



FA1203: Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)

Short Term Scientific Mission Report

Create a demographic model for *O. communis* that can be linked to its host plant

STSM details

COST STSM Reference Number: COST-STSM-FA1203-26937

Timing of STSM: 2015-04-15 to 2015-04-27

Applicant details

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Host details

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Summary of the STSM

One possible management strategy for *A. artemisiifolia* is classical biological control. In 2013, *Ophraella communa*, a potential biocontrol agent of *A. artemisiifolia* has been found in Northern Italy. To assess its potential impact on the weed we aim to develop an insect population and subsequently a coupled plant-herbivore demographic model, together with the modelling expert Eelke Jongejans from the Radboud University in Nijmegen, who is already cooperating with Suzanne Lommen (Université de Fribourg) to create a demographic model for the plant. This Short term scientific mission was designed as a mean for knowledge transfer about the theoretical background and the practical application of population dynamics modelling.

Purpose of the STSM

When evaluating a potential biocontrol agent (BCA) of plants, two important factors should be assessed: The risk on non-target host species, and the impact on the target species. Non-target host range tests are rather straightforward, but the feeding impact on the target species is fairly hard to predict.

In the past two decades, great progress has been achieved by considering the plant's population dynamics as this can provide valuable information on the Achilles heel of the plant's life-cycle. This information can then be used in selecting biological control agents (or other management schemes) that reduce the transition probability of that specific stage (cf. approved proposal by UniFR).

A critical and presently still rather neglected issue with regard to improving biological control success is a better understanding of the mechanisms leading to high densities of the control agent. Whether the biological control agent will be able to reduce the critical transition in a weed's life-cycle by the required amount depends on the combination of the per capita impact and the population dynamics of the biological control agent. The per capita impact of a herbivore on a plant can be relatively easily tested and current regulations for biological control often ask for some basic information on the potential impact on the target weed. However, there is little evidence that the per capita impact of a biological control agent is correlated with success in biological control programs.

The prerequisite of successful biological control is that the biological control agent reaches high population densities in the introduced range. Hence, predicting the likelihood of success of a biological control programme largely depends on improving our understanding of the effects of biotic (e.g., host-plant attributes, mortality due to parasitism or predation) and abiotic factors (climate) on the survival, development rate and fecundity of biological control agents. Only a few attempts have been made so far to model the demography of biological control agents.

In the course of the PhD project 'Assessing non-target risks of candidates for the biological control of ragweed in Europe', we will create a model that describes the demography of the potential BCA, *O. communis*. We aim to link this model to a demographic model of *A. artemisiifolia*. In this quest, we will be collaborating with the modelling expert Eelke Jongejans from the Radboud University in Nijmegen, who is already cooperating with Suzanne Lommen (Université de Fribourg) to create a demographic model for the plant.

In this STSM, we aim to lay the base to create a meaningful Integral projection or matrix model of *O. communis* population dynamics. The host has offered to provide material for productive self-study. Next to that, we will discuss which values for the models can be obtained from literature data, and how we can derive essential parameters from experiments.

The action points for the STSM are as follows:

1. Acquiring practical experience in the software necessary for creating Integral Projection Models (IPM's) (15.4-21.4)
 - a. R studio
 - b. IPMpack
2. Discuss and explore which parameters have to be sampled to get a meaningful demographic model of insects (20.4-23.4)
3. Discuss and explore which parameters have to be measured to couple a demographic model of *O. communis* to an IPM of *A. artemisiifolia* (in development)

by Suzanne Lommen, Eelke Jongejans and Caspar Hallmann), and which parameters can be obtained from literature (22.4-24.4)

4. Discuss and explore how to make approximations for parameters that are difficult to measure in the field (24.4-27.4)
 - a. Some parameters (eg. mortality) are very problematic to measure in the field. We discussed the methods (eg. mark-recapture analysis) to estimate them.
 - b. We will compare time expenses and accuracy of model estimates to additional experiments or measurements
5. Establish further collaboration with the host Eelke Jongejans

Description of the work carried out during the STSM

The work carried out during this STSM consisted mainly of self-study, with meetings every day to discuss progress and new ideas.

The host Eelke Jongejans kindly provided the visitor with self-study material. This consisted of selected books and manuals, as well as tutorials and exercises from courses given at Radboud University.

The first days of the STSM (15-19 April) were mainly used to getting more familiar to the R environment. This was mostly achieved by reading the book 'Getting started with R' by Andrew P. Beckerman and Owen L. Petchey, in combination with Andy Field's 'Discovering statistics using R' and discussions with the host.

In the second week of the STSM (20-23 April), the focus was shifted to matrix algebra and the background of modelling biological systems. Here, the student worked mostly with Stephen Ellner's and John Guckenheimer's book 'Dynamic models in Biology', in combination with exercises from a Population Ecology course given at the Radboud University Nijmegen. The basics of matrix algebra is not only useful for matrix models, but also is applied in IPM's.

In the last part of the STSM (24-27 April), the focus was expanded to IPM's, with exercises in the R-package 'IPMpack', and discussions about parameter definition and the importance of different parameters. These discussions proved to be very fruitful and were the base of major reorganizations in the experimental design.

Description of the main results obtained

In the course of this STSM, the student learned enough about the modelling program R to start using it as a default program for data processing. He became familiar with the basics in R, introducing data in the programme, descriptive data analysis and graphic representation of results. Furthermore, the student was able to conduct basic matrix algebra in the programme.

During the introduction to R, the student also gained insights in the principles of matrix algebra and matrix models, by discussions based on the book 'Dynamic models in Biology' by Steven Ellner. The basics of matrix algebra also apply for IPM's, so this background led to fruitful discussions about which parameters of the model organism are essential to create a meaningful demographic model.

With the theoretical and practical background of the modelling improved, discussions about the importance of single parameters to measure during fieldwork were held, and potential bottlenecks identified.

Future collaboration with the host institution

The student and the host will stay in close contact about the project, and issues for the modelling aspect of the project will be discussed if they might emerge during the course of the field work.

Furthermore, it is aimed to work on this project together more closely in winter of 2015/16, after a first dataset has been collected in the summer of 2015.

Foreseen publications/articles resulting from the STSM

- Demographic model of *O. communa* under influence of temperature and relative humidity
- Use the demographic model of *O. communa* to estimate its performance under different climatic conditions in Europe
- Coupling the demographic model of *O. communa* to *A. artemisiifolia* to assess the potential of *O. communa* as a biocontrol agent

Confirmation by the host institution of the successful execution of the STSM

Dear Dr. Vurro,

I'm writing to you to confirm that Benno Augustinus has had a fruitfull STSM project here in Nijmegen, the Netherlands. I have read and approved his report.

with high regards,
Eelke Jongejans

Acknowledgements

I would like to express my gratitude to Eelke Jongejans for hosting me in Nijmegen during a

very busy period, his patience and shared knowledge. I also want to thank everybody else of the Ecology group, who made my stay in the Netherlands a very pleasant one.