

Dear Reviewer,

We greatly appreciate your professional comments on our manuscript. We are also pleased to say that the associate editor (Dr. Richard) really found some experts who know quite well about this topic not only theoretically but also actually did the similar process in the field. Thus, there is no doubt that we would like to revise the manuscript based on your kind constructive statements.

A. Major comments

1. "However, I would also suggest the authors seek assistance with English grammar and translation where appropriate, as the impact of this paper is currently obscured."

Yes, the current version of manuscript was not clearly presented (non-native English speakers) given we had revised several times. This time, after revision of the whole structure in details, this paper will be sending to professional polish company with attached certificate for your consideration.

2. "The introduction of this paper is scattered and somewhat confusing. I think spending time re-organizing/framing this section will provide clarity for the results and discussion sections. Perhaps the authors could introduce the topic of flowering bodies and their higher litter quality (N content), then discuss how aboveground litter quality influences belowground biogeochemical cycling through microbial subsidies, and conclude with a section discussing alpine ecosystems and evolved traits."

Very good recommendation to the point! I agree with you that introduction part is always a challenge for young researchers with neat and logically presented. We would like to revise that part according to your kind suggestions for better addressing scientific questions, results, and discussion sections. If there is any further details need us to proceed and address, please kindly let me know.

B. Other comments

1. "Lines 137-142 provide specific research questions that will be addressed by the authors. Currently they are a little unclear and seem to set up questions that are not directly tested. I would suggest refocusing on the major comparisons being made- is flower litter of higher quality than leaf litter? do these traits facilitate faster decomposition? does the time of litter fall influence ecosystem productivity?"

Yes, manuscript will be improved definitely if we focus on the major comparison. Thus, after supplying method in details of litter collection, we revised three questions as follows: 1) Should flower litter be considered in the alpine ecosystem's biogeochemical cycles for their relatively innegligible biomass production and/or allocation? 2) Does flower litter of higher quality and with unique traits have faster decomposition than leaf litter? 3) Does the time of litter fall influence soil available nutrients and ecosystem

productivity in special temporal period and location?

2. "The methods/materials section is generally clear. However, the authors do not provide details regarding their litter collection method (makes question 1 difficult to assess). The number of replicates and control treatments are sound. In my personal opinion I think it is important the field moves beyond litter bag experiments and mass loss. Litter bags exclude fauna and litter fragmentation, which contribute greatly to litter decomposition. While the authors used mesh bags with two layers of differing mesh size, the smaller mesh actually surrounding the litter still excludes faunal decomposers and minimizes biophysical perturbation. Since the study is focused on nutrient cycling more than soil organic matter mass loss/formation I think the litter bag approach is okay, but in the future it would be good for us to move beyond these techniques."

Ok, it has been supplied of litter collection procedure in the revised version as follows. Yes, the smaller mesh affected faunal decomposers and minimizes biophysical perturbation of litters to some extent. We did similar kind of comparison with quantification method between different mesh sizes. If chose smaller size, tiny size litter can be hold in the litter bag better, but it may exclude some soil fauna. If chose bigger size, tiny litters might be easily dropped in the procedure. Thus, we quite agree reviewer's constructive recommendation that in the future it would be great to move beyond these techniques to closely simulate real statues. For example, dual-labelled litter has been applied in recent decomposition studies.

Litter collection method: In the study, 4 litter traps were placed under the crown of each individual shrub in different communities (5–8 individuals were chosen for the placement of litter traps), which were processed and modified based on the litterfall monitoring protocol (Muller-Landau and Wright, 2010). The litter trap was composed of 1 cloth bag and 4 support legs. Window screen (with a mesh size of 0.8 mm) was used to seize the cloth bag. Its size was about 50 cm deep and 25 cm long. Four legs (made with 80 cm PVC pipe) were tied with a cloth bag and frame. The frame of the opening was made of iron wire with 3 mm diameter. After inserting it into the soil under the shrub's crown, the plant litter was collected twice per week, which was later sorted as flower litter and other types during the blooming period. Given the small size of herbaceous individuals, flowers were plucked at the end of the flowering phase, and their mass ratios to aboveground biomass were calculated. Freshly fallen leaves of different species were collected from the floor of the alpine meadow (i.e., mixed leaf litters, ca. 3950 m a.s.l.).

Determine the weight of litter after decomposition: Firstly, the debris or mud was remove outside the litter bags carefully, then litter was taken outside and sank into small water basin for short period of time, which

would go through 0.5 mm mesh filter to sort out clay and litter. Lastly, litters were dried at 60°C in an oven for 48 hours and measured the weight on the balance (accuracy 0.001 g).

3. "A-P is never defined in the manuscript. Correction factors for microbial biomass C and N are commonly employed, but are highly specific to soil mineralogy/sorption. Direct testing of recovery efficiency at a particular site should be assessed before a correction factor is applied."

Sorry for this missed information (A-P definition), which has been supplied in the methods section. Total phosphorus (TP) consists of phosphorus mineral and organic phosphorous compound in the soil which can be converted into the dissolved orthophosphate. Available phosphorous is the fragments in soil can be absorbed by plants, which consist of water solvable phosphorus, some adsorbed phosphorus, and organic phosphorus, even including precipitated phosphorus in certain soil types. Chemically, A-P is defined that phosphorus and phosphate in soil solution can be isotope exchanged with ^{32}P or can be easily extracted by some chemical reagents.

We agree with your professional point that correction factors for microbial biomass C and N are highly specific at different soil sampling sites or soil types. This issue has been discussed with the lab staff in our institution, who also referred the same opinion about methodology of MBC and MBN given it was processed by general international method and relevant correction factor. However, as referee also mentioned this paper is not specially focused on the microorganism scope, this flaw will not make a decisive change to the results and conclusions for the same soil type and also fully mixed through sieve before litter addition. Surely, we will pay more attention to site-specific correction factors in the future's research. Thanks for your helpful suggestions.

4. Line 357: clarify which species were used to compare decomposition rates between flower and mixed litters.
Yes, we have clarified. *R. przewalskii* and *M. integrifolia* are two typical plant species widely distributed and easily collected. Both species were assessed to compare their decomposition rates of flower litter and mixed leave litter.
5. Line 397: lignin/N and C/N ratios are commonly accepted as good indicators of decomposition rates under short time frames, but there is little evidence lignin is preferentially preserved in soils, compared with bulk soil, over long-time periods (Cotrufo et al., 2015, Mikutta et al., 2005, Kleber et al., 2007).

Yes, yes, quite agree with you. This point was hard for us to make it to be fully acceptable in the first draft. Now it is easier after your kind favor. We have revised previous statement, started from Line 395, as follows, "Generally, tissues with high lignin, polyphenol, and wax contents and higher lignin/N and C/N ratios exhibit

slow decomposition. lignin/N and C/N ratios are commonly accepted as good indicators of decomposition rates under short time frames, but there is little conclusive evidence that lignin is preferentially preserved in soils, compared with bulk soil, over long-time periods (Melillo et al., 1982; Mikutta et al., 2005; Kleber et al., 2007; Cotrufo et al., 2015). Moreover, lignin plays dual role in plant litter decomposition if taken photochemical mineralization these abiotic decomposition into account (Austin and Ballaré, 2010)". According to the literature from Austin and Ballaré (PNAS, 2010), it was said that biotic decomposition in mesic ecosystems is generally negatively correlated with the concentration of lignin, which is a typically recalcitrant material that is resistant to microbial decomposition. However, for its dual role in plant litter decomposition, lignin is quite complicated if we take photochemical mineralization of carbon into account.

Please kindly see reference: Austin, A.T. and Ballaré, C.L., 2010. Dual role of lignin in plant litter decomposition in terrestrial ecosystems. *Proceedings of the National Academy of Sciences*, 107(10): 4618-4622.

6. Line 467: microbial community composition was not directly tested (no sequencing/PLFA analysis etc) so it cannot be concluded that flowering litter increases nutrient status and therefore changes microbial assembly. There is support that MBC and MBN pools increase, but that could be due to faster turnover or growth, not necessarily to a change in species composition.

Yes, we revised this not quite convincing deduction since there was no direct evidence. We have another study this year, which is also in the process to compare the microbial community composition (sequencing) in soil after flower litter addition (two dominate shrubs- *Rhododendron capitatum* and *Rhododendron przewalskii*), which has been conducted both in the field and in the incubator. We sincerely wish that referee #2 can review the draft once our paper submitted at the end of this year, if our *Biogeoscience's* rule allows.

Started from Line 465 that "Flower litter contains more than twice MBC (increased from 46.25 to 102.05), and both MBC and MBN pools increased potentially after flower litter addition. Therefore, microbial functional groups might be changed for nutrient supplement from litters, or could also be due to their faster turnover or growth, which need more evidences in the further study by directly testing of soil microbial community composition.

7. Line 499: the impact of this paper is significant and should be re-stated clearly in the conclusion.

Thanks for your compliment. We have re-stated the significance of this paper.

C. Comments regarding tables

Make sure to clearly define variables tested in each caption.

Table 1: it is not clear how species dominance is assessed (Y/N).

We have added in the method part about how to assess dominance of species for both shrub and herbaceous species in the study sites. "Target species were firstly decided by visual observation. For herbaceous species, their dominances were determined using quadrat methods. Each quadrat (1 m × 1 m) was spaced at least 2 m apart from each other along the transect for recording community composition (totaling 10 quadrats along one transect, and three transects at each site). Weighted means of frequency and biomass of target species were sorted and used to assess their dominances. For shrubs, line-point intercept method was conducted to calculate targeted species' frequency, height, and cover, which represented by "hit" (3 transects at each site, use 20 m rope with ca. 1 cm diameter or measuring tape), whose weighted means of were sorted to determine dominant species (Herrick et al., 2005). We also consulted expert who already has prior knowledge or researches about the dominant species at the selected sites."

Reference: Herrick, J.E., Van Zee, J.W., Havstad, K.M., Burkett, L.M. and Whitford, W.G., 2005. Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick Start. Volume II: Design, supplementary methods and interpretation. USDA-ARS Jornada Experimental Range.

Line 303, 324, 329 etc.: the authors are assessing N pools, not fragments.

Thanks for this precise comment. We think this is similar with comment from Referee #1. So, we combined Fig. 4 and Fig. 5 together with DIN and DON deleted. Besides, the relevant content has been revised regarding the modified figures, in particular, focused more on N pools.

Table 3: DNN/DHN are not necessary; although defined as such in the text, NO₃⁻ and NH₄⁺ are clearer.

Yes, revised and just used NO₃⁻ and NH₄⁺.

Table 4/5: Define TP and A-P: α values of total phosphorus (TP) and A-P

Ok, TP and A-P are total phosphorus and available phosphorus, respectively. α values indicate natural logarithm of ratio flower litter addition to non-addition control of different soil indexes (TN, NO₃⁻-N, NH₄⁺-N, TP, A-P).

Table 6: Mean values (not comparison medium values)

Sorry for this mistake. We have corrected.

D. Comments regarding figures:

Figure 1: It is very difficult to identify where the sampling sites are on the map because the elevation shading is so dark (either increase shading transparency or make text and symbols larger)

Yes, map has been re-drawn with clearer text and symbols. If need better one, we will do.

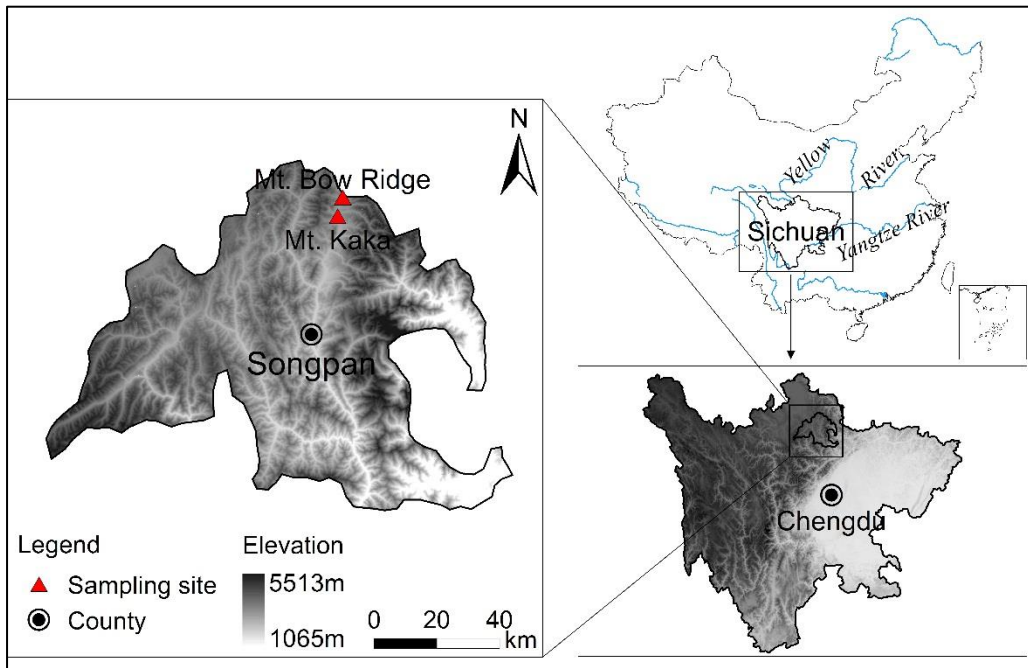
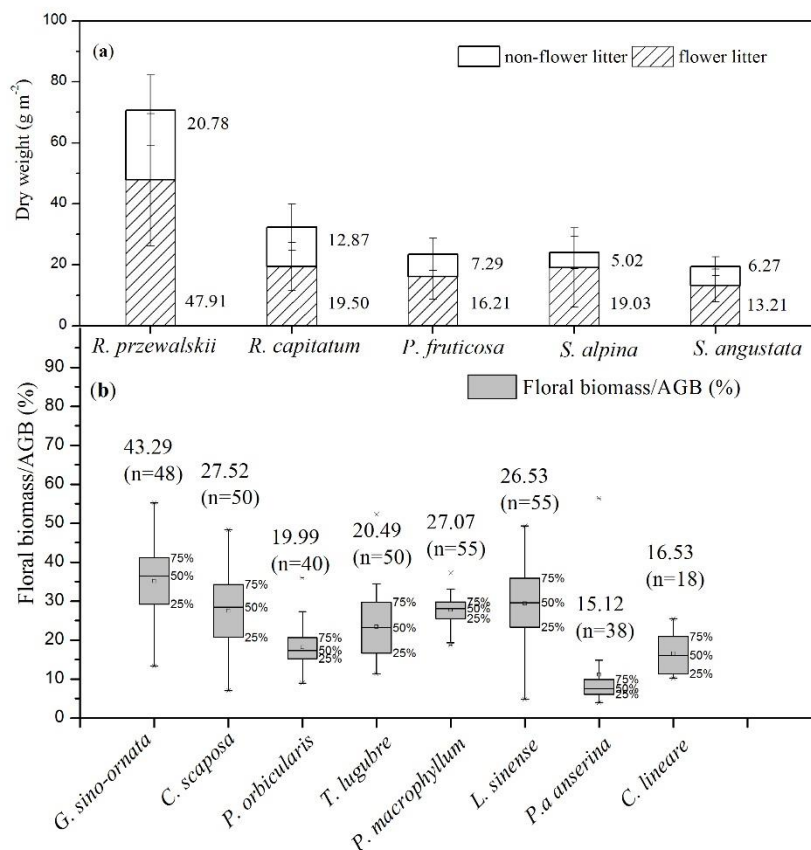


Figure 2: Include the mean ($n=X$).

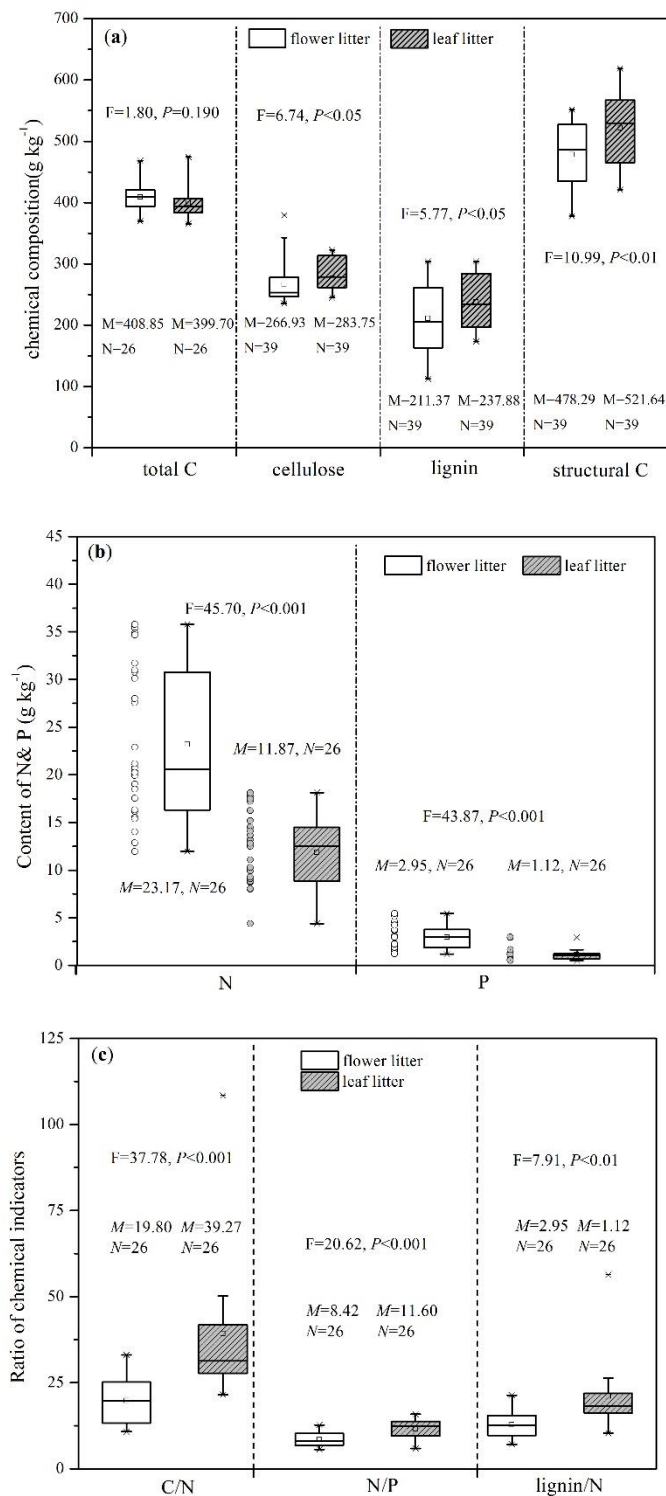


We have added the mean ($n=X$) for all the plots and with n value in (b). In (a), the values of sample number are the same ($n=20$) and we just mentioned in the figure caption.

Figure 3: Explicitly state the statistical analysis used (are the bars 95% confidence intervals/SE, or quantiles)?

If the whiskers represent SE it seems impossible that the flower litter vs. leaf litter means are significantly different from each other. What are the values (mean, n=X)?

Ok, we have supplied details of statistical analysis in methods part. In figure 3, box-plots are used to better present the range of data distribution. Bars/whiskers refer to quantiles for comparable settings of all data distribution except extreme outliers (asterisk *). The values (mean, n=X) are also stated by One-way ANOVA.



Figures 4 & 5: Define the variables in the figure caption (dissolved inorganic nitrogen (DIN), dissolved organic nitrogen (DON), etc). mean, n=X. What do the boxes represent? What does deviation from the 0 lines signify (significantly different at what level)?

Sorry for this unclear display. In fact, they are scatters while not boxes. However, we have to draw them a little bit bigger for the relative smaller error bar, otherwise, both will be overlapped and not well presented. These boxes (scatters) represent α mean values of different indexes in soil N and P pools after flower litter addition (n=3). It is significantly different at $P=0.05$ level for deviation from the 0 lines. The variables in the figure caption have been defined regarding revised figure and relevant context.

Figure 6: letters indicate significant differences (at what level, $p=0.05$)?

Different lowercase letters indicate significant differences of decomposition rate between litter materials at $P=0.05$ level.

E. Comments regarding cited literature

“Overall, the authors seem well read on these topics. There are some citations that do not seem relevant to the paper the way it is currently written (for example, findings from tropical, agricultural, and Arctic sites). I think these findings are important because they show flowering litter quality influences soil nutrient status across ecotones, but this needs to be made explicitly clear. The authors also touch on soil organic matter formation/stabilization processes. There is a highly relevant body of literature that could be incorporated to strengthen these points (Kogel-Knaber, Sollins, Cotrfo, Kleber, etc).”

Yes, after restructured introduction part, we read carefully about the relevant literatures recommended by referee and also incorporated properly.

F. The last comment about language

“I would highly suggest a thorough language editing review is taken before the paper is published.”

Thanks, it has been done regarding the suggestion.

Many thanks for your time!

Jinniu Wang on behalf of all co-authors