SOIL Discuss.,
https://doi.org/10.5194/soil-2019-86-AC2, 2020

Interactive comment on "Switch of fungal to bacterial degradation in natural, drained and rewetted oligotrophic peatlands reflected in δ^{15}N and fatty acid composition" *by* Miriam Groß-Schmölders et al.

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Received and published: 13 March 2020

Dear Referee,

Thank you, for your helpful comments, which will improve our paper considerably.

1. To me, the Introduction is the part of the manuscript that requires the most attention. The research methods and questions need to be prepared in more detail and especially the role of roots and mycorrhiza should be considered in more detail.

Answer: We have rewritten the introduction and have insert a more detailed part for research methods and questions (see also answer 7). You are right; we have not sufficiently discussed the expected role of roots and mycorrhiza. We are sorry for that and have now complemented a paragraph with it. Our study sites are open peatlands with a small amount of vascular plants (result of our vegetation analysis). Hence, mycorrhiza should also play a minor role. But of course, there might still be an effect of mycorrhizal activity and rooting in our study sites. Mycorrhiza mediate the uptake of nitrogen into plants. Rooting and the existence of mycorrhiza leads to enriched 15N values in the remaining bulk material (Högberg et al., 1996), because (1) mycorrhiza preferentially process lighter 14N and transfer them to plants (Adams and Grierson, 2001, Asada et al., 2005a, Högberg et al., 1996, Kohzu et al., 2003, Robinson et al., 1998) and (2), even without mycorrhizal activity, plants preferentially incorporate the lighter 14N. But, because of the small amount of vascular plants and therefore also of mycorrhiza, these cannot not be the main drivers for our observed pattern.

2. For consideration in the journal SOIL, the soil type/classification need to be adequately described.

Answer: You are right, we have forgotten to describe the soil type adequately and have inserted this classification to the manuscript. All investigated sites are classified as Histosols (organic soils). Histosols are classified as soils with a cumulative organic layer and an organic matter amount of 35% or higher in at least half of the uppermost 80-100 cm (IUSS, 2015). In addition all investigated peatland soils are Sphagnum peat, because of their mean annual temperatures (between +1.2°C and +7 °C) and their annual precipitation between 523ppm and 1600ppm (Eurola et al., 1984, Vitt et al., 2006). Lakkasuo and Degerö Stormyr are classified as Northern eccentric bogs and the peatlands in the black forest are characterized as ombrotrophic bogs (Eurola et al., 1984).

3. In some figures, but also text the acrotelm-mesotelm designations are an issue: Is there an acrotelm or not? Figure 3 shows an acrotelm/upper mesotelm, but in the

remainder of the manuscript, an acrotelm is not mentioned. On the other hand, an "upper" and "lower" mesotelm are introduced. Please find a consistent way to handle the issue.

Answer: We are sorry, for not being clear enough with our definition. Yes, there is an acrotelm and a mesotelm in all sites. We have forgotten to mention this in figure 3 and have changed it accordingly. The acrotelm is the uppermost part of the peatland with living sphagnum vegetation (Morris et al., 2011). The deeper part, with dead plant material and in permanent waterlogged, anaerobe conditions, is called catotelm (Morris et al., 2011). In between the acrotelm and the catotelm, with fluctuating conditions, the mesotelm is located (Clymo and Bryant, 2008, Lin et al., 2014). With drainage, the mesotelm is expanding and a supplementary separation is reasonable, because the condition within the mesotelm differ a lot from aerobe, light and warm conditions (upper mesotelm) to semi-oxic, dark and cold conditions in the lower mesotelm (Artz, 2014, Lin et al., 2014). These changed conditions are the reason for the changed microbial metabolic pathways and are therefore critical for the 14N:15N ratio we see in the data sets (Lin et al., 2014).

4. Please check the manuscript again for signs of sloppiness: Throughout the manuscript, the abbreviations for Tables and Figures are inconsistently spelled; sometimes capitalize and sometimes not. Somewhere in the text, I quit nothing this in "Specific comments". In the references section, journal titles are generally spelled out, but sometimes not. Please edit following journal guidelines

Answer: Thank you for pointing this out. We have checked and deleted mistakes in tables and figures as well as in the reference section.

5. Specific comments: L12; L14; L16; L28; L32; L74; L219; L221; L247; L250; L287; L246; L443; L444

Answer: Thank you for your careful and constructive review of the manuscript. We have changed and improved the mentioned sentences.

6. L38-39: There are quite a few approaches to describe "peatland condition". But what is "peatland condition"? And are the methods you are proposing more time and cost efficient than others? You are hypothesizing that 15N isotopes could be such a tool. Fine, but PLFA analysis isn't that cheap and you are also heavily relying on that method. Please explain in more detail.

Answer: With the wording "peatland conditions" we are referring to the hydrology status, whether it is natural, drained or rewetted. We have changed the wording to hydrology status. You are right; FA analysis is not a cheap and easy method. We have done this analysis to support our hypothesis based on stable isotopes, and only the latter we refer to as a time- and cost efficient method to indicate drainage and rewetting. We do not suggest establishing an approach as a routine analysis, which uses both methods. The three main methods today to measure the hydrology status are (1) a macro analysis of peatland vegetation, (2) gas emission measurements and (3) measurement of growth heights of peatland vegetation. Method (1) was also done in this study. We wanted to prove, that our investigated stable isotope patterns are related to decomposition and that they are not primarily a consequence of the vegetation assemblages. But this method is time consuming and needs a high level of expert knowledge and is thus very costly. Method (2), the measurement of gas exchange in peatlands (Baldocchi et al., 1988) measures current gas emissions and therefore provides an indirect measurement of ongoing decomposition processes (Bubier et al., 2003). But it is not able to give information on drainage history and gas exchanges at another time of the year (Bubier et al., 2003). Furthermore, this method is also very intensive in analytical equipment and expert knowledge needed. A third available method (3) is the measurement of the growth of peatland vegetation. But there are several problems with this method: Firstly, not only the sole growth of mosses indicates peat growth. It is important how much vegetation material enters the catotelm and is therefore stored under aerobe conditions. Secondly, peat shrinks and swells with water supply. Hence measuring peat height at different times would lead to completely different assumptions for peatland growth (Clymo, 1970). And thirdly, peat growth is really slow and it would need decades to get a positive reply with this method to indicate successful restoration efforts (Clymo, 1970, Fenton, 1980). Summing up, there are methods available to get information of the success of restoration effort, but these methods are lacking some important information or/ and are expensive and time consuming. Hence, there is a need for a new and less expensive and time-consuming indicators, which could be done not only by specific experts. We believe that bulk isotopes can be such suitable indicators, but we need to prove that with the FA method.

7. This is a general phenomenon Introduction chapter in general: Biogeochemical transformations as a consequence of rewetting re not introduced, but in the last paragraph of the introduction, you are looking for changes of 13C and 15N with the onset of the rewetting process.

Answer: Thank you, for your comment. You are right; we have missed to introduce our hypothesis of the influence of rewetting to stable isotopes. Rewetting increases the water table height and therefore enlarges the anaerobe catotelm (Andersen et al., 2006). We hypothesize, that the observed stable isotope pattern for drained horizons will be conserved, when formerly aerobe parts will get rewetted (Andersen et al., 2006). With rewetting the conditions in the former mesotelm will get anaerobe and microbial activity will be inhibited (Andersen et al., 2006, Asada et al., 2005b, Thormann et al., 1999). Hence, no or only few metabolism processes take place and stable isotope patterns shouldn't change anymore. For the upper part of the rewetted peat, we expect to find natural conditions and vegetation growth, like in natural peatlands. Hence, we expect to find the same stable isotope pattern, as we see in natural peat.

8. L70-80: This paragraph should be rewritten. It lists methods, but the aim/objective/hypothesis is not sufficiently clear. Many methods are listed without having been introduced before. Please introduce these methods. When looking at d15N, not only decomposition must be considered, but also mycorrhizal activity. Are you expecting root effects on d15N?

Answer: We have improved the wording of the mentioned paragraph and inserted an introduction to the mentioned methods (bulk density and carbon:nitrogen ratio measurements). Our aim is to find an answer for the depth trends of carbon and nitrogen stable isotopes corresponding to the hydrology status, which were investigated in previous studies. Our main hypothesis is that microbial metabolic pathways are the drivers behind these stable isotope depth trends. The hydrology status determines the abundance of microbial communities. With changing hydrology microbial abundance changes significantly (Kohl et al., 2013) and therefore also stable isotope values must change (Tfaily et al., 2014). Vice versa this would mean that stable isotope values reflect the hydrology status, which we aim to test. We hypothesize, that drained conditions lead to expanded microbial abundance, because of the attendance of oxygen also in deeper horizons. We aim to find significant links between this pattern and the observed stable isotope pattern. For natural and rewetted conditions we hypothesize to find low values of stable isotopes in accordance to low microbial abundance. For mycorrhizal- and rooting effects please see answer 1.

9. Chapter 2.2. Coding of the sites is inconsistent. Some codes appear to relate to minerotrophic or ombrotrophic hydrology or drained vs. natural status, but others don't. Please code in a consistent way. Chapter 2.3: What does LOD1, LON3, DDC3, DNM1 mean? Did you take replicate cores at these sites? From which depth were samples taken?

Answer: We have changed the coding, to be more consistent. We have now named them as follows: first letter of the site + hydrology status (plus with subscript, if needed, for additional information) (Tab.1). Yes, we had three replicates per site and analyzed samples of the upper 60 cm of the cores. The cores were sliced in 2 cm sections and every second layer was analyzed, giving a 4 cm depth resolution. We have mentioned it in section 2.2 (L134/135 and L148).

10. L 283-284: This sentence is incomprehensible. Does fungal biomass decrease in peatlands? Where? When? Please explain.

Answer: Yes, our hypothesis is, that with increasing depth and changing hydrological conditions (darker, less oxygen) fungi will be outcompeted by bacteria, which means, that fungal biomass must decrease, whereas bacterial biomass increases with depth. In the uppermost part (acrotelm and upper mesotelm) fungal biomass is the highest, whereas in the deeper part of the mesotelm bacterial biomass will increase. In the catotelm all microbial biomass is strongly reduced because of the anaerobe conditions. In natural peatlands a small amount of fungal biomass is also visible in the acrotelm, but in a much lower scale than for drained sites. (Thormann, 1999)

11. Supplementary data: This xls. file is not for publication. It requires formatting and translation.

Answer: We have re-formatted the supplementary data to make it more comprehensible for readers.

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Interactive comment on SOIL Discuss., https://doi.org/10.5194/soil-2019-86, 2020.

Table 1: Labeling of all drilling sites

Location	Labeling
Degerö	
natural mire	DN
drained	DD
Lakkasuo	
minerotrophic natural	LN_m
minerotrophic drained	LD_m
ombrotrophic natural	LN_o
ombrotrophic drained	LD_o
Breitlohmisse	
natural mire	BN
natural dry	BN_{dry}
drained	BD_1
near the mire edge	BD_2
Rotmeer	
natural mire	RN
drained, with Sphagnum	RD_1
drained, without Sphagnum	RD_2
Ursee	
natural mire	UN
drained	UD

Fig. 1.