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Climatic effect on seasonal polyphenols/phenoloxidase interplay in Sphagnum fallax along a narrow ecological gradient

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Sphagnum-dominated peatlands are characterized by sustained imbalance between rates of plant production and decay, which results in the accumulation of organic matter. Reviews about the chemical composition of Sphagnum genus, suggest that recalcitrant organochemical compounds produced by Sphagnum such as phenolic compounds contribute with the paucity in available nutrients, high soil moisture and anaerobic conditions to the low decomposition of organic matter (1). The decomposition process of polyphenols is mediated by fungal extracellular enzymes, the phenoloxidases. These enzymes represent a crucial component of the cycling of complex organic matter and recalcitrant aromatic materials in the decompositional environment of peatlands. Therefore, environmental changes mediated by global warming are likely to affect the stability of the carbon cycle of peatlands via an alteration of polyphenols/phenoloxidase interplay. Thus, this work proposes to study climatic effect on seasonal variations of polyphenols/phenoloxidase interplay in Sphagnum peatlands across different ecological settings.

Open-Top-Chambers (OTCs) were installed to simulate an air temperature increase (1 up to 3°C) along a narrow ecological gradient (Fen to Bog condition) in the peatland site in Frasne (a) (Jura Mountains, France). From May 2009 to November 2009, climatic effects on seasonal variation of polyphenol production and phenoloxidases activities were quantified in living segments of Sphagnum: 0-3 cm (Top) (0 defined as the top of the capitulum) and 3-10 cm (Bottom). Water soluble phenolics were extracted with distilled water and primarily bound phenolics with ethanol/distilled water (80/20 v/v). Then, total phenolic were quantified using Folin-Ciocalteau assay and gallic acid as standard. Phenoloxidases activities were extracted and quantified using L-DOPA as substract and were expressed in enzymatic unit (UE) / g DW.

Climate warming had no effect on phenoloxidase activity (average activity: 20 x 10-8 UE/g DW). It suggested that phenoloxidase activity was limited by low pH, which was known to be unfavourable in peatlands (2). On the other hand, our results demonstrated that elevated temperature had greatest impact on the phenolic metabolism since phenolic contents were constantly lower in climatic treatment (an average of 1.6 mg/g DW) than in controls (an average of 1.2 mg/g DW). In particularly, in the fen area a diminution of an average of 0.4 mg/g DW of water soluble phenolics was observed. Multivariate analyses revealed that phenolics/phenoloxidase variables were linked to moisture and air temperature in the fen and bog areas. Moreover, the climate warming exacerbates such observed seasonal variations of phenolics/phenoloxidase. A significant negative relationship between polyphenols and phenoloxidase activity in controls ($r = -0.35$, $P < 0.05$) and climatic treatments ($r = -0.35$, $P < 0.05$) was also clearly shown, suggesting an inhibitory effect of phenolics on phenoloxidase activity. However, this inhibitory effect diminished with climate warming in the fen area.

To conclude, any significant decrease of phenolic compounds induced by repeatedly elevated temperature would impact the peatland ecosystem functioning and carbon cycle through an alteration of polyphenol production and interactions with microbial communities (3) and the extracellular enzyme production. Furthermore, this work highlighted that climatic treatments did not similarly affect the fen and the bog area, suggesting that all peatland habitats would not respond similarly to climate forcing.

References

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