SOIL Discuss., 1, C399–C404, 2014
www.soil-discuss.net/1/C399/2014/


SOIL Discussions Open Access



# *Interactive comment on* "A meta-analysis of soil biodiversity impacts on the carbon cycle" *by* M.-A. de Graaff et al.

**Anonymous Referee #1**

Received and published: 31 December 2014

General Comments:

This meta-analysis of the effects of soil biodiversity on carbon cycling pools and processes is very topical and interesting. As the authors also state, compared to our knowledge about the relationship between plant diversity and ecosystem functioning, our understanding of the impact of soil biodiversity on ecosystem functioning is still very limited. In the light of the ongoing global loss of biodiversity, including soil biodiversity, at unprecedented rates, quantitative reviews such as this one are of critical importance to improve our ability to predict the consequences of this diversity loss for the functioning of ecosystems.

I commend the authors for the well-written manuscript. The introduction and discussion

are very in-depth with ample citations to the relevant literature and I have very little to add to them. A short statement at the end of the conclusions paragraph of the discussion about the importance of elucidating links between soil biodiversity and C cycling and its broader implications would be nice (cf. page 909, line 10 and further). Now this paragraph is mostly focused on methodological challenges and knowledge gaps.

Most of my specific comments below are fairly minor. I do, however, have a few main concerns. First, the mixed use of terms such as "organismal groups" and "trophic groups" is often confusing. Second, I do not understand the explanation about the natural log of the response ratio, as the latter was defined as a value ranging from negative to positive. Third, I wonder if the data points in the regressions using multiple levels of diversity reduction per study (if I understood this correctly) can be considered independent. Fourth, some of the groups within the regressions seem to be represented by very few data values, and I have questions about the validity of some of the conclusions about them in the discussion.

Specific Comments:

1. Page 908, line 15. Not clear what "overall" means here. I assume this refers to the analyses including both studies that manipulated diversity within and across groups, but I had to read the methods and results section to realize this. Please clarify so that the abstract is clear by itself.

2. Page 909, line 5 and further. You mention land use change and fertilization, but I would think climate change qualifies as one of the main drivers of (future) biodiversity reduction as well.

3. Page 912, line 19 and further. "Further, we tested the hypothesis that biodiversity manipulations across multiple organismal groups more strongly affect C cycling processes than manipulations within organismal groups, due to a higher degree of functional redundancy within than across organismal groups (Andrén and Balan-



SOIL
1, C399–C404, 2014

dreau,1999; Setälä, 2002)." From the abstract and the figures, it seems that these so-called "organismal groups" are just trophic groups. If so, I would prefer "trophic group" as "organismal group" is very vague. See also comment #6.

4. Page 912, line 23 and further. "In addition, we tested whether diversity of the type of group, soil microbes vs. soil fauna (including micro-, meso- and macrofauna), impacts C cycling differently. Finally, since “biodiversity” is a metric that differs greatly in absolute numbers for different soil organismal groups, we evaluated how the relative loss of diversity (in percent) within organismal groups (i.e., microbes, soil fauna) affects soil C cycling." This use of the phrases "type of group" and "organismal group" is confusing. Why not just write something like: " In addition, we tested whether diversity of soil microbes vs. soil fauna (including micro-, meso- and macrofauna) impacts C cycling differently. Finally, since “biodiversity” is a metric that differs greatly in absolute numbers for soil microbes and soil fauna, we evaluated how the relative loss of diversity (in percent) within these two groups affects soil C cycling."

5. Page 914, line 1 and further. Why not add that there were 3 studies investigating effects on soil C pools? Then this would flow logically into "All soil C pool data...".

6. Page 914, line 23 and further. "Soil biodiversity impacts on C respiration and decomposition were assessed by manipulating biodiversity either within a single organismal group or across multiple organismal groups; we treated these two categories separately in the analysis. For plant biomass, however, there were not enough studies to run meta-analyses for individual categories. For studies that manipulated diversity across multiple organismal groups, soil biodiversity was altered by manipulating either (1) the number of organismal size class groups (e.g., micro-, meso-, macrofauna; e.g. Bradford et al., 2002) or (2) the number of functional or taxonomic groups within an organismal size class group (e.g., mycorrhizal fungi, saprophytic fungi and bacteria, root herbivores; e.g. Ladygina et al., 2010)." Are "organismal groups" just trophic groups? You explain that studies conducted across such groups either manipulated the number of size classes, or the number of functional or taxonomic groups within a size class. I



SOIL

1, C399–C404, 2014

can understand this. But does this mean that "within group" studies manipulated the numbers of species/taxa within a distinct trophic group? Please clarify these terms throughout the manuscript. See also comment #3. See also comment #13 about changing size classes and diversity.

7. Page 916, line 3 and further. Explain to me how you would take a natural log of r, when r becomes negative? Usually one just divides the response value of the experimental treatment by the response value of the control treatment. This ratio is always positive if measured response variables do not contain negative values, and is thus bounded at the lower end by zero. Taking the log linearizes and normalizes the raw ratios, which has several desirable properties. Or did you just use the response ratio r, as defined by the formula in Line 5, without taking the natural log? The figure captions stating "percent response" seem to indicate so. Please clarify.

8. Page 917, line 9. "We performed two sets of regressions. The first included all soil biodiversity levels, and the second included the highest and lowest biodiversity levels only." Would this be all biodiversity levels within a given study vs. the highest and lowest diversity levels within a given study? Does this mean that in the regressions including all diversity levels several observations from a same study were used? If so, these data are not truly independent, and I wonder if the authors could have corrected for this source of data dependence, i.e. grouping of data points per study, in some way, e.g. by the use of a random effect.

9. Page 918, line 21. "We further examined how a decline in diversity within organismal groups (microorganisms, microfauna, mesofauna, or macrofauna) was related to soil C respiration." Your summation seems to imply that four different groups of organisms were tested, whereas Fig. 4 distinguishes between "Microbes", "Macrofauna" and "Multiple Organismal Groups", so three groups. Please explain.

10. Page 918, line 23. "Soil microbial diversity was the only organismal group significantly related to soil C respiration, with a decline in soil microbial diversity reducing



SOIL
1, C399–C404, 2014

C respiration (Fig. 4a)." As change in macrofauna diversity is only represented by a single value, how does a regression for this group make sense? Or was this group not tested? In panel b, there are only two values for the change in diversity of multiple organism groups, so I wonder how useful a regression is in this case as well. Consequently, it is not so surprising that a significant relationship was only found for soil microbial diversity. See also comment #11.

11. Page 922, line 14. "In addition, the regression analysis revealed that a loss in soil biodiversity was significantly related to a loss in soil C respiration only when soil microbial diversity was included in the analysis." Again, I wonder how much this has to do with the lack of levels of diversity manipulation for groups of soil organisms other than microbes. See also comment #10.

12. Page 924, line 14. "Our analysis, however, suggests that diversity across multiple organismal groups has similar impacts on soil C cycling to diversity within organismal groups." This was true for the effects on plant tissue decomposition. For soil C respiration, the effect of reduced diversity within groups was even stronger than that of altered diversity across groups. Maybe include this information here.

13. Page 925, line 21. "inoculating sterilized soils with soil communities derived through a series of different sized filters". Although this technique has its merits and is interesting, I would think that body size and diversity are confounded by such an approach. As one filters out larger organisms, one will not only lower the diversity of the soil community, but also the average body size, and with that the functional composition of the community. If one then observes a change in e.g. an ecosystem function, is this due to the functional differences between large and small soil organisms, or because of the lower diversity? This approach can demonstrate what happens when one changes the body size classes, which correlate to some degree with functional groups, and the taxonomic richness simultaneously. It does not, however, enable one to assess the effects of altered biodiversity per se.



**SOIL**

1, C399–C404, 2014

Interactive Comment



14. Page 944, fig. 4. Here I read in the y-axis label "ln-R". Is this R the response ratio as defined in line 5 of page 916, or just the ratio of the high diversity response and the low diversity response? If it is the ratio as per the formula on page 916, again, I don't understand how you can take the natural log of a negative number. Please explain.

15. Page 945, fig. 5: The caption mentions three groupings of organisms, while the figure displays four groups. I suggest replacing "faunal" in the caption by "mesofaunal" and "macrofaunal" for consistency.

Technical Comments:

16. Page 908, line 14. Change "amd" to "and". 17. Page 912, line 18. Change "processes rates" to "process rates". 18. Page 919, line 1. Change "biodiversityimpacteddecomposition" to "biodiversity impacted decomposition". 19. Page 920, line 24. Change "promotes" to "promote". 20. Page 923, line 17: I suggest changing "mediated through earthworm-mediated changes" to "mediated through changes". 21. Page 923, line 27 and further. I suggest changing "and manipulation of soil faunal biodiversity on plant tissue decomposition was significant" to "and the effect of manipulation of soil faunal biodiversity on plant tissue decomposition was significant". 22. Page 924, line 26. Change "(e.g., Ingham et al., 1985, resulting" to "(e.g., Ingham et al., 1985), resulting". 23. Page 925, line 4. I suggest changing "diversity of any organisms" to "diversity of any group of organisms" and "manipulation of soil organisms" to "manipulation of soil organism diversity". 24. Page 925, line 28. Change "functionstudies" to "function studies". 25. Page 937, line 2. Change "multifunctionalityl" to "multifunctionality".

---

Interactive comment on SOIL Discuss., 1, 907, 2014.