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Charcoal production and degradation in peatland vegetation fires

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Aims

- To study the effects of formation conditions (duration and temperature of burns) and feedstock on black carbon (BC) characteristics and production.
- To assess the C cycle significance of different BC materials e.g. the effects of BC on DOC fluxes.
- To quantify the rates of BC degradation under different experimental conditions and within field settings.
- To assess the impacts of BC in peatlands on wider environmental issues e.g. rates of ecosystem recovery

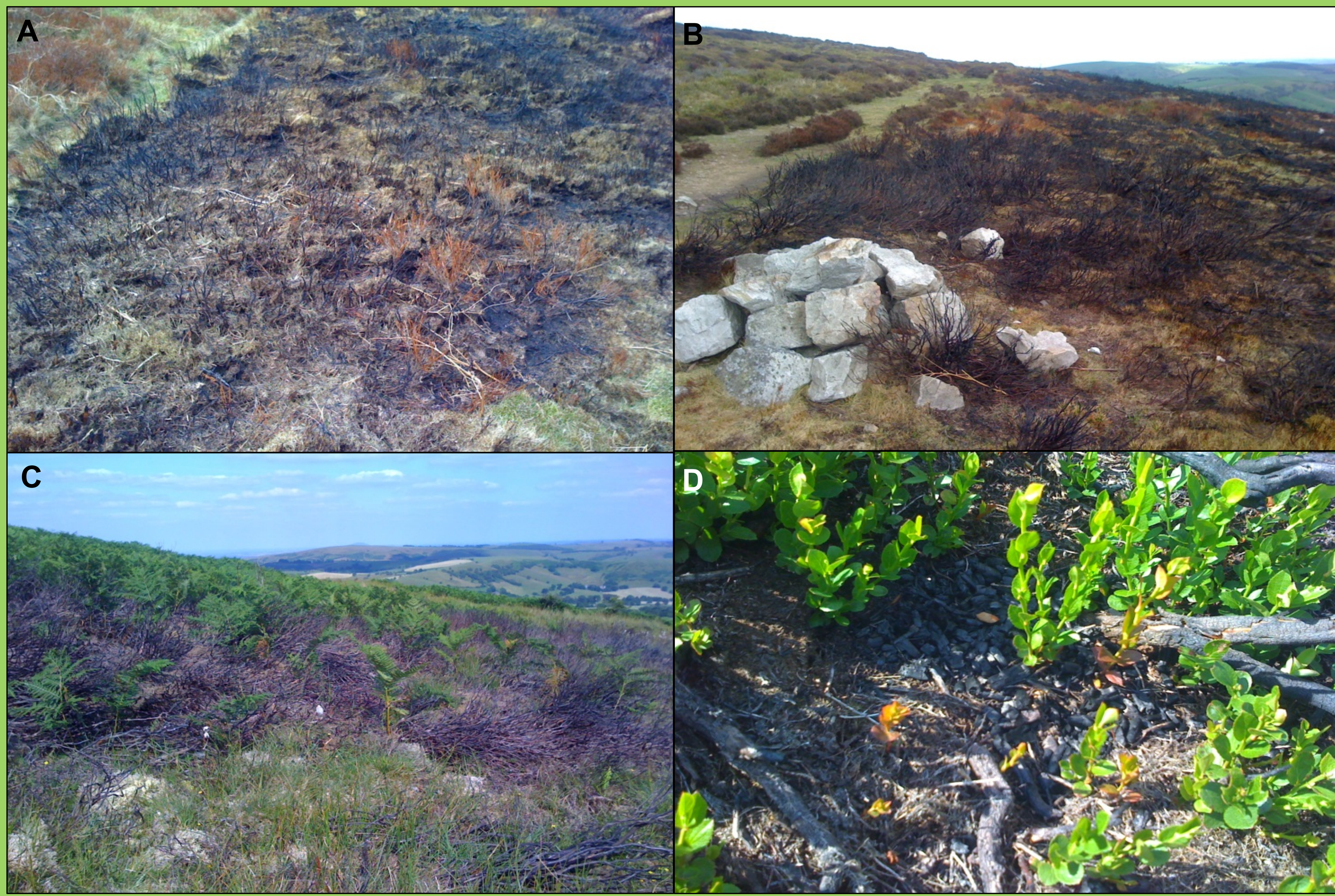

Figure 1.
A: Observable differential degree of combustion of both vegetation and substrate.
B: Observable effect of fuel break on burn extent.
C: *Pteridium aquilinum* invading a *Calluna vulgaris* patch following a prescribed burn.
D: BC retained at burn site following plant (*Vaccinium myrtillus*) regrowth in a *Calluna vulgaris* dominated patch.

Justification

Wildfires:

Wildfires can cover a considerable range of burn characteristics, in terms of burn temperature and duration; the impacts of these events will vary with the aforementioned factors, as well wider climatic and human influences (Davies et al, 2009; Hamilton, 2000).

Prescribed burns:

Prescribed burns are deliberate fires implemented for a range of purposes; they are commonly used to reduce future fire risk by removing fine fuels from a plot, or to create a patchwork of different stand ages for habitat management (e.g. Alday et al, 2015).

Black Carbon:

When biomass is consumed in a fire, some is emitted to the atmosphere as gases and particulates, whilst incompletely combusted material is converted to charcoal; this is sometimes referred to as black carbon (BC) (Worrall et al, 2013). BC constitutes a high density store of carbon (C); this C has been shown to have residence times of thousands of years in certain settings, meaning it may form an important long term C store (Clay and Worrall, 2011).

Fire in UK landscapes:

UK peatlands, important stores of C and sites of biodiversity, are subject to management burns, as well as episodic wildfires; pyrogenic activity in such settings can have numerous effects on biophysical processes, and thus may interact with wider environmental concerns (e.g. Davies et al, 2010).

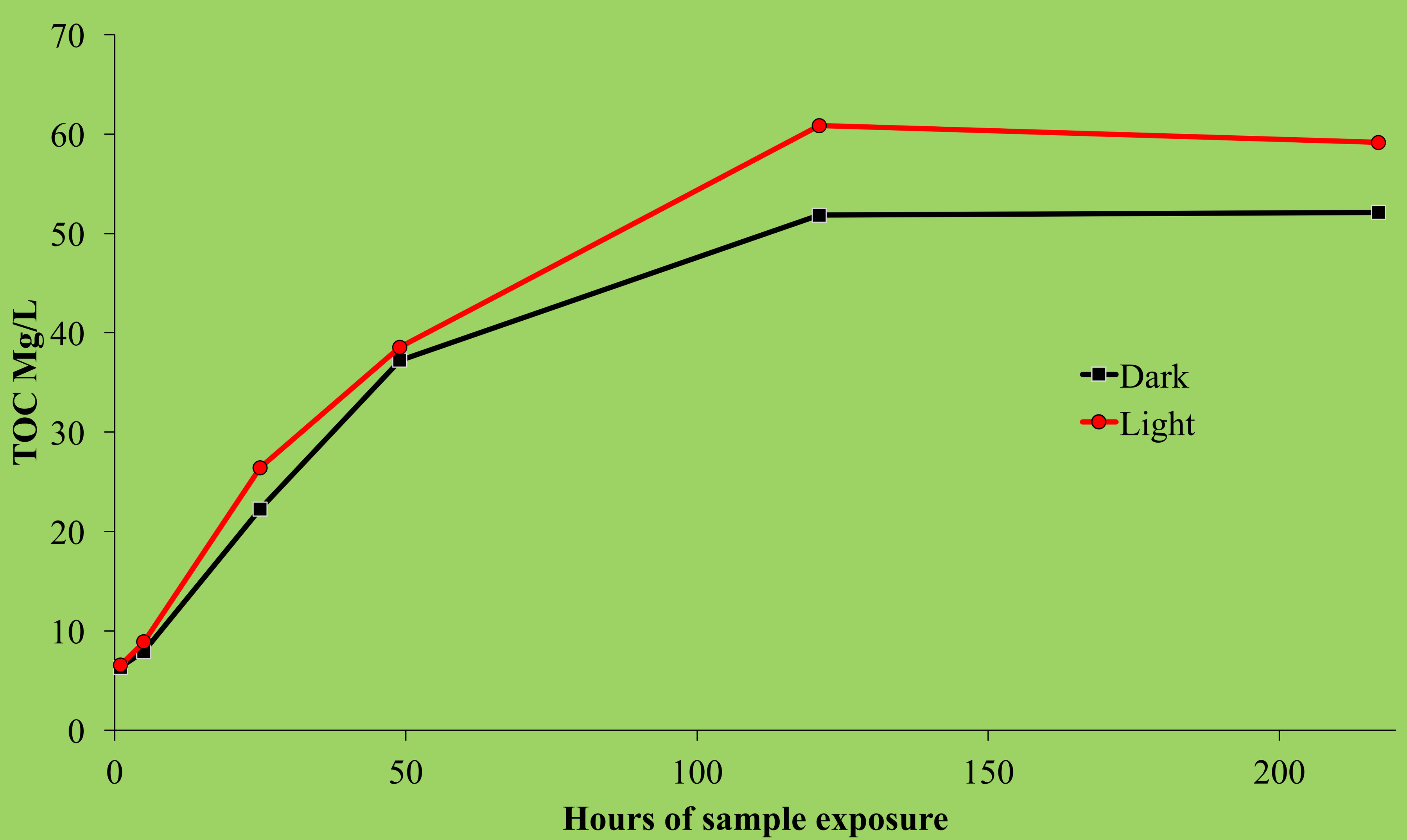

Figure 2. Photo-induced degradation comparative study. Averaged total organic carbon (TOC) from *Calluna vulgaris* BC samples. From Kennedy-Blundell (unpublished MSc thesis).

Methodology

Laboratory experiments:

BC samples will be produced in the labs from a range of feedstocks (e.g. *Calluna vulgaris* and *Vaccinium myrtillus*) using muffle furnaces; the physical and chemical properties of the samples will be assessed through a range of analytical methods (e.g. Davies et al, 2009), e.g. elemental analysis, FTIR, and surface area analysis.

Degradation experiments will be carried out with samples being submerged in water, or subject to rainfall simulations. Subsamples will then be analysed across a set time period to assess quantify elemental leachates (e.g. Figure 2).

Field studies:

Mesh bags will be used to study BC degradation in the field, with the bags allowing for loss of sample fragments and leachates; the bags will be placed in recently burnt plots to assess differing rates of degradation of sample groups, as well as the effects of sample placement within a plot (Figure 1; Kasin and Ohlson, 2013).

Summary

Research suggests that fire regimes have changed within recent decades, with important ecosystems projected to experience greater pressures from wildfire events in the coming decades (e.g. Albertson et al, 2010), as a result of both natural and human forcing (Santana and Marrs, 2014).

As such it is essential that the effects of fires and BC production be understood with regards to their local impacts, as well as their wider environmental interactions (Clay et al, 2010).

References

Albertson et al. (2010) *Climate Research*, *45*(1), 105–118. **Alday et al.** (2015) *Perspectives in Plant Ecology, Evolution and Systematics*, *17*(5), 388–396. **Clay and Worrall** (2011). *Journal of Environmental Management*, 92(3), 676–682. **Clay et al.** (2010) *Journal of Geophysical Research: Biogeosciences*, *115*(4), 1–14. **Davies et al.** (2009) *Journal of Applied Ecology*, *46*(5), 1054–1063. **Davies et al.** (2010) *Journal of Applied Ecology*, *47*(2), 356–365. **Hamilton** (2000) The characteristics and effects of management fire on blanket bog vegetation in north-west Scotland. *PhD thesis, University of Edinburgh*. **Kasin and Ohlson** (2013) *Soil Biology and Biochemistry*, *65*, 39–49. **Santana and Marrs** (2014) *Journal of Environmental Management*, *139*, 88–96. **Worrall et al.** (2013) *Journal of Environmental Management*, *120*, 27–36.