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Amoebozoa

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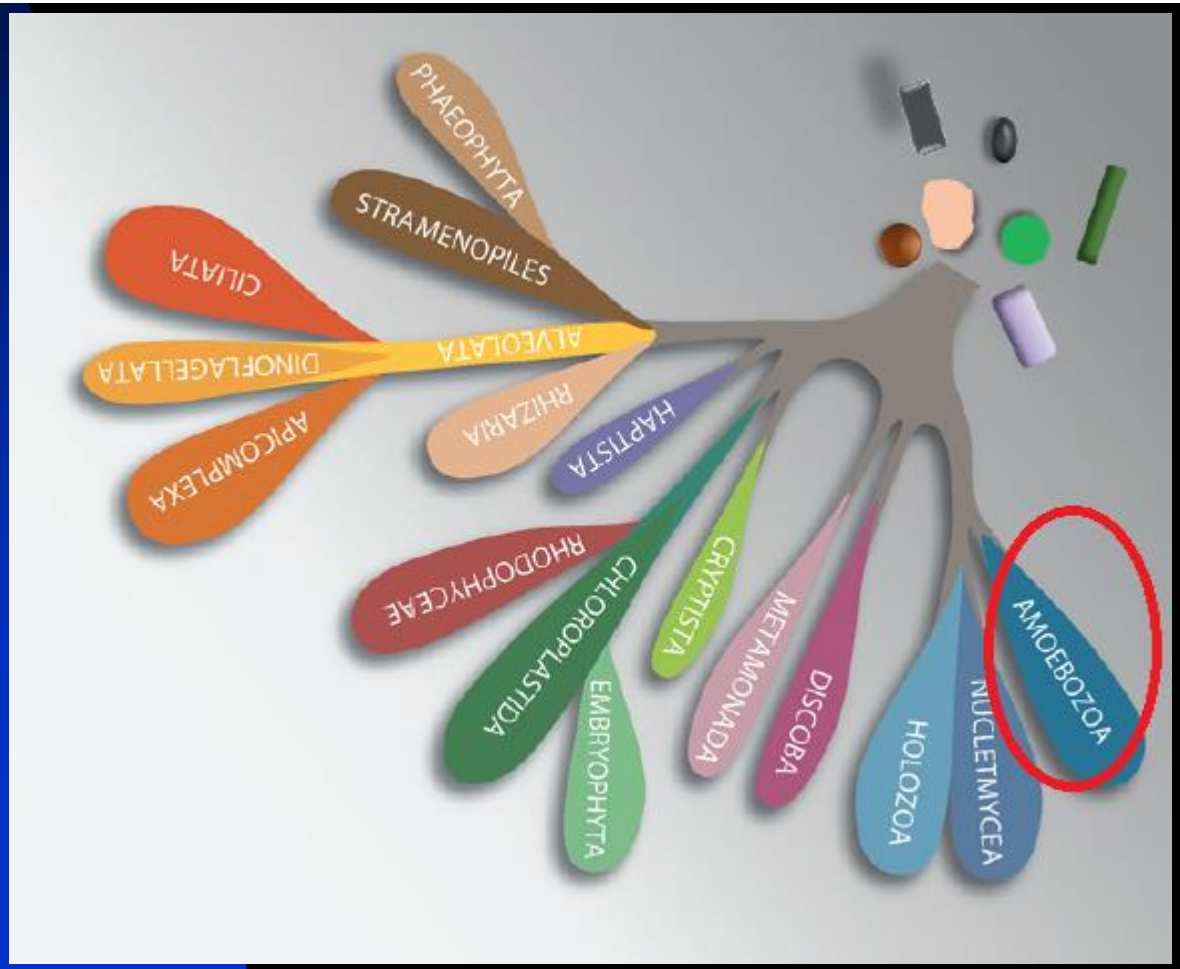
План лекції

1. Загальна характеристика
2. Tubulinea
3. Evosea
4. Discosea

1. Загальна характеристика

Amoebozoa Lühe 1913, sensu Cavalier-Smith 1998

Organisms almost all demonstrating 'amoeboid activity'[1] in all or in certain stage(s) of their life cycle. Amoeboid locomotion with steady flow of the cytoplasm or occasional eruptions in some groups; alternatively, amoeboid locomotion involving the extension and retraction of pseudopodia and/or subpseudopodia with little coordinated movement of the cytoplasm. Cells naked, often with well-developed, differentiated glycocalyx; in several groups cells are covered with a tectum[2] or a cuticle[3]. Two groups are testate (enclosed in a flexible or hard extracellular envelope with one to several opening(s)). Mitochondrial cristae tubular (ramicristate), with few exceptions; mitochondria secondarily reduced to mitochondrion-related organelles (MRO) in archamoebians. Most only reported to be asexual, but sex and life cycles consistent with sex have been reported in all three major lineages—Tubulinea, Evosea and Discosea. Many taxa exhibit either sporocarpic[4] or sorocarpic[5] fruiting. Biciliated, uniciliated or multiciliated stages in the life cycle of some taxa; some taxa exhibit reduction of the bikont kinetid to a unikont kinetid.



2. Tubulinea

*Tubulinea Smirnov 2005

● **Tubulinea** Smirnov et al. 2005

Organisms producing lobose pseudopodia (lobopodia)[9]. The entire cell or individual pseudopodia (in polypodial cells) are tubular, cylindrical or subcylindrical, rounded in cross-section. If cells are flattened or branched they are capable of altering the locomotive form from a flattened, expanded one to monopodial or polypodial, with subcylindrical pseudopodia. Monoaxial flow of the cytoplasm in every pseudopodium or in the entire cell. No convincing evidence of ciliate stages[10]. Two groups are testate, and two sorocarpic taxa are known. No sporocarpy has been reported.

●● Corycida Kang et al. 2017

**Corycida Kang et al. 2017

●● Corycida Kang et al. 2017

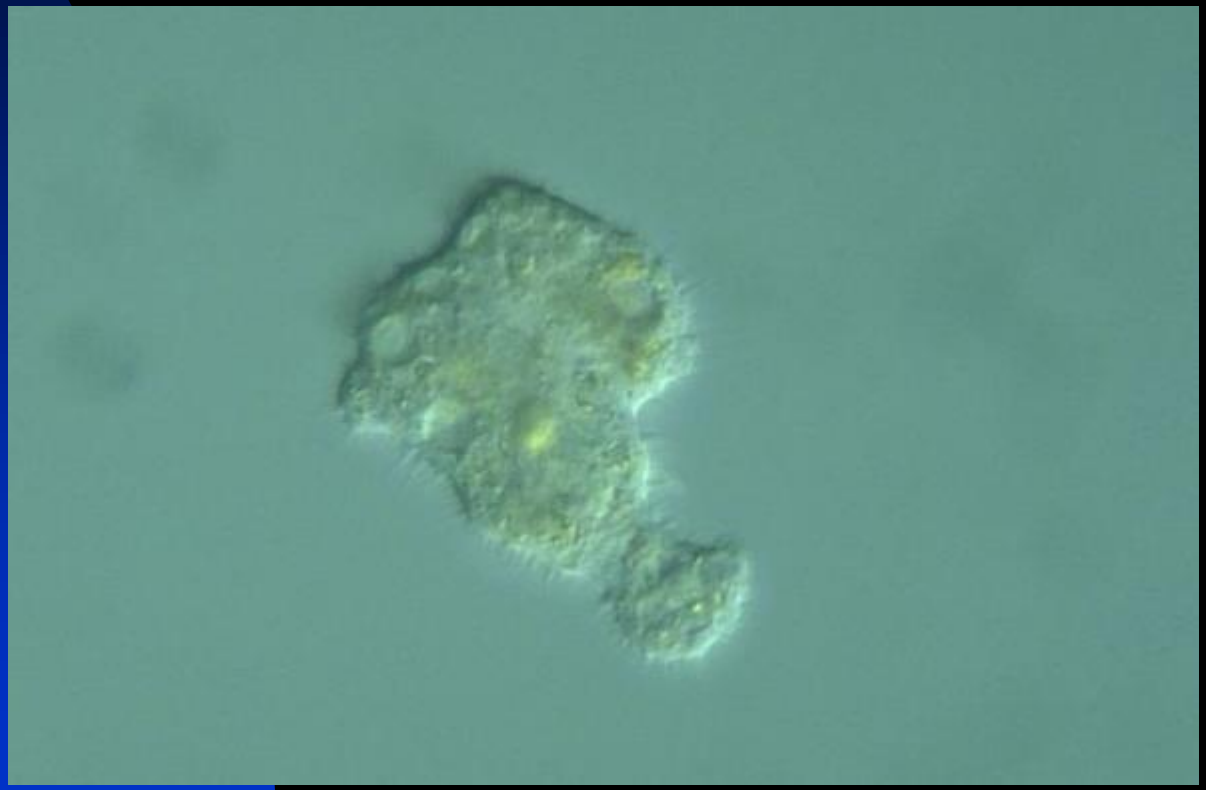
Cells covered with flexible, leather-like coating forming one or several openings used to protrude pseudopodia or are enclosed in hard test made of spicules with multiple apertures. The least inclusive clade containing *Amphizonella* sp.[11], *Diplochlamys* sp.[11], *Trichosphaerium* sp.[11], *Amphizonella*, *Diplochlamys*, *Trichosphaerium*[12].

Amphizonella violacea (on algae over mosses)

** Echinamoebida Cavalier-Smith 2004

●● Echinamoebida Cavalier-Smith 2004 (R)

Cells tubular, vermiform or flattened, with or without spine-like subpseudopodia; capable of adopting subcylindrical monopodial form under certain conditions. The least inclusive clade containing *Vermamoeba vermiformis, Echinamoeba silvestris* and *Micriamoeba tesseris. Echinamoeba, Micriamoeba, Vermamoeba*.



Echinamoeba sp.

Original Paper | Published: 28 March 2003

Cultivation and properties of *Echinamoeba thermarum* n. sp., an extremely thermophilic amoeba thriving in hot springs

Manuela Baumgartner, Ahoua Yapi, Regina Gröbner-Ferreira & Karl O. Stetter

Extremophiles **7**, 267–274(2003) | Cite this article

** Elardia Kang et al. 2017

●● Elardia Kang et al. 2017 (R)

Cells naked or covered with a hard test; tubular or produce tubular pseudopodia; if flattened or branched, capable of altering the locomotive form to monopodial or polypodial, with tubular pseudopodia. The least inclusive clade containing *Amoeba proteus*, *Arcella intermedia* and *Rhizamoeba saxonica*.

Amoeba proteus

3. Evosea

*Evosea Kang et al. 2017

● **Evosea** Kang et al. 2017 (R)

Representatives of this clade can vary across almost the entire range of morphologies seen in Amoebozoa. Many members have complex life cycles[15] that include amoeboid, ciliated and fruiting stages. Some species appear to be exclusively ciliated with no amoeboid features. Most taxa with only a subset of these life cycle stages. The least inclusive clade containing *Physarum polycephalum* (Eumycetozoa), *Protostelium nocturnum* (Variosea), *Squamamoeba japonica* (Cutosea), and *Entamoeba histolytica* (Archamoebea).

**Variosea Cavalier-Smith et al. 2004

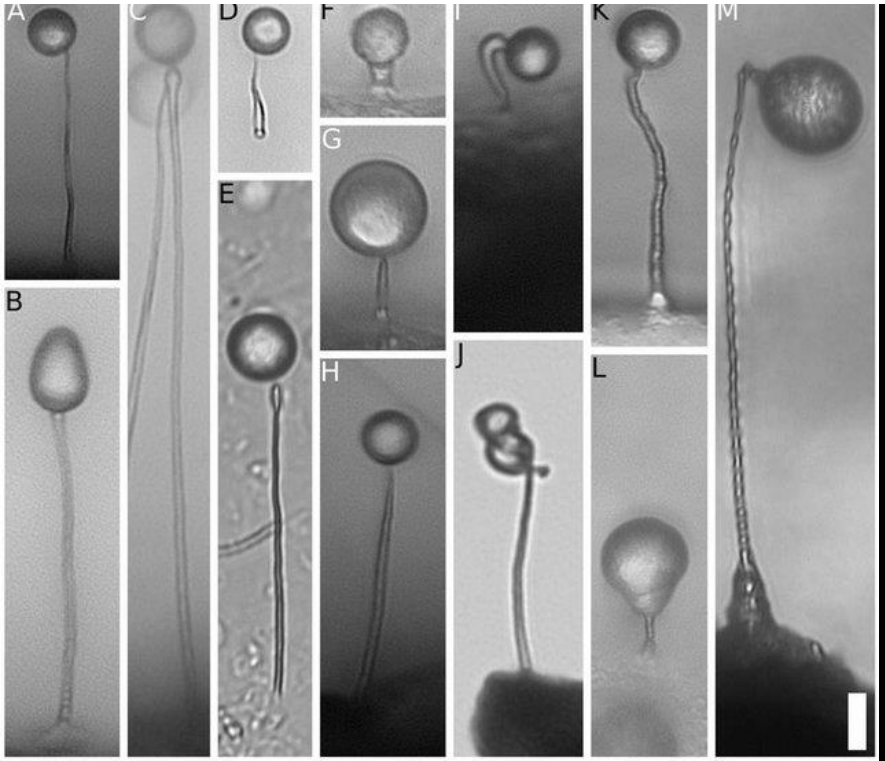
●● Variosea Cavalier-Smith et al. 2004 (R)[16]

Amoebae elongated or flabellate during locomotion and sometimes branched to reticulate, with long, pointed, often branching and occasionally anastomosing subpseudopodia; ciliated cells may be the sole state, or present as ciliated amoebaes, or be one state in a life cycle that also includes obligate amoebae; the kinetid of ciliates bikont or unikont, associated at least with one cone of microtubules; several taxa contain a sporocarp state. The least inclusive clade containing *Flamella balnearia, Protostelium nocturnum, Acramoeba dendroida* and *Phalansterium solitaruium.*

***Protostellida Olive & Stoianovich 1966
*** Fractovitellida Lahr et al. 2011

●●● Protosteliida Olive & Stoianovitch 1966, sensu Shadwick et Spiegel in Adl et al. 2012;
Sporocarpic amoebae with acutely pointed subpseudopodia and usually orange pigmentation contained in lipid droplets visible *en masse*; one taxon ciliated amoebae with 1–9 unikont kinetids not associated with nucleus; taxa without cilia with ring-shaped component in a nucleus-associated MTOC; sporocarps of variable morphology, with long, delicate stalk supporting single spore. The least inclusive clade containing *Protostelium nocturnum* and *Protostelium mycophaga*. *Protostelium*[17].

●●● Fractovitellida Lahr et al. 2011, sensu Kang et al. 2017 (R)[18]
Uninucleate, flabellate to branching amoebae; several members sporocarpic, one species with ciliated amoebae and obligate amoebae. The least inclusive clade containing *Soliformovum irregularis, Nematostelium gracile* and *Acramoeba dendroida*. Acramoebidae, Schizoplasmodiidae, Soliformoviidae.



A) Protostelium mycophaga,
B) Nematostelium ovatum,
C) Ceratiomyxella tahitiensis,
D) Soliformovum expulsum,
E) Soliformovum irregularis,
F) Cavostelium apophysatum,
G) Schizoplasmodiopsis amoeboidea,
H) Tychosporium acutostipes,
I) Clastostelium recurvatum,
J) Protosporangium articulatum,
K) Protosteliopsis fimicola,
L) isolate LHI05,
M) Endostelium zonatum.

**Eumycetozoa Zopf 1884

●● **Eumycetozoa** Zopf 1884 sensu Kang et al. 2017 (R)

All known members fruit, either sorocarpically (Dictyostelia), or sporocarpically (Myxogastria, Protosporangiida); with a life cycle having a single haploid amoeboid state (Dictyostelia); or a life cycle with a bikont ciliated amoebae state that gives rise to a non-ciliate obligate amoeboid state from which sporocarps develop (Myxogastria and Protosporangiida); ciliated amoebae of myxogastrids and protosporangiids and amoebae of dictyostelids flat and form wide pseudopodia with acutely pointed subpseudopodia and no pronounced streaming of the granular cytoplasm; where sex is well studied, the zygote cannibalizes haploid amoebae. The least inclusive clade containing *Dictyostelium discoideum, Physarum polycephalum* and *Ceratiomyxa fruticulosa*.

●●● Dictyostelia Lister 1909, sensu Sheikh et al. 2018 (R)

Sorocarpic amoebae, also known as cellular slime moulds or social amoebae, with stalked fruiting bodies developing from aggregation of amoebae; sorocarps consisting of stalks with terminal sori of haploid spores; stalks (sorophores) acellular (acytosteloid), cellular and unbranched or sparsely branched (dictyosteloid), or cellular and regularly branched with whorls of lateral branches (polysphondyloid); cells of stalks dead, consisting of walls, only, at maturity; spores usually ellipsoid, spherical in some species; cysts present in some species; sex, when present associated with a zygote that causes haploid amoebae to aggregate towards it such that the aggregate lays down a common cyst wall to form a macrocyst in which the haploid cells are ingested and digested by the zygote and meiosis occurring in the zygote prior to germination of the macrocyst; amoebae aciliate, haploid, with nucleus with peripheral reticulate nucleolus; upon starvation, amoebae aggregating, often in streams, towards an aggregation centre that signals with a chemical attractant (an acrasin) with aggregate developing into a slug-shaped, multicellular mass that can migrate then fruit or fruit directly; anterior cells becoming stalk cells in dictyosteloid and polyspondyloid species and bulk of the remaining cells becoming spores. *Acytostelium, Cavenderia, Coremiostelium, Dictyostelium, Hagiwaria, Heterostelium, Polysphodylium, Raperiostelium, Rostrostelium, Speliostelium, Synstelium, Tieghemostelium*, probably—*Coenonia**[19].

Dictiostelium discoideum

●●● Myxogastria Macbride 1899 [Myxomycetes Link 1833, sensu Haeckel 1866] (R)
Sporocarpic amoebae where a multinucleate obligate amoeba—the plasmodium—differentiates into one or more multinucleate spore-forming masses where the cell cleaves into individual, uninucleate spores that undergo meiosis after spore wall development in sexual species; sporocarps can be individual sporangia (with or without stalks), clustered sporangia, aethalia (massive fruiting derived from a whole plasmodium) or plasmodium-shaped plasmodiocarps; fruiting bodies initially covered by an extracellular peridium and may contain thread-like spore-suspending capillitium; spores germinating as bikont ciliated amoebae with rootlets as with Eumycetozoa with rootlet 3 consisting of a band of several microtubules; ciliated amoebae developing into plasmodia (involving plasmogamy and karyogamy of gametic ciliated amoebaes in sexual species); plasmodia usually tubular in cross-section with streaming of central granular cytoplasm. One species known to lack plasmodial state and one species known to lack ciliated amoebae.

Hemitrichia calyculata

●●● Protosporangiida Shadwick & Spiegel in Adl et al. 2012 (R)

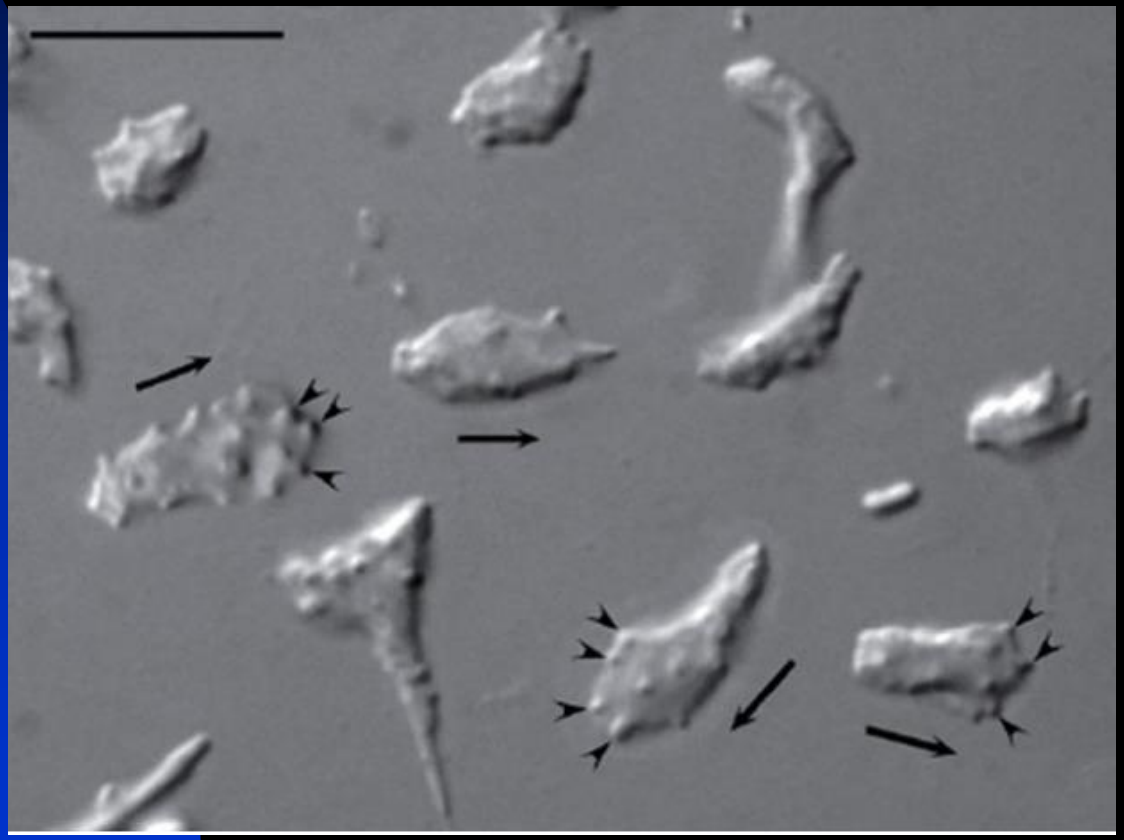
Exclusively fruiting, with microscopic (protosteloid) sporocarps with a microscopic stalk with one to four, sometimes more, spores; life cycle with ciliated amoebae stage with rootlets as Eumycetozoa with rootlet 3 consisting of a band of only two microtubules; giving rise to a uninucleate to plurinucleate obligate amoeba that develops into one or more sporocarps; prespore cells site of meiotic prophase and meiosis completed in spore complement.

Ceratomyxa fruticulosa

** Cutosea Cavalier-Smith et al. 2016

●● Cutosea Cavalier-Smith et al. 2016

Amoebae bounded by a continuous thin, somewhat flexible, envelope separated from the plasma membrane and having oval scale-like substructure within a denser matrix; small pores penetrate the envelope, allowing subpseudopodia to protrude for very slow, occasional locomotion; locomotive cells flattened, oval, rounded or irregularly triangular. *Armaparvus, Sapocribrum, Squamamoeba.*



Squamoeba japonica

**Archamoebea Cavalier-Smith 1983

●● Archamoebea Cavalier-Smith 1983, sensu Cavalier-Smith et al. 2004

Amoebae or ciliated amoebae, anaerobic or microaerophilic, free-living or endobionts of different invertebrate or vertebrate hosts; ciliated amoebae usually with hyaline lateral pseudopodia; unikont, with single kinetosome at the base of cilia, connected to the microtubular cone, in some cases both the kinetosome and the axoneme have atypical complements of microtubules; without typical mitochondria, in several cases mitochondrial derivates, i.e. mitosomes, have been demonstrated.

Pelomyxa lacustris

Entamoeba coli

4. Discosea

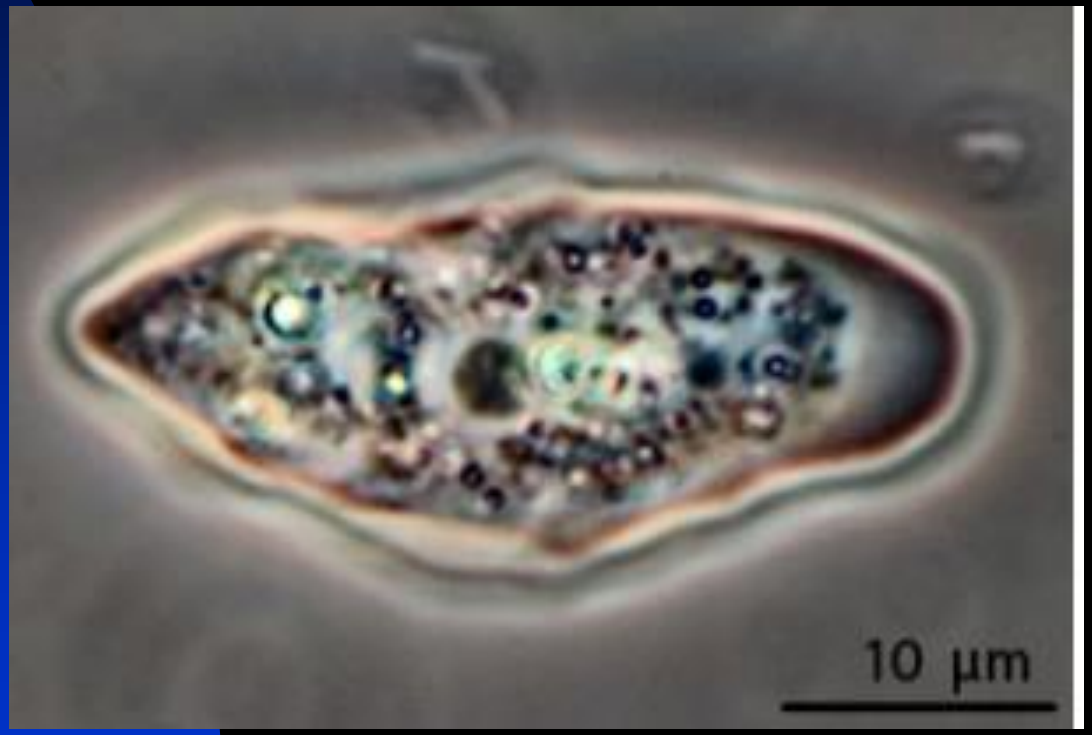
*Discosea Cavalier-Smith et al. 2004

- **Discosea** Cavalier-Smith et al. 2004, sensu Smirnov et al. 2011

Flattened naked amoebae, never producing tubular, subcylindrical pseudopodia and never altering the locomotive form to the tubular, subcylindrical one; cytoplasmic flow polyaxial or without a pronounced axis; ciliated stages unknown; several taxa sporocarpic.

**Flabellina Smirnov et al. 2005

●● Flabellinia Smirnov et al. 2005
Flattened generally fan-shaped, oblong or irregularly triangular cells, never with pointed subpseudopodia.

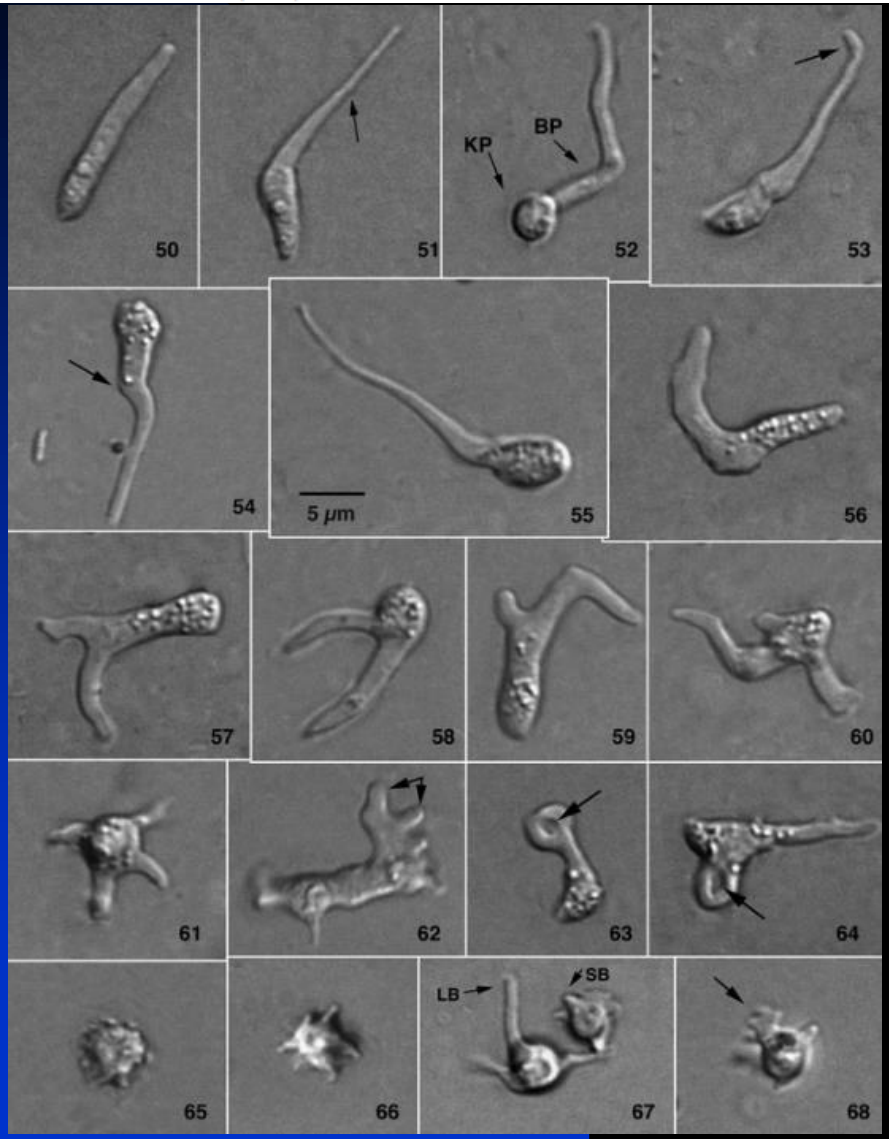


Paradermamoeba sp.

**Stygamoebida Smirnov et al. 2011

●● Stygamoebida Smirnov et al. 2011 (P)[24]

Flattened, elongate amoebae resembling tooth-picks or splinters, temporarily acquiring forked or branched form; elongate, expanded area of anterior hyaloplasm; mitochondrial cristae flattened, ribbon-like; MTOC known in one species. *Stygamoeba, Vermistella.*



Vermistella antarctica
(Morgan et al. 2007)

J. Eukaryot. Microbiol., ∗(∗), ∗ pp. ∗–∗

DOI: 10.1111/j.1550-7408.2007.00249.x

A Description of Seven Antarctic Marine Gymnamoebae Including a New Subspecies, Two New Species and a New Genus: *Neoparamoeba aestuarina antarctica* n. subsp., *Platyamoeba oblongata* n. sp., *Platyamoeba contorta* n. sp. and *Vermistella antarctica* n. gen. n. sp.

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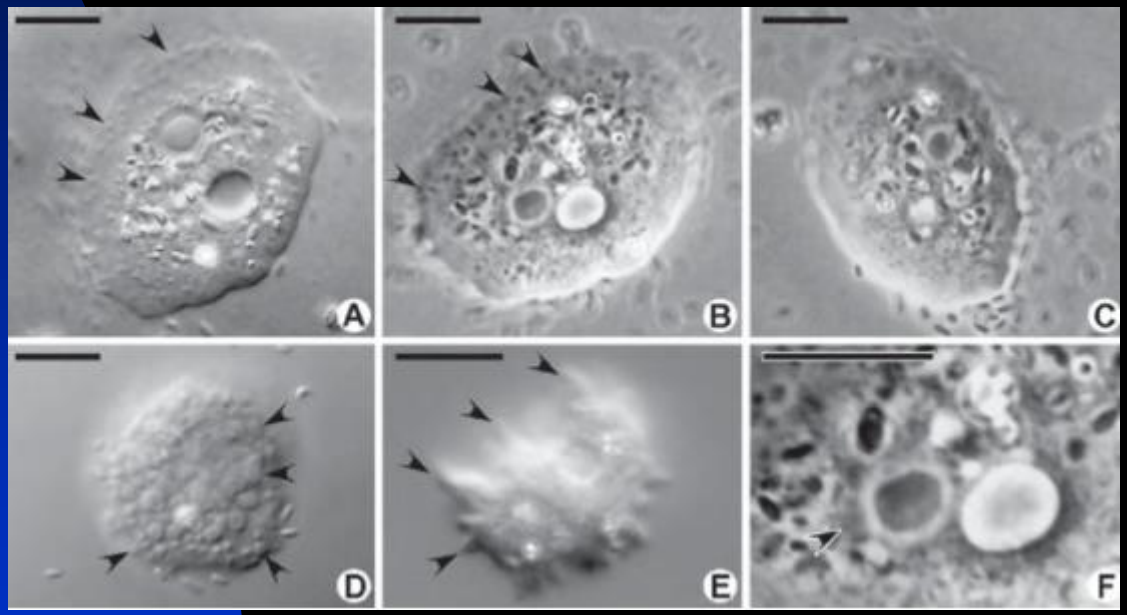
ABSTRACT. Seven marine gymnamoebae were isolated from different environments of seawater, slush (pack ice meltwater), and sediment in the Ross Sea area of Antarctica. All amoebae were isolated and maintained at temperatures below 4 °C. Growth, rate of locomotion, and general morphology were observed at an environmentally appropriate temperature (1 °C) and at room temperature (~25 °C). Molecular (srDNA sequences) and microscopical techniques were used to identify the gymnamoebae and establish their phylogenetic affinities. Three isolates (S-131-2, SL-200, and W4-3) were assigned to a psychrophilic subspecies of *Neoparamoeba aestuarina*, *N. aestuarina antarctica* n. subsp., one isolate (S-205) was assigned to a new species of *Platyamoeba*, *P. oblongata* n. sp., two isolates (W51C#4 & W51C#5) were also assigned to a new species of *Platyamoeba, P. contorta* n. sp., and one isolate (S-241) was a novel psychrophilic gymnamoeba *Vermistella antarctica* n. gen. n. sp. Molecular and morphological results revealed that *V. antarctica* was not related to any described family of gymnamoebae. Strains S-205, W51C#4, and W51C#5 were capable of locomotion at room temperature, while strains SL-200, S-131-2, W4-3, and S-241 exhibited locomotion only below ~ 10 °C. Our results imply that the Antarctic environment is host both to cosmopolitan gymnamoebae that have acquired adaptations for existence at low environmental temperature and to apparently novel psychrophilic amoebae described here for the first time.

Key Words. Amoebae, cold water, microplankton, nanoplankton, protist, protistan community, psychrophilic, Ross Sea.

**Centramobia Cavalier-Smith et al 2016

●● Centramoebia Cavalier-Smith et al. 2016 (R)
MTOC located near the dictyosome; several taxa with protosteloid sporocarpy. The least inclusive clade containing *Pellita catalonica, Gocevia fonbrunei, Endostelium zonatum, Acanthamoeba castellanii.*



Endostelium zonatum

Рекомендована література:

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Питання для самостійної роботи:

1. Характеристика Amoebozea.
2. Обсяг та характеристика Tubulinea, Evosea та Discosea, як груп першого рангу та положення представників групи в класичних таксономічних системах.
3. Знайти оригінальні відомості в інтернет просторі про одного представника з наступних груп другого рангу: Corycida, Echinamoebida, Elardia, Variosea, Eumycetozoa, Cutosea, Archamoebea, Flabellina, Stygamoebida, Centramobia. На основі знайдених в інтернеті публікацій, з урахуванням філогенетичних та молекулярних даних, надати коротку характеристику, яка б включала: морфологічний тип, специфічні морфологічні або біохімічні особливості, екологічні особливості, місце в системі органічного світу та реальне або ймовірне використання.