

Name: Csongor Gedeon

Host institution: Department of Natural Sciences, Dickinson State University, North Dakota, USA

Subject title: Mega- and mesofauna diversity and abundance, and microbial biomass in field-margins
and adjacent agricultural grasslands

Theme I: Managing natural capital for the future; Co-operative research Programme: Biological
Resource Management for Sustainable Agricultural Systems

Host scientist/ collaborator: Professor Eric C. Brevik, Department of Natural Sciences, Dickinson
State University, North Dakota, USA

Dates of my fellowship: May 26, 2018-October 8, 2018

Home institution: Department of Soil Mapping and Environmental Informatics, Institute for Soil
Sciences and Agricultural Chemistry, Agricultural Research Centre, Hungarian Academy of Sciences,
Budapest

I, Csongor Gedeon, give my consent to posting either my final report or a short paragraph on the Co-
operative Research Programme's website.

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

Objectives

The aim of the research project was to quantitatively and simultaneously investigate the effect of different land uses (grazing by cattles combined with no-till agriculture or conservation reserve program), and later in the project the short term effect of cattle manure on soil fauna diversity, abundance, and microbial biomass of grasslands. Soil fauna is considered a good (meaningful, easily understandable, measurable, cheap, policy relevant, responsive) indicators of biological soil quality and supporting ecosystem services. We studied the temporal change of soil fauna diversity and abundance at mesofauna level (taxonomic diversity and level of adaptation to soil conditions by QBS-ar index; by both surface pit-fall traps and soil animal traps at depth between 5 and 25cm) and megafauna level (by transect strip counting method). These soil fauna traps allow long-term sampling without disturbance to the soil ecosystem. Microbial biomass/ activity was also estimated (by phospholipid fatty acid analysis (PLFA), chloroform fumigation extraction (CFE), and/ or fluorescein diacetate analysis (FDA)).

Importance

There is a strong scientific and societal need for investigating the effect of intensified agriculture on biodiversity. Grasslands suffer most from unsustainable agriculture and land use change however their protection is the least emphasized. This research has focused on the effect of agricultural activities on grassland soil micro-, and macro-organisms whether grazing combined with no-till agriculture or long-term maintenance of grasslands (Conservation Reserve Program) has significantly different effect on the abundance and diversity of soil organisms.

The simultaneous measurement of the temporal change of abundance and diversity of soil organisms (from the microbial decomposers to the ecosystem engineer burrowing mammals) may reveal mechanical relationships between the biotic members of soil ecosystems in response to agricultural activities. It can help formulate recommendations on agricultural practices to farmers and policy makers in the interest of sustainable agriculture.

The research has implications for agriculture and grassland soil conservation, and for Hungary and U.S.A. as much, since soil degradation is continuously increasing due to land use change, increased agricultural activity, and global warming.

2. Were the objectives of the fellowship achieved?

The achievement of the research objectives has not finished yet because after the field work laboratory analysis must follow. During this phase, which has already started, the mesofauna will be classified into major taxa (e.g. Acari, Collembola, Diptera, Araneae, Symphyla, Protura, Diplura, Formicidae, Coleoptera, and according to QBS-ar index samples will be evaluated) and microbial biomass will be estimated by different methods (CFE, FDA; PLFA was finished in the USA) in Hungary.

3. What were the major achievements of the fellowship?

First, we completed a field experiment in a private ranch (including different agricultural activities), in Montana, in which we collected / trapped soil mesofauna, estimated the abundance of soil megafauna, and collected soil samples to measure the activity/ biomass of micro-organisms. Sampling was done in about every two weeks. Samples for further analysis were sent to my home institute. At the last period of the field work, we were able to add a manipulative experiment on the short-term effect of cattle manure on soil organisms.

Second, certain laboratory analysis (such as PLFA) has already finished at the university (PLFA analysis of microbial biomass) but certainly the most of the lab-work has yet to be done in Hungary in my home institute.

Third, I was able to give both a research talk (Research Talk, September 26) for the university students and staff about the work in my home institute and my research in the US. I consider this opportunity a good chance to build future collaborations between my home institute and Dickinson State University and to inform colleagues about the work done at the only academic institute of soil sciences. Moreover, in a cultural talk (Global Table, September 19) I was able to introduce Hungary and its culture, people, music to the audience. Since I was in a smaller, teaching university in North Dakota both opportunities were a great chance for cultural, social and scientific engagements.

4. Will there be any follow-up work?

During the fellowship program I could co-author a journal article which was accepted before the end of my program. (Csongor Gedeon, via a fellowship under the OECD Co-operative Research Programme: Biological Resource Management for Sustainable Agricultural Systems:

Brevik, E. C., Pereg, L., Pereira, P., Steffan, J. J., Burgess, L. C., & Gedeon, C. I. (2019). Shelter, clothing, and fuel: Often overlooked links between soils, ecosystem services, and human health. *Science of The Total Environment*, 651, 134-142.

Besides, I was also invited to take part in the writing of a chapter (co-writer) in the book *Medical Geology of Soil*. The work has already been started and will be finished by December 31, 2018.

Chapter title: Sampling and monitoring of soil organisms. Macro-organisms. Book title: *Medical Geology of Soil* by Lily Pereg (University of New England, Australia), Joshua J. Steffan (Dickinson State University, USA), Csongor Gedeon (Hungarian Academy of Sciences), Phil Thomas (University of New England, Australia) and Eric C. Brevik (Dickinson State University, USA).

Further publication(s) (in peer-reviewed journals) is agreed and expected to come out next year after laboratory work will have finished.

Another important result is that my host professor and I are planning to submit a shared, researcher initiated research project to the National Research, Development and Innovation Office of Hungary next year as soon as the funds will be available for applications. Moreover, he would be glad to come to visit my home institute during the project (2019) if resources are available (teaching and research purposes). For this purpose, another project proposal (academic fund) is planned to be submitted if the research proposal is successful.

Another future collaboration can be based on my intentions to participate in teaching both in Hungary and the USA (at graduate school level), and options, circumstances of this activity were discussed.

Finally, I was able to meet Lily Pereg from the University of New England, Australia, who is a well-known microbial ecologist leading research on microbial diversity in natural and agricultural environments, and soil and human health. She is one of the editors of the book titled *Medical Geology of Soil*, to which I am contributing with a chapter. She, my host professor, and I share the interest in the topic of the relationship between soil health and human health.

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?

As much as in the case of human health, soil health or quality can be estimated by using both abiotic and biotic indicators simultaneously. Soil organisms' activity is emphasized in many soil processes and functions but their contribution to soil quality measurements and particularly of soil macro-organisms is less highlighted in soil quality measurements. There is a limited information on how different levels of soil functional groups respond to agricultural activity. Our results can both reveal and give an insight into this network of different levels of soil organisms and also can demonstrate a comprehensive methodology how to monitor them from micro-organisms through mesofauna to megafauna.

Soil macro-organisms cannot be excluded from any considerations if the interdependence of 'soil health and security-food security-human health' link is taken seriously and efforts should be made to measure, survey, or monitor their activity simultaneously and determine correlations or relationships between these functional groups, and study their response to agricultural activities under different abiotic variations. This can contribute to our understanding of the soil ecosystem and to improve soil health and security.

6. How was this research relevant to:

The objective of CRP?

Soil with its biodiversity and organic content is a limited natural capital. One of the main aims of the European Union's framework on reaching a resource-efficient Europe (Roadmap for a resource-efficient Europe 2011) is to „manage our renewable resources (including ecosystems) to maximise the services they provide us and keep within the limits of the ecosystems that supply us with stable conditions for survival“. This approach conforms to food security, nutrition, and sustainability, objectives of CRP. A simple conclusion from these is to be able to survey or monitor and examine the conditions of natural resources, such as the soil and to foresee if they are prone to degradation or to forecast if disadvantageous processes occur/ are in progress. In other words, it means to manage agriculture sustainably.

Our research's results are expected to show different effects of differently managed grasslands on biodiversity including micro-organisms and macro-organisms of the soil. Our results will provide farmers and policy makers the relevant information for practical management decisions at local scale, such as effect of no-till agriculture or cattle manure on soil organisms within a former prairie grassland ecosystem.

The CRP research theme?

Our research results can help understand soil processes and soil organisms' response to agricultural activities particularly. They represent the most important factor of soil quality however they are underrepresented in soil quality measurements. The results can give an insight into the relationship between different soil organisms from micro- to macro-organisms, and the effect of grazing combined with no-till agriculture on them. Besides, it will also help evaluate the long-term effect of the conservation reserve program (combined with grazing) on soil organisms in the USA.

In addition, the comprehensive measurement of soil organisms can give us the opportunity to see the above-mentioned effects on the temporal change of soil biodiversity in response to agricultural activity and abiotic factors, such as temperature, precipitation. These factors, among others, will probably change dramatically both locally and globally due to the effect of climate change. Consequently, it is recommended to see how grassland soil ecosystems (most affected ecosystems by humans) respond to the change of these abiotic factors. Although it was a short term, a few month long research study the change of temperature and precipitation during this period can be similar to the longer term patterns and effects of these climatic factors.

7. Satisfaction

I am absolutely satisfied with the OECD CRP programme, and it fulfilled my expectations both scientifically and personally. A direct positive outcome has been so far a publication in a high-rank

journal, an invitation to co-writing a book chapter, and an agreed (not yet submitted) shared grant application in addition to further publications from the results.

Practical difficulties faced during the fellowship were solved and managed by my host professor very quickly and efficiently so I can say that they finally did not become problems. Also, the administrative support from the headquarter of OECD was excellent and fast. To sum up, it was well-organised and successful completely.

Published and planned publications will definitively help me competing for grants in the future and the prospects of future co-work including both research and teaching will enrich my professional skills and enhance my chances for getting research grants.

8. Advertising the CRP

I learned about the OECD CRP from my host professor, Eric C. Brevik. I would recommend advertisement of the programme in scientific institutes and research universities directly by organising presentations on the programme and its achievements.