Final report on the NKFI-PD 120775 Grant (30.09.2019)

Trait divergence and convergence in aquatic plant communities

Principal Investigator:

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Researchers involved between 2017-2019:

2016-2019: Anna E-VOJTKÓ (University of South Bohemia, Czech Rep.), hereafter EVA.

2019: Ádám LOVAS-KISS (Centre for Ecological Research, Debrecen, Hungary), hereafter LKÁ.

2019: Viktor LÖKI (Centre for Ecological Research, Debrecen, Hungary), hereafter LV.

2019: Felícia PALLÉR-KAPUSI (Centre for Ecological Research, Debrecen, Hungary), hereafter PKF.

Students involved between 2017-2019:

2017-2019: Levente KÉKEDI (B.Sc., University of Nyíregyháza, Hungary), hereafter KL.

2018: Gréta KOVÁCS (B.Sc., University of Debrecen, Hungary), hereafter KG.

Research results (*numbers in brackets refers to the publications above*)

The main aim of my project was to set up a plant functional trait database of aquatic plants; a database that can be used to study the assembly rules of aquatic plant communities in more details. Before my project, only a few plant-functional-trait data were available for aquatic plants; researchers used WILLBY et al. (2000) trait-attribute if they proposed to study the functional aspect of aquatic plant communities, but these attributes are not suitable to calculate functional diversity indices. To build up a plant functional trait database, we did sampling campaigns and collected aquatic plants in lakes and rivers in Hungary, Spain, Finland, Denmark and Poland. We collected leaves and seeds from the plants; we measured functional traits (leaf area, fresh mass, dry mass, seed weight) on the sampled materials. (I have to note that during this time period we were busy with trait measurements because we collected trait data not just from aquatic plants but from terrestrial plants of the Hungarian flora.) As a result, we gathered trait data from 50 hydrophyte plants (two-thirds of the Hungarian macrophyte flora) and additional 20 helophyte species.

Between 01.10.2016 and 30.09.2019 I am the author of 20 peer-reviewed articles (I am the leading author of eight). However, only nine of these articles belongs strictly to the aims of the project, the project ID listed only in these articles.

At the beginning of the project, I made studies that aimed to investigate the functional trait differences of native and alien aquatic plants [1]; to investigate the effect of alien species on the seed-bank (as response trait) of native species [2]. Our results indicated that alien aquatic plant species deplete the seed-bank of native species, and the competitive superiority of alien species can be explained by their higher leaf area and lower specific leaf area. According to these studies, we suggested a kind of superiority of alien aquatic plants over native species. We have also known that environmental induced

phenotypic plasticity is expressed among aquatic plants. Accordingly, we investigated how phenotypic plasticity alters the competitive ability of alien plants. We tried to answer an open question of aquatic plant ecology, how can *Elodea nuttallii* prevail its congener *E. canadensis* [5]. We made a microcosm experiment, *Elodea* plants were grown in aquaria containing five different nitrogen concentrations and incubated at five different light intensities. We used six functional traits (apical shoot RGR), total shoot RGR, relative elongation, root length, lateral spread, branching degree) to measure the environmental response of the species. We calculated plasticity indices to express the phenotypic differences between species. We found that under more eutrophic conditions, *E. nuttallii* reach the water surface sooner than *E. canadensis* and through intensive branching outcompetes all other plants including *E. canadensis*. Our findings support the theory that more successful invaders have wider phenotypic plasticity. We continued to investigate this issue by moving forward and using ecophysiological traits. We have a submitted paper [10] about the results.

One of my goals was to investigate the functional aspect of community assembly processes of aquatic plant communities during the project. With the use of the obtained database (together with data from LEDA database), we studied the processes governing community assembly along major environmental gradients related to carbon and nutrient limiting factors as well as physical strain in Hungarian streams and rivers. We found that the effect of environmental filtering significantly increased toward higher pH, indicating the response of functional traits to carbon limitation. Our results showed trait convergence among riverbank species in rivers with higher productivity. Larger functional diversity (i.e. trait divergence) among hydato-helophyte species suggests an increase in the diversity of resource acquisition strategies under higher productivity. Our study highlight that the functional trait distribution of aquatic and riverbank plant communities respond to major environmental drivers related to nutrient and carbon availability. This publication [6] gave us detailed knowledge about how aquatic plants physically adapt to certain environmental scenarios; these results might be used in future climate change analyses.

I wrote (or contributed as co-author) additional papers during the project. However, these papers are not strictly related to the main project aims. We revised the distribution of a formerly unknown aquatic plant *Elatine gussonei* listed on IUCN red list [3]. Some of the trait data we measured during the project are published in a database paper [7]; it was accepted and will be published soon. This database also involved in the next edition of the TRY database, therefore, also appears in the forthcoming paper about TRY [8]. I have to note that this database contains only the data of terrestrial plants. We started to prepare a paper about the trait data of aquatic plants [13]. At the moment we collate data together; the paper will be finalised and submitted soon.

The project covered only my salary in the last three years; it does not support research costs. Fortunately, I applied and won NKFI-FK and NKFI-KH projects in the last year of the research period. The three projects altogether made it possible to set up a small research group and support functional diversity researches on aquatic plants. I could attend in several local and international conferences where I gave oral presentations about my research results (details see above).

Altogether, I was the leading author of five Q1 and one Q2 articles (three of them are within D1 range), and I was also a co-author of two additional Q1 articles with the support of NKFI-PD project. These papers were published yet. The total impact factor of these articles is 24.

Additionally, I am the leading author of two manuscripts and co-author in three manuscripts that are submitted or under review at the moment. I worked on these papers with the support of the NKFI-PD project. All of these manuscripts are written about functional diversity issues of freshwaters or community assembly of aquatic plants [9-12].

PUBLICATIONS

Papers published in peer-reviewed scientific journals with support of NKFI-PD 120775 Grant in 01.10.2016-30.09.2019:

Asterisk (*) indicates the researchers involved, and hashmark (#) indicates the students involved in the research project.

2017

[1] **Lukács, B.A.***, Vojtkó, A.E.*, Mesterházy, A., Molnár, V.A., Süveges, K., Végvári, Zs., Brusa, G. & Cerabolini, B.E.L. (2017). Growth-form and spatiality driving the functional difference of native and alien aquatic plants in Europe – *ECOLOGY AND EVOLUTION* 7: 950–963. [***IF~2.537; D1***]

[2] Vojtkó, E.A.*, Mesterházy, A., Süveges, K. & **Lukács, B.A.*** (2017). Changes in sediment seed-bank composition of invaded macrophyte communities in a thermal river. – *FRESHWATER BIOLOGY* 62: 1024–1035. [***IF~2.933; D1***]

[3] Takács, A., Molnár, V.A., Horváth, O., Sramkó, G., Popiela, A., Mesterházy, A., Lovas-Kiss, Á., Green, A.J., Löki, V., Nagy, T. & **Lukács, B.A***. (2017). The rare aquatic angiosperm *Elatine gussonei* (Elatinaceae) is more widely distributed than previously thought. – *AQUATIC BOTANY* 141: 47–50. [***IF~1.972; Q1***]

2018

[4] Krasznai-K., E., Boda, P., Borics, G., **Lukács, B.A.***, Várbíró, G. (2018). Dynamics in the effects of the species-area relationship vs. local environmental factors in bomb crater ponds. – *HYDROBIOLOGIA* 823: 27–38. [***IF~ 2.056; Q1***]

2019

[5] Szabó, S., Peeters, E., Várbíró, G., Borics, G. & **Lukács, B.A.*** (2019). Phenotypic plasticity as a clue for the invasion success of the submerged aquatic plant *Elodea nuttallii*. – *PLANT BIOLOGY* 21: 54–63. [***IF~2.1; Q1***]

[6] **Lukács, B.A.*,** E.-Vojtkó, A*., Erős, T., Molnár, V.A., Szabó, S. & Götzenberger, L. (2019). Carbon forms, nutrients and water velocity filter hydrophyte and river-bank species differently: A trait-based study. – *JOURNAL OF VEGETATION SCIENCE* 30(3): 471–484. [***IF~2.944; D1***]

[7] E-Vojtkó, A.*, Takács, A., Nagy, T., Molnár, V.A., Lovas-Kiss, Á.*, Löki, V.*, Süveges, K., Vojtkó, A., Tóth, E., Balogh, N., Sonkoly, J., Kis, Sz., Kelemen, A., Valkó, O., Deák, B., Tóth, K., Kiss, R., Lukács, K., Tóthmérész, B., Török P. & **Lukács B.A.*** (2019, *Under minor revision*): New leaf trait records of vascular plant species in the Pannonian flora with special focus on endemics and rarities. – *FOLIA GEOBOTANICA* [***IF~1.04; Q2***]

[8] Kattge, J., Bonisch, G., Díaz, S., Lavoler, S., Prentice, I., **… Lukács, B.A.*** … (2019, *Under minor revision*). Twelve years of TRY – towards a third generation of plant trait data assimilation and sharing. – *GLOBAL CHANGE BIOLOGY* [***IF~8.8; D1***]

Papers submitted:

[9] Szabó S., Peeters ETHM, Borics G., Veres Sz., Nagy P.T. & **Lukács B.A.*** (Under Review): The ecophysiological response of two invasive submerged plants to light and nitrogen. – *FRONTIERS IN PLANT SCIENCE [**IF~4.2; D1**]*

[10] Borics G., B-Béres V, Bácsi I., **Lukács B.A.**, Botta-Dukát Z. & Várbíró G. (Under Review). Trait convergence and divergence: reflect rules in phytoplankton community assembly in eutrophic lakes. – *JOURNAL OF ECOLOGY* [***IF~5.68; D1***]

[11] García-Girón J., Heino J., Båstrup-Spohr L., Bove C.P., Clayton J., de Winton M., Feldmann T., Fernández-Aláez C., Ecke F., Grillas P., Hoyer M.V., Kolada A., Kosten S., **Lukács B.A.**, Mjelde M., Mormul R.P., Rhazi L., Rhazi M., Sass L., Xu J., Alahuhta J. (Under Review): Global patterns and determinants of lake macrophyte taxonomic, functional and phylogenetic diversity. – *JOURNAL OF ECOLOGY* [***IF~5.68; D1***]

[12] García-Girón J., Heino J., Båstrup-Spohr L., Bove C.P., Clayton J., de Winton M., Feldmann T., Fernández-Aláez C., Ecke F., Grillas P., Hoyer M.V., Kolada A., Kosten S., Lukács B.A., Mjelde M., Mormul R.P., Rhazi L., Rhazi M., Sass L., Xu J., Alahuhta J. (Benyújtva): Elements of lake macrophyte metacommunity structure: global patterns, compositional breakpoints and community-environment relationships. – *LIMNOLOGY* AND *OCEANOGRAPHY* [***IF~4.325; D1***]

Papers under preparation

[13] **Lukács, B.A.***, Lovas-Kiss, Á.* Kapusi-Pallér, F.*, Löki, V.* & E-Vojtkó, A.* (*Under preparation*) Leaf, seed and dispersal traits of aquatic plants. – *AQUATIC BOTANY* [***IF~1.972; Q1***]

Papers published in local journals (in Hungarian):

[14] Mesterházy, A., Vidéki, R**., Lukács, B.A.***, Mészáros, A. & Molnár V., A. (2017). Adatok a színes békaszőlő (*Potamogeton coloratus*) hazai előfordulásához / Contributions to the Atlas Florae Hungariae III. – *KITAIBELIA* 22: 77–83.

ORAL PRESENTATIONS

2017

[1] **Lukács B.A,** Erős T., Molnár V.A., E.-Vojtkó A. & Götzenberger L. (2017). *A növényi tulajdonságok szerepe a folyóvízi makrofiton vegetáció szerveződésében*. Előadás: LIX. Hidrobiológus Napok, Tihany, 2017. október 4-6.

[2] Schmera D., Árva D., Boda P., Bódis E., Bolgovics Á., Borics G., Csercsa A., Deák Cs., Krasznai E., **Lukács B. A.,** Mauchart P., Móra A., Sály P., Specziár A., Süveges K., Szivák I., Takács P., Tóth M., Várbíró G., Vojtkó E. A. & Erős T. (2017). *Hogyan befolyásolják a lokális és regionális folyamatok a folyóvizi közösségek szerveződését? A hálózati pozíció hipotézis tesztelése*. Előadás: LIX. Hidrobiológus Napok, Tihany, 2017. október 4-6.

[3] **Lukács B.A,** Erős T., Molnár V.A., E.-Vojtkó A. & Götzenberger L. (2017). *Chemical and physical properties act as filters on aquatic river plant communities: A trait-based*

study. Előadás: 1st International Conference on Community Ecology, Budapest, 2017. szeptember 27-29.

[4] **Lukács B.A,** Erős T., Molnár V.A., E.-Vojtkó A. & Götzenberger L. (2017). *A növényi tulajdonságok szerepe a folyóvízi makrofiton vegetáció szerveződésében*. Előadás: 6. Kvantitatív Ökológiai Szimpózium, 2017.október.13.

[5] **Lukács B.A.**, Ács É., Boda P., Erős T., Várbíró G., Zagyva T.A. & Borics G. (2017). *A Víz Keretirányelv, és ami mögötte van: a hazai hidrobiológiai kutatások a nemzetközi követelmények és a hazai fejlemények sodrában*. XI. Magyar Természetvédelmi Biológiai Konferencia. Előadás: XI. Magyar Természetvédelmi Biológiai Konferencia, „Sikerek és tanulságok a természetvédelemben", Eger, 2017. november 2-5.

2018

[6] Mesterházy A., Király G., Vidéki R., Csiky J., Stranczinger Sz. & **Lukács B.A.** (2018). *A hazai vízinövény-kutatás eredményei Felföldy Lajos (1990) Hínárhatározója tükrében.* Előadás: Advances in research on the flora and vegetation of Carpato-Pannonian region XII,. Debrecen, 2018. február 23-25.

[7] **Lukács B.A,** Erős T., E.-Vojtkó A. & Götzenberger L. (2018). *Changes in the trait composition of river plant communities along environmental gradients: A trait-based study*. Előadás: British Ecological Society Annual Meeting, Birmingham, 2018. december 16-19.

[8] Lovas-Kiss Á., Urgyán R., Vizi B., Fekete R., Nagy A., Vincze O., **Lukács B.A.,** Molnár V. A. & Green A.J. (2018). *Variation in duck-plant seed dispersal interactions throughout the annual cycle*. Előadás: British Ecological Society Annual Meeting, Birmingham, UK, 2018. 12. 16-19.

[9] Kékedi L.#, Szabó S., Löki V., Botta-Dukát Z. & **Lukács B.A.** (2018). *Klímaváltozás hatása a hínárnövények közösségszerveződésére.* Előadás: 11. Magyar Ökológus Kongresszus, Nyíregyháza 2018. augusztus 28-30.

[10] **Lukács B.A.** (2018). *Növényi inváziók kutatása hazai vizekben: Kérdések, módszerek és irányvonalak*. Előadás: LX. Hidrobiológus Napok, Tihany, 2018. október 3-5.

[11] Urgyán R., Vizi B., Fekete R., Nagy A., **Lukács B.A.,** Vincze O., Molnár V.A., Green A.J. & Lovas-Kiss Á. (2018). *Tőkés récék endozoochór magterjesztésének vizsgálata őszi és tavaszi vonulás során a Velencei-tavon*. Előadás: LX. Hidrobiológus Napok, Tihany, 2018. október 3-5.

[12] Lovas-Kiss Á., Marta I. S., David M. W., Neil E. C., José. A. A., **Lukács B.A.,** Urgyán R., Molnár V. A. & Green A.J. (2018). *Partimadarak, mint jelentős növény terjesztő vektorok Európában*. Előadás: LX. Hidrobiológus Napok, Tihany, 2018. október 3-5.

2019

[13] **Lukács B.A.,** Molnár V.A. & Mesterházy A. (2019). *A színes békaszőlő (Potamogeton coloratus) „visszatérése" forráskifolyókba a karsztvízkiemelés megszűnése után*. Előadás: Másodlagos és antropogén élőhelyek kutatása, előadóülés, Debrecen, 2019. március 8.

[14] **Lukács B. A.,** Pallér-Kapusi F.*, Löki V.*, Lovas-Kiss Á.*, Szabó S., E-Vojtkó A.* (2019). *Növényi jelleg adatok a vízben: korlátok és feladatok. Előadás:* Növényi stratégiák és jellegek szerepe az ökológiai kutatásokban, előadóülés és munkaértekezlet, Debrecen, 2019. április 12.