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Climate change strongly affects interaction between herbivorous insects, plants, and rhizosphere biota

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Summary: Living conditions for insects – the most diverse group of higher organisms – will be strongly affected by future global climate change. The large group of herbivorous insects face a particularly complex situation not only being affected directly by climate change but also experiencing marked changes in their food source because of the effects of climate change on the plant cover. In this study we show how the three factors, elevated CO2, increased temperature and reduced precipitation in all combinations affect the feeding activity of the grasshopper Chortippus brunneus on wavy hairgrass (Deschampsia flexuosa) and how the feeding affects microbial activity in the rhizosphere of the grass. Climate change, in particulate elevated CO2 and reduced precipitation, had marked effects on herbivore activity as well as on the effect of herbivory belowground. Moreover effects of a climate change factor can be reversed when another climate change factor is combined with the first. So, even though the effects observed can be explained based on knowledge of the biology of the system, we have a long way to go just to predict the effect of climate change on aboveground-belowground interactions as foreseen by the International Panel for Climate Change (IPCC 2007).
Methods: A full factorial field experiment with eight treatments (±300ppm extra CO2, ±1.5oC elevated temperature, ± reduced precipitation, in all combinations) is situated in a grass-heather vegetation on a sandy soil in the temperate zone (Denmark). After two years of treatment 10 cm diameter pots with uniform soil and a Deschampsia plant was installed in all treatments for another 1.5 years. In September 2008, 50 pots were individually isolated with a net and two grasshoppers added to half of the pots. After eight days of grazing activity insects were removed and plants remained for further 10 days. Herbivory within the pots was assessed as difference in height of the grass during the eight days of herbivory. Microbial biomass and activity in the rhizosphere was evaluated based on substrate induced respiration (SIR) and biomass of bacterivores (protozoa).
Results: The effects of grasshoppers on microbial biomass and activity in the rhizosphere were complex. Basically, grasshoppers reduced the microbial measures at ambient conditions but tend to have a positive effect at elevated CO2 and reduced precipitation. The effect of grasshoppers on micro-organisms was not affected by elevated temperature as opposed to the abovementioned impact of elevated CO2 and reduced precipitation.
Conclusion: The very complex interaction of the global change factors elevated CO2, increased temperature, reduced precipitation regarding their effect on insect herbivores make sense when considering well-known effects of climatic factors on plant chemistry. But this multi-facetted response surface also tells us that extreme care should be exerted when attempting to predict the effects of global change on the organisms in the terrestrial environment.

