Microbes
(bacteria and ciliates)
In the soil ecosystem

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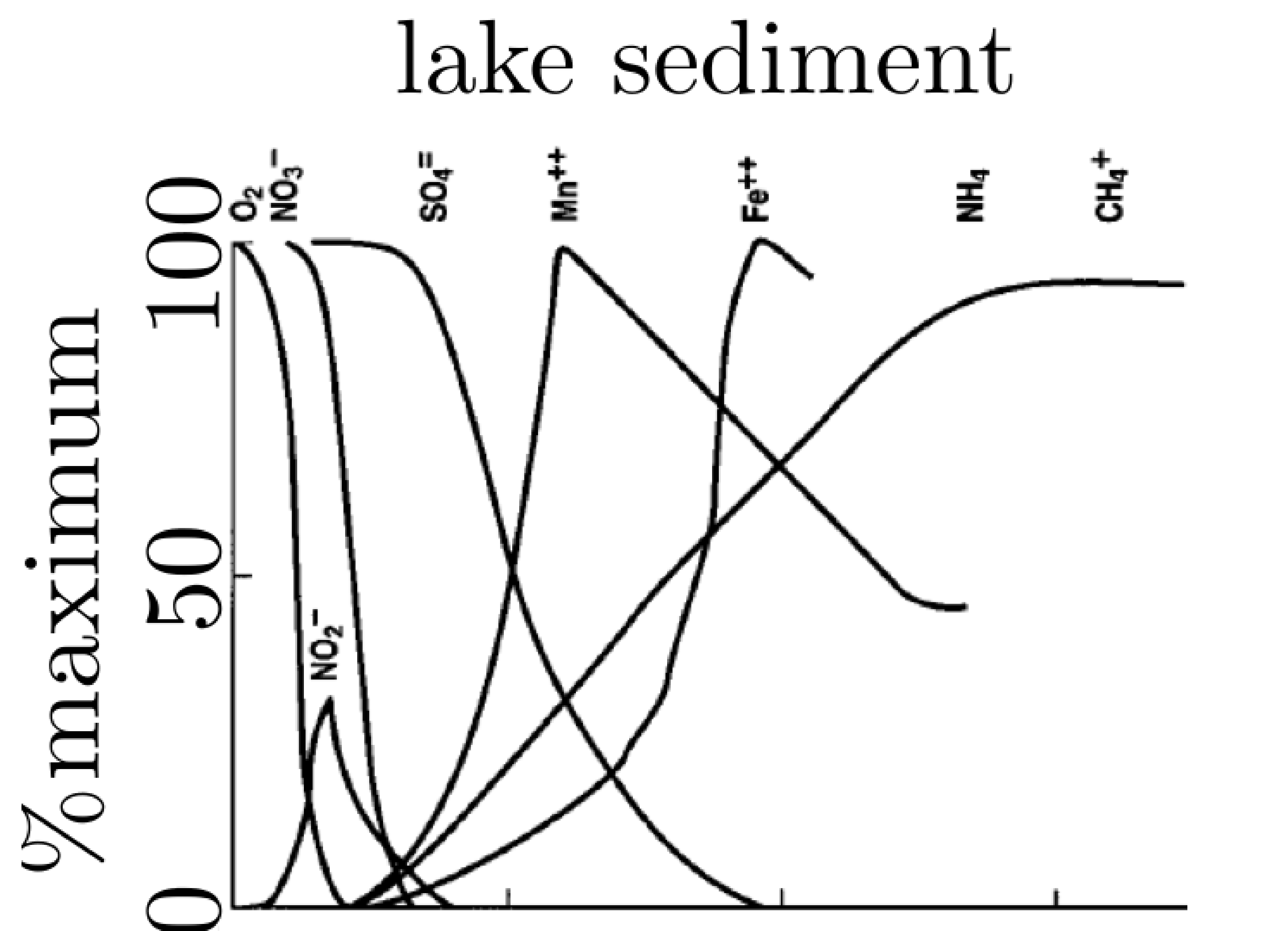
The primary biology of our planet is microbial.
We are only now beginning to explore the biological diversity of our planet.

Microbiologists have emphasize the abiotic features of habitat (electron donor acceptor, salinity, temperature) but not enough the mutual relations between organisms.

We are beginning to develop an understanding of the organization (ecology) and the mechanism of changes (evolution)

There is also a correlation between closely related populations and habitat (Thiovulum Majus and Uronemella).


4
3
2
1

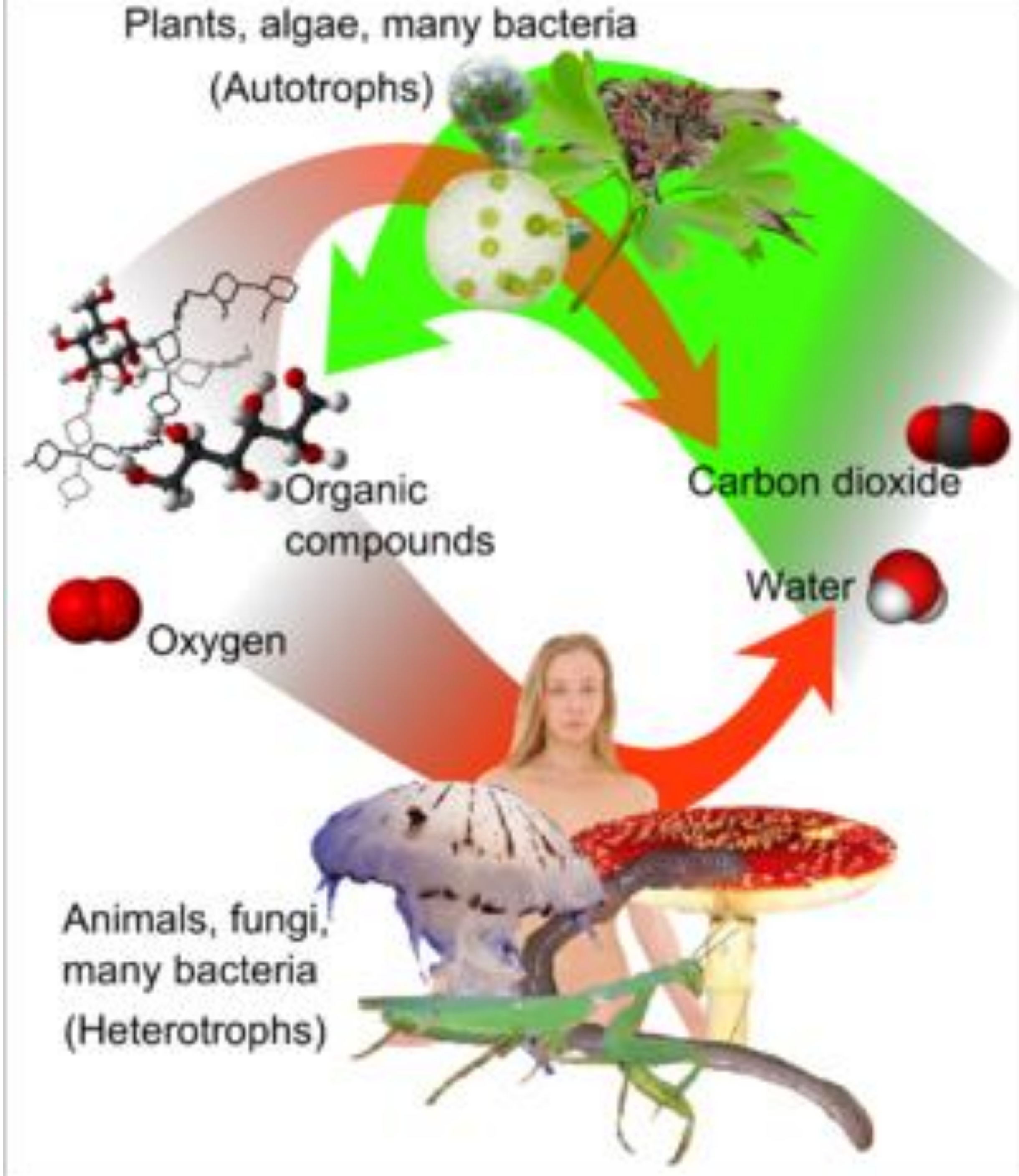


lake sediment
% maximum
100
50
0
O2
NO3−
SO4=
Mn++
Fe++
NH4
CH4+
NO2−

Two parts in this talk: the hydrodynamic of microbes

Behavior in nature of the ciliate and the bacterium

Biophysical study of the bacterium crystal formation



Plants, algae, many bacteria
(Autotrophs)
Organic
compounds
Carbon dioxide
Oxygen
Water
Animals, fungi,
many bacteria
(Heterotrophs)

Some soil microbes use decomposition to get their energy, oxydating sulfur. In this environment two solutions are present: a cilliate and a bacterium.

To increase oxygen flow through water, they apply strong advection of water, a large Peclet number.

They move extremely fast, 0.5mm/sec, have a size of 10 μm, thus a low Reynolds number.
They store sulfur in granules.

They can tether on boundaries and produce veils as new boundaries.
Each microbe acts like a small tornado.
They contribute to the soil ecosystem.

A CELIATE (Uronemella) A BACTERIUM (Thiovulum)

Both Sulfur oxydation Microbes

Both Sulfur granules

Both Tether Form a veil They tether to the veil

Both Fast moving ~ .5mm/sec (20 times E.Coli)

Both Live in mud sulfur decomposition

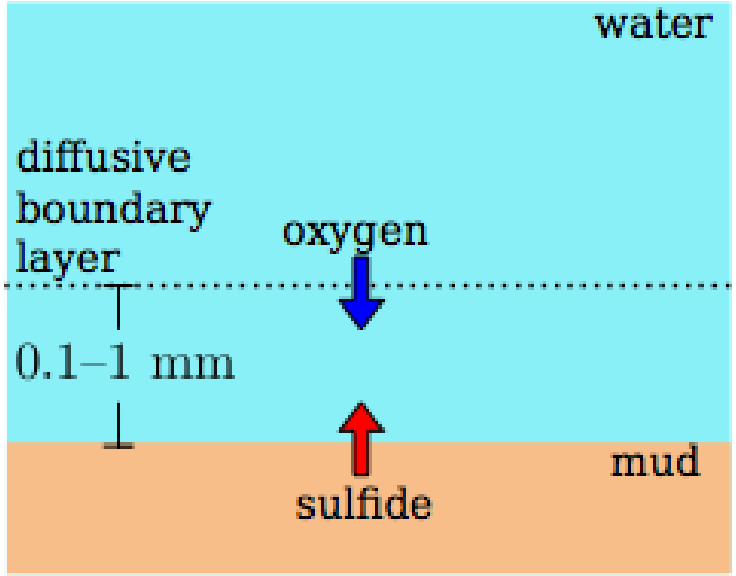
Both Large Oxygen Peclet Number in veil ~ 40

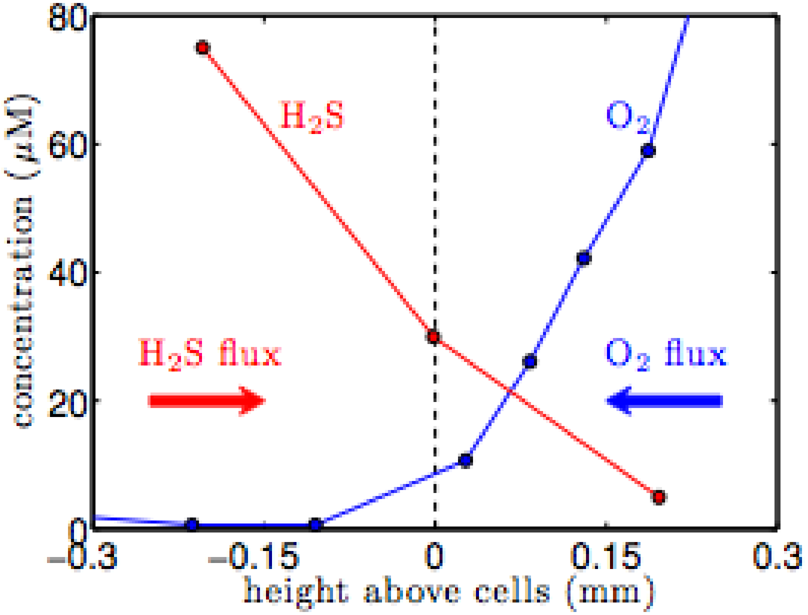
Both hydrodynamic interaction

Thiovulum majus: a sulfur-oxidizing bacterium

$$H_2S + 2O_2 \rightarrow SO_4^{2-} + 2H^+ + \text{energy}$$

use energy to make sugars from CO_2



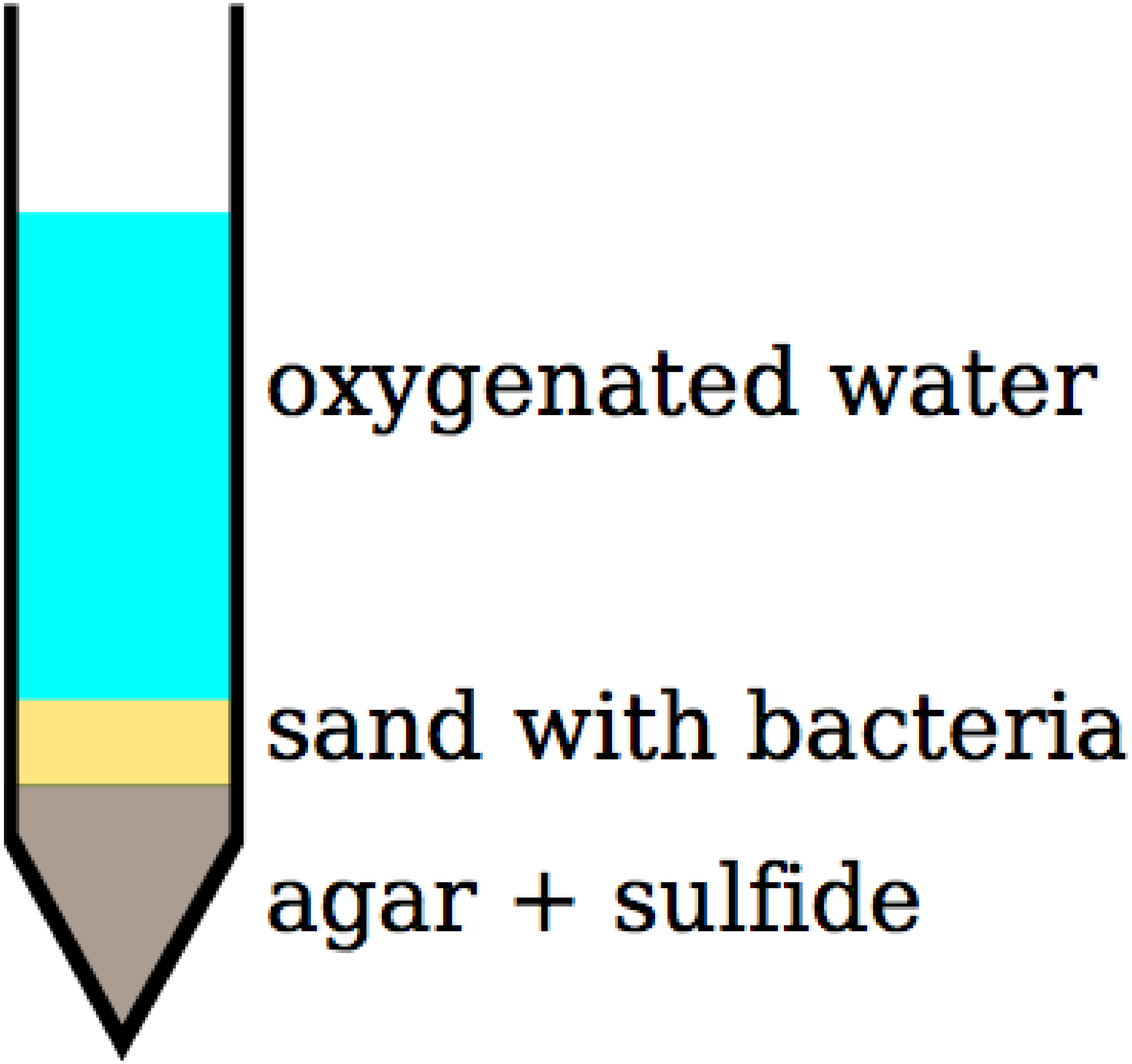


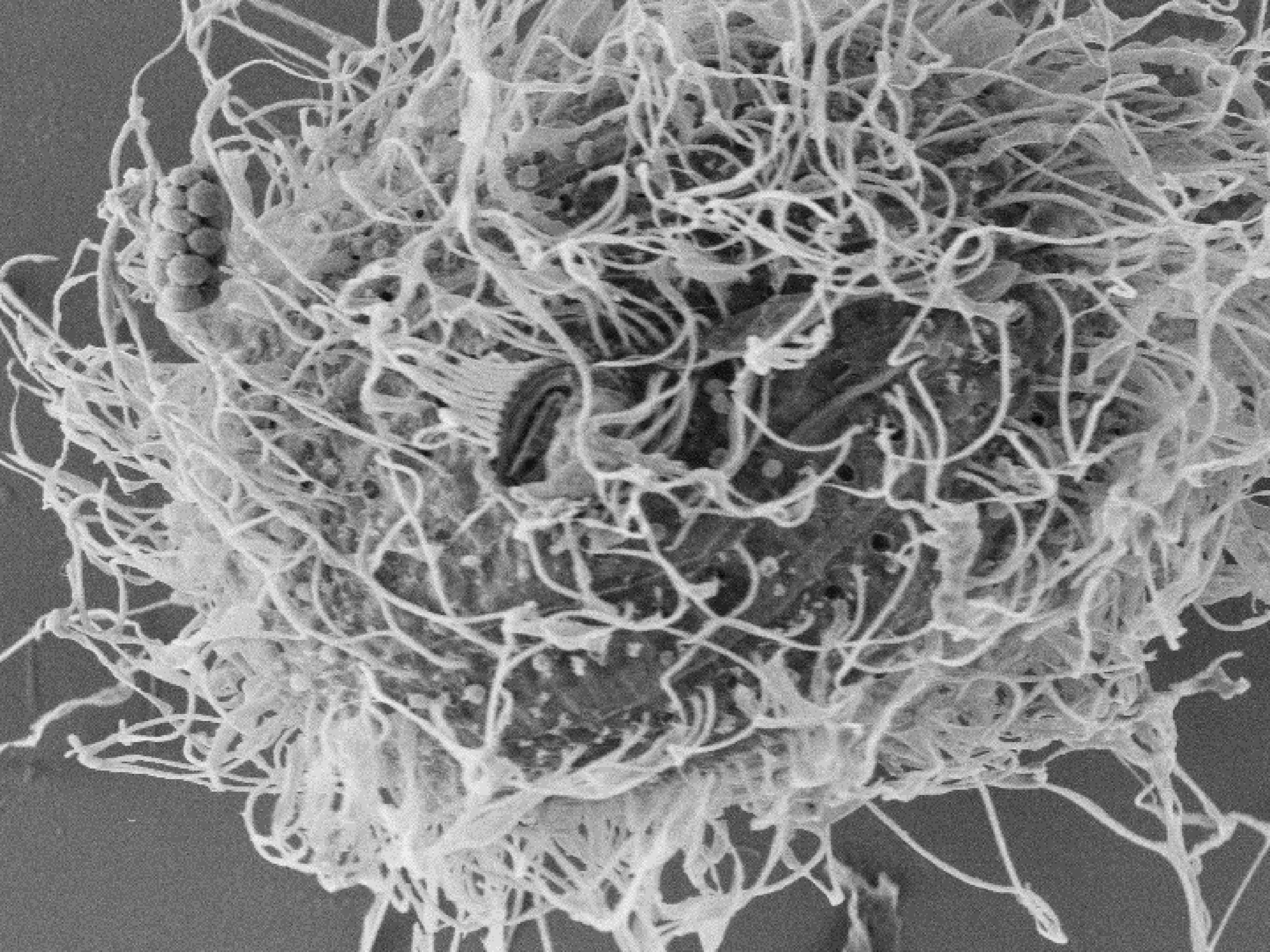
(data from Jørgensen 1983)

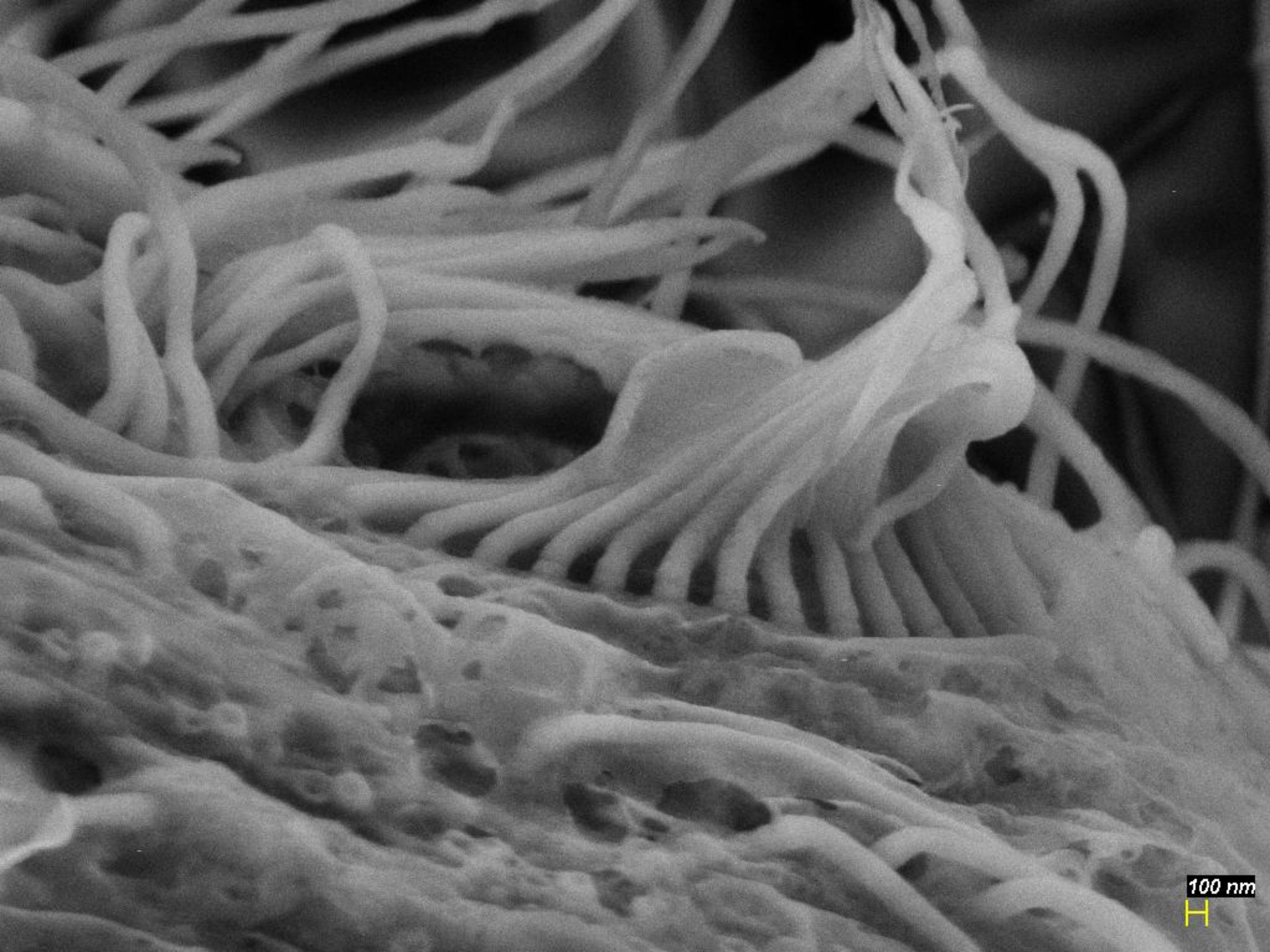
- *Thiovulum majus* live in the diffusive boundary layer.
- One expects diffusion limitation

Start with mud

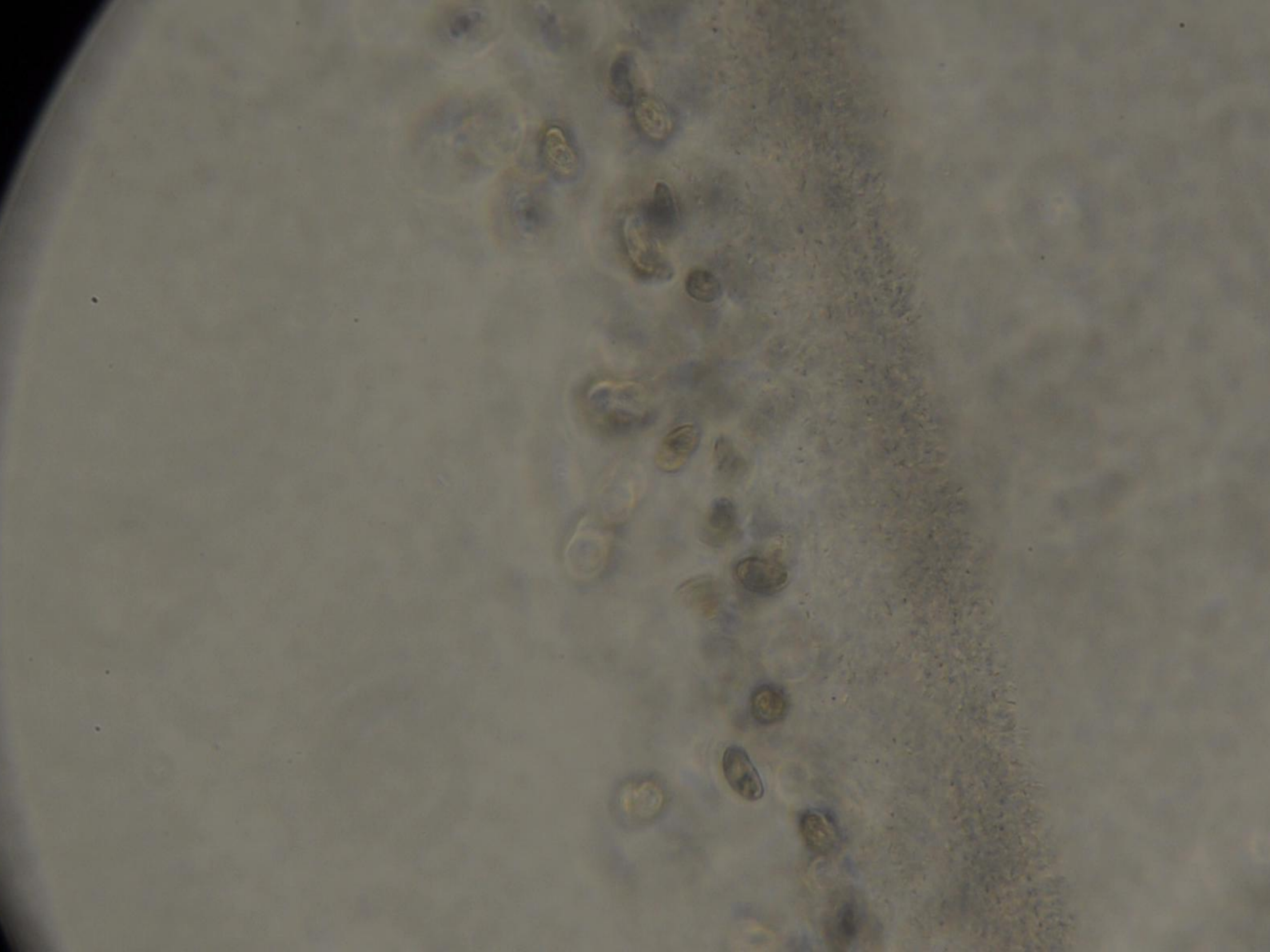
Select for a metabolism: *T. majus* needs H_2S and O_2



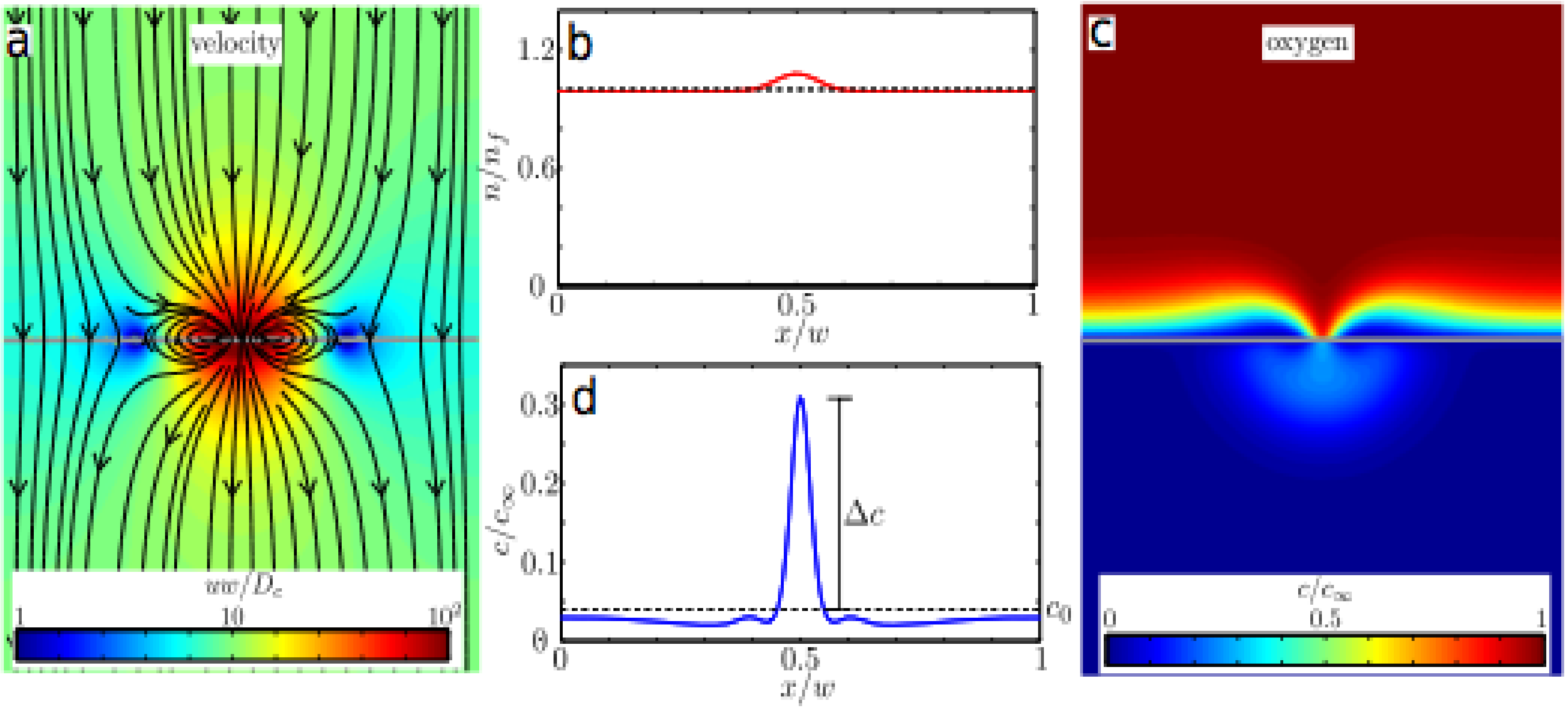



100 nm


2 µm

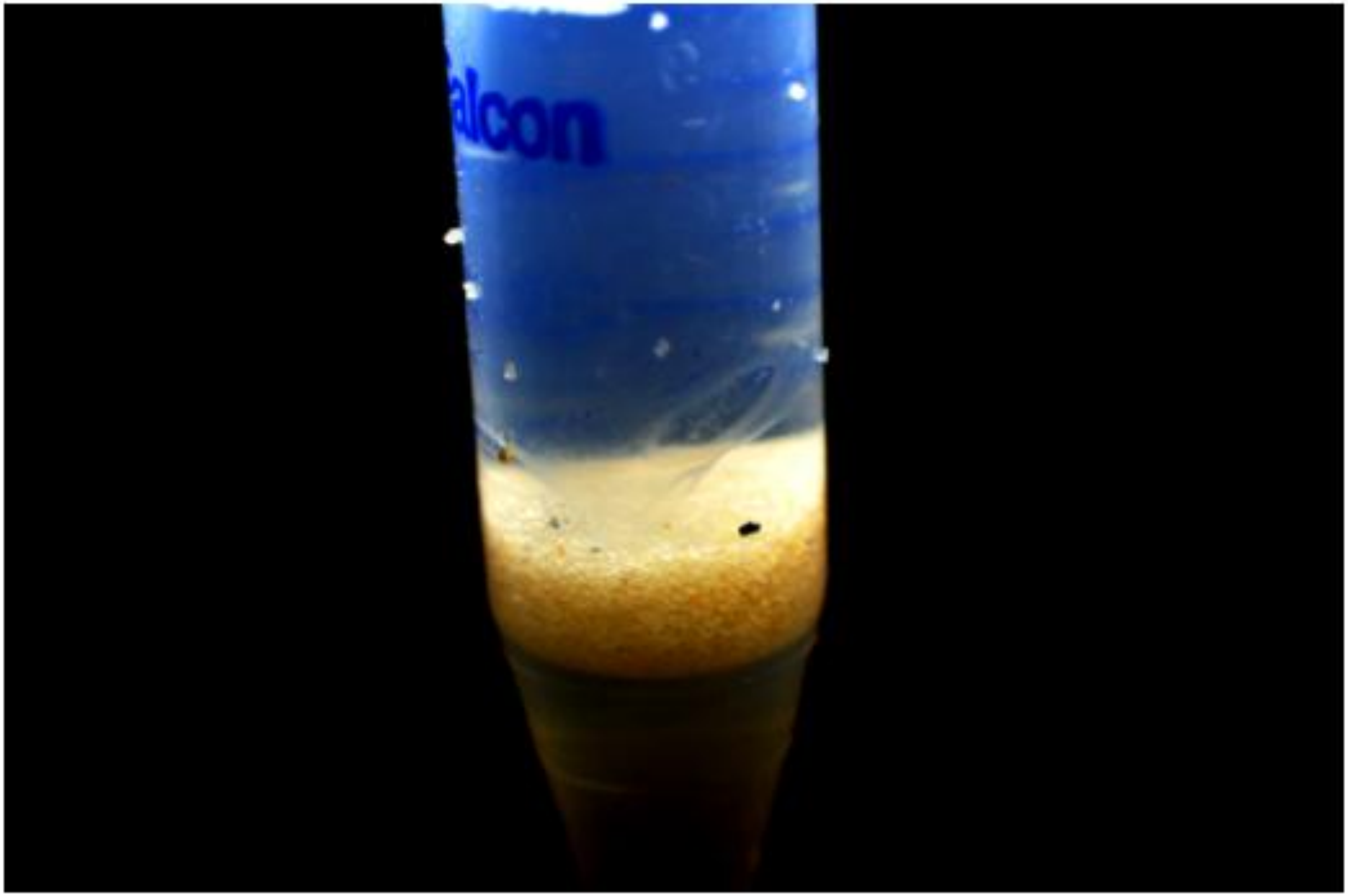


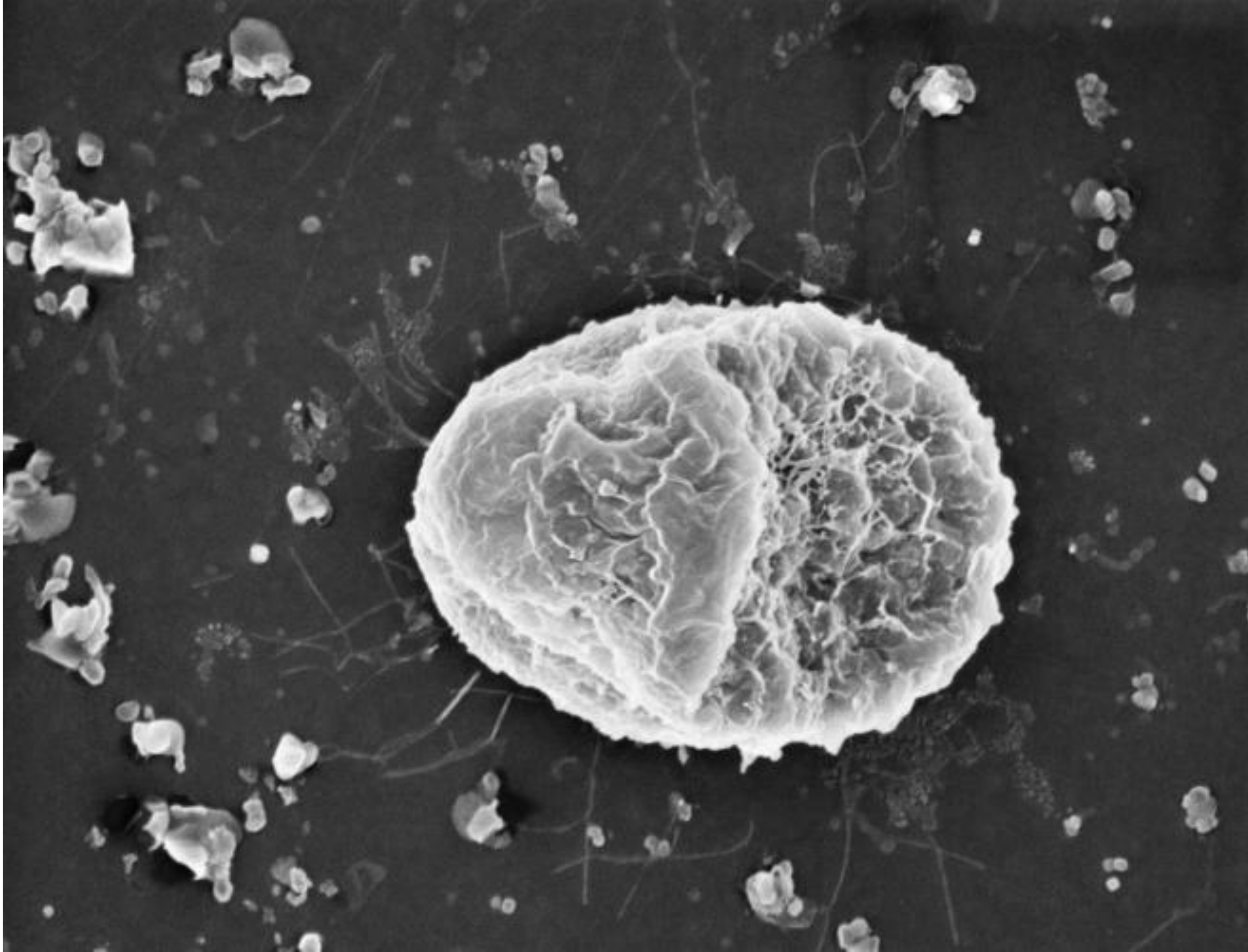
How do the bacteria respond?

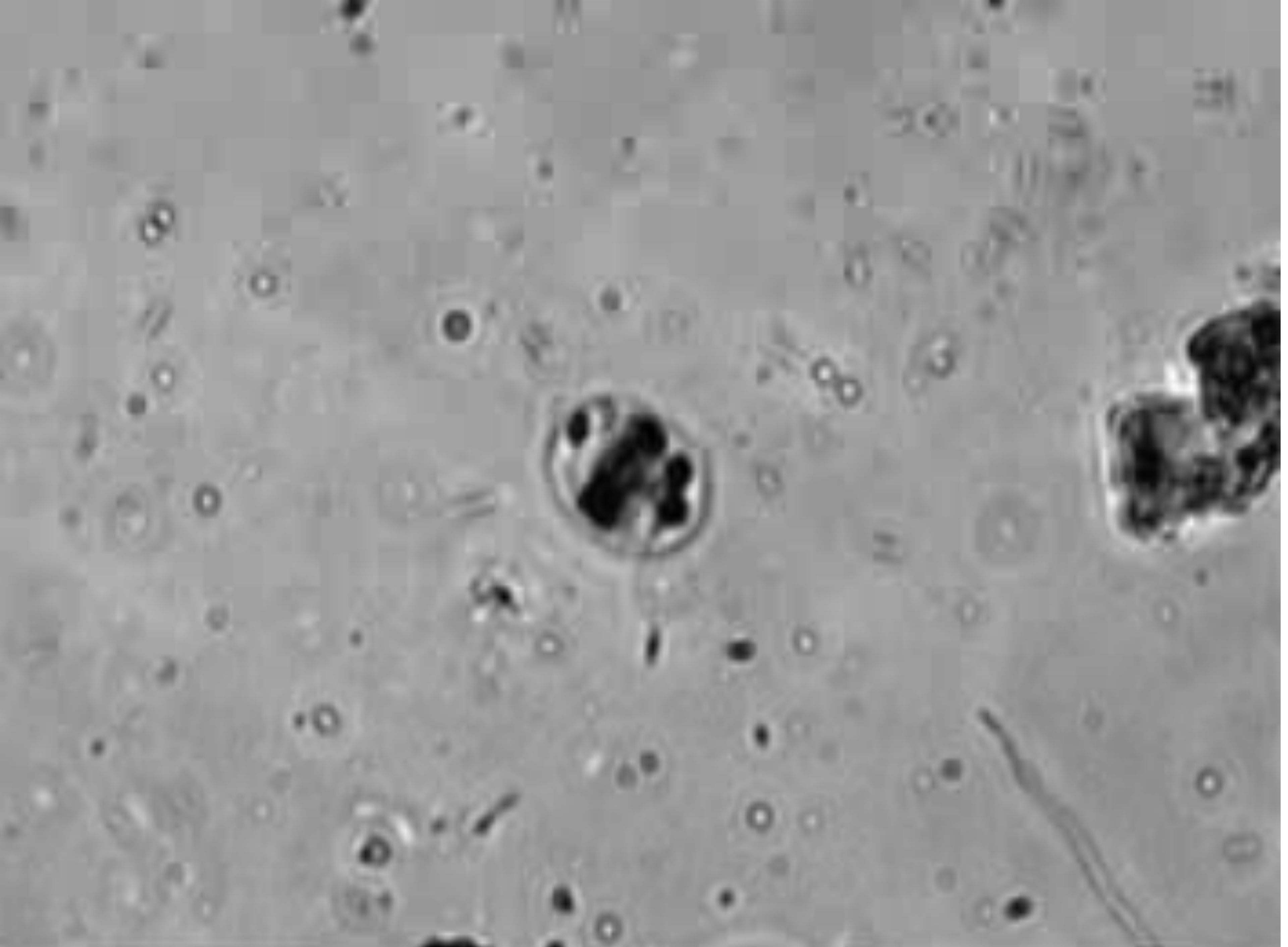


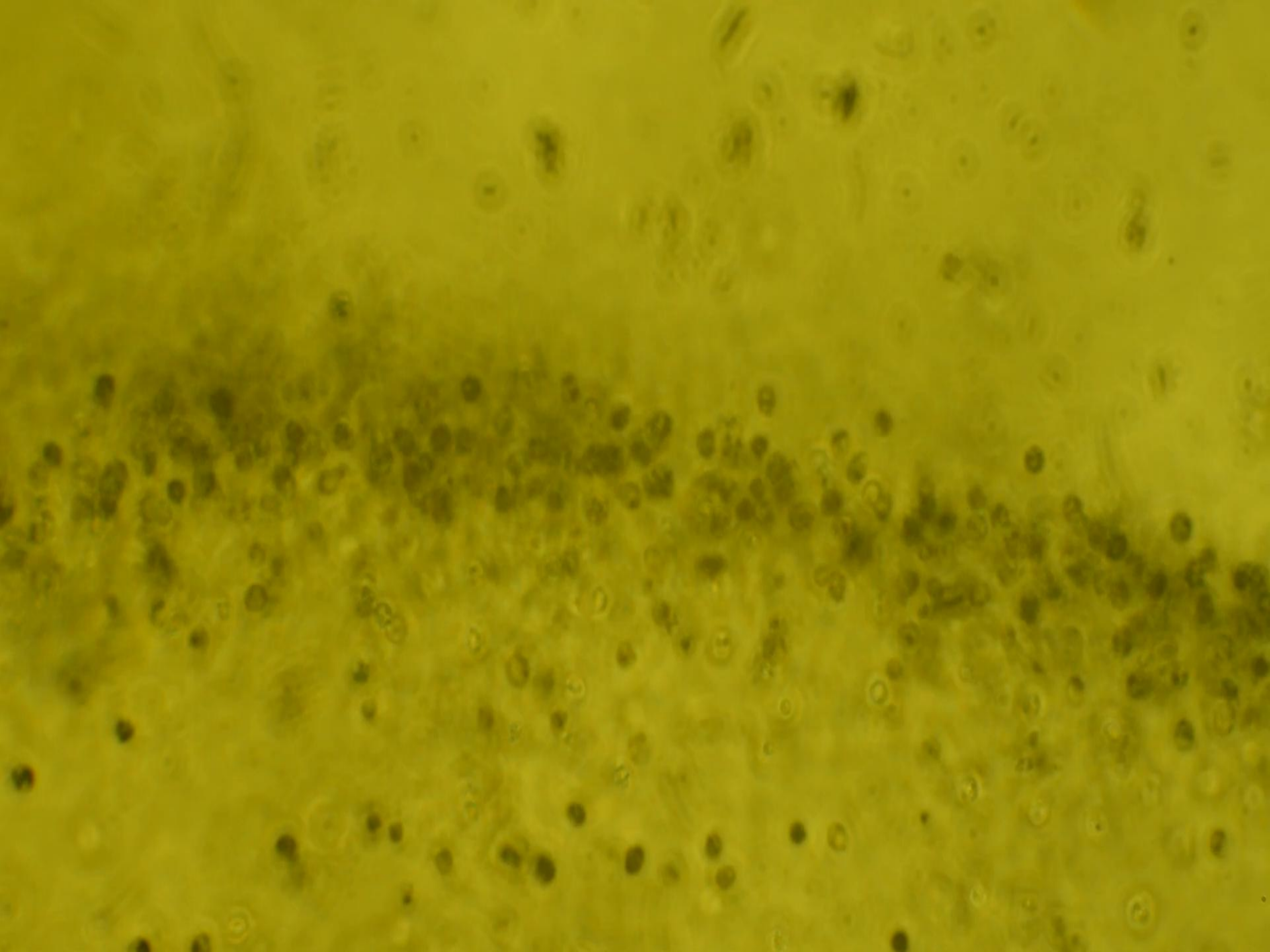
$$\frac{\partial n}{\partial t} = D_{eff} \nabla^2 n + \frac{\partial D_{eff}}{\partial c} \nabla c \cdot \nabla n$$

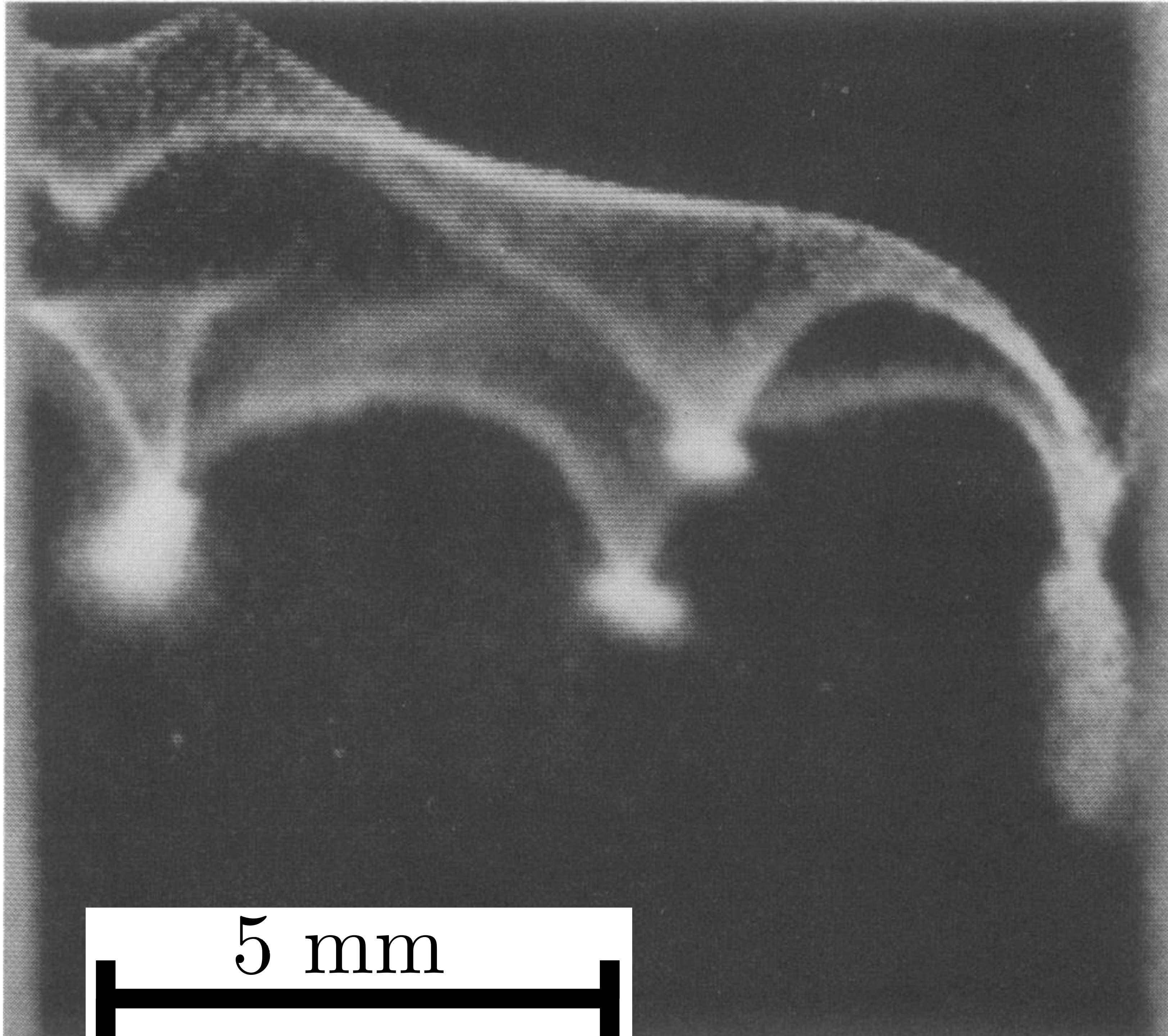
Select for a metabolism: *T. majus* needs H_2S and O_2










5 mm