

We thank the reviewers for the time and effort that they invested into the review of our manuscript, and for their helpful comments and suggestions. We were pleased by the positive evaluation of our study. We revised the manuscript with special attention to the comments we received, and have added our responses in bold face after each specific comment or suggestion.

In addition to the changes made based on the reviewers' comments, we changed the term "water level" to "water table" throughout the manuscript, as this was recently recommended to us during the review of another manuscript (and since this term also seems to be preferred by Referee 1).

Anonymous Referee #1

General comments:

The study examines the effects that litter quality and water table decrease have on the enzymatic activity and soil decomposition rates at two time scales. This manuscript presents interesting data that can be an important contribution to the scientific community because there are few long-term studies of the effects of water table drawdown on ecosystem processes. The results show that litter quality is the dominant factor affecting enzymatic activity, while water table drawdown plays a secondary role. The authors of the paper were meticulous in the sample processing and data analysis. I have several suggestions for improvement of the manuscript:

- In the introduction the authors mentioned the effects of water table decrease on some ecosystem processes, but failed to mention why the water table can decrease. Decrease in water table is likely to be an indirect effect of changes in precipitation patterns, increased temperature and evapotranspiration.

We added the information into the Introduction section (first paragraph):

“Global climate change is predicted to result in lowered WT in northern peatlands ... via changes in precipitation patterns, and/or increased temperature and evapotranspiration. Another important issue is currently the C balance of peatlands drained for forestry by ditching, which is the most extensively applied land-use practise on peatlands of Northern countries and Russia...”

- Table 1. The authors should be clearer about the number of plots (replicates) that were established at each location. How far apart were the plots from each other? Was there only one plot with two or three bags?

We revised the caption of Table 1 to clarify this issue. As described in the Material and Methods (section 2.1., second paragraph), we had two study sites with differing nutrient regimes: bog and fen. Both sites included 1) a pristine control plot, 2) a plot with short-term water table drawdown, and 3) a plot with long-term water table drawdown. For each plot (different nutrient and water table regimes; altogether 6 plots), 2–3 replicates (incubated in a minimum distance of 5 m from each other) per litter type were prepared for annual recovery (year 1 and year 2). The two litterbags that represented the same plot, litter type and replicate, just were of different incubation period and thus represented different stages of decomposition (one was recovered after 1 year and the other after 2 years), were incubated next to each other: the distance was few cm.

- Taking into account the importance of temperature in microbial and enzymatic processes, I think that the authors should indicate why soil temperature was not considered during the experiment.

The soil (litter) temperature was considered for “actual activities” when field-specific temperature at the time of sampling (5 °C) was used during the assays. For “potential activities” we used a more favourable temperature (20 °C), the reasoning is described in the manuscript, section 2.4. in Material and Methods. We revised the text and hope that the information can now be easily found there.

- The authors in great detail explain the procedures and methods; however, I feel that they fail to explore the ecological meaning of their findings. Therefore, I think that the discussion and conclusion sections need further work prior to publication.

We revised the Discussion and Conclusions section with a special attention to emphasize the ecological meaning of our findings. However, we still need to stay focused enough on the topic of this manuscript, and perhaps leave more broad syntheses for future review papers.

- The authors should include a brief explanation of why they chose to look at C,N,P and particularly S. There is limited discussion about this in the manuscript.

We added this information into the Introduction section (between our aims and hypotheses).

- The authors showed that after a period of 4 and 40 years litter quality plays a more important role than water table drawdown in determining the patterns of microbial and enzymatic activity. I suggest for the authors to also consider and discuss the effects of water table decrease in shorter periods on the microbial and enzymatic activities, such as weeks to seasons.

We agree that short-term fluctuations of the water table will have effects that are different to the effects of a persistent change that we report here. We now point this out clearly, with references to studies focusing on different time scales, at the end of the Introduction section:

“Water table in a peatland usually fluctuates within a certain range, depending on season and weather conditions. Such fluctuations have their specific effects on biogeochemical processes, and these may differ from those of a persistent change. In this study we focus on a persistent change in average WT. Our results may thus not be applied on temporal WT fluctuations or short-term droughts.”

However, to keep the manuscript concise, we would not like to repeat their results in any detail, since the focus of our paper is on the longer-term patterns.

- I found interesting that the pH decreased with time. Changes in pH can have important effects on nutrient availability, especially that of P. The authors should add to the discussion about their reasoning for the change in pH and the implications for the microbial and enzymatic activity.

We added our reasoning of the decrease in pH with the long-term water table drawdown, and revised the text to emphasize the implications of lowered pH for the microbial processes (section 4.2.1. in Discussion, second paragraph).

- The authors put a great emphasis on the importance of litter quality over water table decrease on the increase of enzymatic activities, however, the authors should also consider that:

1) the change in species composition and thus litter quality is a result of the change in water table

We fully agree with this statement, and in the manuscript we talk about the change in litter quality (at the community level) as the "indirect effect of water table drawdown".

2) I would expect that a quick change in water table (hours, days to months) would have a greater effect on the enzymatic activities than the litter fall.

Yes, that is very likely to be true and this assumption is supported by the results of our manuscript that emphasize the importance of considering the time-scale of the changes. A quick change in water table (hours, days to months – even years as our plots with short-term water table drawdown) changes the site environment, but not yet the plant community structure and the litter fall (Straková et al., 2010). Thus, the direct effects of water table are greater than the effects of changes in plant community structure/litter fall (indirect effects of water table drawdown). In the long-term, however, the changes in plant community structure/litter fall (indirect effects of water table drawdown) overrule the direct effects of water table drawdown.

Specific comments

- Please add a citation at the end of the first paragraph of the introduction.

Added as suggested.

- In the litter fall section, second paragraph “. . . 3-5cm thick layer beyond. . .” should it not be below instead of beyond?

Corrected as suggested.

- In Fig 3. The authors might consider including the mean water table in the graph because it is not obvious to the reader that in the short and long-term the fen had water tables at least twice as low as the bog.

We revised the graph as suggested.

- In the results section, the last sentence of the litter type effects, the authors need to clarify if the P acquisition was positively correlated with an increase or decrease in C:P and N:P ratios.

We revised the sentence to clarify this issue. We emphasized that "allocation of enzyme activity towards P acquisition" means "increased activity of P enzymes relative to the activity of C and N enzymes". So now it should be clear that positive correlation means that in litters with high C:P and N:P ratios we detected high activity of P enzymes (relative to the activity of C and N enzymes).

Anonymous Referee #3

General comments

The authors have produced an ms which shows a strong development of a research field that has been underdeveloped for a long time. In short- and long-term drained wetland ecosystems they have investigated no less than 23 combinations of plant litter and type of nutrient regime using analyses of enzymes and microbial communities. The focus has been on an analysis of microbial community and the activity of no less than 11 extracellular enzymes. The authors conclude that litter species/litter type is the main factor determining enzyme activity and thus decomposition rate.

Although the authors have made an interesting study and produced a manuscript that is scientifically correct and acceptable I found it a bit difficult to read. An interesting study must be ‘sold’ to the reader to reach a wider acceptance. One general problem is the number of abbreviations, which may be necessary, but I found the language a bit difficult too (see below) In general the ms appears very good and I would suggest minor revisions.

We revised the manuscript and tried to emphasize the ecological meaning of our findings. To reduce the number of abbreviation in the text (which was, admittedly, rather high) we removed the abbreviations “STD” for plots with short-term water table drawdown, and “LTD” for plots with “long-term water table drawdown”.

Specific comments

Page 4, section 2.2, line 4. The first time a Latin name is written – write out the full name, e.g. *S. balticum* should be *Spagnum balticum*

Corrected as suggested.

Page 4, section 2.2 last sentence in first para. Sub-samples were withdrawn to determine initial litter quality. How many subsamples (n=?). At what temperature were they dried? **Two sub-samples per litter type and plot were withdrawn to determine initial litter quality, and dry mass content was determined by drying two sub-samples at 105 °C overnight. We added this information into the manuscript (section 2.2. in Material and Methods, second paragraph), and for more details refer to Straková et al (2010) that presented the detailed chemical characterization of the litters.**

Page 4, section 2.2, second para, line 3. The opposite? Opposite to what? Nutrients? Klason lignin? Holocellulose?

We revised the sentence, and believe that it is now clear that some pattern was found for the chemistry of *B. nana*, and the opposite pattern was found for the chemistry of *Sphagnum*.

Page 5, section 2.4, line 4. The authors mention incubation temperature ‘high’ and ‘natural’ – why not give them in °C here?

We revised the text based on this comment. First we talk in general about the “laboratory” and “natural” conditions (section 2.4. in Material and Methods, first paragraph), so we don’t give the specific temperatures in °C. In the next paragraph, when we talk about our specific conditions, we added °C specifically used in our assays (20 °C and 5 °C for “laboratory” and “natural” conditions, respectively).

Page 5, section 2.4.1 line 2. Substrate in plural

We revised the sentence for improved clarity. We mean substrate solutions (thus substrate in singular) and standard solutions.

Page 6 bottom. Substrate concentration mol/L is normally written with M, M meaning molar or mol per litre.

We agree that the unit “Mols/L” used here was not correct and that was probably a typing error. We changed that to M as suggested.

Page 6 line 3 from the bottom. I have tried to see what ‘dicq’ stands for, assuming that it is an abbreviation. I think it may need some kind of explanation (alt a correction).

We revised the text (2.4.2. section of Material and Methods; last paragraph) to make it easier to read. Phenol oxidase activity was expressed as μmol of the L-DOPA product (2,3-dihydroindole-5,6-quinone-2-carboxylate; diqc) produced per minute and per g of litter dry mass.

Page 9, section 3.1. The authors use the term ‘easily assimilable C’. I assume that this is concentration of water soluble substance obtained in the Klason lignin analysis?

The term easily assimilable C includes extractives (here substances extractable by hot water) and we added this information into the manuscript. The methods used for the chemical analyses are described in detail in the study by Straková et al (2010), that we refer to in the manuscript.

Page 9 section 3.2. The authors refer to Fig 2 and in the following (the last) sentence – “Allocation of enzyme activity.” Should this sentence also be supported from Fig 2? What I can see in the two lower subfigures are negative relationships, not positive.

We revised the Figure 2 and its caption to improve the clarity of the figure.

A comment to figure 2 – the text – litter mass loss rate? The upper left figure has accumulated mass loss on the X axis. Mass loss as written on the X axis is OK but please change the legends.

We changed the legend as suggested.

The upper right figure shows ‘extractives’ – is that water soluble or water soluble plus that of an organic solvent?

In this manuscript the term "extractives" includes substances extractable by hot water. We added this information to the caption of figure 2.

Page 9, section 3.3 last para. If possible, support your statement with error bars in the figure. For *Betula nana* the differences appear small – as far as I can read the figure.

We revised the figure 4 as suggested.

Page 10 line 2. Litter chemical quality? This is a small thing and just a comment. The term ‘litter quality’ was once introduced (I think by Aber and Melillo) to indicate degradability. High quality – high degradation rate. Basically this could be related back to chemical composition. Having said that I believe that ‘litter chemistry’ or ‘litter quality’ would be better to use here.

We changed the term “litter chemical quality” to “litter quality” as suggested.

Page 10 3rd para, the first 3 words. ‘Enzyme activity allocation’. Is that an accepted expression? To me enzymes can be allocated but activity reflects a property of an allocated enzyme and is a consequence of e.g. temperature or pH.

We could not find a proper term for "standardized activities of each enzyme within a sample" in the literature, and thus created the term "enzyme activity allocation". We revised the paper to make sure that this term is properly introduced and explained in the manuscript (section 2.6.1 in Materials and Methods, last paragraph; mentioned also in the Introduction in the paragraph with our hypotheses). We believe that the meaning will be obvious to the readers.

Table 2. It would be helpful to have MUF explained in the legend.

We added the explanation of this abbreviation to the legend of Table 2 as suggested, together with the explanations of the other abbreviations used in the table.

Appendix A. The head text says “Enzyme activity, mass loss (%) and pH, mean values” I had 4 pages of appendix in my ms copy and can only find values for enzyme activity.

The values of mass loss and pH are at the end of the Appendix A (page 1901 of this manuscript presented in Biogeosciences Discussion)