UFZ-Umweltforschungszentrum Leipzig-Halle GmbH
in der Helmholtz-Gemeinschaft

Dept. of Community Ecology
Theodor-Lieser-Str. 4
06120 Halle (Saale)
Germany

Dr. Ingolf Kühn
Phone: (++49)345/558-5311
Fax: (++49)345/558-5329)
email: ingolf.kuehn@ufz.de

Dr. Ingolf Kühn, UFZ Leipzig-Halle GmbH, Dept. of Community Ecology,
Theodor-Lieser-Str.4, D-06120 Halle (Saale), Germany

Review on the PhD thesis „Population ecology of the invasive alien plant *Heracleum mantegazzianum*" of Jan Pergl, Department of Invasion Biology, Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice

Short assessment of the thesis

In his thesis on the "Population ecology of the invasive alien plant *Heracleum mantegazzianum*" Jan Pergl presents a comprehensive overview of the population biology of this important invasive plant species. The work is relevant not only for ecologists but as a scientific base for managers and conservationists, alike. Not only was this plant species analysed under very many different aspects of its life-cycle, its population dynamics, dispersal, spread etc. Furthermore, a variety of different methods was employed, partly specifically designed to deal with the problem under analysis. Here, the mutual benefit of the cooperation in an international project team was evident. This cooperation, which was crucial not only for the Giant Alien project, but for the thesis in its current state as well, yielded high profile scientific results which lack alikes in respect to such intense in-depth though multi-faceted analyses. The contribution of Jan Pergl's work to the understanding of the biology and ecology of the Giant Hogweed in this context was extremely important.

The candidate used classical methods of population biology to measure a plethora of relevant metrics to understand the dynamics of *H. mantegazzianum*'s populations, covering e.g., seedling dynamics, relative growth rate, population structure, mortality, flowering, spread, etc. This work did not only feed into the papers presented in this PhD thesis but furthermore into other important articles. Additional to the "classical" analysis in population biology, Jan Pergl used his results and knowledge within the international cooperation to apply modern techniques such as

remote sensing, matrix modelling and individual-based modelling. Therefore the thesis is excellent in its scientific aspects as well as a basis for tools and management options to control *H. mantegazzianum*.

Questions:

- Why, after all, is *H. mantegazzianum* a good invader - compared to other species?
- Is there any evidence that seedling mortality of *H. mantegazzianum* follows the rules of 'self-thinning'?
- What are the detailed mechanisms behind the relationship residence time – rate of spread – invaded area?
- What might be possible mechanisms of long-distance-dispersal? How far might they act; (how) can they be classified?
- How could one explain the different outcomes of the matrix model and the individual-based model with respect to the capabilities of the different methods? Were the models satisfactorily describing the invasion situation in Lacovský les? Which other ecological parameters might be useful, if at all?

Detailed Evaluation

The thesis comprises five published or accepted papers on the population ecology of *H. mantegazzianum*. The first one is a review of much of the work the author (and his collaborators) did. It summarizes the analyses which were not yet published (such as those on seedling dynamics, seedling relative growth rate, population density, or mortality) and those which were published and are detailed in later papers of this thesis (such as population structure and flowering, and population dynamics at scale of individual the stands using a matrix model). It details many results in a compact way and thus summarizes more information than a paper in a dissertation would usually do (on the expenses of detail per analysis). However, this first paper very nicely sets the scene for the following analyses.

The second paper uses a recently developed method to determine the age of the Giant Hogweed individuals by counting the annual rings of the secondary root system. It thus efficiently enabled the analysis of the age structure of Giant Hogweed and related this to the age of flowering in managed and unmanaged habitats in its native and its invasive range.

The third paper uses the analysis of aerial photographs to infer the local population dynamics in the Lacovský les region in Western Bohemia. By using path analysis, a more complex statistical

analysis followed the remote sensing results to disentangle several confounded effect, namely residence time and spread, on invaded area.

While the first the three papers mainly used statistical models to infer relationships, the last two papers use more process oriented modelling techniques, namely matrix modelling and individual-based modelling (IBM). Interesting here is that the different methods will not only give different results but have different capacity in recognizing different processes at different scales. Especially the more detailed parameterised IBM yielded better results and showed the importance of comparably rare long-distance dispersal events.

The complete thesis is thus clearly structured, well balanced in recognizing different aspects, easily understandable and adds new knowledge for a better understanding of the ecology of Giant Hogweed as well as aspects from which to infer efficient management procedures to stop the progress of the invasion process and to control the plant species. The data gathered by Jan Pergl during his field work and experiments is invaluable and will definitely be a good base for many more analyses on the ecology of *H. mantegazzianum*. The used methods were appropriate and thoroughly applied. The conclusions stem from the results and the comprehensive discussions of the respective topics.

I am impressed by the level of detail the species *H. mantegazzianum* was analysed, the different perspectives of the plants population dynamics as well as life-histories were taken into account and the multitude of methods were used for the analyses. Though I know that this was done in teams with varying collaborators, it is still impressive what work is “hidden” in the “unpublished data”, “personal observations” or “unpublished manuscript” comments throughout the articles of this thesis. And I really appreciate that this work would not have been possible in such an excellent way without the different skills contributed by the collaborators. Having said so, this should not diminish the work of Jan Pergl but rather stress his contribution to the overall work (even beyond this thesis) but also to acknowledge the joint research that was done.

However, I would have liked to see some more of the many underlying investigations, even though they were unpublished now (e.g. presenting manuscripts instead of some already published or accepted articles). The review on the work of Jan Pergl of the “Population dynamics of *Heracleum mantegazzianum*” is remarkable. However, I would have liked to read more on the original analyses, e.g. on seedling dynamics, relative growth rate as it was presented for population structure, regional dynamics, and dispersal in the forth-following chapters.

A few things struck me when reading the articles. It seems, e.g. that (in the first paper) the protocols for categorising different age groups of plants were not fully agreed upon the partners in the Czech Republic and Germany before-hand. I also wondered why in fig 6.6 the age structure in the managed Caucasus region was obviously reversed, but did not find an answer in the discussion. It is also hard to infer from only one extreme climatic event on some pattern that might be related to this. For the second paper, I wondered why the data was pooled and the nested structure was not implemented in the analysis e.g. as random effects. The third paper concluded that the species is not limited by site conditions. I am not sure whether this result might be biased because potentially unsuitable sites were excluded from the analysis (having totally invaded area as denominator in the logit model). Having process based models it is always possible t have a splendid discussion on the correct parameterisation. However, as the models were thoughtfully and constructed yielded reasonable results, this would not lead to increase in knowledge. However, classifying a habitat as suitable or unsuitable according to the occurrence of the species in the field may ignore temporal developments and might lead to circularity. Jargon specific to such models was sometimes used without introducing it explicitly to the readers (such as ‘elasticity analysis’).

However, almost all of the points mentioned will almost inevitably occur whenever collaborating in a large project team and when doing extensive analyses. These are points to be aware of in the readers’ interpretation of the results but do not in general reduce the quality of this remarkable thesis.

Dr. Ingolf Kühn