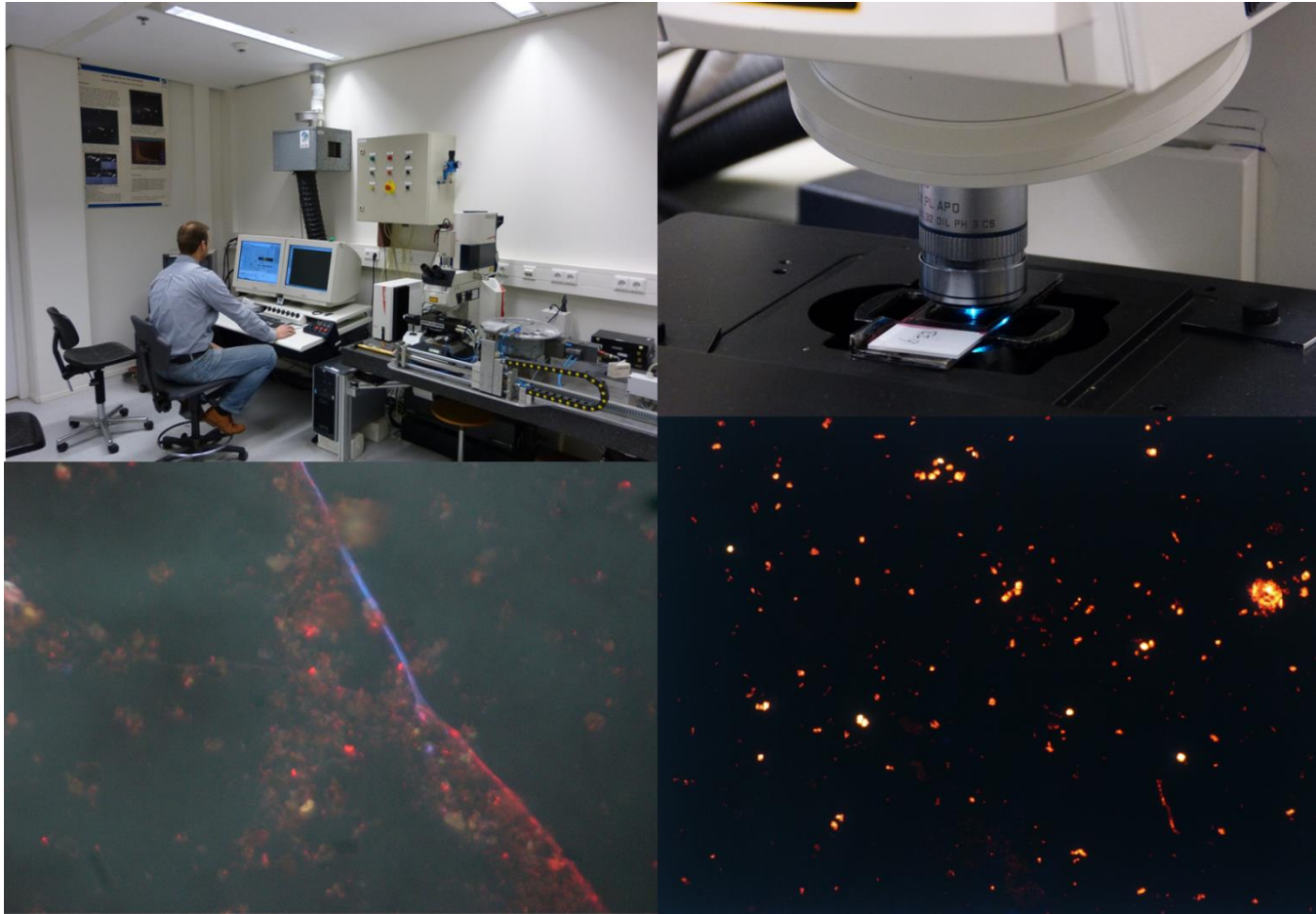


Micro-organismen

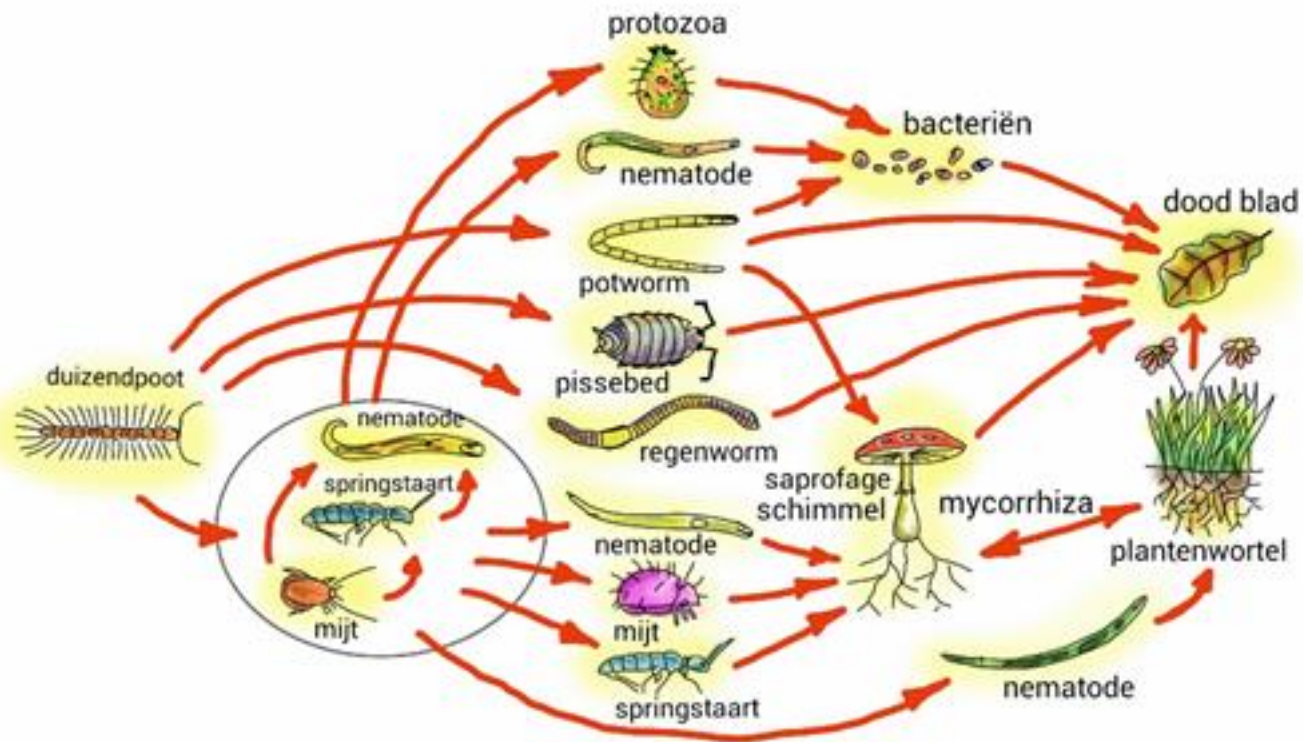
Effecten van kalk- en organische stofgehalte in de duinen

Jaap Bloem, An Vos en Rolf Kemmers

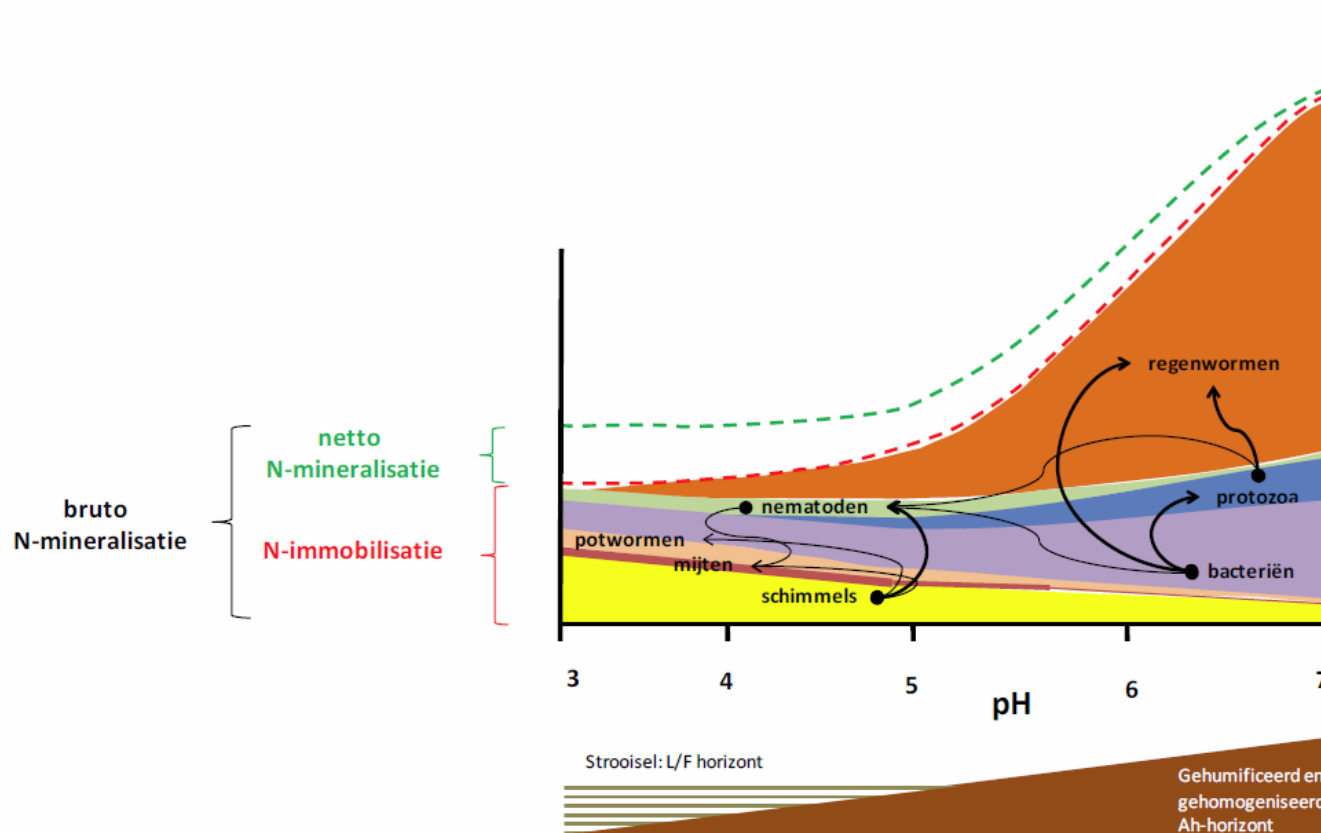


Bodemvoedselweb: bacteriën, schimmels en fauna

Figuur Ron de Goede, WU Bodemkwaliteit



Verstoring en verzuring remt bacteriën sterker dan schimmels minder stikstof vastlegging, meer beschikbaar voor planten

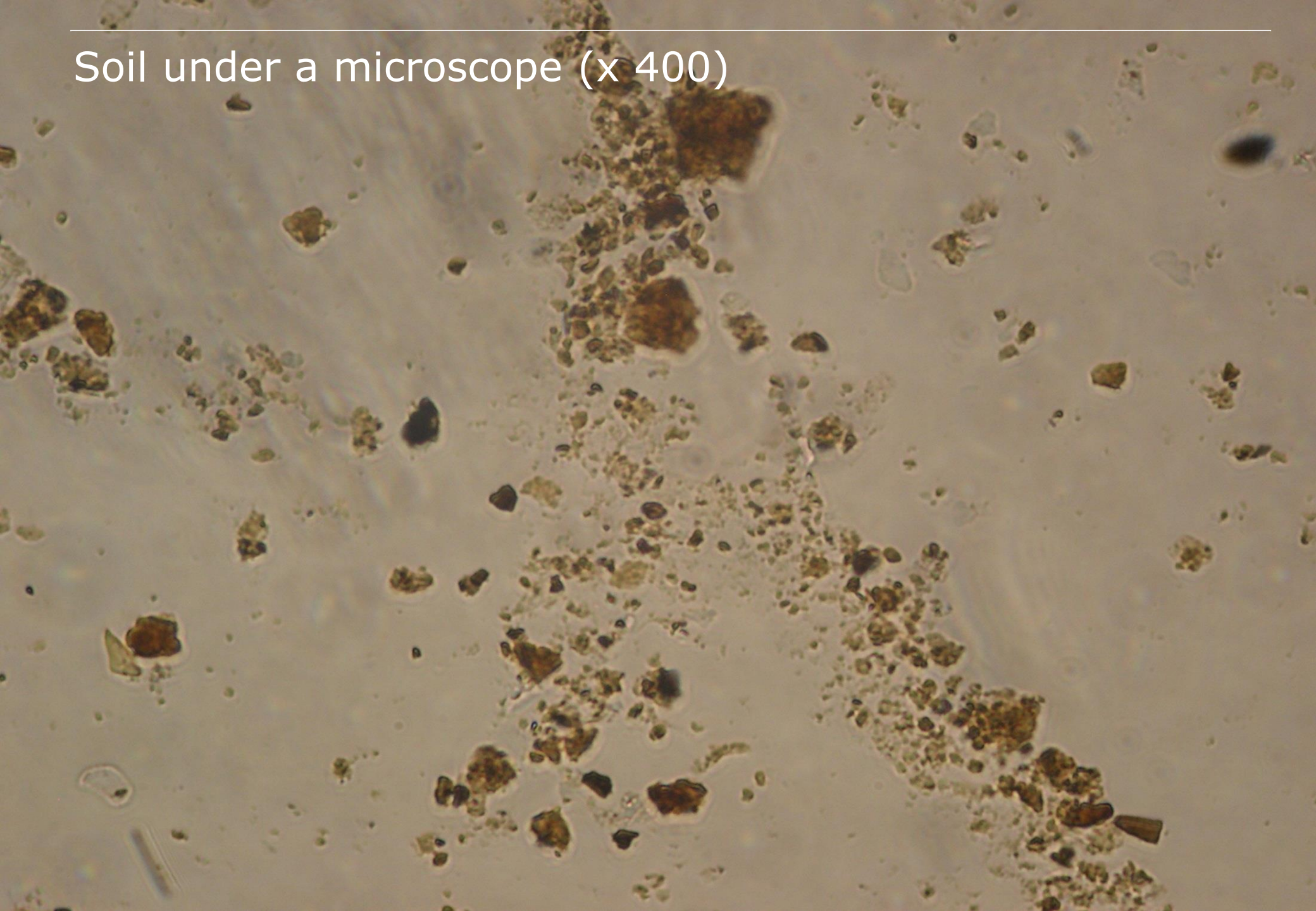


Kemmers, R. 2012. Zijn bodemorganismen van belang voor herstel van verzuurde bossen? De Levende Natuur 113, 24-28.

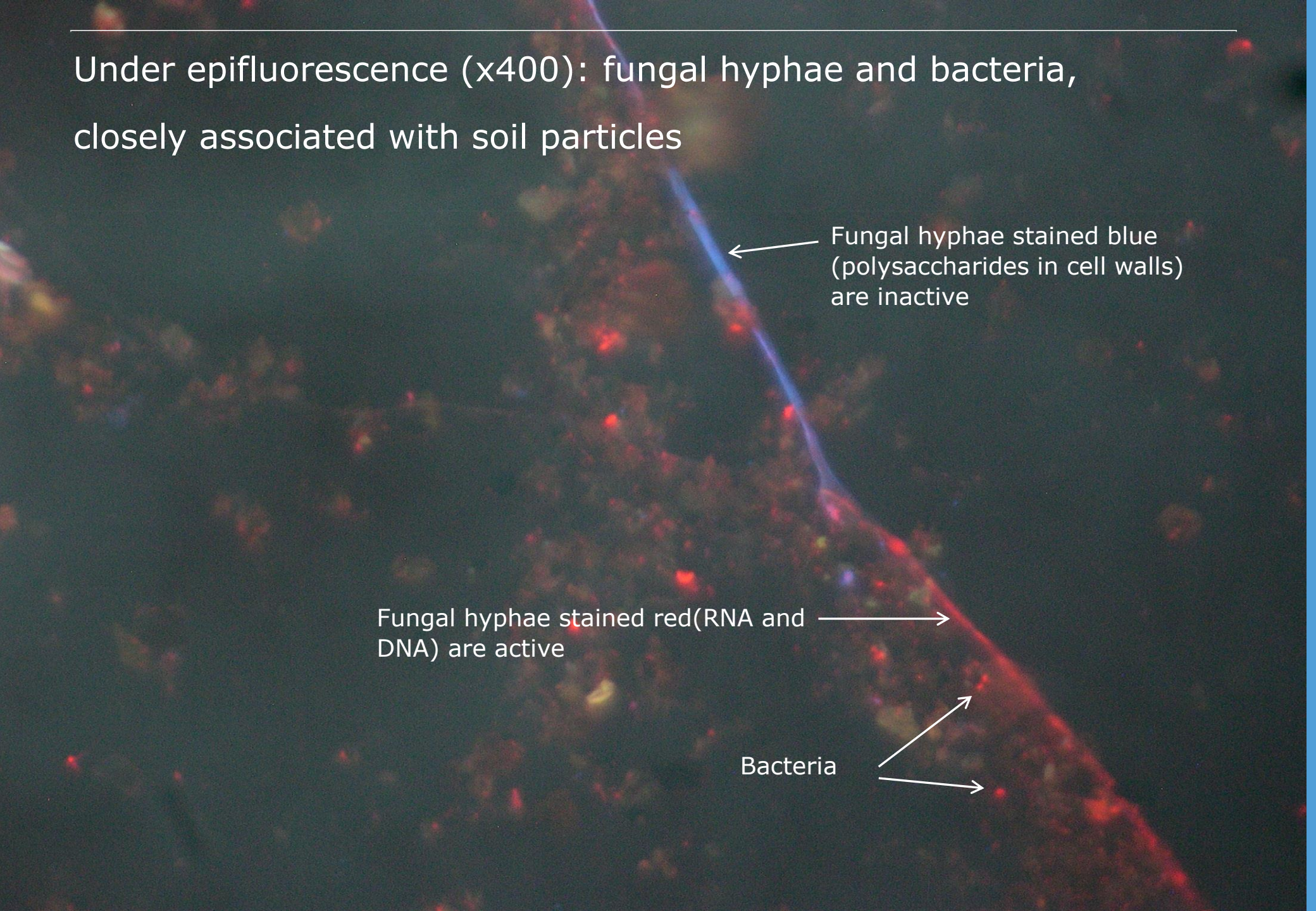
Kemmers, R.H.; Brinkman, E.P.; Bloem, J.; Faber, J.H.; Putten, van der W.H. 2011. Is bodembiodiversiteit van belang voor herstel van beekdalvegetaties? De Levende Natuur, 112, 4 - 9.

Kooijman, A.M., Kooijman-Schouten, M.M., Martinez-Hernandez, G.B. Alternative strategies to sustain N-fertility in acid and calcareous beech forests: Low microbial N-demand versus high biological activity (2008) Basic and Applied Ecology, 9, 410-421.

Soil under a microscope (x 400)



Under epifluorescence (x400): fungal hyphae and bacteria,
closely associated with soil particles



Fungal hyphae stained blue
(polysaccharides in cell walls)
are inactive

The image shows a dark background with a diagonal line of soil particles. A prominent blue-stained fungal hypha runs along this line. Numerous small red spots, representing active bacteria, are scattered throughout the soil particles, particularly concentrated near the hyphae. A few green spots are also visible.

Fungal hyphae stained red (RNA and
DNA) are active

An arrow points from this text to a red-stained section of the fungal hyphae.

Bacteria

Two arrows point from this text to individual red-stained bacterial spots.

Confocal laser scanning microscope (x 1000):

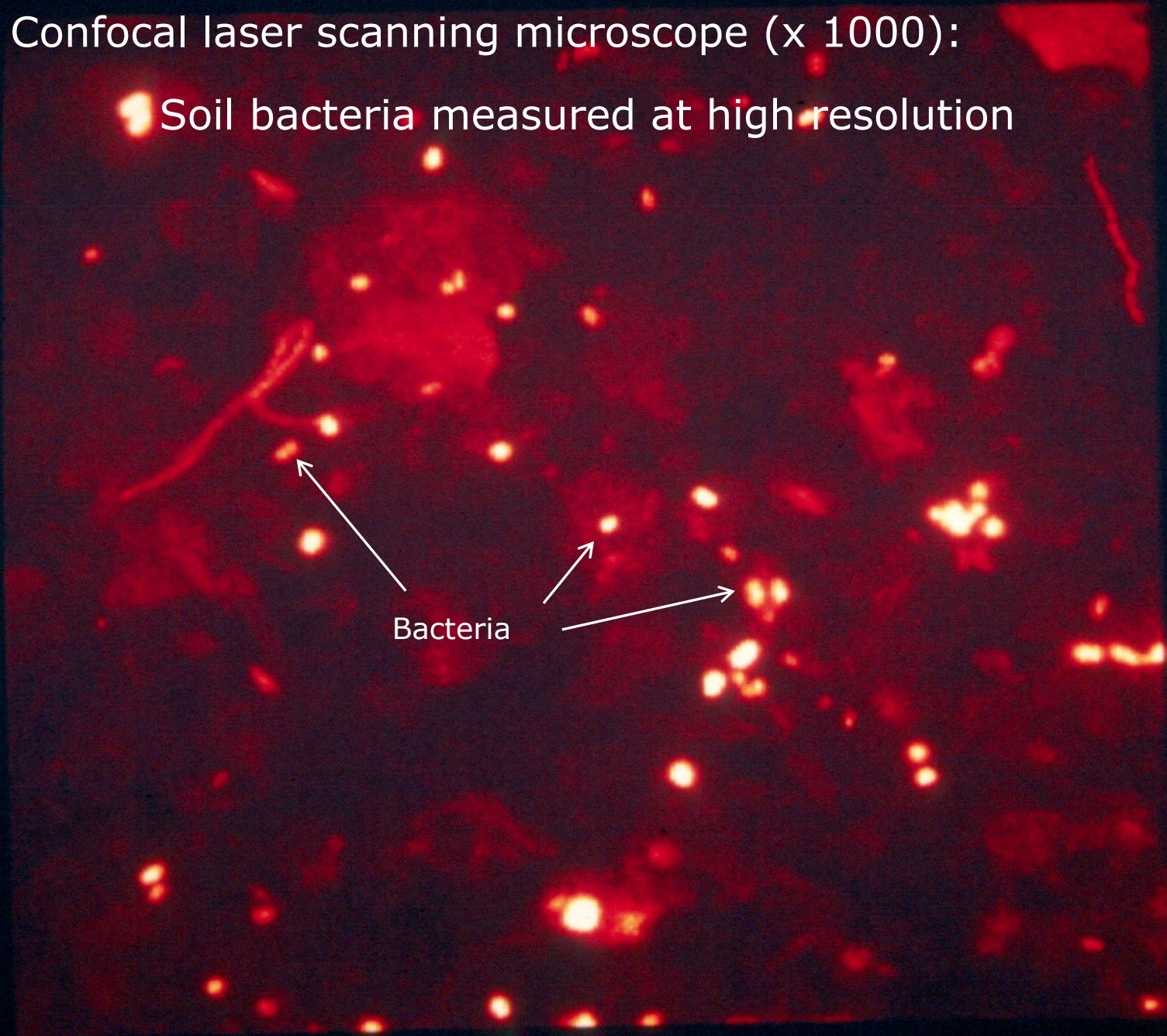
Soil bacteria measured at high resolution

fluorescence
confocal
1001.32 01L
xy:50x50 um

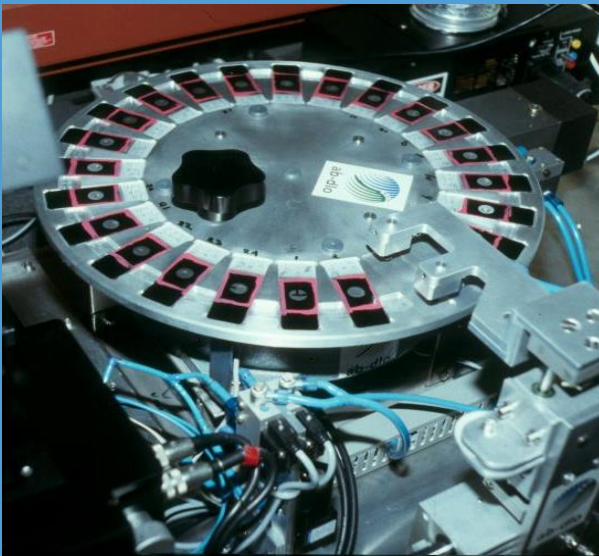
DTAF

Bacteria

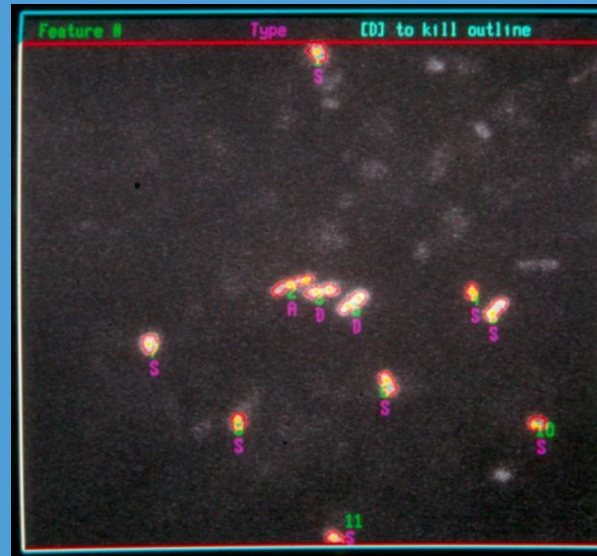
2 um



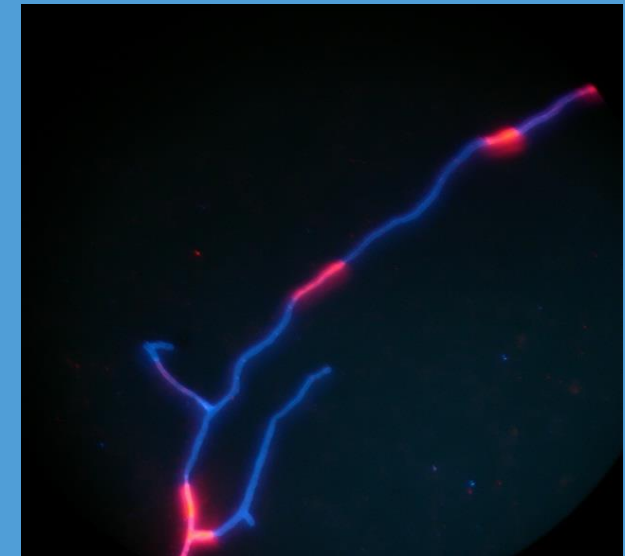
Biomass of bacteria and fungi measured by direct microscopy



Automatic scanning of soil smears



Bacteria measured by automatic image analysis



Fungal hyphae, active (red) and inactive (blue)

Bloem et al., 1995, Applied and Environmental Microbiology 61, 926-936.
Bloem, J. and A. Vos. 2004. In "Molecular Microbial Ecology Manual", 2nd edition

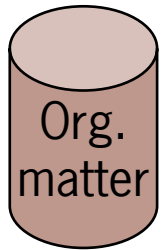
Bacterial activity

Bacterial growth rate: incorporation rate of ^3H -thymidine and ^{14}C -leucine into bacterial DNA and proteins during a short incubation (1h).
Very sensitive.



N mineralization and mineralizable N

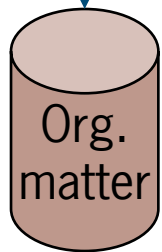
Aerobic incubation



net N mineralization

Anaerobic

-----> part of microbial biomass killed



higher N mineralization

} Difference is
proxy for
N immobilization

Microbial community structure measured by PLFA

- Phospholipid fatty acids (PLFA) are membrane components of all living cells
- Fingerprint of microbial community structure (about 30 PLFAs)
- Biomarkers: fungi, total bacteria, major groups of bacteria (actinomycetes, Gram +, Gram -,...)

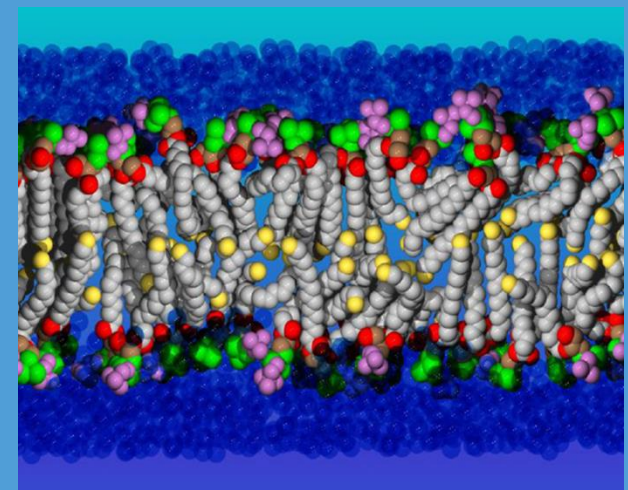


Image courtesy of Wikimedia Commons under the GNU Free Documentation License

Microbial biomass

- Direct microscopy (may be combined with automatic image analysis): number and body size (biomass) of different functional groups i.e. fungi, bacteria, protozoa....; biomass calculated from biovolume
- Chloroform fumigation extraction (CFE): soil is fumigated with chloroform, increase in extractable organic carbon (and nitrogen) is a measure of total microbial biomass (C and N)
- Amounts of PLFA also used as proxy for biomass

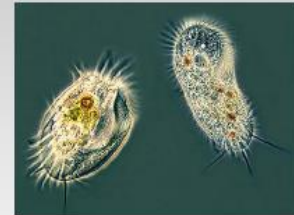
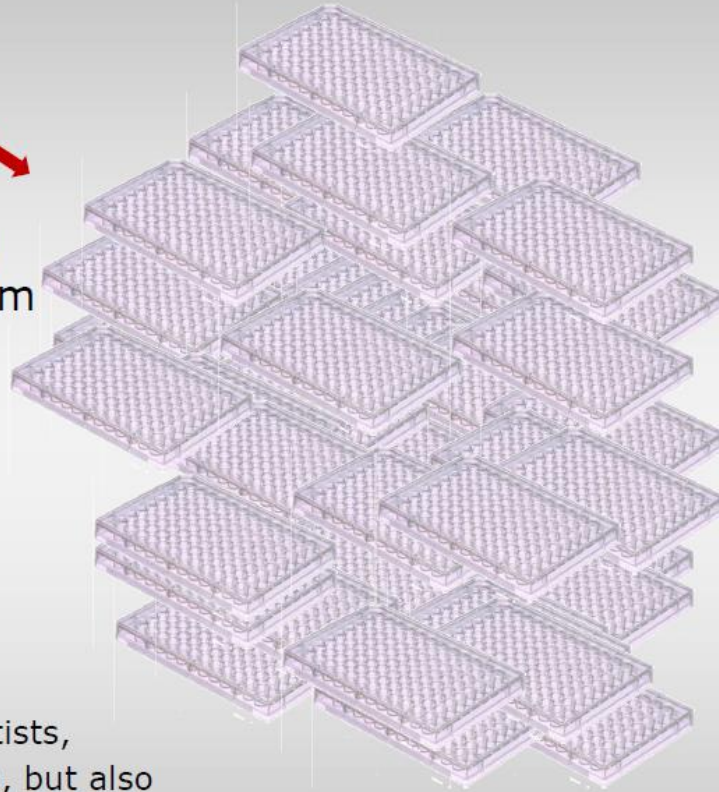
Protozoën geteld na seriële verdunning in voedingsmedium

(next figures: Dr. Anna Maria Fiore-Donno, University of Cologne)



soil suspended
in some medium

Most Probable Number



Ciliaten



Schaal-amoebe



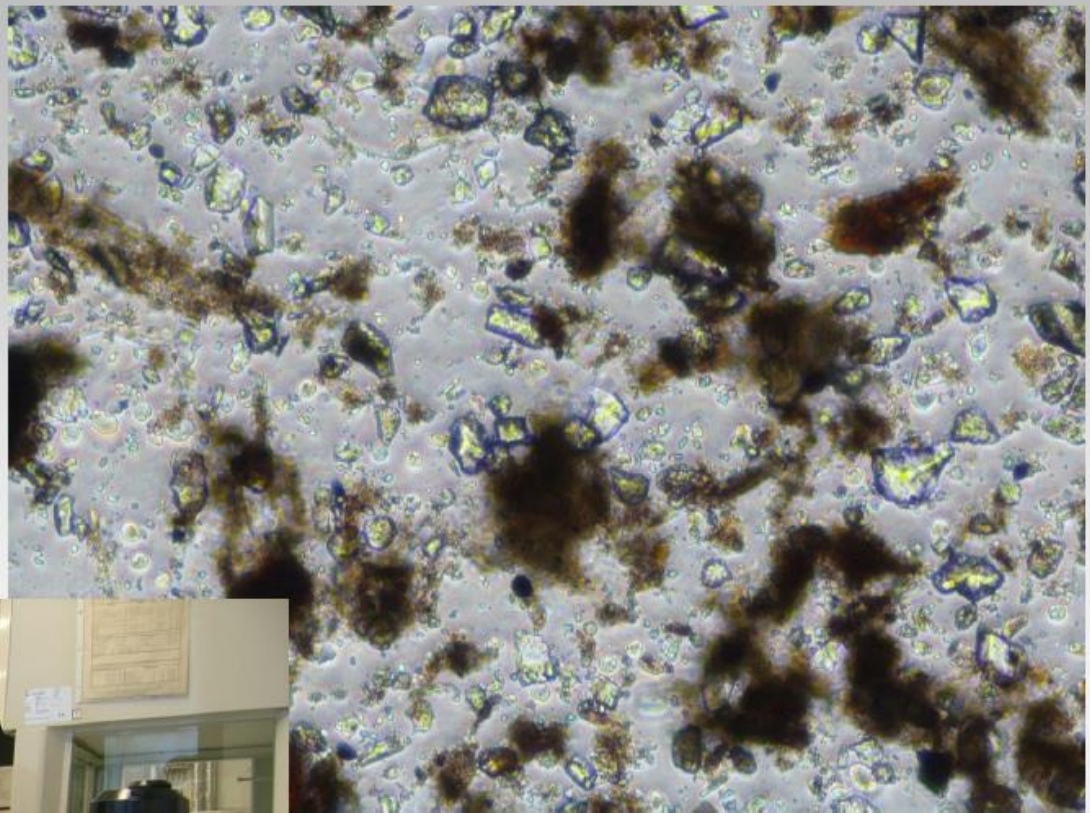
Amoebe



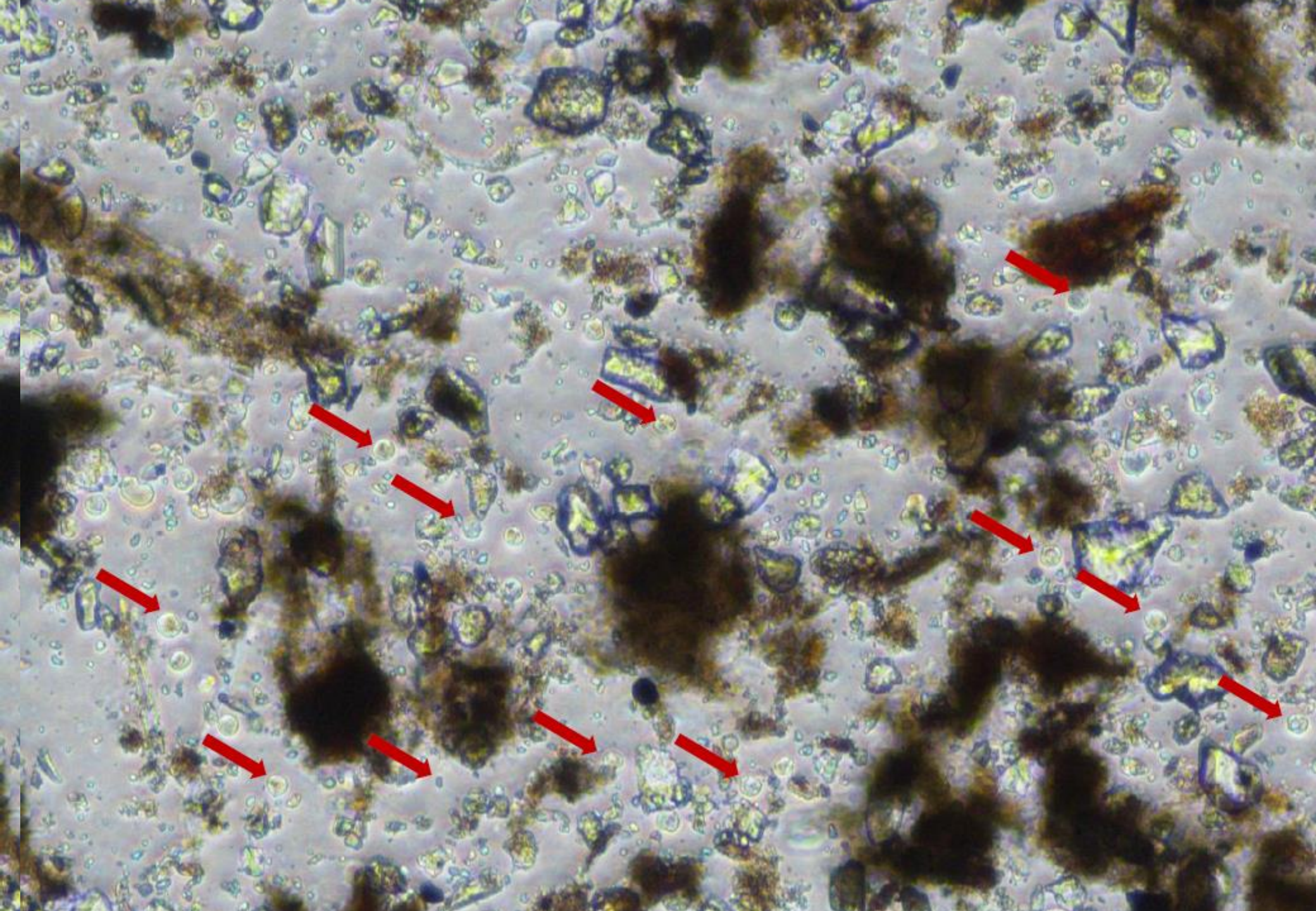
flagellaat

When applied to protists,
not only the medium, but also
the available food influence the outcome.
Observation possible only after some days,
protists need some time to multiply

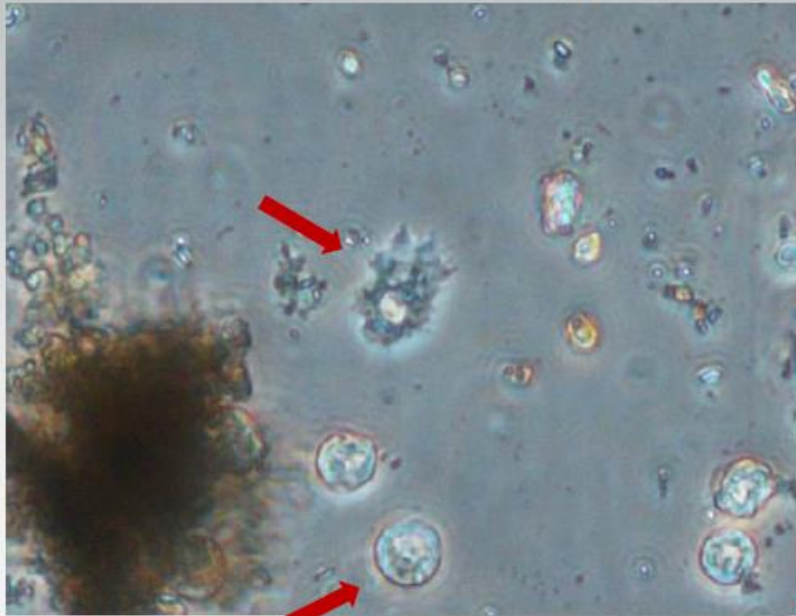
A difficult and repetitive task



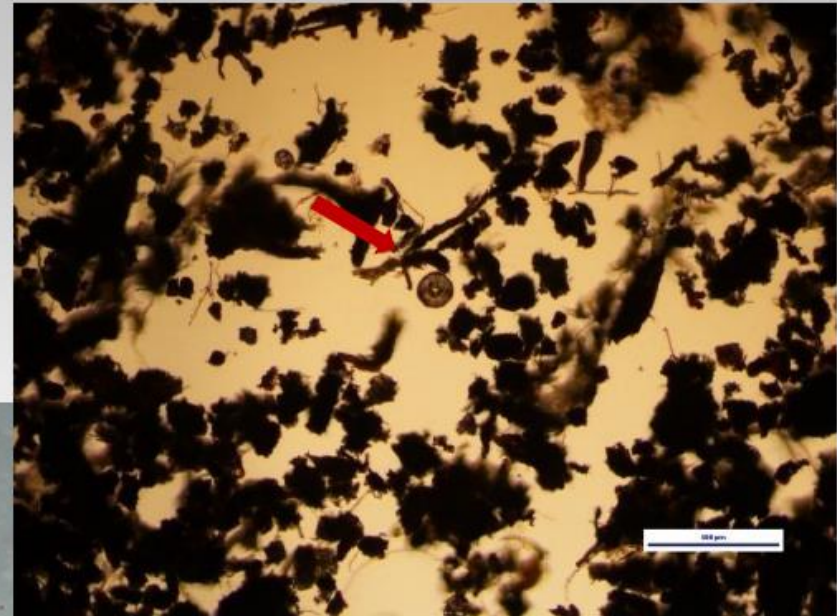
... that is what they see



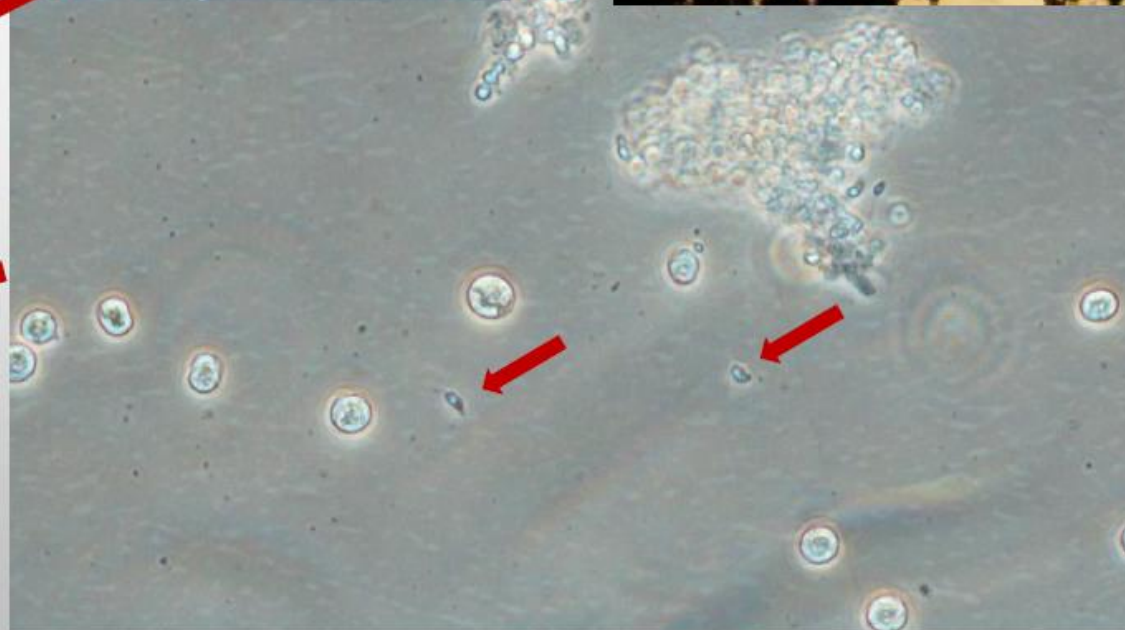
Acanthamoeba sp.



Testate amoeba (Arcellina)

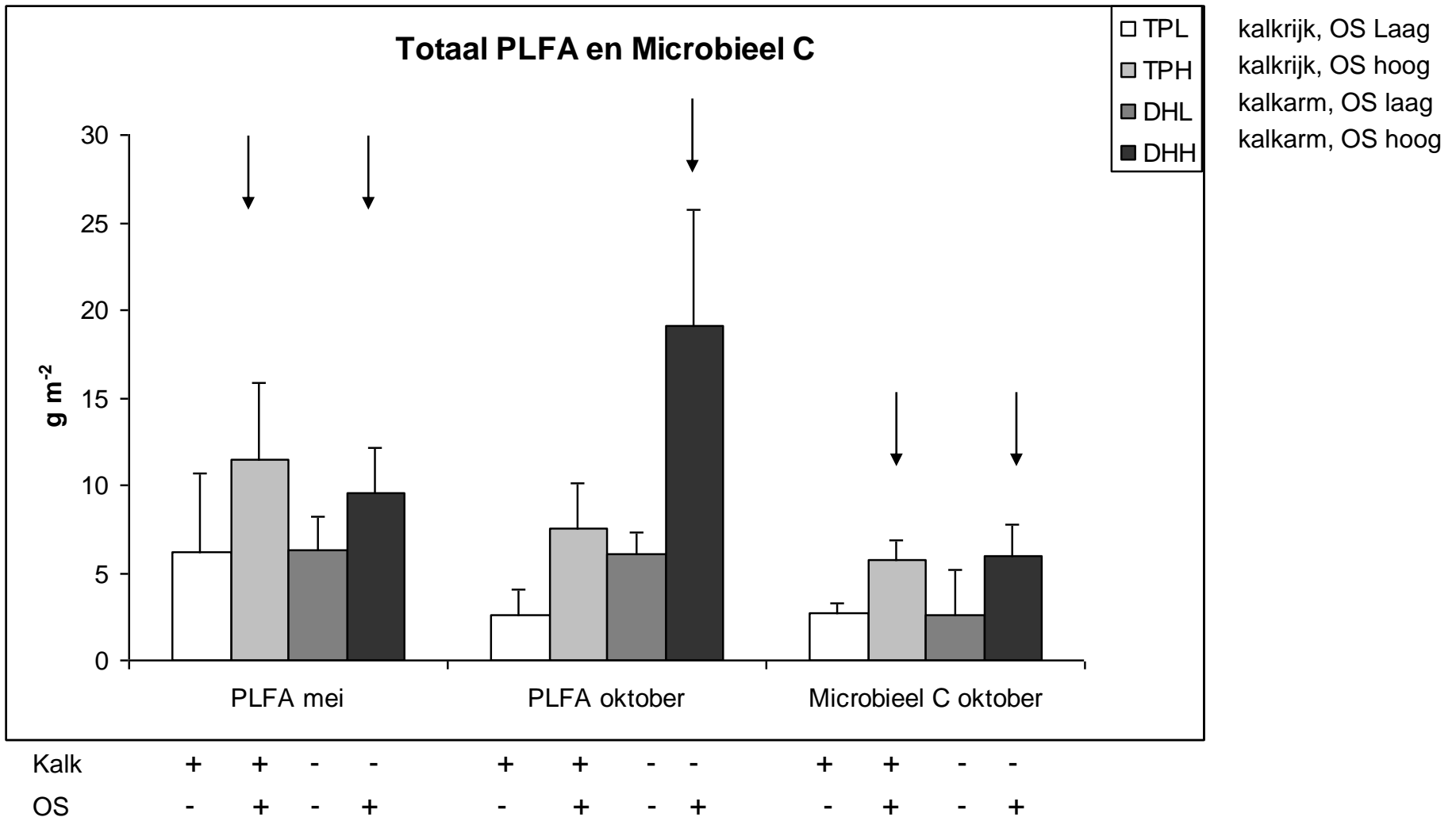


Testate amoebae (Rhizaria)



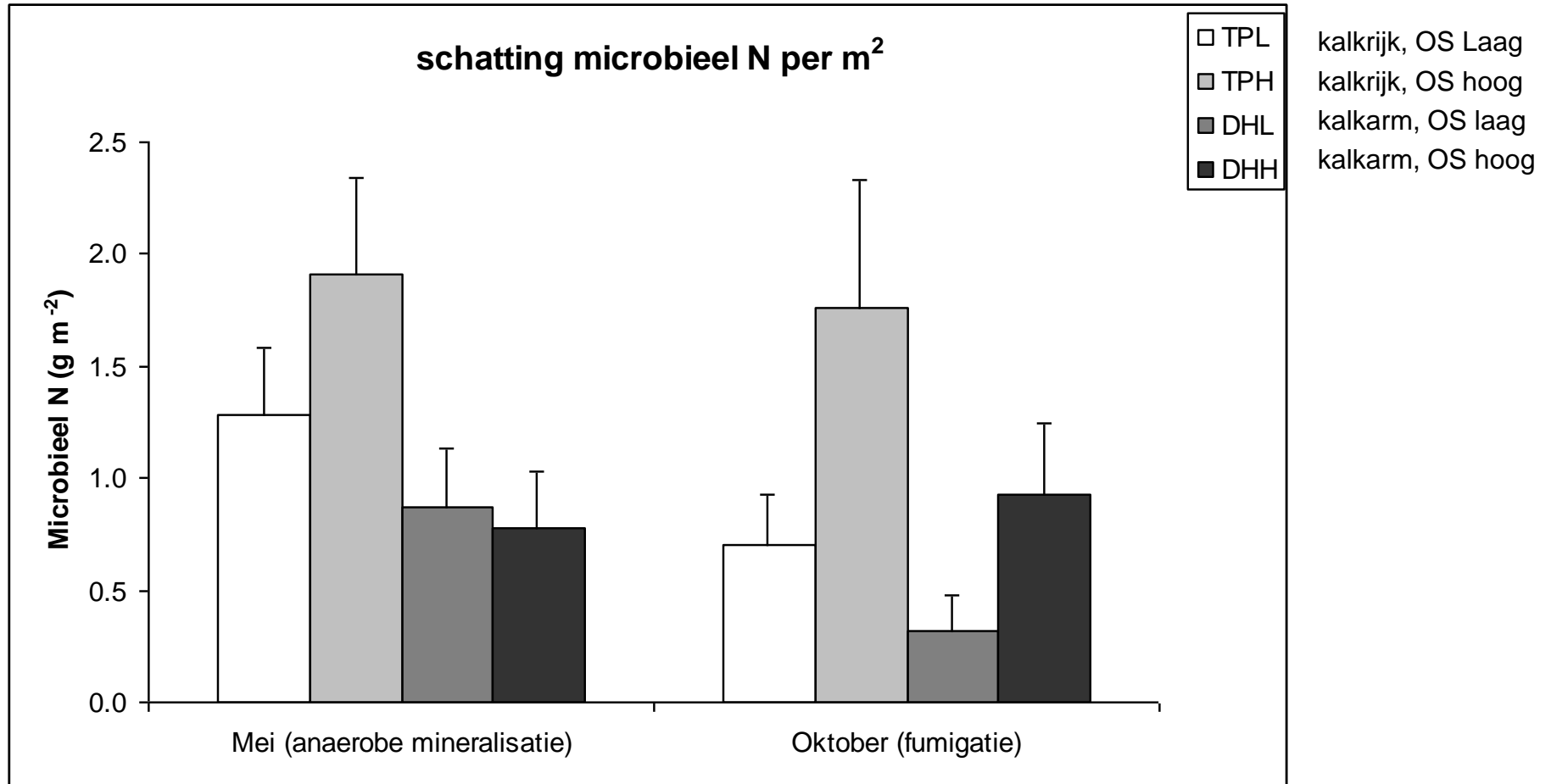
Flagellates (Cerczoa)

Microbiële biomassa C en PLFAs hoger met meer organische stof, geen effect van kalk



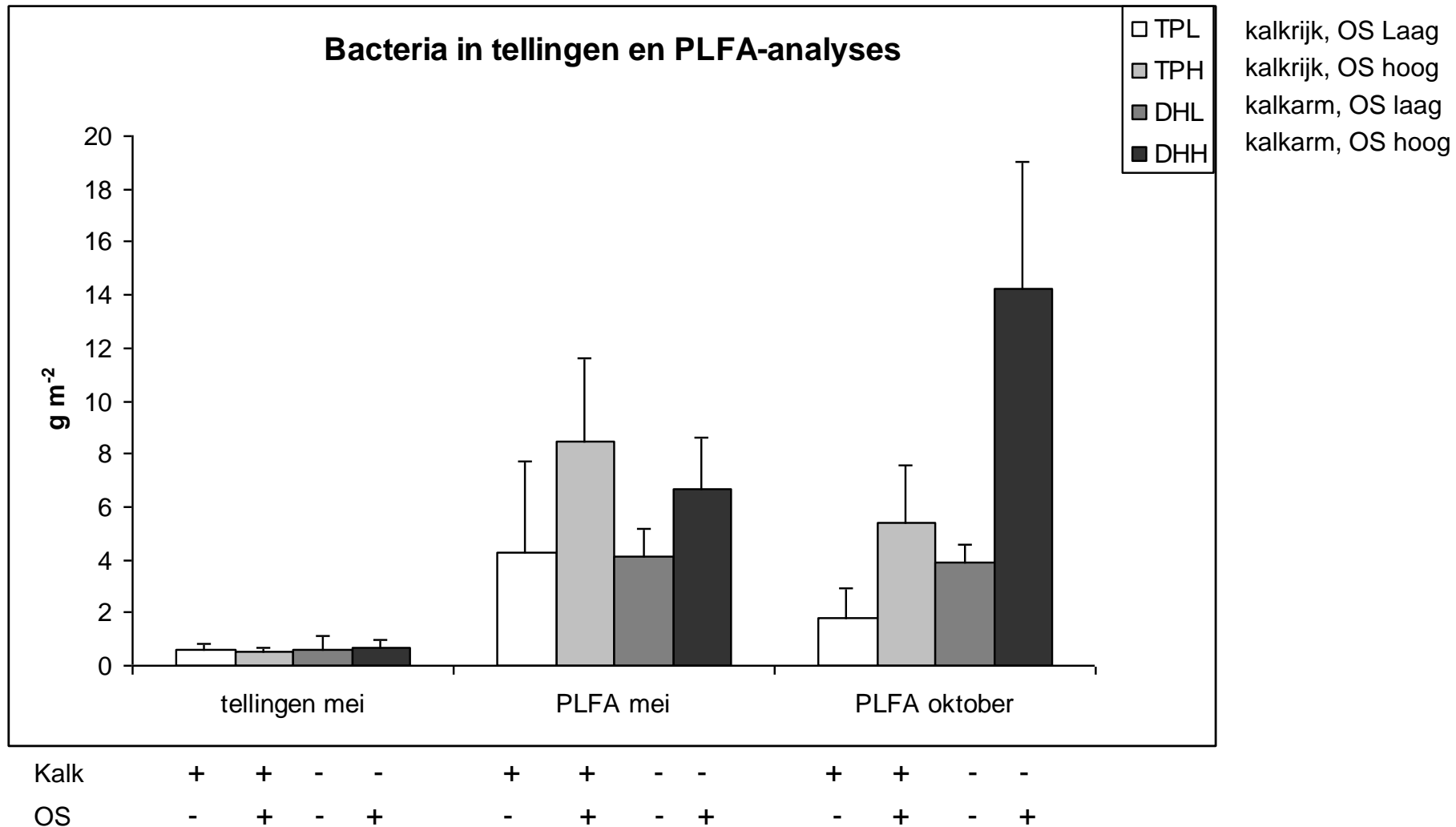
Microbiële biomassa-N

Hoger met kalk (en met organische stof in oktober)

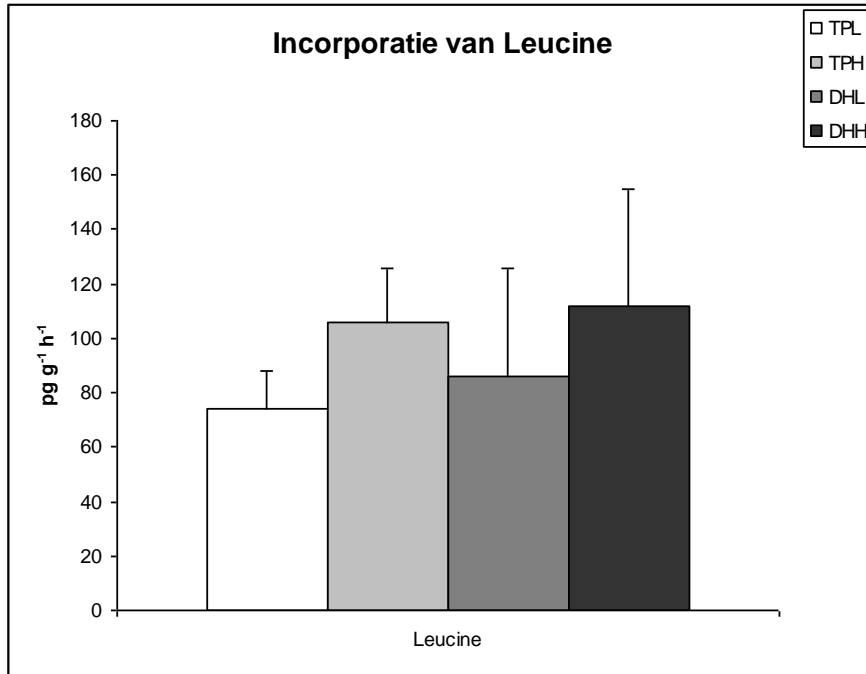


Kalk	+	+	-	-	+	+	-	-
OS	-	+	-	+	-	+	-	+

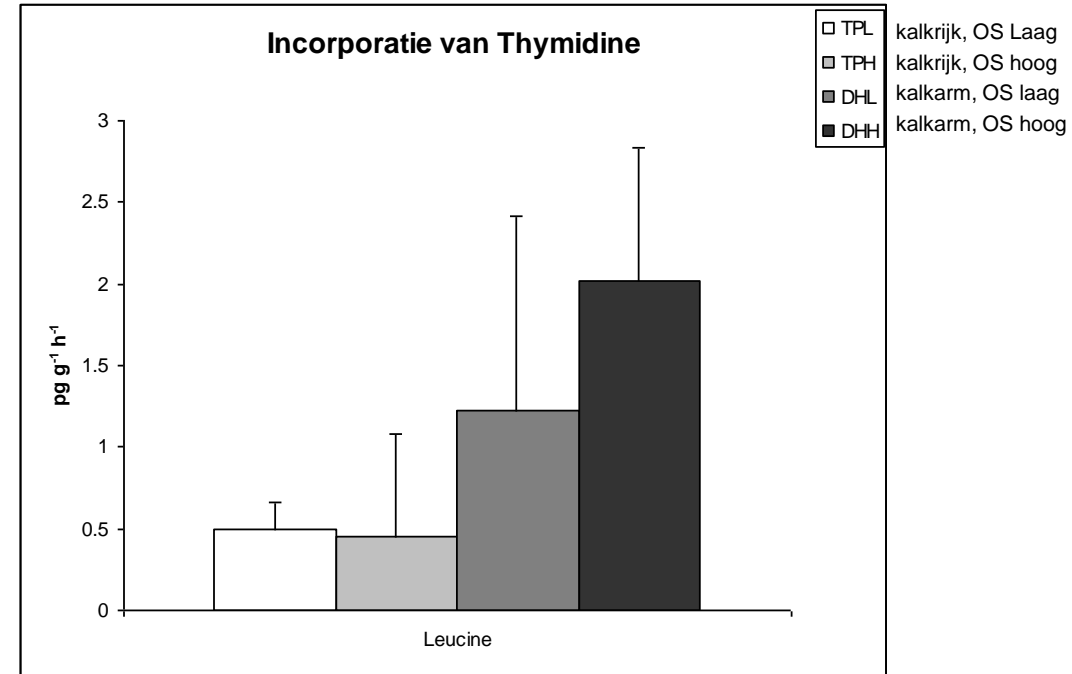
Bacteriebiomassa: PLFA hoger met meer organische stof microscopische tellingen zeer laag



Bacteriële productie: DNA synthese (thymidine inbouw) *hoger* in kalkarm, alle waarden erg laag



kalk	+	+	-	-
OS	-	+	-	+

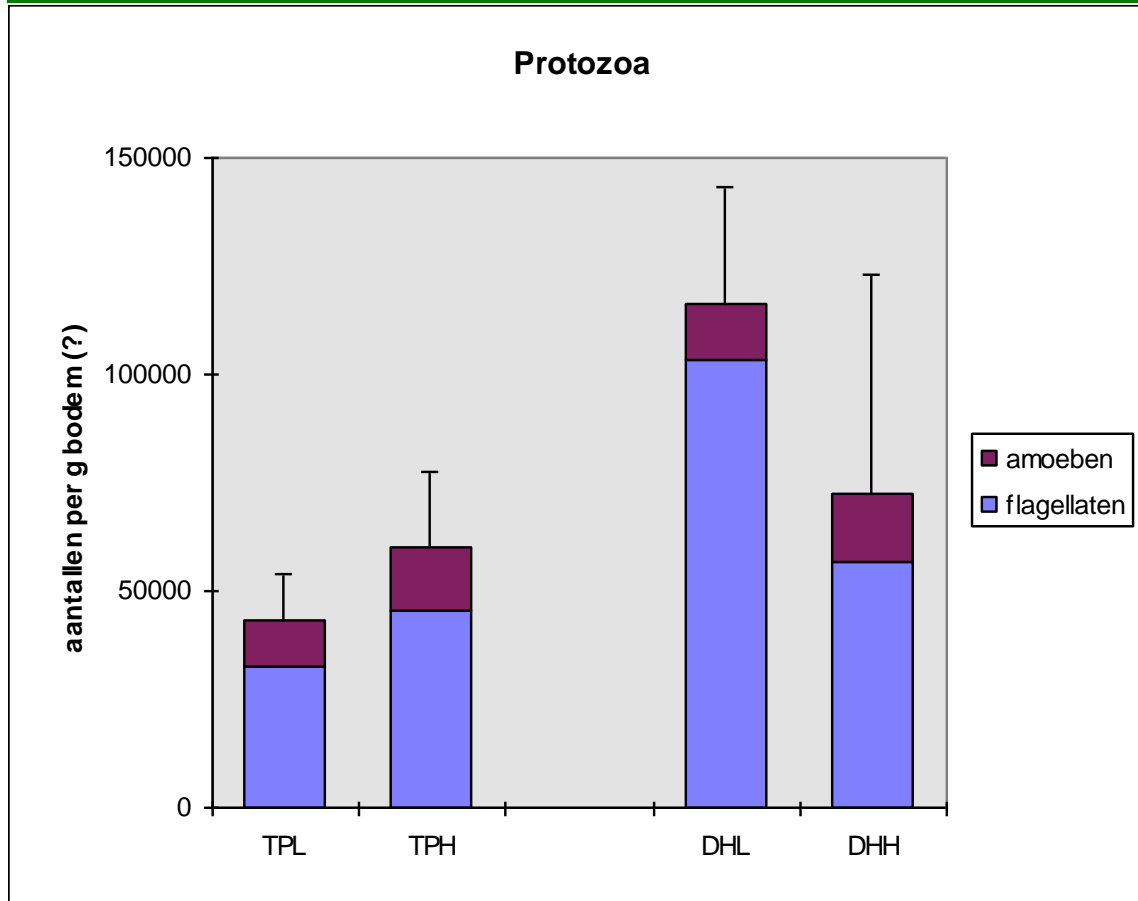


kalk	+	+	-	-
OS	-	+	-	+

□ TPL kalkrijk, OS Laag
 □ TPH kalkrijk, OS hoog
 ■ DHL kalkarm, OS laag
 ■ DHH kalkarm, OS hoog

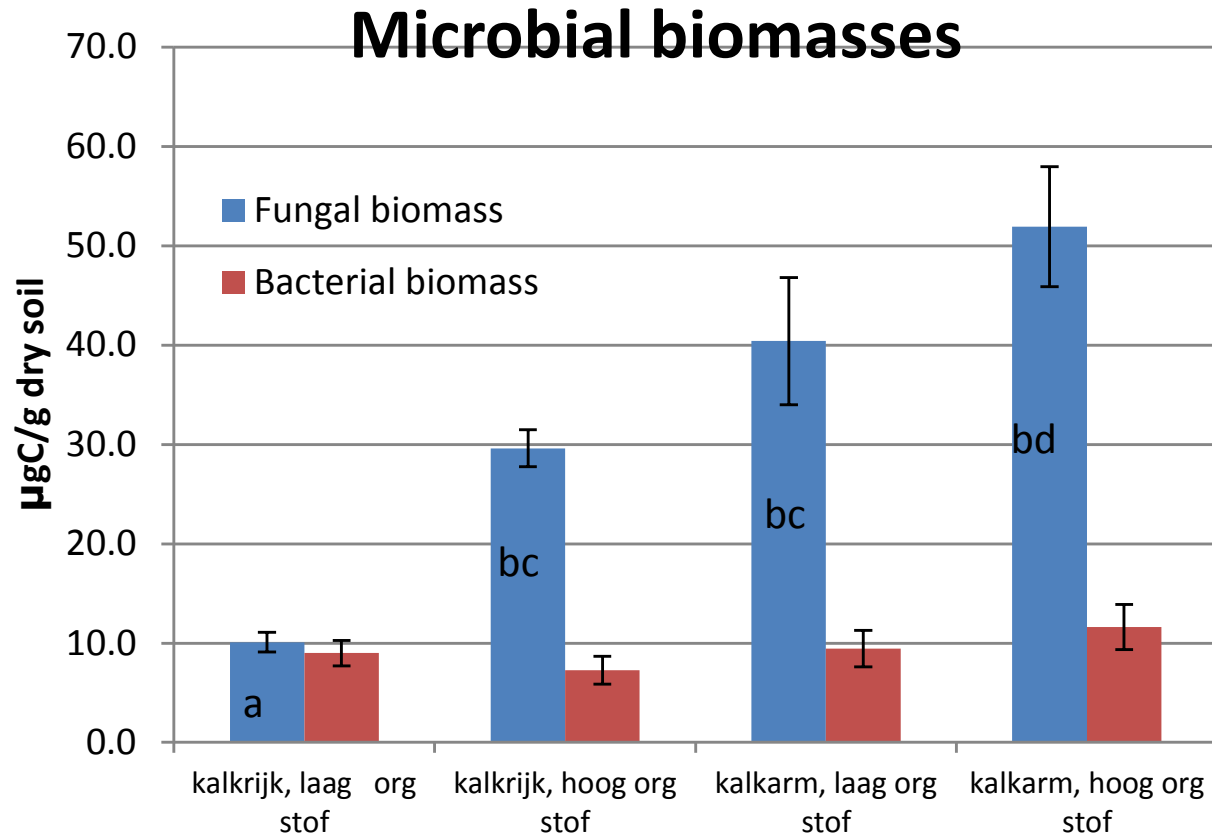
Protozoën

meer flagellaten in kalkarme bodem, komt overeen met bacterieproductie

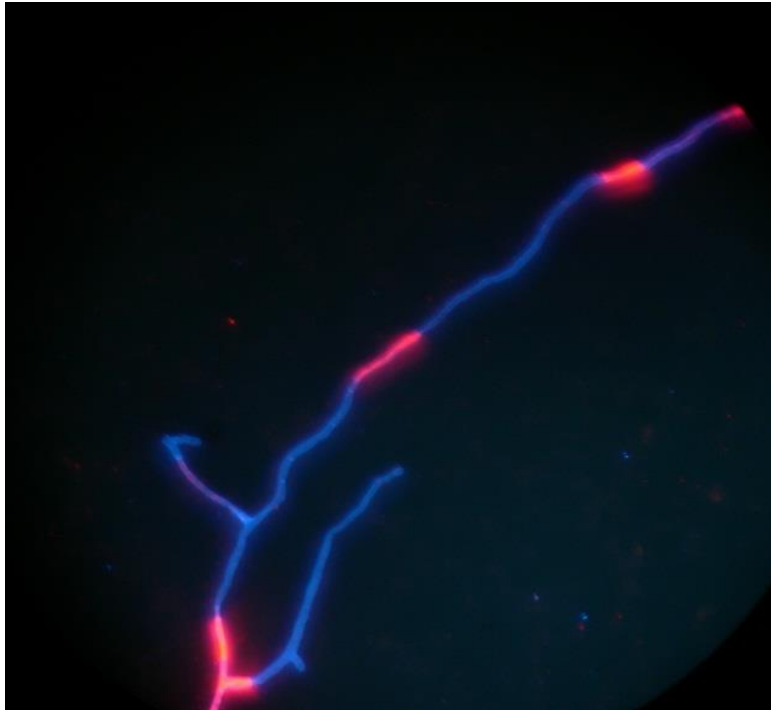


kalk	+	+	-	-
OS	-	+	-	+

Biomassa van schimmels en bacteriën (microscopische metingen) schimmel-gedomineerde bodems



Gekleurde (hyaline) en ongekleurde (melanine) schimmels

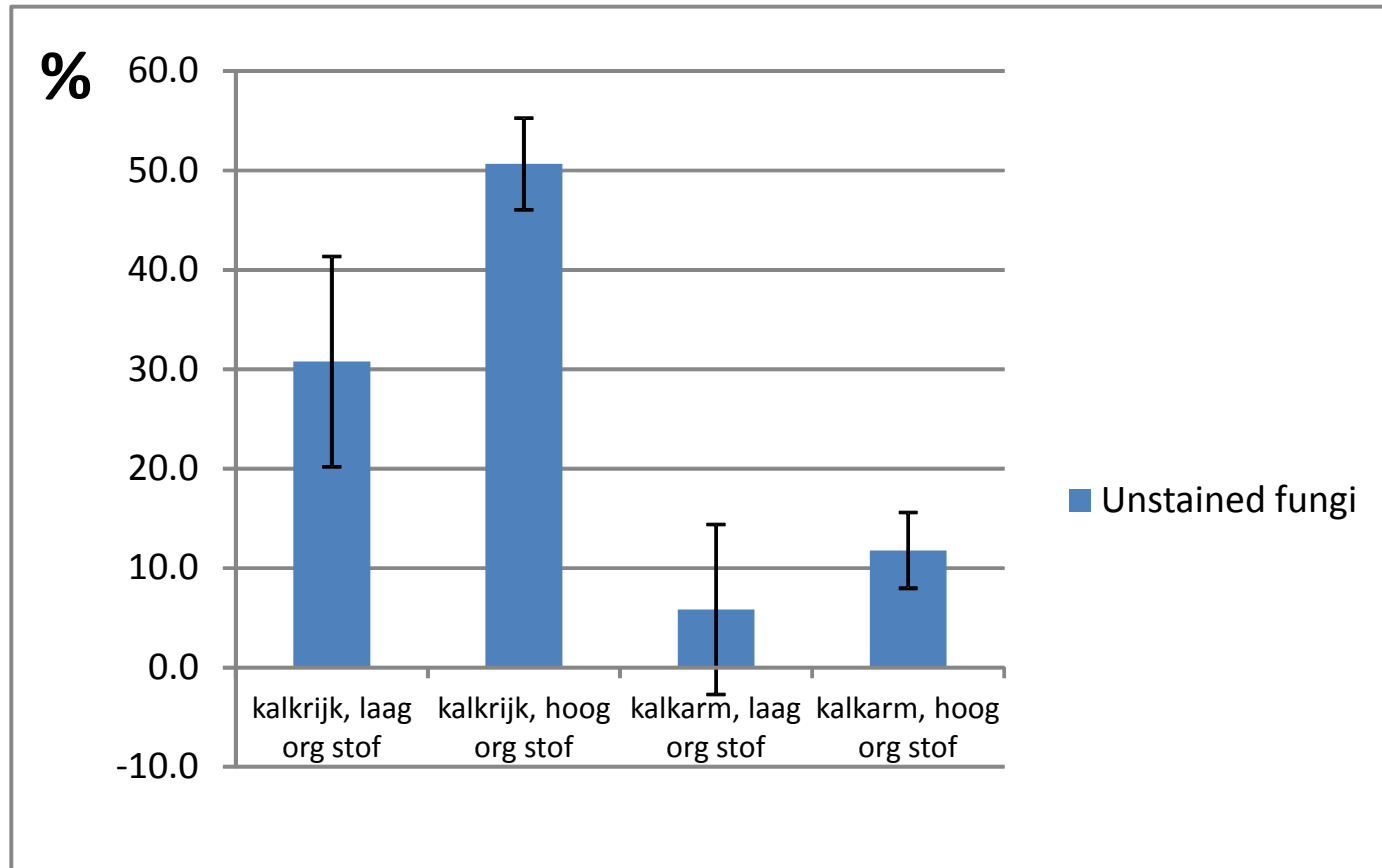


Melanine is donker pigment in celwanden

bescherming tegen stress: straling, hitte, droogte, antagonisten, infecties en grazers

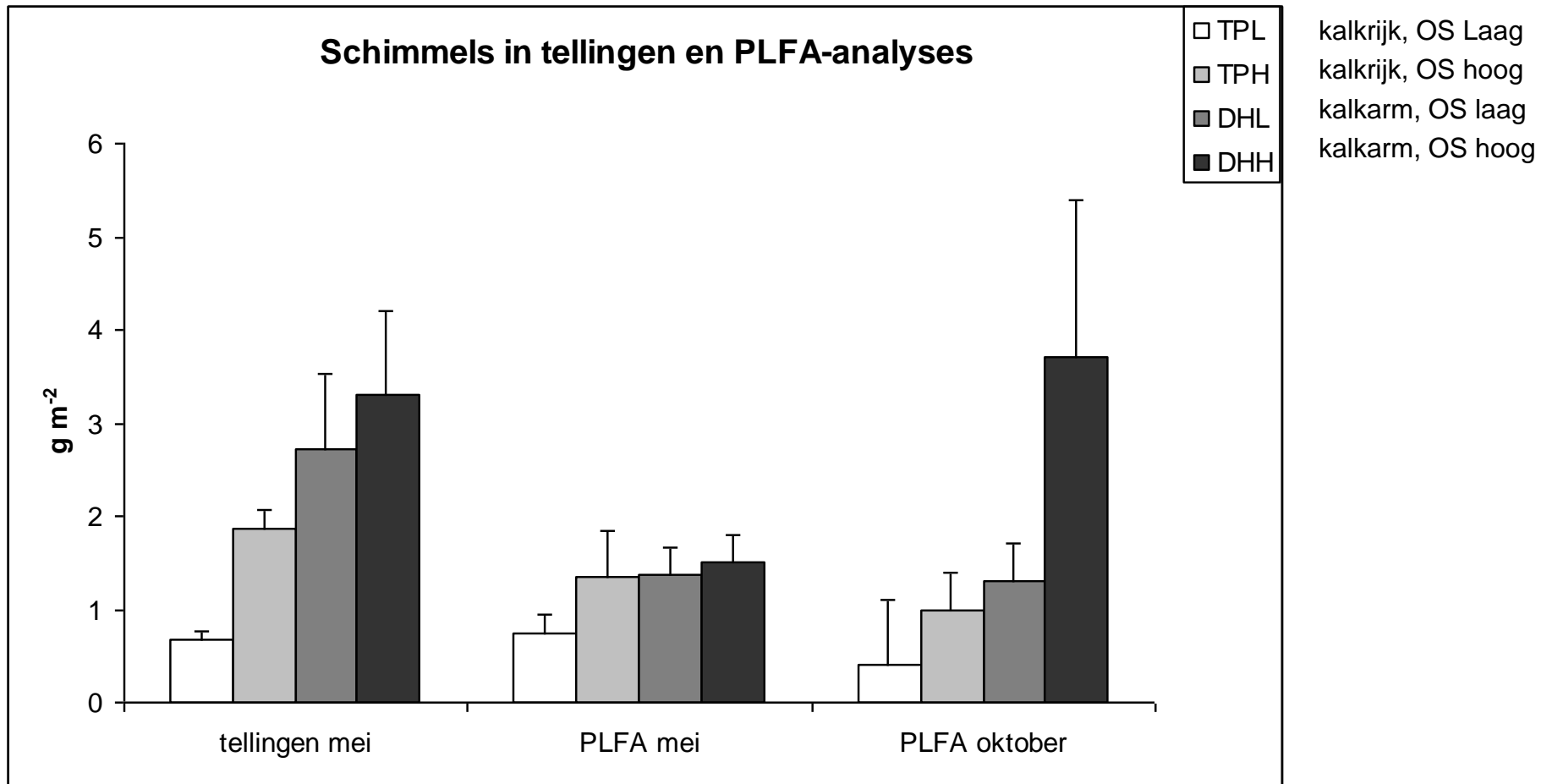
complexe ringstructuren, moeilijk afbreekbaar, vertraagt afbraak necromassa, speelt rol bij humusvorming

Kalkrijke bodem meer (niet gekleurde) melanine schimmels



Schimmelbiomassa

Hoger in kalkarme bodem, neemt toe met organische stof



Kalk	+	+	-	-	+	+	-	-	+	+	-	-
OS	-	+	-	+	-	+	-	+	-	+	-	+

□ TPL kalkrijk, OS Laag
 ◻ TPH kalkrijk, OS hoog
 ◼ DHL kalkarm, OS laag
 ◼ DHH kalkarm, OS hoog

Conclusies

- Microbiële biomassa neemt toe met organische stof
- Kalk geen effect op biomassa C
- Kalkrijke bodem
 - meer biomassa N
 - meer mineraliseerbare N
 - groter aandeel melanine schimmels
- Kalkarme bodem
 - meer schimmels
 - hogere bacteriële groeisnelheid (celproductie)
 - meer flagellaten (bacterivore protozoën)
- Microbiële biomassa sterk gedomineerd door schimmels, bacterie activiteit laag:
 - wijst op weinig N vastlegging via bacteriële voedselweb.
 - mogelijk wel N vastlegging via schimmels (celwanden en residuen)