BugNet Treatment Addon: Warming

Date: 14/01/2025, by Anne Kempel & Eric Allan

Warming treatment (particularly for sites with low vegetation)

Rationale

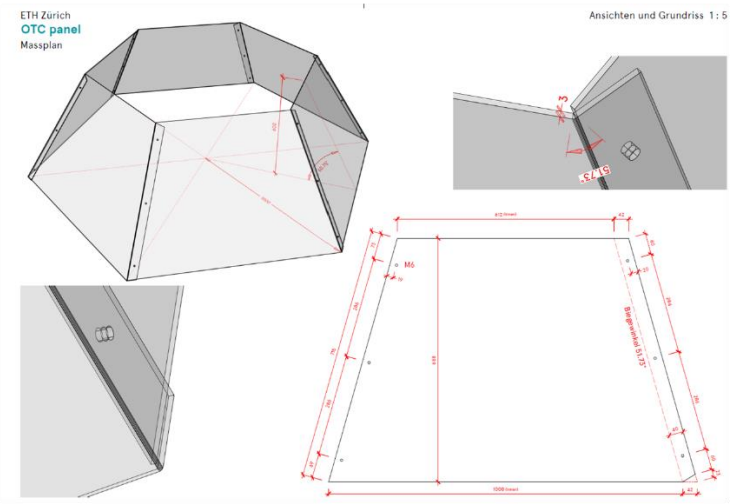
Warming is likely to affect plant communities indirectly via modifying the interactions of plants with their antagonists (Blois Jessica L. *et al.* 2013; Coakley *et al.* 1999; Paseka *et al.* 2020; Post & Pedersen 2008). The general prediction is that the intensity of herbivory and pathogen infection will increase with increasing temperatures (Lemoine *et al.* 2014; Malmström & Raffa 2000; Tylianakis *et al.* 2008), and several studies found increases in herbivory and pathogen *attack* in warmed plant communities (Liu *et al.* 2011; Roy *et al.* 2004). However, how the actual impact of enemies, i.e. their effect on plant community biomass, changes with warming, is not known.

In this addon we therefore propose to manipulate temperature using Open Top Chambers (OTCs) within our enemy exclusion experiment. Experimental warming approaches provide mechanistic insight into the direct effects of temperature on short-term responses of plant and plant-enemy communities to climate warming (Yang *et al.* 2018). Although OTCs, as many other warming manipulations, unavoidably alter additional environmental factors such as wind or moisture (Kennedy 1995; Wolkovich *et al.* 2012), they are a valuable tool to elevate temperature particularly in remote areas, where access to electricity is scarce. However, one of their limitation is that they might constrain invertebrate movement and hence restrict biotic interactions within the OTC (Richardson *et al.* 2000, 2002). This could have major implications for the interpretation of global change experiments in general, as the observed vegetation change might not be solely driven by changes in temperature, but also by variation in enemy pressure. We aim to overcome this limitation at least partly by using modified OTCs, which have a gap between the base of the OTC and the soil, and which facilitate invertebrate movement (Richardson *et al.* 2000). Moreover, in contrast to all previous OTC experiments, a simultaneous manipulation of enemies and warming allows us to assess the direct effects of warming on the vegetation, and to disentangle it from the indirect effects, via changing enemy interactions.

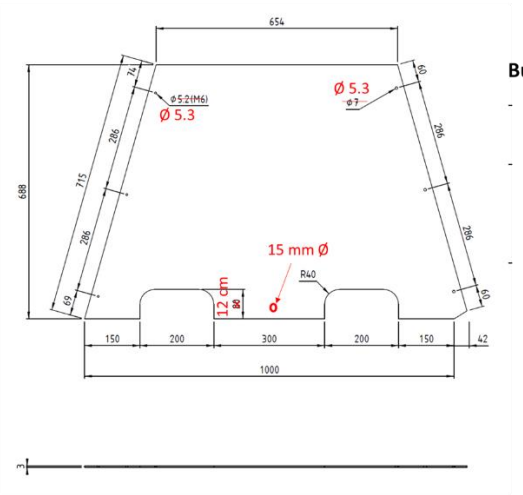
Methods

We will experimentally warm the vegetation using open top chambers (OTCs), following the hexagon-design of the International Tundra Experiment (ITEX, ITEX Manual, page 17). OTCs simulate warming in a controlled manner and elevate ambient temperatures by 1-3°C (Frei *et al.* 2020; Marion *et al.* 1997). OTCs will be slightly modified by leaving a gap of 12 cm height and c. 40% of the base length of the OTC-hexagons long, between the base of the OTC and the soil, to facilitate movement of invertebrates (see Figure 1, and Richardson et al., 2002) and air exchange. We highly recommend using an OTC size that allows vegetation to be assessed over 1 m^2 inside the OTC, ensuring a comparable area for assessing cover to that of ambient plots (important for comparing diversity, dimensions see plan of ETH here, and Fig. 1).

A



B



BugNet adapations

- 2 gaps of 12 cm height, and 20 cm long
- Small holes at the sites, with a diameter of 5.3 mm. These are to attach the panels together with screws
- Additional hole at the lower base of each panel (in the middle) of 15 mm diameter, approximately 3 cm away from the edge.

C

Fig. 1: Recommended dimensions of OTCs. A) Exact plan, kindly provided by Jake Alexander from ETH Zürich. Using these dimensions, the area inside the OTC is > 1m^2, which allows sampling of vegetation in the same area as in ambient conditions. B) In BugNet, we will use OTCs with gaps at the bottom to allow herbivores to move inside the OTCs. C) Image of an OTC with gaps at the bottom.

Ideally, one OTC will be placed in each experimental plot (24 OTC per site). However, as OTCs are expensive, a reduced setup is also possible where OTCs will be placed only in a subset of plots; in each insect removal, mollusc removal, fungal removal, all enemies excluded and control plot (all enemies present), giving a total of 15 OTCs per site (Fig. 2). The OTCs will be placed in one of the subplots dedicated to site specific or network related studies and secured to the ground with ground pegs and ropes to protect against storms. In regions with a lot of snowfall, OTCs need to be removed during winter to avoid damage. Temperature and moisture within and outside the OTC should be monitored with data loggers (e.g. Tomps Loggers). At least four loggers per site (in two plots, e.g. the control plots) should be installed, two inside an OTC, and two outside the OTCs, but in the same plot, e.g., in the middle of the core plot dedicated for cover assessment. If you have the chance to place more loggers, that is even better (e.g. 6 loggers per site; inside and outside of OTCs in all control plots).

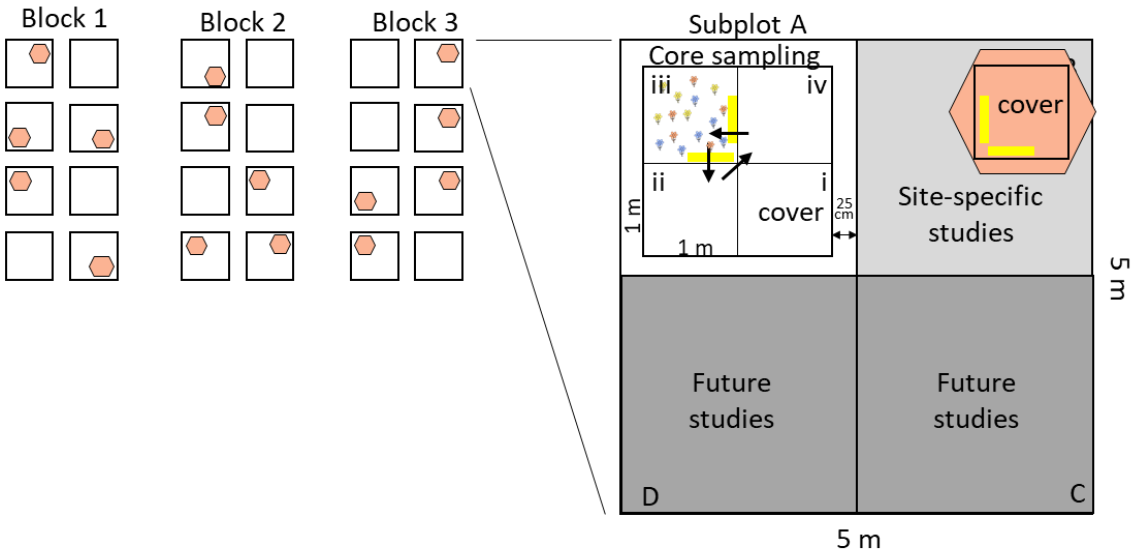


Fig. 2: Position of the OTC in an experimental BugNet site. Shown is the reduced setup with only 15 OTC positioned in each insect removal, mollusc removal, fungal removal, all consumer removal and in the control plots. In each OTC the same annual measurements will be taken as in the subplot dedicated to the core measurements (biomass and cover).

Measurements

Each year, the **basic annual measurements of plant biomass and vegetation cover**, which are done in the core sampling plot, should also be done in the centre of the OTC (avoiding edge effects). We highly recommend to use the above mentioned dimensions of OTC so that the area in the OTC is at least 1m^2. This is important to have comparable plots when assessing plant diversity. If your OTC does not cover an area of 1 m^2, get in touch with us. This requires additional cover sampling in the core plot, of the size comparable to the OTC.

Lots of other measurements are possible, e.g., assessing pathogen and herbivore damage in ambient and warmed plots, characterising the invertebrate and microbial community in ambient and warmed plots (above or/and belowground), measuring traits, or decomposition, and many more. We will discuss measurements in special treatment addon workshops.

Add Movie of building OTC.

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