evropský sociální fond v ČR
EVROPSKÁ UNIE
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Inovace studia hydrobiologických disciplín s důrazem na rozšíření možností uplatnění absolventů biologických oborů PřF UP v praxi.

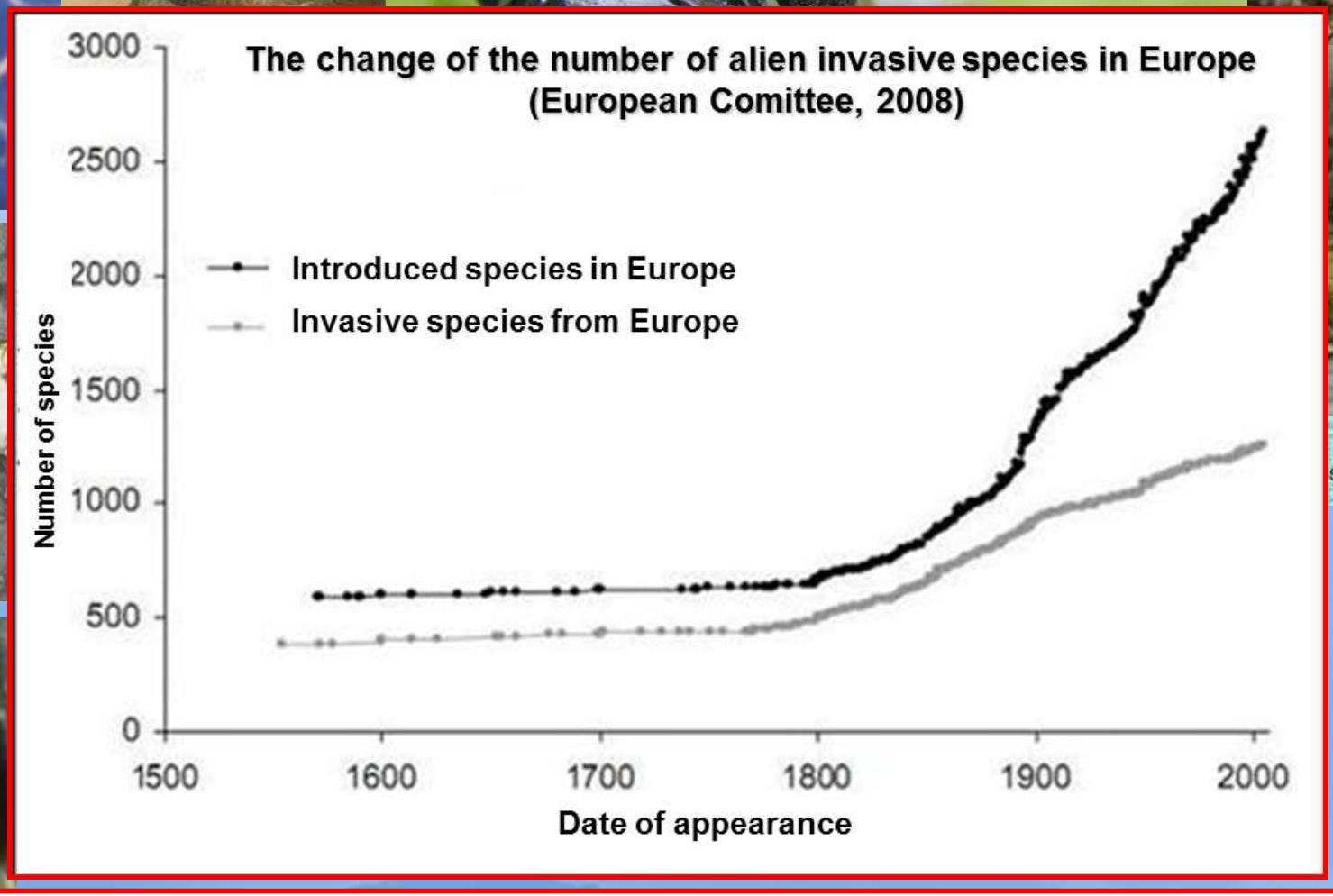
reg. číslo: CZ.1.07/2.2.00/28.0173

Invasion of *Dreissena* species in Lake Balaton

3. 12. 2014
ZS 2014/2015

Csilla Balogh

Biological invasions

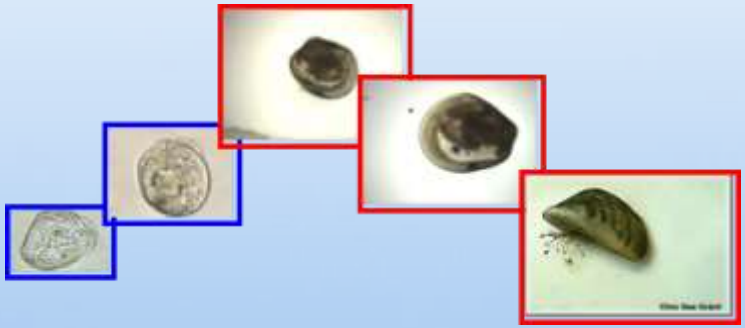


According to **DAISSE** (Delivering Alien Invasive Species Inventories for Europe) database in Europe have appeared more than 8000 species, in which 5400 species have acclimatized.

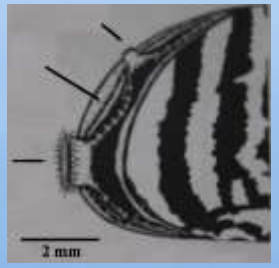
Effect of *Dreissena on ecosystem*

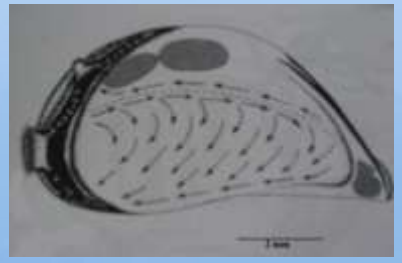
Rapid spread with free living larvae

Dense colonies



Intensive filter feeder: particles of 0,4-4,0 μm





Filtrate:

- ☑ bacteria;
- ☑ zooplankton
- ☑ suspended material and algae

↓

Change matter-energy flux

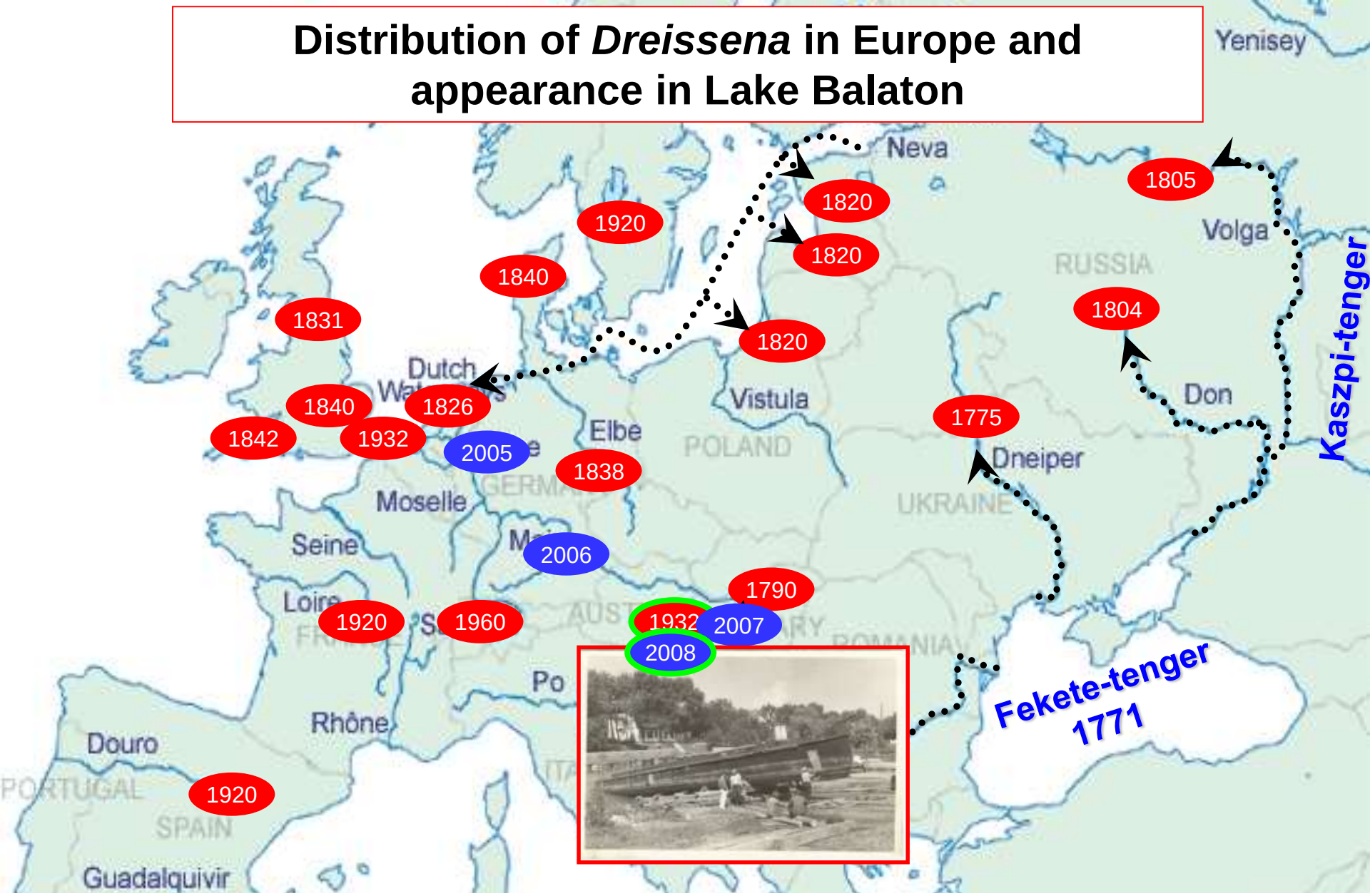
Increase transparency

Important foodsources

Suitable surface for the settlement

„ecosystem engineer”

Distribution of *Dreissena* in Europe and appearance in Lake Balaton



Dreissena polymorpha is one of the most invasive r-strategist (Vanderploeg, 2002), have started its invasion in1920'. *Dreissena bugensis* appeared in 2005-ben in Rhine Delta and spread rapidly in Rhine-Main-Danube water system.

Ponto Caspian invasive species in Lake Balatonban

Date	Invasive species
1932	2
1950	6
1994	7
2001	9
2008	11
2012	11

Taxonomical identification, molecular evidence of the new species

Morphological identification, collection, separation

Db: *Dreissena bugensis – new species (2008)*
Dp: Dreissena polymorpha (1932)

Molecular taxonomical identification

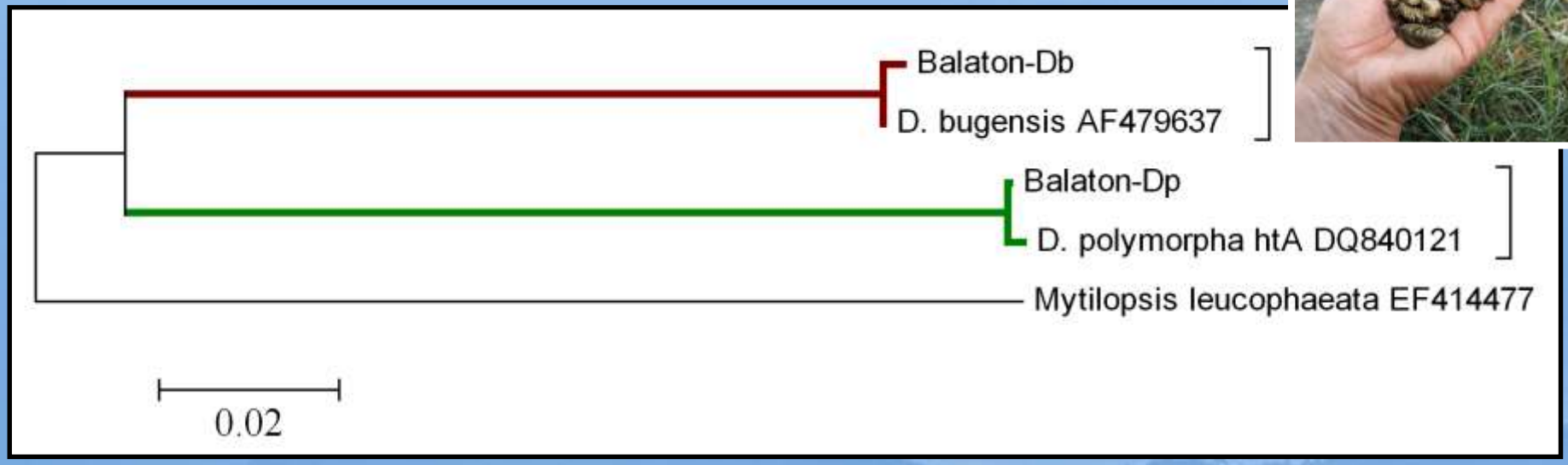
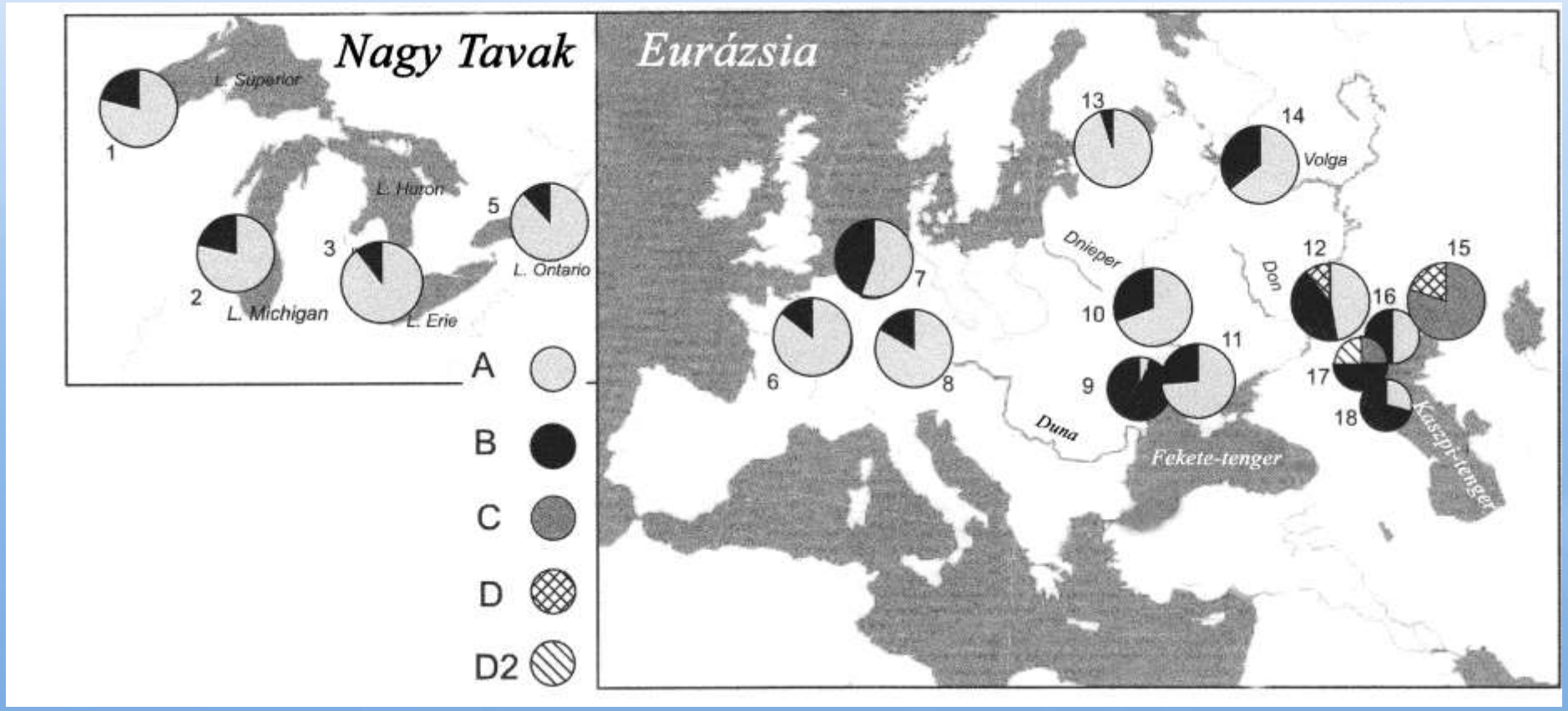


Figure. 537 basepairs of the COI region, neighboring algoritmus based on the Kimura-2-parameter model

Cs. Balogh, J. Nédli


Dreissena cluster and beds in the mud

Haplotype of *Dreissena* invaded in Lake Balaton



All specimen presented the same haplotype, which was identical to the invading *D. polymorpha* haplotype B reported by May (2006).

Cs. Balogh, J. Nédli

Lake Balaton

- Surface area: 596 km^2
- Mean depth: 3 m
- Shoreline: 270 km

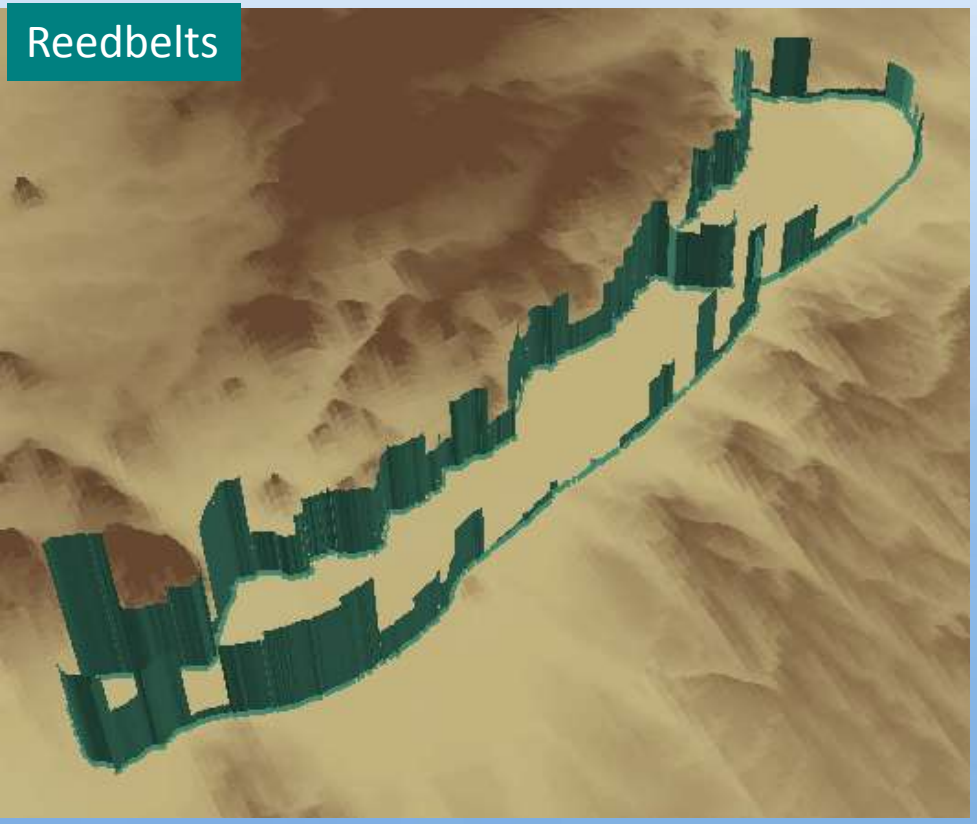
Rip-rap: 120 km (2,5-3,5 km^2)

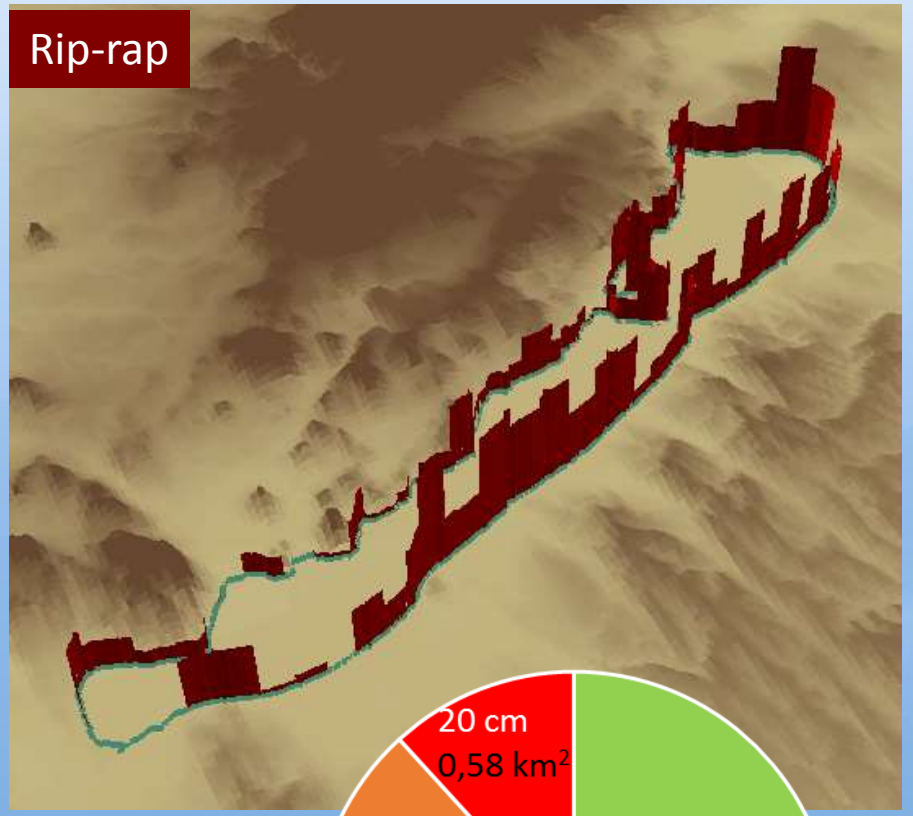
Reed belt: 123 km (4,5 km^2)

Pier and other concrete walls: 23,6 km

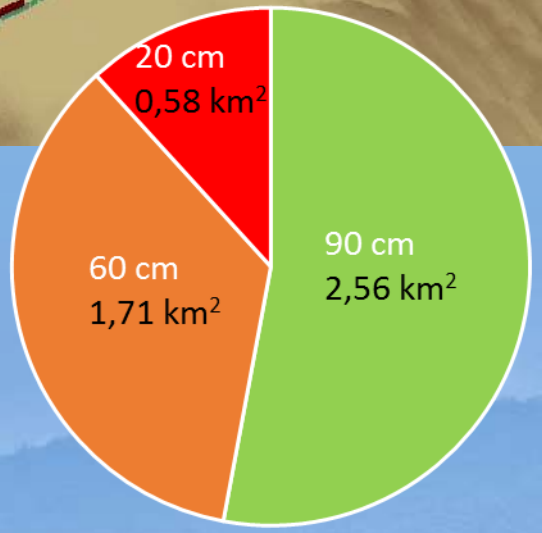
Sandy shoreline: 3,4 km

Sublitoral surfaces of Lake Balaton in different water levels



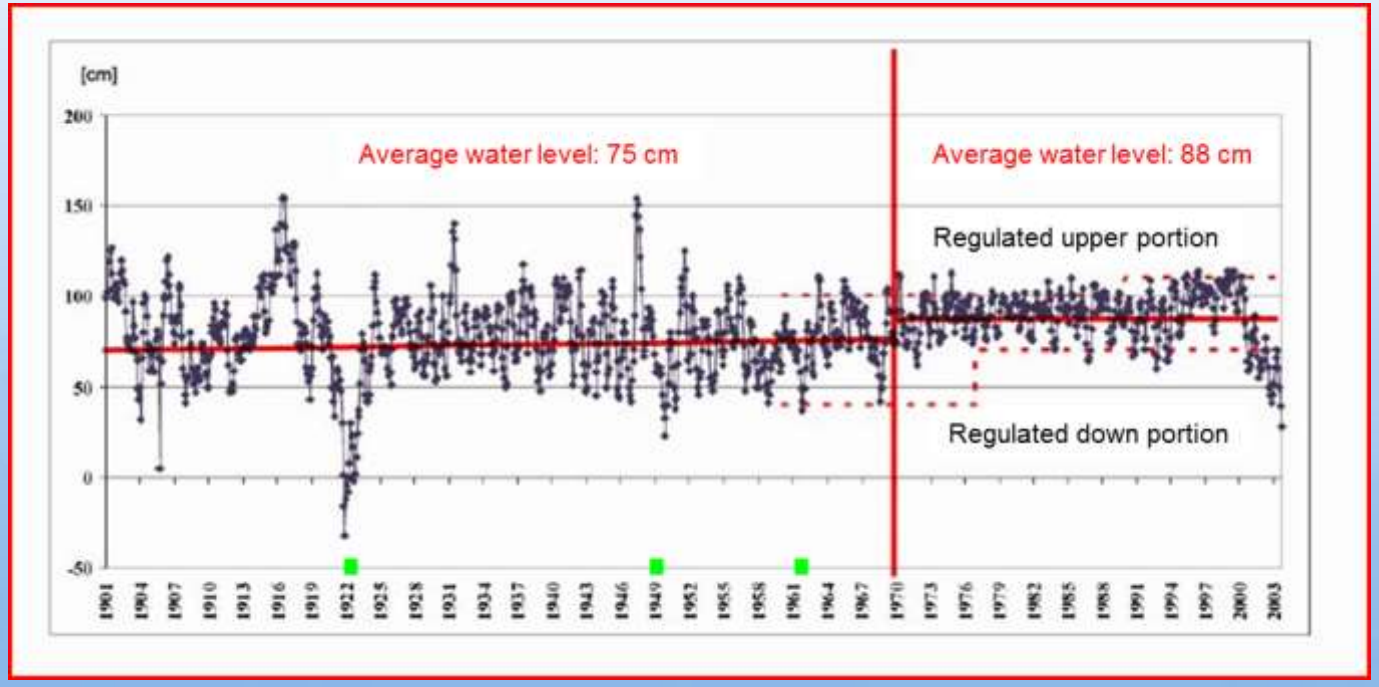


Depth [cm]	Surfaces for colonization [km^2]
120	3,31
90	2,56
60	1,71
20	0,58



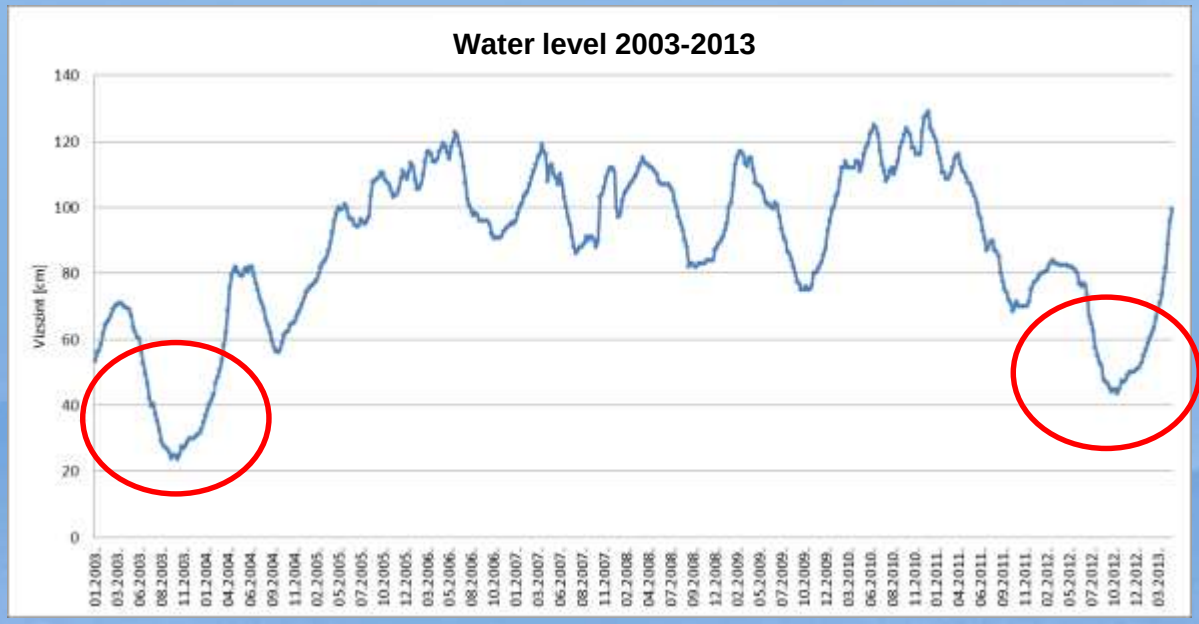
L. G.-Tóth

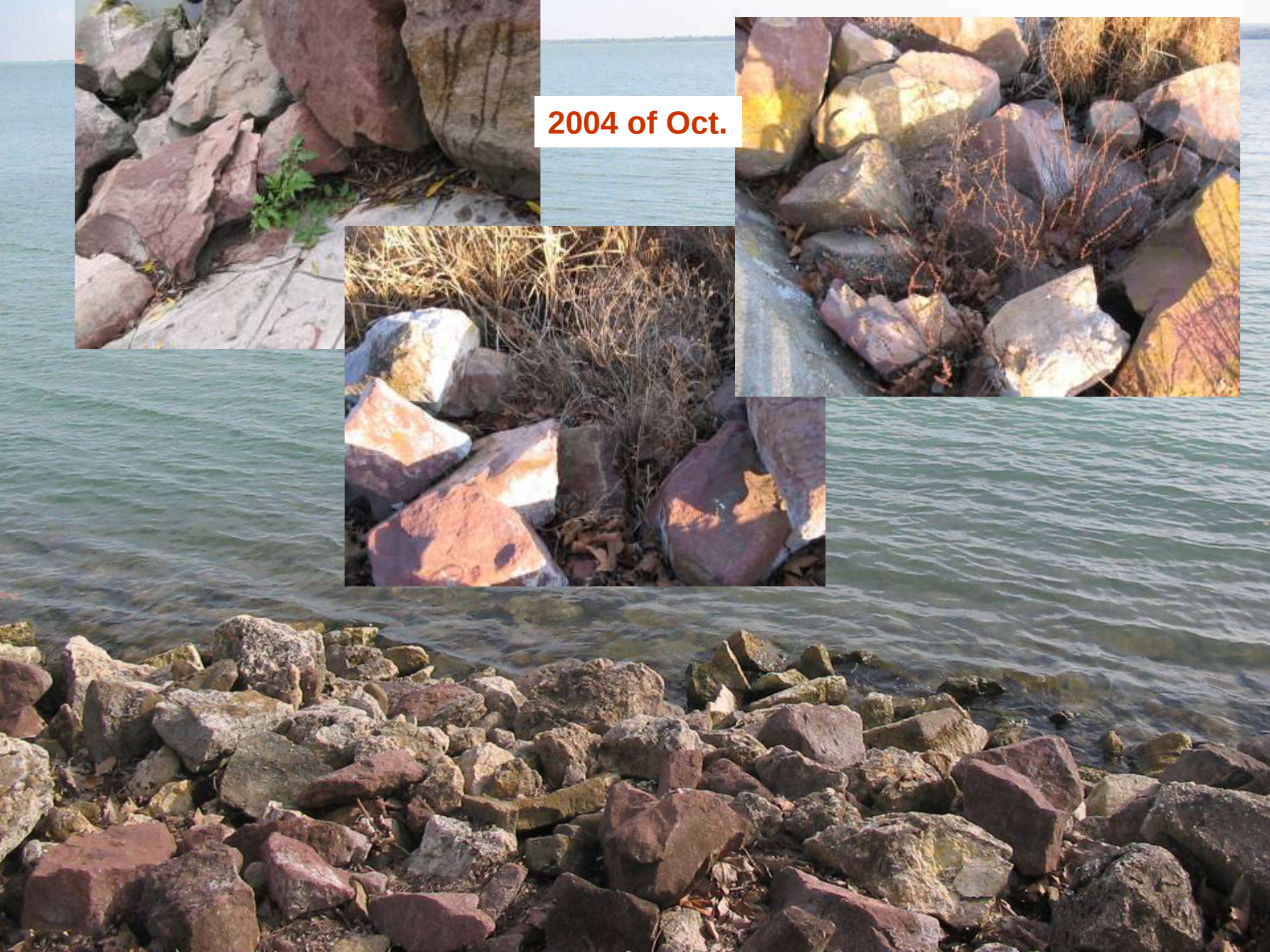
Water level fluctuation of Lake Balaton



Extreme and dry summers

Water level reduced 0,5 m in a year

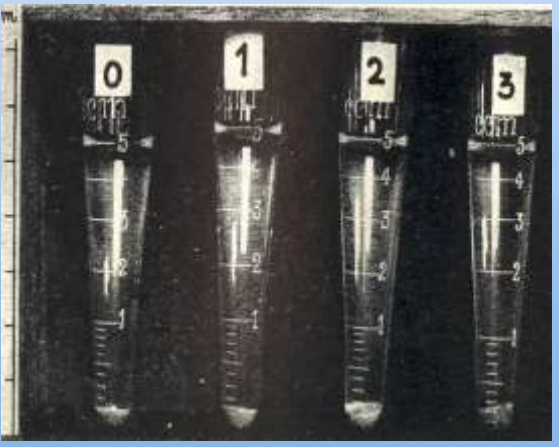



2004 of Oct.

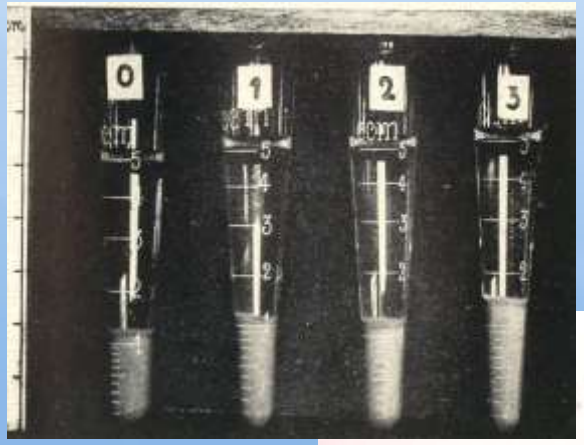
2012 of Aug.

Resuspension of particulates in Lake Balaton

>4 m s^{-1} wind speed every 3rd day,> 10 m sec^{-1} 10-12 times a year



Calm weather:
5 – 10 mg $liter^{-1}$
dry matter

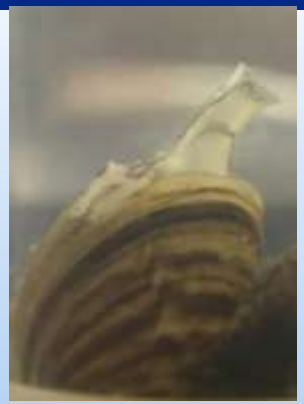


After storm:
600 mg $liter^{-1}$
dry matter

AVERAGE:
30 mg $liter^{-1}$
dry matter

J. Padisák

G. Entz and O. Sebestyén 1942



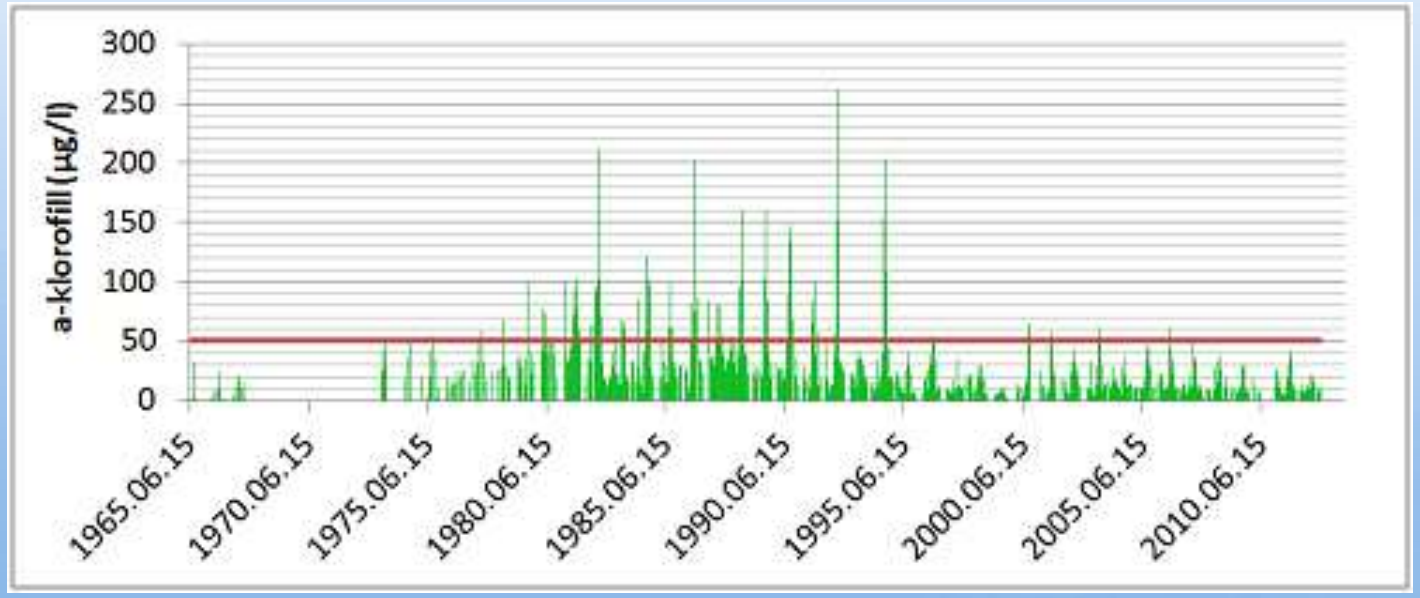
„ In Lake Balaton filter feeders work hard and waste extra energy to obtain food from the lake water, rich in tripton, suspended material.”

Olga Sebestyén, 1942

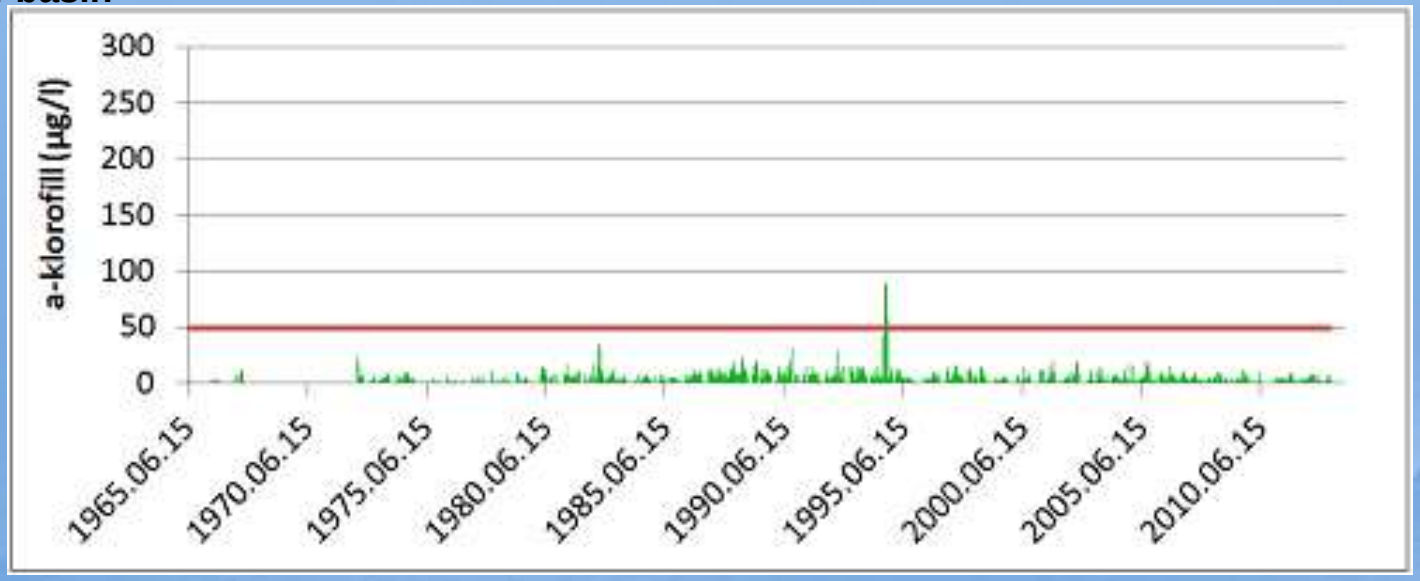
Filter feeders filtrate
4 peaces of mineral grains 1
peace of bacteria
and
140 peaces of mineral grains 1
peace of algae cell

Algae biomass, chlorophyll-a in Lake Balaton

Keszthelyi-basin



Siófoki-basin



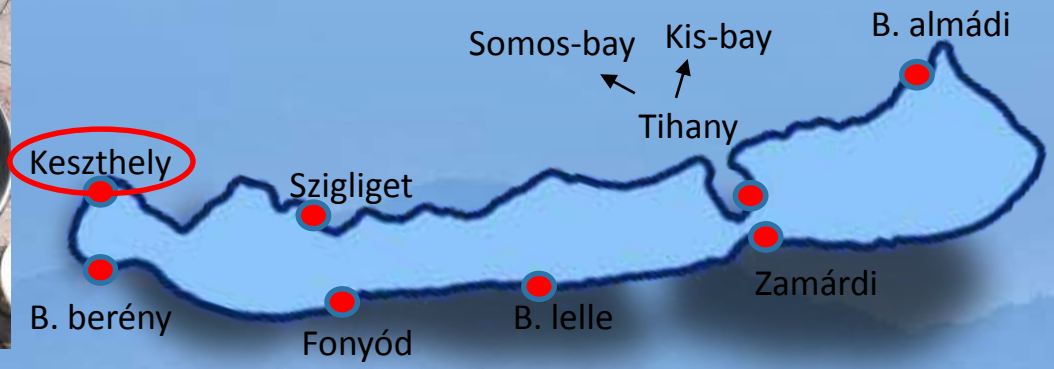
L. Vörös

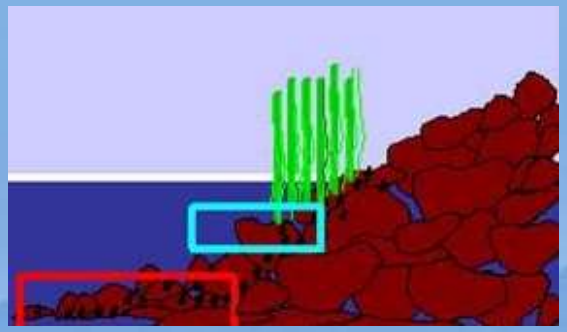
Monitoring

MONITORING I.
2002-2014; May, July, September

MONITORING II.
2009-2014; May, July, September

MONITORING III.
2009-2014; May, July, September





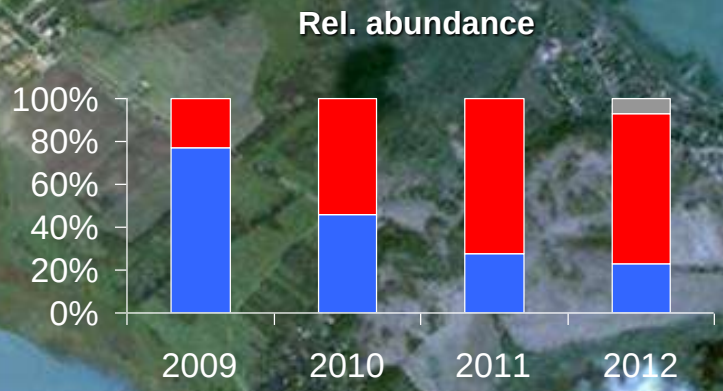
Maximal values during the 10 years monitoring

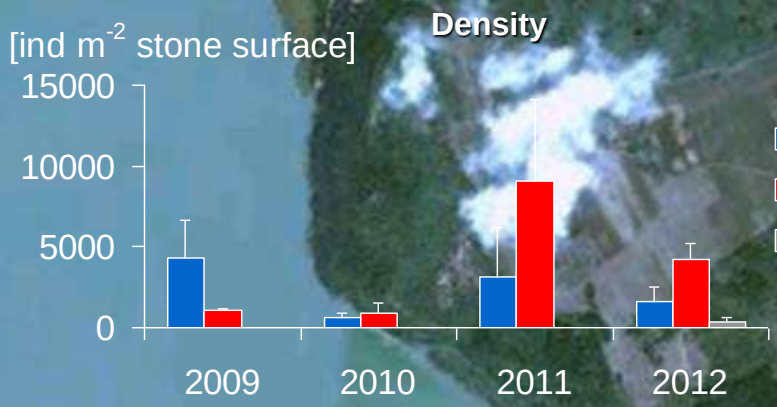
Density: **237 000 - 512 000 ind m^{-2} lake surface**
Biomassza: **2870 g dry weight with shell m^{-2} lake surface**
Length: **25 mm**
Relative abundance: 97 %

Area	Density [ind m^{-2}]	References
Lake Mikolajskie	2,200	Stanczykowska, 1975
River Rhine The Netherlands (1989)	21,000	Bij de Vaate et al., 1992
Polish Lakes	6,720	Stanczykowska & Lewandowski, 1993
Lake Garda	20,000	Franchini, 1978 *
Lake Constance	21,000	Walz, 1975
Lake Constance	~ 330,000	Werner et al., 2005
Lake Zurich	30,000	Burla and Lubini-Ferlin, 1976 *
Lake Dojran	4,000-5,000	Sapkarev, 1975 *
Dneprodzerzhinsk Reservoir	25,000-36,000	Gaidash and Lubanov, 1978 *
Szczecin lagoon	114,000	Wiktor, 1963 *
Lake Erie (1989-1990)	342,000	Leach, 1993
Lake Huron	300,000	Nalepa et al., 1995
Lake Ontario (2000)	38,865	Dermott et al., 2003
Illinois River (1993)	100,000	Schloesser et al., 1996

Length of the mussels in other ecosystems: 3,5-5 cm-t
(USGS database, Beisel et al., 2010).

Dynamics between the two Dreissena species

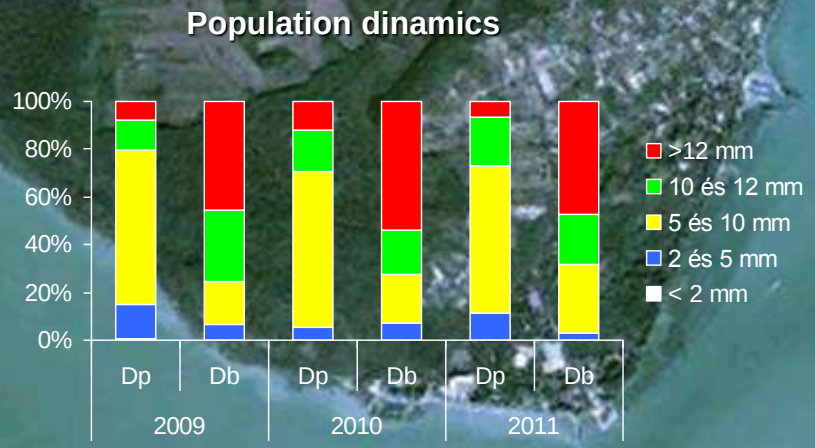




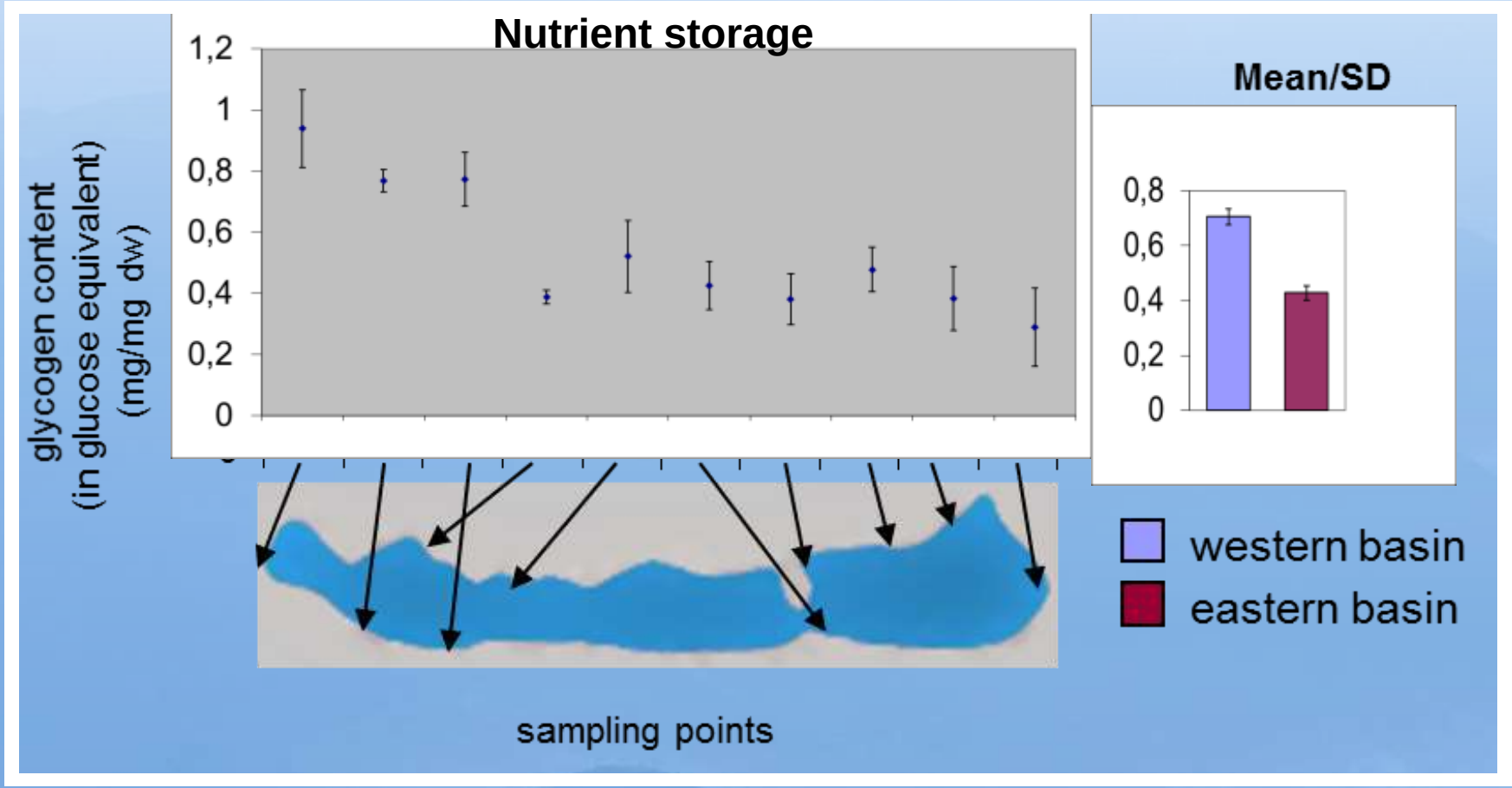
Kis-bay

Balaton Limnological Institute
Sampling point of the yearly monitoring program from 2003

Somosi-bay



Condition index
Glycogen content

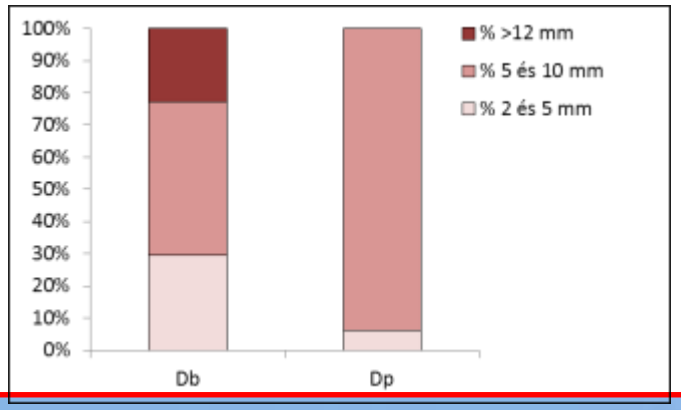


Z. Serfozo, Cs. Balogh

Invasive species on the top of each other

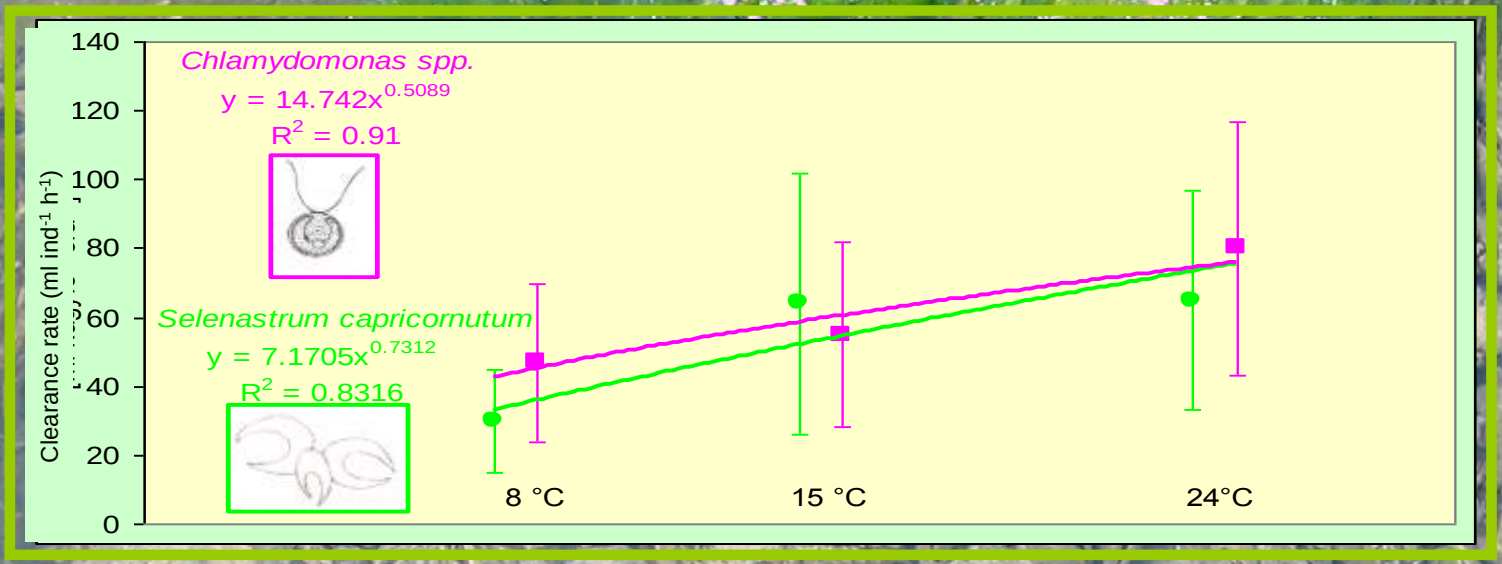
The relative abundance and the species richness of other macroinvertebrates on the *Anodonta* shell were less than on the stones obtained from of the rip-rap. The colonization of *D. polymporpha* on the shell was more successful than of *D. bugensis* Density of dreisenids can reach up to 175 000 ind m^{-2}.

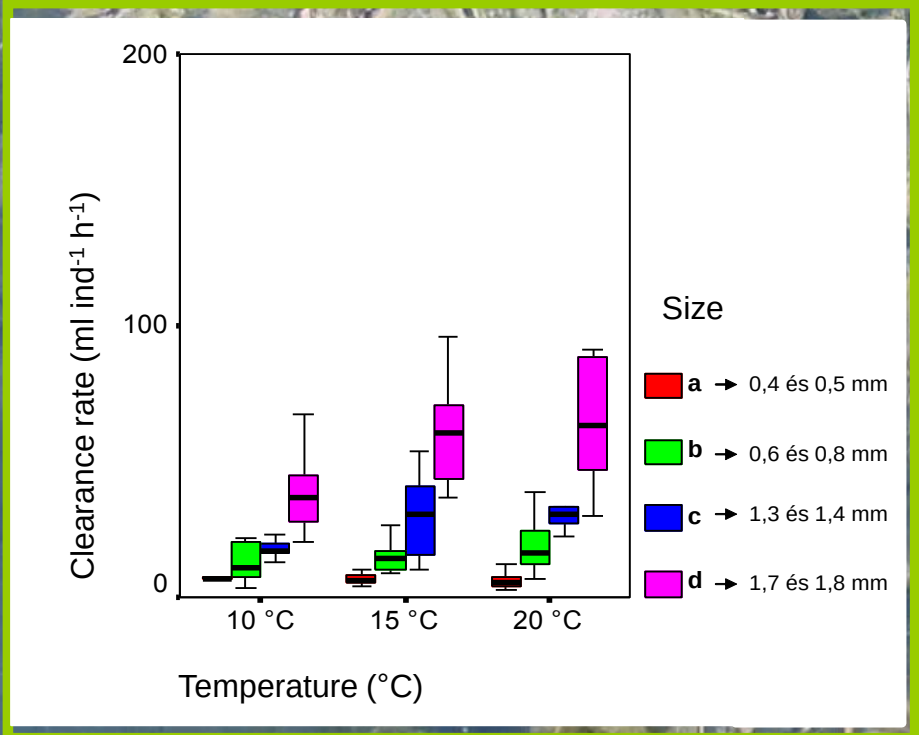
A *Dreissena* density on boat (4 x 2 meter) 1 million ind m^{-2}



A *Dreissena* population

Filtration study of Dreissena polymorpha

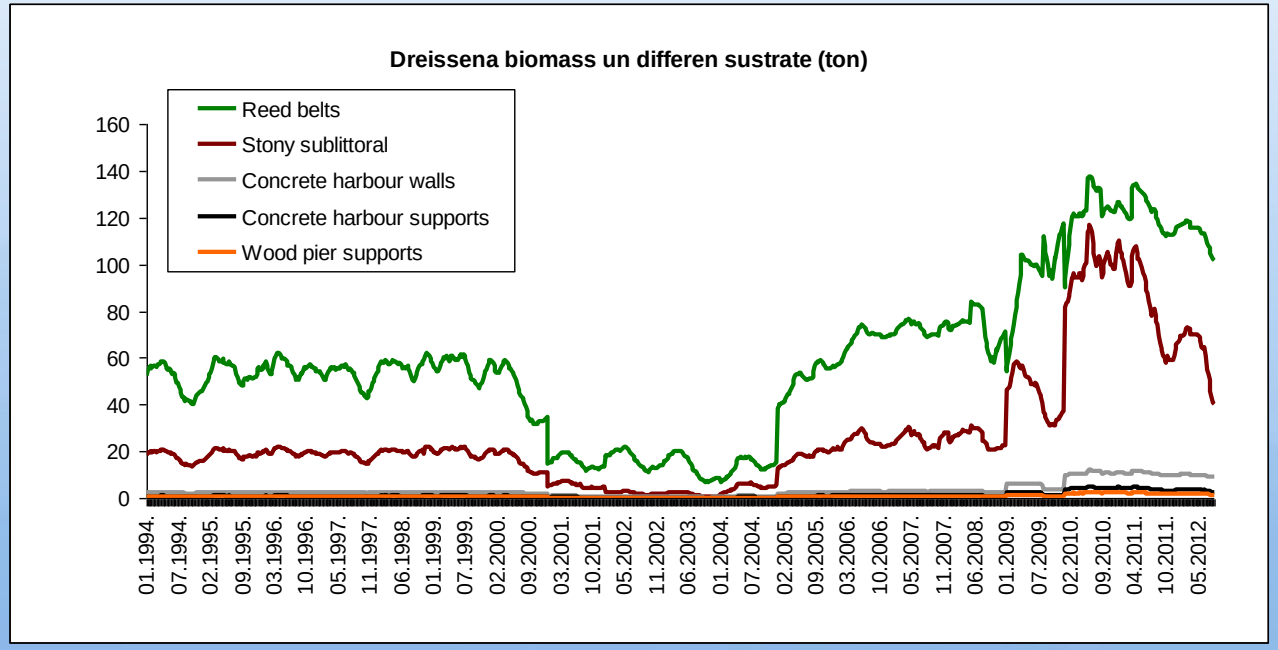




Clearance rate 6-72 ml ind^{-1} h^{-1}

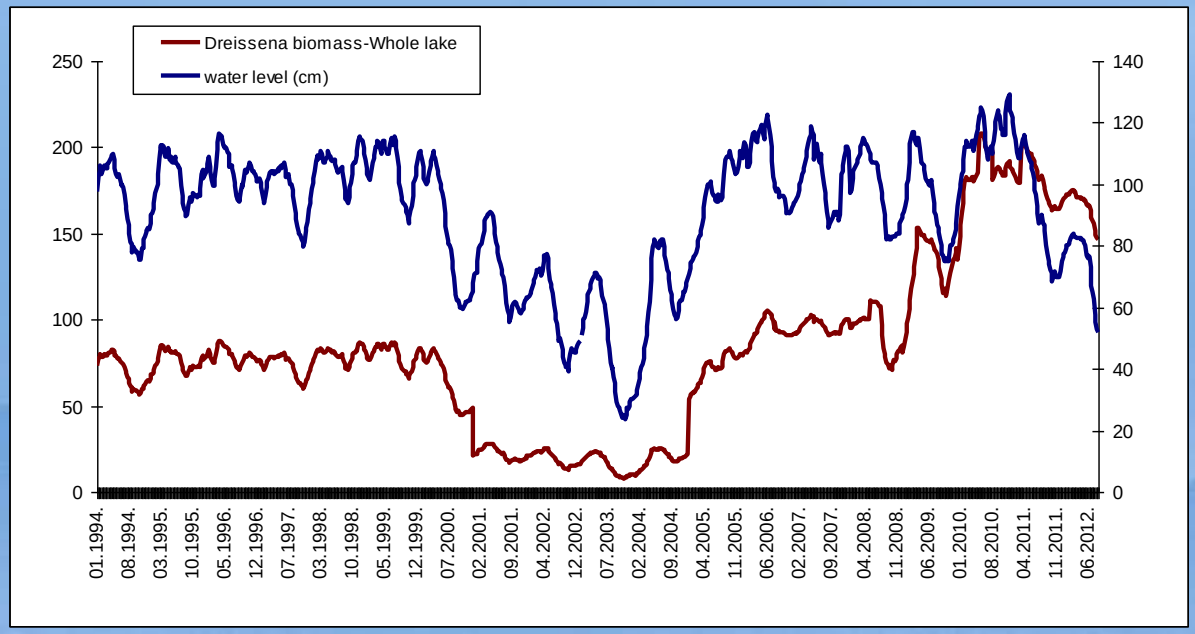
Quantity and clearance capacity of *Dreissena sp.* in Lake Balaton

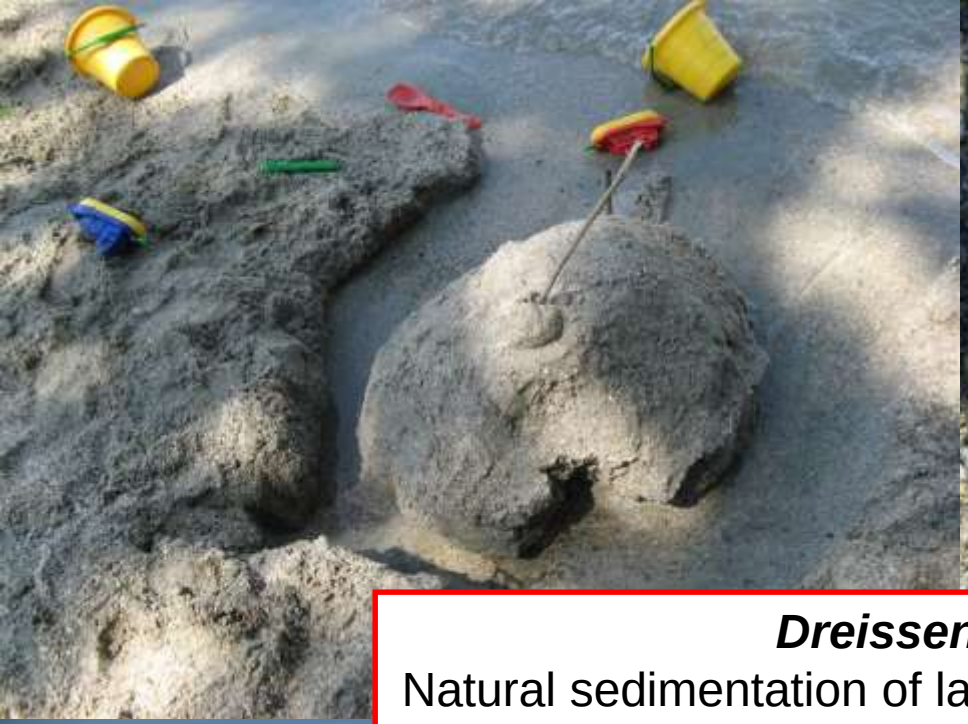
Use the water level, surface and Dreissena biomass data



Whole lake

Using the temperature, the clearance rate dataset





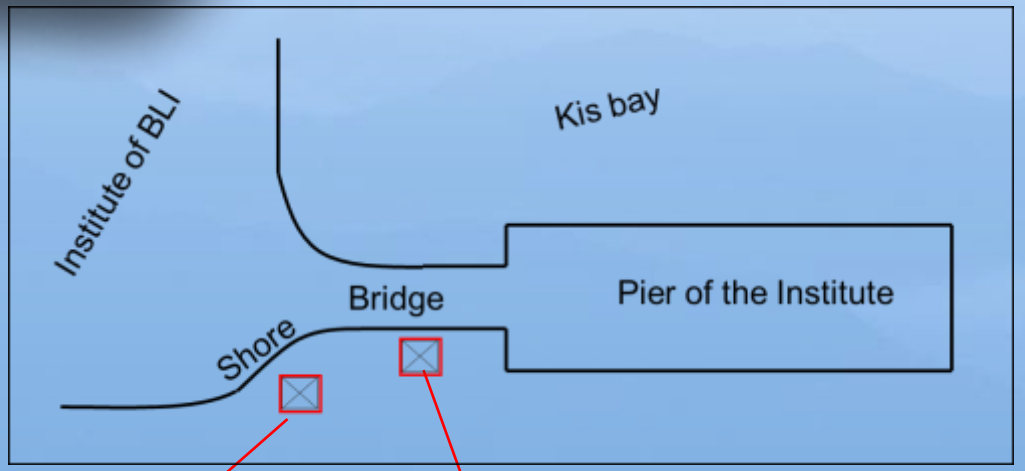
***Dreissena* shoal**

Natural sedimentation of lake Balaton: 0.38 mm/year
(Tullner & Csernyi, 2003)
Dreissena shell production: 0.0003 mm/year/lake

Colonization study

Sampling

Aug. 2009 – every 3 days, daily
Sept. Oct., Nov., Dec. of 2009 - monthly
Aug. of 2010, 2011, 2012 - yearly



Results of turbulent measurements

WinADV

RMS turbulence values ranged between 1,17 és 12,6 cm s^{-1}.

Overall the turbulence was higher near the bridge than on the shore.

The differences was strong **in calm weather**:

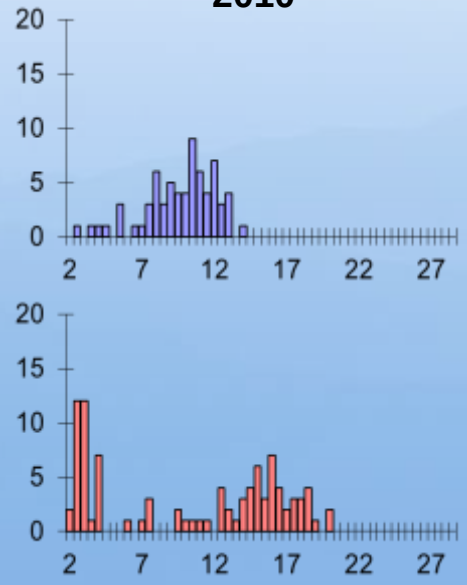
In windy weather there was small differences between the two sampling points.
The average was 10,8±2,4 cm s^{-1}.

Growth and lengths of the two Dreisenid

Length frequency histogram

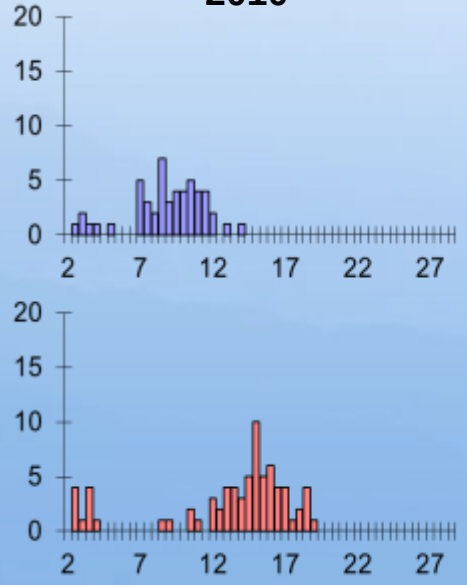
Shore

2010

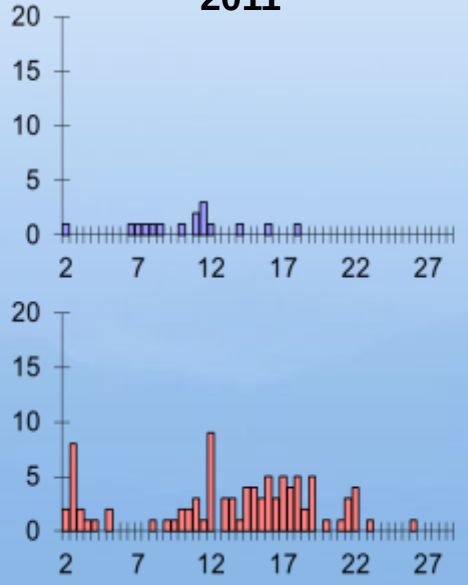


Bridge

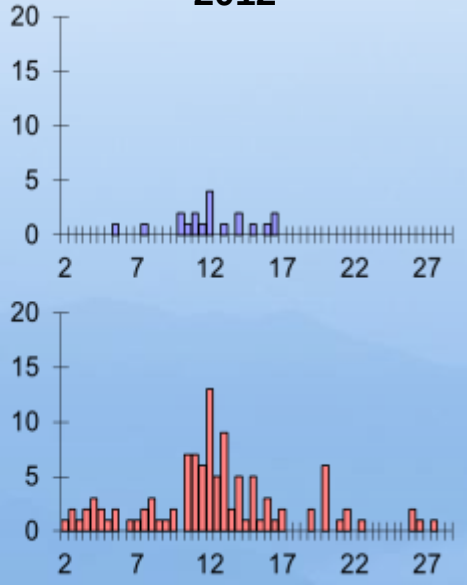
2010



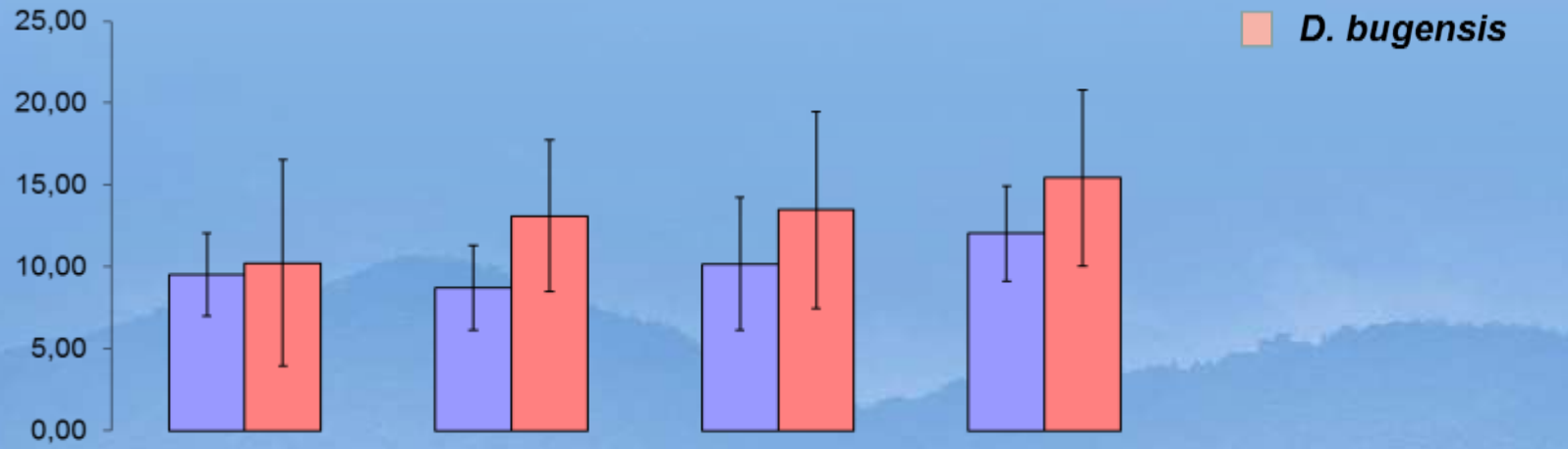
2011



2012



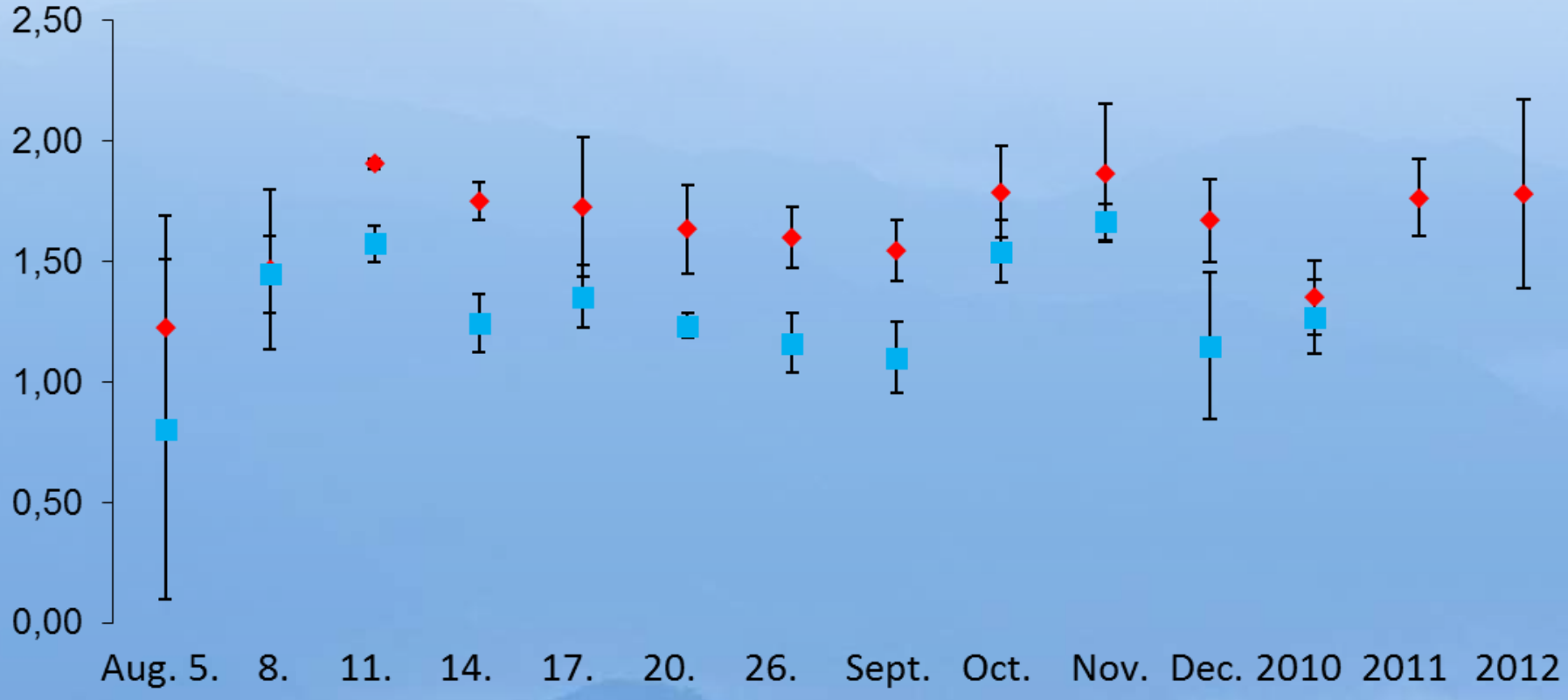
Average length [mm]



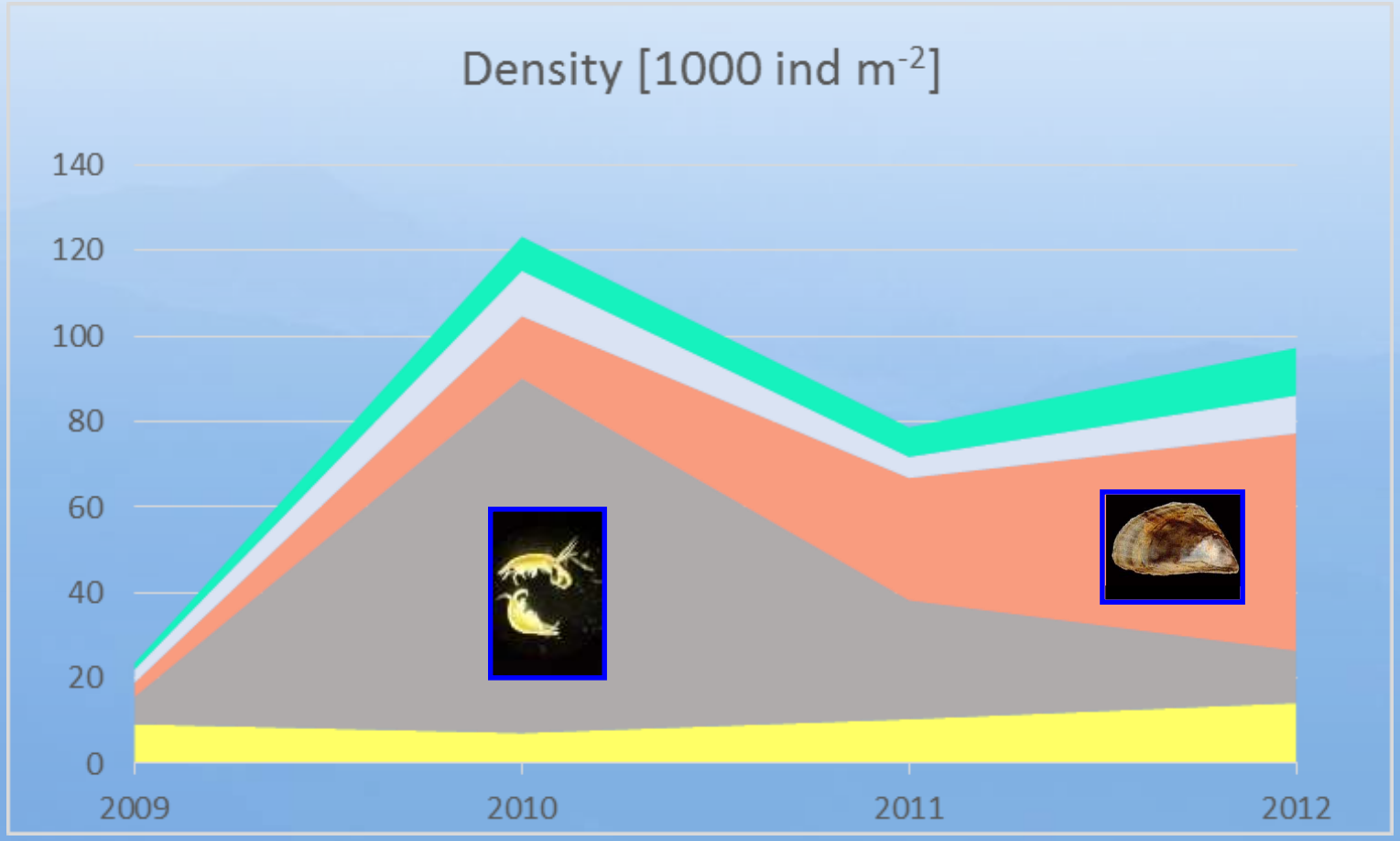
Shannon diversity index

Bridge: disturbed area

Shore: protected area



Density of invasive and native species



Conclusion and discussion

The new Dreissenid species detected in Lake Balaton in 2008 September is the nineth Ponto-Caspian species present in Lake Balaton.

In the past four years a very strong competition between the two *Dreissena* species were found for the suitable surface and food. Due to the number of adventages of quagga mussels they spread rapidly: one year after its appearance it established important part of the *Dreissena* population, two years later turned over the ratio of the two species and *D.* bugensis overdominated *D. polymorpha*, and 3 years later almost total displaced the zebra mussel.

It seems that *D. bugensis* competes with *C. curvispinum* too, but favorizes Dikerogammarids and other native macroinvertebrates.

The turbulence could positively influences the colonization success of native benthic macroinvertebrates, which might exploit the opportunity for settling during unflavoured high turbulence conditions for Dreissenid.

Compare the new *Dreissena* the quagga mussel with zebra mussel, the lengths are bigger and the growth of the new species are faster. The settling of quagga population starts earlier in spring and lasts later in the autumn. The deeper part of the lake *D. bugensis* spread and the shallow southern part *D. polymorpha* dominates. The *Dreissena* popultation contain supposedly hybrids.

Dreissena population in lake Balaton can filtrate the 35% of the total volume of the entire lake daily. The captured algae and detritus turned back as faeces pellets to the lake and the sedentary pellets have important role in sediment deposition and initiate a new food-chain.

The condition indices and the glycogen content of the animals showed correlation. Both properties changed equally with the lake trophic gradient. These values are similar to that found in other lakes with higher trophity, the issue is raised whether other nutrient sources than algae might coming from the inlets also influence beneficially the successive spreading of *Dreissena* in the lake.

Short video about Dreissena population on stones and in the mud

V. Uvira team

„ecosystem engineer”

(Jones et al., 1994; Karatajev et al., 2002; Vanderploeg et al., 2002)

Density of Dreisenid in Lake Balaton can reach
on mussels: 125 000 ind m^{-2}
on stones up to 500 000 ind m^{-2}

Acknowledgement

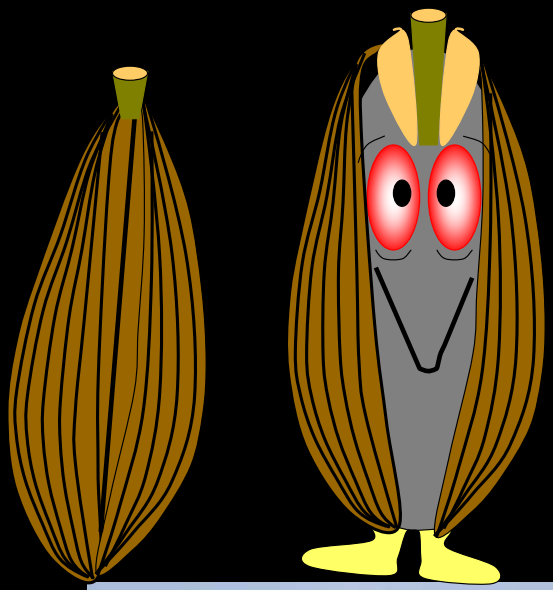
The contribution is much appreciated to

Tünde P.-Klein, Henriette Szabó, Ildikó Starkné Mecsnóbel, Géza Dobos and Péter Harmati for the help during the sampling

Projects:
TÁMOP-4.2.2.A-11/1/KONV-2012-0038,
TÁMOP-4.2.2.A-11/1/KONV-2012-0064

Thanks

for your



attention