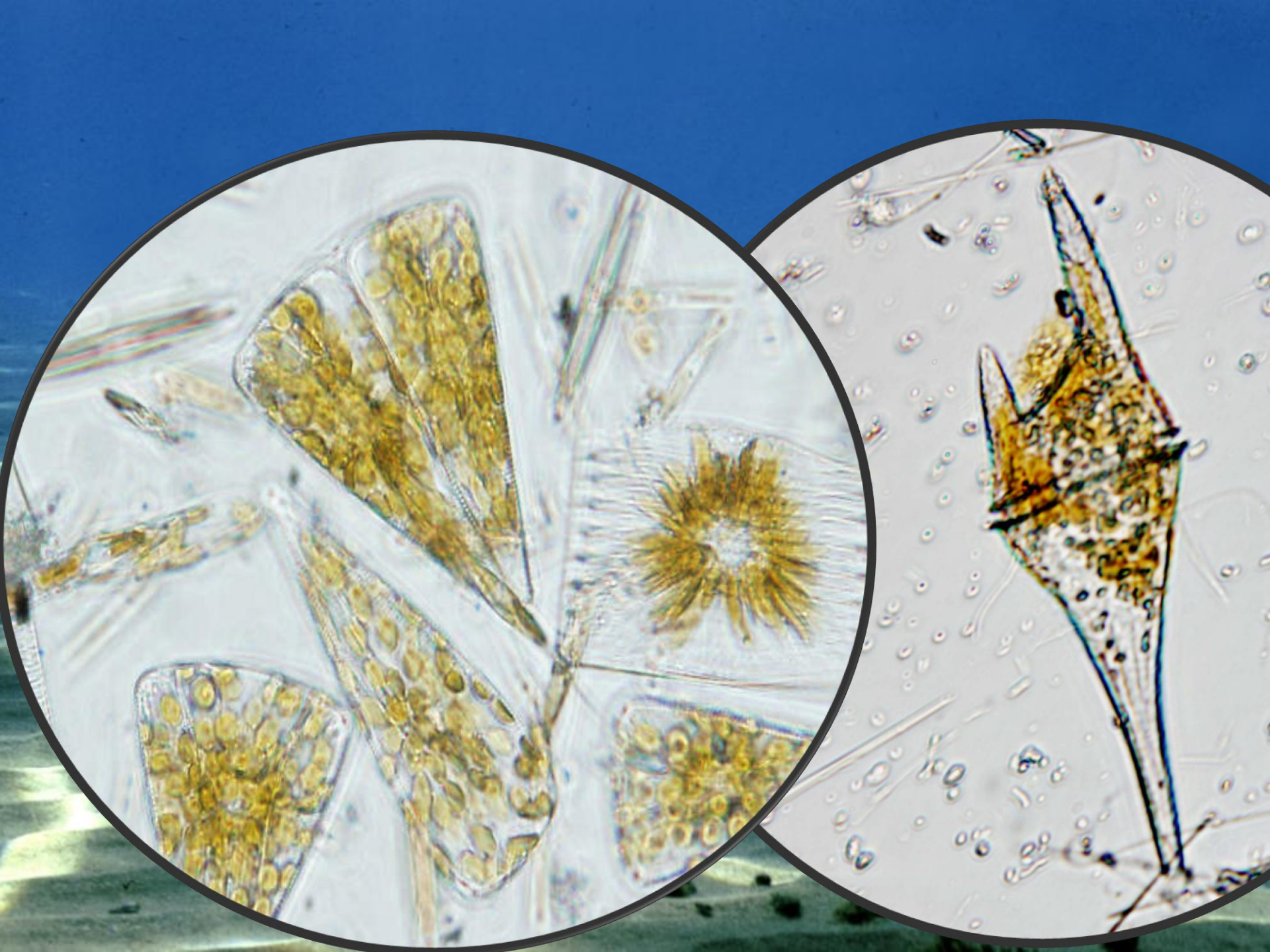
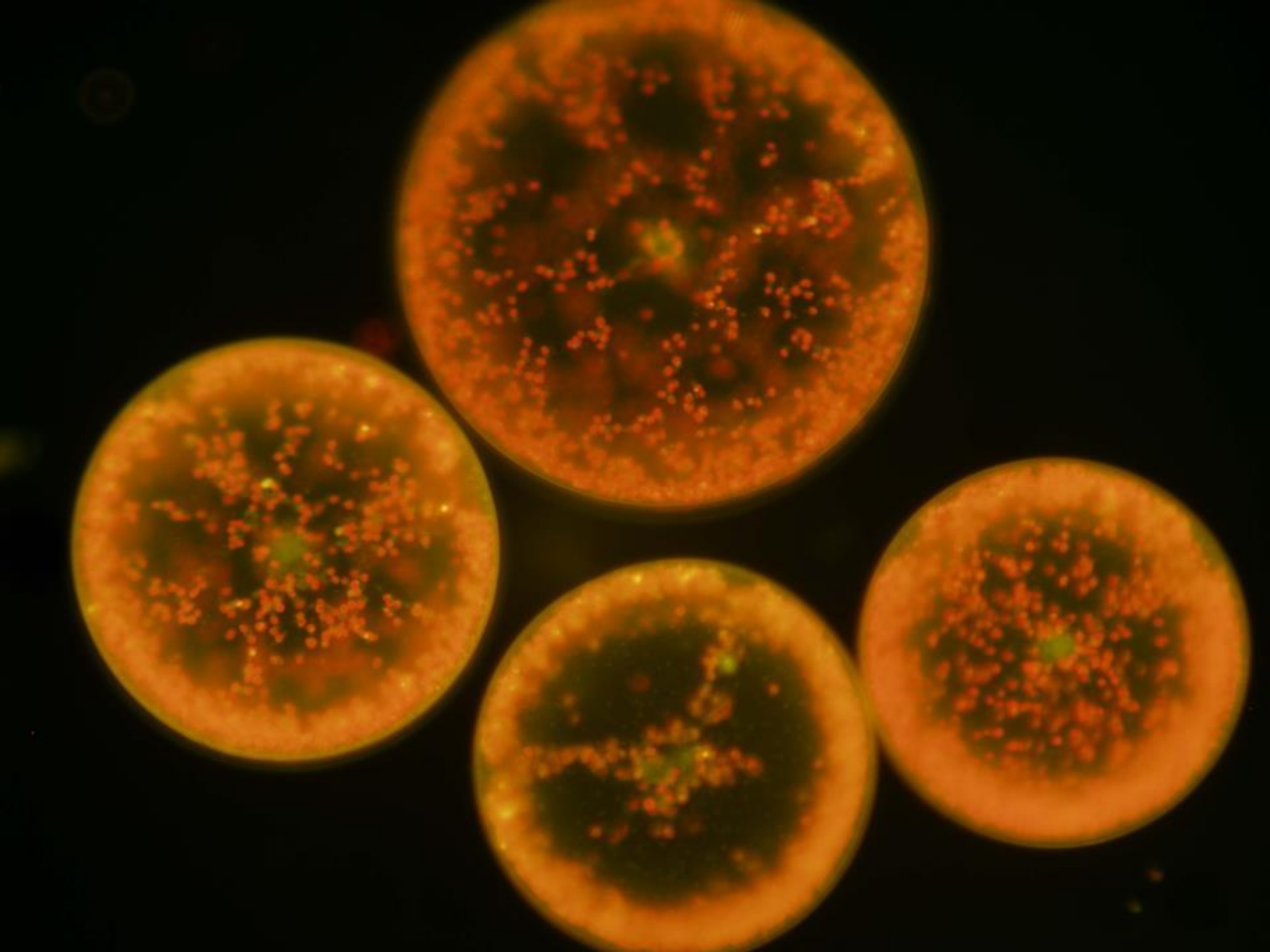
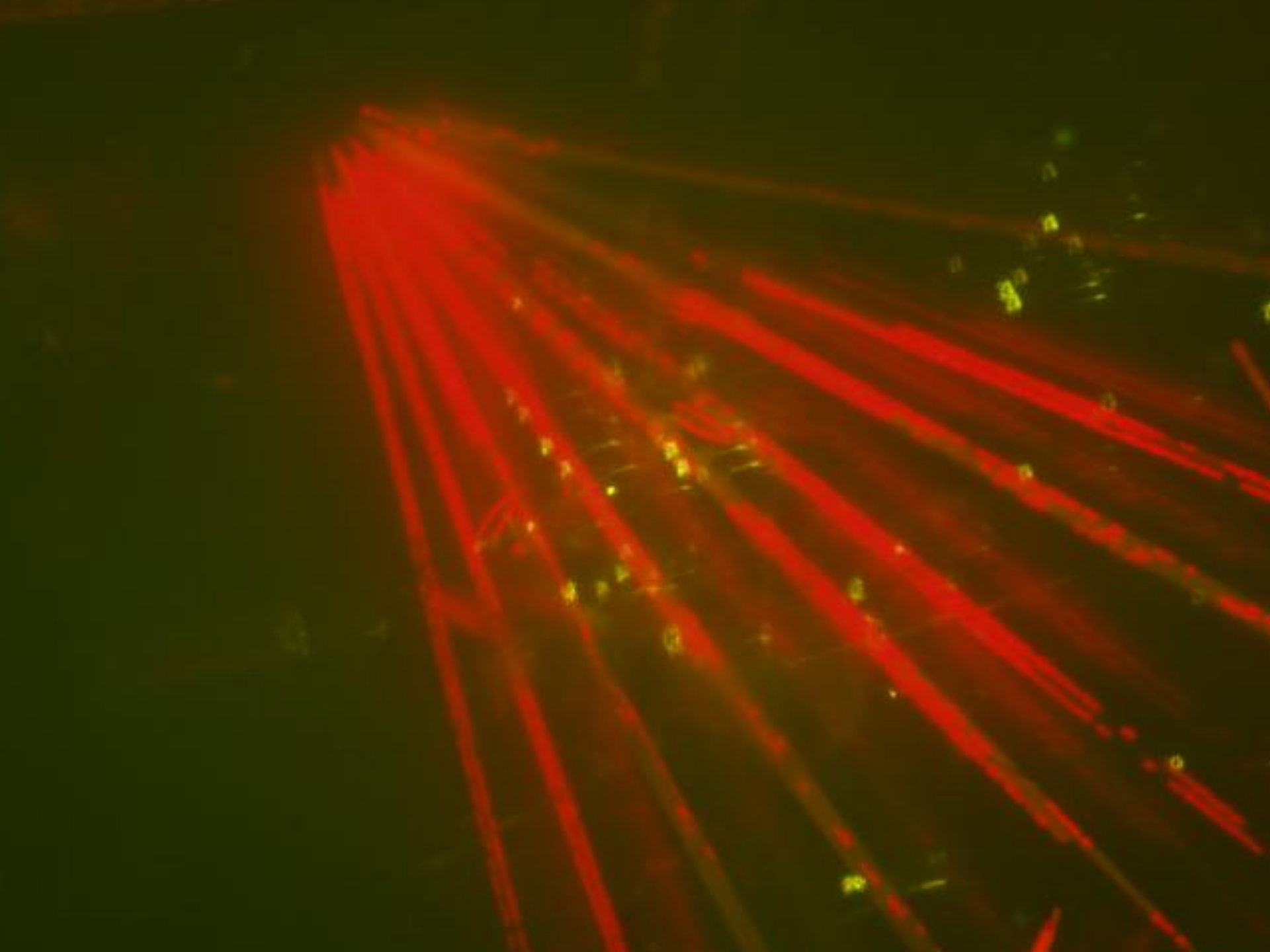
POMEN MIKROBOV V MORJU

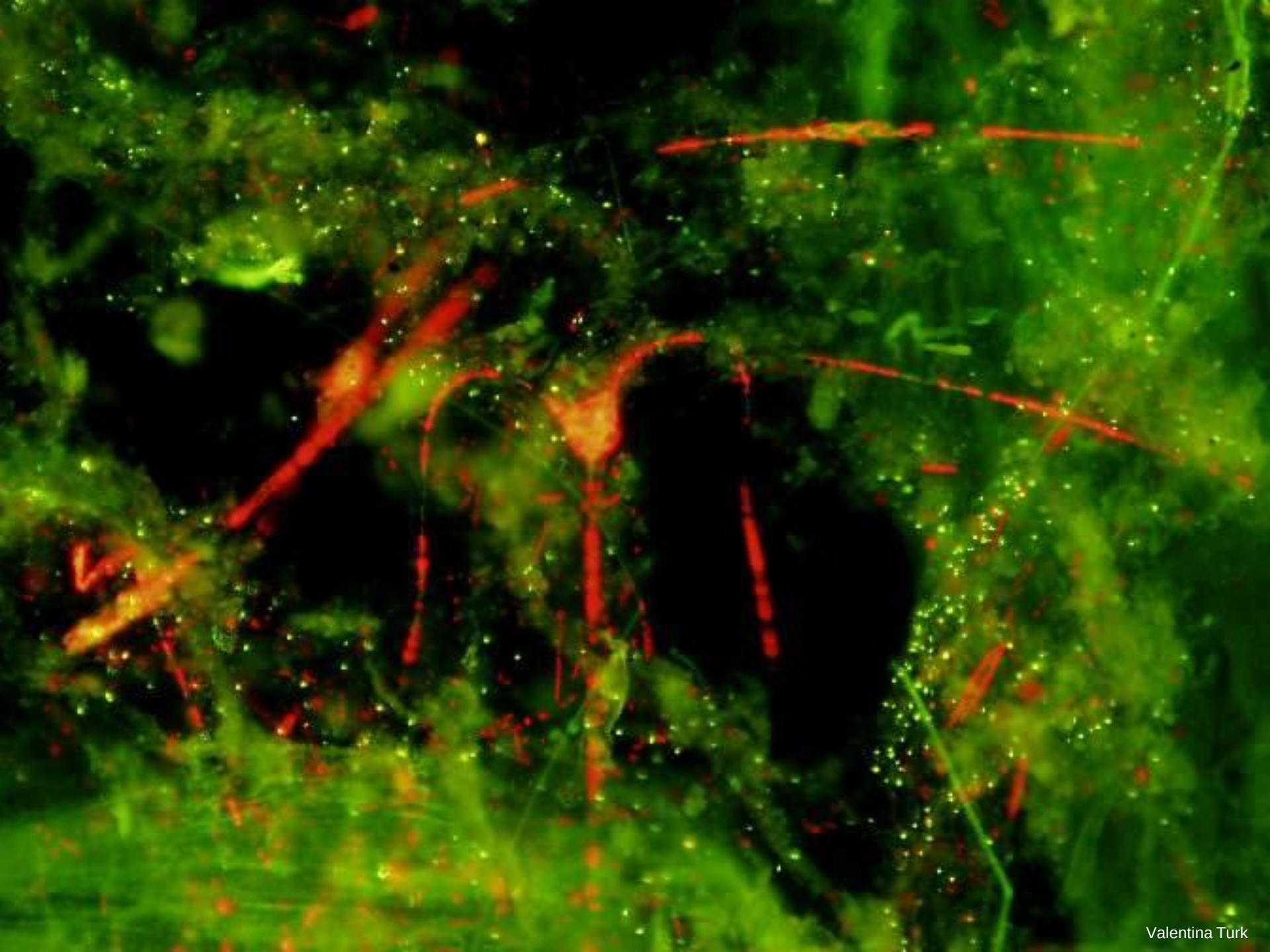
VALENTINA TURK

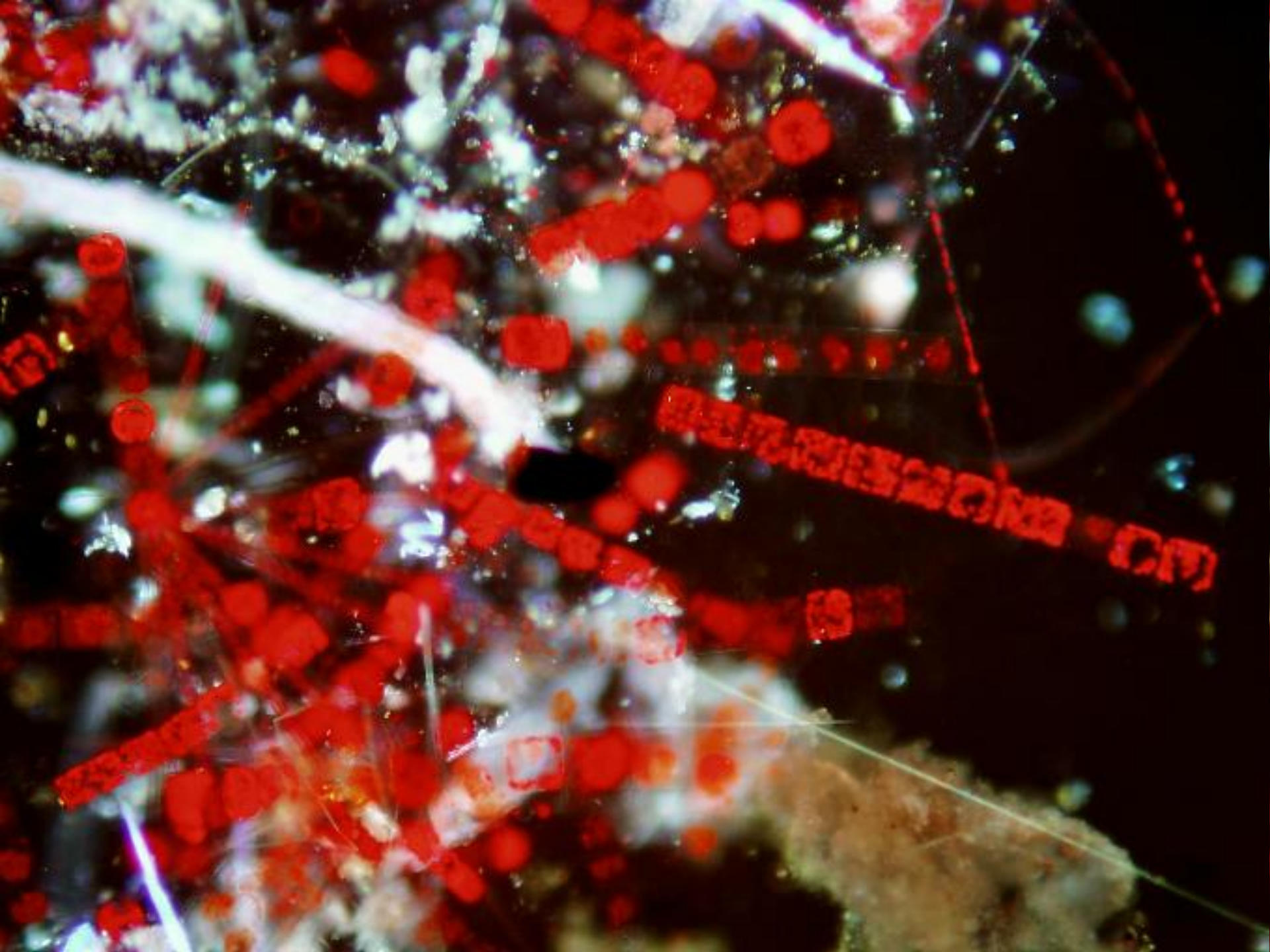
NACIONALNI INŠTITUT ZA BIOLOGIJO, MORSKA BIOLOŠKA POSTAJA PIRAN

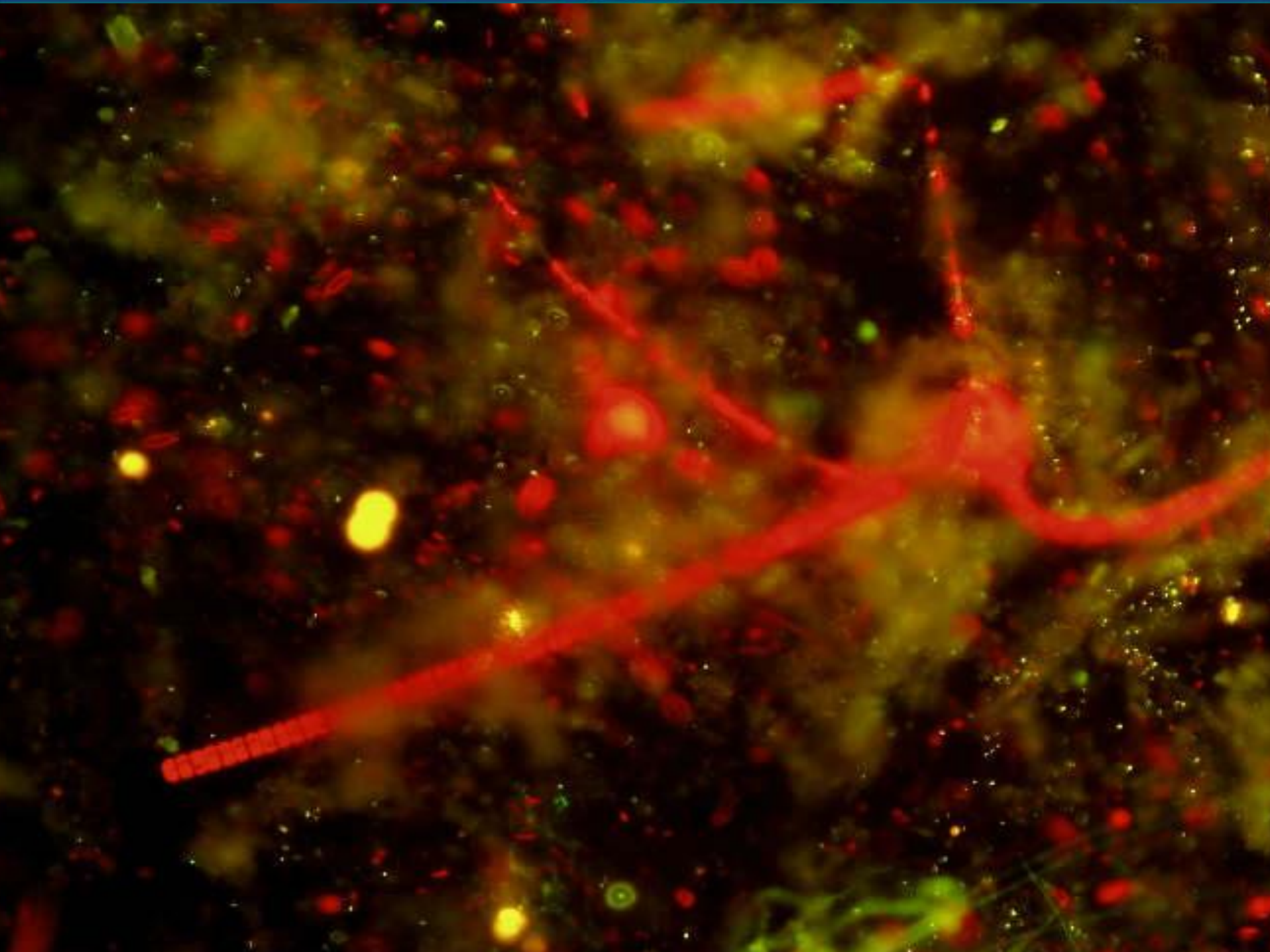


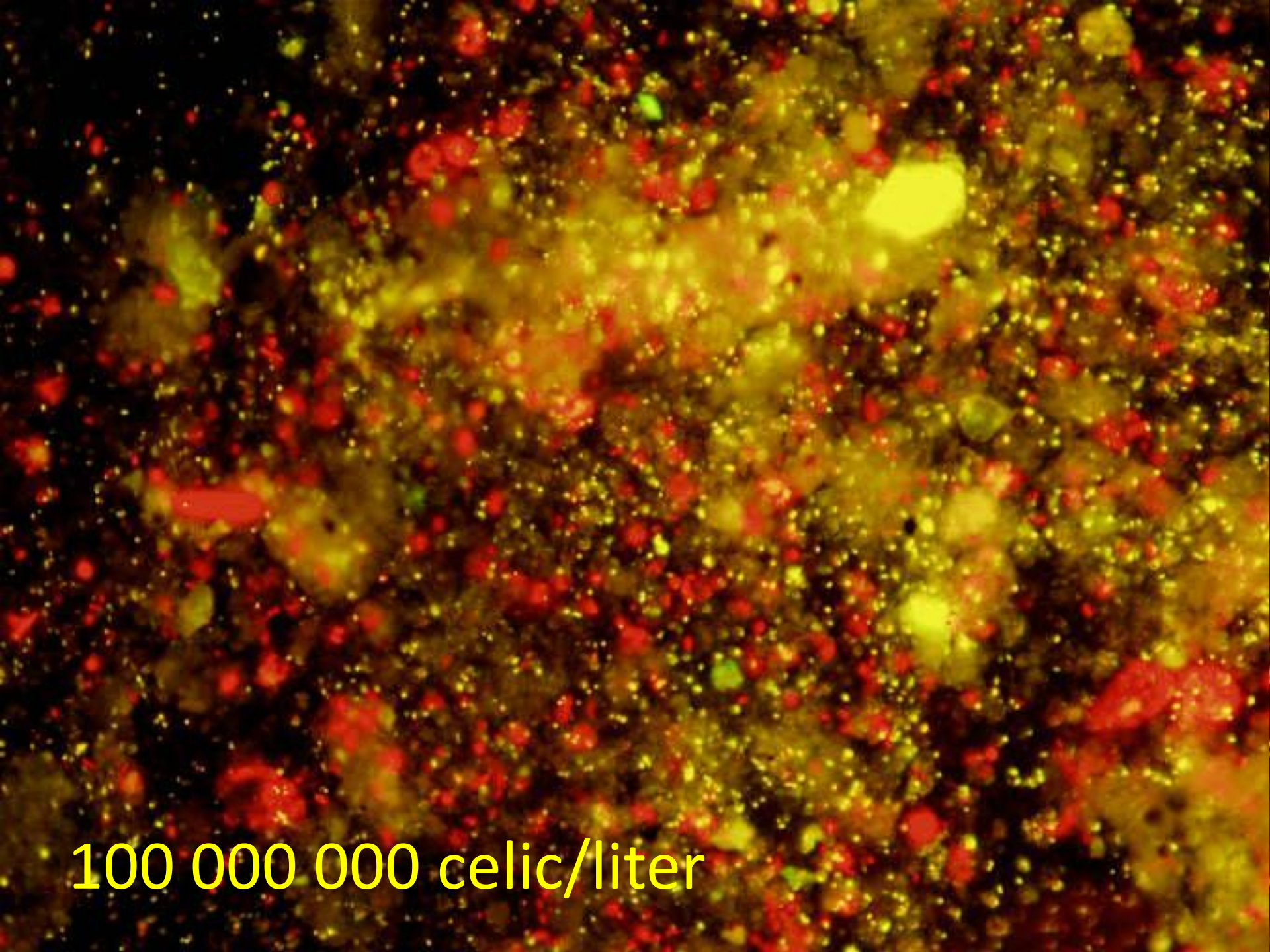




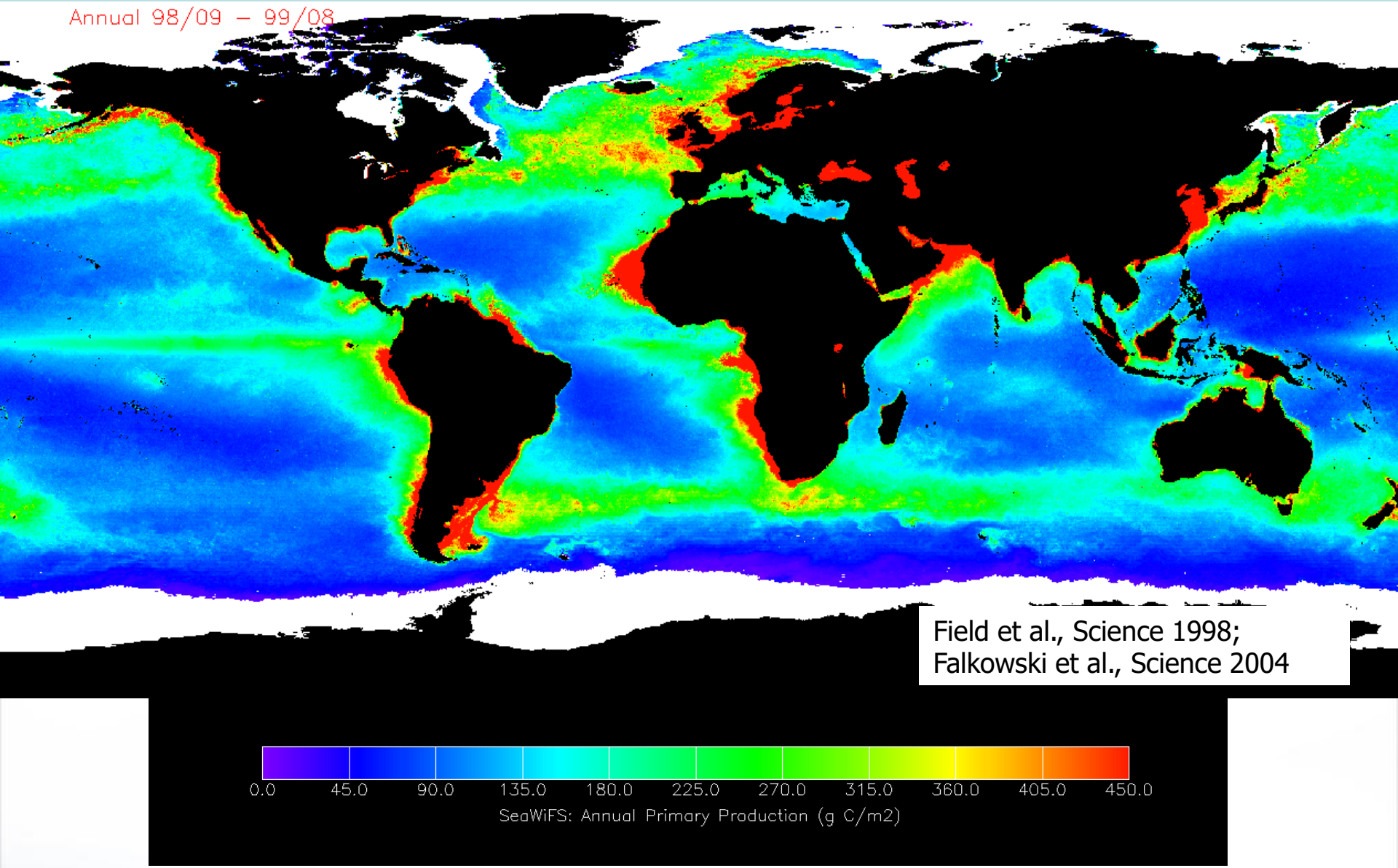

Valentina Turk



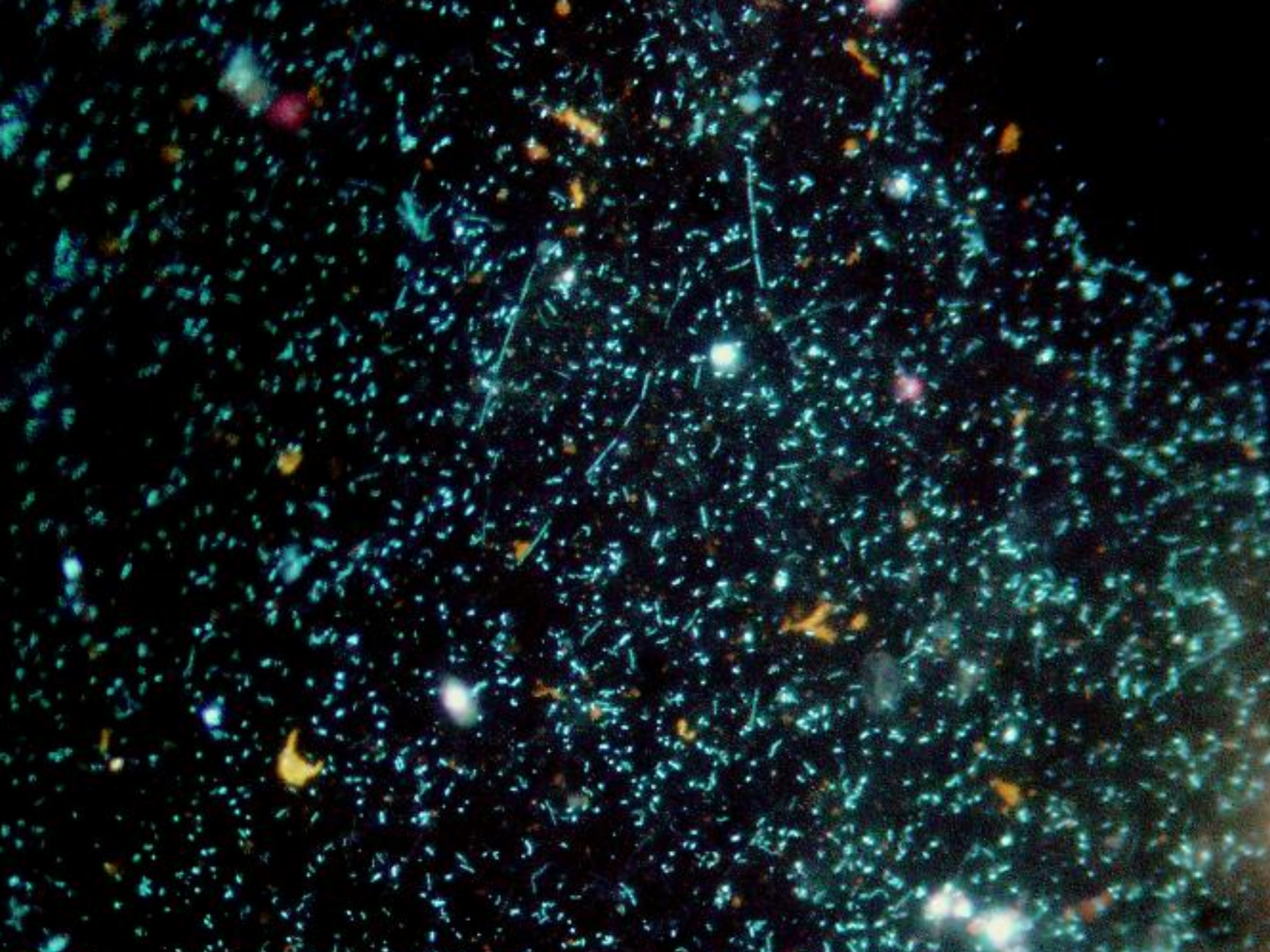


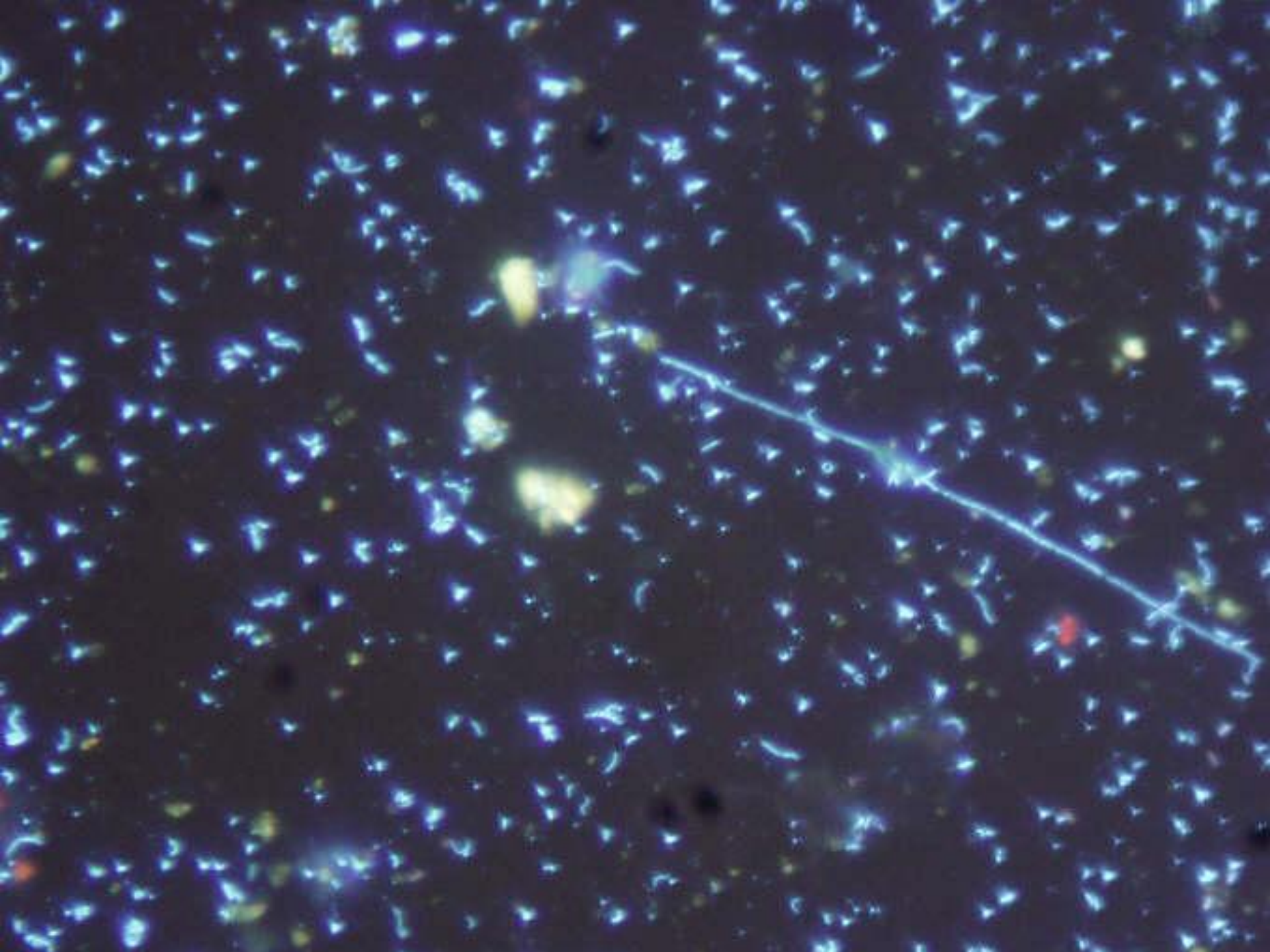

100 000 000 celic/liter

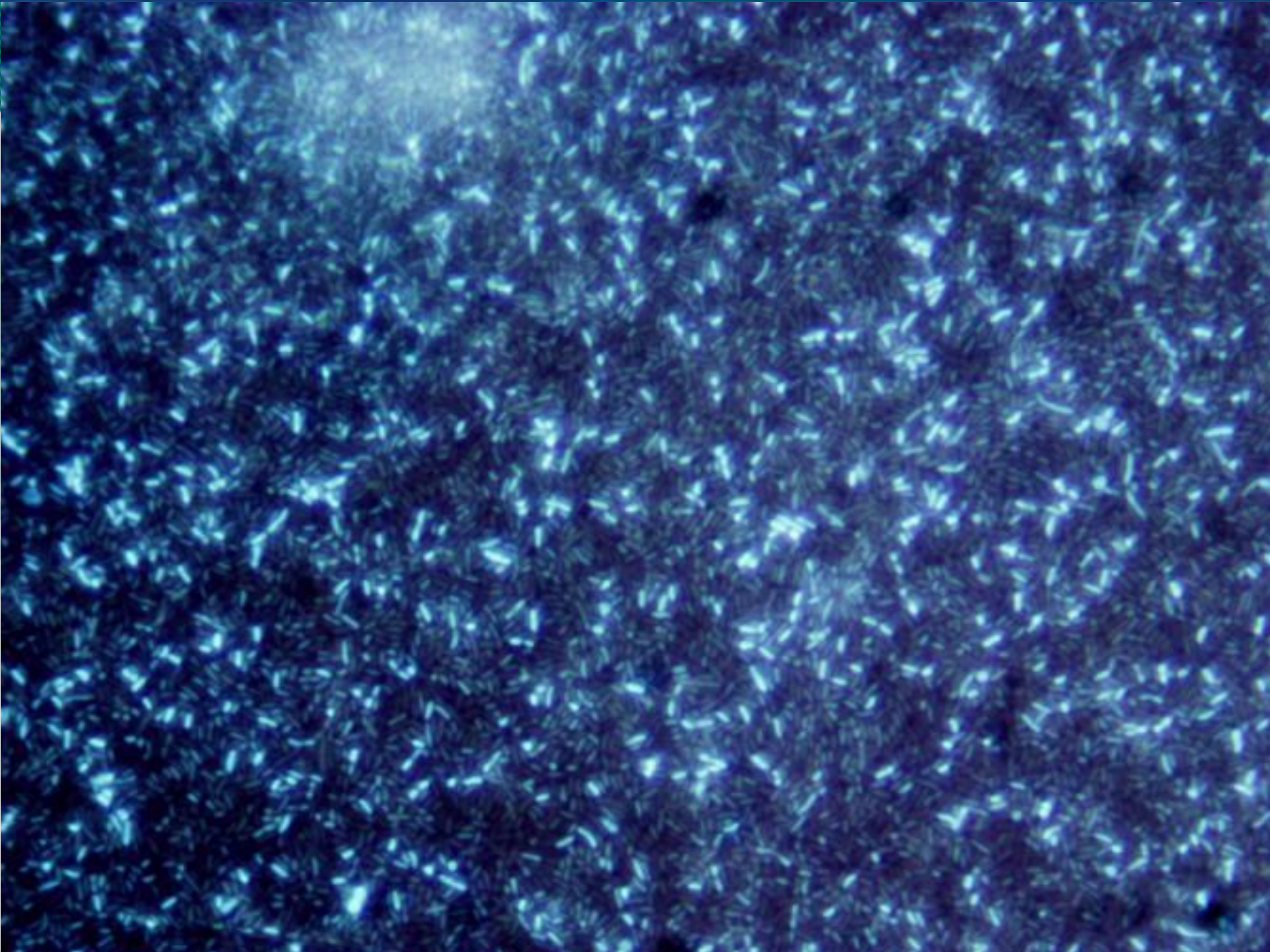
Letna primarna produkcija

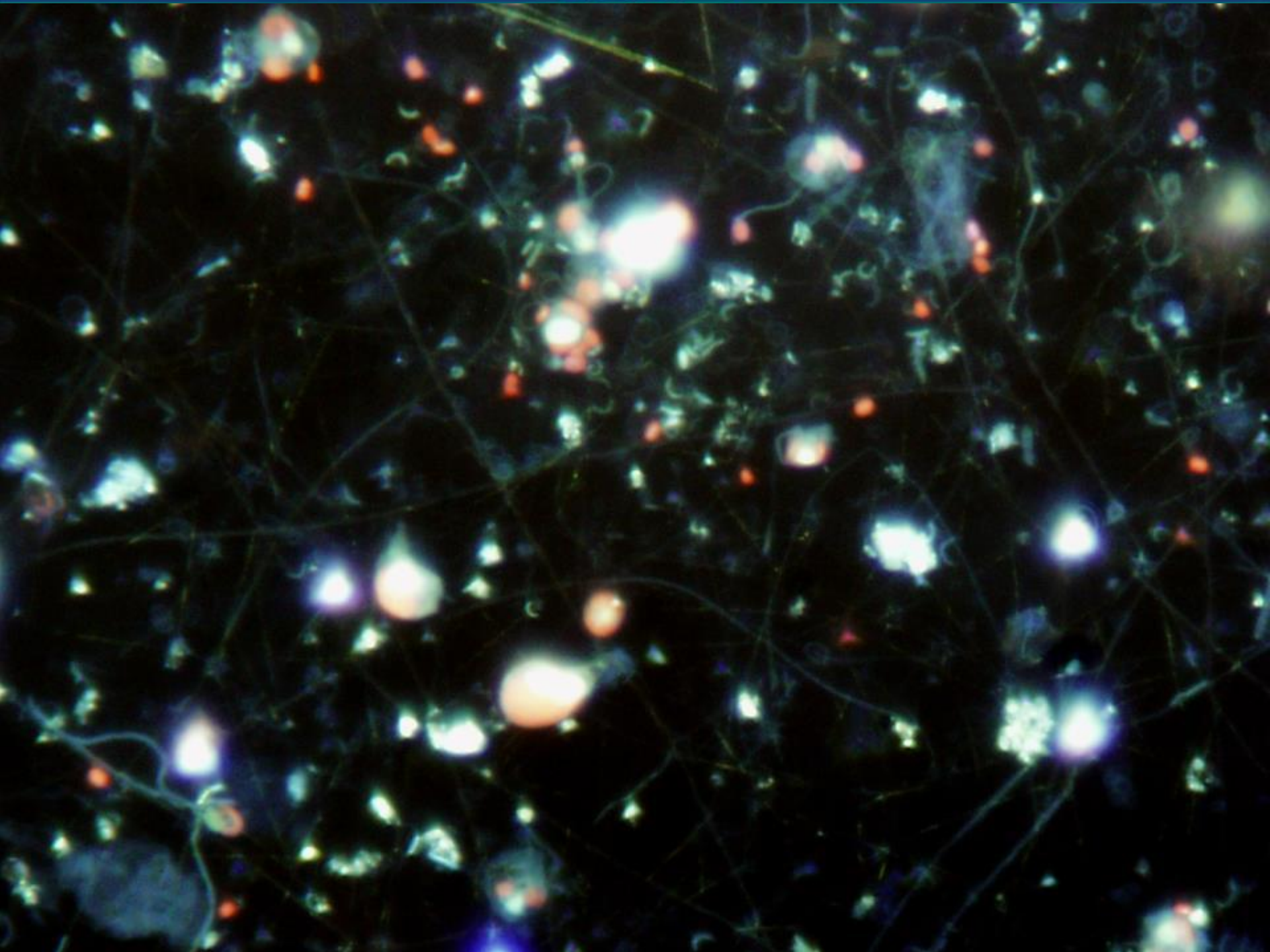


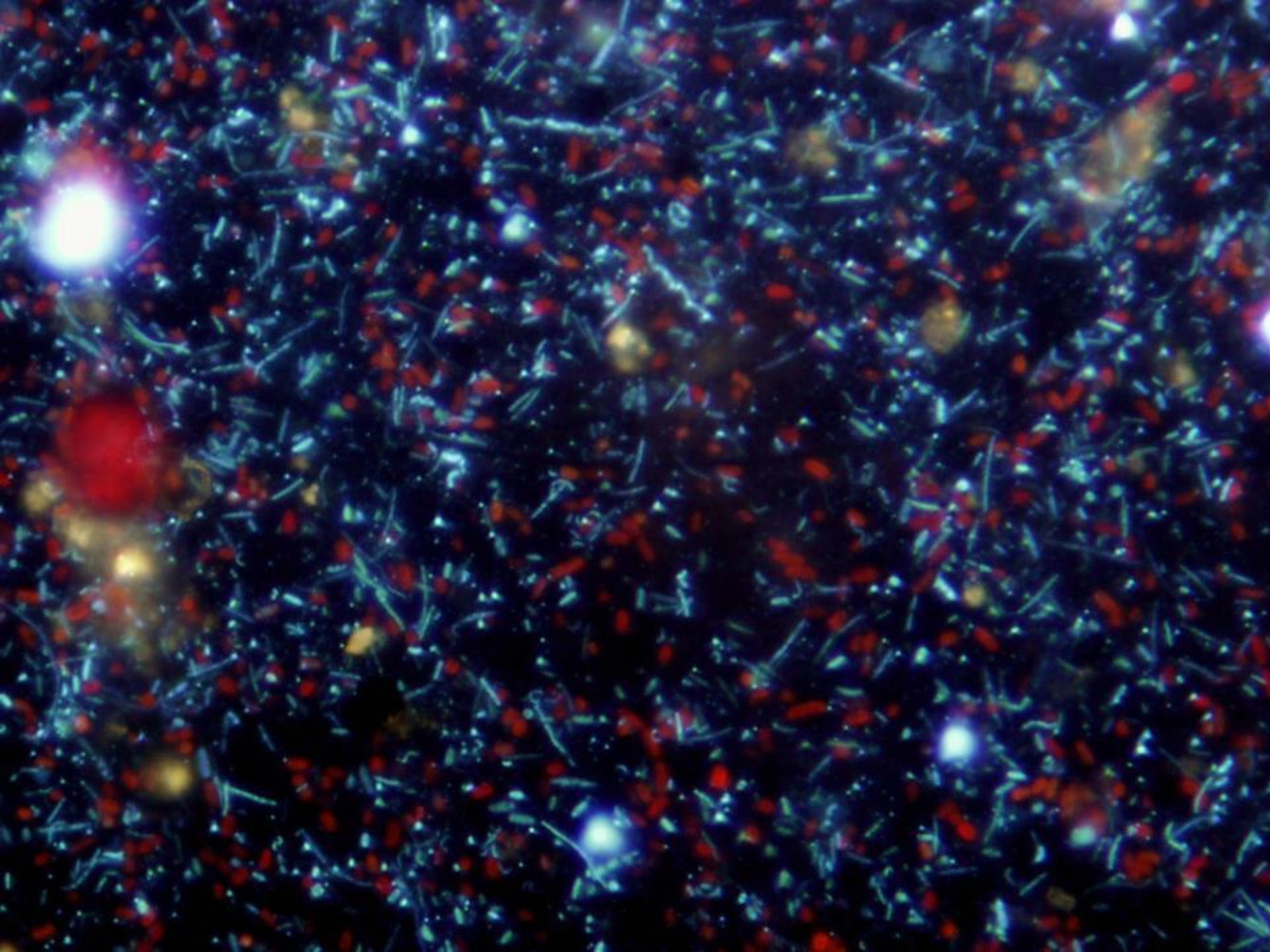
Field et al., Science 1998;
Falkowski et al., Science 2004

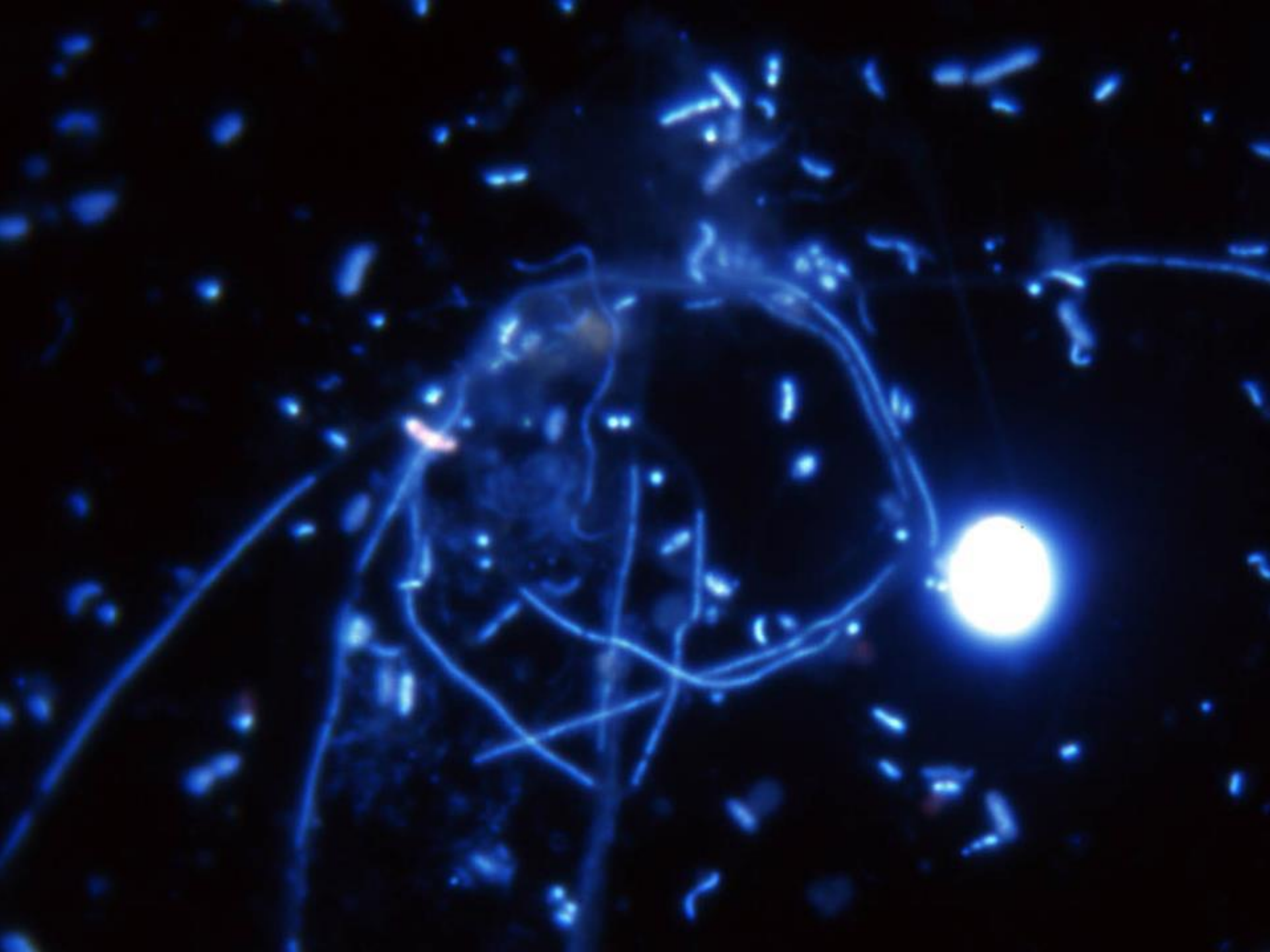






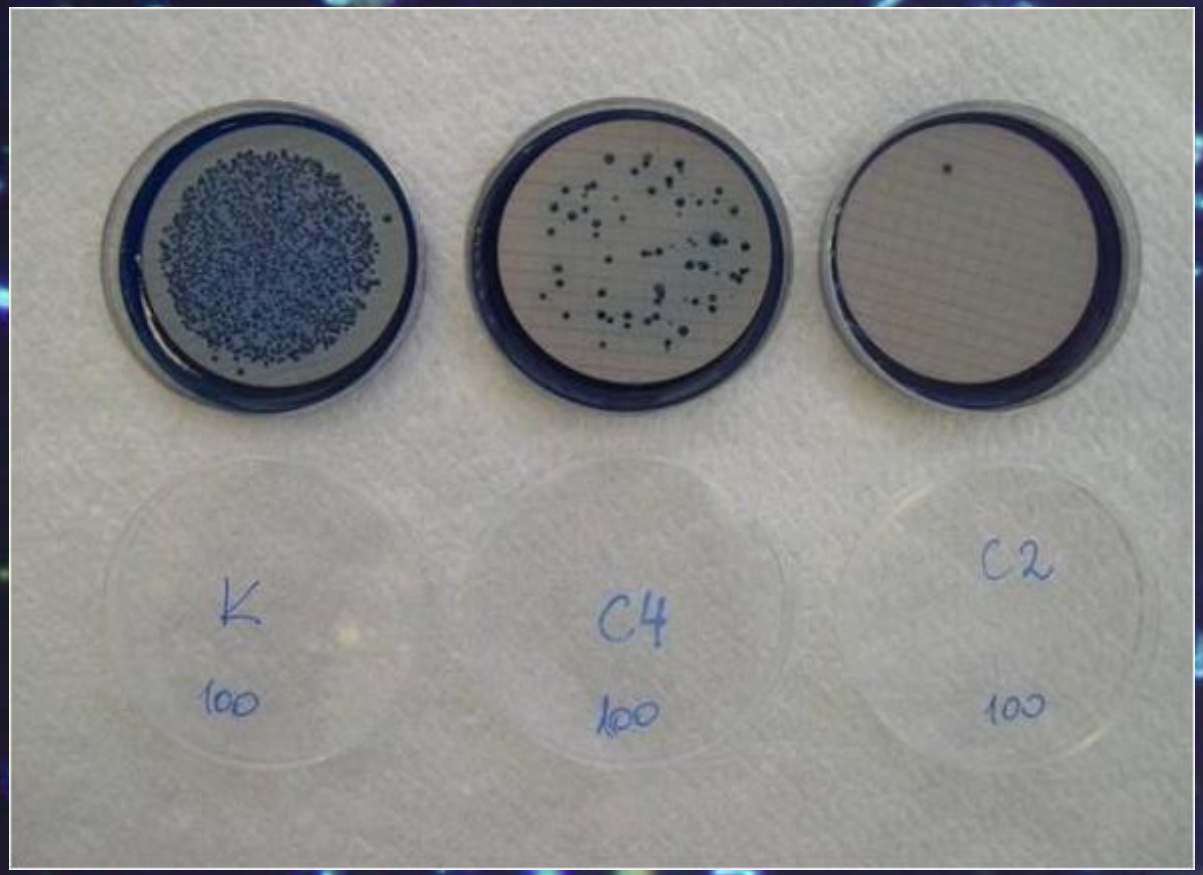


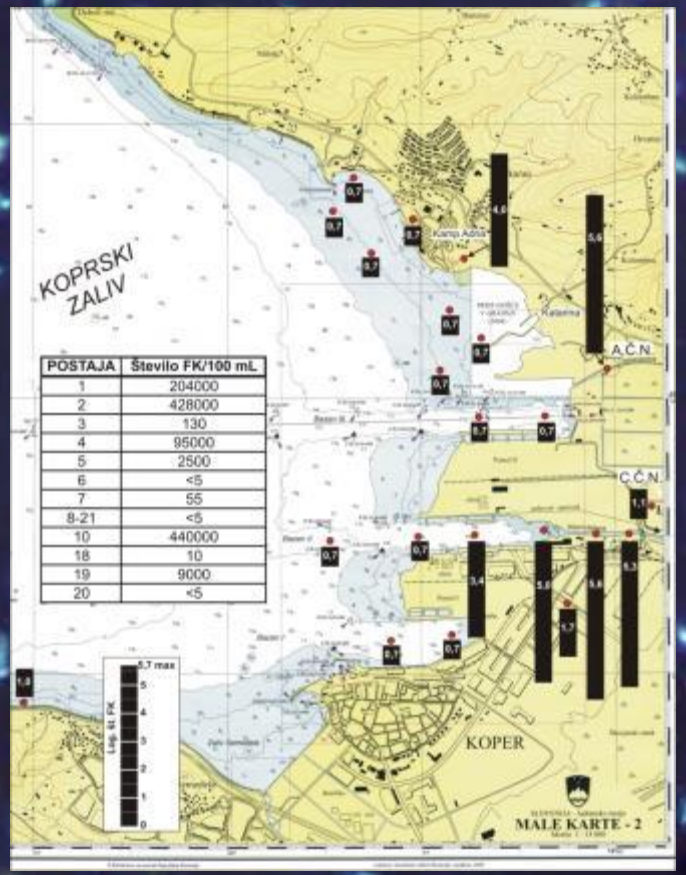




Kaj so bakterije?

Patogene bakterije





Claude E. ZoBell (1904–1989)

- monografija *Marine Microbiology* (1946)
  - začetnik moderne mikrobiologije
  - pregled znanja in novih odkritij v obdobju po letu 1933
  - objavil več kot 300 znanstvenih prispevkov
  - geomikrobiologija, petro mikrobiologija
- Sodeloval pri ekspedicijah
  - danska *Galathea ekspedicija* globoko morje (1950–1952)
  - bakterije na morskem dnu 10.462 m Philippine Trench
  - demonstracija življenja – nizke temperature (2.5° C) in visokih pritiskov (1000 atm)
- Scripps Institution of Oceanography

V začetku 1960

- Institute of Marine Resources SIO skupino (1963)
  Food Chain Research Group (FCRG):
  - John D.H. Strickland (kemija) Tim Parsons
  - Angelo Carlucci (bakteriologija)
  - Richard Eppley (fitoplankton)
  - John Beers (protozoa)
  - Osmund Holm-Hansen (produkcija in biokemija)
  - Peter Williams (organska biokemija)
  - Michael Mullin (mesozooplankton)

Drugo zlato obdobje mikrobne ekologije

- E.J. Ferguson Wood (1904–1972):
  - *Marine Microbial Ecology*
  - *Microbiology of Oceans and Estuarie*
  - *Advances in M*
  - *icrobiology of the Sea*
- Strickland and Parsons, 1968 Handbook of Seawater Analysis
- 1972, Rita Colwell in Michael Zambruski
- A.G. Rodina's monografija *Methods in Aquatic Microbiology*
- John Sieburth (1975):
  - Nove metode, nove tehnike, nova oprema
  - *Microbial Sea*
- Rheinheimer (1980), Austin (1988), Sorokin (1999), Munn (2004)
  evolucija novih idej
- M.R. Droop and H.W. Jannasch *(1977): Advances in Aquatic Microbiology*

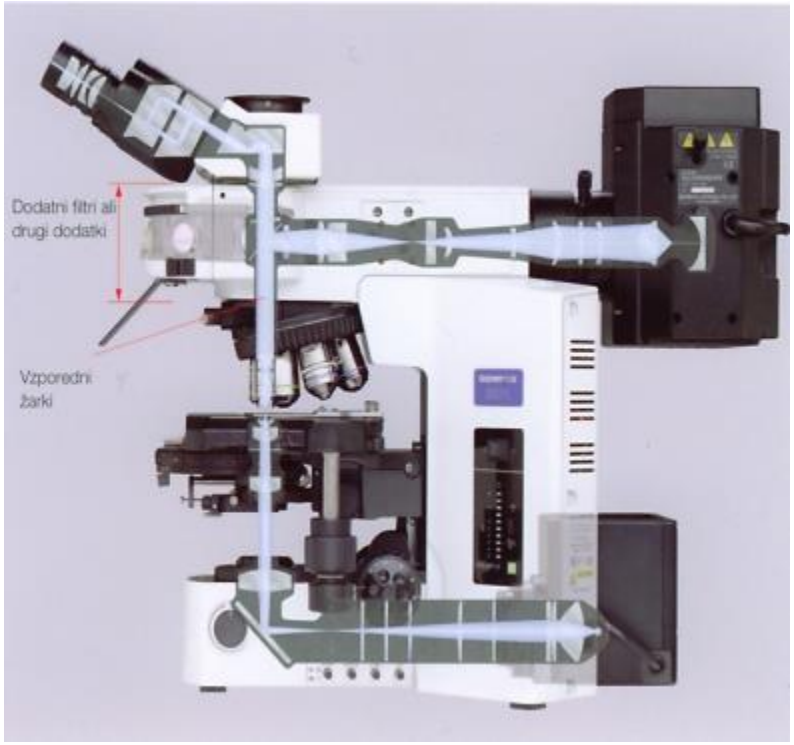
Nove metode, instrumenti, tehnike

Uporaba radioaktivnih izotopov ogljika, C-14

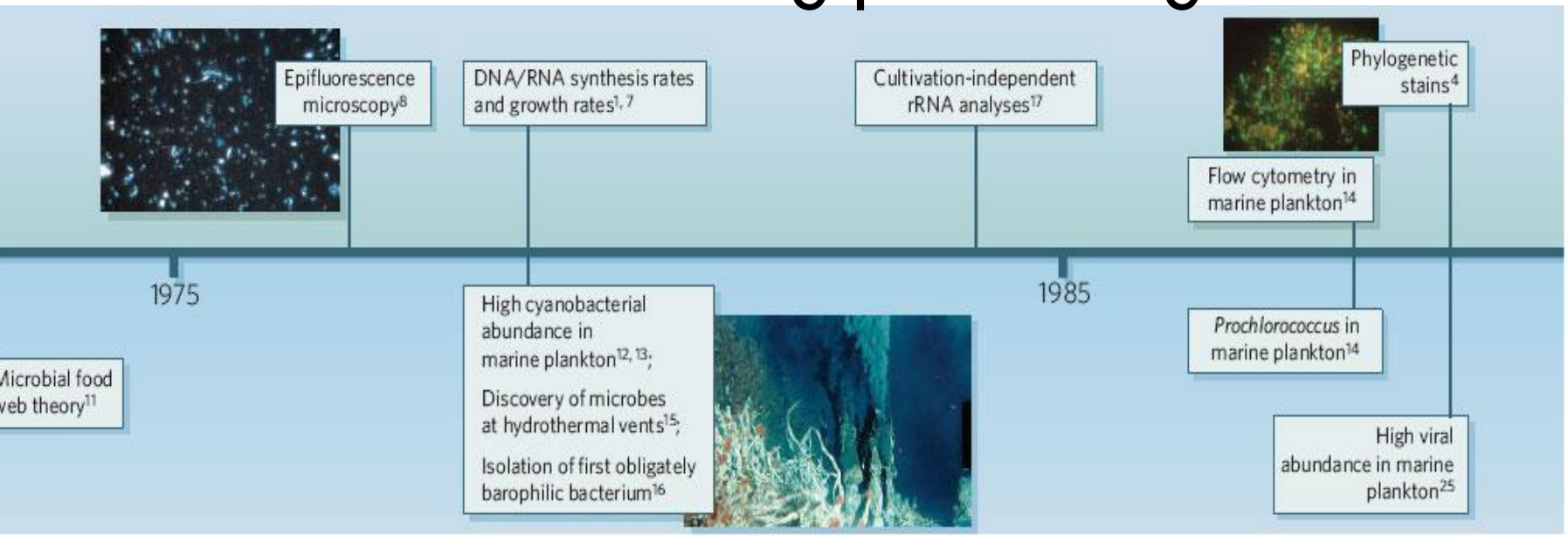
- primarna produkcija (Steemann Nielsen,1951)
- Heterotrofna bakterijska produkcija (Parsons & Strickland,1962)

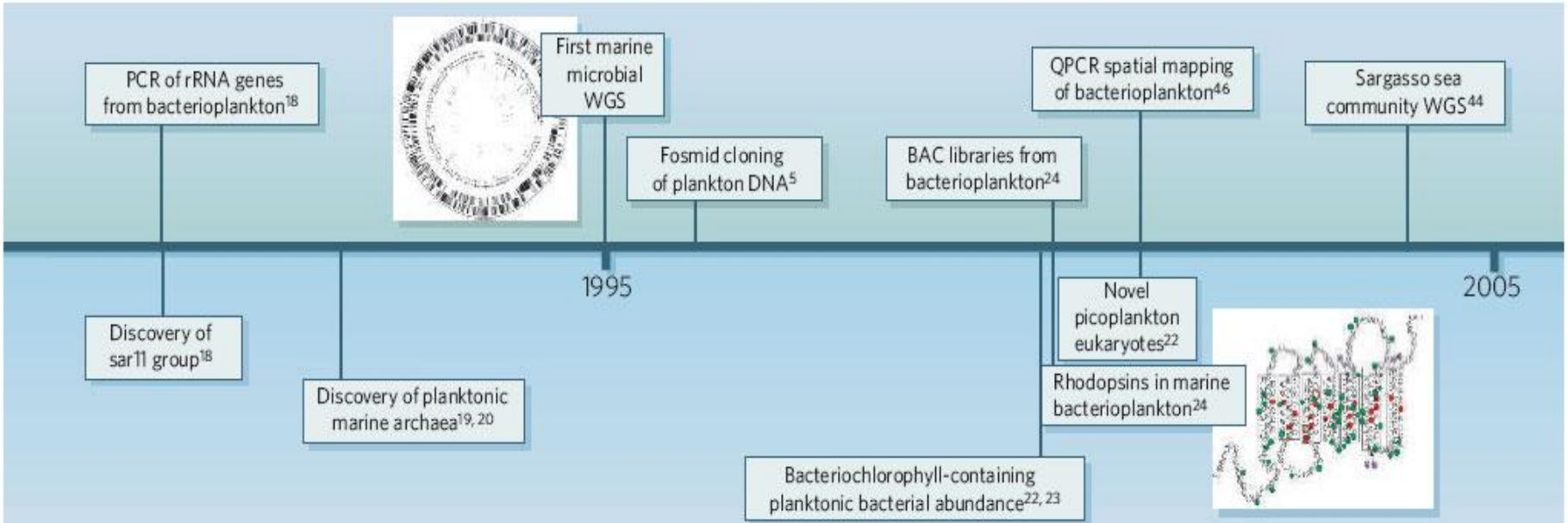
Nove metode, instrumenti, tehnike

Epifluorescentna mikroskopija in membranski filtri (Nuclepore) (Fleischer *in sod*., 1964)



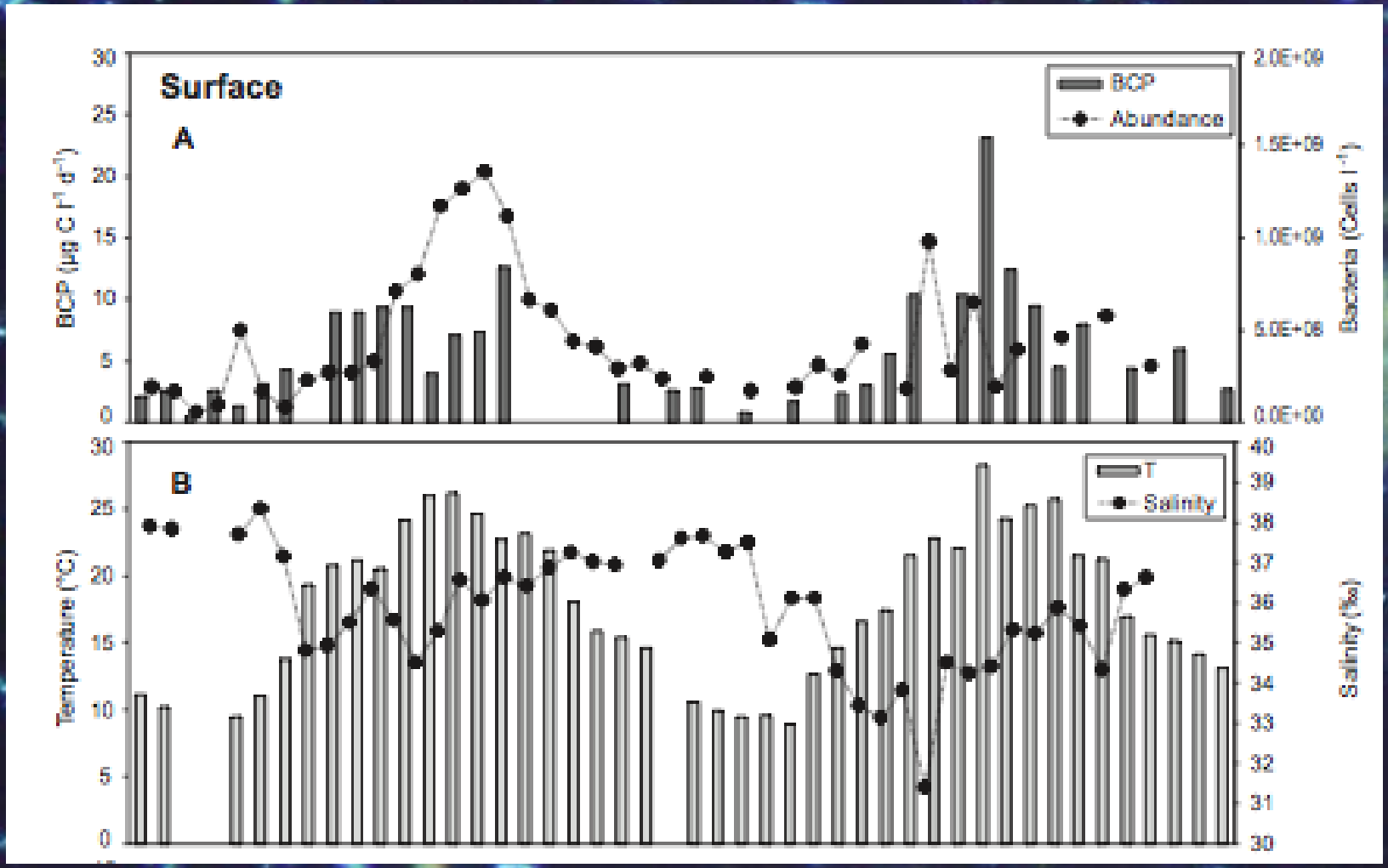
Mikrobna ekologija skozi zgodovino





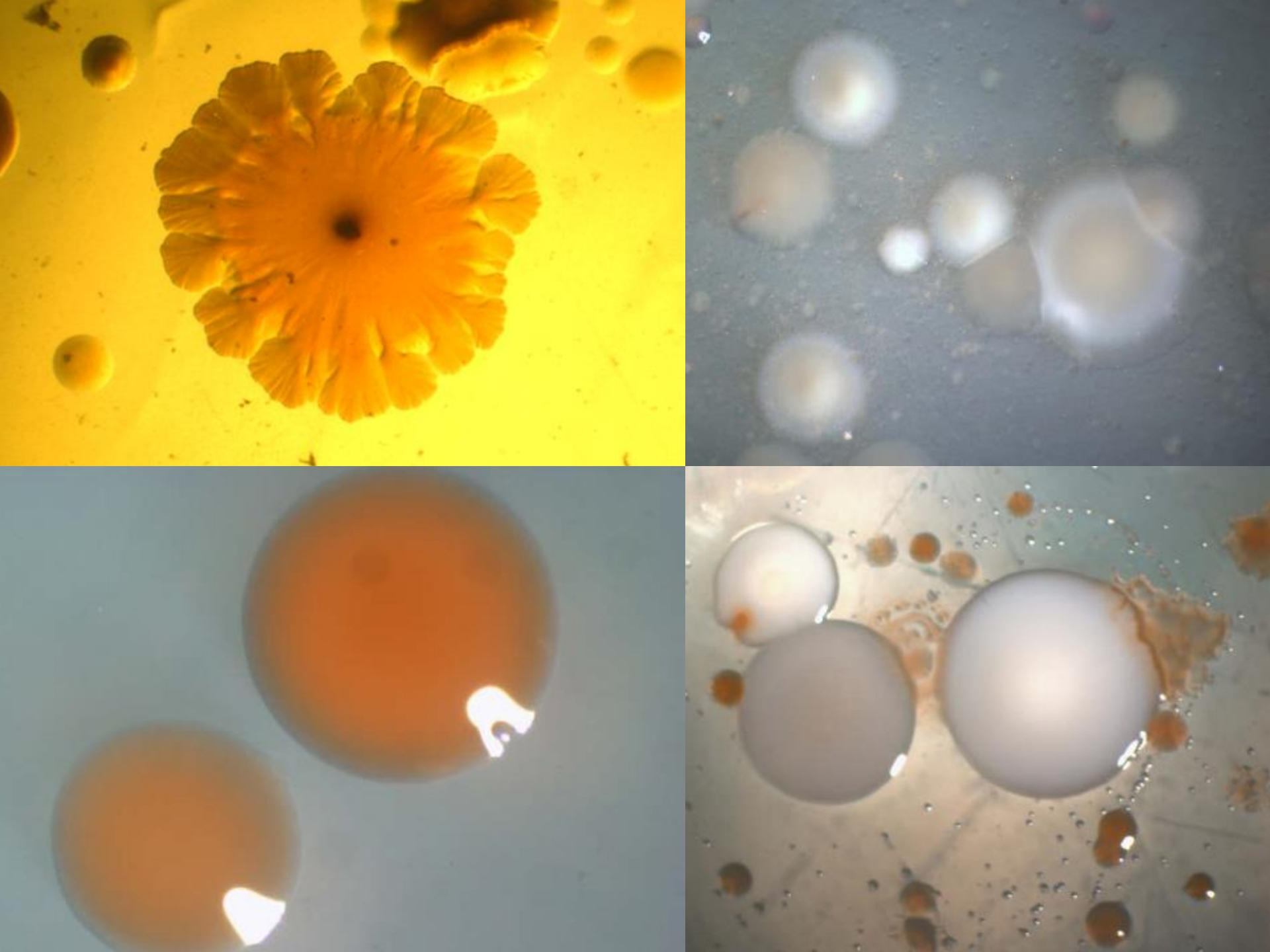
Koliko bakterij je v 1 L morske vode?

1. 000.000. 000



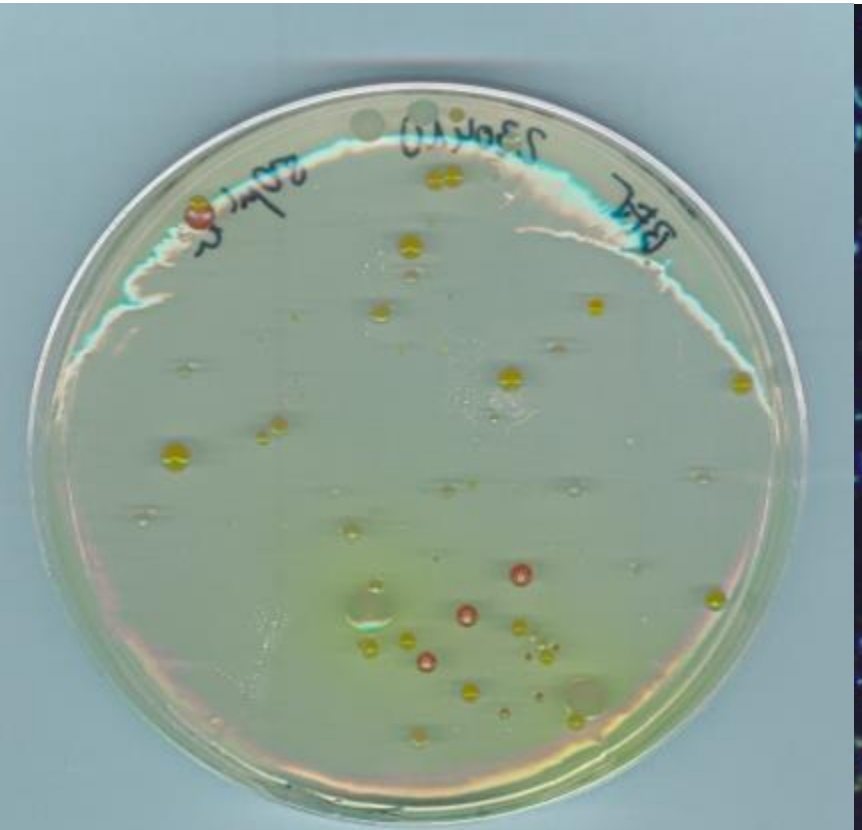
T. Tinta,[1]* J. Vojvoda,[1] P. Mozetič,[1] I. Talaber,[1] M. Vodopivec,[1] F. Malfatti[2,3] and V. Turk[1]

Environmental Microbiology (2015) **17**(10), 3581–3596



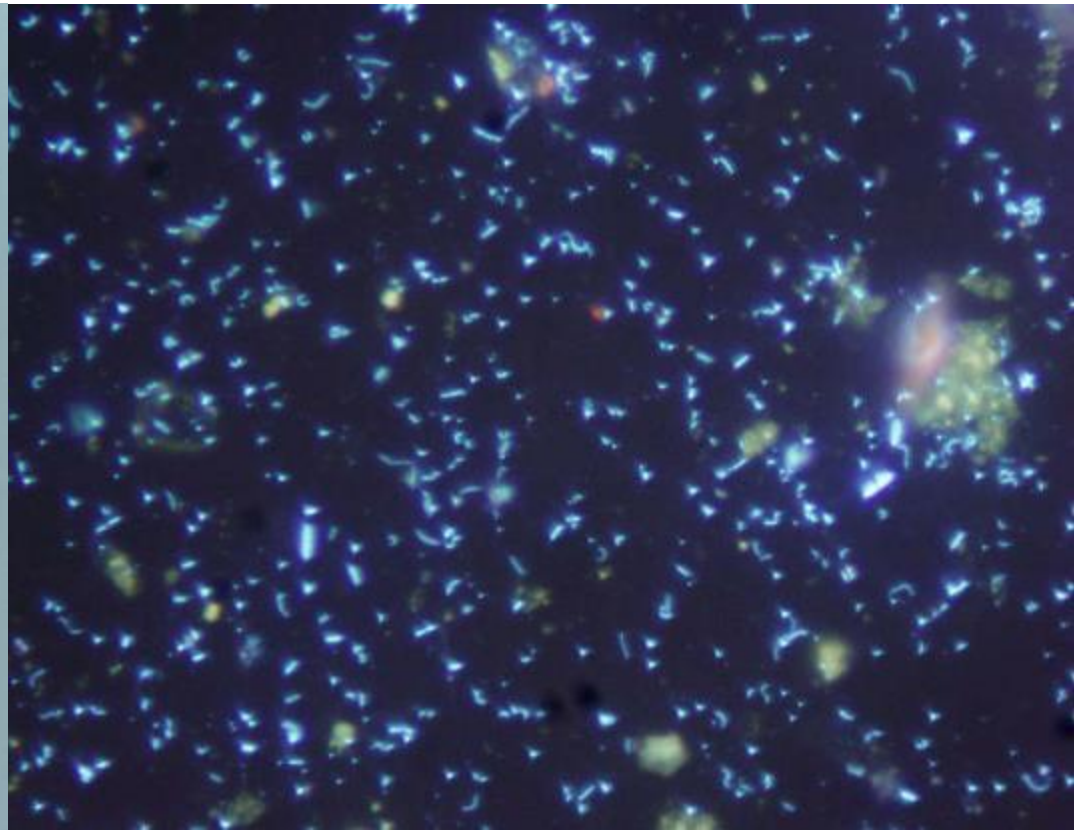
Gojenje

100 kolonij/ mL



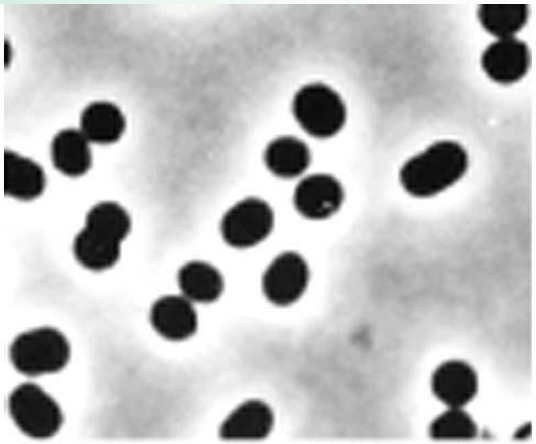
Štetje pod mikroskopom

1.000.000 celic/mL



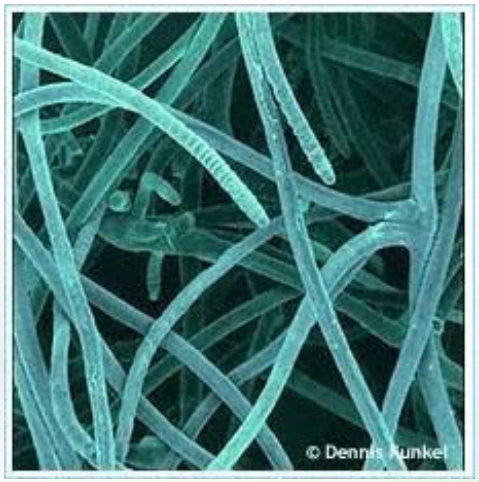
Tisoče vrst,vendar samo pet oblik

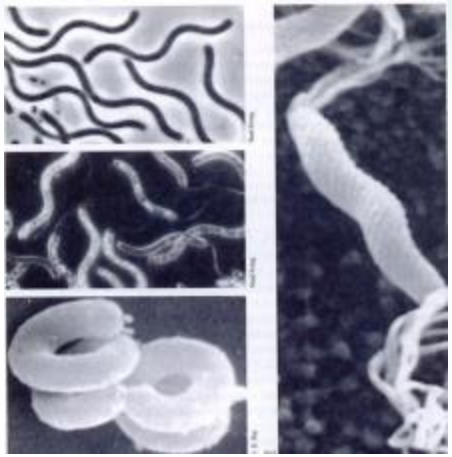
koki



paličke

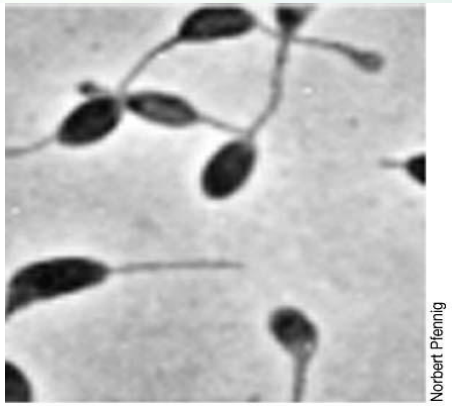
filamenti





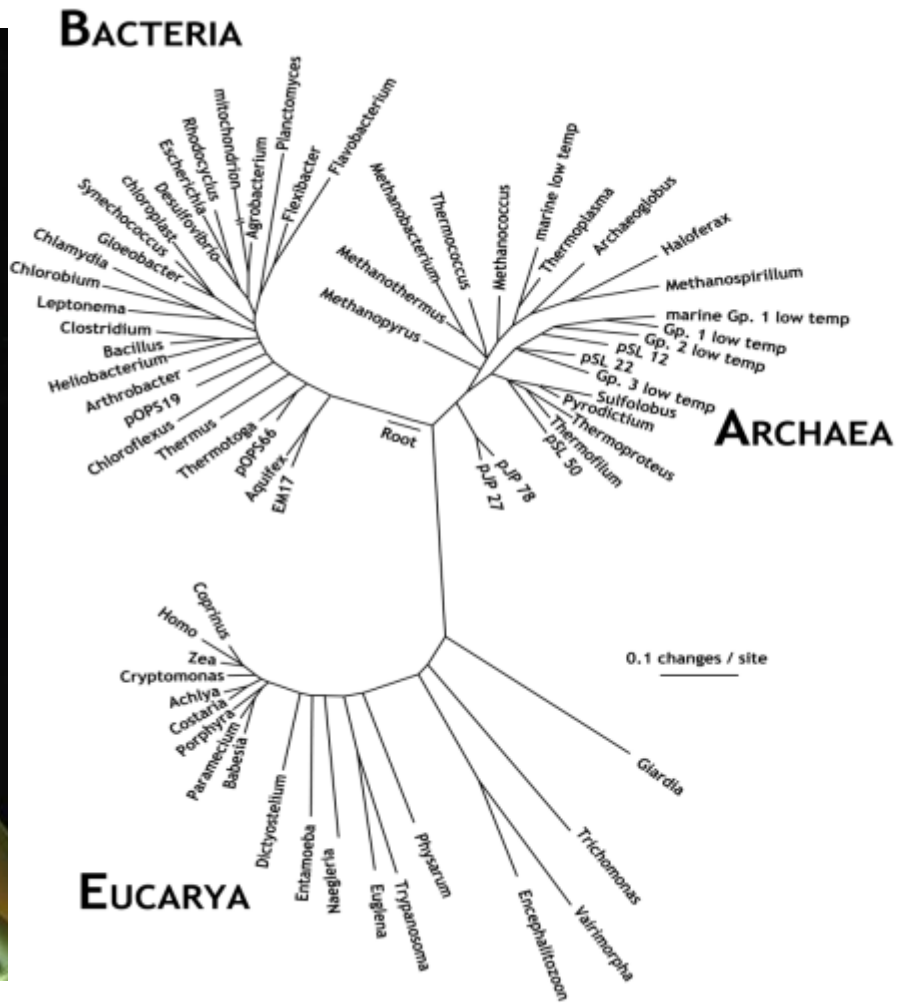
spirile

spiruhete

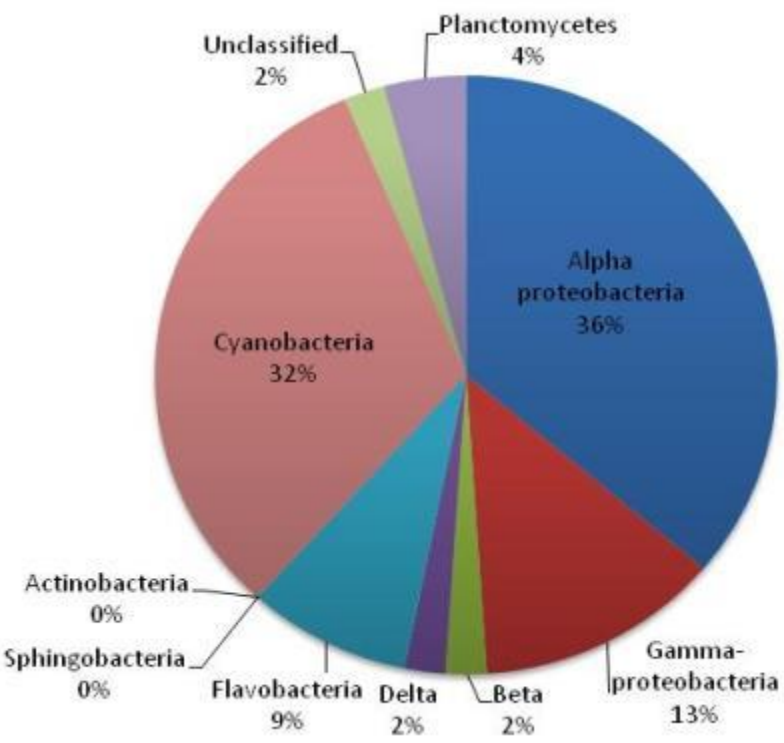


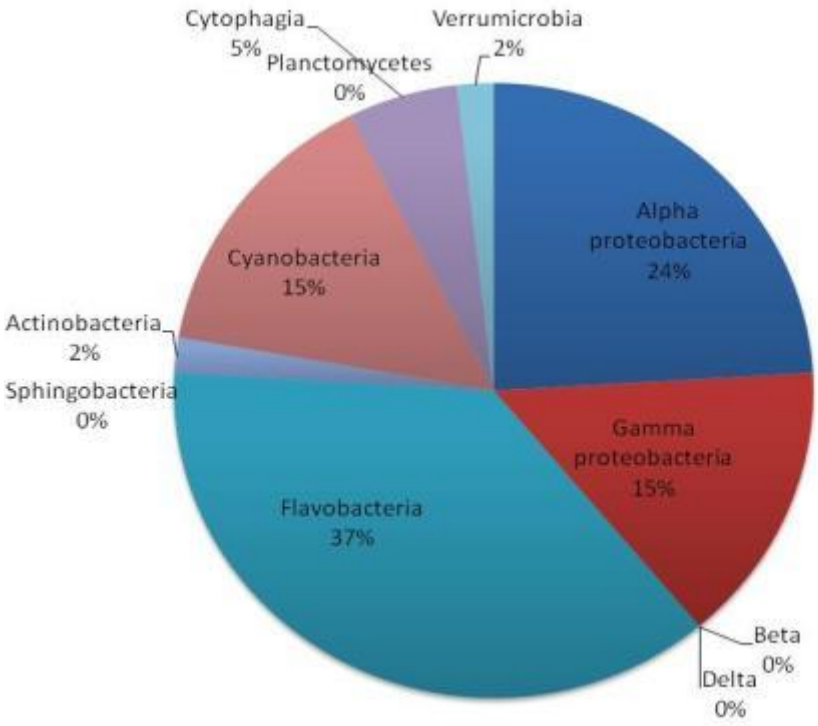
vijačne oblike s polarnim bičkom

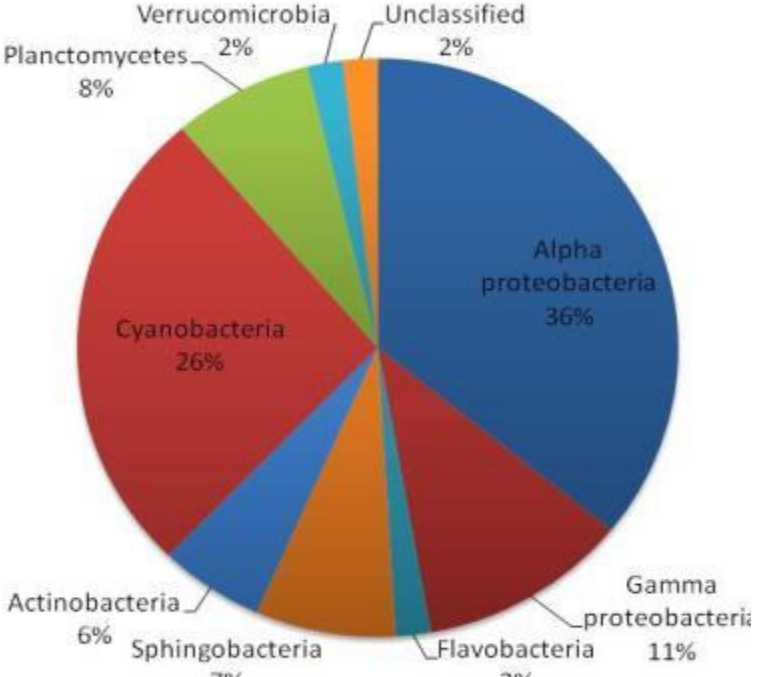
Koliko vrst poznamo?

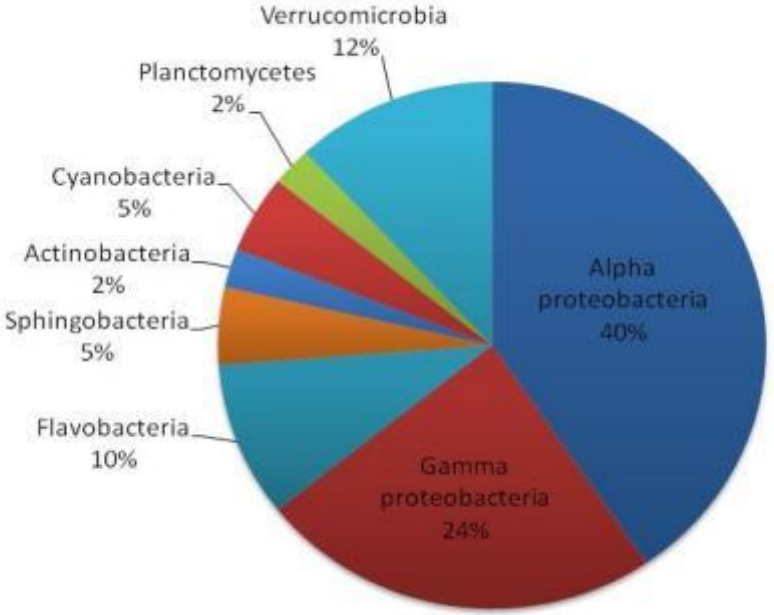


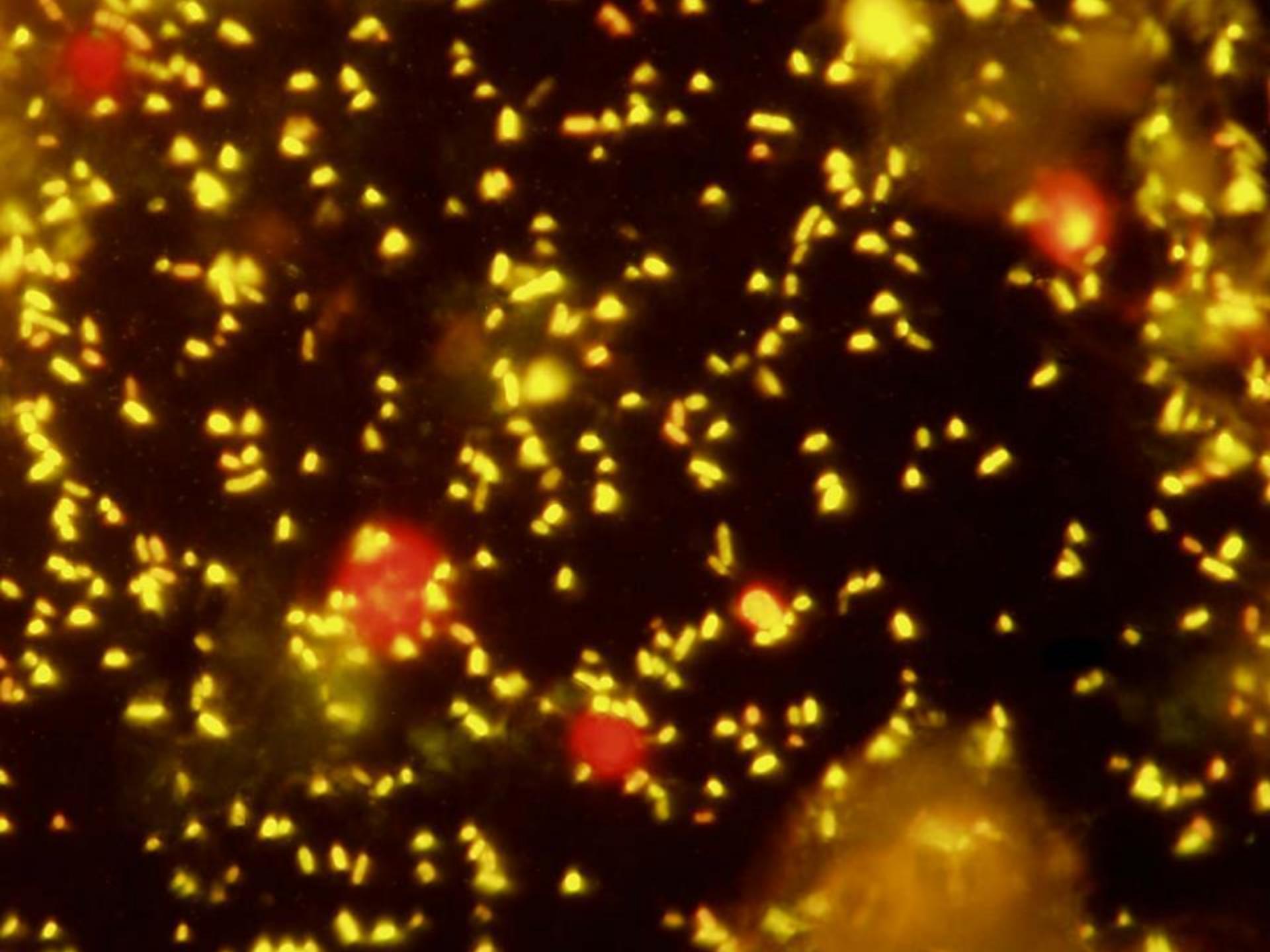
Carl Woese
Photo by Jason Lindsey,
U. Ill. Alumni Magazine

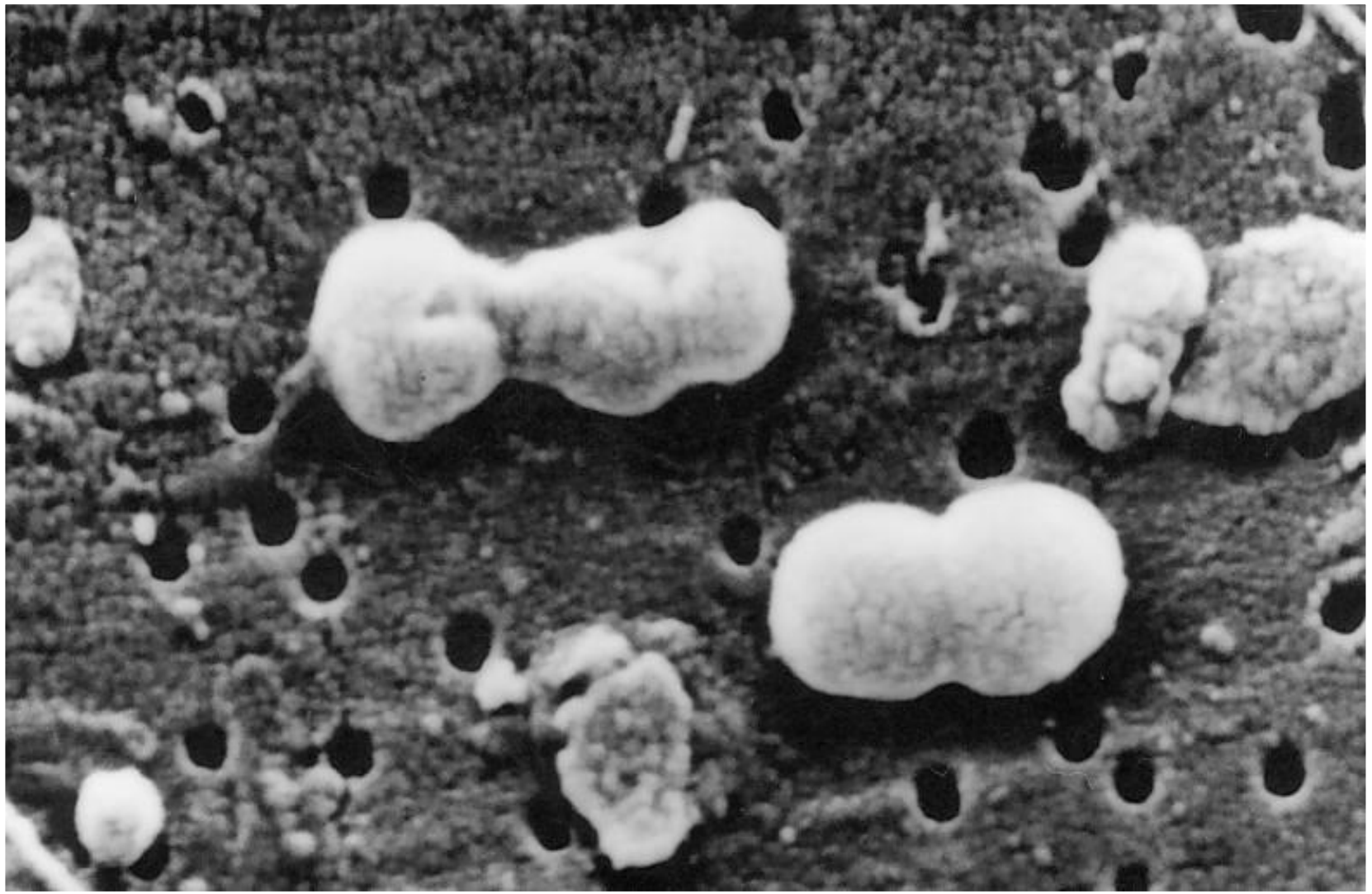

Unclassified
2%
Planctomycetes
4%
Alpha
proteobacteria
36%
Cyanobacteria
32%
Actinobacteria
0%
Sphingobacteria
0%
Flavobacteria
9%
Delta
2%
Beta
2%
Gamma-
proteobacteria
13%

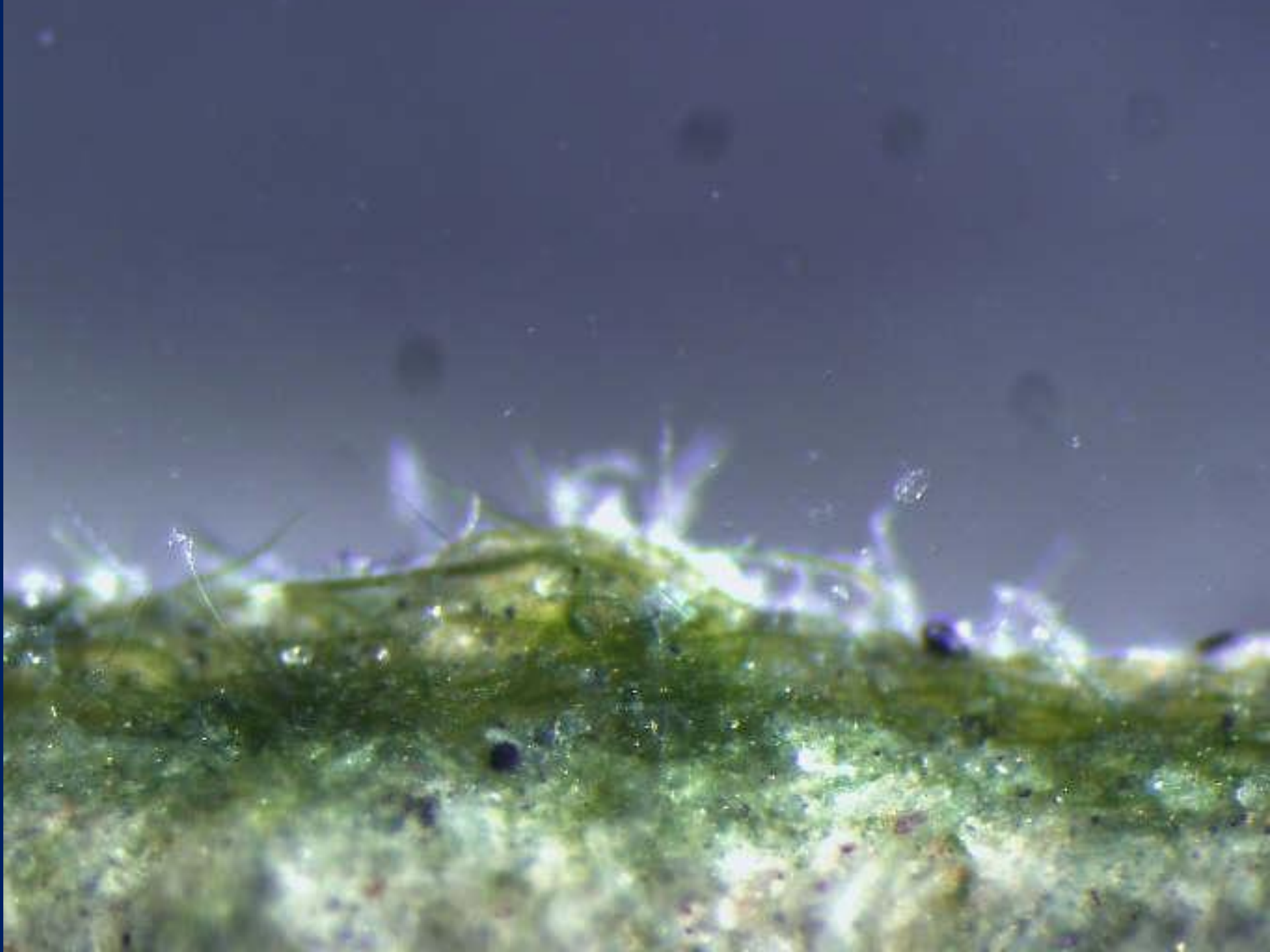

Cytophagia
5%
Planctomycetes
0%
Verrumicrobia
2%
Alpha
proteobacteria
24%
Cyanobacteria
15%
Actinobacteria
2%
Sphingobacteria
0%
Gamma
proteobacteria
15%
Flavobacteria
37%
Beta
0%
Delta
0%

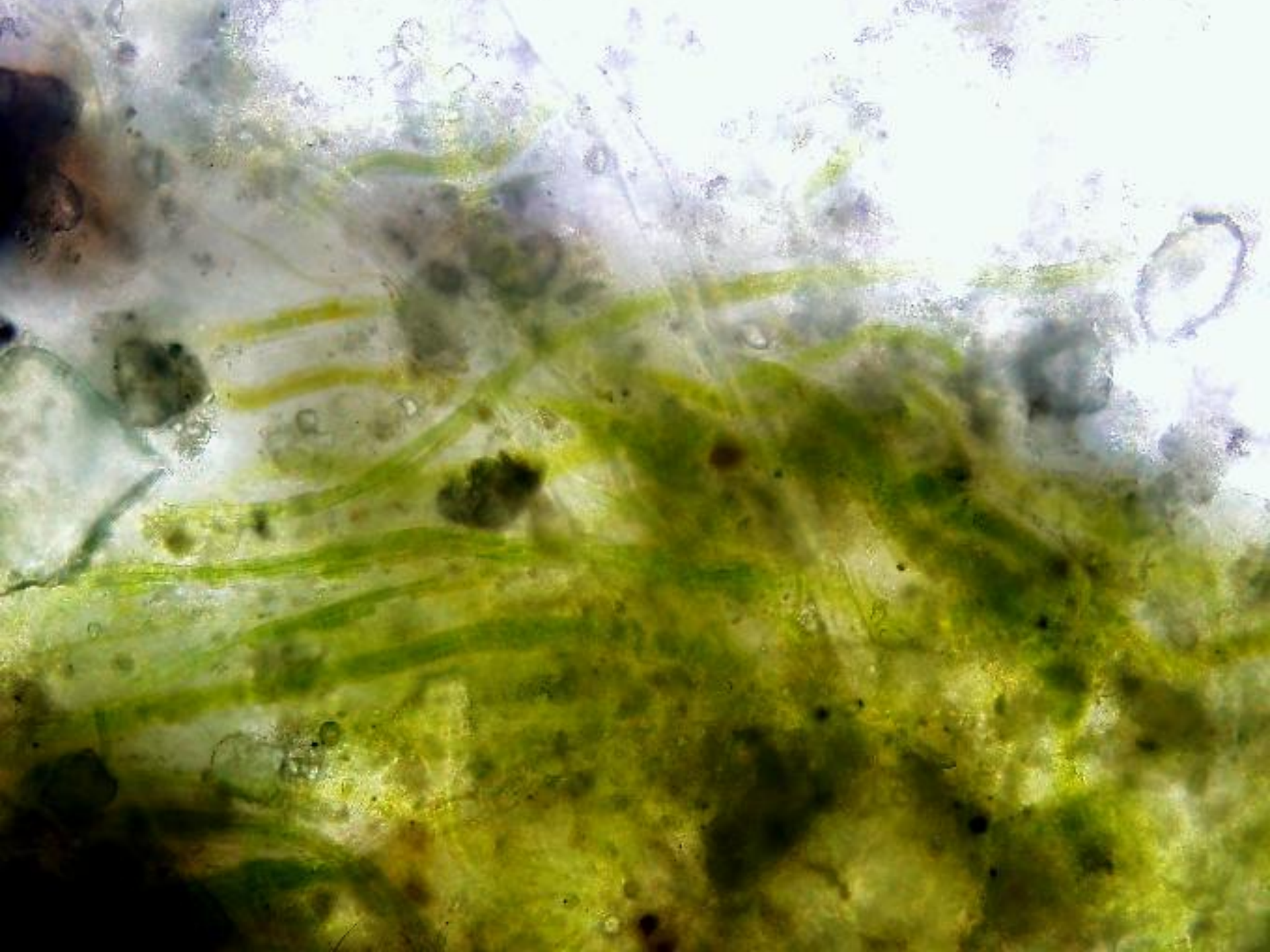

Verrucomicrobia
2%
Unclassified
2%
Planctomycetes
8%
Alpha
proteobacteria
36%
Cyanobacteria
26%
Actinobacteria
6%
Sphingobacteria
Flavobacteria
Gamma
proteobacteria
11%

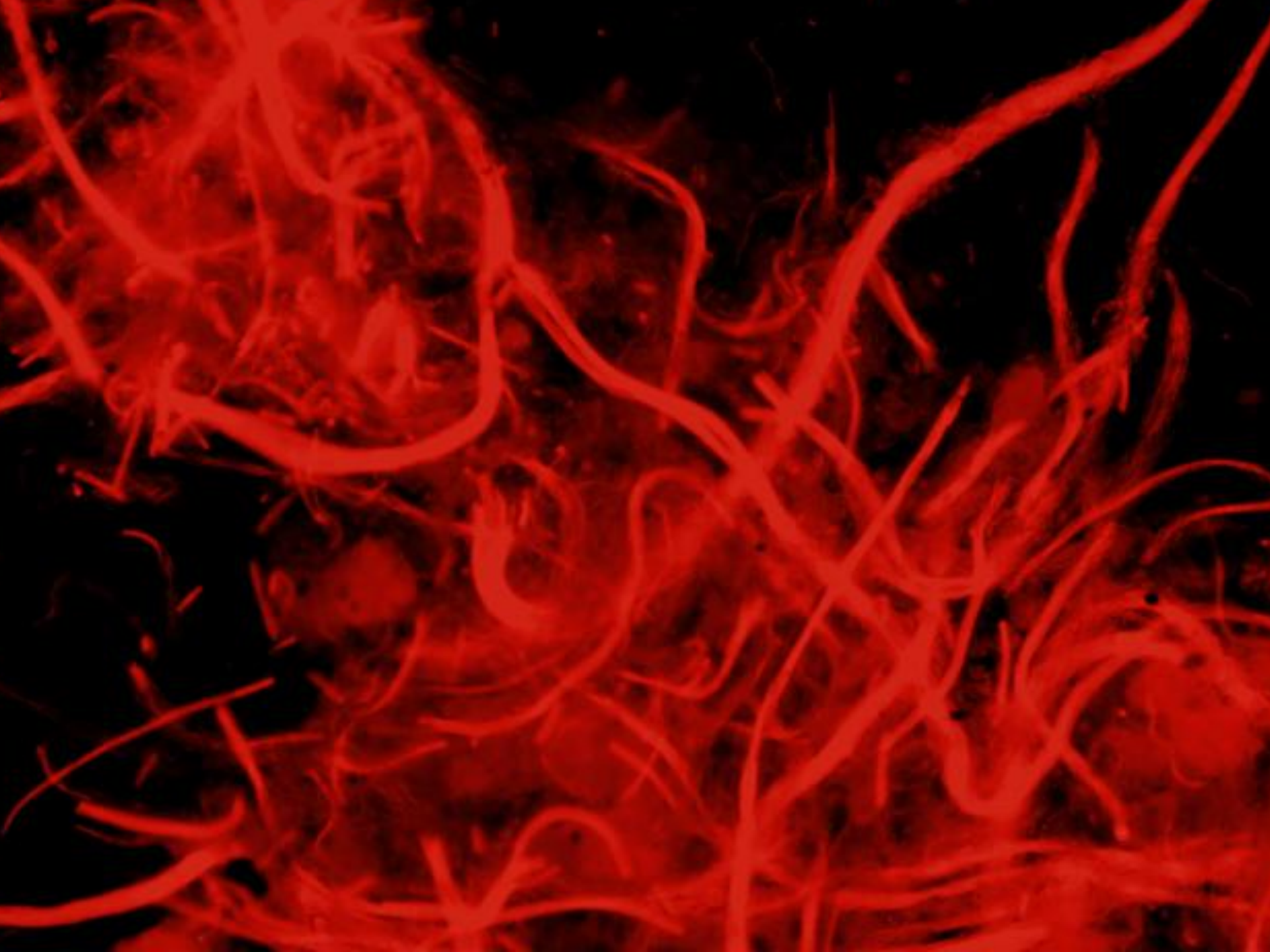

Verrucomicrobia
12%
Planctomycetes
2%
Cyanobacteria
5%
Actinobacteria
2%
Sphingobacteria
5%
Flavobacteria
10%
Alpha
proteobacteria
40%
Gamma
proteobacteria
24%





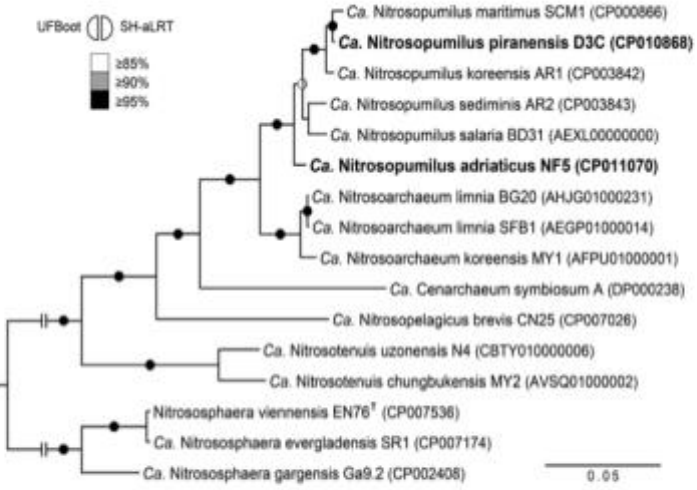






Arheje

Nitrosopumilus piranensis
Nitrosopumilus adriaticus



tree of concatenated 16S–23S rRNA genes from cultivated Thaumarchaeota with sequenced genomes the affiliation of strains D3C and NF5. Full-length gene sequences were aligned with MAFFT (L-INS-I method) ific structurally accurate seed alignments (1474 and 3026 aligned positions for 16S and 23S rRNA genes, iable positions were filtered from the resulting alignments with TCS before concatenation (4443 aligned positions gnment). The tree was calculated by maximum likelihood with IQ-Tree based on the GTR+I+Γ4 model, with oot) and SH-aLRT support values inferred from 1000 replicates each (see Supplementary materials and methods ues ⩾85% are represented on the respective branches by semi-circles color-coded as indicated on the figure.

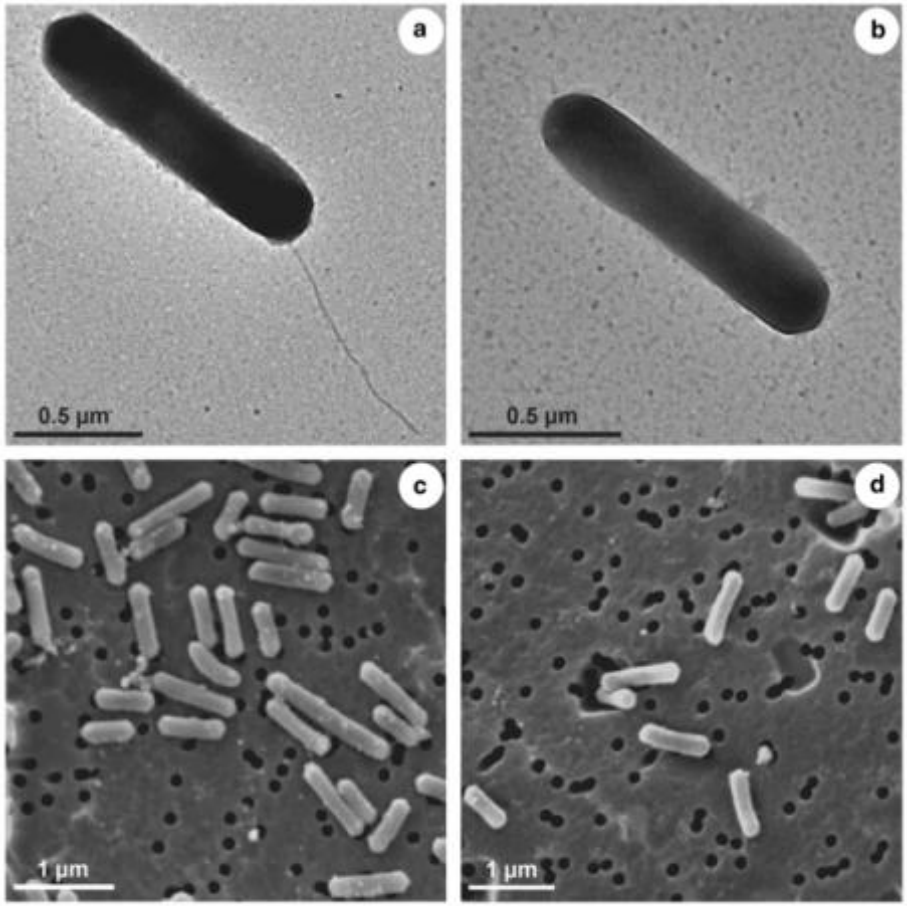
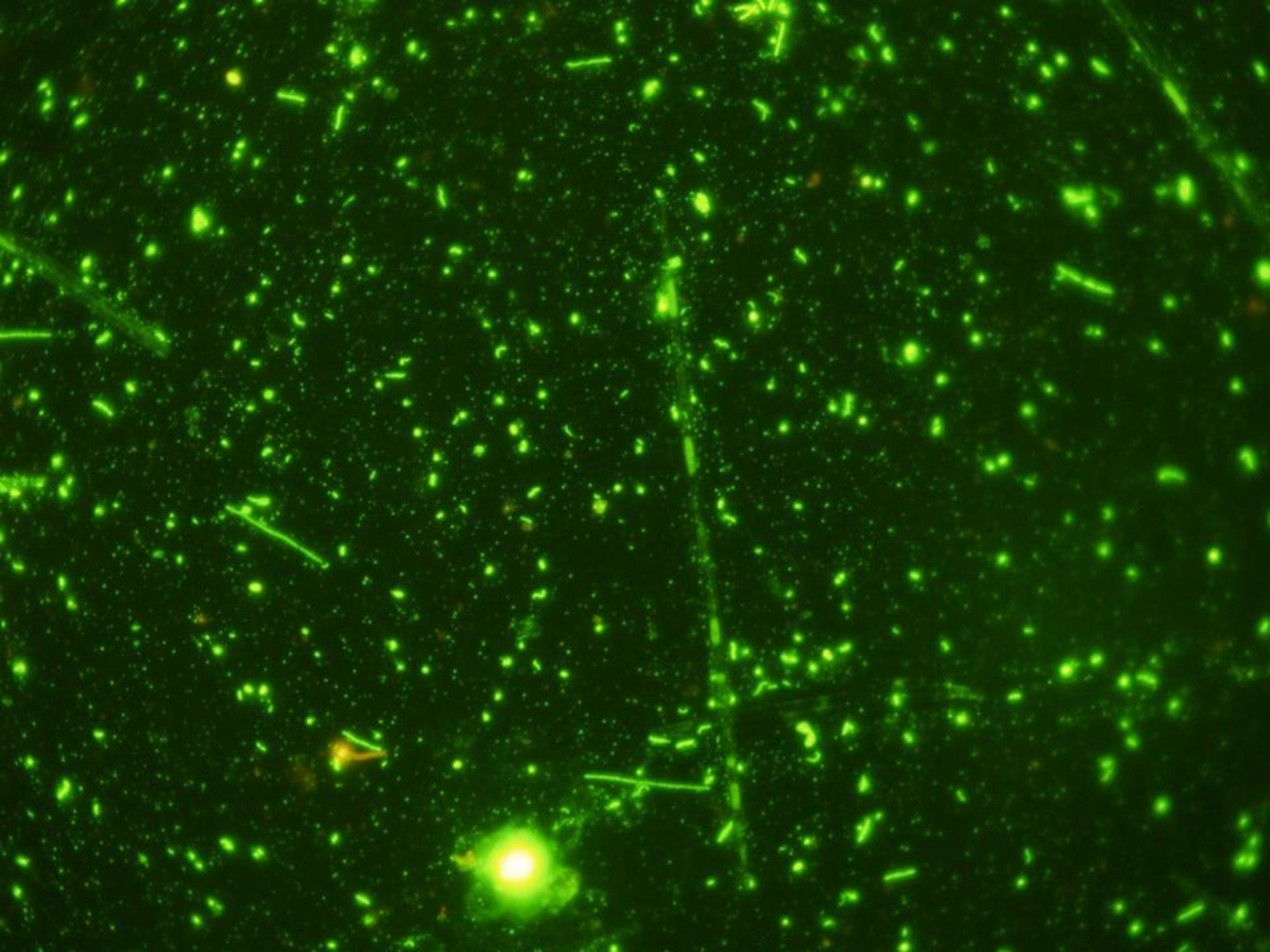
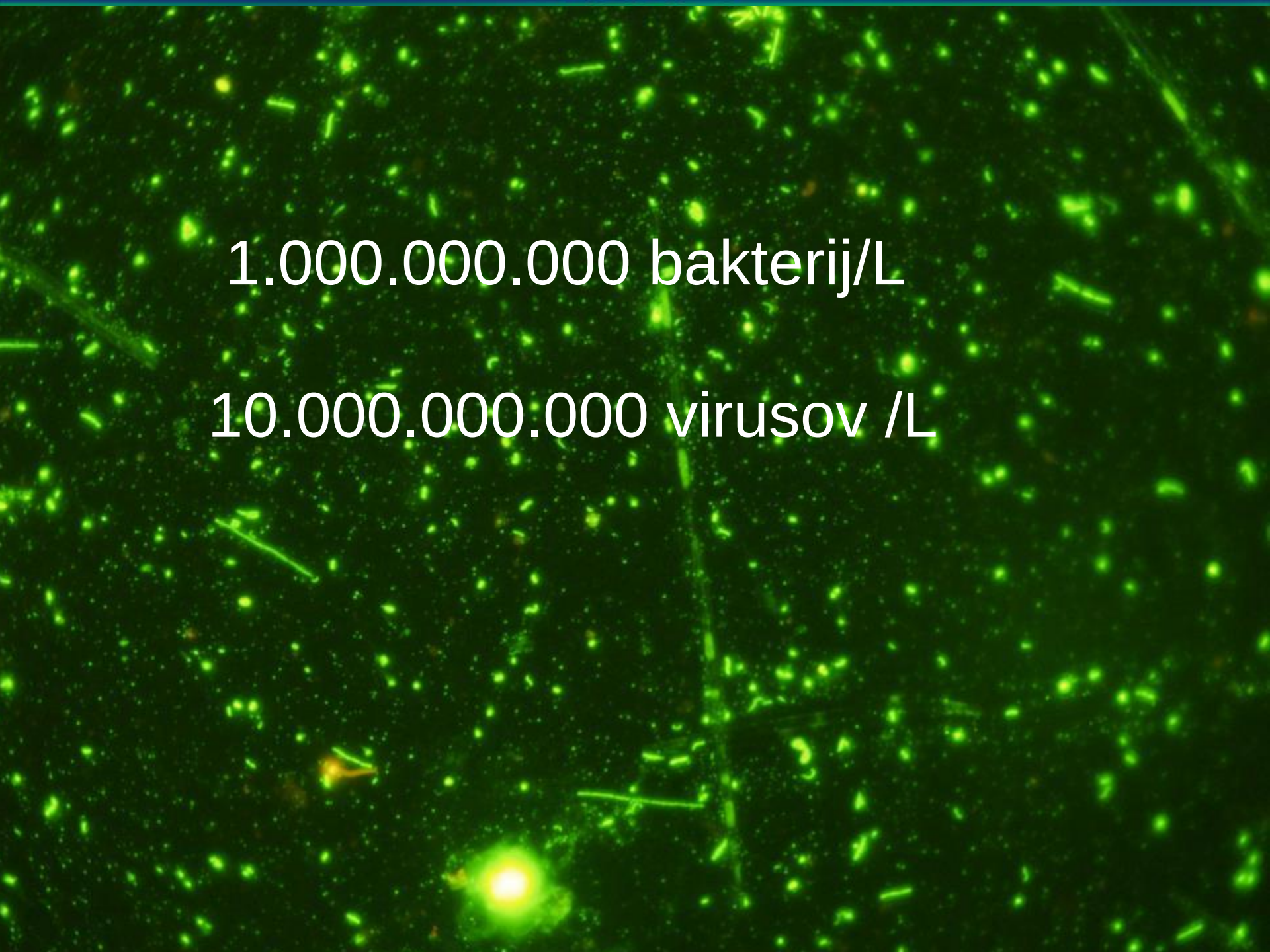


Figure 2 Transmission electron microscopy (**a**, **b**) and scanning electron microscopy (**c**, **d**) images of strains NF5 (left) and

The ISME Journal (2015), 1–13

www.nature.com/ismej




1.000.000.000 bakterij/L
10.000.000.000 virusov /L

Virusi

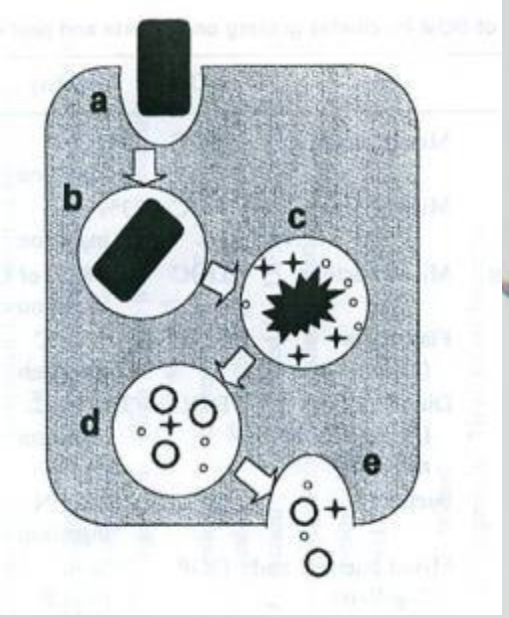
Table 1. Virus morphology in the Gulf of Trieste as determined by transmission electron microscopy

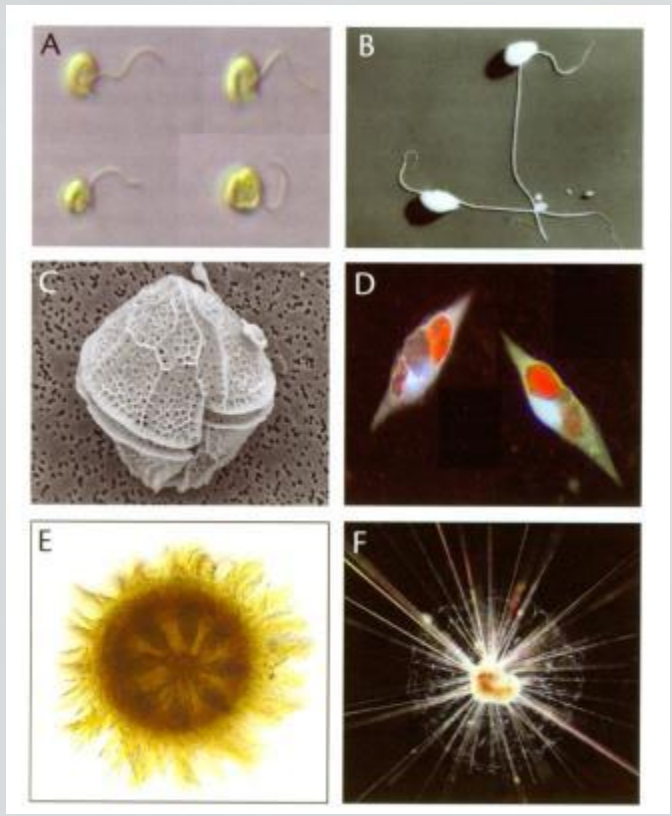
Virus morphology	*Virus family*	*% of virus in the class*	*Head size (nm)*	*Tail size (nm)*
Tailed	*Myoviridae*	12	100 ± 25	80 ± 70
	Siphoviridae	3	50 ± 20	120 ± 90
	Podoviridae	11	55 ± 20	10 ± 5.0
Nontailed	n.d.	74	50 ± 25	

[a]Seawater was concentrated 2000 times prior to the observation. To obtain statistics 400 VLP were characterized. n.d., could not be uniquely determined.

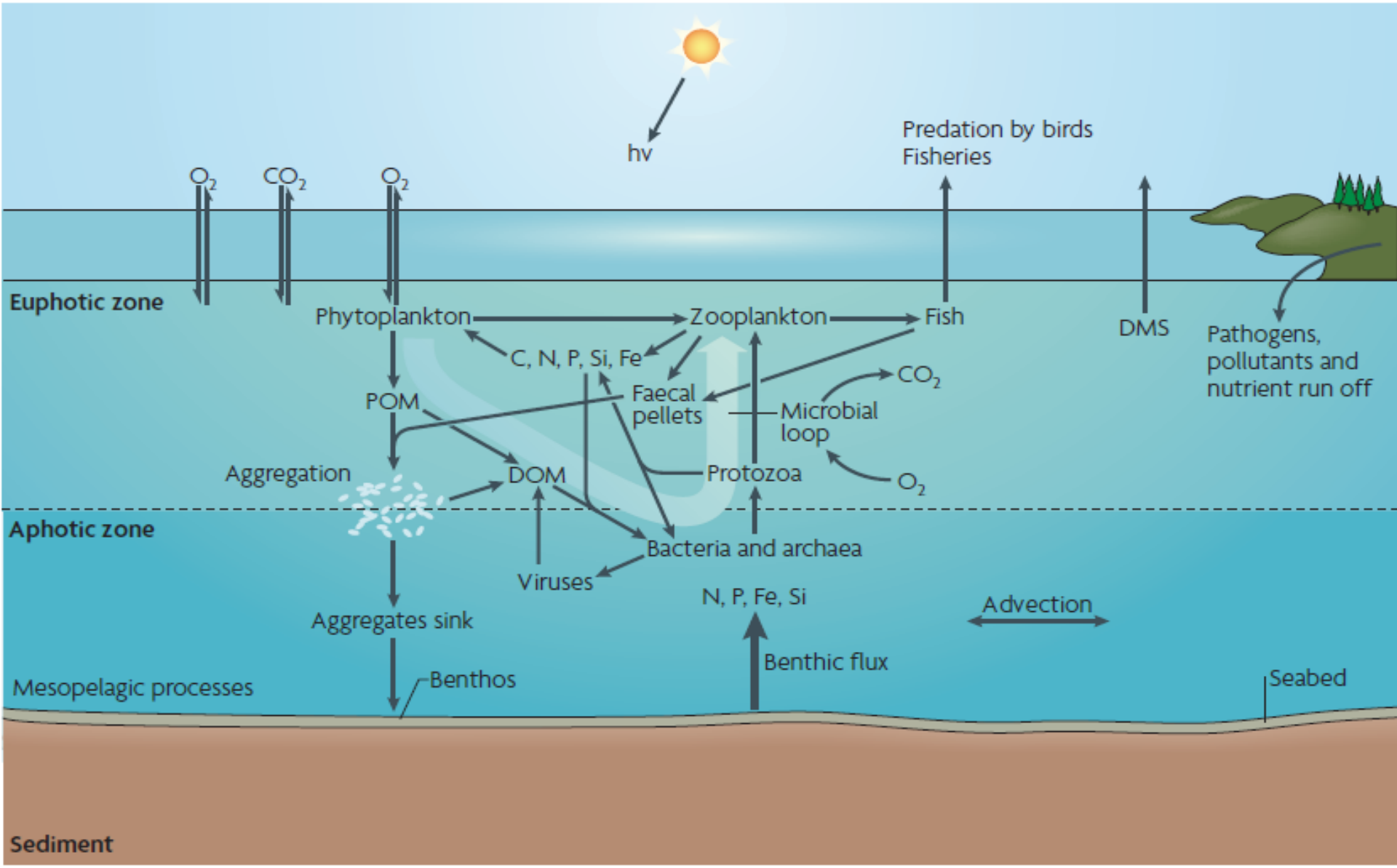
D. Stopar et al: Microbial Community in the Gulf of Trieste

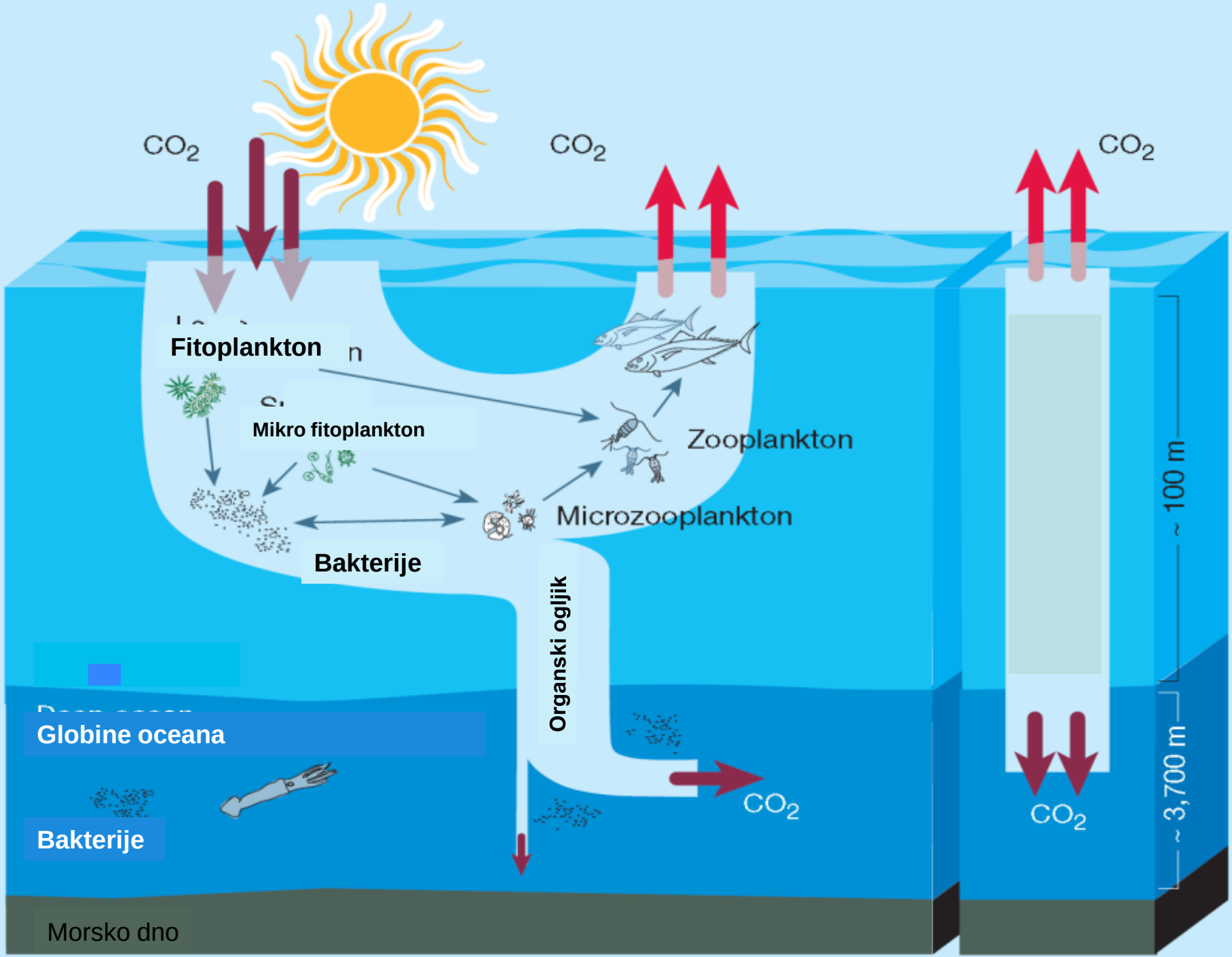
Predatorji



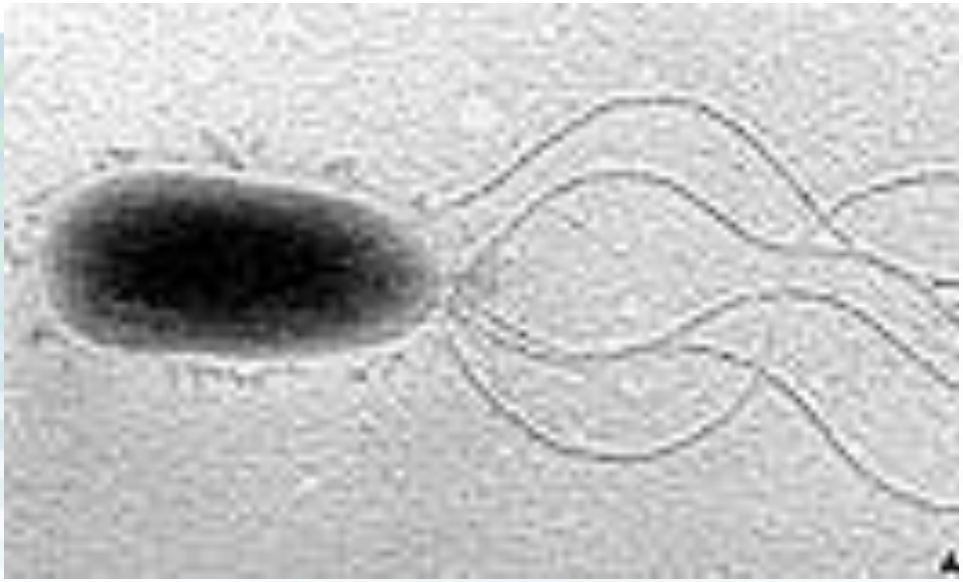


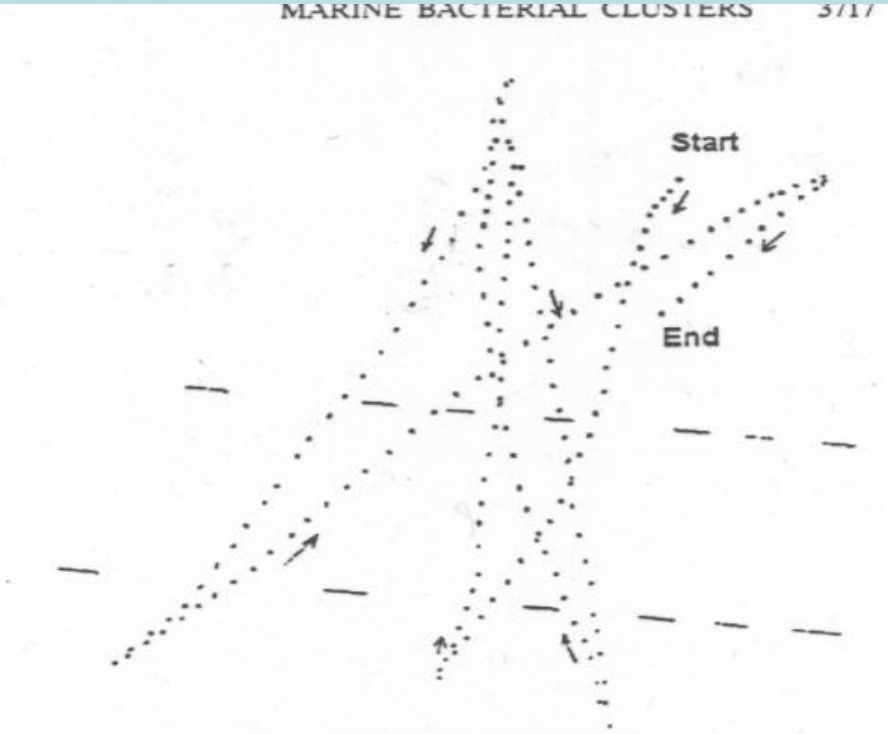
Mikrobna zanka

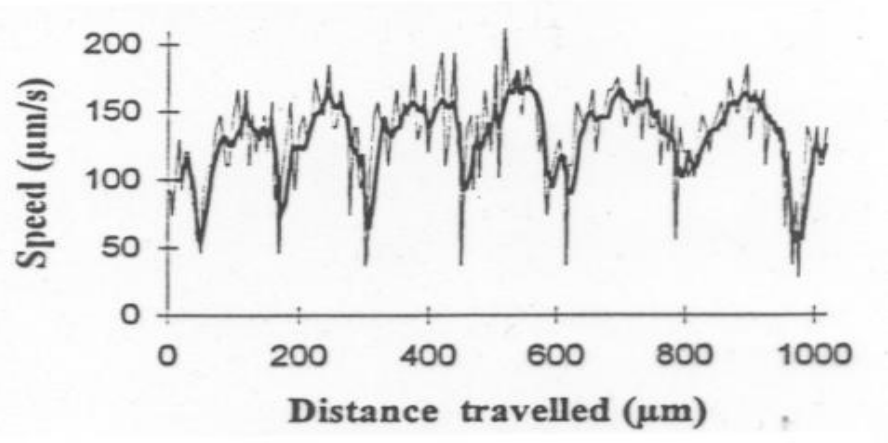



CO_2
CO_2
CO_2
Fitoplankton
Mikro fitoplankton
Zooplankton
Microzooplankton
Bakterije
Organski ogljik
Globine oceana
Bakterije
CO_2
CO_2
~ 100 m
~ 3,700 m
Morsko dno

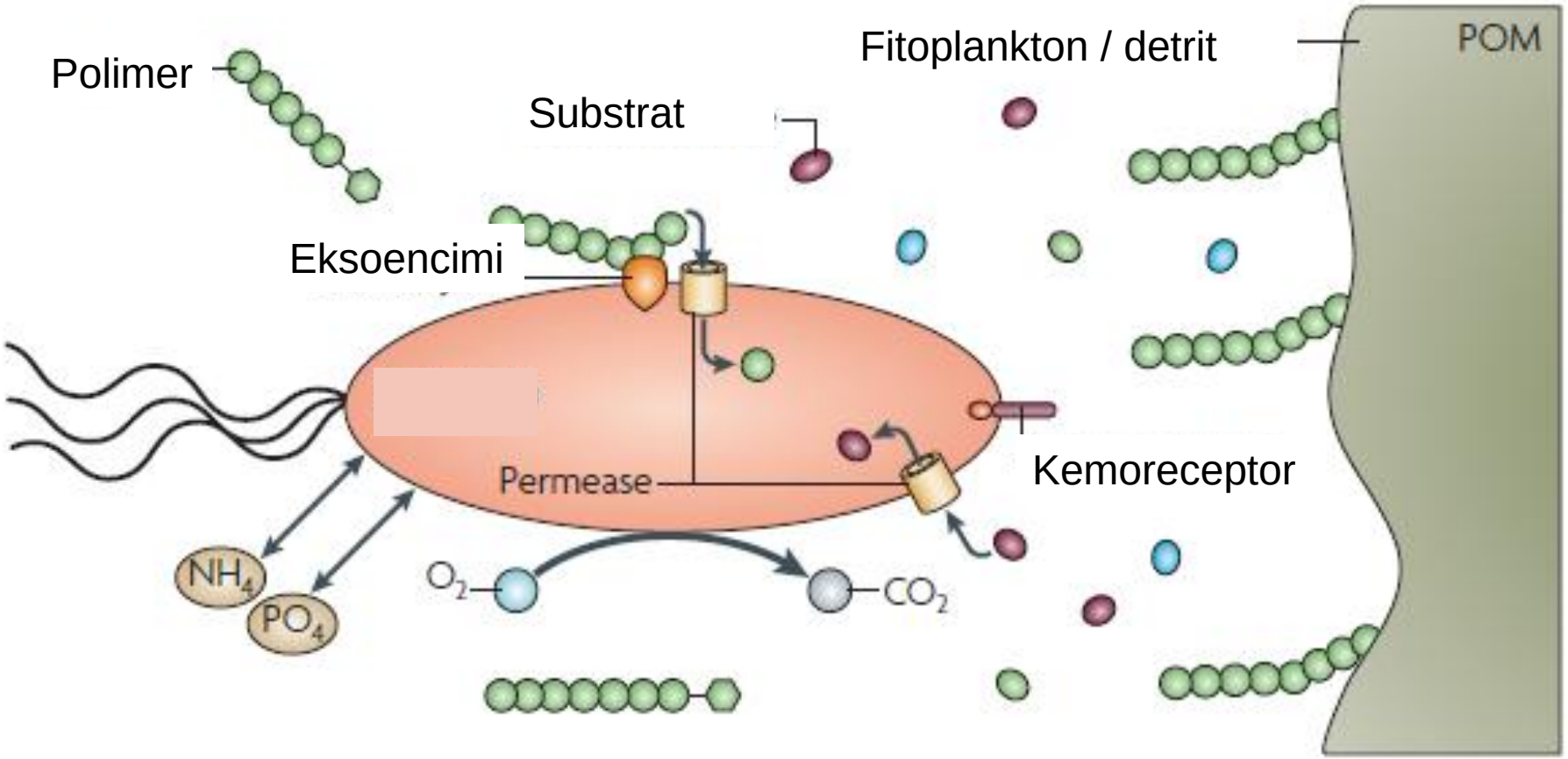
Gibanje in taksije







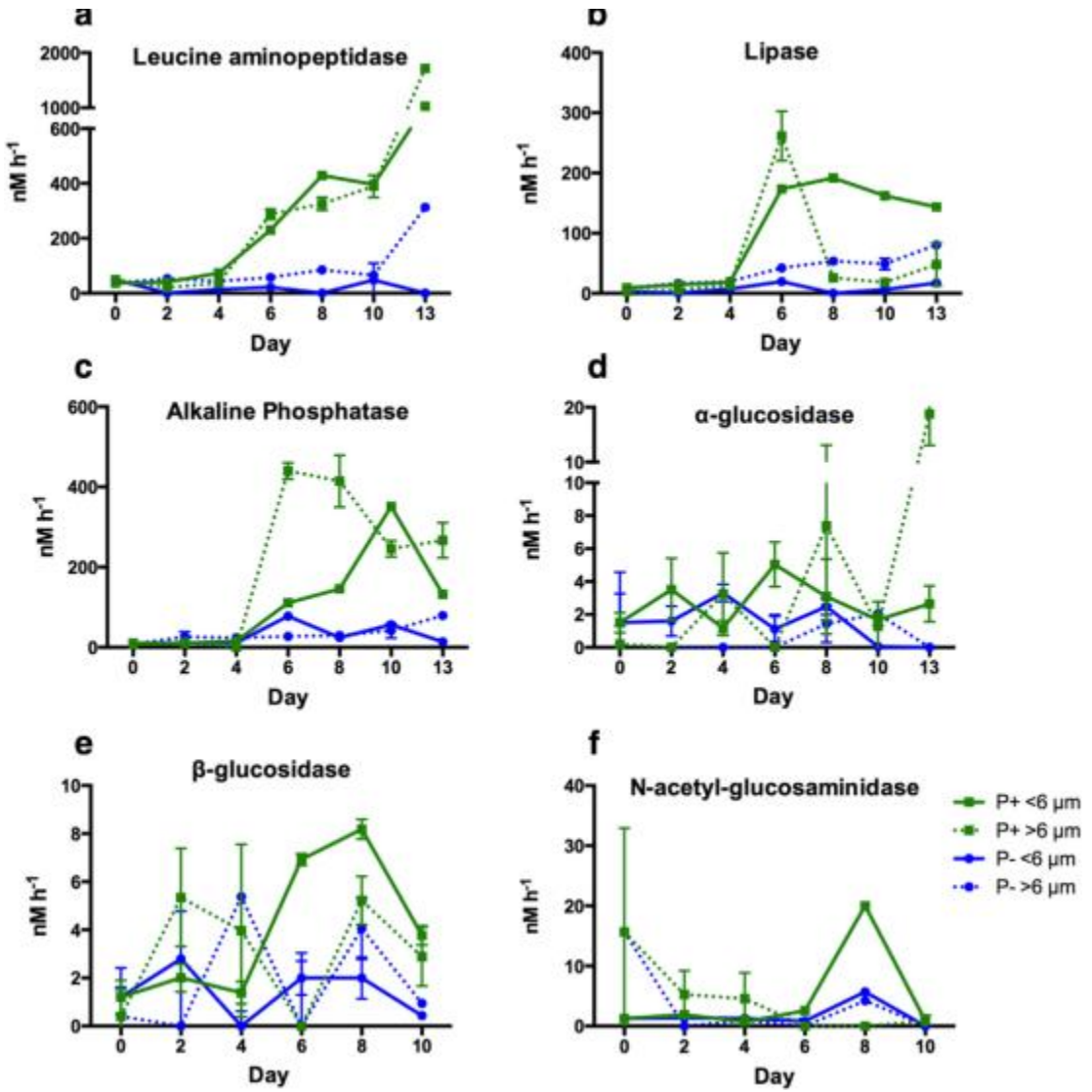
Blackburn N in sod.,1994



Azam & Malfatti, nature reviews | **microbiology Vol 5,** 2007

Delovanje različnih encimov

- Proteaze
- Lipaze
- Glukozidaze
- Hitinaze
- Fosfataze
- ….



F. Malfatti et al. / Science of the Total Environment 470–471 (2014) 1173–1183

Mehanizmi pritrjanja na površine

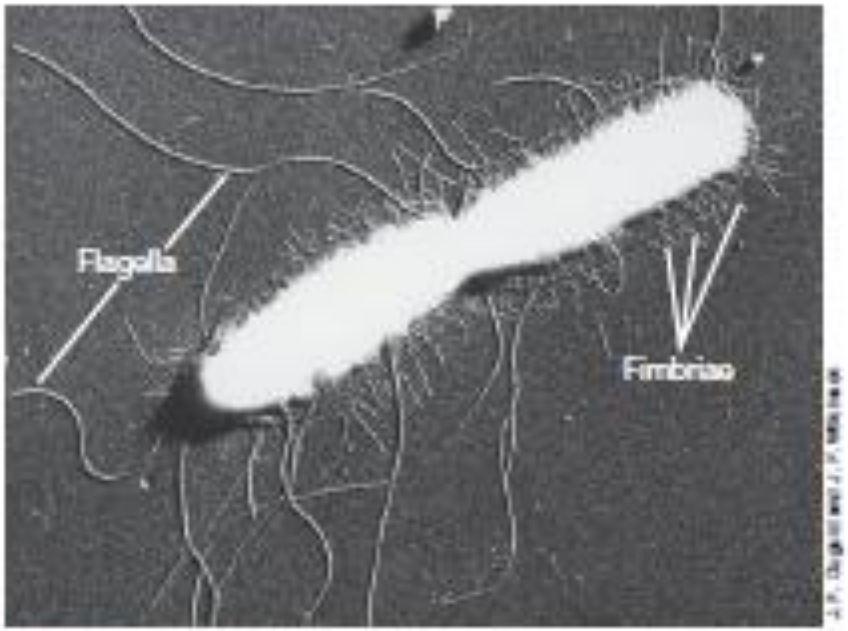
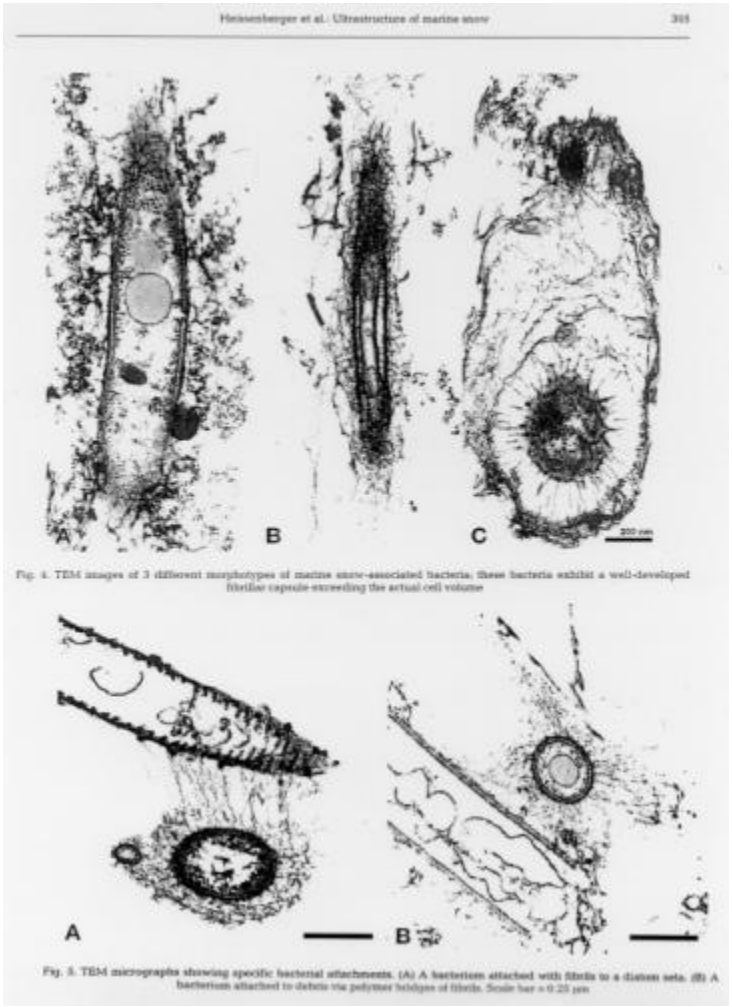
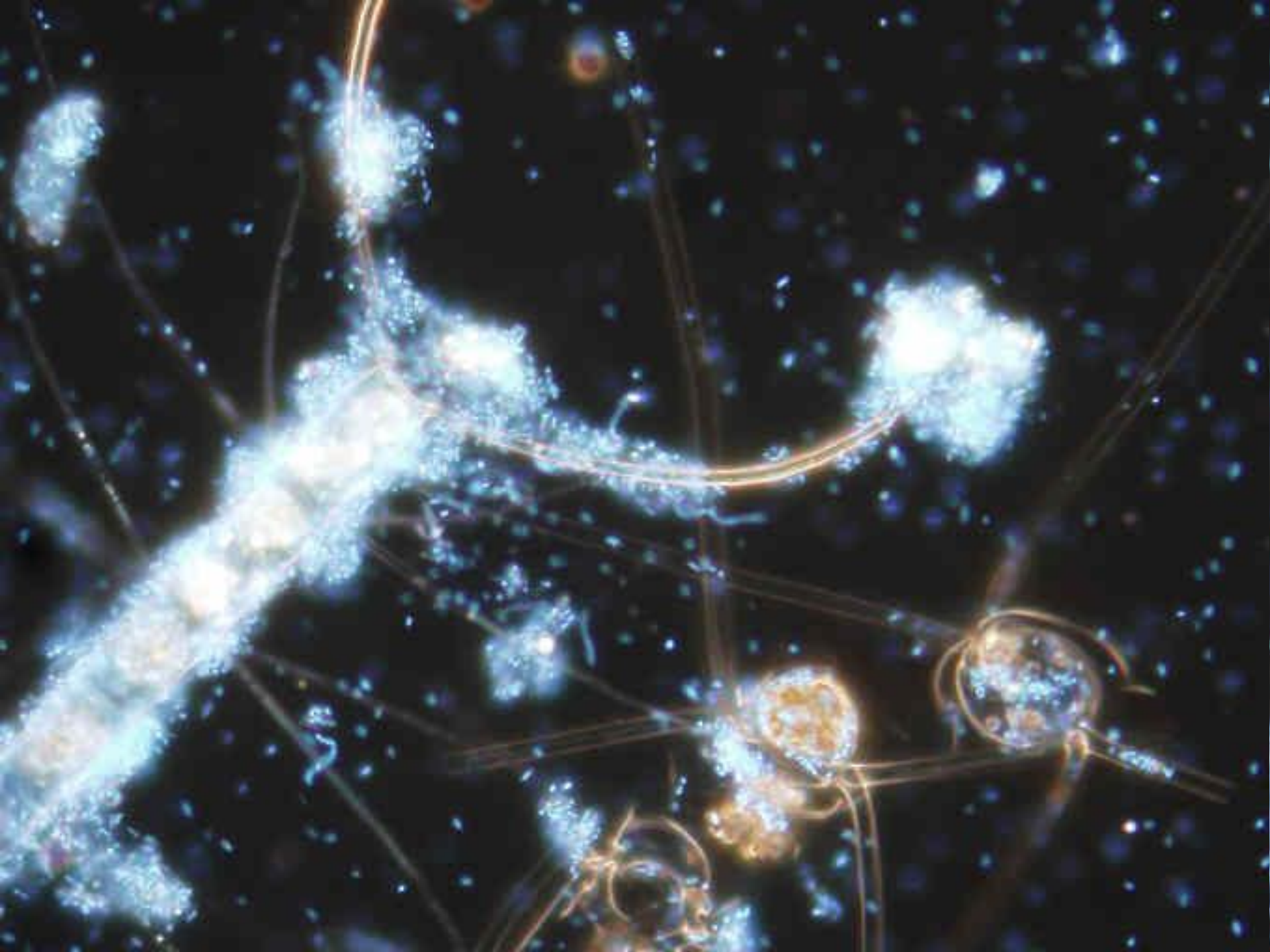
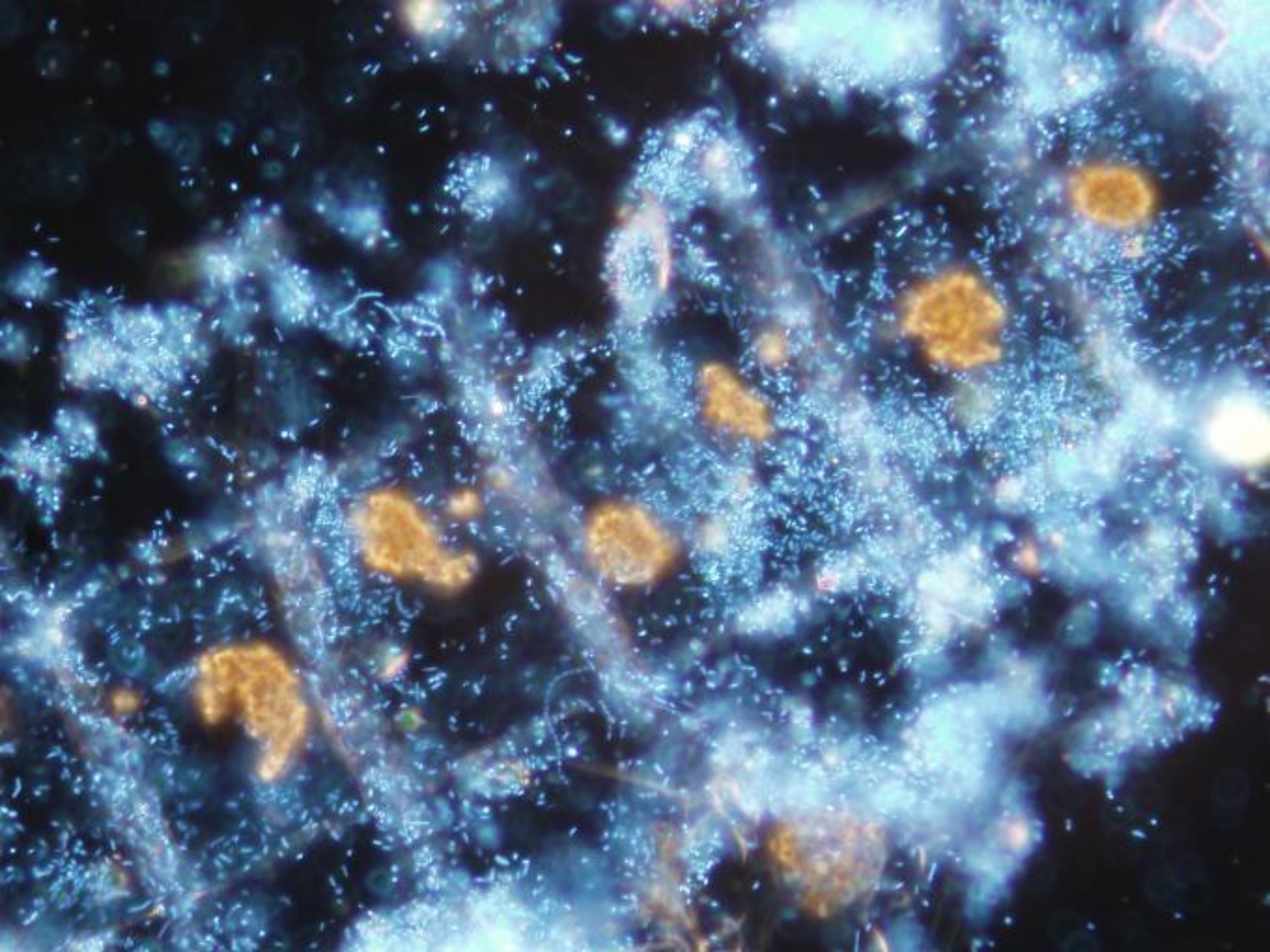


Figure 3.24 Fimbriae. Electron micrograph of a dividing cell of *Salmonella typhi*, showing flagella and fimbriae. A single cell is about 0.9 μm wide.



Heissenberger et al. (1996)

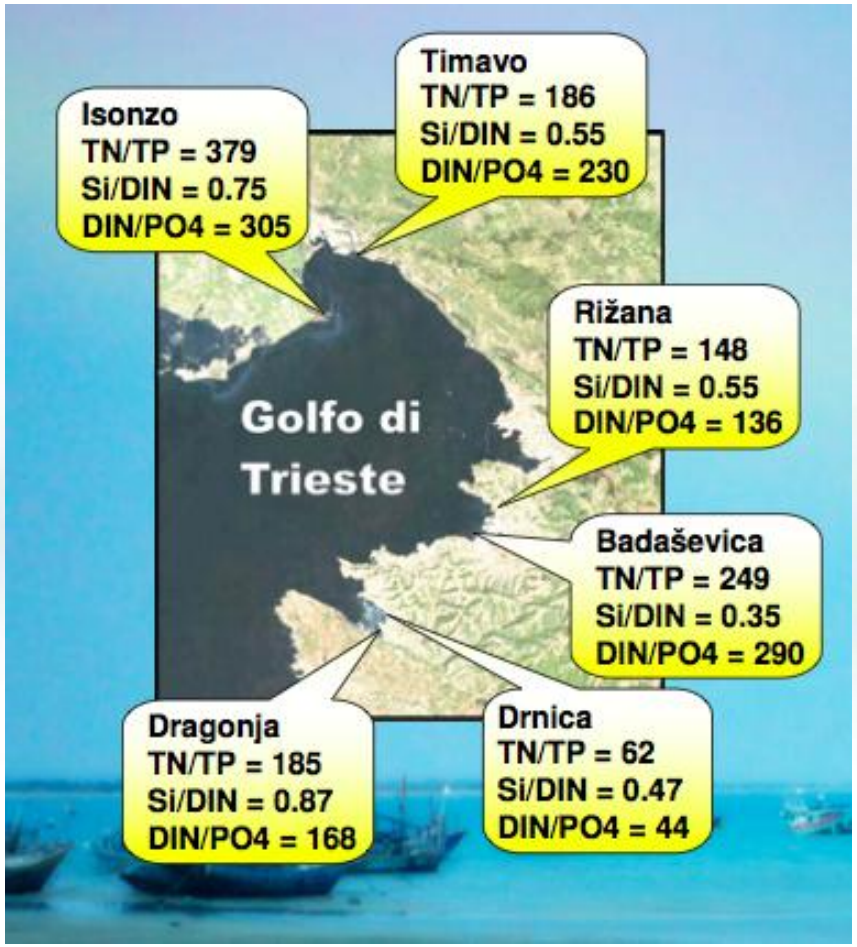




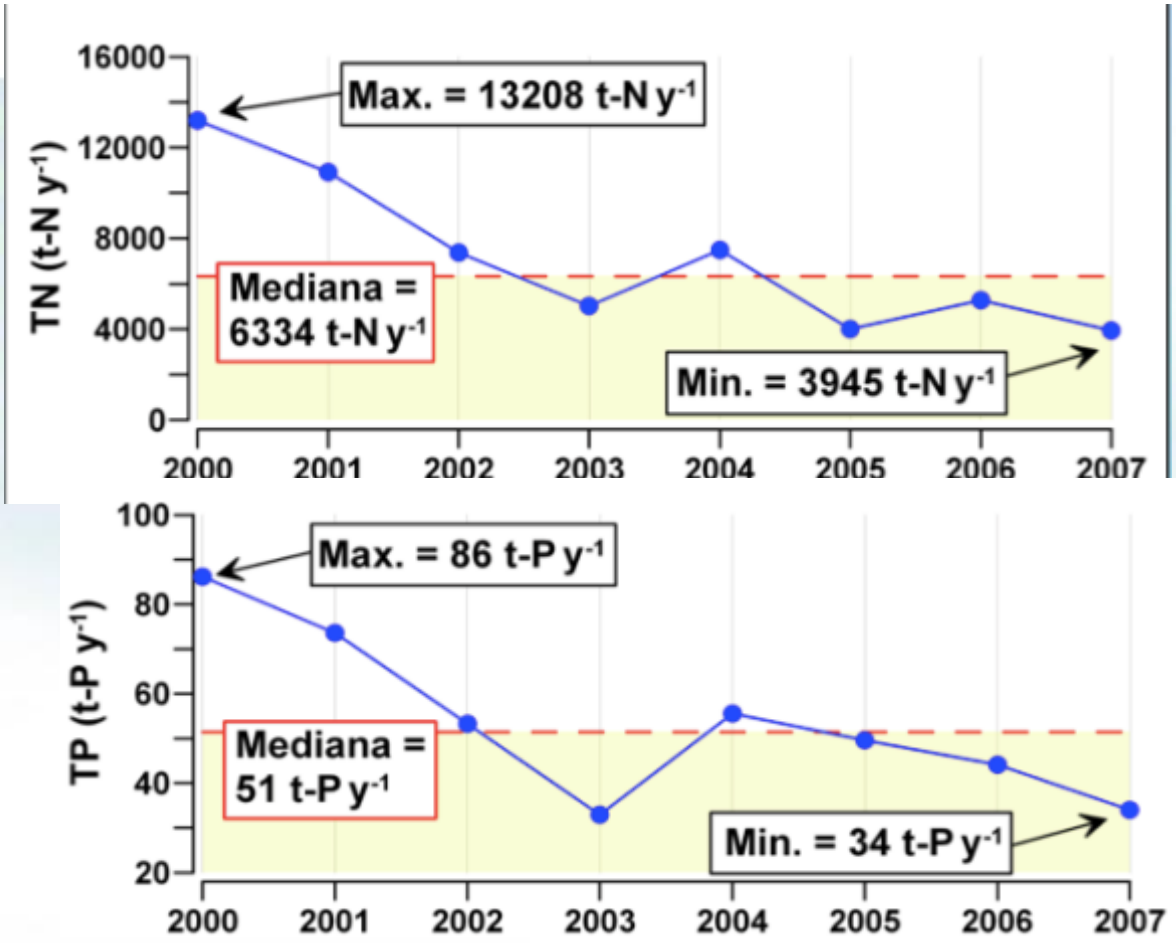

© Glynn Gorick

Vnosi hranil snovi

- Kategorije
  - točkovni viri: reke, odpadne vode, čistilne naprave, industrijske odpadne vode, meteorne vode
  - netočkovni viri: precipitacija, vnos preko atmosfere, spiranje s kmetijskih površin, izpust balastnih voda



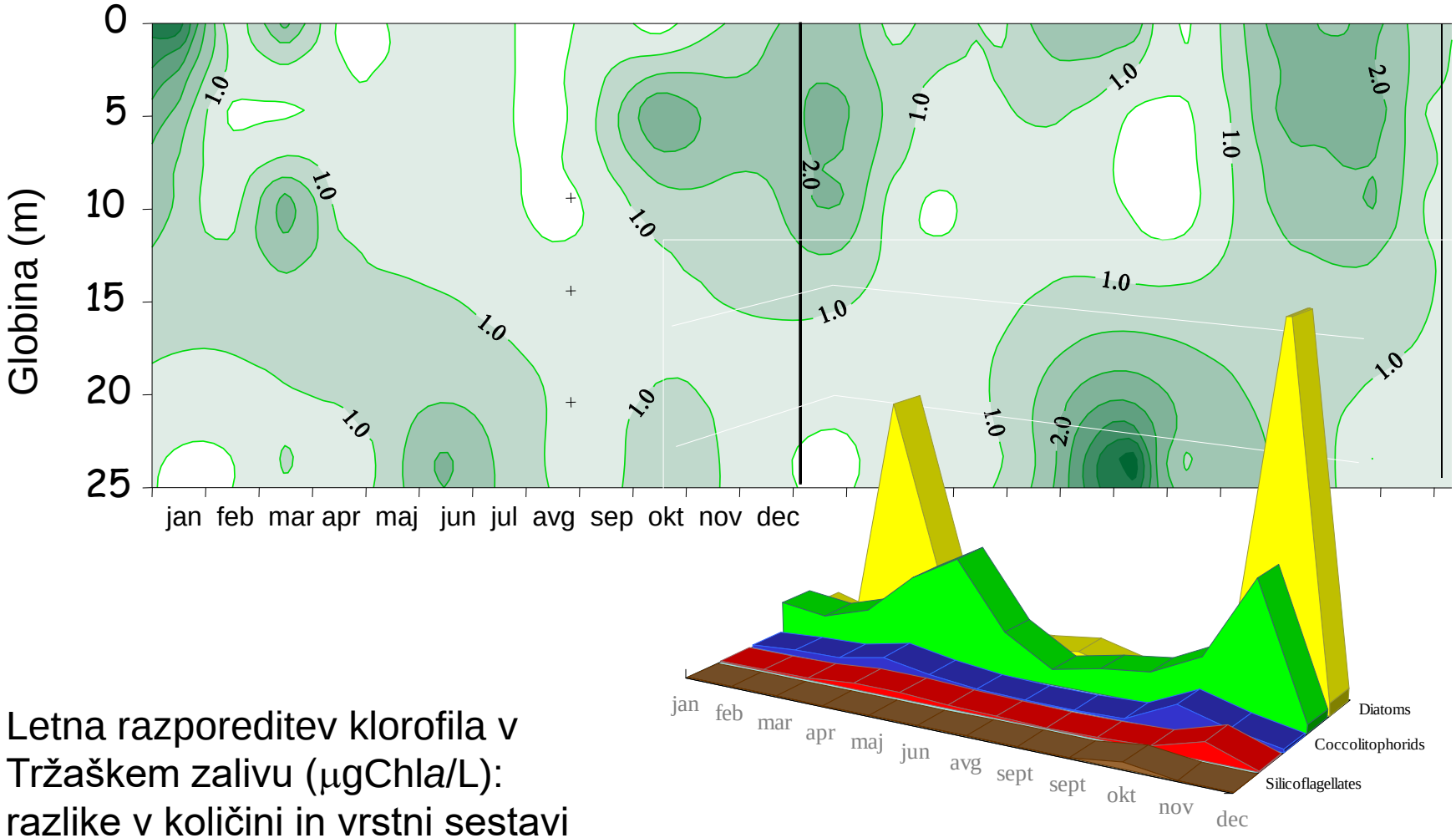
Cozzi et al. 2012, Estuaine Coastal and Shelf Science



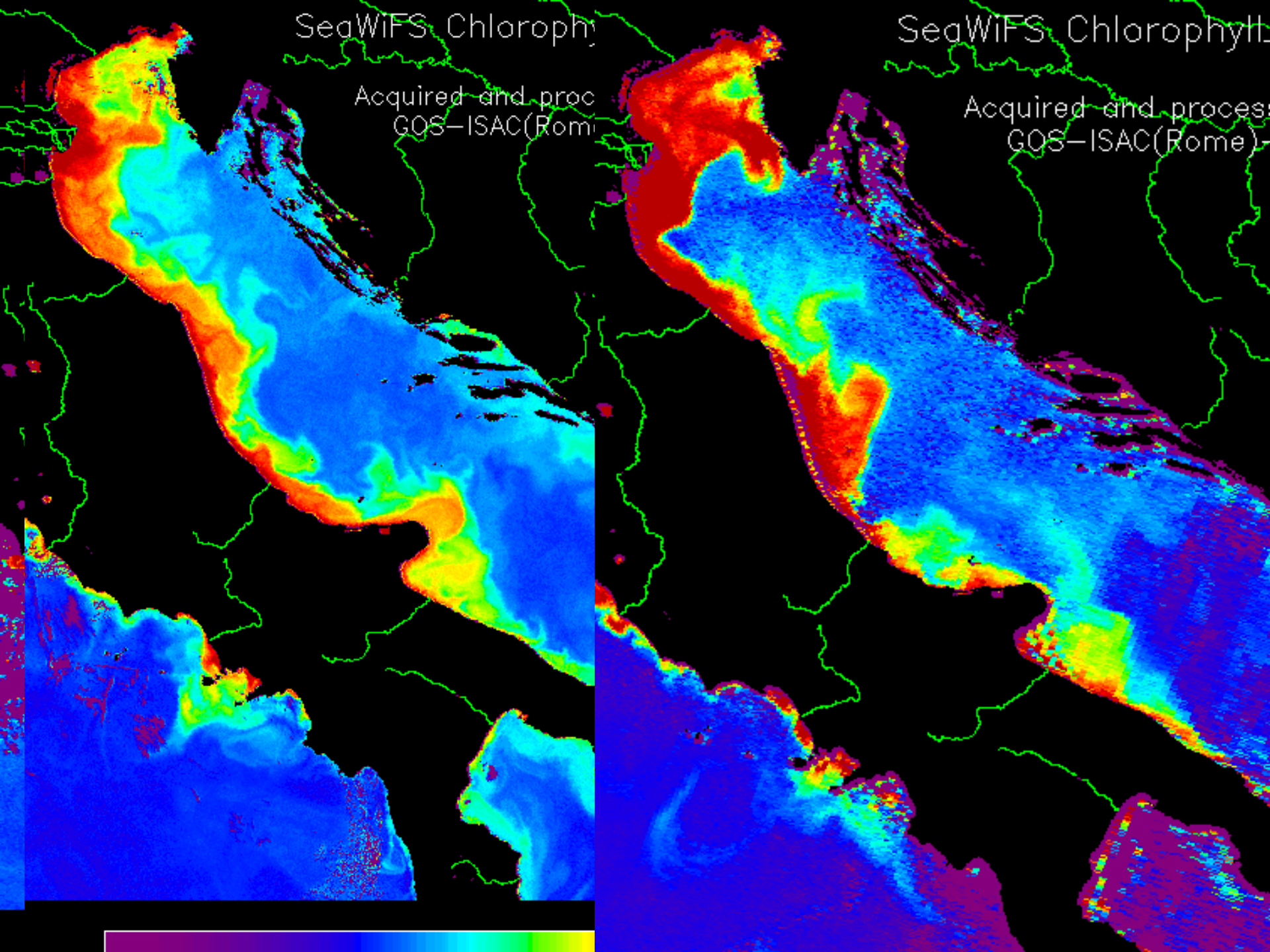
+ Po River : 15.600 t P/leto in 114.000 t N/leto

Cozzi et al. 2012, Estuaine Coastal and Shelf Science

Sezonske razlike fitoplanktona



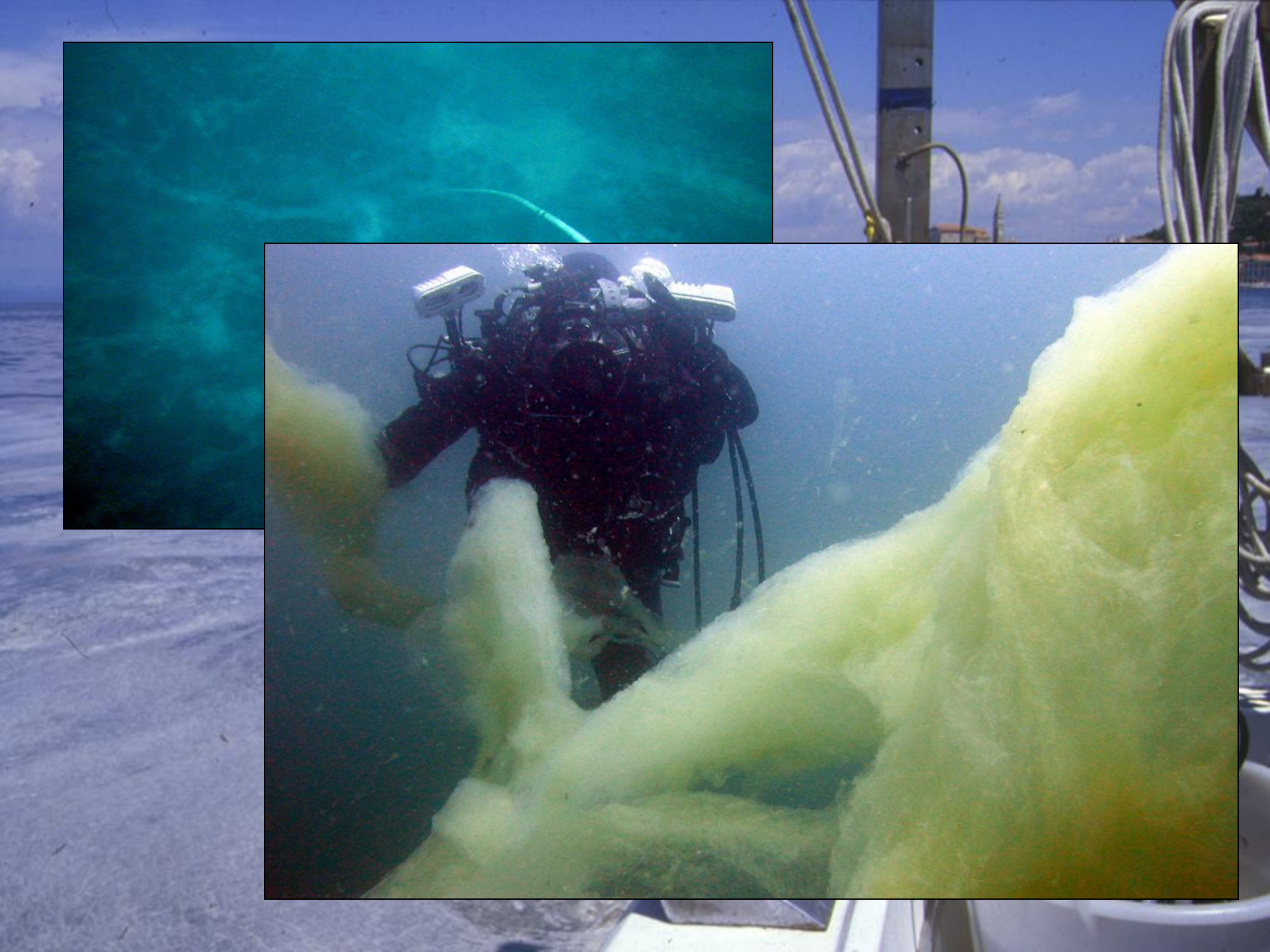
Letna razporeditev klorofila v Tržaškem zalivu (μgChla/L): razlike v količini in vrstni sestavi


SeaWiFS Chlorophy
Acquired and proc
GOS-ISAC(Rom
SeaWiFS Chlorophyll
Acquired and process
GOS-ISAC(Rome)

Cvetenja

Sluzenje morja

povečanje števila celic planktona (> 10 miljonov celic/L)



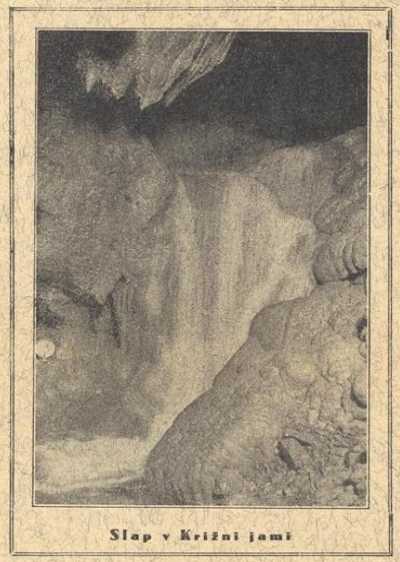
GIOVANNI BIANCHI-Descrizione del tremuoto
grande, che fu in Arimino l'anno 1672,
in : Raccolta d'opuscoli scientifici e filologici",
T.34, Venezia 1746, pp.243-258.

vedi pp.256-257: notizie sulla

Poštnina plačana v gotovini

PROTEUS

ilustriran časopis za poljudno prirodoznanstvo



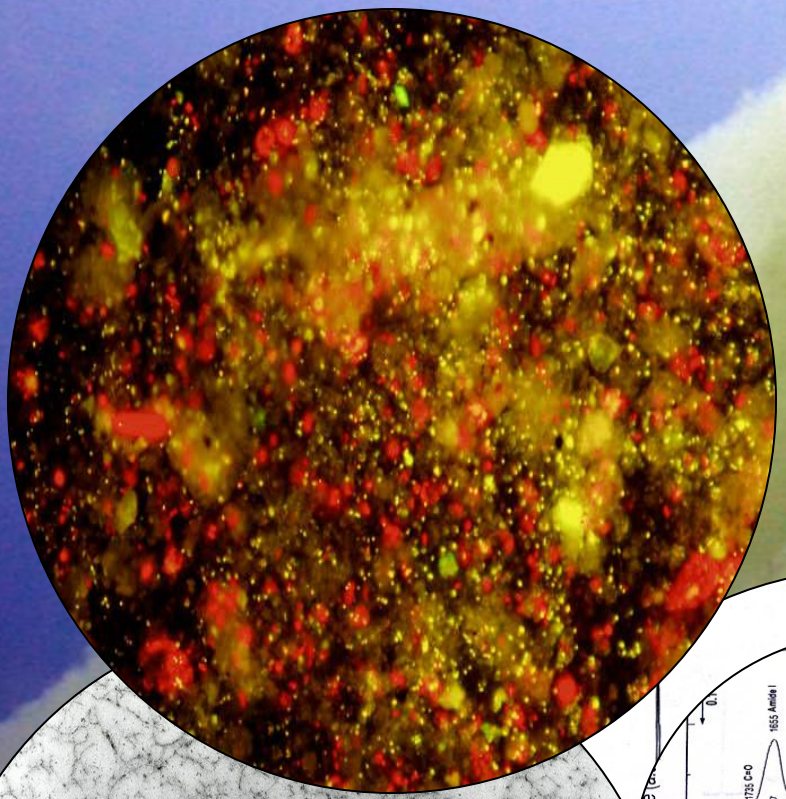
Slap v Križni jami

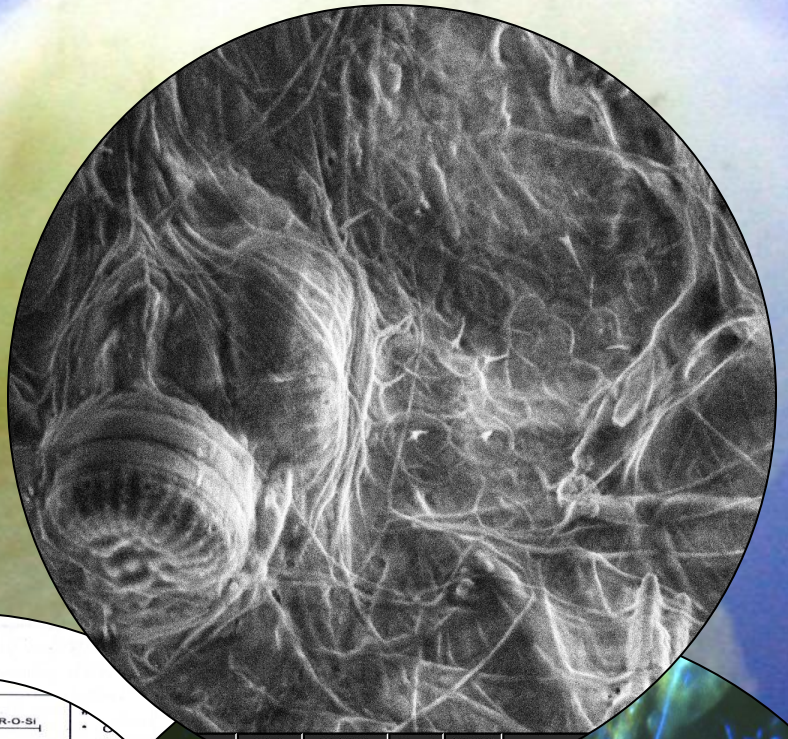
Leto I. ■ FEBRUAR 1934 ■ Štev. 5

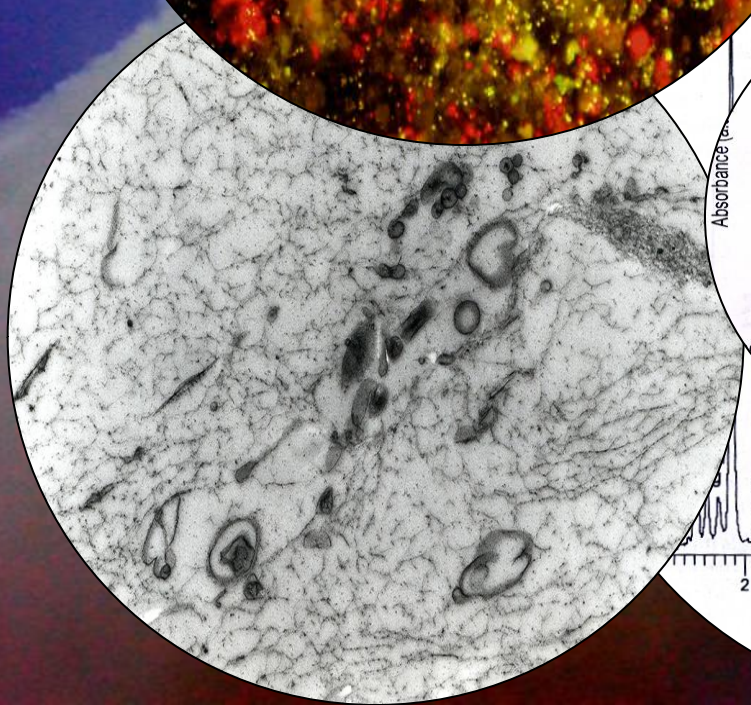
UREJUJE DR. PAVEL GROŠELJ

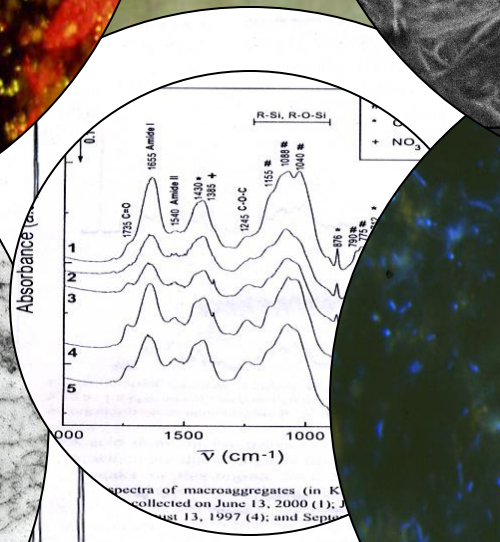
DROBNE VESTI

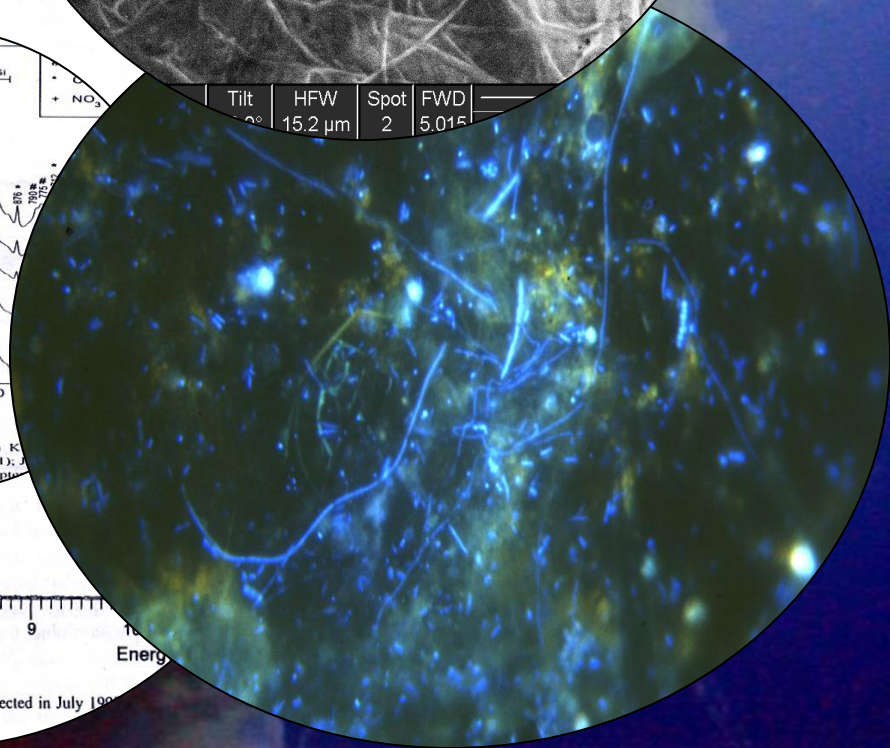
»Umazano morje«, ali, kakor ga nazivljejo Italijani, »mare sporco«, predstavlja pojav, ki ga često opazujemo v gornjem Jadranu, osobito v Reškem zalivu. V poletnih mesecih, juli, avgust, se pojavijo na morski površini rumenkaste ali sivkaste sluzaste krpe, tako, da imamo v istini vtis, kakor da je morje onečiščeno. V tej dobi se vrši lov na sardele in ribiške mreže se neredko napolnijo z odvratnimi masami sluzi, da se trgajo, ko jih vlečejo iz vode, ter da ribe uhajajo. Zato ta pojav ni samo kot prirodni fenomen zanimiv za prirodoslovce, temveč je tudi praktičnega pomena. Že iz starih raziskavanj Castracane-a, Syrskega, Steuer-ja, Cori-ja in dr. vemo, da te sluzaste mase producirajo enostanične kremenaste morske alge (Diatomaceae). Teh mikroskopsko drobnih alg, kojih protoplazmatsko telo je shranjeno v predrobni in krasno skulpturirani kremenasti hišici najraznovrstnejše oblike, se nahaja posebno mnogo v morskem planktonu, to je med stalno plovečimi organizmi. Zato so mislili, da so vprav te alge vzrok zasluzenju morja, češ da pod gotovimi pogoji ali v določeni fazi svojega življenskega cikla izloči vsaka algica zaščitni ovojček iz rahle sluzi. Ti sluzni ovojki se pri medsebojni dotiki strnejo in tako nastajajo skupne večje ali manjše sluzne mase. Medtem pa so nova raziskovanja italijanskega specialista za poznavanje diatomej Zanona Vita v zvezi z morskim biologom D'Anconom, ki si je l. 1929. v Reškem zalivu pribavil primerke »umazanega morja«, pokazala, da imamo opraviti z drugim vzrokom tega pojava. Točna morfološka analiza sluznih mas je pokazala, da izločujejo sluz mase diatomej (določil je okoli 180 raznih oblik v isti sluzni masi!), ki sicer žive epifitsko na morskem dnu (na pol gniložive ali saprobijske vrste, ki preraščajo večje alge in na morskem dnu prirastle živali). Med temi mnogobrojnimi kremenastimi algami sta posebno prevladovali dve obliki, a bilo je med njimi tudi 80 novih vrst za Jadran, a 1 vrsta in 7 podvrst je za znanost popolnoma novih. Drugih organizmov, tudi planktonskih, ni bilo v teh sluznih masah. Kedar se morje na plitvejših mestih jače segreje in dotok sladke vode po močnem deževju morje zadostno nagnoji (t. j. donese soli, ki so za razmnoževanje kremenastih alg potrebne, a jih morje sicer vsebuje le v minimalnih količinah), tedaj se pojavi izredno hitro razmnoževanje, spojeno z izločevanjem sluznih ovojkov, ki se tudi sicer redovito izločujejo. V sluzi se pojavijo plinasti mehurčki, ki se v solnčnih žarkih segrejejo in razširijo. S tem pa zmanjšajo specifično teže sluzi, ki je že sama na sebi le neznatno težja od morske vode. Vsled hitre in obilne rasti razvijejo te diatomeje pravcato plast, ki duši pod seboj vso ostalo vegetacijo in življenje sedavih nežnih morskih živali. Sedaj pa se sluzne krpe za-




Tilt
HFW
15.2 µm
Spot
2
FWD
5.015




R-Si, R-O-Si
1725 C=O
1655 Amide I
1540 Amide II
1430
1395
1245 C-O-C
1155
1088
1040
876
790
775
1
2
3
4
5
1500
1000
ν̄ (cm-1)



S
Cl
K
Ca
Ca
Fe
2
4
6
9

Arheje

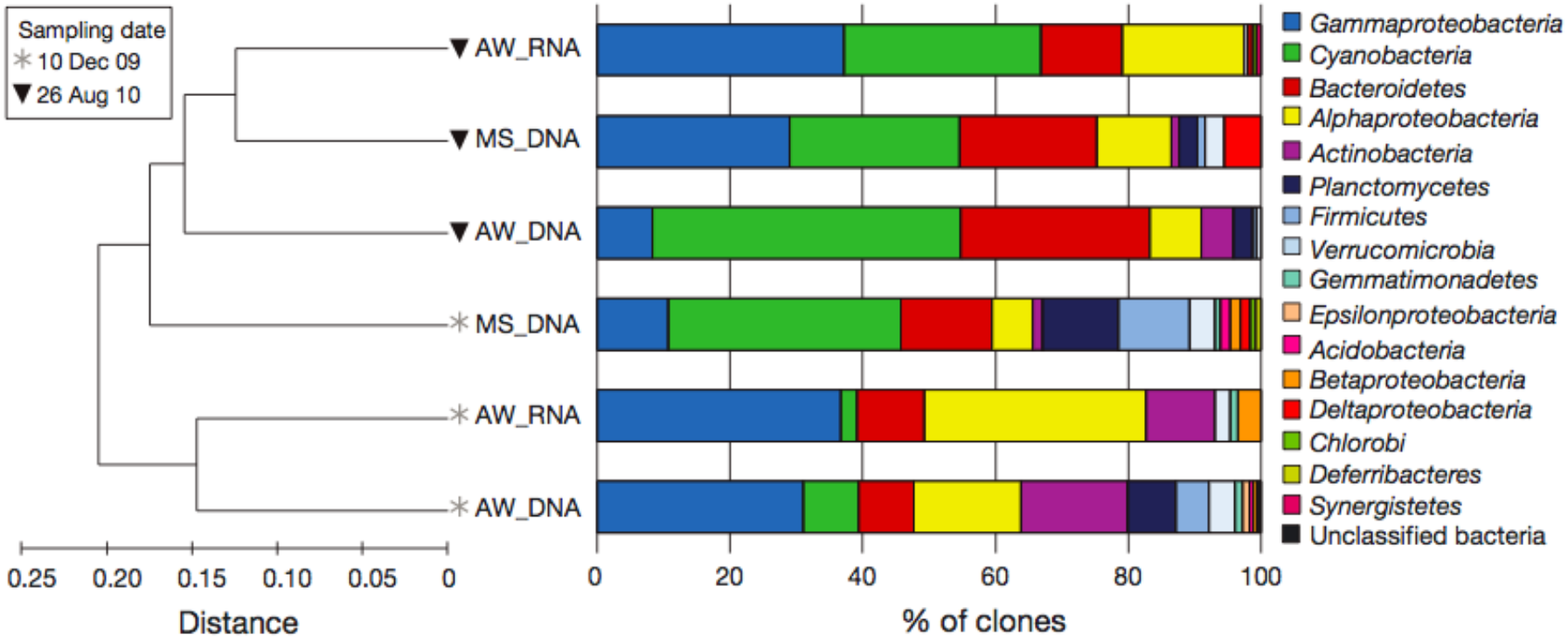


Fig. 3. Bacterial community composition in marine snow (MS) and ambient water (AW) in 2 contrasting months (August and December) based on cloning and sequencing. UPGMA dendrogram constructed based on UniFrac environment distance matrix (Lozupone et al. 2006) followed by the proportion of clones affiliated to each phylogenetic group compared to the total number of clones obtained for each individual sample. Distances between samples are given in UniFrac units (0 = composition identical, 1 = composition completely different). DNA: 16S rDNA, RNA: 16S rRNA

Jana Vojvoda *in sod*., 2014

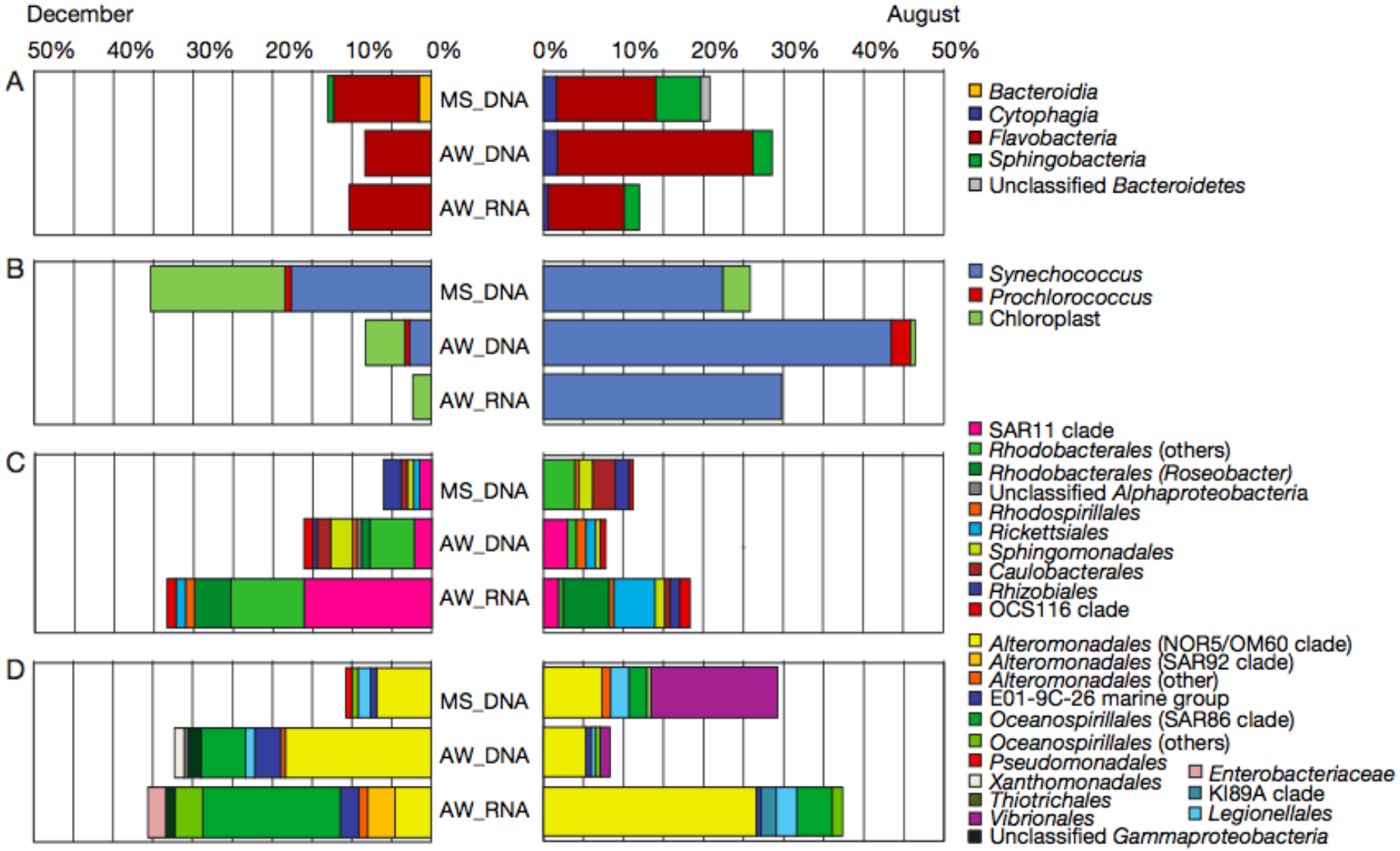
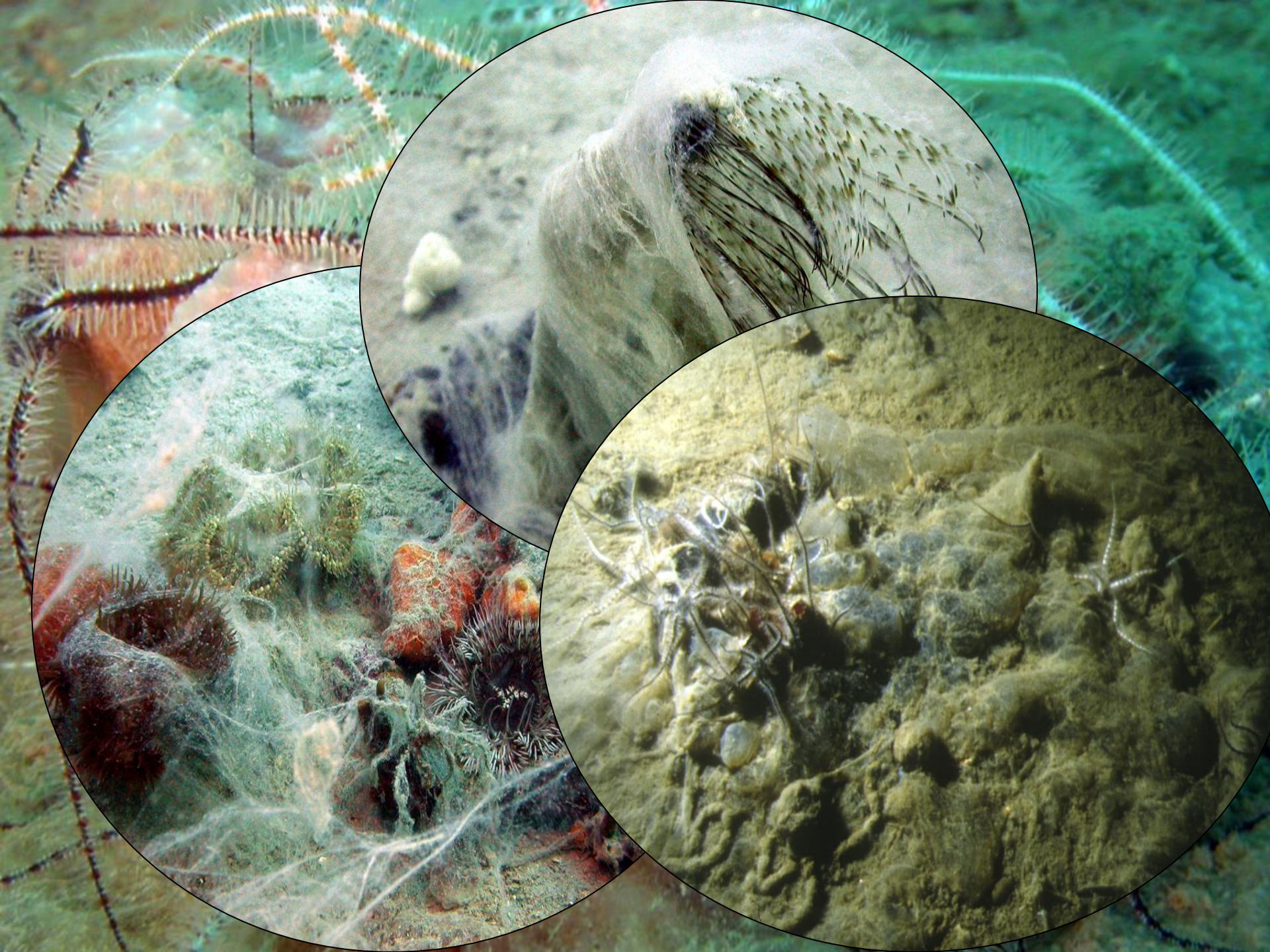


Fig. 4. Phylogenetic classification of the 4 most abundant (>20% of clones) bacterial groups of the northern Adriatic Sea obtained in December and August. (A) *Bacteroidetes*, (B) *Cyanobacteria*, (C) *Alphaproteobacteria*, (D) *Gammaproteobacteria*. The length of differently colour-coded bars indicates the proportion of clones affiliated to each specific phylogenetic group compared to the total number of clones in each corresponding clone library. Dec: December 2009, Aug: August 2010, AW: ambient water, MS: marine snow, rDNA: 16S rRNA genes, rRNA: 16S rRNA



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Mauve stringer (*Pelagia*)

Barrel jellyfish (*Rhizostoma*)

Moon jellyfish (*Aurelia*)

Compas jellyfish (*Chrysaora*)

Fried egg jellyfish (*Cotylorhiza*)

Razgradnja

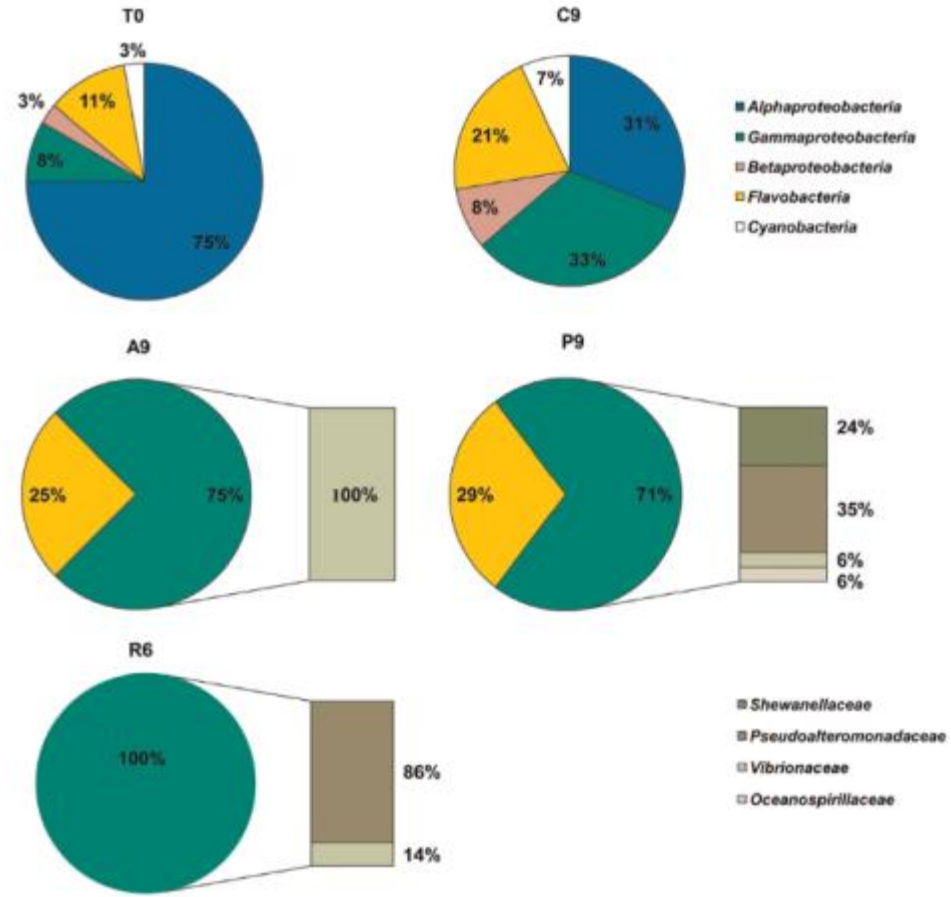


Figure 4. The distribution of phyla in each 16S rRNA library (% of clones) from different treatments. DNA extraction from the s
the beginning of the experiment (T0), on day 9 from the control (C9), on day 9 from the treatment with *Aurelia* (A9) and treatment with *Pel*
and on day 6 from the treatment with *Rhizostoma* (R6).
doi:10.1371/journal.pone.0039274.g004

JELLYFISH BLOOMS

Degradation of the Adriatic medusa *Aurelia* sp. by ambient bacteria

Tinkara Tinta · Alenka Malej · Maja Kos · Valentina Turk

Journal of Experimental Marine Biology and Ecology

Microbial transformation of jellyfish organic matter affects the nitrogen cycle in the marine water column – A Black Sea case study

Tinkara Tinta *,1, Tjaša Kogovšek *,1, Valentina Turk *, Tamara A. Shiganova *, Alexander S. Mikaelyan b, Alenka Malej *

PLoS one

Jellyfish Modulate Bacterial Dynamic and Community Structure

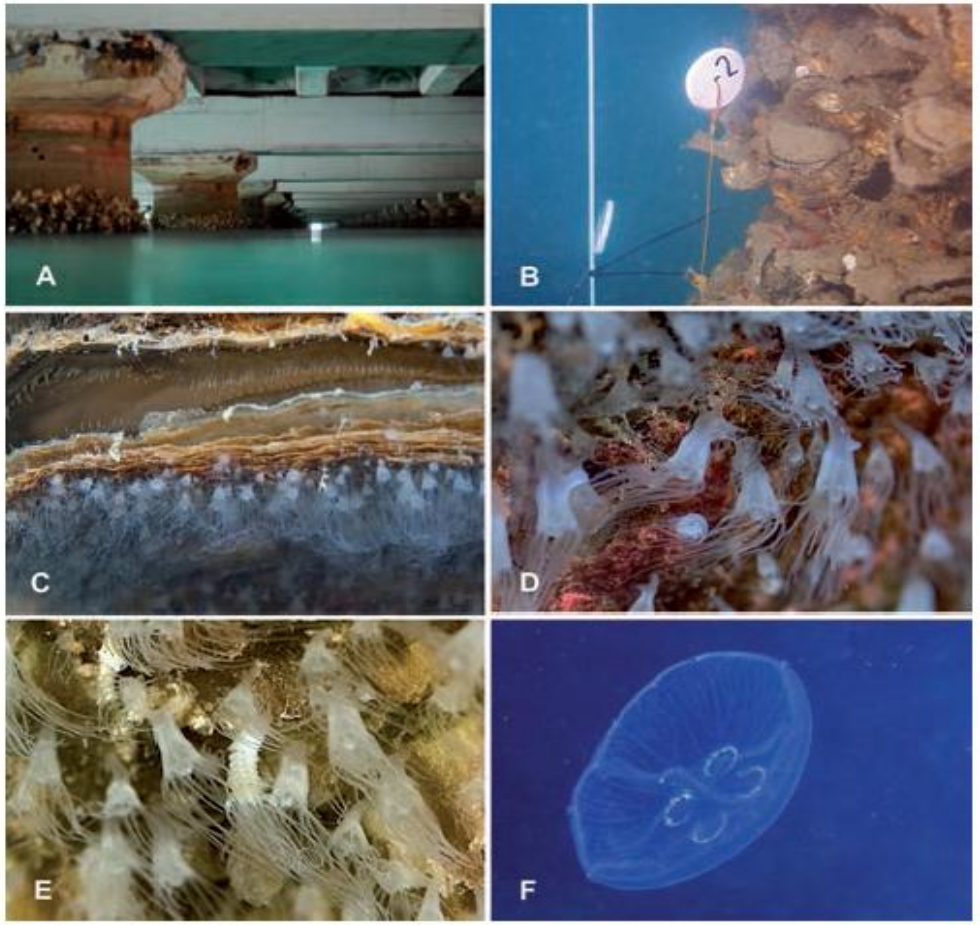
Tinkara Tinta, Tjaša Kogovšek, Alenka Malej, Valentina Turk*

Vnos in podlaga tujerodnih organizmov

- Površina struktur: 21.600 m^2
- Gostota: 6-27 polipov /cm^2
- Največ 18 strobil/ polip
- 82% polipov strobilira od Nov do Mar

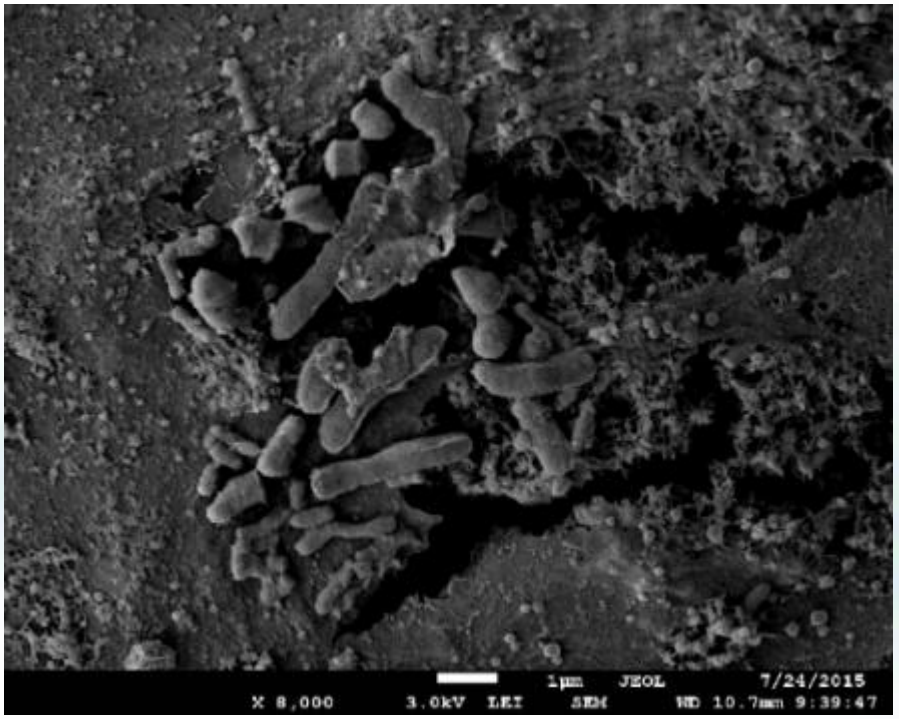
Luka Koper 3456 x 10^6 polipov

5.1 x 10^{10} efir (Nov)

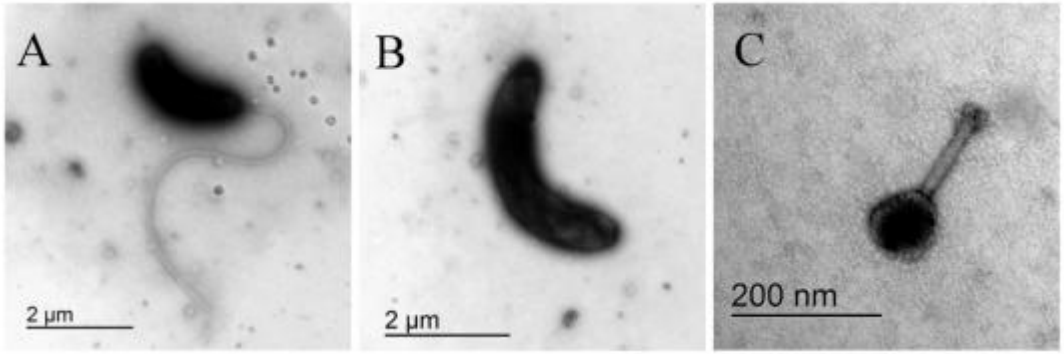


Malej *et al*. (2012) Can.Biol.Mar.53:337-342

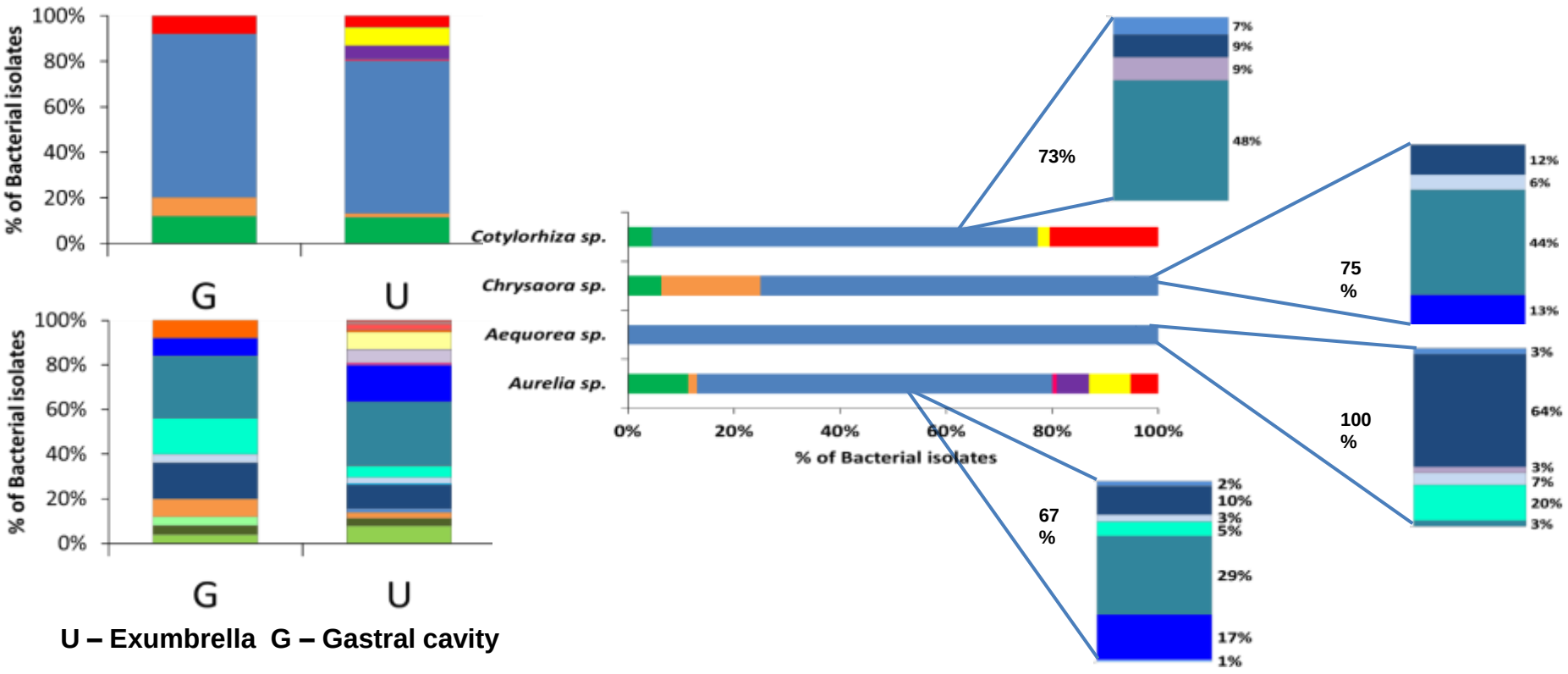
Mikrobi - površine polipov



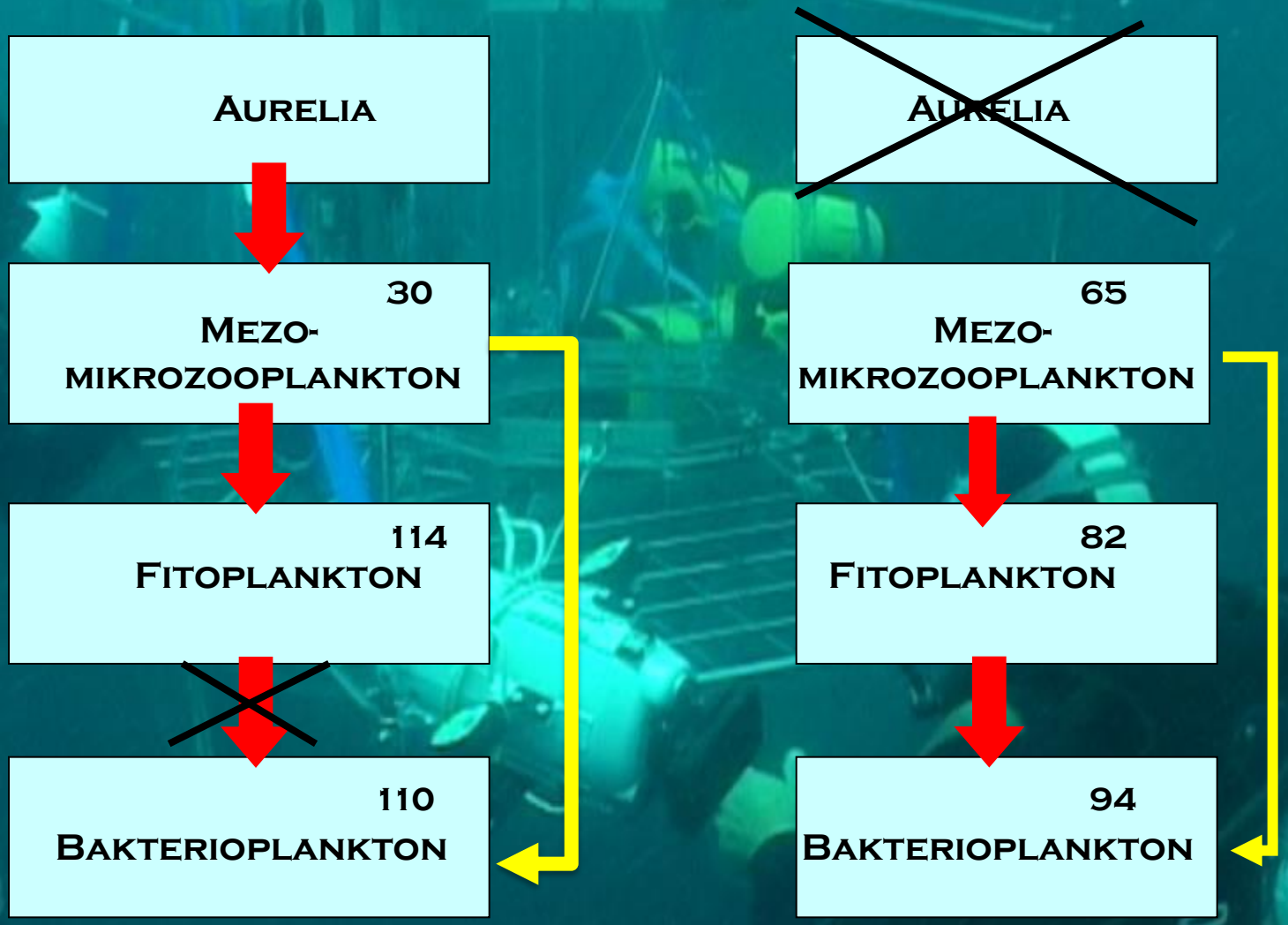
Ana Fortič - Master thesis, 2016



Bakaterije - meduze

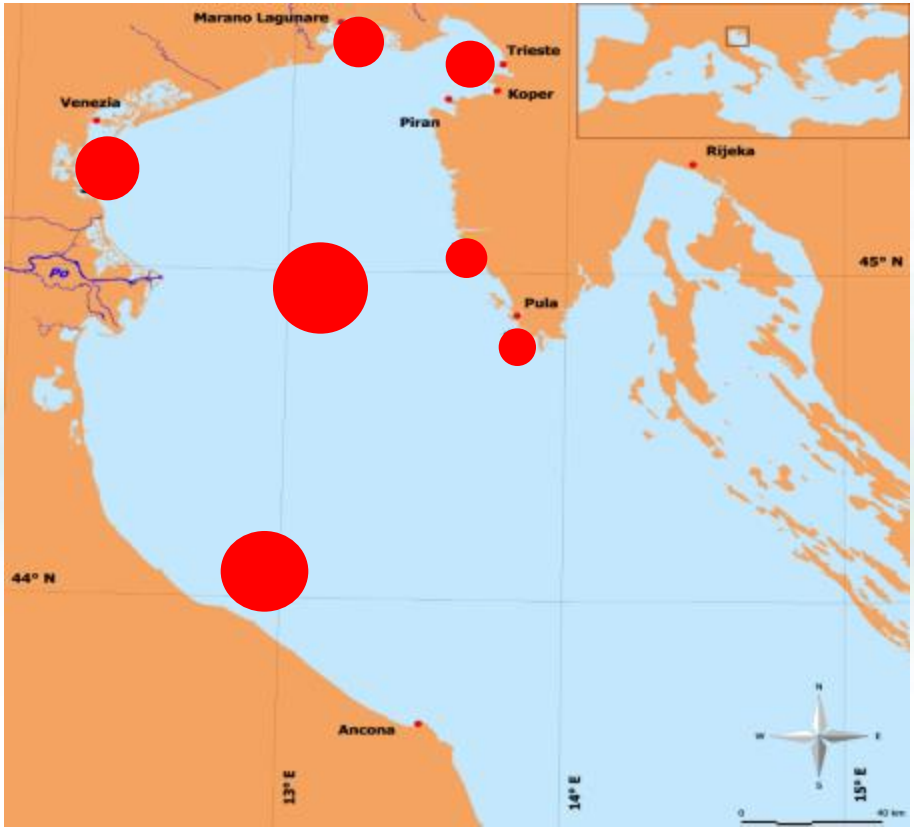


Maja Kos- Kramar *in sod*., in prep.


Aurelia
30
Mezo-
mikrozooplankton
114
Fitoplankton
110
Bakterioplankton
Aurelia
65
Mezo-
mikrozooplankton
82
Fitoplankton
94
Bakterioplankton

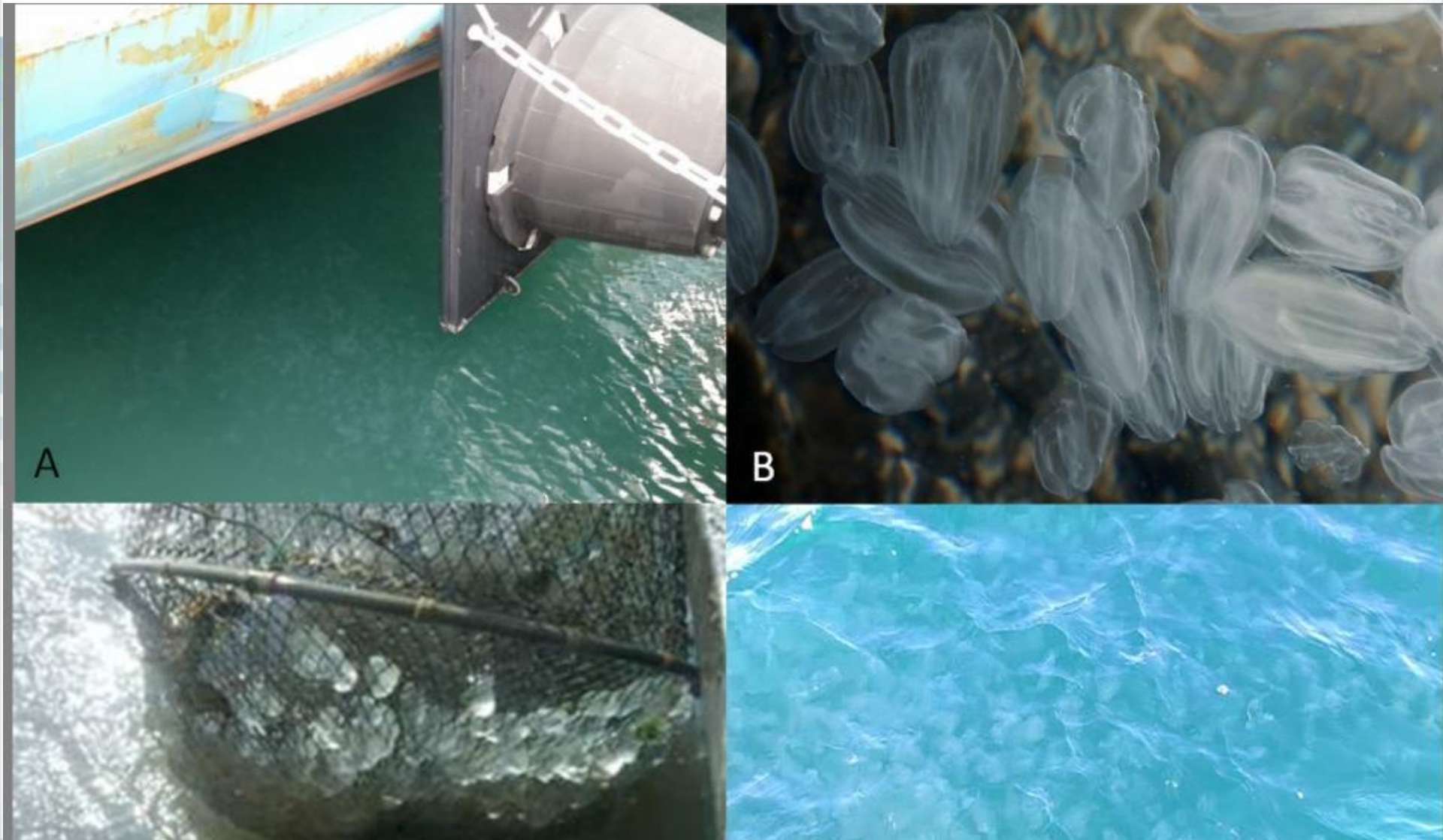
Mnemiopsis leidyi (Ctenophora)

- Oktober 2005
  - prvi zapisi prisotnosti *M. leidyi*
- Julij – November 2016
  - *M. leidyi* različne lokacije v severnem Jadranu (temp. od 13° C do 28° C)
    - Razmnoževanje *M. leidyi*
  - maks. produkcija jajc
    13.512/ind/dan



Malej et al., 2017, Invasive Mnemiopsis leidyi (Ctenophora) in the northern Adriatic: here to stay? ASLO Meeting 2017

Invazija rebrač *Mnemiopsis leidyi*



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Infrastruktura

Površina 2.500 m^2:

- Dormitorij z 24 ležišči
- Kongresna dvorana (95 sedežev), učilnica (40 sedežev), sejna soba (25)
- Knjižnica : 1500 znanstvenih monografij in 60 specializiranih revij
- Potapljaška baza in delavnica

NIB

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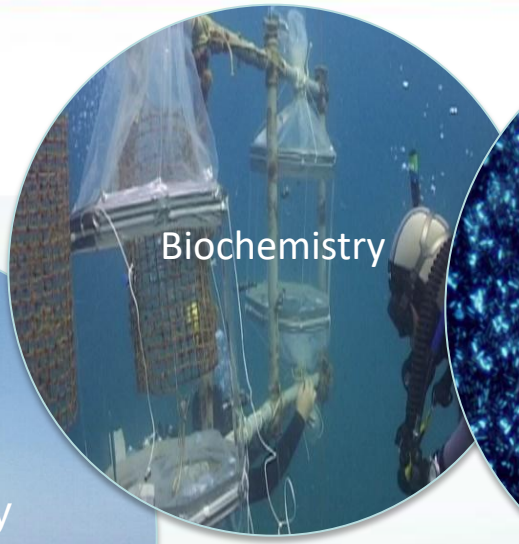
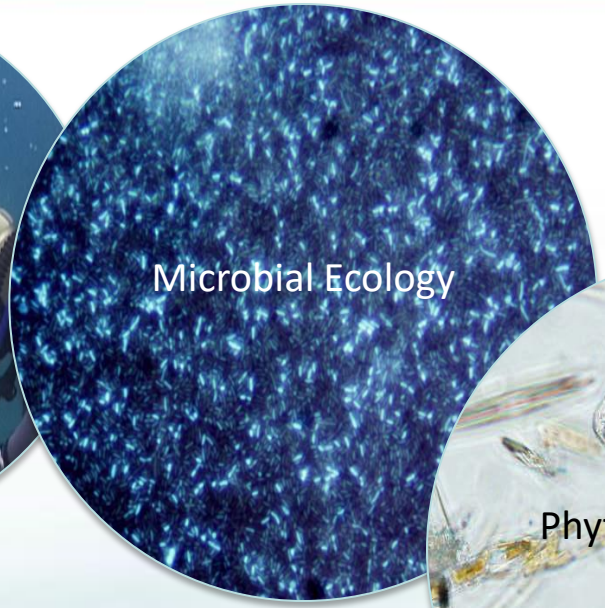
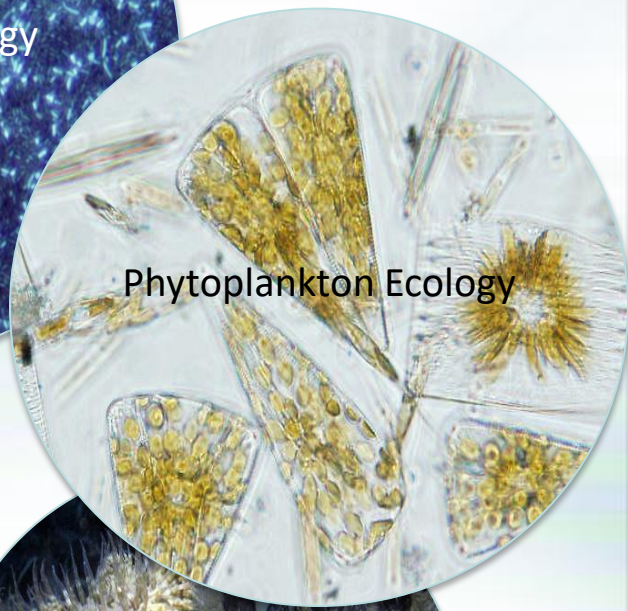
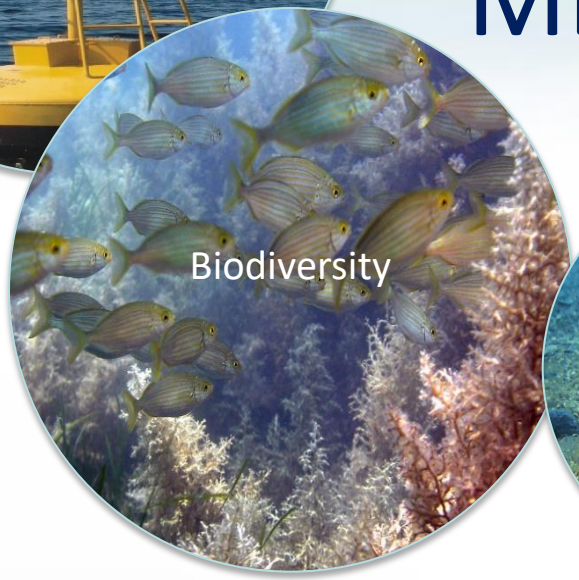




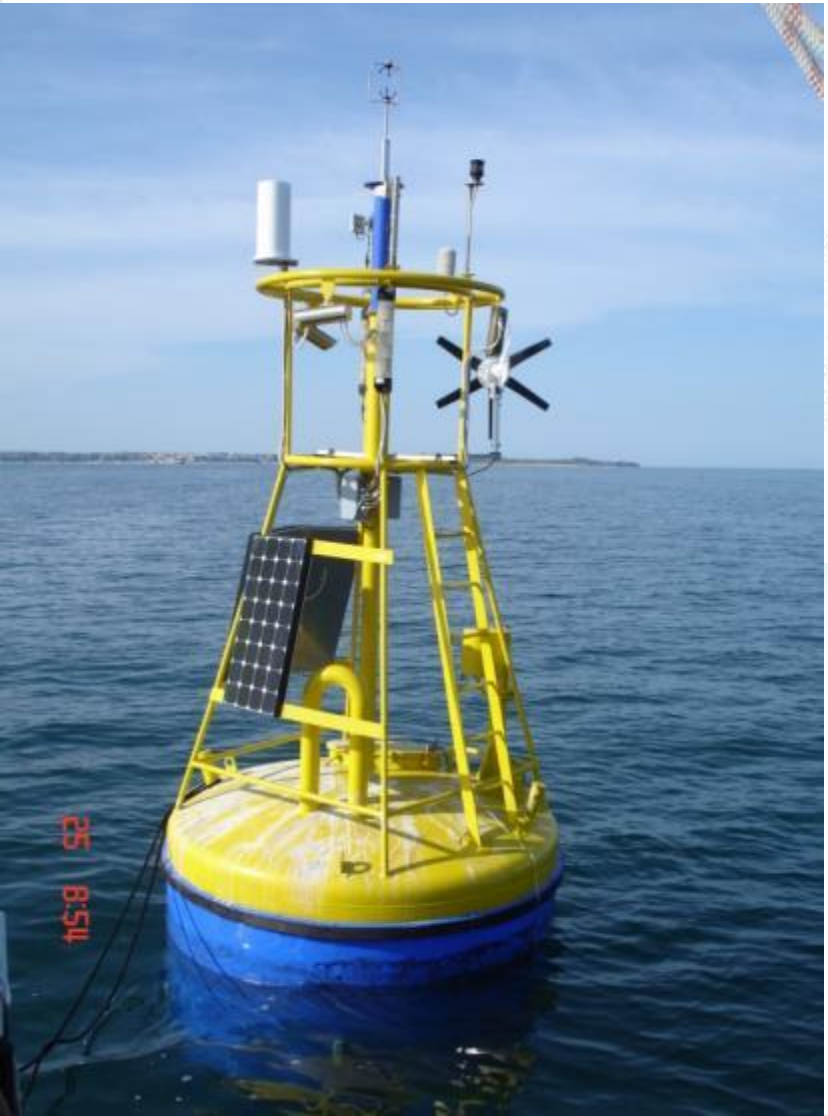


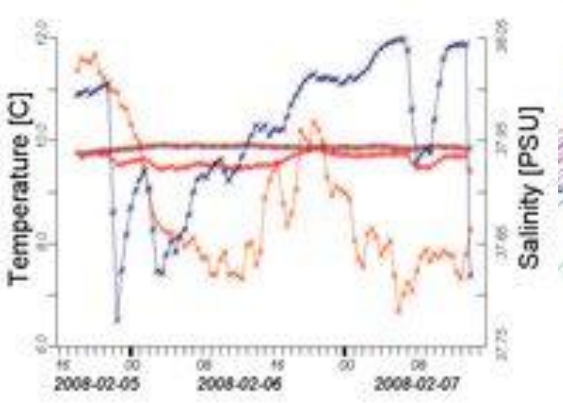
MBS Piran

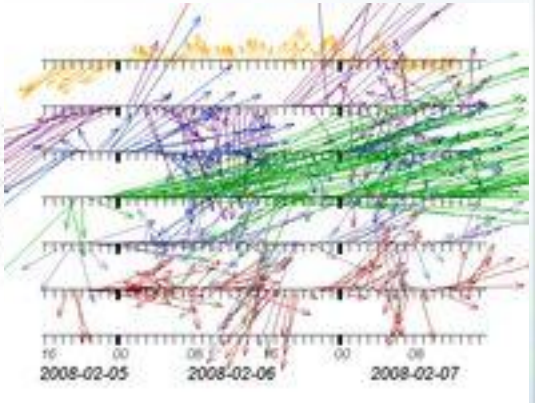



YAMAHA

Oceanografska boja Vida in HF radarji







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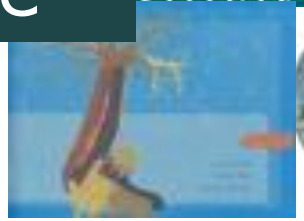
Podvodna kamera

http://www.nib.si/mbp/sl/tools/uw-cam

Promotion of science

tables



monographs, CDs, underwater photography, videos

Science Fair, Madrid

¿Aun respira el mar?

DAN ODPRTIH VRAT

World Ocean Day

Kids and sea: paintings, web page "Zanimivosti o morju
kids) International Ocean Institute (IOI)


UNESCO
United Nations
Educational, Scientific and
Cultural Organization
Intergovernmental
Oceanographic
Commission
www.ocean-climate.org
Zdravi oceani,
zdrav planet
Svetovni dan oceanov
World Oceans Day
8 junij 2017
UNESCO

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vsi ostali sodelavci MBP