PHOTO-EXPOSE AFFECTS SUBSEQUENT PEAT DECOMPOSITION

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Introduction

Several recent studies have indicated that photodegradation, enhancement of decomposition rate caused by exposure to light and UV light, may play an important role in plant residue and soil organic matter decomposition (Austin and Vivanco 2006; Parton et al. 2007; Day et al. 2007; Foereid et al. 2011; Meyer et al. 2012). The mechanism for how photo-exposure affects litter mass loss is insufficiently known, but recent work suggests that it particularly affects the degradation of lignin, the plant compound most resistant to microbial degradation (Austin and Ballare 2010), and that photo-exposure can enhance subsequent microbial degradation (Foereid et al. 2010).

A large proportion of the planet's carbon stores are in the soil, and a disproportionally large percentage of this is found in northern latitude peats (Batjes 1996; Kremenetski et al. 2003; IPCC 2007). However, surprisingly little is known about the controls of peat decomposition in natural and semi-natural ecosystems. Decomposition appears to be patchy with a large portion of the peat seemingly inactive at any one time, but with hot-spots of microbial activity (Fenner et al. 2011). The difference between active and inactive patches has been difficult to understand.

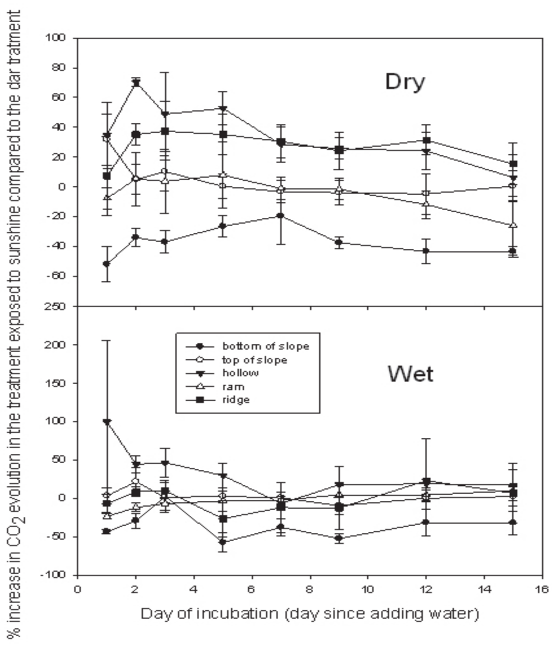

***Fig.** Percentage increase in CO_2 evolution in the sun-exposed peat compared to the shaded for each peat type (negative numbers denote decrease). Error bars are standard error (n=4)*

Previous studies on terrestrial photodegradation have mostly focused on tropical semi-arid areas, but there is potentially enough radiation in the summer also at higher latitudes on surfaces free of vegetation or with low vegetation cover to have an effect, as shown by a simulation study (Foereid et al. 2011). Ruthledge et al. (2010) showed that photodegradation plays a role for carbon fluxes in a de-vegetated peatland in New Zealand. Photodegradation could be a factor in explaining the patchy nature of peat decomposition, as previous work has also shown that exposure to sunlight can prime plant residues for subsequent microbial degradation (Foereid et al. 2010). Photodegradation has been shown to play a role in decomposition in arctic waters, and to interact with microbial degradation (Cory et al. 2013). It is possible that exposure to sunlight in some exposed areas of the peat primes it for microbial activity, and therefore explains the patchy nature of peat decomposition.

Here we collect peat in spring and put it out exposed to the sun together with shaded controls over the summer. The samples were then incubated, both at field capacity and submerged to determine if pre-exposure to sunshine primes the peat to faster decomposition.

Materials and methods

The study area was located at the east bank of the Irtysh River near the confluence with the Ob River in the middle taiga area of Western Siberia (60°54'N, 68°42'E), 30 km west of the town of Khanty-Mansiysk.

Peat was sampled from the top layer of 5 typical microlandscapes within the peatland (at the bottom and the top of an eroded slope, in a hollow, on a ryam and in a ridge). Bags were prepared with cotton material on one side, and UV-transparent Alcal film on the other. Control bags also had a layer of black plastic between the sample and the Alcal plastic. The collected peat was air dried and put in the bags, all peat samples split to have both exposed and control from each sample. All bags were put out and fastened on a sun-exposed wooden platting in the peatland. The bags were put out in the morning of 24th of May and collected in the evening of 21st of August 2013.

About 5 g of dry peat from each bag (exposed and controls) was put in each jar. Replicate jars were made for an incubation at field capacity (dry) and one under saturated conditions (wet). Water was added to field capacity in the dry incubation, and enough to fully cover all samples in the wet incubation. Extra water was added as needed. The temperature during the incubation was 22.32±1.87 ºC.

Before each measurement the jars were closed for between 1 and 4 hours. 10 ml gas sample was taken out by a syringe. The gas concentration in the samples was measured on a chromatograph. CO_2 evolution was measured every day in the beginning, then every second day and then every third day for just over 2 weeks. CH_4 was measured at the same time, but only in the wet incubation.

Preliminary results and discussion

There was a marked effect of photo-exposure on the decomposition rate at field capacity (dry) (Figure). In the submerged peat (wet), the effect of photo-exposure was only seen in some peats, and the effect was short-lived. No methane emission was recorded from any peat at any time, indicating that even the submerged peat did not go anaerobic. The results indicate that exposure to sunshine can significantly increase peat decomposition- and carbon loss rate even at this relatively high latitude. This could mean that peat disturbance that exposes the peat to sunshine, for example erosion, cultivation or cutting, could have disproportionally large effects on carbon losses. This effect could be further exacerbated if the water table is also lowered, as the effect was only marked when the peat was not water-logged. Further work will focus on the how photo-exposure changes the chemical composition of peat to make it more degradable.

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