

OECD – CRP Fellowship Report

Name: Robert Bradley

Subject title: Do earthworms compromise the ecological integrity of forested riparian buffer strips?

Theme #1: Managing Natural Capital for the Future

Host institution: Institute of Soil Biology (Academy of Sciences of the Czech Republic)
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Host collaborator: Dr. Miloslav Simek

Dates of the fellowship: 21 June to 26 September, 2018

I consent to my report being posted on the Co-operative Research Programme's website.

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

The objectives of this research partnership were as follows:

- Confirm that forested riparian buffer strips are a refuge for earthworms in agricultural landscapes
- Determine which EW life habit is most prevalent in forested riparian buffer strips
- Determine how major vegetation types (e.g. coniferous vs. deciduous) influence EW community structure
- Determine the impacts of different EW life habits on soil GHG emissions and soil C sequestration
- Determine whether EW-induced GHG emissions are offset by increased soil carbon (C) sequestration
- Provide recommendations relative to the design of forested riparian buffer strips that would optimize the net GHG balance of forested riparian buffer strips
- Provide training and travel opportunities for students and a postdoctoral fellow in Canada and the Czech Republic
- Develop new and lasting collaborative ties between Czech and Canadian researchers
- Disseminate policy-relevant information via peer-reviewed scientific publications, as well as through various knowledge and technology transfer (KTT) activities involving stakeholders and policy makers.

This project is important because earthworms are non-native to Eastern Canada and were introduced a few hundred years ago by European settlers. Their spread through the agricultural landscape constitutes a biological invasion, and the factors controlling their numbers and community composition, as well as their full impacts on soil greenhouse gas emissions, are not yet fully understood.

2. Were the objectives of the fellowship achieved?

The objectives of the partnership were achieved. Using the LPIS geographic information tool, two Czech students located 40 forested riparian buffer strips (FRBS) in South Bohemia, where landowners gave us permission to sample. Sampling of earthworm communities was performed in FRBS and in adjacent agricultural fields. We noted physical and biological characteristics of each site such as drainage class, soil texture and understory vegetation. Earthworm specimens were identified at the species level and sorted according to their life habit. Soils and live earthworm specimens were collected to perform a microcosm bioassay study comprising a replicated factorial array of two earthworm species (anecic vs endogeic) × two soil types (coniferous vs deciduous) × two soil textural classes. Two Canadian students will be visiting the host laboratory from October to December 2018 in order to (1) complete the earthworm survey, and (2) perform greenhouse gas (CO₂, N₂O and CH₄) measurements from the soils used in the bioassay. Further soil physico-chemical tests will be performed at the ISB over the winter of 2019. The Canadian students involved in this partnership will be performing the statistical analyses of the data over the winter of 2019. Results will be transferred to end-users to support recommendations on the design

of forested riparian buffer strips that would optimize the net GHG balance of agricultural landscapes.

In the original OECD fellowship proposal, it was mentioned that the Fellow would try pursuing secondary objectives such as developing a DNA-based technique for identifying earthworms, or proposing future projects on soil nitrogen cycling using a micro-dialysis approach. Instead, the fellowship provided its recipient an opportunity to initiate a new project that is striving to show some of the environmental benefits of tree-based intercropping (i.e. agroforestry) systems. This project involved sampling soils of different cropping histories, performing greenhouse bioassays and quantifying arbuscular mycorrhizae. We plan to recruit a new graduate student who will take the reins of this project in 2019.

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

- Provide scientifically based recommendations for designing forested riparian buffer strips that minimize greenhouse gas emissions.
- Develop new and lasting collaborative ties between Czech and Canadian researchers, and create training and travel opportunities for students from both countries.
- Develop new research initiatives that will bolster environmentally friendly agroforestry systems in temperate climates.

4. Will there be any follow-up work?

The following ongoing work is a direct aftermath of this OECD fellowship:

- In summer 2018, one Czech Ph.D. student (P. Benetkova) spent 11 weeks in Robert Bradley's lab in Canada. She assisted in the Canadian earthworm survey and performed an earthworm bioassay study that complements those performed by the Canadian students. Soil samples were sent back to her in the Czech Republic by air freight and she is currently describing soil faunal communities. This work expected to produce one peer-reviewed scientific article.
- Two Canadian students will be visiting the host laboratory in the fall 2018 to complete the earthworm survey and perform greenhouse gas (CO₂, N₂O and CH₄) measurements. This work is expected to produce two peer-reviewed scientific articles.
- Field sampling and bioassays were performed in summer 2018 in order to test the efficiency of certain tree species to maintain high soil inoculum levels of arbuscular mycorrhizal fungi. This sets the basis for an ongoing collaboration between Drs. Miloslav Simek, Engy Ahmed and Robert Bradley, as well as a shared graduate student to be recruited in 2019.

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?

We expect to disseminate policy-relevant information on riparian buffer strip design that will reduce greenhouse gas emissions, and on agroforestry practices that harness nature's potential to produce quality crops (e.g. increasing plant-mycorrhizal interactions) while minimizing environmental impacts (e.g. decreasing dependency on synthetic fertilizers). Results will be disseminated via peer-reviewed scientific publications, various conferences and workshops, as well as through various knowledge and technology transfer (KTT) activities. One poster was already presented last summer (June 2018) at the Canadian Soil Science Society Annual Meeting in Niagara Falls, Canada. At least three research articles will be prepared for publication in 2019 and more are likely to follow. Results will also be diffused to end-users and policy makers through Canada's Agricultural Greenhouse Gas Program (AGGP), as well as through Canada's "Centre SÈVE" (i.e. inter-institutional research network). Likewise, the ISB is expected to diffuse results via their ongoing extension work and institutional channels, which is conducive to policy development through scientific programmes such as SCOPE, IGBP and those supported by NATO and UNSECO.

6. How was this research relevant to the objectives of the CRP and the CRP research theme?

Our project's short-term objective is to determine the interaction between vegetation, soil characteristics and earthworm communities that control greenhouse gas emission in forested riparian buffer strips. In the longer term, we are committed to transfer our results to end users through various knowledge and technology transfer (KTT) activities. Thus, both short-term and long-term objectives of this project are aligned with the objectives of CRP of providing scientific knowledge that will guide future land-management policy decisions.

Our project is especially relevant to the objectives of CRP-Theme #1, which is about managing natural capital for sustainable food production. In Eastern Canada as well as in the Czech Republic, the planting of trees in riparian buffer strips has been touted as a viable solution for sequestering diffuse pollutants while producing woody biomass. However, forested riparian buffer strips may be a refuge for large earthworm populations whose comminuting and burrowing activities might increase soil greenhouse gas emissions. Our project addresses, therefore, a novel question on the interactions between the biological components of forested riparian buffer strips, and how these interactions ultimately control the environmental friendliness of various buffer strip designs. We plan on revisiting and monitoring the selected sites in future years, and to integrate new objectives related to nutrient leaching and plant-soil-microbe interactions. Our project is thus fully aligned with the objectives of OECD-CRP Theme #1.

7. Satisfaction

The OECD fellowship conformed to my expectations. It increased directly the career opportunity of the four students who participated in the work as well as that of an early-career scientist (Dr. Engy Ahmed) at the Institute of Soil Biology. I encountered no major practical problem. The OECD Fellowship Programme appears to work fine and does not need improvement.

8. Advertising the Co-operative Research Programme

I have been aware of the CRP for several years. The first time I heard about it was through a colleague. As a way of making it more “visible”, it might be a good idea to include a link to the CRP program on the website of foreign embassies of each participating countries.

A handwritten signature in black ink, appearing to be 'T. Ahmed', written in a cursive style.

5 October, 2018

Signature and Date