POSSIBLE APPLICATION OF INVASIVE DREISSENIDS AS PROTEIN SOURCE ALTERNATIVE IN INTENSIVE FRESHWATER FISH FARMING PROJECTS: GROWING DYNAMICS AND NUTRIENT VALUE OF MUSSELS IN SITU AND FEEDING WITH ALGAE

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CENTRE FOR ECOLOGICAL RESEARCH

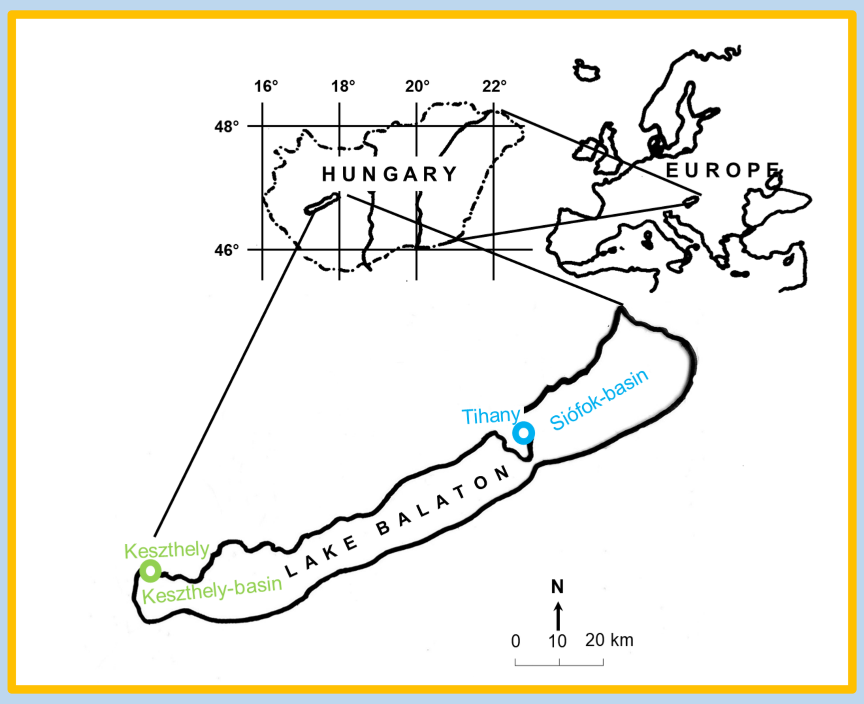

Fig. 1. Site map of Lake Balaton with sampling points.

INTRODUCTION

Invasive dreissenid species (*D. polymorpha, D. r. bugensis*) was introduced from Danube River to Lake Balaton - the largest shallow lake in Central Europe - supposedly by ship transport (Sebestyén, 1932; Balogh et al., 2009). The dreissenid-mediated impacts on aquatic environments are of special interest because they can create and/or modify habitats, and promote numerous direct and indirect system-wide effects; hence they are considered as ecosystem-engineers (Jones et al., 1994, 1997; Karatayev et al., 2002; Vanderploeg et al., 2002; Gonalez et al., 2008). Dreissena species as dominant freshwater filter feeders playing intermedier role in the food chain. Their biomass (dry mass without shell) reaches around 22 t/year in Lake Balaton (Balogh, 2008), where dreissenids are main food sources for carp, bream and roach (Bíró, 1997). We found that the protein content of the soft tissue was high enough (55-60% dw, Balogh and Serfőző, 2017) to count with this animal as a potential protein source alternative provided by freshwater ecosystem service for feeding developing fishes in intensive fish farming.

The aim of this study was to investigated the type and quantity of algae that yields intensive growing, higher weight and therefore more energy source biomacromolecules of dreissenids, which is beneficial in fish bait composition. Monocultures of those algae were used, which can be found with high number in the natural environment of dreissenids and can be easily cultured in laboratory conditions.

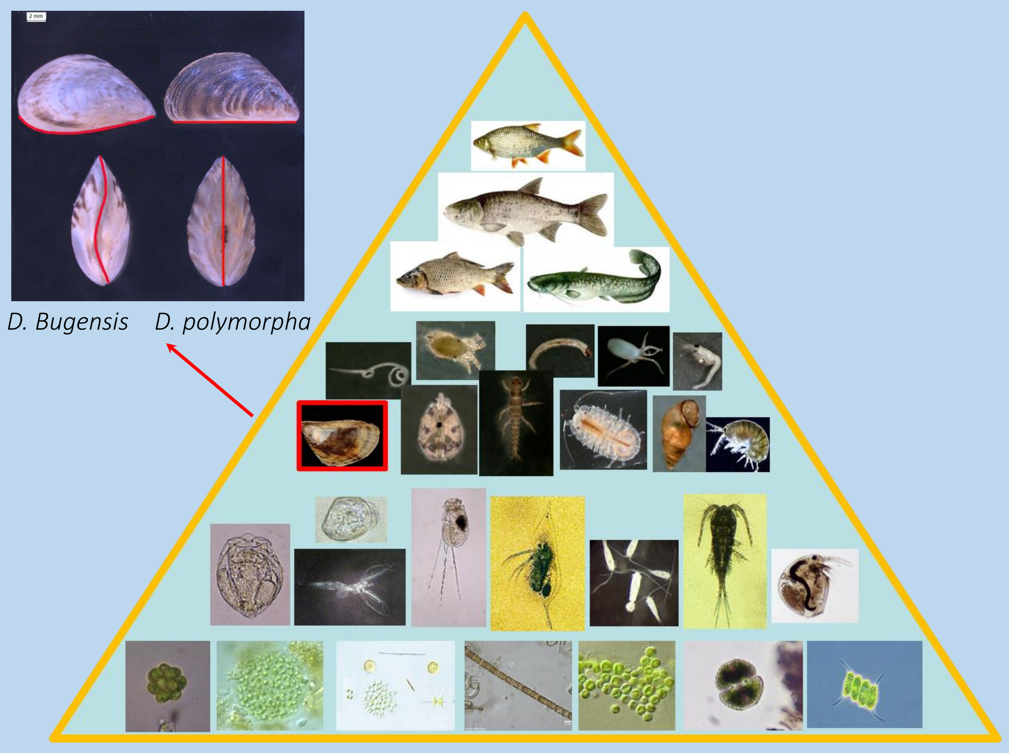

Fig. 2. Food chain of Lake Balaton, demonstrating the intermedier position of Dreissena species

MATERIALS AND METHODS

Algae-mussel laboratory experiment were carried out to know the optimal algae concentration which dreissenids consume daily, and using this optimal concentration we measured the growth of the animals in a mid-term (3 months) microcosm study (Fig. 1a.). We used four kind of algae species (*Chlorella sp., Scenedesmus sp., Neochloris sp., Phaeodactylum sp.)* and an algae-mix, containing the mixture of them (Fig. 1i.). The lake water filled with natural plankton represent the control. In the microcosm study, the weight, length, width and the shell area of the mussels (10 pieces per cup, in 5-10 parallel) were measured (Fig. 1d-h.). The shell length and area increment were determined by using Image J softwer. We collected animals living in the western eutrophic (Keszthely) and eastern oligotrophic (Siófok) bays of Lake Balaton (Fig. 1j). We followed the algae concentration by flow cytometry (Fig. 1b.). We measured (Fig. 1c.) glycogen (total carbohydrate) content according to Van Handel (1965), adapted to mussels by De Zwaan and Zande (1972). Protein was measured with BCA method (ThermoScientific), and the fatty acids by the phosphovaniline method (Nalepa et al., 2014). To analyse differences in used algae species (transformed in case of need), we used a GLM ANOVA (different letters means significant differences).

Fig. 1d-h. Mussel measurement processes.

Fig. 1a. Design of the laboratory experiment.

Fig. 1b. Measurement with the flow cytometer.

Fig. 1c. Mussel body content measurements.

Fig. 1i. Sample of algae cultures used for mussel feeding expeiments.

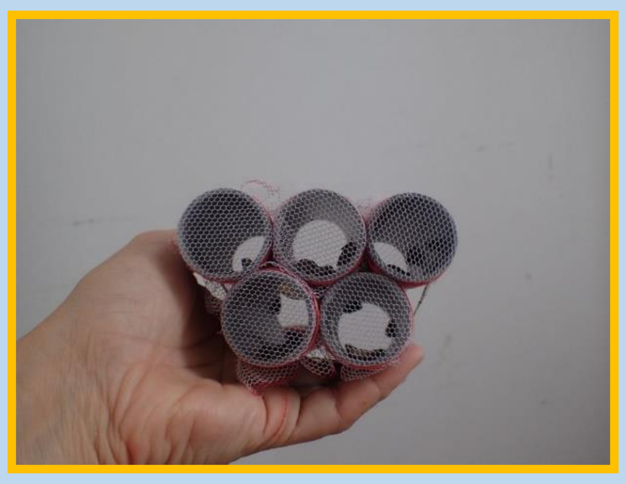

Fig. 1j. Artificial substrates (tubes) with mussels implanted into the lake.

RESULTS

We found that optimal algae concentration for mussel growth was 1-3x10^7 ind/L/day.

There were significant differences on the growth (weight, size) parameters of the mussels depending on the algae species used to feed them (Fig. 2a., b). Reduction of the weight was found in control samples (Fig. 2a). The survival of the mussels were up to 85% at the end of the three-month experiment. The highest survival rate reached with the mussels feeded by the algae-mix.

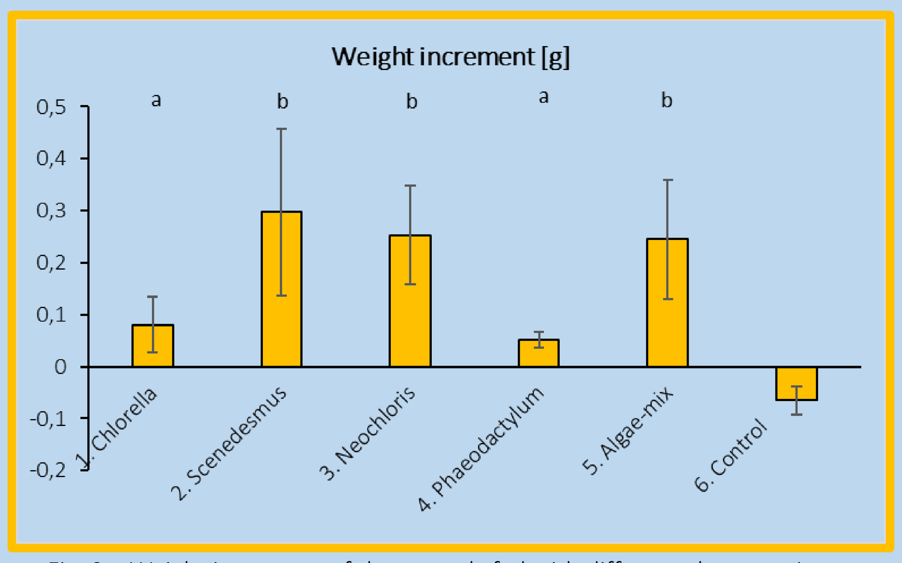

Fig. 2a. Weight increment of the mussels fed with different algae species.

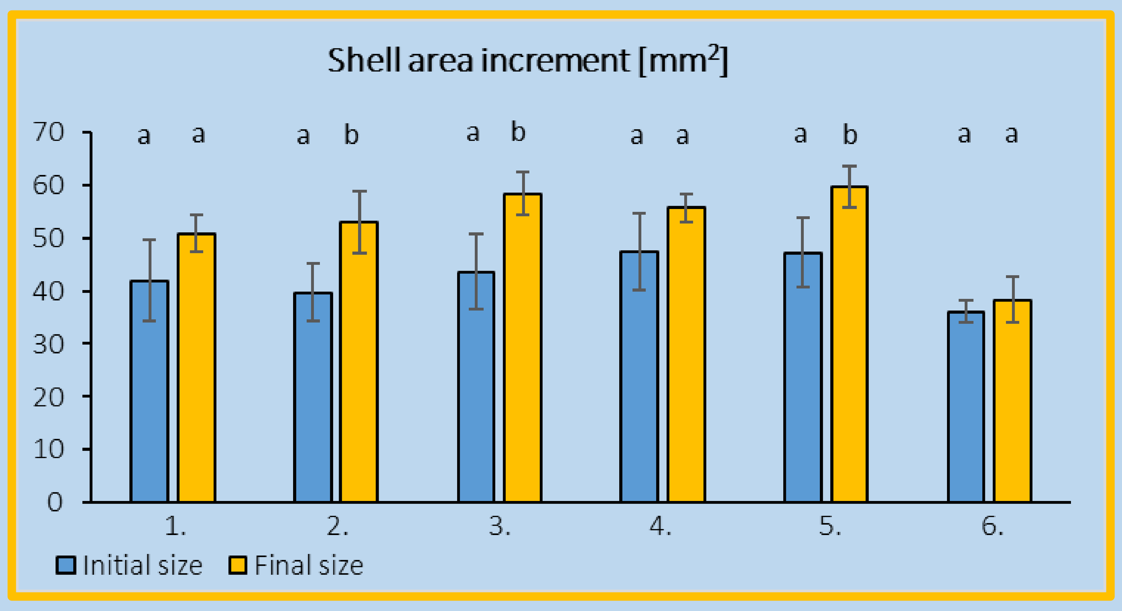

Fig. 2b. Shell area increment of the mussels fed with different algae species.

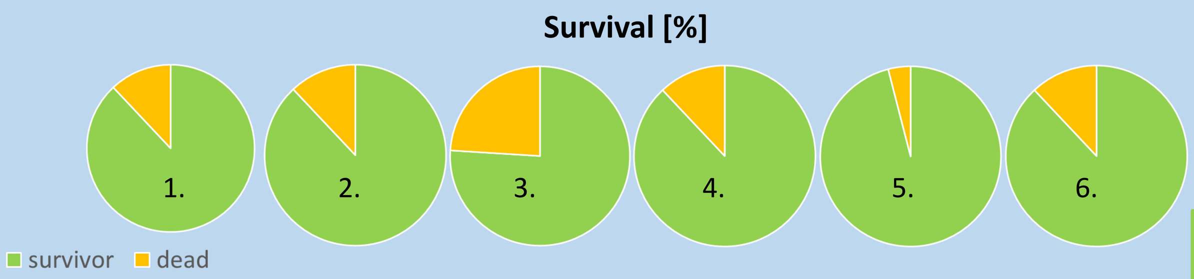

Fig. 2c.Survival of the mussels fed with different algae species.

Protein content was significantly higher in case of feeding the mussels with *Chlorella sp.* or with *Phaeodactylum sp.* compared with those mussels kept under Lake Balaton water obtained from the oligotrophic part. On the other hand, high biomacromolecule values of the experimental samples were exceeded that of the samples taken from the eutrophic part of the lake (Fig. 3a). Carbohydrate data showed significant emergence only in case of feeding with *Scenedesmus sp., Phaeodactylum sp.* (Fig. 3b), similarly to fatty acids (Fig. 3c).

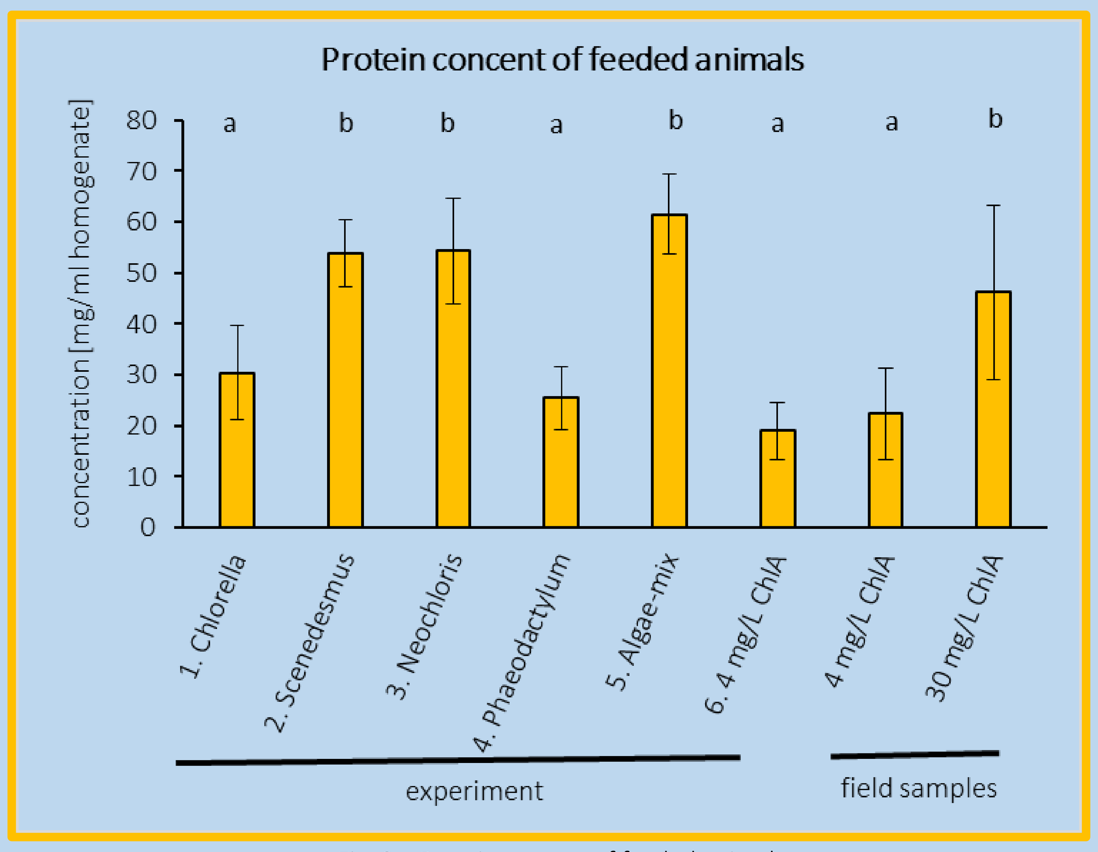

Fig. 3a. Protein content of feeded animals.

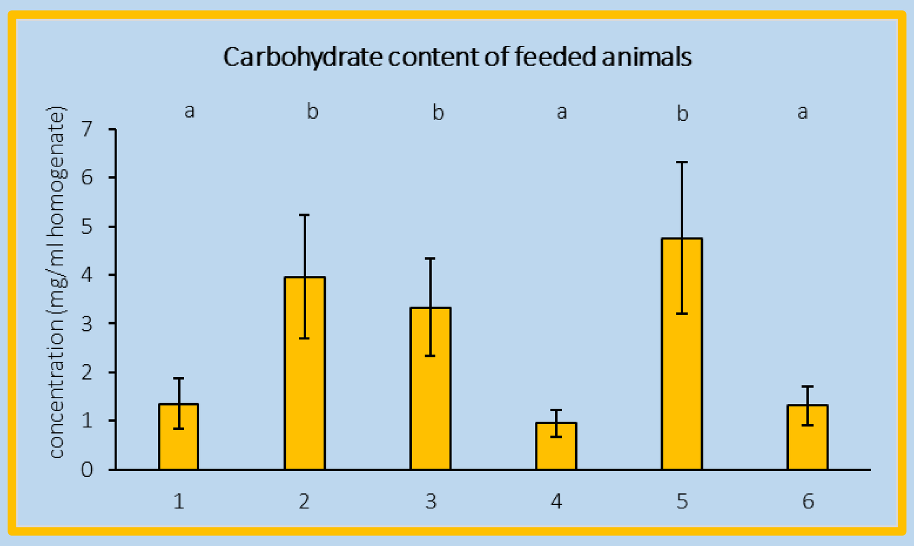

Fig. 3b. Carbohydrate content of feeded animals.

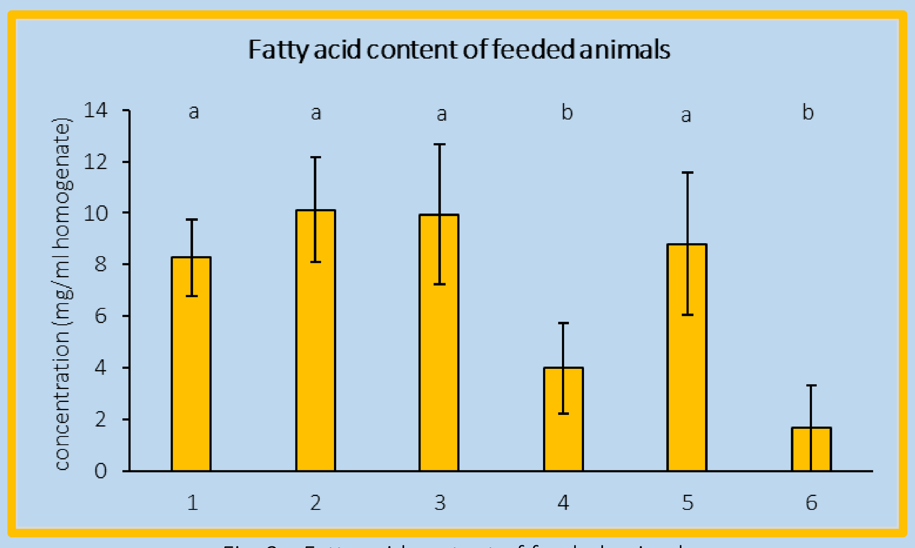

Fig. 3c. Fatty acid content of feeded animals.

Results showed that length increment, wet weight, protein and carbohydrate content of the mussels were highly correlated (Table 1.).

	shell strength	length	lipid	carbohydrate	protein
wet weight	0,25	-0,07	0,20	0,82	0,78
protein	0,24	-0,09	0,20	0,85	
carbohydrate	0,23	-0,06	0,12		
lipid	-0,11	-0,11			
length	-0,02				

Table. 1. Correlation between the measured parameters. Boxes showing significant p-values are filled with color

CONCLUSION

Scenedesmus sp., Neochloris sp. and the algae-mix ensure the best food sources for the mussels. All growth parameters (weight, lengths) as well the body protein content were higher at the mussels feeded by these algae species. Absolute values of all energy source materials measured were the highest in the case of nourishing the mussels with these algae. High biomacromolecule values of the experimental samples were exceeded the value that of the samples taken from the eutrophic part of the lake. Thus, the mussel body content indicates the trophic state of the lake, showing the gradiently declining trophic state along the longitudinal axis from the eutrophic Western to the oligo-mesotrophic Eastern basins (Padisák, 1994, 2001; Padisák et al., 1998; Tátrai et al., 2000; Vörös et al., 2000). In the experiment, the mussel growing dynamics were similar to that found earlier in the field (Balogh et al., 2019), and in the substrata implanted into the lake (Balogh et al., unpublished). In conclusion, considering natural conditions, amount of biomacromolecules could be enriched in dreissenids fed on selective algae monocultures.

ACKNOWLEDGEMENT

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