



FELLOWSHIP SUMMARY REPORT

Name: George E. Heimpel

Subject title: Biological control of invasive pests: implications for biodiversity and ecological stability

Theme number: Theme II: Managing Risks in a Connected World

Host Institution: University of Catania

Host Collaborator: Lucia Zappalá

Dates of Fellowship: 15 September – 8 December, 2022

I hereby consent that my report may be posted on the CRP website,

George E. Heimpel 3 February, 2023





1. What were the objectives of the research project? Why is the research project important?

The research project had four objectives as follows:

Obj. 1: Determine whether insecticide applications in citrus indirectly endanger native plants by killing vedalia beetles.

Obj. 2: Determine whether native plants around citrus orchards provide a refuge for Vedalia beetles that then benefits citrus.

Obj. 3. Determine whether protection of native plants (if documented) is restricted to areas surrounding citrus orchards.

Obj. 4. Incorporate indirect ecological benefits into the conceptual framework of risk-benefit analysis in biological control.

This research is important for two main reasons. The first is that it can provide information on the connectivity between natural and agricultural habitats, which can occur through insect movement. The project focuses on a polyphagous invasive pest insect (the cottony cushion scale) and its specialized biological control agent (the vedalia beetle). The scale insect moves between agricultural (citrus) and natural habitats and our goal was to investigate whether the biological control agent ‘follows’ it between these habitats, thus providing protection to both citrus and native plants. The second reason the research is important is that it fills a gap in our understanding of biological control interactions. Most studies of biological control have focused on either benefits to agriculture or risks to native species. This study attempts a more holistic analysis that contemplates benefits in both habitats.

2. Were the objectives of the fellowship achieved?

We made significant progress on all of the objectives in a general sense, but a finer scale understanding of the spatial relationship is still possible. Finding populations of scales and vedalia beetles was challenging - likely because of the effectiveness of the beetle in suppressing scale populations! However, it was clear that finer-scale studies are possible and would probably be particularly fruitful during Spring/early Summer. Below I explain the achievements by objective.

Obj. 1: Determine whether insecticide applications in citrus indirectly endanger native plants by killing vedalia beetles.

We found that vedalia beetles do indeed attack cottony cushion scale at high levels on native plants. It follows that insecticide applications that cause vedalia mortality would lower the capacity for this protection to occur.

Obj. 2: Determine whether native plants around citrus orchards provide a refuge for Vedalia beetles that then benefits citrus.

We confirmed that vedalia beetle is present on native plants in an area of Sicily (central-East) that also contains the main citrus growing areas of the Island (central- and southeast). While this is consistent with a refuge around citrus in a general sense, we do not have a fine-scaled understanding of this phenomenon.

Obj. 3. Determine whether protection of native plants (if documented) is restricted to areas surrounding citrus orchards.





We did document protection of native plants. As noted above, this was in the general area of Sicily in which citrus is grown, but tens of kilometres away from production-level citrus orchards, so we are not able to answer this question at a finer scale.

Obj. 4. Incorporate indirect ecological benefits into the conceptual framework of risk-benefit analysis in biological control.

We used both field and laboratory studies (both of which are still in progress) to obtain parameter values to include in an existing framework of risk-benefit analysis for biological control.

3. What were the major achievements of the fellowship? (up to three)

- We found populations of cottony cushion scale on two native Sicilian plant species: Spanish Broom (*Spartium junceum*) and Mt. Etna Broom (*Genista aetnensis*). The latter plant species is endemic to Sicily + Sardinia.
- We found evidence of vedalia beetle on both plant species in natural habitats, including evidence of strong suppression on Spanish Broom.
- We have established a laboratory colony of vedalia beetle (and the scale insect) and have initiated studies on their interactions on both of these native plant species.

4. Will there be any follow-up work?

Follow-up work is currently in progress thanks to strong support of the collaborative research group at the University of Catania. I am in frequent contact by email and zoom with the group concerning the follow-up work.

The goal of this follow-up work is to produce one or more publications that can provide information about biological control interactions across agricultural and natural landscapes to the scientific community, and as a springboard for more funding initiatives.

The fellowship is also initiating a more formal collaboration between my home institution (The University of Minnesota) and the University of Catania through a Memorandum of Understanding, which is in progress.

I do not anticipate the work leading to protected intellectual property, novel products or processes.

5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?

By better understanding the indirect effects of biological control introductions on native biodiversity, this research project can provide input into deliberations involving biological control regulations, which are currently being modified at national levels and internationally at the Food and Agriculture Organization (FAO). The linkage to regulatory bodies is facilitated by the involvement in the International Organization of Biological Control (IOBC) by myself and collaborators at the University of Catania. Since the goal of the work is to uncover previously underappreciated benefits of biological control to the environment, it has a strong capability of leading to improvements in environmental and food security.





6. How was this research relevant to:

- The objectives of the CRP?

By providing novel information on the benefits of biological control interventions on environmental health, this research can improve regulatory guidelines in ways that improve agricultural sustainability.

- The CRP research theme?

This research project is relevant to all CRP themes:

- (i) Managing Natural Capital:

Biological control is an ecosystem service by which natural interactions between pests and natural enemies provide economic and environmental benefits to human societies. It therefore embodies the idea of Natural Capital. The current research project extends and refines the concept of biological control as an ecosystem service.

- (ii) Strengthening resilience in an interconnected world:

Natural and agricultural habitats are more resilient when the use of chemical insecticide is reduced or eliminated. Much of this resilience comes from natural enemies of pests (biological control agents). The current research project shows how this resilience operates across natural and agricultural habitats.

- (iii) Transformational Technologies and Innovation:

Even though it has been in use for over 100 years, the introduction of biological control agents is a transformational technology. It is currently experiencing an era of innovation with novel methodologies to lessen risks and improve efficacy. The current research project helps to define the benefits across natural and agricultural habitats.

7. Satisfaction

- Did your fellowship conform to your expectations?

Yes – the fellowship provided much-needed support and was flexible with respect to COVID-caused delays and complications.

- Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities? Please specify.

The fellowship has allowed me to expand my sphere of collaboration and in that way aided my career goals.

- Did you encounter any practical problems?

The fellowship had to be postponed due to COVID, but this problem was overcome

- Please suggest any improvements in the Fellowship Programme.

I would like to see an option for a longer stay of 6, 9 or 12 months to better match a sabbatical timetable, and also a research budget would be very helpful.





8. Advertising the Co-operative Research Programme

- How did you learn about the Co-operative Research Programme?

It was suggested to me by my Department Head.

- What would you suggest to make it more “visible”?

Perhaps it could be advertised at relevant conferences/meetings.

- Are there any issues you would like to record?

I would just like to thank the OECD CRP program for the support.