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Fribourg, 17. September 2011

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Report on the PhD thesis **„ EFFECT OF HERBIVORE INSECTS ON GROWTH AND REPRODUCTION OF *Cirsium arvense* IN ITS NATIVE AND INVASIVE RANGE",** submitted by **Inés Abela Hofbauerová**

Invasive alien plant species traditionally have been studied in the context of conservation biology and targeted management interventions to mitigate their negative impact on native and managed ecosystems. More recently, biological invasions increasingly became model systems to study basic process in ecology and evolution, especially due to expected altered genetic structure and strong directional selection in populations introduced into a new range as compared to their native range. Many theories and hypotheses have been put forward to explain the so-called "paradox of invasion". Thus, why can exotic plant populations, new to a region or continent, displace and dominate ecosystems composed of locally well-adapted plant species?

Plant-antagonist interactions have been studied traditionally and most intensively in the context of pest species in agricultural production. More recently, but still over 100 years, the use of specialist herbivores, predominantly insects, has become an important tool to mitigate the invasion of exotic plants through the so-called classical biological control approach, i.e. by using natural enemies from the weed's native range to control the weed in the introduced range.

The PhD thesis of Inés concentrates on herbivory on *Cirsium arvense*, a most prominent weed over most of the temperate zones of our planet, comparing attack rates and types of damage in the native European with the introduced North American range. She performed various approaches ranging from field observations to common garden studies and impact experiments of both single and combined attack of four insect herbivores. This allowed her to test various ecological (e.g. enemy release: ER) and evolutionary (e.g. evolution of increased competitive ability: EICA) hypotheses related to a bio-geographic comparison (native vs. introduced range) of herbivory and its impact on the host plant. Besides insights into basic ecological and evolutionary interactions

between plants and their antagonists, the thesis also aimed at contributing to biological control measures of this prominent weed in its introduced North-American range, and thus to a sustainable management of an exotic plant invader.

The thesis comprises 4 studies, preceded by a general introduction, resulting in 5 chapters.

The General Introduction very briefly treats the various issues relating to the background, concepts and the methodology of the various studies, gives an outline of the thesis and finishes with a conclusion. This Introduction is really very short but gives a good appeal on what will come in the subsequent chapters. I just cannot agree with some statements given in the Conclusion, especially the suggestion to weed science researchers to follow this approach before the application of biological control measures (the introduction and release of control agents). The presently applied procedure goes FAR beyond to what has been done here; just think of all the biosafty (host specificity studies), the genetic studies tracking the introduction history (to later match both the climate and host genotypes when selecting agent populations). Also, as one of the two main questions of the thesis, Ines mentions the assessment of herbivory at the population level, which indeed is THE most important issue for selecting effective agents, but this has not really been addressed in the thesis. This also is now a standard procedure when selecting effective agents. Today, pre-release studies involve easily well over 10 scientists years!! Thus, the suggestions made should be down-rated a bit. I also miss some thoughts on where to go from here, thus suggestions for studies to be followed given the findings of this thesis. The term “invasive range”, although used from time to time, is not really appropriate as a range cannot be invasive, thus rather use “introduced range”.

The first chapter is an observational study assessing plant damage on *Cirsium arvense* in four populations under different abiotic (wet vs. dry) conditions in its native range in the Czech Republic. The results show great variation in degree and type of damage among populations and years, with overall damage levels on stems, flowers and leaves being highest. However, the impact on plant growth and its association with individual species remains difficult and predictions made not really convincing in this observational study. This study is published in a good journal for which the authors are to be congratulated.

The second chapter compares naturally occurring plant damage in populations from the native (4 populations in the Czech Republic) and invasive range (11 populations in Nebraska, but with less plants per population). Plants in the introduced range were found to be larger and damage was lower compared to the native range, but overall larger plants tended to be more damaged than smaller plants. Although the data represent just a snapshot in time and only a very limited area of the overall native and introduced range, the results are in support of the enemy release hypothesis. It would have been helpful to integrate the Figures and Tables in the text. Discussion of published records on species numbers and attack levels from various regions in both ranges of *C. arvense* will be necessary to substantiate the findings and to hopefully publish it.

The third chapter describes results from a common garden experiment (in the Czech Republic, but this is NOT stated in the abstract!) looking at plant growth from seeds collected in the USA (Nebraska, Illinois) and Europe (Spain, Czech Republic) and impact on plant performance of four insect species representing four different insect guilds (flower head herbivores by a weevil, folivores by a leaf beetle, gall-formers by a stem galling tephritid and root herbivores by a weevil), alone and in combination. The root herbivores were tested in a separate experiment, in which also soil nutrients were manipulated (nutrient rich vs. poor soil). All four tested insect species, applied singly, were found to reduce performance of *C. arvense*, but effects were significant only in some years and for some response variables. Effects of multiple insects were generally stronger and complementary, thus confirming the cumulative stress model.

This chapter still needs considerable work before it can be submitted for publication. For instance, no results are given in the abstract, and the terms “the most effective herbivore hypothesis and the complementary herbivore hypothesis” needs to be rephrased, as this presently means “the most effective hypothesis”. I indeed suggest combining chapters 2 and 3 for publication to make it more convincing, as both are on herbivory in the two ranges. A nice complement would be growth performance bioassays of the insects on the various origins of *C. arvense* to substantiate the EICA hypothesis.

The final fourth chapter stems from the common garden experiment in the Czech Republic described already in chapter 3, but now focuses on plant performance of *C. arvense.* The results confirm the EICA hypothesis, thus plants from the invasive range grew more than plants from the native range, which is supposed to be the result of an evolutionary translocation of resources away from defense towards increased growth in the absence of specialist herbivores. This paper is already published in Flora, a journal with a similar impact factor as Weed Research (> 1.5).

Thus, two of the four studies have already been submitted to good journals, and at least one more publication is to be expected. Inés successfully applied a large range of methods ranging from designing, setting-up and maintaining field and common garden experiments in various countries and both in Europe and North America, assessing plant performance, herbivory and its impact on plant performance.

In summary, Inés has greatly contributed to a better understanding of the antagonist-plant relationship of *Cirsium arvense* in both its native and introduced range, She has equally contributed to basic ecology and evolution as well as to how this knowledge could be used for biological control measures in the introduced range. She proved expertise in designing, conducting, analysing and finally writing up of both observational and experimental studies involving a wide range of methods and procedures.

Thus, it is with great pleasure to recommend to the Faculty of Science accepting the PhD thesis of Inés Abela Hofbauerová without any restrictions.

Yours sincerely