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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

Replacement of zebra mussels by quagga mussels in Lake Balaton

19. 5. 2015

Dr. Csilla Balogh

Lake Balaton

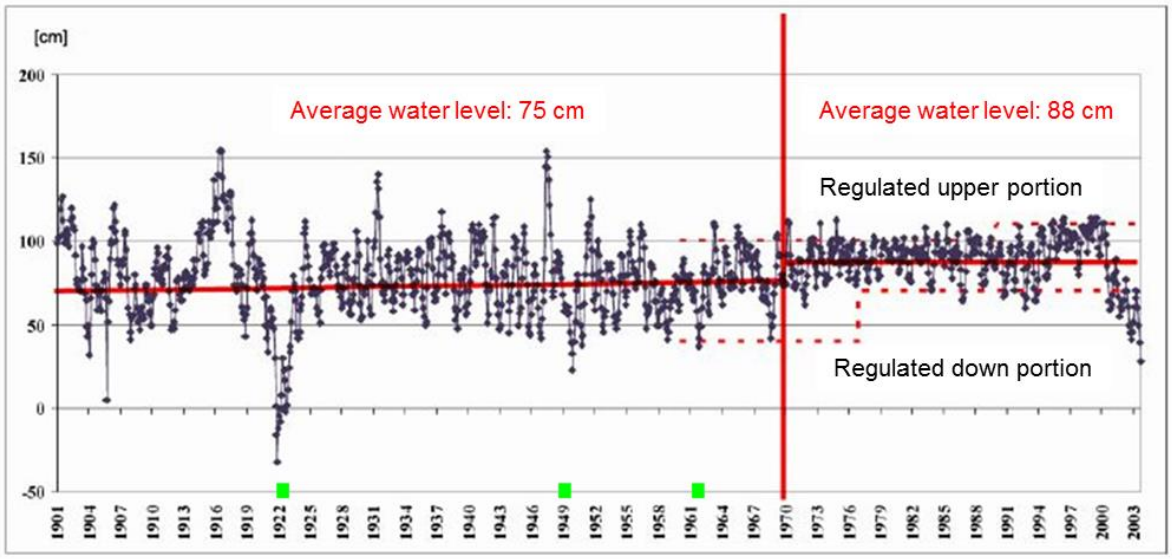
Substrata around the lake

Surface area: 596 km^2

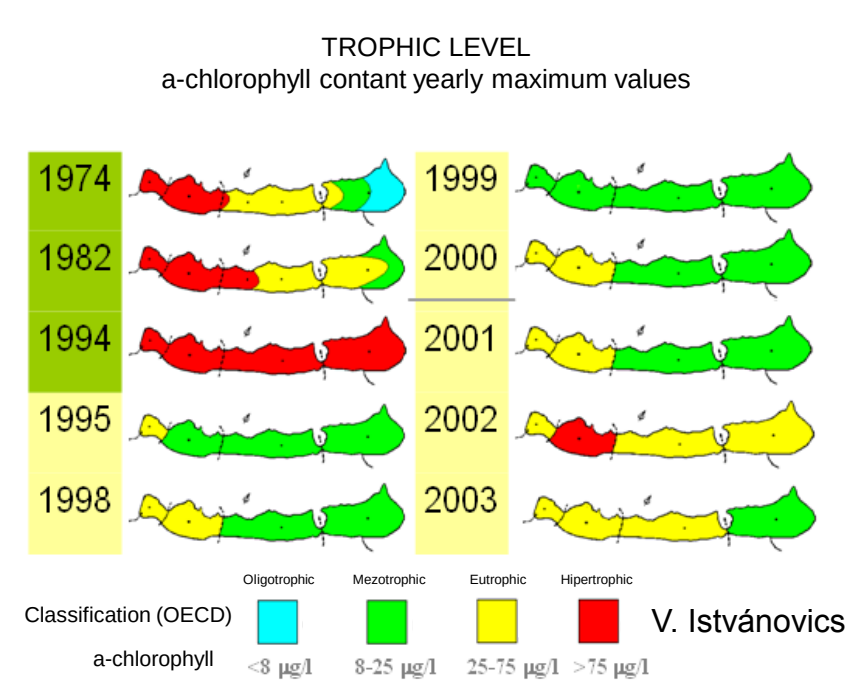
Shoreline: 270 km

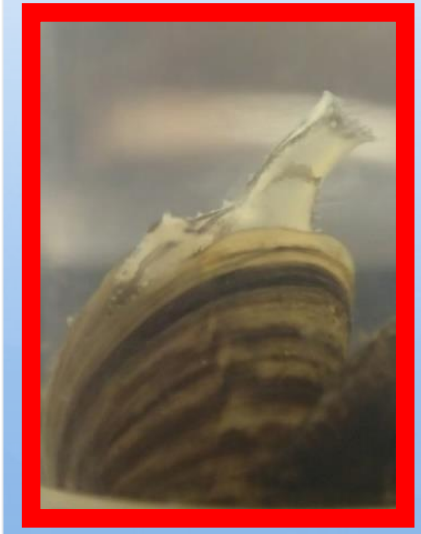
- Rip-rap: 120 km (2,5-3,5 km^2)
- Reed belt: 123 km (4,5 km^2)
- Pier and other concrete walls: 23,6 km
- Sandy shoreline: 3,4 km

Water level fluctuation



Algae biomass

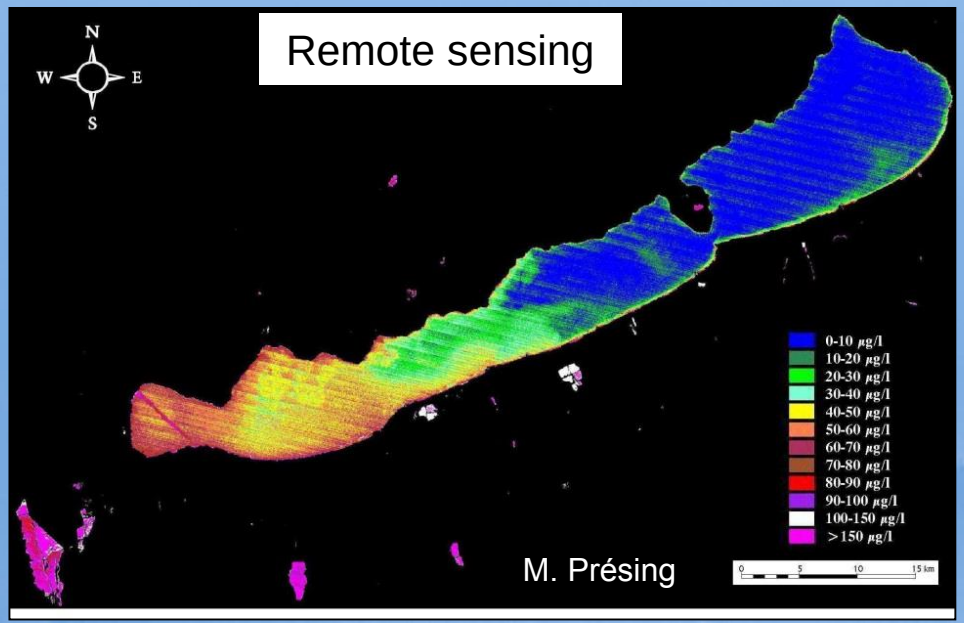




Suspended matter

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

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



List of snails and mussels in Lake Balaton

Snails

Acroloxidae
Acroloxus lacustris
Bithyniidae
Bithynia leachi
Bithynia tentaculata

Hydrobiidae
Potamopyrgus antipodarum (jenkinsi)

Lithoglyphidae
Lithoglyphus naticoides

Lymnaeidae
Galba truncatula
Lymnaea auricularia
Lymnaea palustris
Lymnaea peregra (labiata)
Lymnaea peregra ovata
Lymnaea stagnalis
Lymnaea truncatula

Melanopsidae
Amphimelania holandri

Physidae
Physa fontinalis
Physella acuta
Physella draparnaud

Planorbidae
Anisus leucostoma
Anisus septemgyratus (leucostoma, calculiformis)
Anisus spirorbis
Anisus vortex
Anisus vorticulus troschel
Armiger crista
Bathyomphalus contortus
Gyraulus albus
Gyraulus laevis
Gyraulus riparius
Hippeutis complanatus
Planorbarius corneus
Planorbis carinatus
Planorbis planorbis
Segmentina nitida

Valvatidae
Valvata cristata
Valvata naticina
Valvata piscinalis

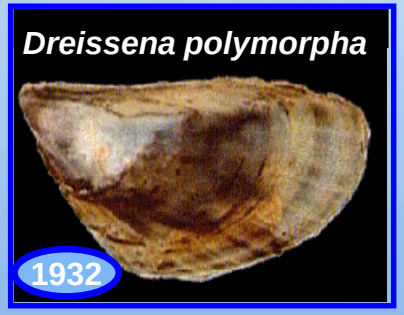
Viviparidae
Viviparus contectus

Mussels

Corbiculidae
Corbicula fluminea

Dreissenidae
Dreissena bugensis
Dreissena polymorpha

Sphaeriidae
Pisidium amnicum
Pisidium casertanum
Pisidium henslowanum
Pisidium moitessierianum
Pisidium nitidum
Pisidium pseudosphaerium
Pisidium pulchellum
Pisidium subtruncatum
Pisidium supinum
Sphaerium rivicola



Unionidae
Anodonta anatina
Anodonta cygnea
Pseudanodonta complanata
Sinanodonta woodiana
Unio crassus
Unio pictorum
Unio tumidus

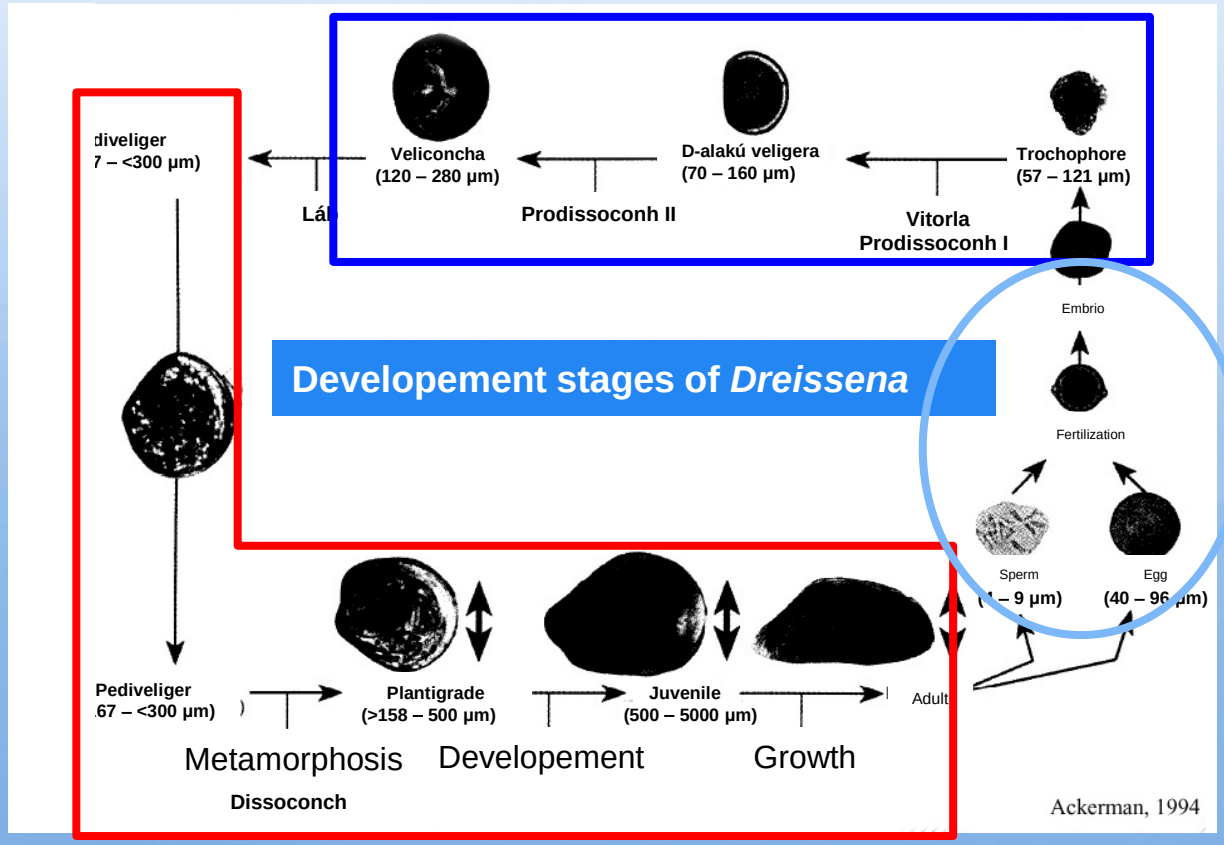
Key of the invasive species succcess

Most of them „r-strategist”, means

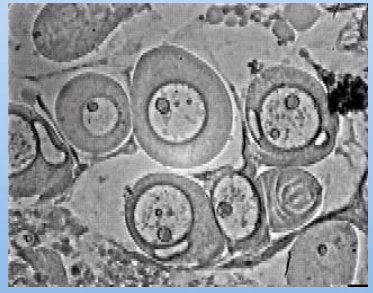
- a high birth rate;
- short life time;
- Intensive mobility;
- more generation per year;
- unique reproductive specialities

(viviparity, free living larvae; agamogenesis or diclinousness).

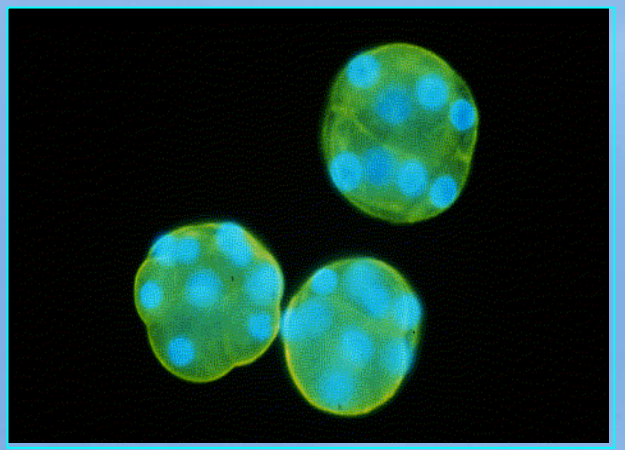
Life cycle of *Dreissena*



larvae – part of the zooplankton

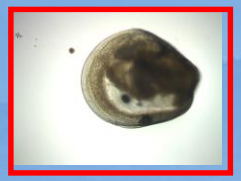


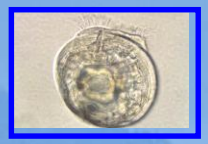
gonads

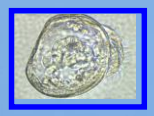


300.000-400.000 eggs per season

Planktonic larvae stadium







Settling veligera stadium and growth

Invasion of *Dreissena* species in the US

Dreissena polymorpha have been transported to the US in 1988 by ballast water (Herbert et al., 1989). Within two years they have spreaded rapidly and shortly after *Dreissena bugensis was* also introduced in 1989 (scientificly in 1991, Mills et al., 1996). The new species was named "quagga mussel" after the "quagga", an extinct African relative of the zebra (May and Marsden, 1992).

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 in Rhine Delta and spread rapidly in Rhine-Main-Danube water system.

Differences between the two *Dreissena* species

Zebra and quagga mussels are closely related invasive sessile organism, have similar requirement and life habitats, however the overlap of each other distribution only 75% (Quinn et al., 2013).

Dp: Dreissena polymorpha – zebra mussel

Db: *Dreissena bugensis – quagga mussel*

- Occurence in deeper waterbodies, profundal zone of the lakes;
- lower temperature of spawing;
- faster reproduction;
- faster growth;
- thinner fragile, softer shell (Casper and Johnson, 2010);
- less strong byssal threads (Prayer et al., 2009);
- lower respiration, reduced energetic costs so greater energetic efficiency (Baldwin et al., 2002; Stoeckmann, 2003);
- difficult to adopt to unstabile environment of upper littoral zone;
- can colonize silt and have higher tolerance to low oxygen conditions;
- narrower distribution.

Areas are also endangered quagga muusels which nowadays has seemed not suitable for *Dreissena* establisment (Quinn et al., 2013).

Role of *dreisenids and importance of their study*

Among bivalves, the dreissenid-mediated impacts on aquatic environments are of special interest because these animals are called as “ecosystem engineers” (Jones et al., 1994, 1997; Karatayev et al., 2002; Vanderploeg et al., 2002; Gonalez et al., 2008).

Dreisenids successful colonize habitats and water bodies and have enormous impact on aquatic ecosystems:

intensive filter feeder (Ota, 1993; Daise, 2003; Pimentel et al., 2005) so exert grazing pressure, top-down control (Carpenter and Kichell, 1992)

on **phytoplankton**

strong impact on **zooplankton** densities and community structure

alters the composition of the **microbial community** inhabiting the sediment.

Ecological impacts of *Dreissena* species especially depend on the density of its population.

We have less knowledge related to quagga mussel than zebra mussel (Karatayev et al., 2013; Sousa et al., 2014) especially in Europe despite the fact that according to the existing studies quagga mussel is more aggressive invador, in most cases replacing or displacing zebra mussel and may have greater system-wide effect than zebra mussel (Karatayev et al., 2015).

Sampling

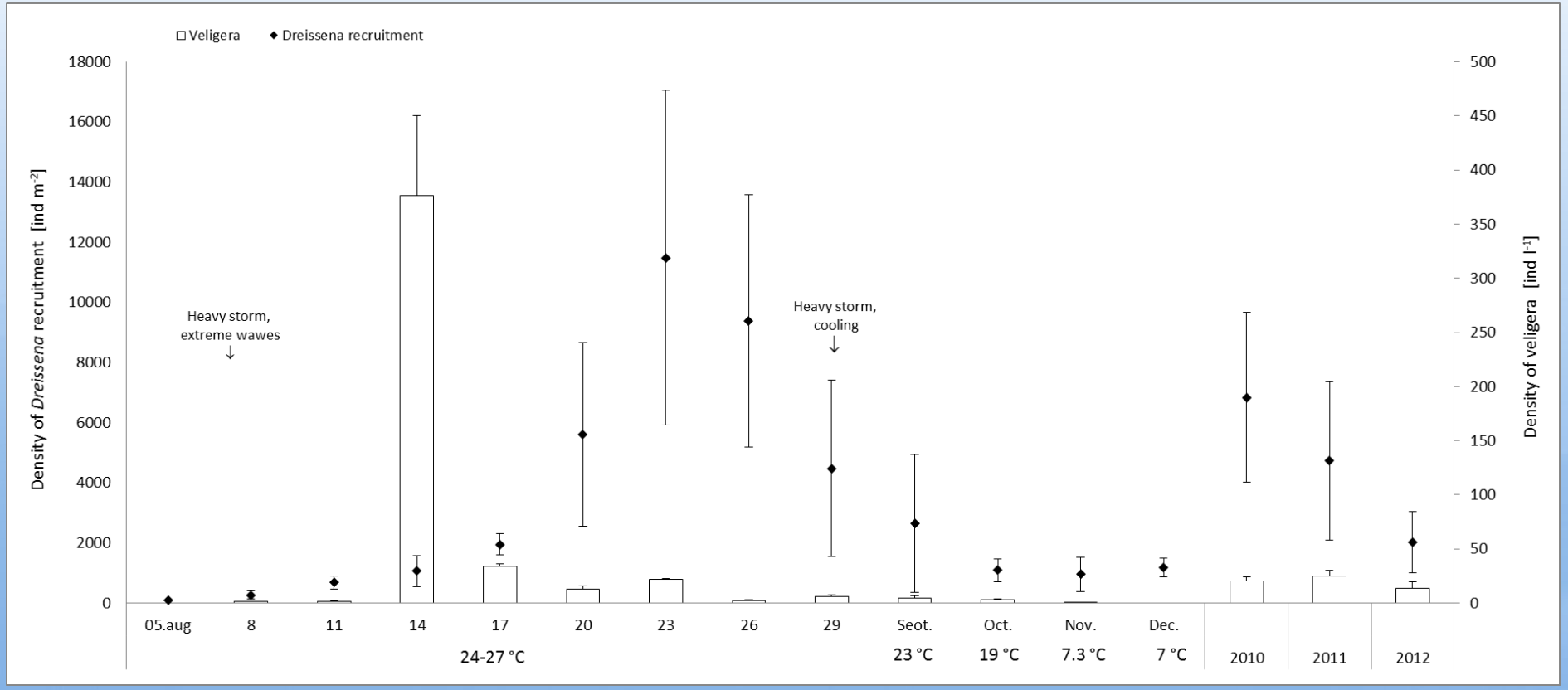
Aug. 2009 – every 3 days, short term
Sept. Oct., Nov., Dec. of 2009 – medium term
Aug. of 2010, 2011, 2012 – long term

Tihany

Collect the animals larger than 60 µm

Veliger samples were taken with a Schindler–Patalas sampler equipped with a 60 µm mesh-sized collector funnel at along the whole vertical depth.

Density of veligers and recruitment

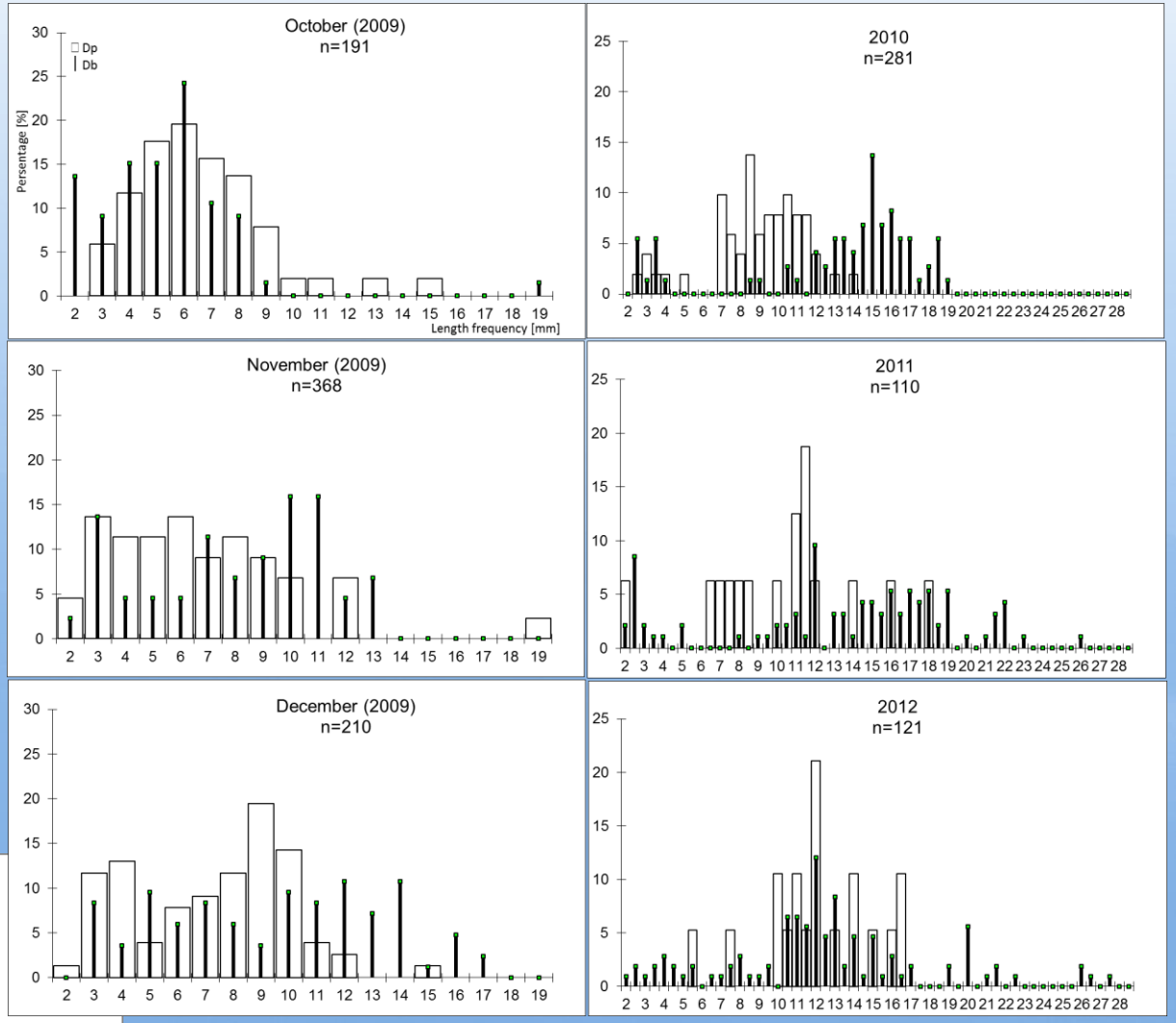


Compare to our earlier dataset (before the quagga mussel invasion) usually in October there were no veligers or only when the water temperature values are higher (Balogh, 2008). According to Sprung (1987) 9 °C is the minimum temperature for maturation of gametes in zebra mussel. Likewise others found the lack of zebra mussels larvae and spawing of quagga mussel when the water temperature reached 9°C (Stoeckmann, 2003) or 4-9°C (Claxton and Mackie, 1998) or 4.5-6°C (Nalepa et al., 2010).

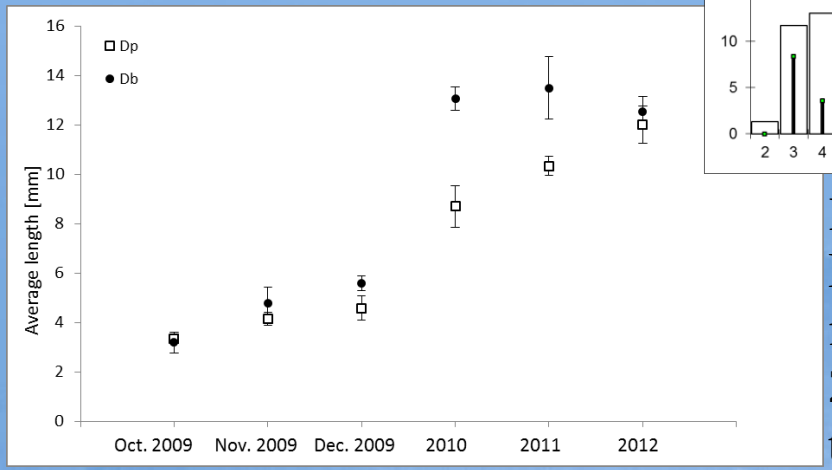
Extension of the larvae production, spawing period in spring and autumn would be one of the key factors promoting the success of quagga mussels invasion.

In a recent study greather lengths of quagga mussels than zebra mussels, clearly show the faster growth of the new invador. Similar was observed in the Great Lakes (Diggins, 2001; Stoeckmann, 2003) which could be explained by the lower respiration and higher filtration rate of quagga mussel - greater energetic efficiency promotes the faster growth of the mussel and ensure better survival of unfavourable conditions (Baldwin et al., 2002; Stoeckmann, 2003).

Histograms – population dynamics

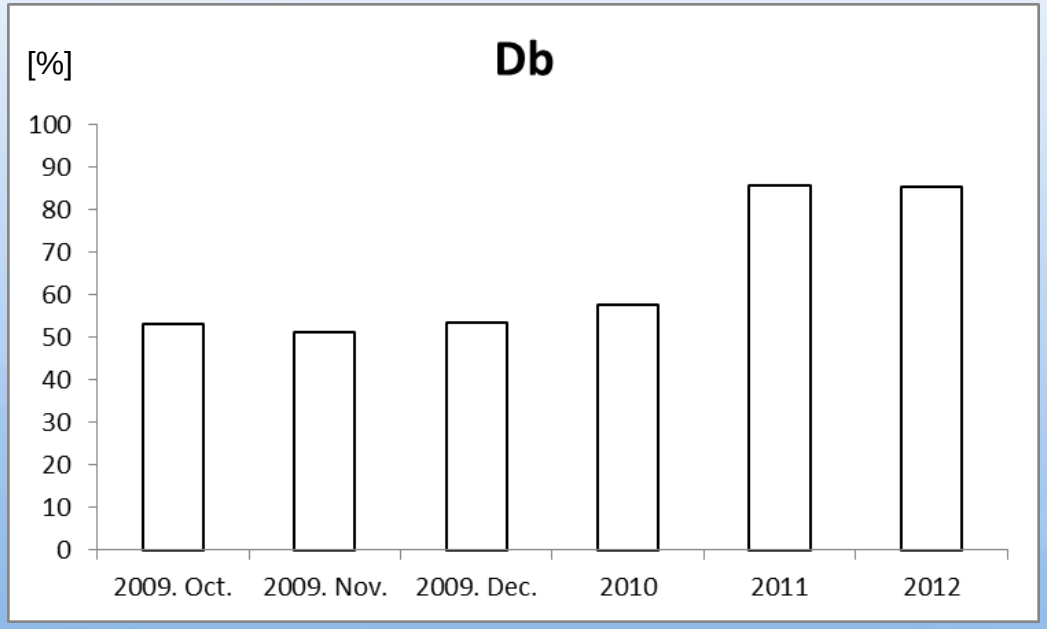


Average length



In a recent study/Our results indicate that maximal shell length of quagga mussels was 20 mm within a year and finally the largest three year old specimen collected in 2012 was 27,5 mm - the intensive growth tendency is in the beggining of its lifecycle.

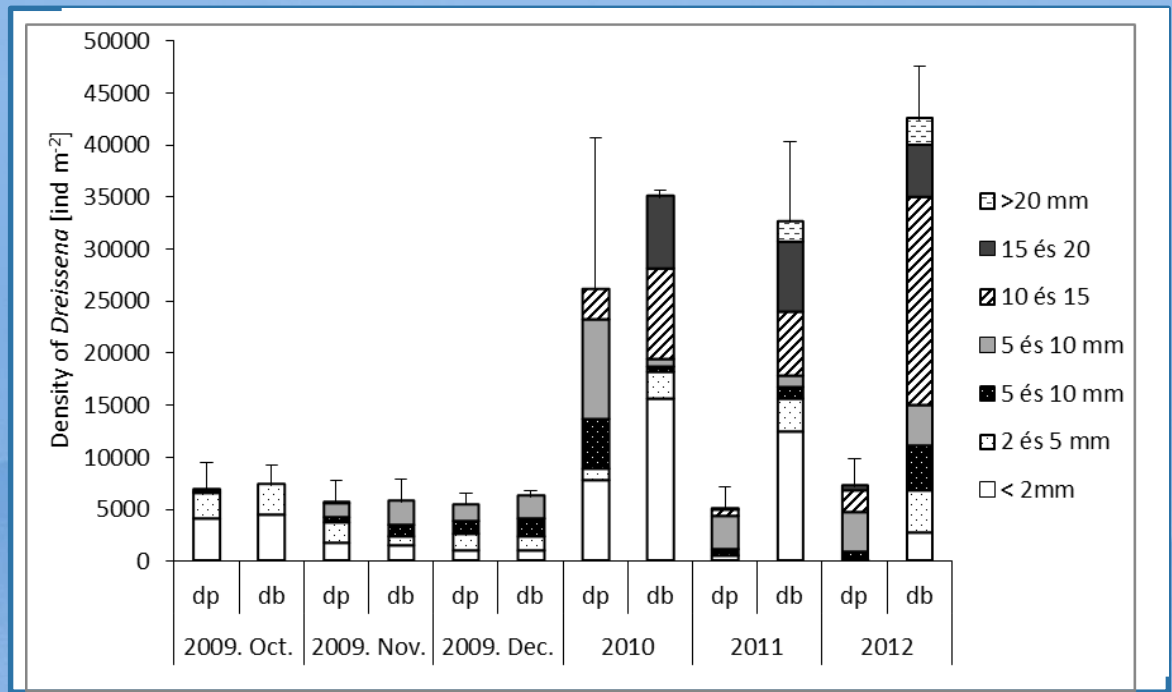
Quagga mussels ratio of the dreissenid population



Our field study revealed that on new surface the competition is very intensive in the first two years, and than replaced the zebra mussel by the new invador, the quagga mussel. At the end of our study quagga mussels become dominant species on the three years implanted new surface, its mean density were six time higher than that of zebra mussels.

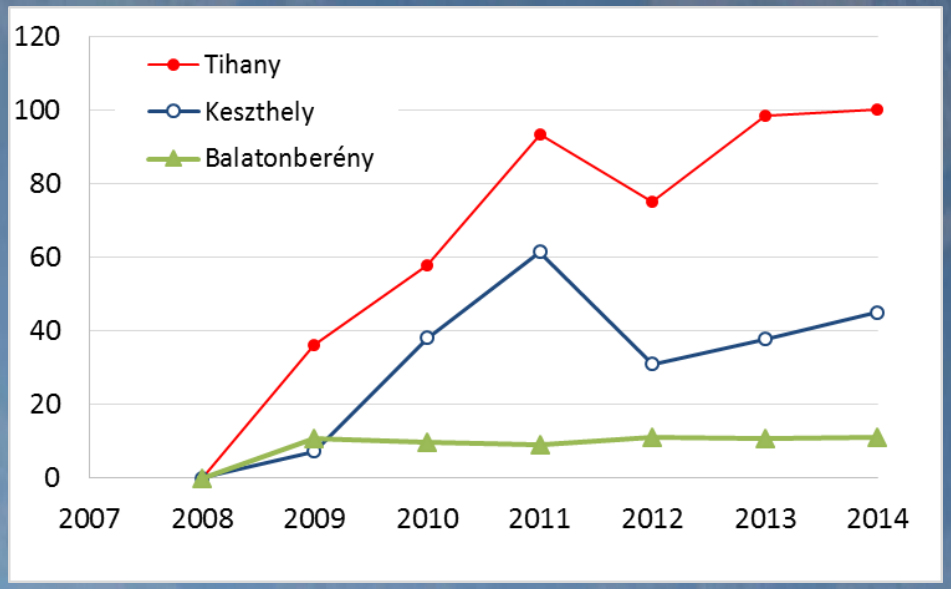
Density of Dreissena species Show different sizeclass

Highest densities of quagga mussel exceeded 45 000 ind m^{-2} on stones by 2012. In 2009 52% of dreisenids were quagga mussels but by 2011 quagga mussels accounted for 85% of the dreissenid population and zebra mussel comprised 15%.

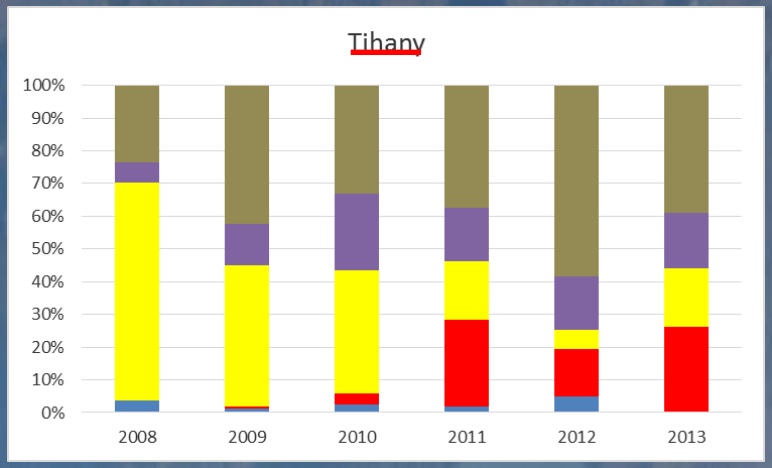


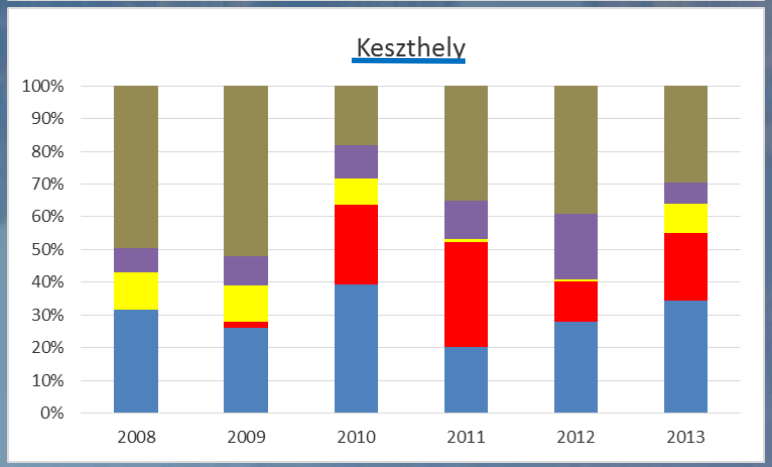
Monitoring of invertebrate in the rip-rap

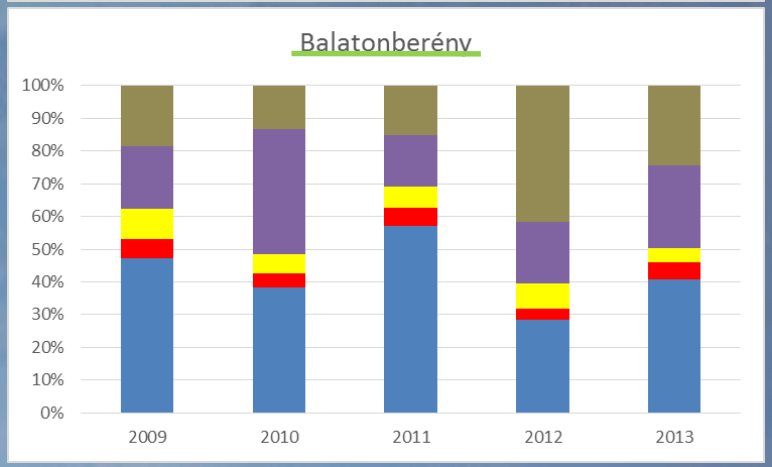
Quagga mussels ratio of the dreissenid population



Relative abundance of invasive and native species







Tihany

Keszthely

Balatonberény

Other species
Dikerogammarus species
Chelicorophium curvispinum
Dreissena bugensis
Dreissena polymorpha

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For

Your

Thanks

Attention