

1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: Mechanisms and consequences of the spread of an invasive thermophilic mollusc to non-heated waters of central Europe. A case study of *Sinanodonta woodiana* (Lea, 1834).

1.1. Project goals The main purpose is to test differences between long-established invasion core (heated waters) and newly formed front populations (non-heated waters) of a thermophilic invasive bivalve: *Sinanodonta woodiana*, to discover traits promoting its invasion success. We will reveal mechanisms supporting their ongoing spread and adaptations to typical thermal conditions in Polish waters. The second purpose is to test the effect of the invasive bivalve on native European freshwater bivalves from Unionidae family. **We hypothesise that:** (1) individuals from the front and core populations differ in their traits and responses to environmental factors. These differences will reveal traits promoting the invasion success. We expect individuals from the front populations to be more tolerant to low temperature, less selective with regard to substratum and other environmental factors, more mobile and bolder. On the other hand, they can also be smaller, less fecund and in weaker physical condition. (2) Invaders negatively affect native molluscs.

1.2. Outline Biological invasions are a globally important phenomenon, predicted to increase in the future due to environmental changes (climate warming, increased land use) (Bellard et al. 2012; Luque et al. 2014). As thermal differences are considered as one of the most important barriers preventing establishment of aliens (Früh et al. 2017), global warming is expected to favour biological invasions (Hesselschwerdt & Wantzen 2018), especially of thermophilic species.

Our model species, the Chinese pond mussel *S. woodiana*, originates from eastern Asia. The species probably reached Poland in the mid-1980s with fry of imported Asian herbivore fishes released into artificially heated Konińskie Lakes (Piechocki & Wawrzyniak-Wydrowska 2016), where it has created a core population. For nearly twenty years, this location has remained the only site in Poland at which the occurrence of *S. woodiana* was documented (Kraszewski 2007). Today, the mussel is known from over 30 Polish localities of the natural thermal regime, including fish ponds, oxbow lakes, canals, rivers and dam reservoirs (Spyra et al. 2016; Romanowski & Winczek 2017; Dzierżyńska-Białończyk et al. 2018).

Differences in physiology, life history and behaviour among core and invasion front populations may result from migrations of individuals with particular traits, selective survival at the invasion front, phenotypic plasticity or evolutionary changes in novel areas. In all cases, their analysis will show traits promoting the spread of thermophilic aliens to natural central European waters, revealing important patterns of biological invasions in the light of global changes.

In novel areas, spreading mussels meet local bivalve fauna. Their negative impact on

native bivalves has been postulated, but remains unsupported by strong evidence. Freshwater bivalves are globally threatened and declining worldwide, endangered by habitat degradation, exploitation, pollution and climate change (Lopes-Lima et al. 2017). Additionally, invasive species may compete with the natives for space and food, affecting their distribution and abundance (Lopes-Lima et al. 2017). Knowledge of interactions between alien and native bivalves will reveal the most vulnerable species, critical conditions and endangered areas, allowing to design effective conservation measures.

1.3. Work plan We will conduct field surveys, field and lab experiments. Field surveys on the core and front alien populations and accompanying native bivalves will allow to find co-existing species, determine their abundances and life history parameters, as well as local habitat parameters. Lab experiments on mussel survival, behaviour (burrowing, locomotion, substratum selection, feeding) and physiology (oxygen uptake rate, stress level) under various environmental conditions (temperature and factors found different between the front and core areas in the field) will reveal differences between the core and front populations. Lab and field (mesocosm) experiments will show the impact of invaders on native bivalves (survival, physical condition, behaviour at various invader densities).

1.4. Literature

Bellard, C., Bertelsmeier, C., Leadley, P., et al. (2012). Impacts of climate change on the future of biodiversity. *Ecology Letters*, 15, 365-377.

Dzierżyńska-Białończyk, A., Jermacz, Ł., Maćkiewicz, T., Gajewska, J., Kobak, J. (2018). Mechanisms and impact of differential fouling of the zebra mussel *Dreissena polymorpha* on different unionid bivalves. *Freshwater Biology* 63, 687-699.

Früh, D., Haase, P., & Stoll, S. (2017). Temperature drives asymmetric competition between alien and indigenous freshwater snail species, *Physa acuta* and *Physa fontinalis*. *Aquatic Sciences*, 79, 187-195.

Hesselschwerdt, J., & Wantzen, K. M. (2018). Global warming may lower thermal barriers against invasive species in freshwater ecosystems - A study from Lake Constance. *Science of The Total Environment*, 645, 44-50.

Kraszewski, A. (2007). The continuing expansion of *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) in Poland and Europe. *Folia Malacologica*, 15, 65-69.

Lopes-Lima, M., Sousa, R., Geist, J., Aldridge, D. C., et al. (2017). Conservation status of freshwater mussels in Europe: state of the art and future challenges. *Biological Reviews*, 92, 572-607.

Luque, G. M., Bellard, C., Bertelsmeier, C., et al. (2014). The 100th of the world's worst invasive alien species. *Biological Invasions*, 16, 981-985.

Piechocki, A., Wawrzyniak-Wydrowska, B. (2016). Guide to freshwater and marine Mollusca of Poland. Bogucki Wydawnictwo Naukowe, Poznań, p. 280.

Romanowski, J., Chmielewski, S., Winczek, M., Strużyński, W. (2017). Stwierdzenie *Corbicula fluminea* (OF Müller, 1774) (Veneroida: Corbiculidae) w środkowej Wiśle.

Kulon, 22, 152-155.

Spyra, A., Jędraszewska, N., Strzelec, M., Krodkiewska, M. (2016). Further expansion of the invasive mussel *Sinanodonta woodiana* (Lea, 1834) in Poland – establishment of a new locality and population features. *Knowledge & Management of Aquatic Ecosystems*, 417, 41.

1.5. Required initial knowledge and skills of the PhD candidate

- Knowledge and experience in field sampling and experimental work in aquatic environment, particularly with Unionidae mussels.
- Ability to determine taxonomic identity of the species used in the project.
- Knowledge and experience in stocking experimental animals in laboratory conditions, particularly freshwater bivalves.
- Understanding the interactions between native fauna and invasive species.
- Driving license category B, necessary during field trips.

1.6. Expected development of the PhD candidate's knowledge and skills

Working in our research team, a candidate will become an independent researcher, capable of obtaining funds for their research, designing and conducting hypothesis-driven scientific studies, interpreting, analysing and presenting their results, as well as working collectively in a team. After completing doctoral studies, a candidate will be able to publish their results in high impacted journals and the PhD dissertation will consist of a series of published papers.