The role of biofilms in travertine/tufa precipitations - Inside story

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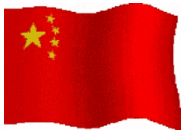
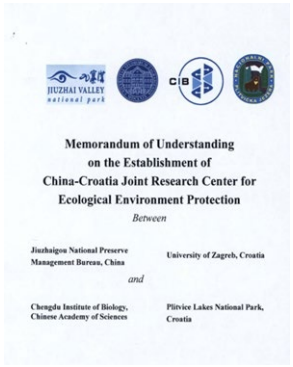
(established in May , 2014)



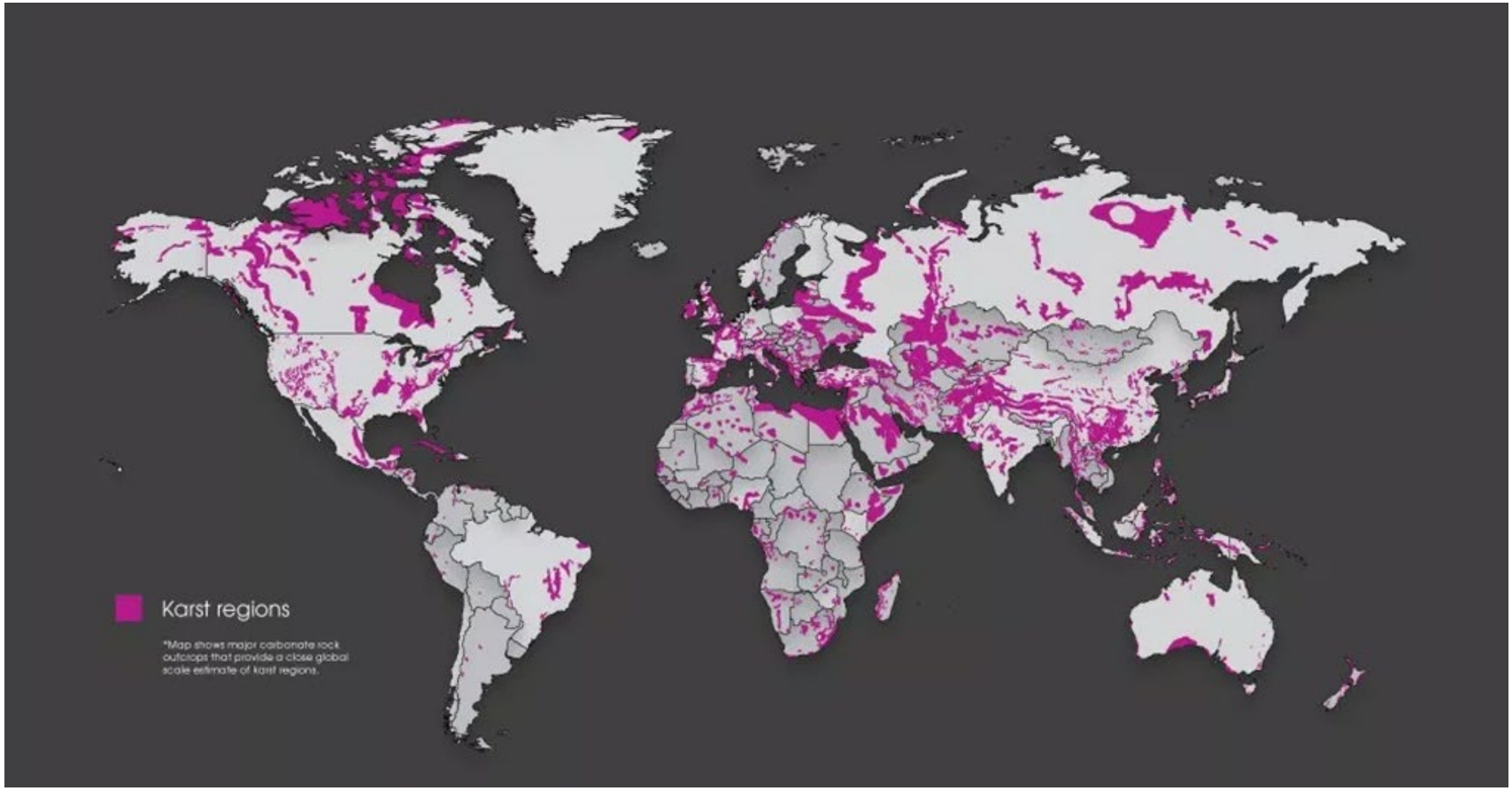


Vice Premier PRC,
Mrs. Liu Yandong

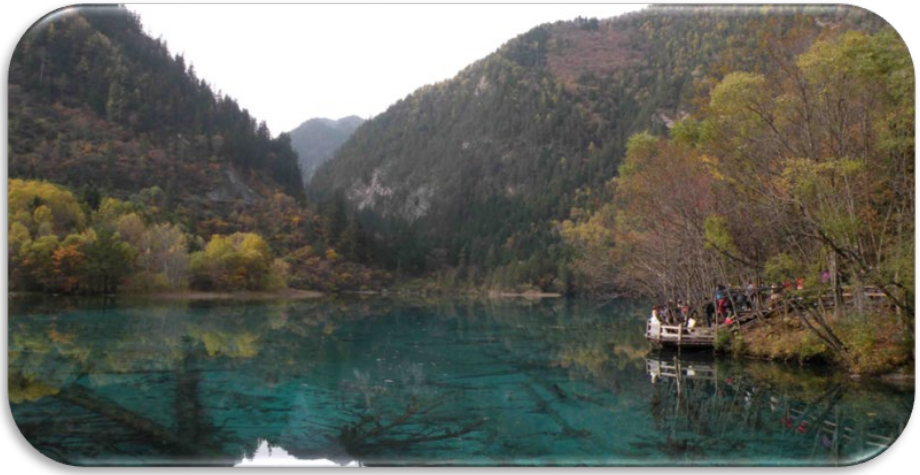
刘延东：“加强中、克生环保领域的合作有战略意义和广阔前景，相关单位在九寨沟的合作是中-克科技合作的典范。”

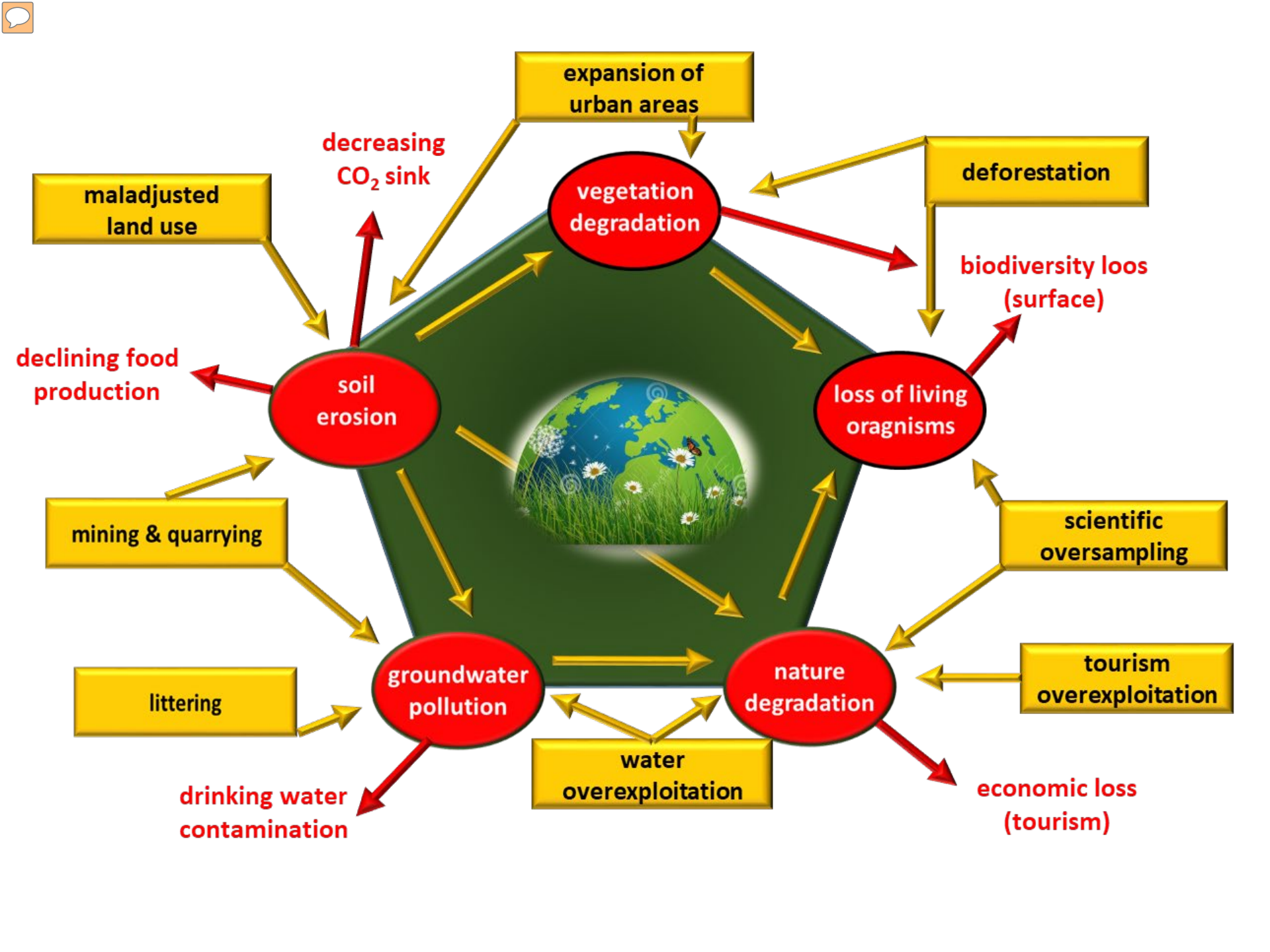
Marco Polo

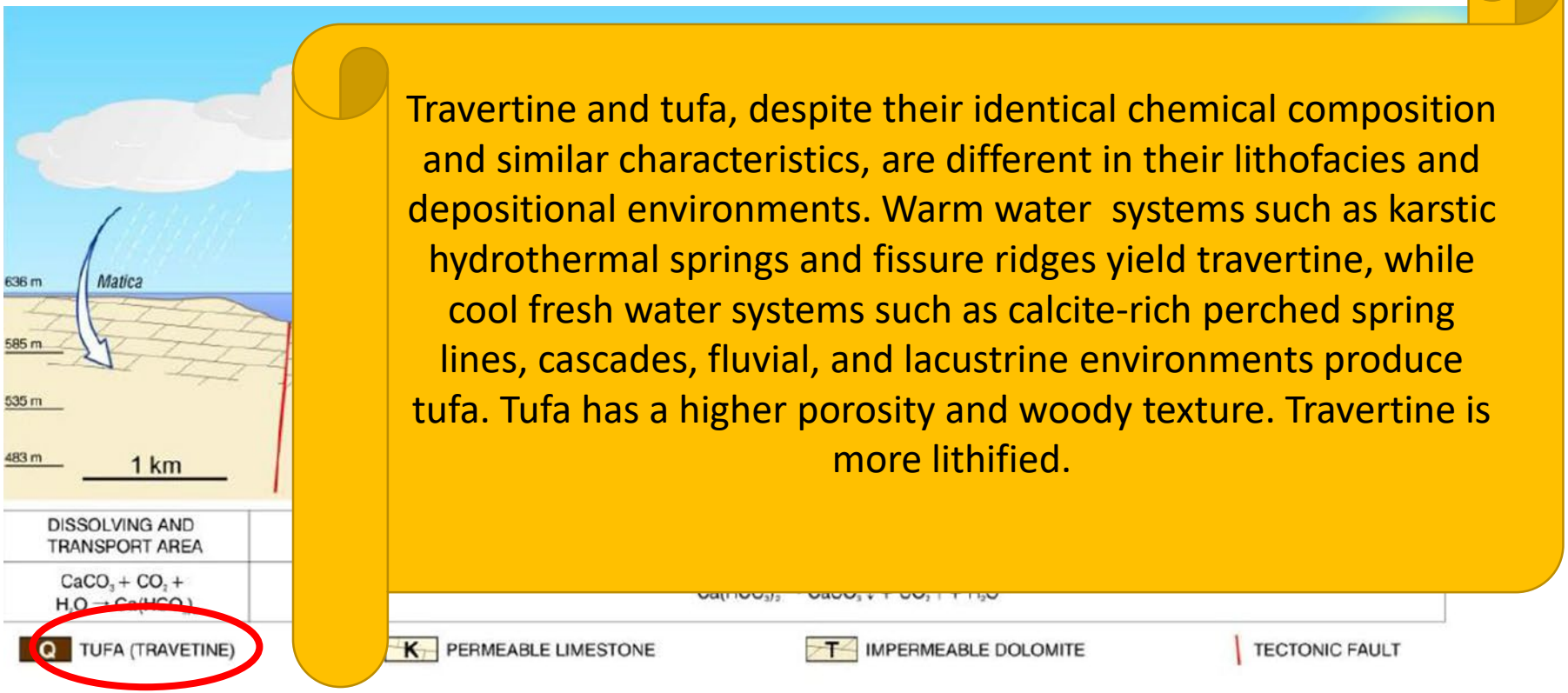
Croatia locates in the convergence region of B&R, plays as a bridge tower role between East and West in the past



- Over 20% of the earth surface consists of karst terrains
- Around 25% of the world's drinking water comes from karst aquifers
- Over 100 million people work directly or indirectly in karst tourism
- Karst host unique ecosystems often restricted to single locations
- Over 50 karst locations are already inserted in the UNESCO World Natural Heritage List



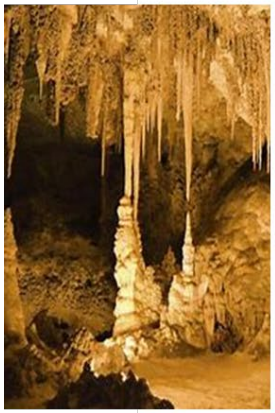

expansion of urban areas
decreasing CO_2 sink
maladjusted land use
vegetation degradation
deforestation
biodiversity loos (surface)
declining food production
soil erosion
loss of living oragnisms
mining & quarrying
scientific oversampling
littering
groundwater pollution
nature degradation
tourism overexploitation
water overexploitation
drinking water contamination
economic loss (tourism)



Travertine and tufa, despite their identical chemical composition and similar characteristics, are different in their lithofacies and depositional environments. Warm water systems such as karstic hydrothermal springs and fissure ridges yield travertine, while cool fresh water systems such as calcite-rich perched spring lines, cascades, fluvial, and lacustrine environments produce tufa. Tufa has a higher porosity and woody texture. Travertine is more lithified.

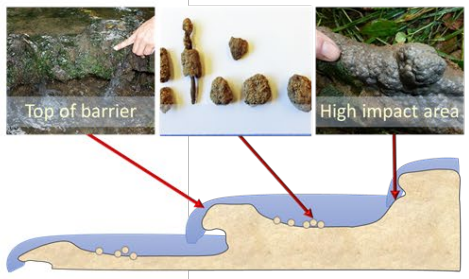
Monthly monitoring of NP Plitvice Lakes in 25 sites covering the different environmental sedimentary settings was carried out over five years (1985 - 1990) to obtain metadata base to clarify:

- influence of hydro and geochemistry conditions to the biofilm composition
- seasonality and dynamics of microbial biofilm colonization rates and their role in
- initial and growth phase of microcrystalline $CaCO_3$ perticipation



in the site
with mild water flow

Oncoids



Lacustrine carbonates

Physico-chemically dominated

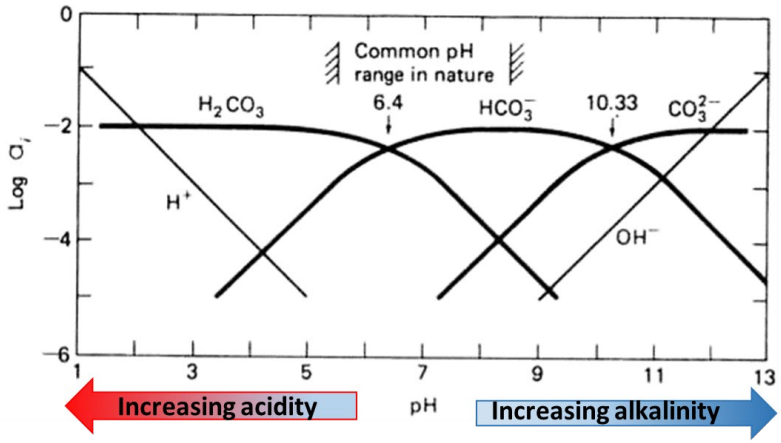
Biologically dominated

Physico-chemically dominated

Dynamic process of interaction between physicochemical and living organisms in water. Appearing through the surface layer of the earth, the rainwater absorbs carbon dioxide (CO_2) and carbonic acid (H_2CO_3) is formed that dissolves the limestone substrate. Water is thus enriched with dissolved calcium bicarbonate / Ca $(HCO_3)_2$ /. At the rapids and barriers, due to water spraying, cause a chemical balance disorder, and calcium carbonate or calcite ($CaCO_3$) is secreted and deposited in the form of tiny crystals in submersible objects.

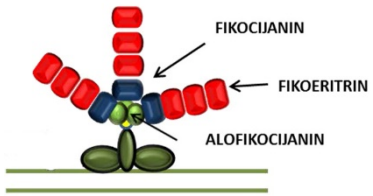
$$Ca(HCO_3)_2 \xrightarrow{\text{spatter}} CO_2 + H_2O + CaCO_3 \text{ (tufa)}$$

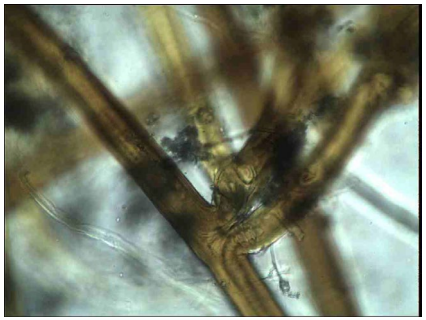
The presence of algae, mosses and submerged vegetation (photosynthesis consumes dissolved CO_2) is a prerequisite for creating a tufa, especially for its shape.

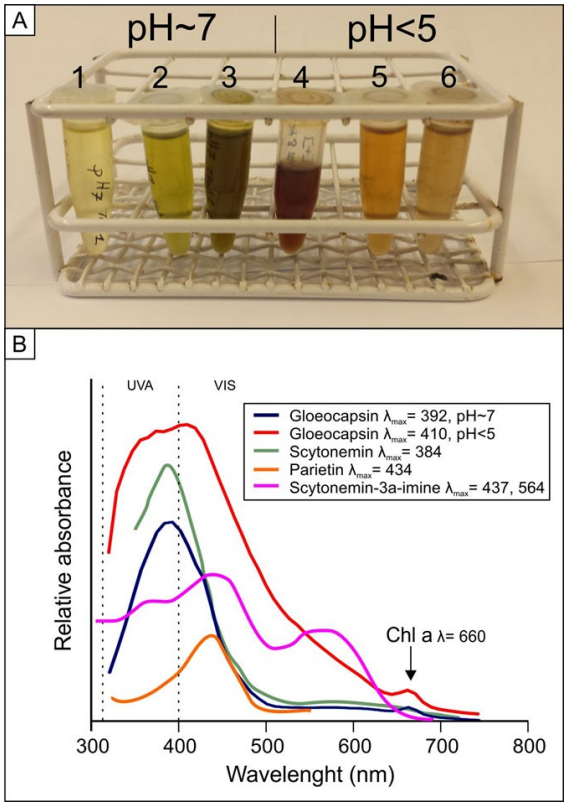


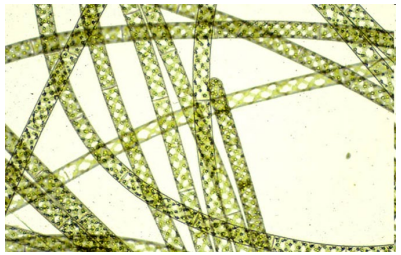
pH controls carbonate species

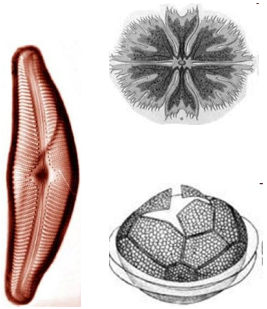
- Increased CO_2 (aq) increases H^+ and decreases carbonate ion
- Thus increasing atmospheric CO_2 increases CO_2 (aq) and causes the water system to become more acidic
- However, natural waters have protecting, buffering or alkalinity (refers to water's ability, or inability, to neutralize acids.

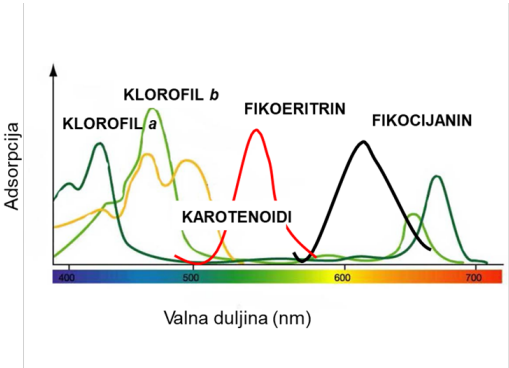


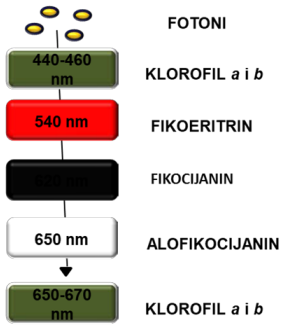


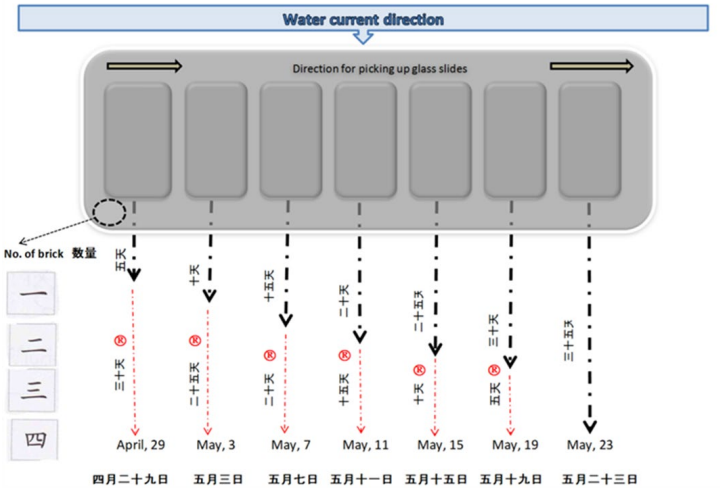








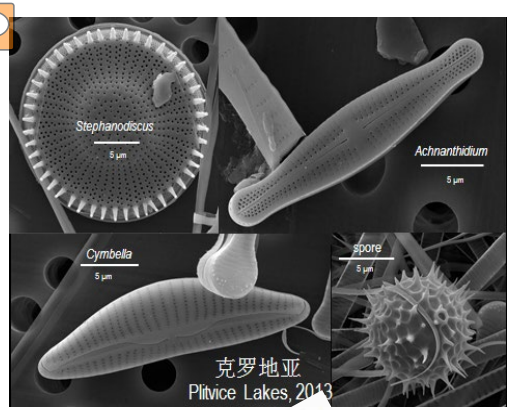


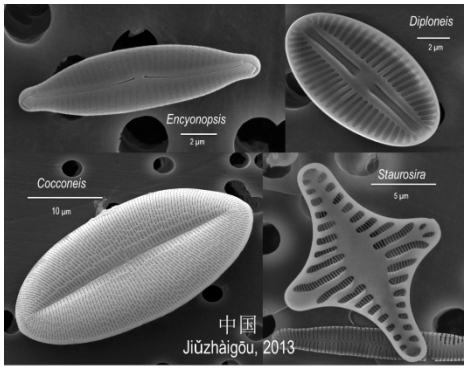


To define microbial biofilm colonization in a nonlinear regressive analysis of empirical data, the following function (Bertalanffy, 1938) was used:

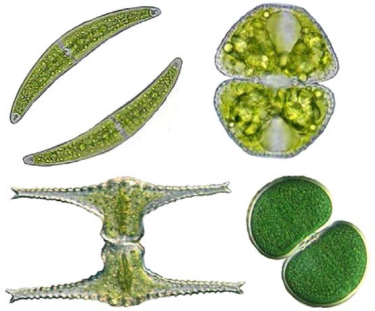
$$S_{(t)}=S_0 /1\text{-}e^{-k\,(t-to)} /$$

$S_{(t)}$ = number of species at time t
S_0 = number of species in asymptote
t = time
t_0 = beginning time of colonization
k = coefficient of colonization current





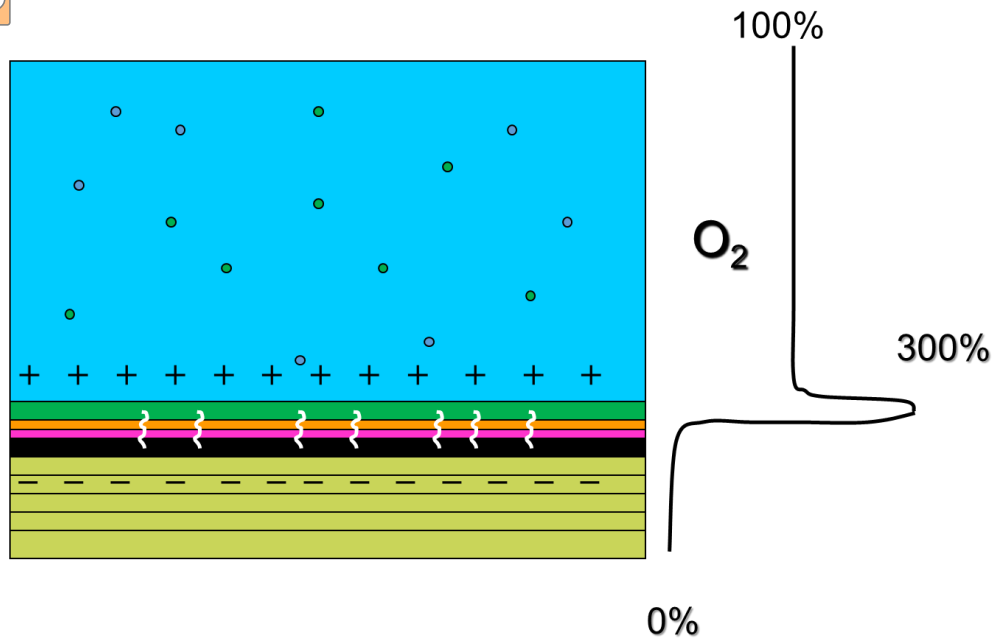
indicator value **TOLERANCE**	indicator weight **SENSITIVITY**
decimal numbers	integer numbers
1-5	1-5
1 = good indicator, tolerates low concentrations of nutrients	1= wide sensitivity range, weak indicator
5= bad indicator, tolerates high concentrations of nutrients	5= narrow sensitivity range, very good indicator



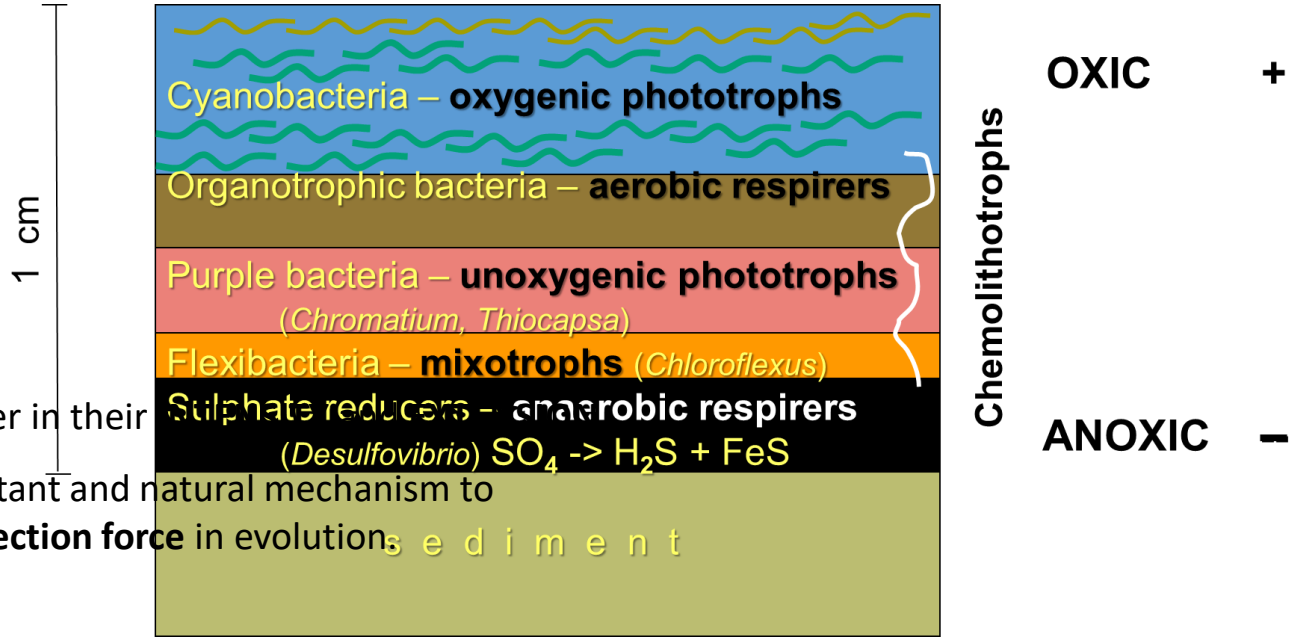
Algal properties: small size, easy to collect, fast growth, etc. make them suitable model organisms for ecological topics in water quality, environmental protection and sustainable development.

A one year climate cycle, during which land plants usually complete one life cycle, is sufficient for algae turnover in the order of 100 times.

Most of algal species indices used in the calculation/equation is assigned two values: the first value reflects the tolerance or affinity of the diatom to a certain water quality (good or bad) while the second value indicates how strong (or weak) the relationship is.



Increasing biomass of microbial biofilm (bacteria & algae) polarize the sediment-water interface

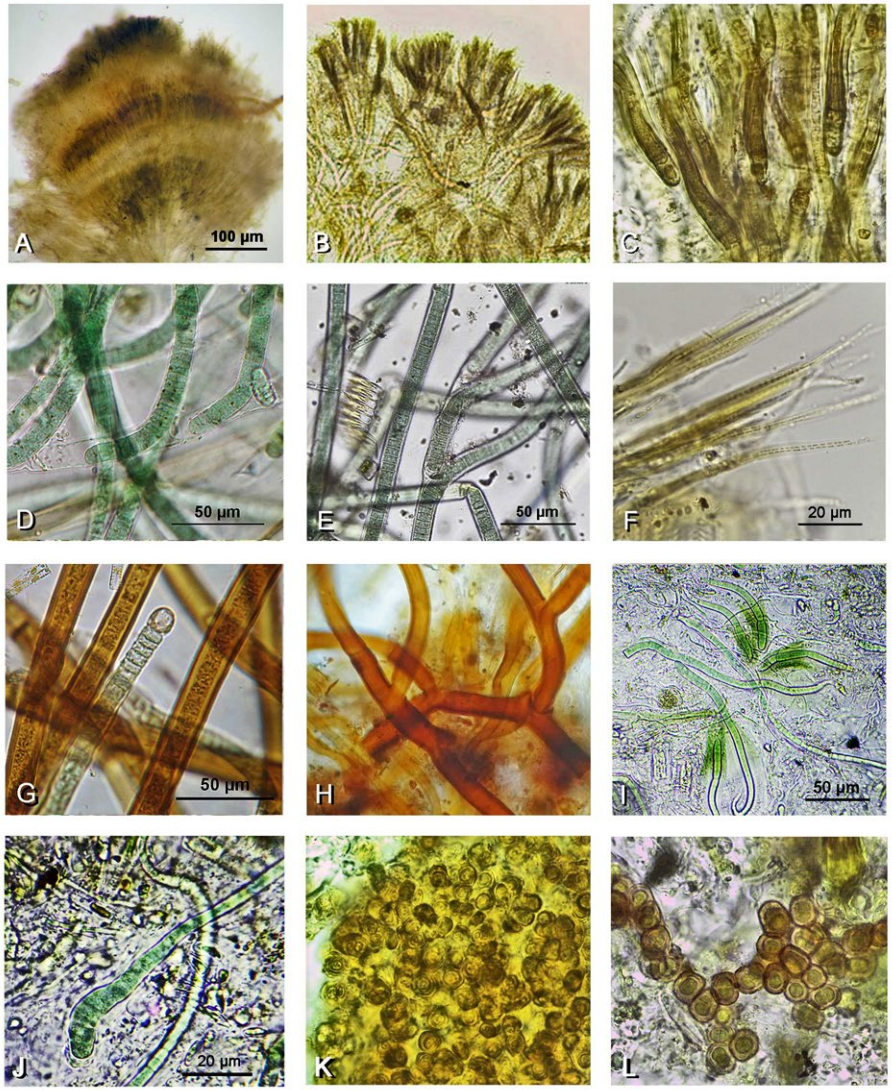


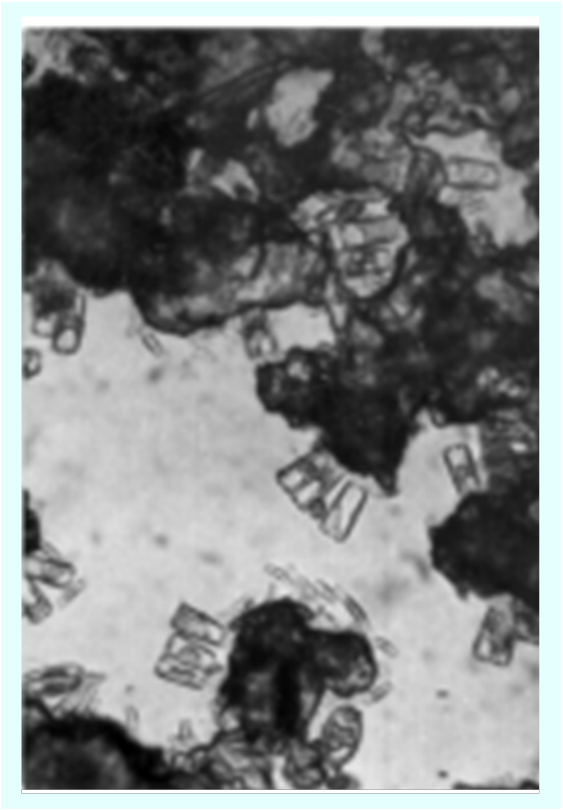
stratified set of microbial communities

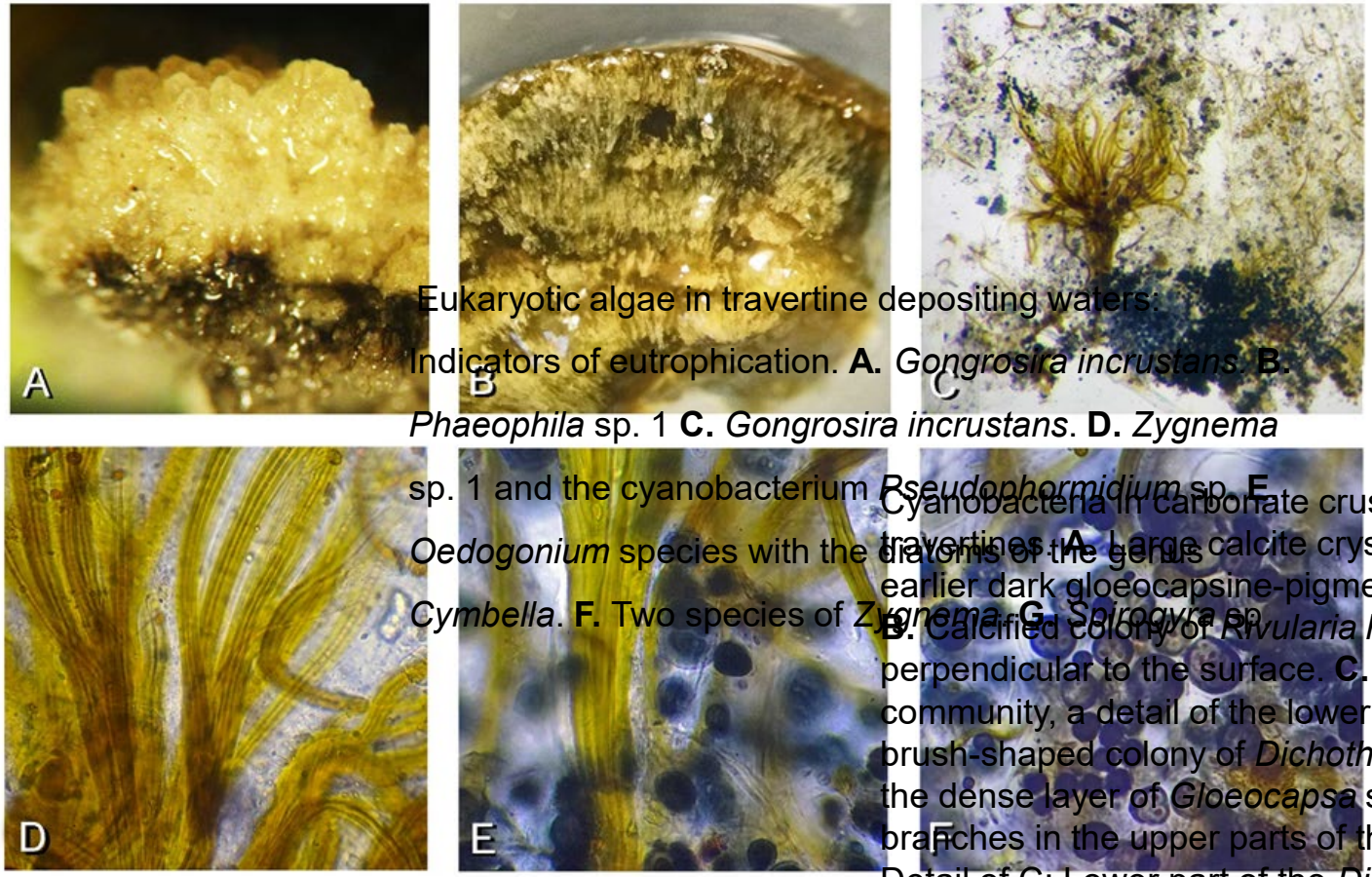
originated by Nature. They differ in their

D or **BAD**. Simply, it is an important and natural mechanism to

ny cases, to act as **a major selection force** in evolution.


A
100 µm
B
C
D
50 µm
E
50 µm
F
20 µm
G
50 µm
H
I
50 µm
J
20 µm
K
L



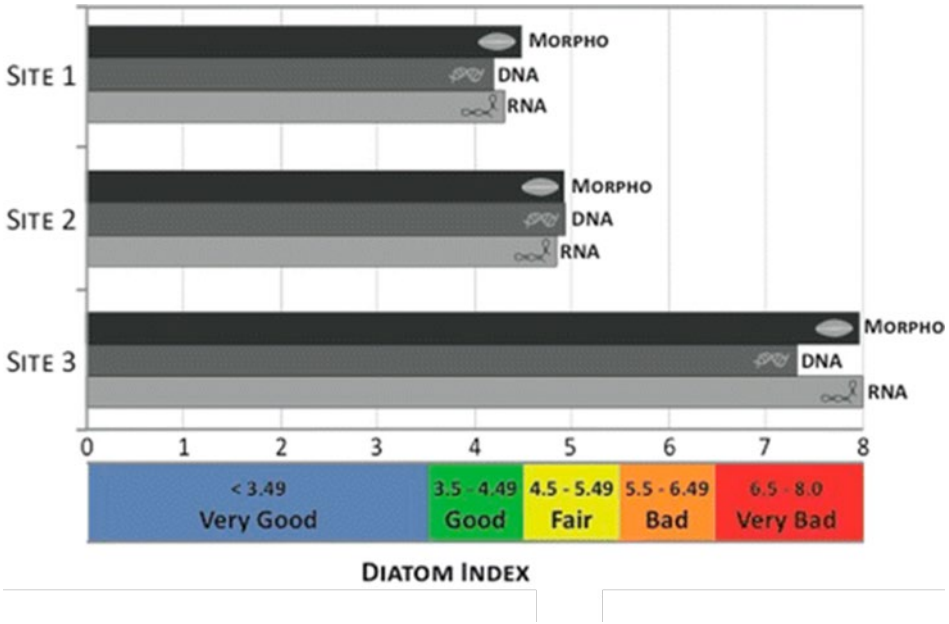


Eukaryotic algae in travertine depositing waters: Indicators of eutrophication. **A.** *Gongrosira incrustans*. **B.** *Phaeophila* sp. 1 **C.** *Gongrosira incrustans*. **D.** *Zygnema* sp. 1 and the cyanobacterium *Pseudophormidium* sp. **E.** *Oedogonium* species with the diatoms of the genus *Cymbella*. **F.** Two species of *Zygnema*. **G.** *Spirogyra* sp.

Cyanobacteria in carbonate crusts of Huanglong travertines. **A.** Large calcite crystalls growing on top of an earlier dark gloeocapsine-pigmented cyanobacterial layer. **B.** Calcified colony of *Rivularia haematites* cut perpendicular to the surface. **C.** Close-up of the residual community, a detail of the lower dark layer in A. Note the brush-shaped colony of *Dichothrix gypsophila* as a part of the dense layer of *Gloeocapsa* spp. **D.** Detail of C: False branches in the upper parts of the *Dichothrix* brush. **E.** Detail of C: Lower part of the *Dichothrix* brush surrounded by *Gloeocapsa* spp. **F.** Horizon of *Gloeocapsa alpina* and *G. compacta*.

Next steps ……

Inferring the Diatom Index from Next-Generation Sequencing Data



Diatoms are widely used as bioindicators for the assessment of water ecology status. Classically, the diatom biotic indices are based on the relative abundance of morphologically identified species weighted by their autoecological value. Obtaining such indices is time-consuming, costly, and requires excellent taxonomic expertise, which is not always available.

The diatom index shows a significant correlation between morphological and molecular data indicating similar biological quality status for the majority of sites. This proof-of-concept study demonstrates the potential of the NGS approach for identification and quantification of diatoms in environmental samples, opening new avenues toward the routine application of genetic tools for bioassessment and biomonitoring of aquatic ecosystems.

When nature gave us so much wealth

It is our duty to preserve it for future generations


Xièxiè nín de guānzhù
单方面的力量是有限的，联合起来会创造奇迹。
—— 海伦·凯勒