BioS Reports

glimpse into the activities of the Master's course „Biology in Society"

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ANIMALS AND MONEY

This part of BioSReports unravels interesting relations between animals and the economy.

Canada's Eathworm Crisis

Hedda Wern

Forests, as well as forest soil, act as a major carbon reservoir[1] and altering these ecosystems can influence their ability to store atmospheric CO_2. Earthworms, which are invasive in boreal forests of Canada, have an immense influence on the ecosystem and ecological communities because they alter forest soil. As a result, earthworms have a substantial influence on the carbon cycle, which could have negative effects on Canada's ecosystem, climate, and even economy.

As ecosystem engineers, earthworms play an important role in regulating physical, chemical, and biological processes in underground ecosystems. They are involved in decomposition processes, nutrient cycles, water regulation and carbon sequestration, greatly affecting soil properties[2]. By degrading organic matter and molecules, produced by plants and animals, earthworms provide small organic compounds and mineral nutrients, such as nitrogen, which plants need to thrive[3]. Since earthworms mix the soil, they influence the soil structure, infiltration of water, and distribution of nutrients[4].

In Canada, however, the delicate chemical equilibrium of soil and organic matter is threatened by invasive earthworms. Native earthworms in North America have been extinct for 12,000 years due to extensive glacier formation[5]. Since then, North American ecosystems have developed and adapted in the absence of earthworms and their soil-forming properties. With the European settlement, earthworms were introduced once again in the boreal forests of Canada. Here, the earthworms' otherwise beneficial decomposition efforts instead throw the ecosystem off balance. Invasive earthworms lead to a decline of organic matter and a reduction in nutrients in the soil[6]. Additionally, less invertebrates live in soils invaded by earthworms[6]. Earthworms therefore interfere with carbon storage in boreal forest soil, allowing more to be released into the atmosphere[5].

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The impact invasive earthworms have on carbon storage and consequently the climate can be measured through the Kyoto Protocol. The Kyoto Protocol is a method to combat greenhouse gas emissions, by placing economic value on carbon emissions. Lower carbon emissions are thereby more economically profitable[1]. Earthworm's impact on forest carbon stocks therefore has an economic significance for the Canadian government. The carbon stocks in Canadian boreal forests have an economic value of 744 USD per hectare[1]. The total area of Canadian boreal forests is 270 million hectares[7]. Assuming a complete loss of the carbon stock value and that earthworms invade the entire forests the economic damage would be over 200 billion USD. However, with invasive earthworms present, carbon stores of the forest floor have already decreased by 59% to 94%[8]. In 2019 already 10% of the Canadian boreal forest was populated by the invasive earthworms[5]. Based on these numbers, earthworms have caused a loss of carbon with a value anywhere from 12 to 19 billion dollars. This carbon gets shifted into mineral carbon stocks but also into CO_2 that is released into the atmosphere. Invasive earthworms therefore have a substantial economic impact in addition to an environmental impact in Canada due to their effects on the carbon stocks of boreal forests.

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EXCURSIONS AND OTHER NEWS

Small insights in student's or professor's points of view, field trips, and other stuff we do.

BioS Reports is Growing

Layanne Abu-Bader

So far BioS Reports has been run by Helen and Nele since June 2022. This month we welcome our newest member to the BioS Reports team. Layanne has come all the way from the USA to study Biology in Society, a one of a kind masters program. She was drawn to the course because it is quite different from other graduate programs in biology, focusing on biology in the context of politics, ethics, and society. What especially drew Layanne to the program was the emphasis on science communication. She is passionate about sharing science with the world, whether she is teaching it to a class or writing about it in a school journal. In the future, she hopes to teach biology at a university, and this master's course is giving her the skills to do so. To become more involved with science communication, Layanne chose to join the BioS Reports team.

PLANT PARASITES

Here we deal with plant diseases and the challenges they pose in agriculture.

The Challenge of Healthy Cabbages

Layanne Abu-Bader

Diseases affect all of us and we are quite familiar with many of them, like influenza or cancer. However, there are some diseases that might not be as well known, even though they can have serious consequences for humans. In this case, we are talking about crop plant diseases. Not only do we depend on crop plants for global food supply, but for some regions the health of crop plant is also crucial for the economy and the livelihood of many people.

One of the most widespread and devastating pathogens that affect crop plants in the world is the clubroot disease[1]. Clubroot is caused by a single-cellular organism, also known as a protist, called *Plasmodiophora brassicae*[1,2]. It is thought to infect all members of the Brassica genus which includes important crop plants such as oilseed rape, cabbage, mustard, turnip and many more[3]. Since Brassica plants are grown nearly all over the world, clubroot has become prevalent in North and South America, Europe, parts of Africa and most of Asia[4]. In fact, it is estimated that clubroot affects well over 10 percent of the cultivated land in the world[4].

As an obligate parasite[2], the protist *P. brassicae* needs a host plant to replicate. The protist can survive in the soil for up to 20 years[3] until it can infect a host plant via its roots. Once *P. brassicae* has infected a host plant, it causes specific cells in the plant to swell and increase in size[2]. This leads the tissue in the affected area to swell, forming large galls and leading to the clubbed root effect. These growths push against other tissues in the plant and thereby physically restrict the water and nutrient flow within the plant[2]. This lack of water and nutrients leads to other symptoms like stunted growth, yellowing of leaves, wilting and even death of the crop plant[2]. It becomes clear how this single-cellular organism can cause a huge drop in crop profits, either because plants do not look good enough for the consumer and cannot be sold, or simply because the crop plant died[3]. This means that clubroot can completely wipe out entire crop fields[4], leaving farmers economically devastated and leaving locals hungry. In Asia, clubroot poses a serious threat as it affects important local staple crops, such as Chinese cabbage. In China clubroot has caused up to 17% in cabbage yield losses in surveyed fields[3]. As a response, China, Japan and the Republic of Korea have all invested their resources into clubroot research and resistance breeding programs[3].

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Root galls due to Clubroot infection of a cauliflower plant.

Managing clubroot is a rather difficult task, since the pathogen can survive for many years in the soil and can infect a wide range of plants. Several methods to manage clubroot exist. Crop rotation can be used to reduce the level of the pathogen infesting the soil for the next set of crops[4]. But this practice cannot completely prevent infection and the disease will still cause losses. Another method is the development of resistant Brassica crops by genetic modification[4]. However, in this case there are already examples of the pathogen *P. brassicae* that have evolved to overcome certain resistant strains of *Brassica* plants[4,5]. Lastly one of the most important methods of clubroot management is simply keeping tools, work gear, and any other equipment clean. In this way, farmers can at least prevent spreading the pathogen to uninfected sites.

Due to the major economic losses caused by this disease around the world, and the difficulty of controlling it, clubroot is considered the most economically significant disease of *Brassica* crops in the world[4]. Hopefully, with increased research efforts from scientists across the globe, a comprehensive solution will be achieved and clubroot will no longer cause such widespread damage and distress.