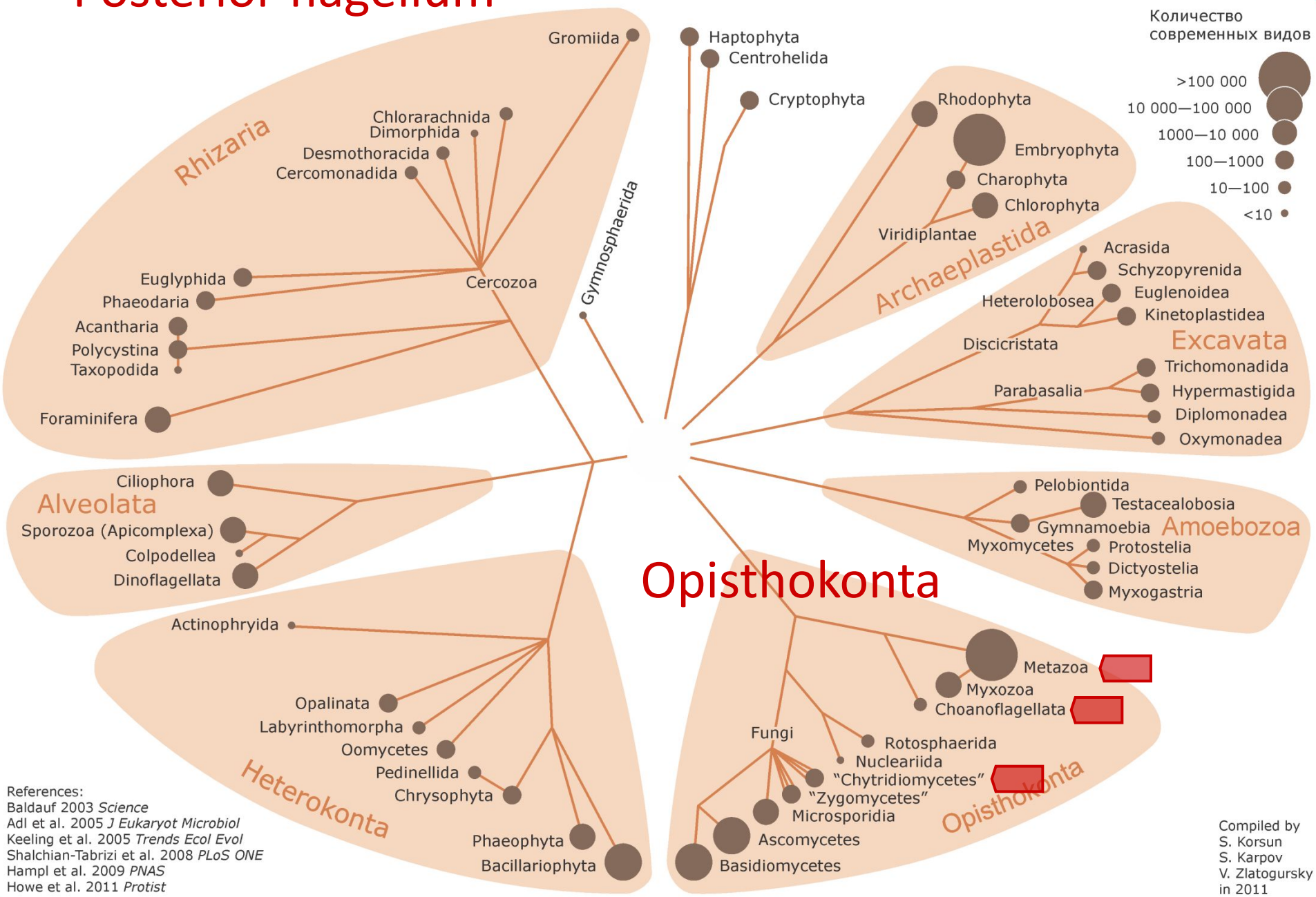


Posterior propeller

Anterior propeller



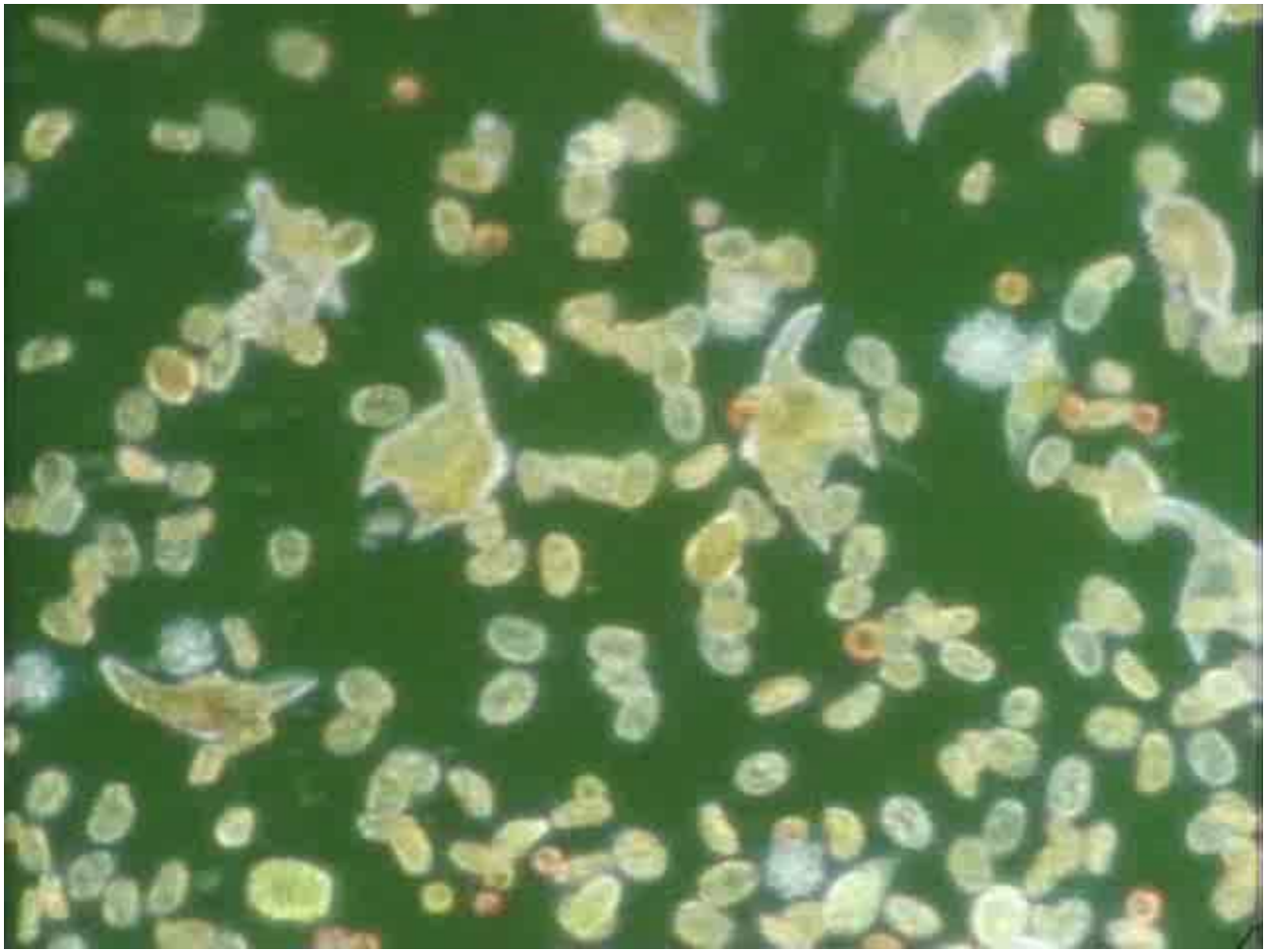
Posterior flagellum



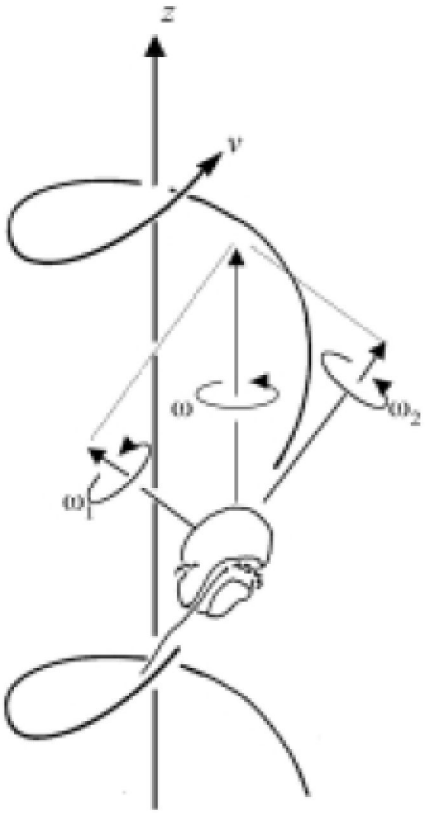
References:
Baldauf 2003 *Science*
Adl et al. 2005 *J Eukaryot Microbiol*
Keeling et al. 2005 *Trends Ecol Evol*
Shalchian-Tabrizi et al. 2008 *PLoS ONE*
Hampl et al. 2009 *PNAS*
Howe et al. 2011 *Protist*

Compiled by
S. Korsun
S. Karpov
V. Zlatogursky
in 2011

Перемещение планктонных жгутиконосцев



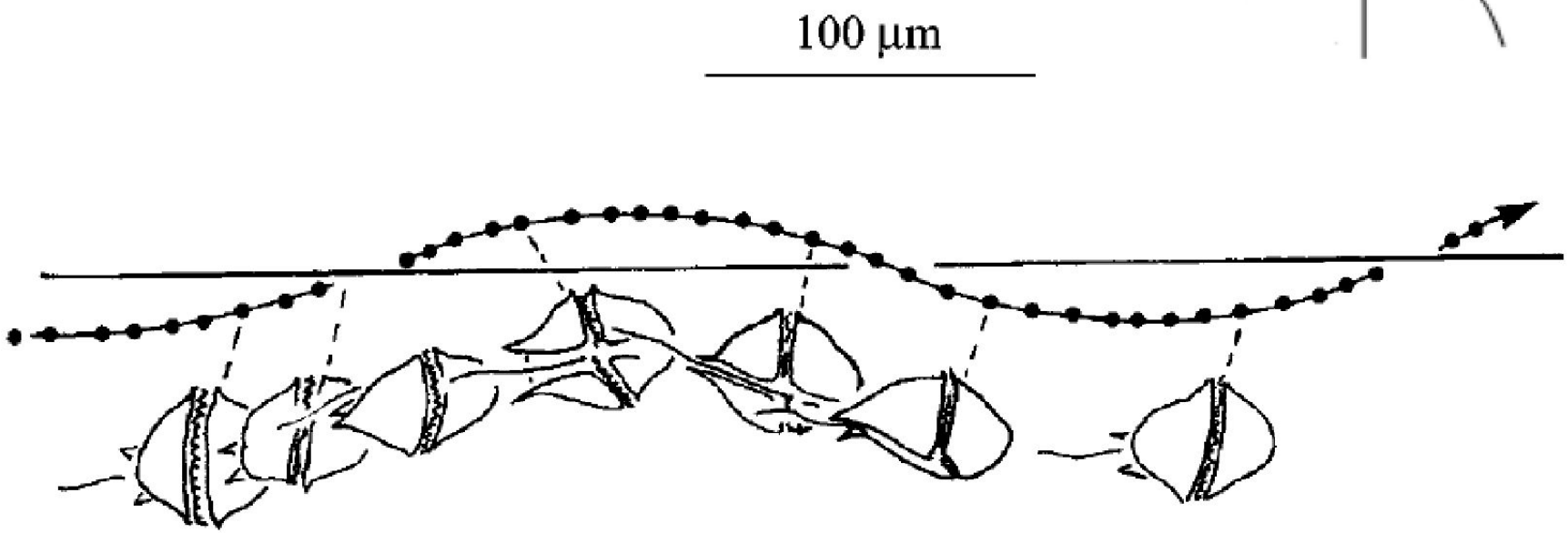
Траектория плывущего жгутиконосца



Смещение по винтовой спирали.

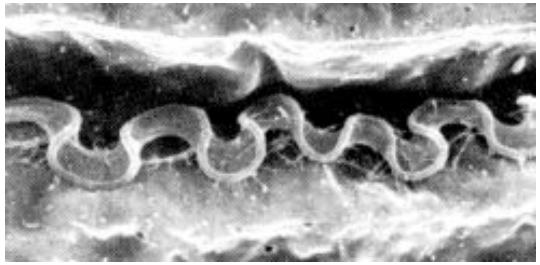
Анизоконт:
Моторный жгутик создает движущую силу.
Рулевой – делает движение целенаправленным.

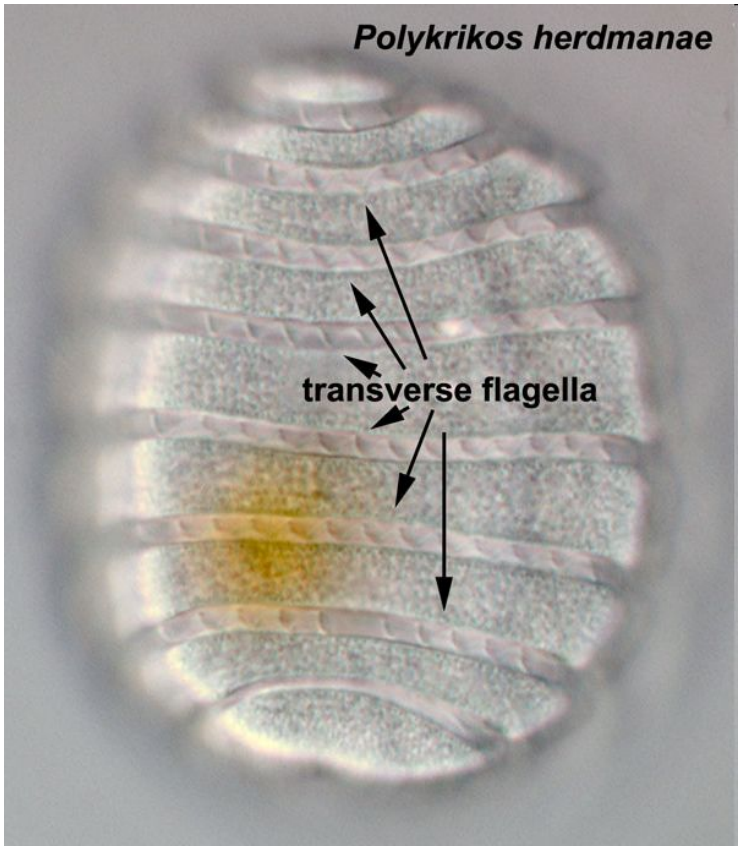
Peridinium bipes



Поперечный жгутик
Dinoflagellata

Рулевой (поперечный) жгут многократно длиннее, т.е. мощнее, чем моторый (продольный).





Локомоция протистов

Конструктивные планы строения протистов

жгутиконосцы

- Choanoflagellata
- Chlorophyta
- Chrysophyta
- Haptophyta
- Cryptophyta
- Dinoflagellata
- Euglenoidea
- Kinetoplastida
- Diplomonadida
- Trichomonadida
- Hypermastigida
- ...

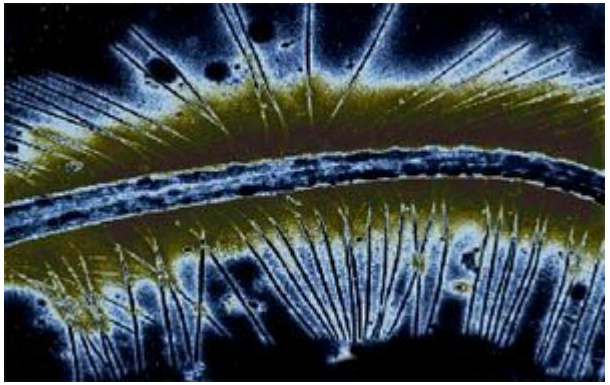
ресничные протисты

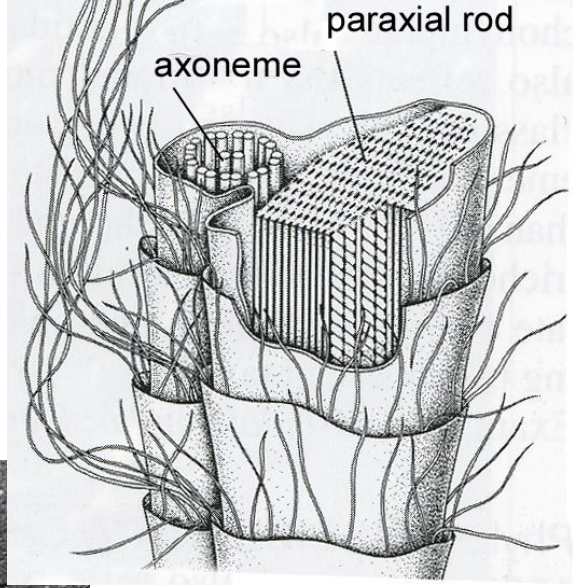
- Opalinata
- Ciliophora

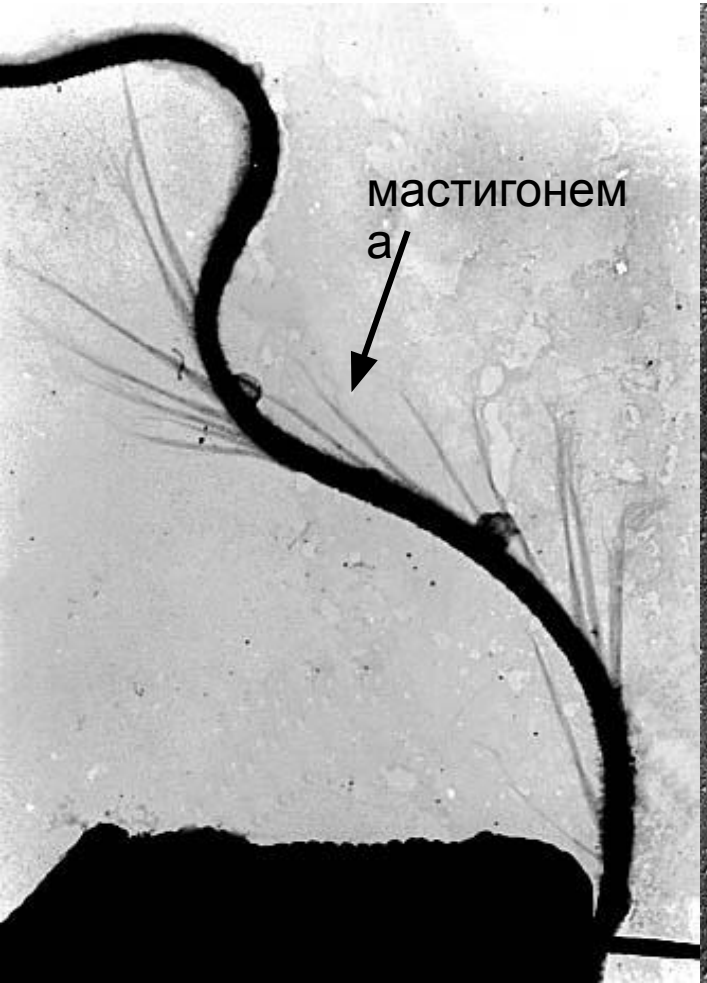
Многожнутиковые/ресничные:
очень мало групп

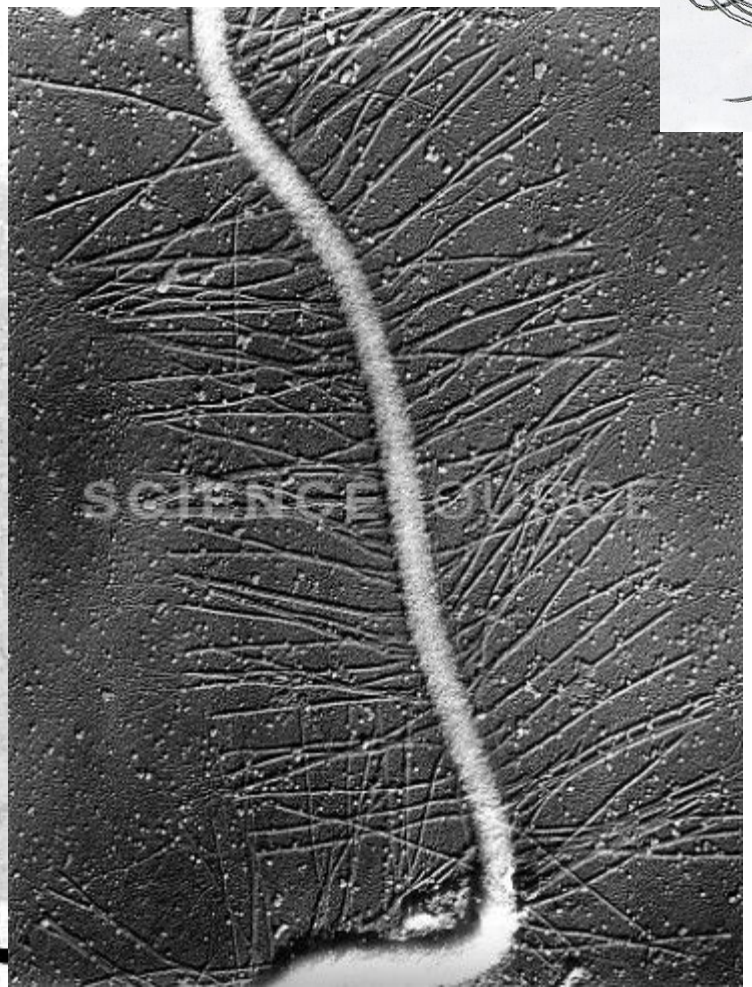
Дополнительные структуры ундулиподии жгутика

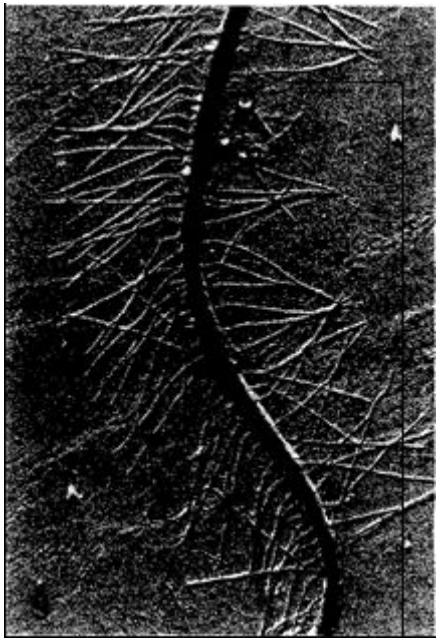
Мастигонемы









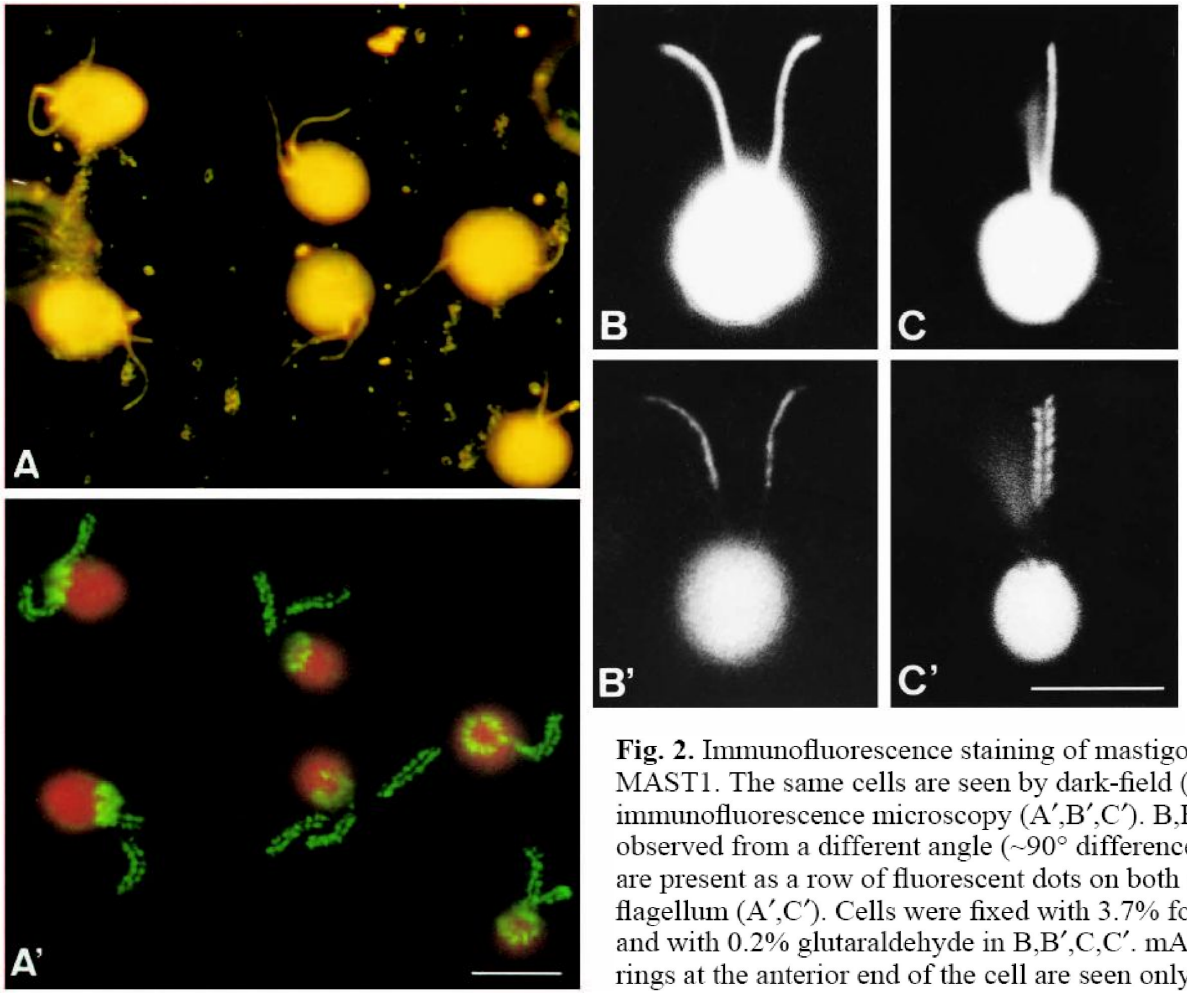


Функция мастигонем

Chlamydomonas (Chlorophycea).

Моноклональные антитела на один из гликопротеинов мастигонемы.

У живых клеток антитела сбривают мастигонемы; скорость 70-80%.



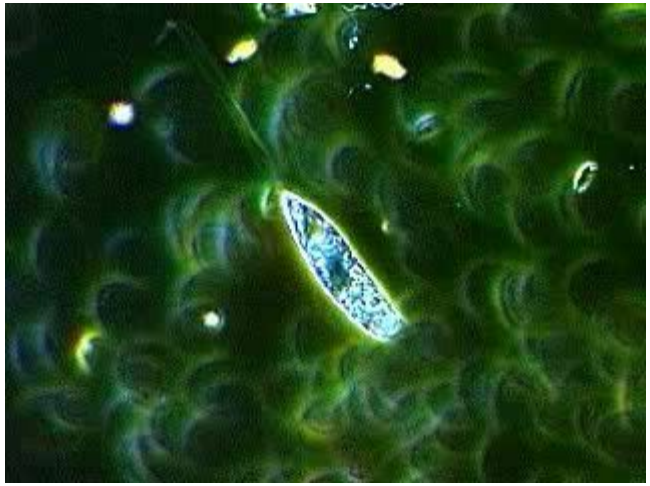
Nakamura et al.
J. Cell Science 1996

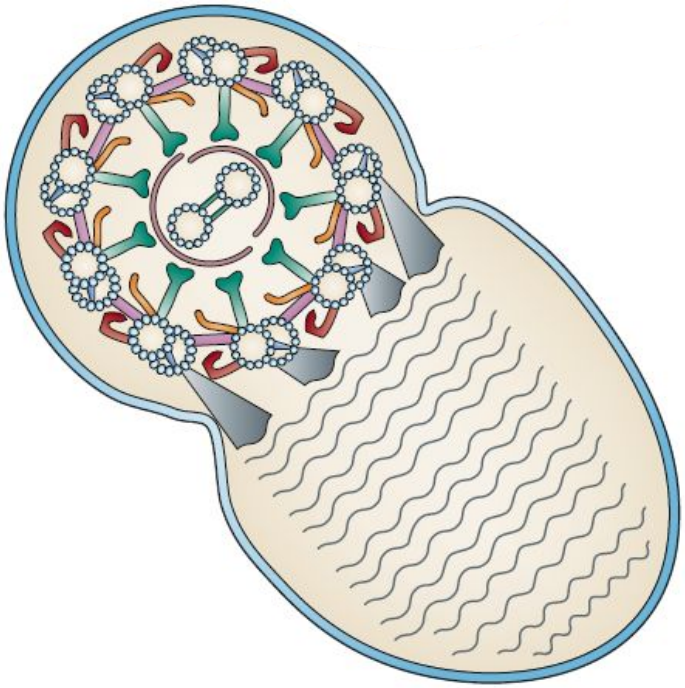
Fig. 2. Immunofluorescence staining of mastigonemes with mAb-MAST1. The same cells are seen by dark-field (A,B,C) and immunofluorescence microscopy (A′,B′,C′). B,B′ and C,C′ were observed from a different angle (~90° difference). Mastigonemes are present as a row of fluorescent dots on both sides of the flagellum (A′,C′). Cells were fixed with 3.7% formaldehyde in A,A′, and with 0.2% glutaraldehyde in B,B′,C,C′. mAb-MAST1 positive rings at the anterior end of the cell are seen only in A′. Bar, 10 μm.

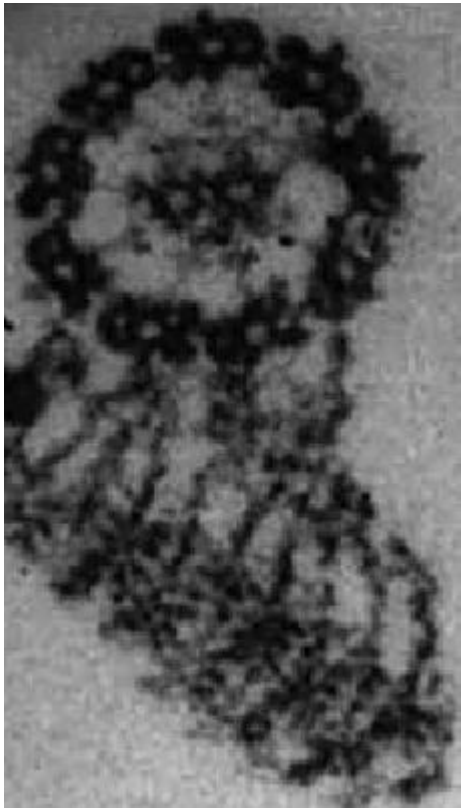
Flagellar locomotion in euglenids

Параксиальный тяж

Peranema trichophorum







Euglena sp.

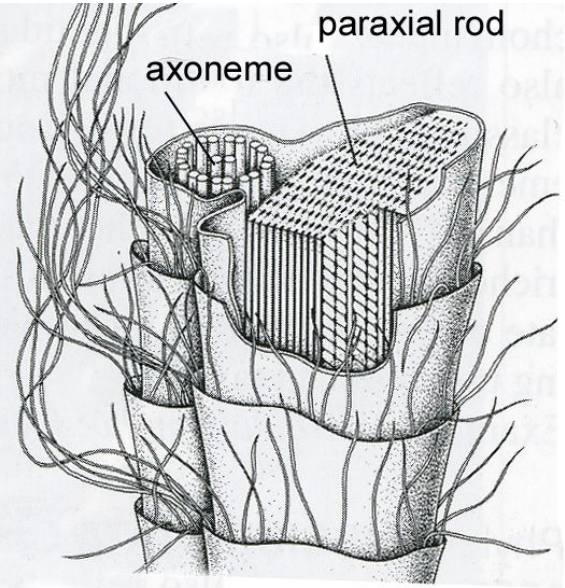
A paraxial rod next to the axoneme

Paraxial rod

- positioned intracellularly
- fastened to certain doublets of the axoneme

Параксиальный тяж: функция

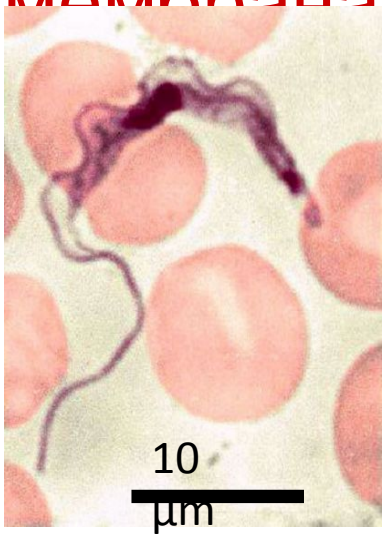
The elastic rod works as a flexion spring. It accumulates and then releases energy of the axoneme bending. Supposedly.

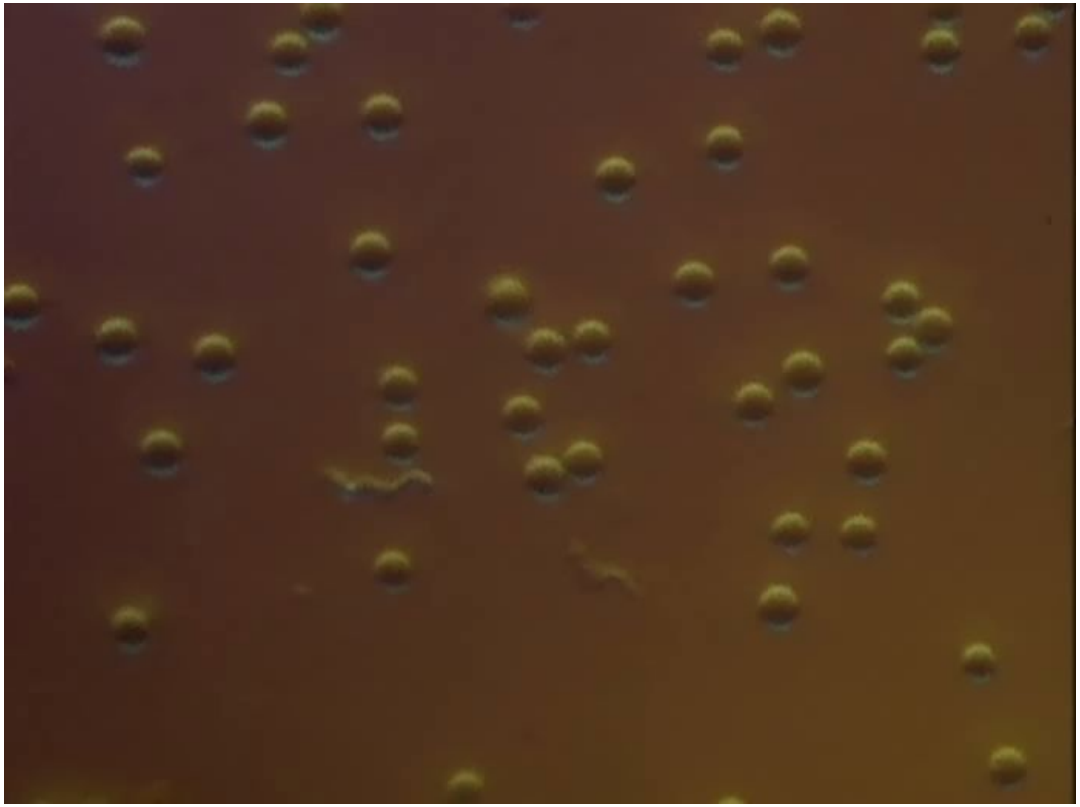


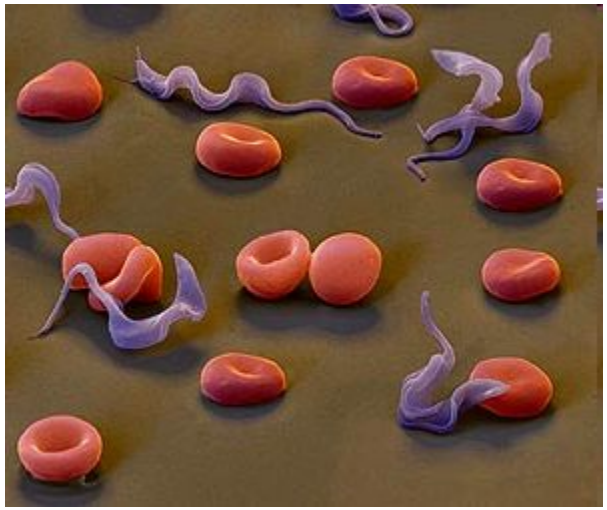
An analogue:

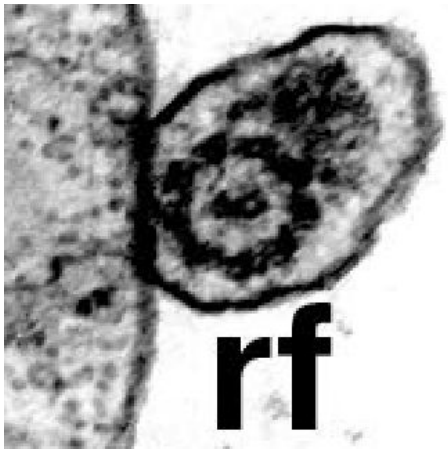
The hind leg tendons accumulate and release the energy of the jump.

Ундулирующая мембрана









Дополнительные структуры ундулиподии жгутика

- мастигонемы
- параксиальный тяж
- ундулирующая мембрана

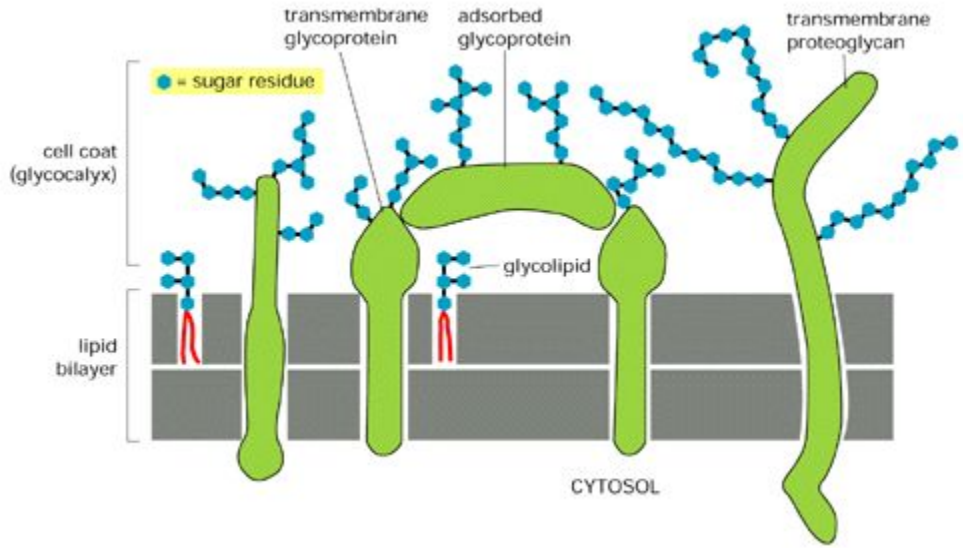
Разнообразие выше, чем у клеток Metazoa

Дополнительные структуры покровов клетки жгутиконосца

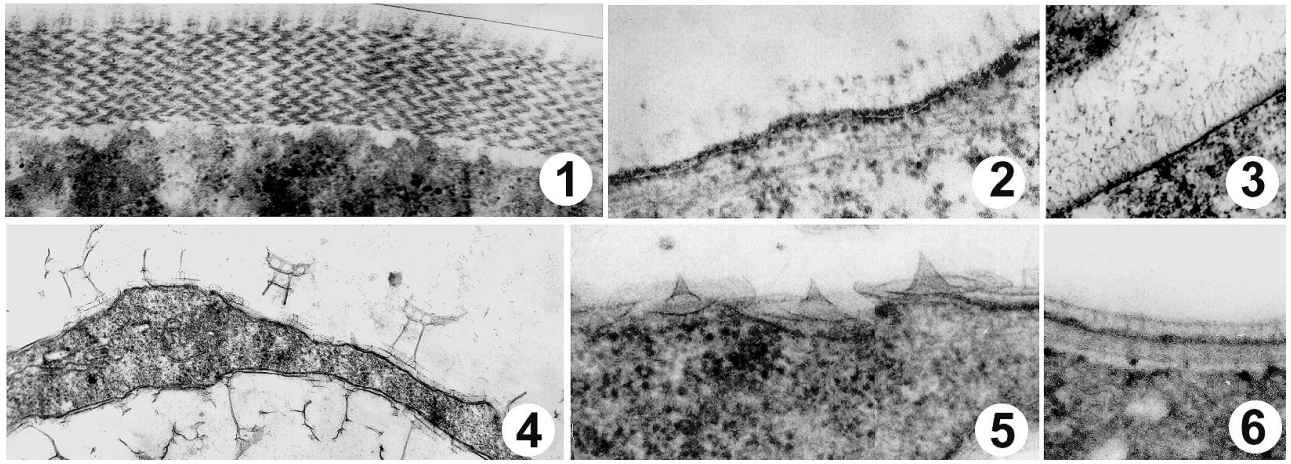
Надмембранные усложнения покровов.

Чешуйки.

Гликокалик
с



Glycocalyx: a coat of poly- and oligosaccharides on the surface of plasma membrane.



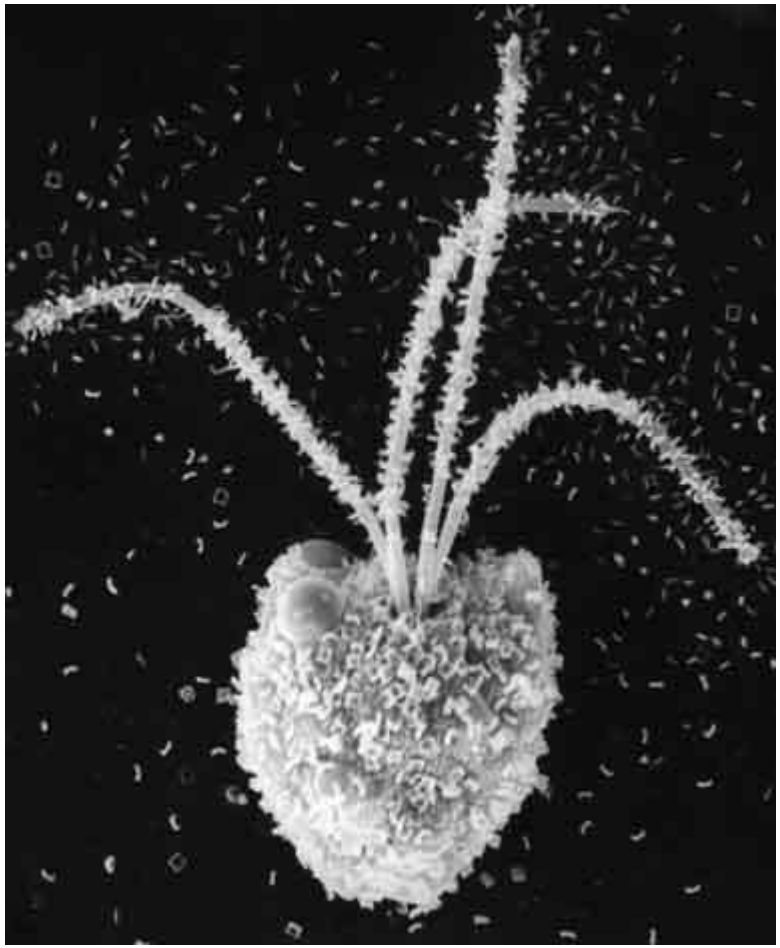
Гликокаликс голых лобозных амеб (Протисты I):

1 – *Paradermamoeba*;
2 – *Ripella*;
3 – *Polychaos*;
4 – *Korotnevella*;
5 – *Korotnevella*;
6 – *Mayorella*

Чешуйки Prasinophycea[кл]

(низшие зеленые)

- До трех типов чешуек у одной клетки (больше, чем у всех других эукариот).
- Чешуйки не минерализованы.

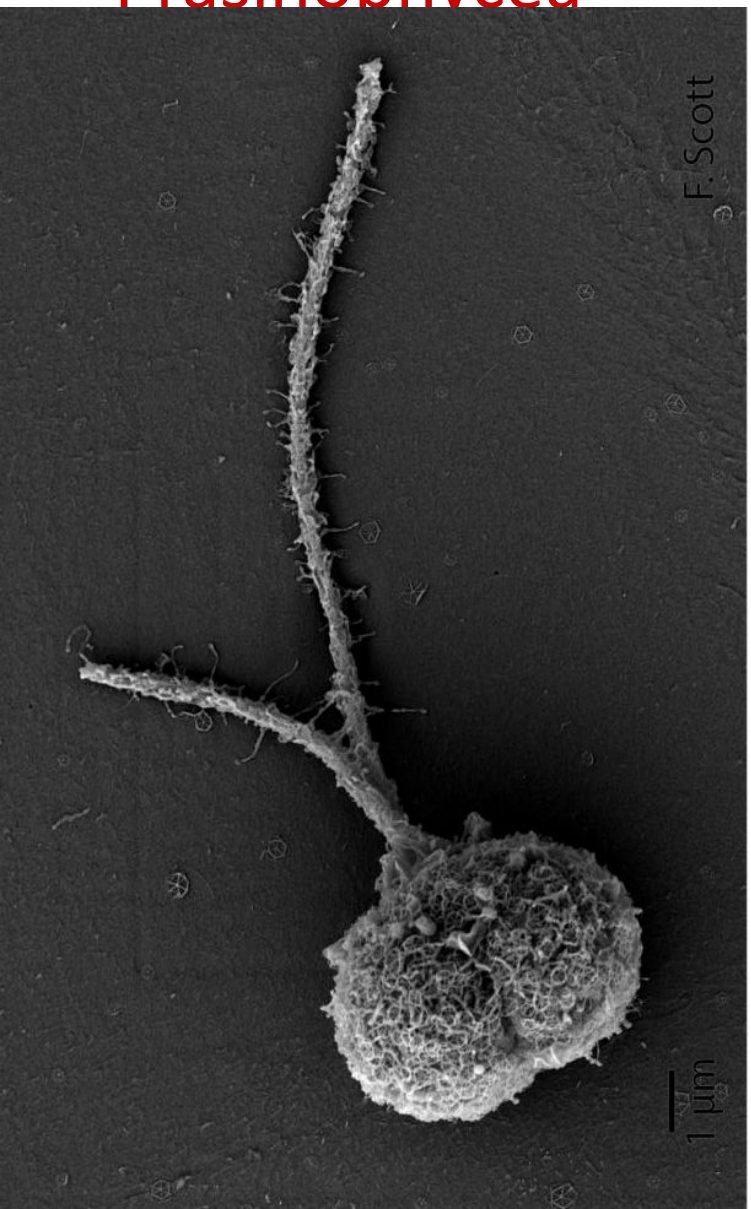


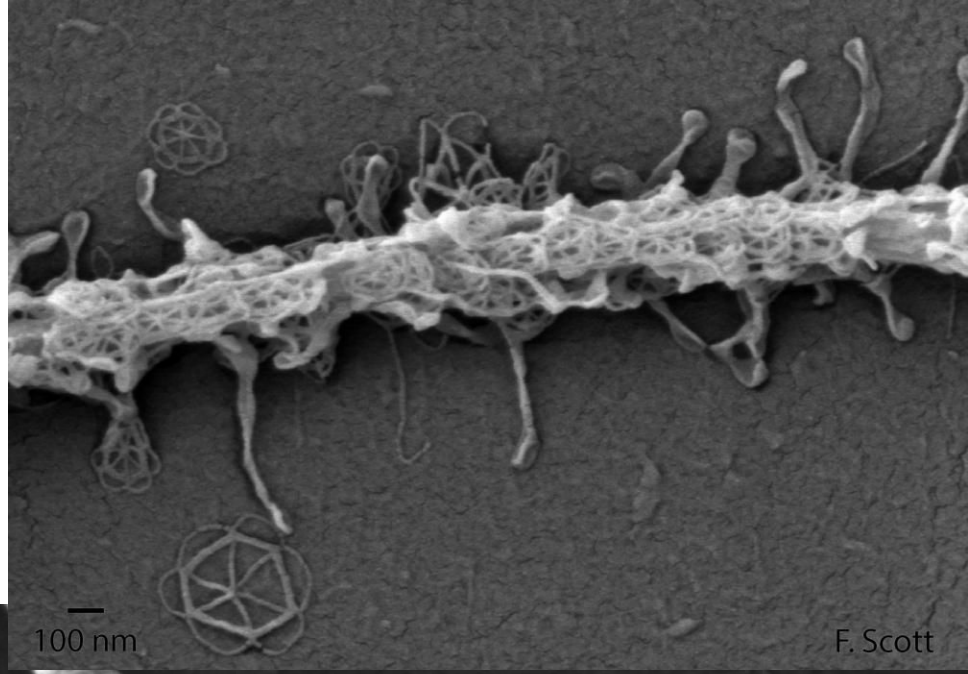
Pyramimonas gelidicola

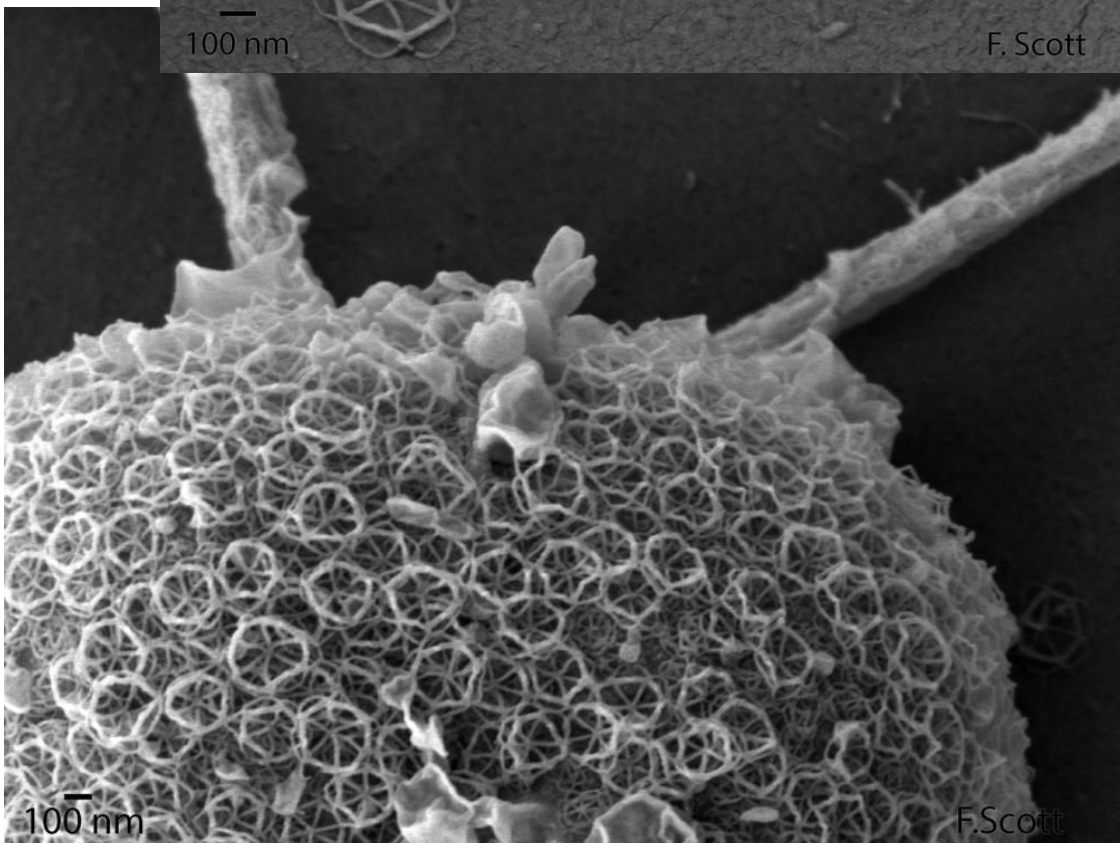
Чешуйки

Mantoniella antarctica

Prasinophycea кл







Чешуйки центрохелидных солнечников

Чешуйки есть в разных группах протистов, в том числе у солнечников.

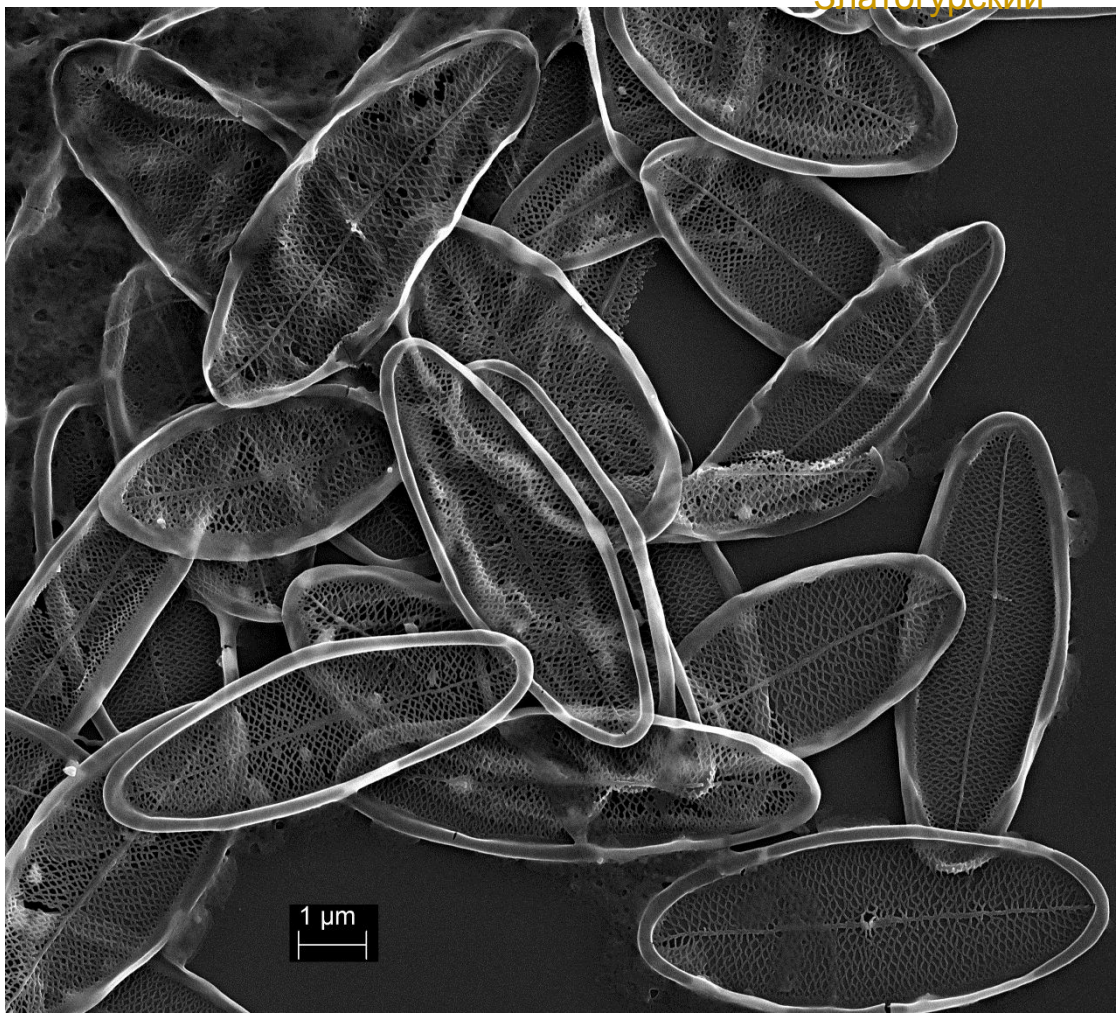
SiO_2

Acanthocystis

В.В. Златогурский

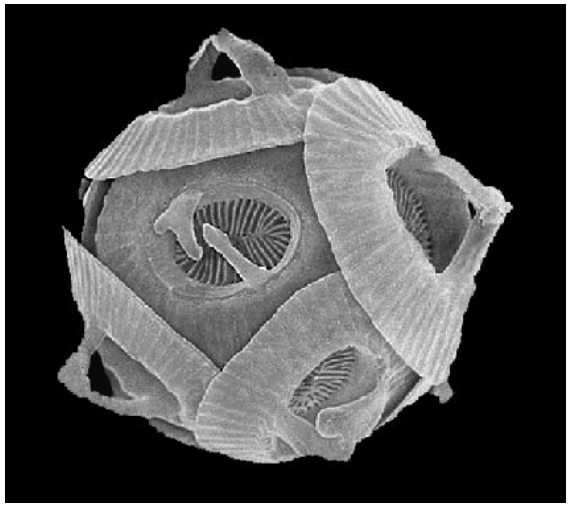
Polyplacocystis

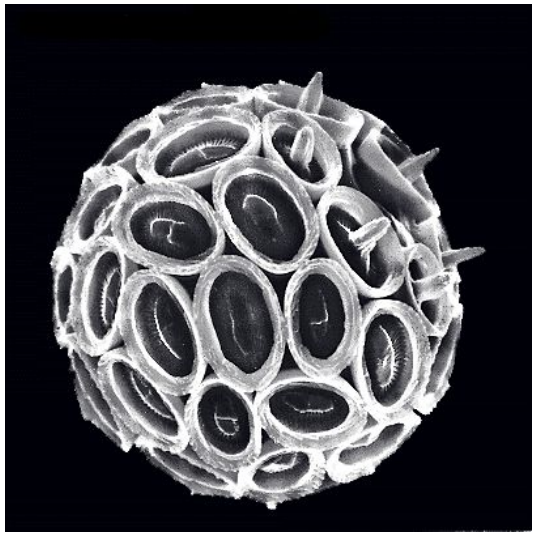
В.В. Златогурский

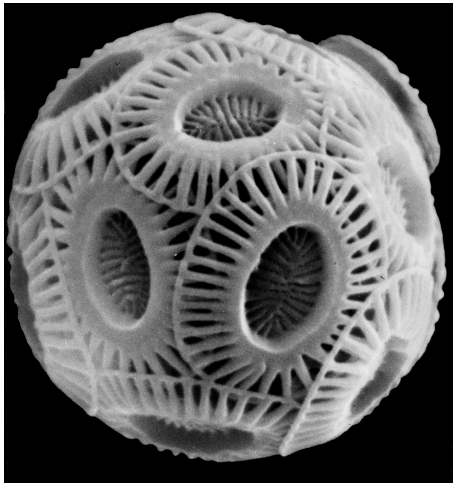


Чешуйки Coccolithophorida^{отр} (Haptophyta^{т})

aragonite $CaCO_3$





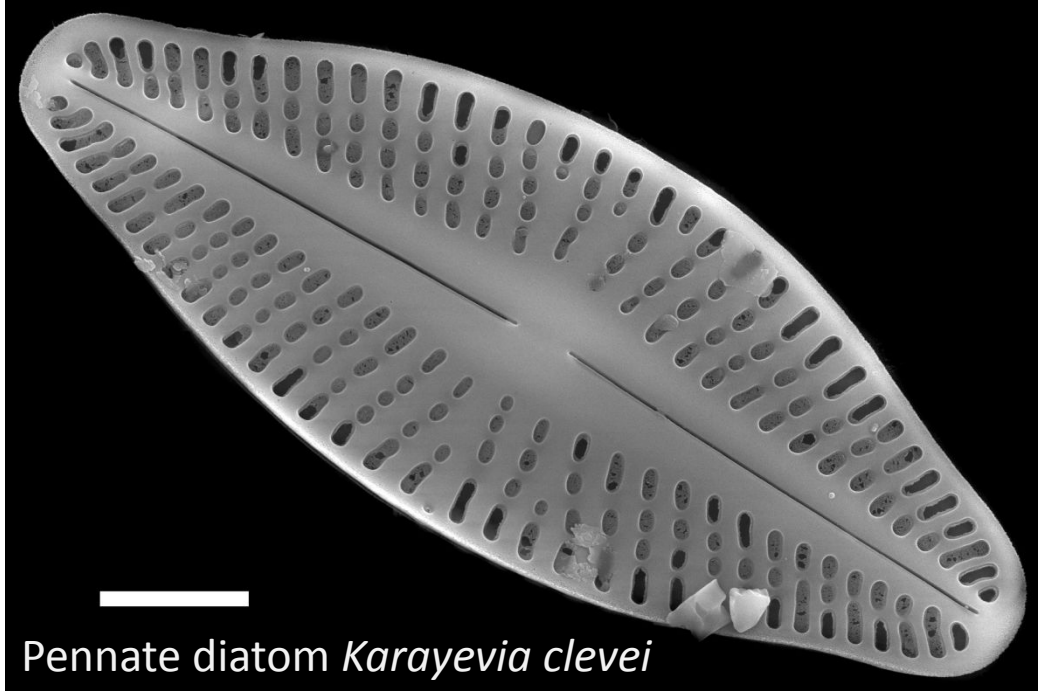


Зачем
?

У метаклеточных организмов есть гликокаликс, но нет сложных его форм, таких как чешуйки.

Клеточная стенка

A cell wall (extracellular structure) occurs in fungi, land plants, macroalgae, as well as in protists, but never in flagellates.



Домики

Субмембранные структуры клетки жгутиконосцев

Микротрубочковые корешки

Пелликула Dinoflagellata

Пелликула Euglenoidea

Тубулемма Kinetoplastida

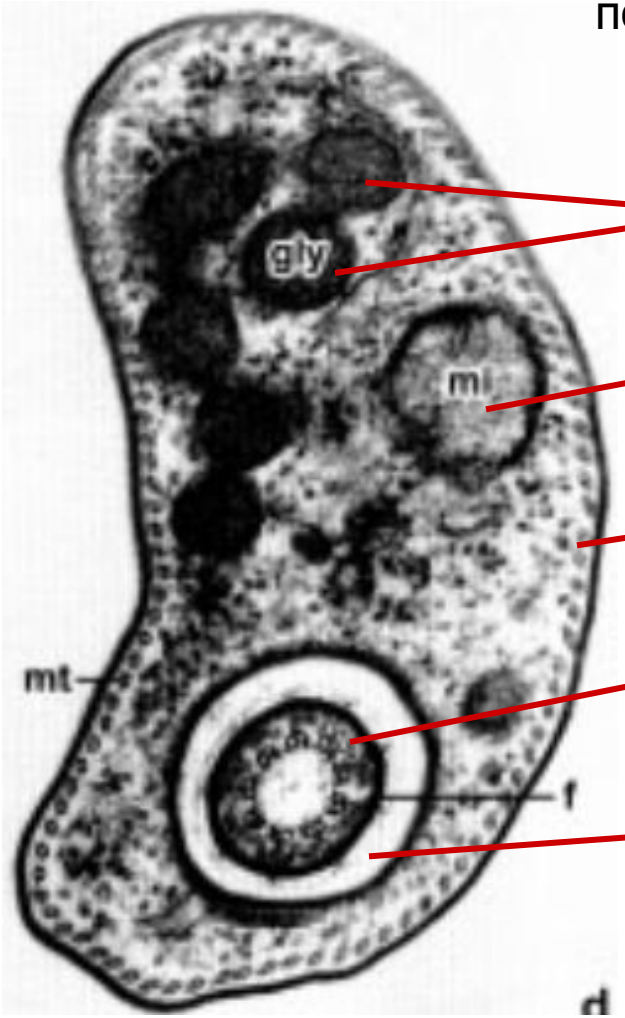
Перипласт Cryptophyta

…

Тубулемма
Kinetoplastida

Tripanosoma brucei

метациклическая форма (из кр.русла)
поперечный срез



гликосомы

митохондрия

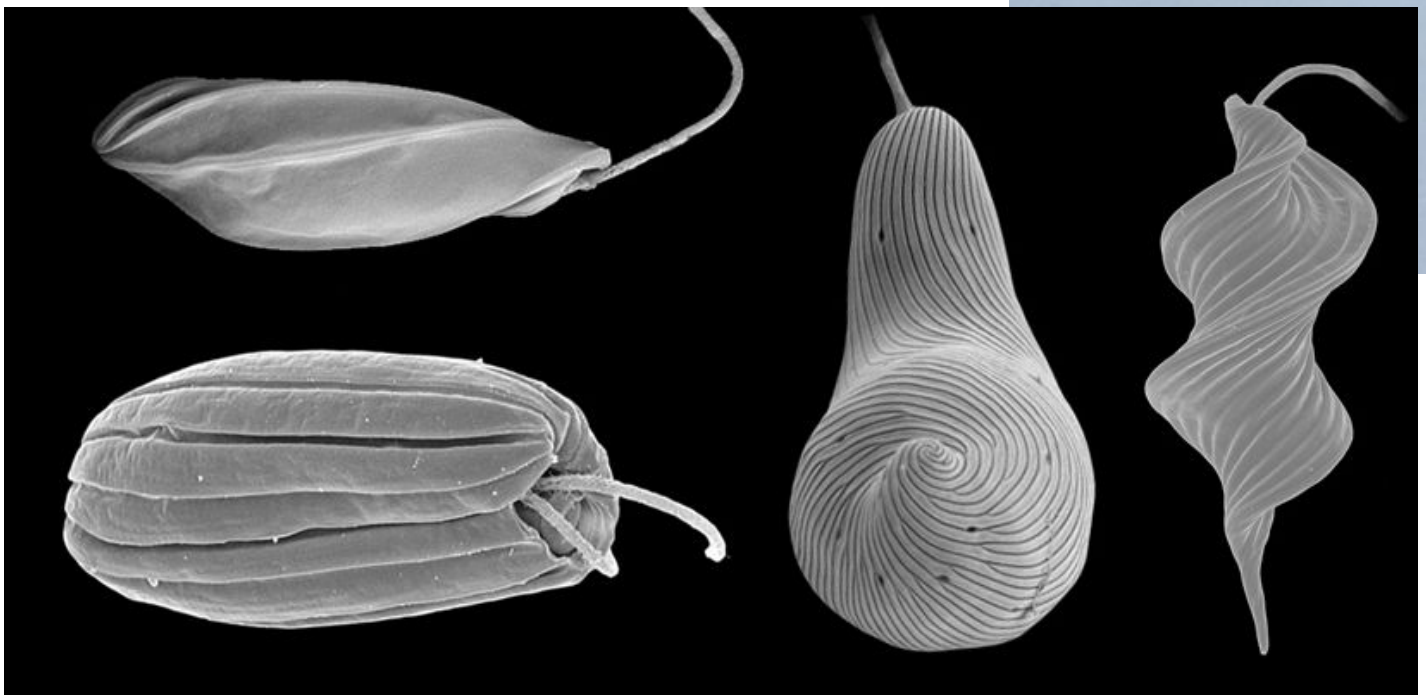
тубулемма

жгутик (переходная зона)

жгутиковый карман

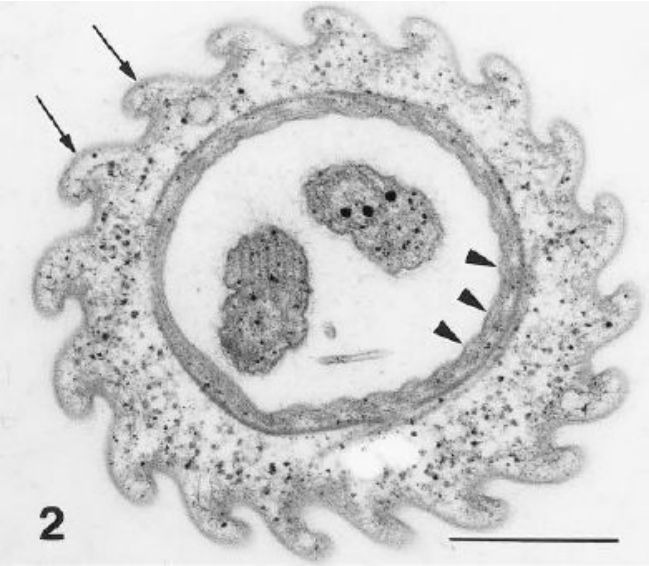
Поверхность клетки эвгленовых

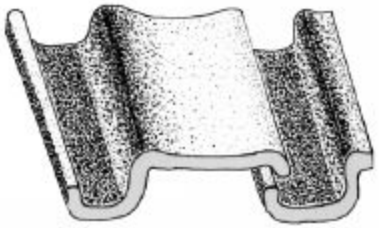
исчерченность

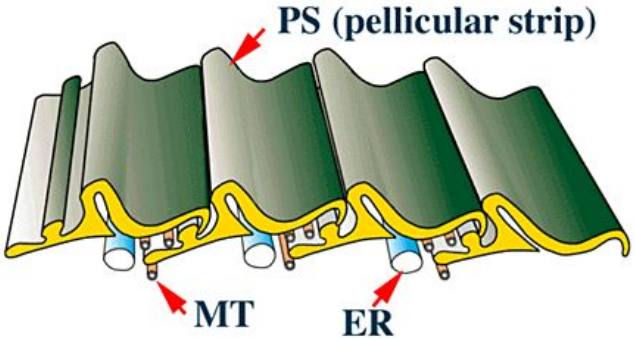


Пелликула

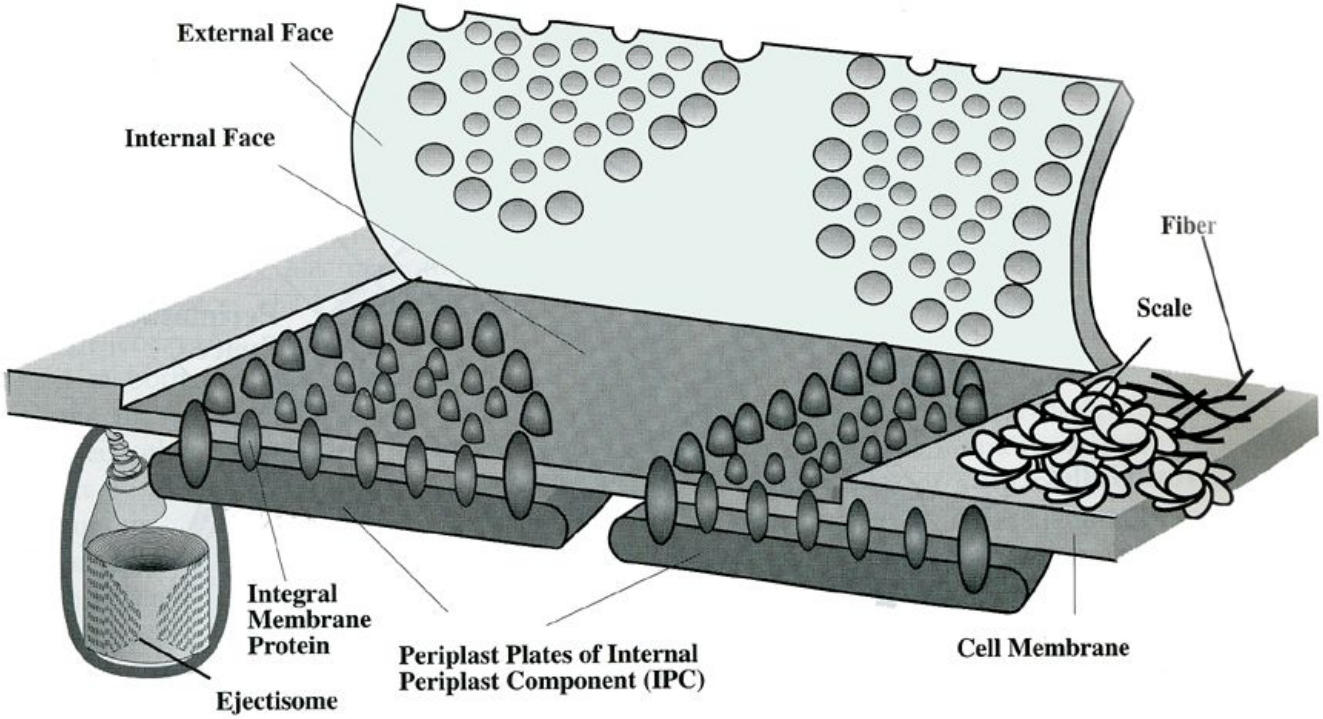
- Система белковых лент, подстилающих клеточную мембрану
- Поддерживается микротрубочками.







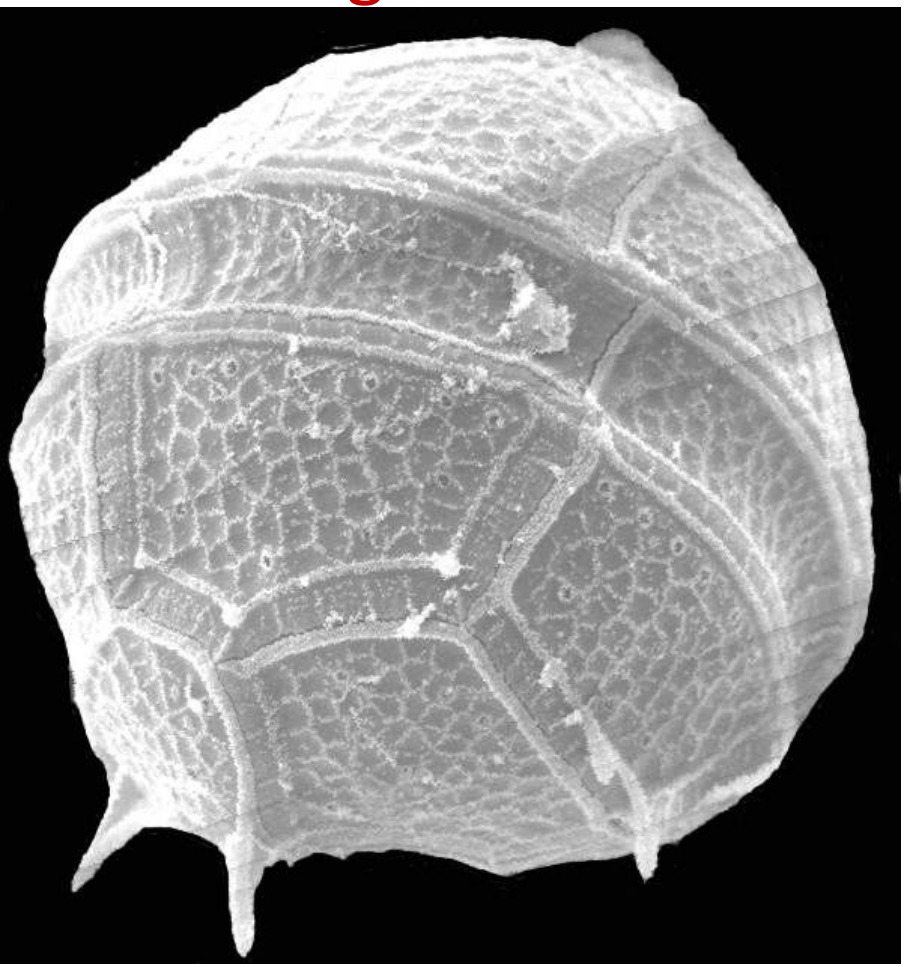
Перипласт Cryptophyta

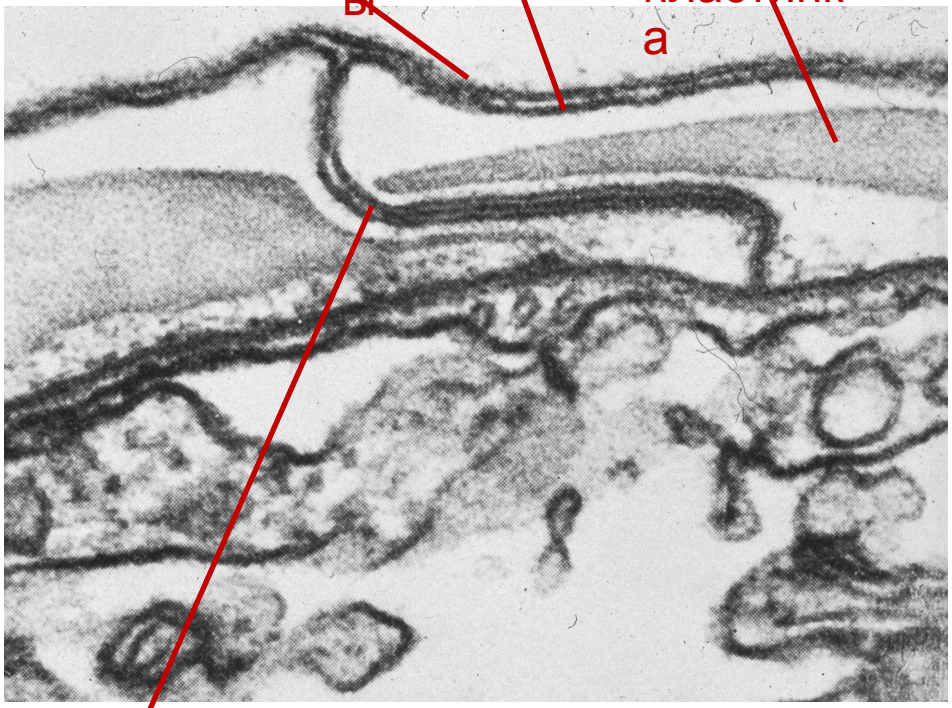


Пелликула
Dinoflagellata

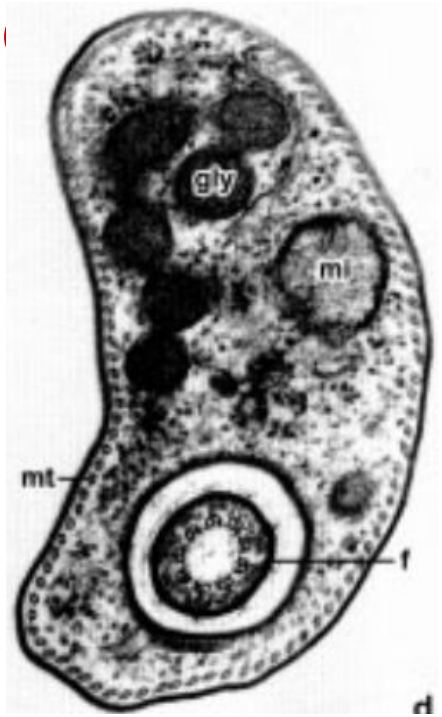
Тека = амфиесма

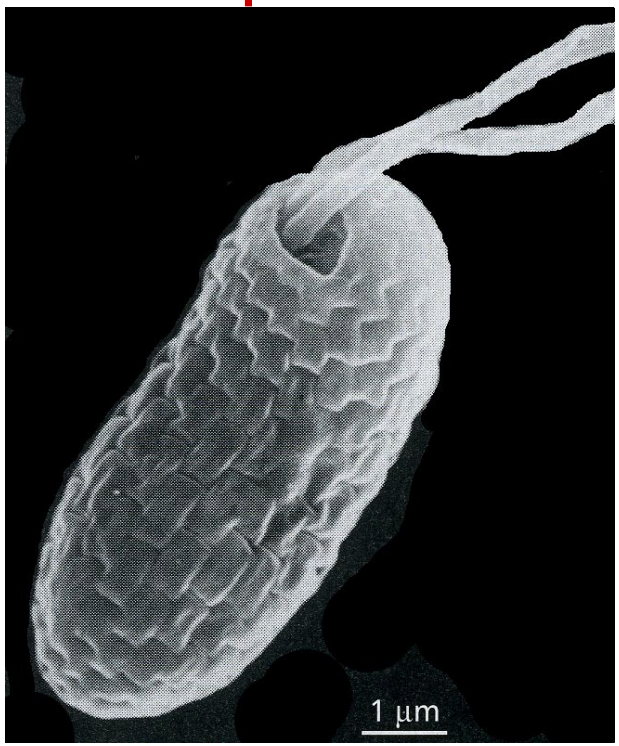
Альвеолы = текальные или амфиесмальные везикулы.

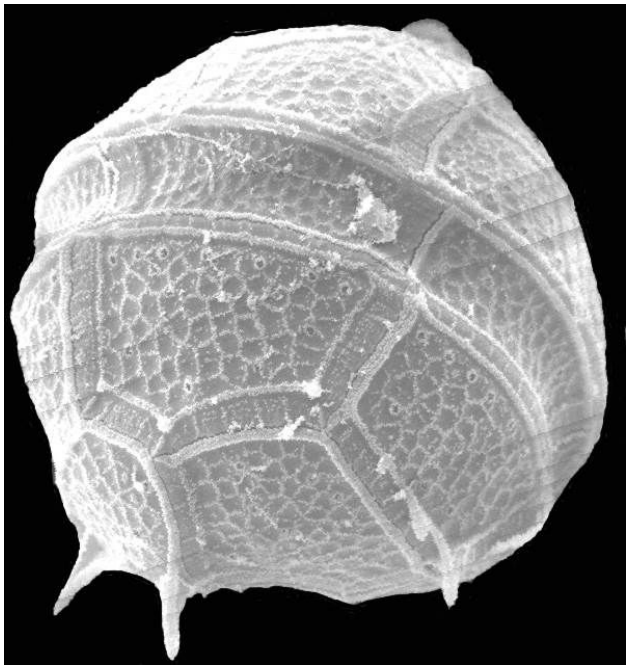




Дополнительные кортикальные







Подобных структур нет у клеток метаклеточных организмов.

Зачем?

жгутиковый карман

Зачем?

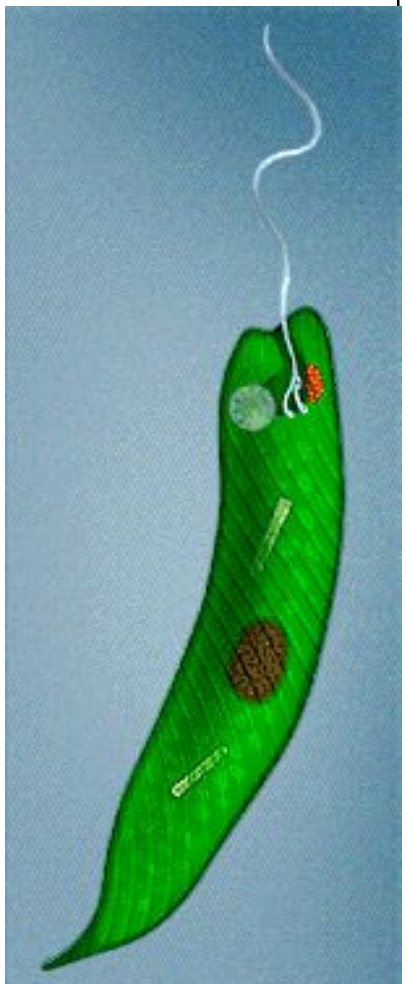
Сложные покровы =>

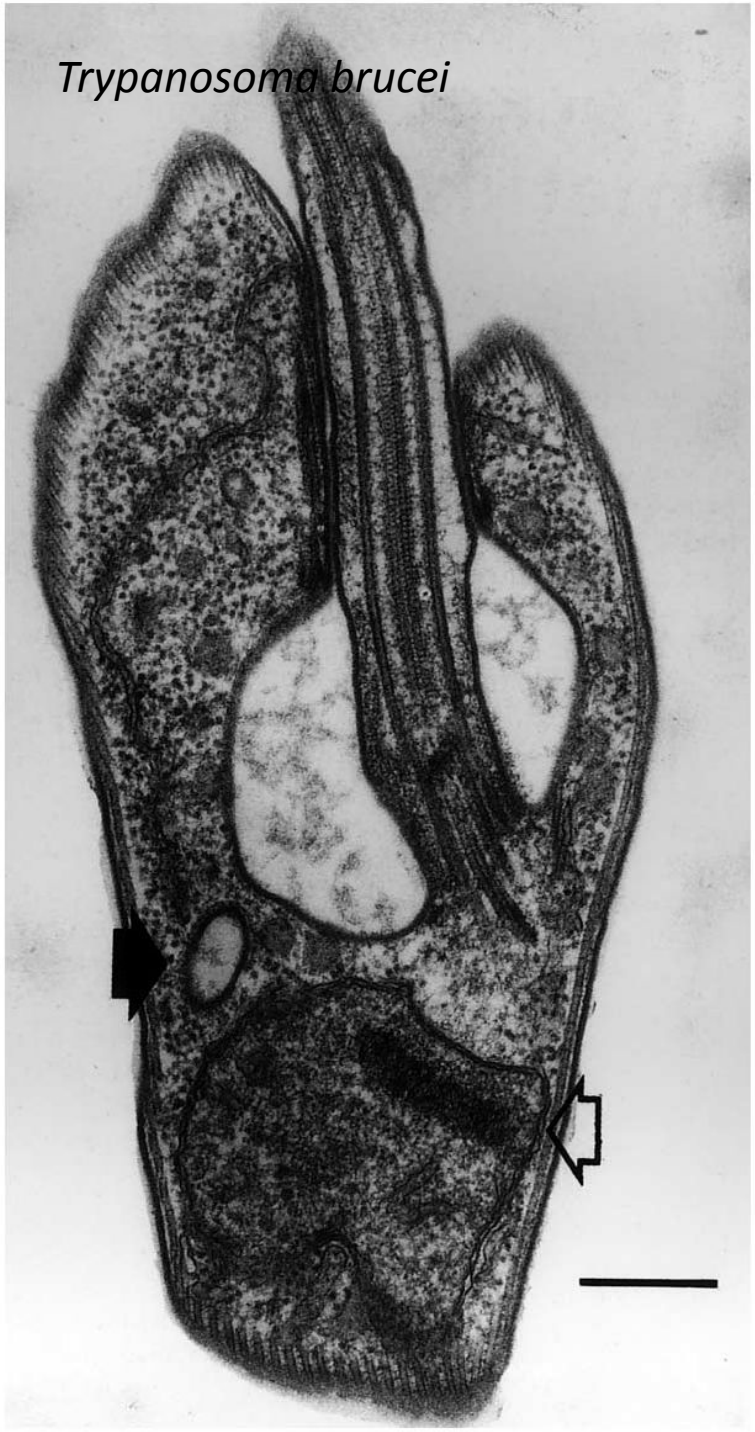
1. Обновление клеточной мембраны.

2. И у некоторых жгутиконосцев выполняеи роль цитостома. Эндо- и экзоцитоз.

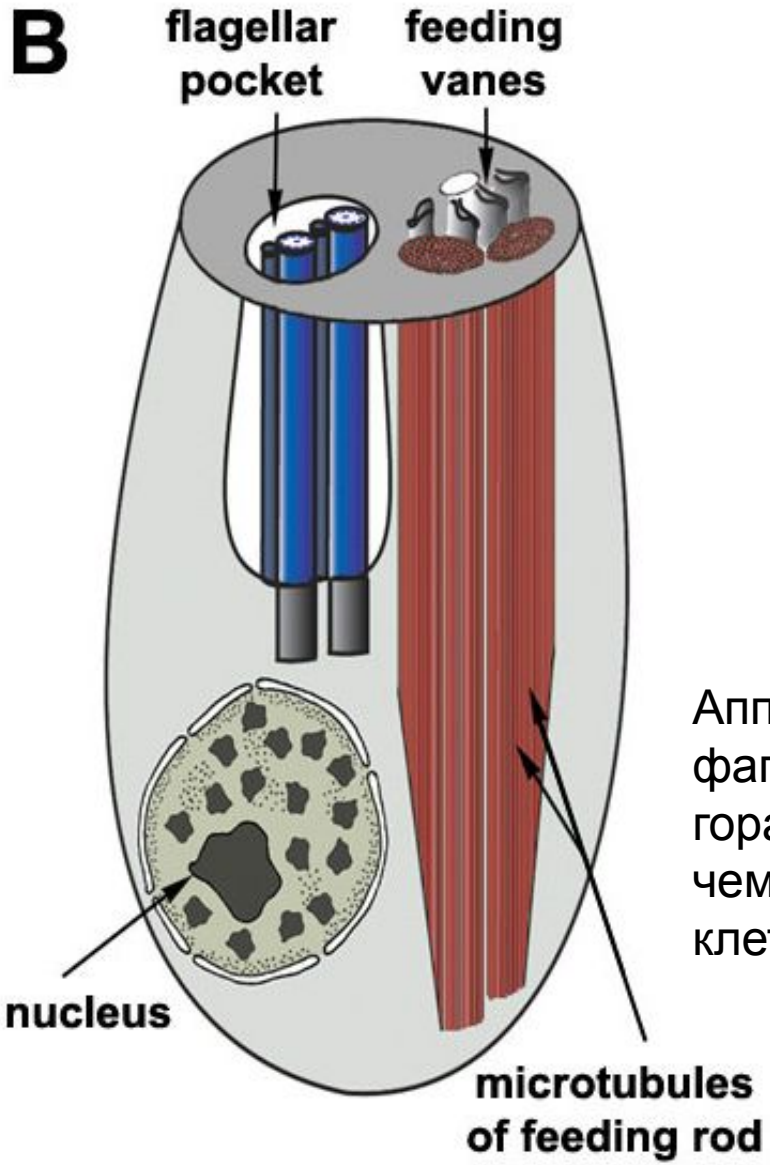
Cryptomonas

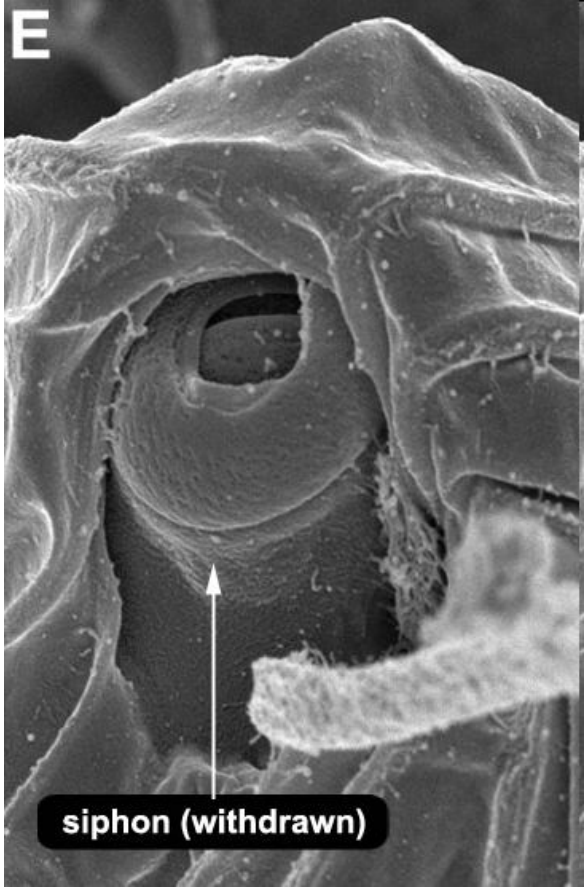
Euglena



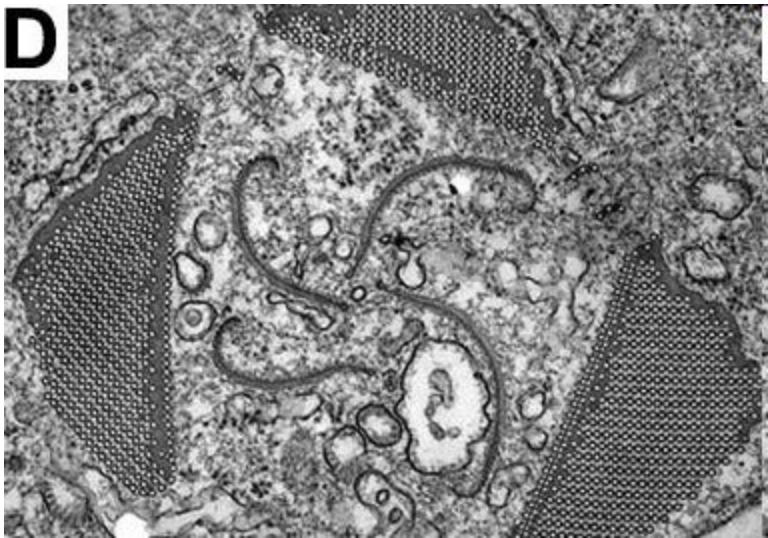


Палочковый аппарат



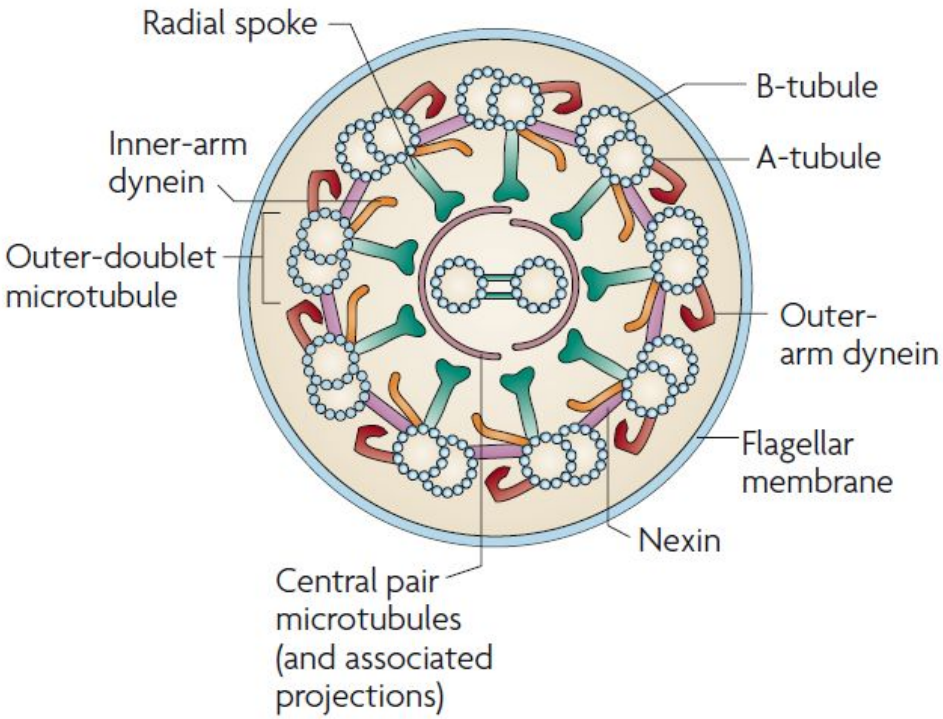


Аппарат фагоцитоза гораздо сложнее, чем в любых клетках Metazoa



The axoneme occurs in all phylogenetic lineages

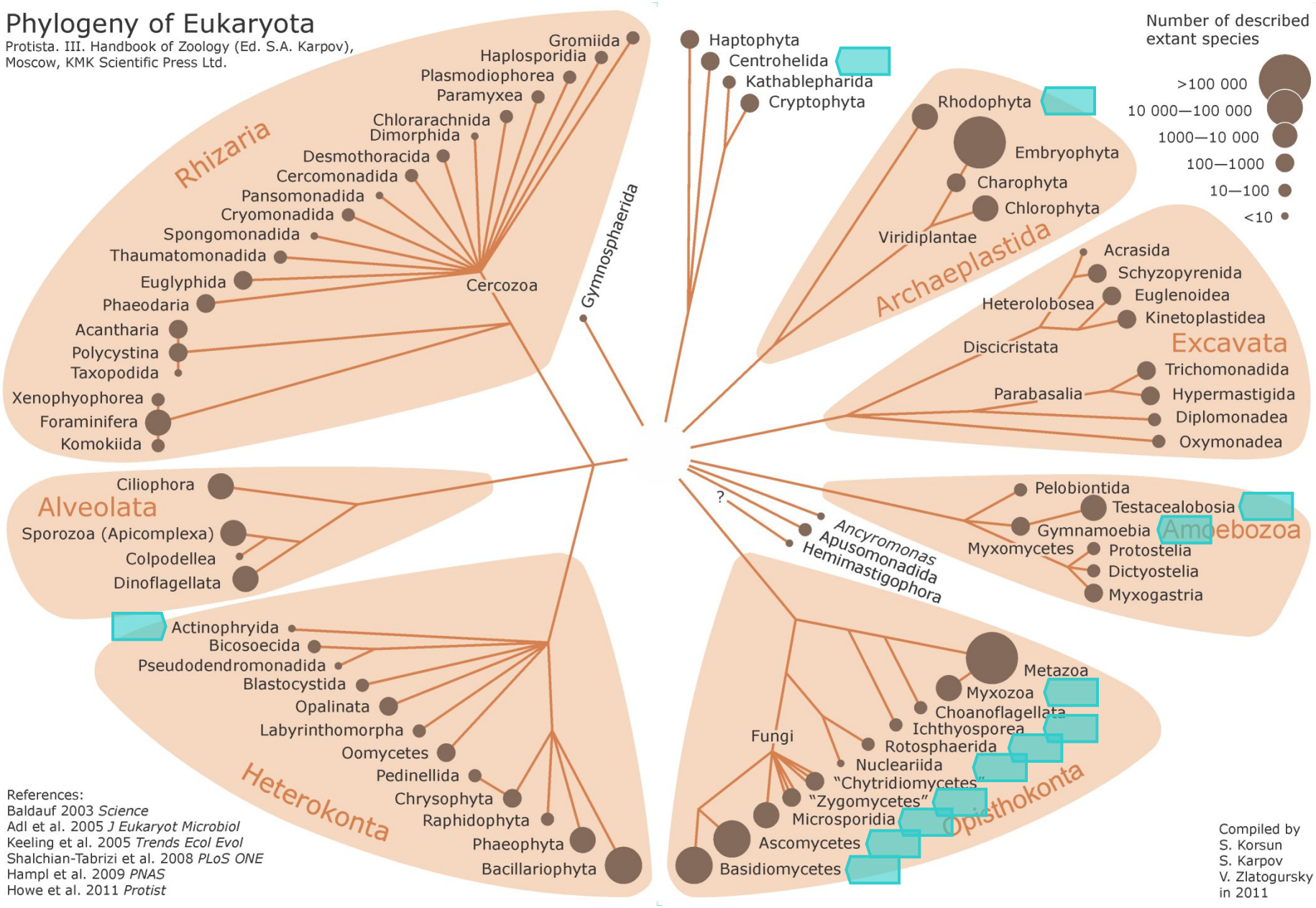
- Emerged independently in different lineages?
- Such a complex structure is likely to evolve once.
- Are there taxa that lack the axoneme and centriole primordially?



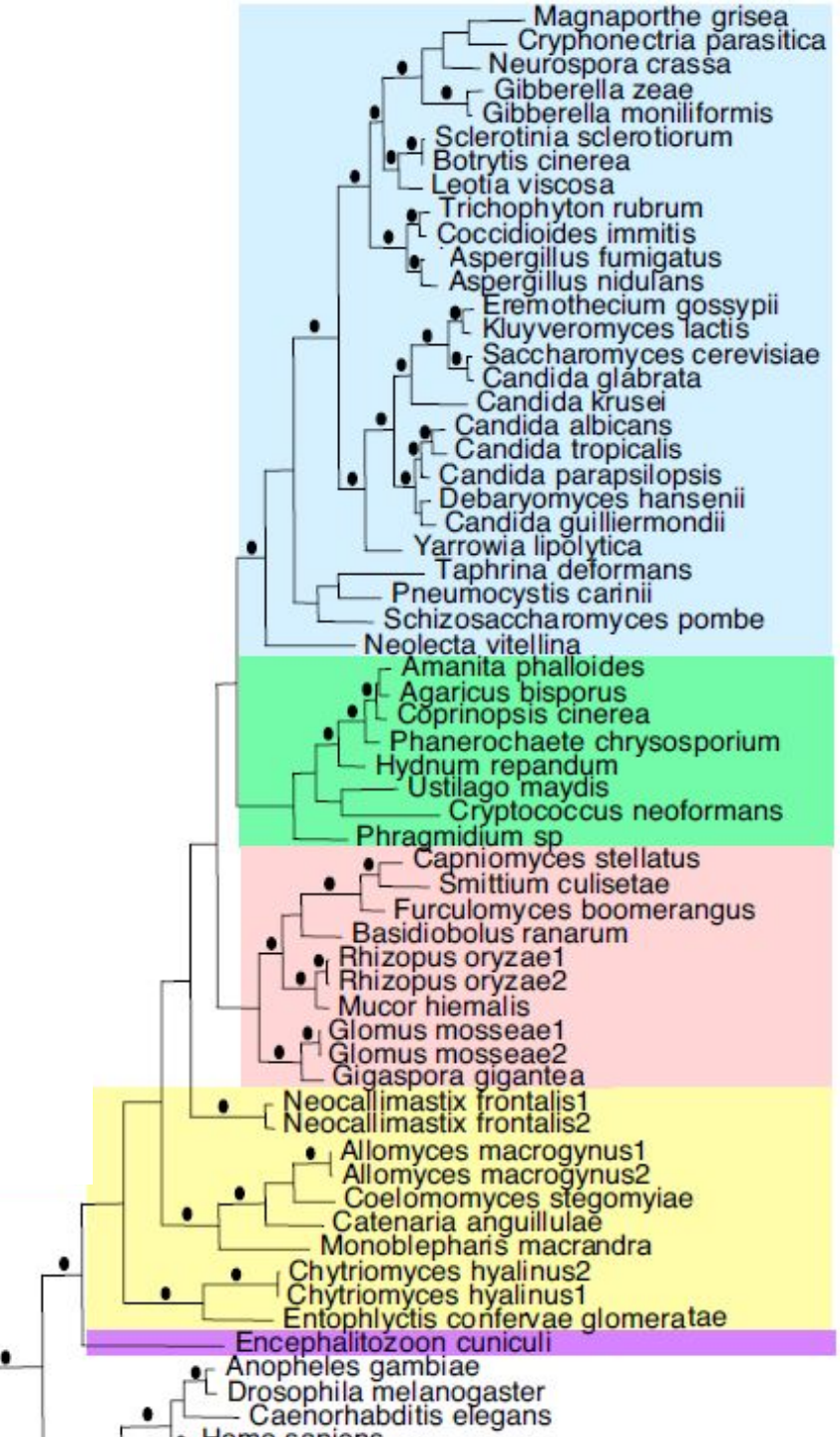
Ginger et al. 2008 *Nature Reviews* Microbiology

Taxa lacking the flagellum

No kinetosomes or centrioles



Is the lack of the flagellum ancestral?



Ascomycetes

Basidio-

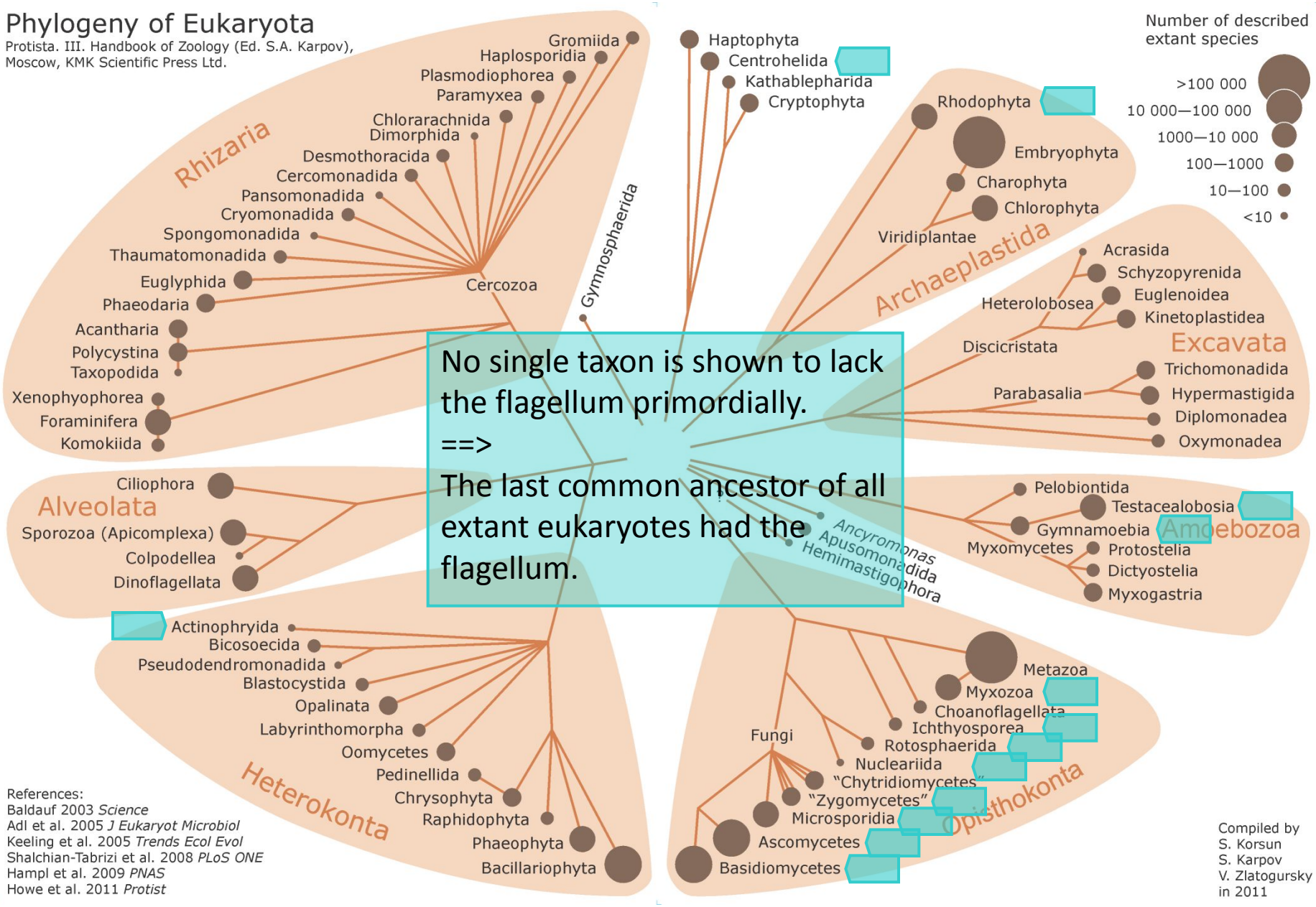
Zygo-

Chytridio-

All taxa without kinetosomes have flagellated relatives.

Phylogeny of the fungi: RNA polymerase II subunit genes

Liu et al. 2006 *BMC Evolutionary Biology*

Taxa lacking the flagellum

No kinetosomes or centrioles