

June 18th, 2016

Editor-in-Chief

*Biogeosciences*

Dear Editor,

Attached please find the revised manuscript, entitled ‘*Variations of leaf N, P concentrations in shrubland biomes across Northern China: phylogeny, climate and soil*’ (bg-2015-414). We appreciate very much this opportunity and the comments from the referees.

We carefully considered the follow-up comment from the referees and made corresponding changes to the manuscript (Please see below for our point-to-point response).

We thank the referees again for their constructive comment that significantly improved the manuscript. We hope you will find the revision to be satisfactory, but we will be happy to make any additional changes that you think are necessary.

I look forward to your replying in due time.

Best regards

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## **Response to referee's comments:**

### **Referee: 1**

#### **General comments:**

*The authors have responded to and made some changes in response to some of my queries from my previous review. I understand that the authors' dataset did not include other traits I thought would improve the analyses, and it seems as though the final part of the conclusion was included to allude to that fact (although mentioning those limitations in the conclusion does not seem to be an appropriate place to do so). My concern about the differing habitats potentially affecting the results was addressed by some further analyses, presented in the supplementary information.*

*In brief, I believe the manuscript presents an interesting dataset and after a thorough revision (mainly to improve readability) it should be suitable for publication. The main area requiring particular attention is the Discussion, which at the moment sometimes repeats results more than is necessary and contains some tenuous explanations, especially when trying to link soil N to the results of the analyses. For this latter point, I believe that keeping in mind the high lability of soil N (and hence the problematic nature of linking a single measurement of soil N to any other attribute) would lead to a more consistent reasoning.*

**Response:** Thank you for your comments.

#### **Specific Comments:**

*A few comments relating to several parts (or all) of the manuscript:*

*When referring to concentrations (or ratios), in general, the word should be used in the plural (because you are referring to the collective concentrations, or ratios, of many species), not singular. This occurs in many places.*

*In the Discussion, there are often unnecessary references to figures and tables, previously referred to in the results section.*

*Make the spacing consistent in all bracketed text: I suggest one space either side of =, < etc.*

*It better to present descriptive statistics with either standard errors or confidence intervals, rather than standard deviations. I assume "std" means standard deviation, which by itself has limited utility as you also need the number of observations to make inferences from it. I would suggest to use 95% confidence intervals throughout.*

**Response:** Thank you for the suggestions. Changes have been made accordingly.

*The precision to which numbers are presented needs to be appropriate (often there are inappropriately many significant figures). There are many examples, but see Table 1 for many such instances.*

**Response:** Based on the nature of our data, we presented two decimal places in Table 1 and Table S1, and one decimal place in Table 2, S2, and S3. We have double-checked to ensure consistency throughout the manuscript.

*Comments and suggestions at specific lines, many of which relate to grammar:*

*p. 2, l. 17: A final conclusion sentence would go well here, i.e. what it all means, what is the significance of the result.*

**Response:** Revised. **Page 2, Line 18-20** for detail.

*p. 2, l. 20-23: This sentence needs toning down. I'm yet to see any evidence to suggest that stoichiometry is the "most important single step" towards understanding. Westoby and Wright (2006) do not make such a claim.*

**Response:** Revised. **Page 2, Line 24** for detail.

*p. 5, l. 9: As written, Hypotheses 3 contradicts itself: "leaf N concentration is less phylogenetically conserved... leaf N concentration tends to be more genetically constrained". This needs rewording.*

**Response:** Thank you for mentioning up the mistake. We have revised it in the manuscript as "we hypothesize that leaf N concentration is **more** phylogenetically conserved than leaf P concentration". **Page 5, Line 11-12** for detail.

*p. 6, l. 12: What was the ratio of soil:water?*

**Response:** Revised. **Page 6, Line 15** for detail.

*p. 8, l. 27: "shuffling the tips for 999 times" – more explanation needed here.*

**Response:** Revised. **Page 8, Line 26-27** for detail.

*p. 9, l. 10: The heading needs changing: overall patterns are described first. Then you have a section on climate. I suggest adding in subheadings for each appropriate result, e.g. one (only) for the effect of climate*

*p. 9, l. 23: Part of this paragraph restates some of the results given in the preceding paragraph. In line with an earlier comment about headings, it may be better to segregate these results into soil-based results and climate-based results (giving two subsections)*

**Response:** In section 3.1, we didn't have a separate part for climate or restate the results twice. The first paragraph described the overall patterns of leaf N and P concentrations and N:P ratios at individual level (Table 1; Figure 2; 3; S2). The second and third paragraph described the patterns at community level, corresponding to the GLM analyses (Table 2; Figure 4). We reported the results of total variation in the second paragraph and the results of interspecific and intraspecific variations in the third paragraph. We recognized that the logic of these paragraphs was not clear enough. In the revised manuscript, we have revised this section to make it clearer.

**Page 9 Line 10 - Page 10 Line 13** for detail.

*p. 9, l. 11: It's slightly ambiguous the way this is phrased: it would be better to start with leaf N and then leaf P, i.e. "Leaf N....and leaf P...". "Northern China" is not needed here. Also, here you mean "ranged" rather than "changed" – this occurs later on too. As a whole, I think this paragraph would be easier to interpret if the changes (increases or decreases) were stated after the concentration ranges, e.g., Leaf N concentration ranged from...increased with soil pH, decreases with STN... That is, each element/ratio would be contained in the one section.*

**Response:** Revised. **Page , Line 10-16** for detail.

*p. 12, l. 16: You would need analyses to back up that statement (about effects of temp and precipitation being confounded).*

**Response:** We removed that statement.

*p. 12, l. 18: The grammatical structure of the last sentence and a half needs revision.*

**Response:** Revised. **Page 12, Line 15-16** for detail.

*p. 12, l. 21: The whole reasoning and argument outlined in this paragraph is long-winded and not convincing. It needs a revision and shortening. The study presents some evidence for P limitation (although an N:P ratio of 18.7 is not especially high), but a literature search will reveal many studies showing leaf P correlated to increasing soil P. As for leaf N, I would suggest that, in contrast to soil P, soil N is highly labile, so sampling soil N at one point in time might not be sufficient to link it to leaf N (i.e. an integration of repeated measures over an extended period of time would be necessary to detect such patterns).*

**Response:** We have revised and shortened this paragraph. However, we don't have evidence to support that soil N is more labile compared with soil P. So testing this hypothesis is excluded in our revised manuscript. **Page 13, Line 3-23** for detail.

*p. 14, l. 13: The statement about leaf N concentrations needs changing - there are undoubtedly many other factors at play, as the low R2 numbers from your study would indicate.*

**Response:** Revised. **Page 14, Line 8-9** for detail.

*p. 14, l. 22: Do you have better references for changes in species composition in the sites covered by this study? The He et al. (2008) reference does not cover the same area.*

**Response:** He et al.'s (2008) study regions is the Inner Mongolia Plateau, the Tibetan Plateau, and the Xinjiang mountain areas, which greatly overlapped with of our study region. Our study is the first one that focused on the influences of species composition and environmental factors on leaf chemical traits of shrubland in northern China. Since no other study could provide an exact match with our study region, no additional literature was cited.

p. 15, l. 3-6: The sentence structure need reviewing and changing.

**Response:** Revised. **Page 14 Line 23-25** for detail.

p. 15, l. 23-24: “concentrations were mainly influenced by different factors” is vague.

**Response:** Removed.

p. 14, l. 11: As you don't present results detailing the shift in community composition you can only speculate (rather than stating) that the climate influences leaf nutrient concentrations in the community by shifts in composition.

p. 14, l. 24: Replace “mainly” with “presumably [or likely]”

p. 16, l. 2: Insert “are likely” before “due”

**Response:** We followed Lepš et al. (2011) to assess the relative contributions of intra- and interspecific variability effects on community level leaf N, P concentrations and N:P ratios. According to their method, using “fixed” trait values (**e.q. 2 Page 7, Line 7**) neglects completely the extent of intraspecific trait variability across habitats, and the variation of trait averages across environments using only “fixed” trait values is therefore affected solely by changes in species composition. Therefore, although we did not analyze the composition of communities, we can state that the climate influences leaf nutrient concentrations in the community by shifts in composition because climatic factors significantly influenced the “fixed” trait values.

p. 15, l. 16: There's no good evidence for that statement, as phrased. It is true that most plants are AM, but plants can also take up P by themselves, even with AM present; proportions of the contributions to nutrition can, and do, vary.

p. 15, l. 17: Replace “of” with “by”.

p. 15, l. 18: The final statement needs revision - Jacobson (1997) doesn't support that - and I know of no comprehensive review that does either.

**Response:** We removed the statements about AM fungi.

p. 29, Figure 4: Please explain in the text or caption how the total variation explained can be less than one component of the total variation (part a). As it stands, this does not make sense. In line 3 replace “parts of the columns” with “shading”.

**Response:** Total variation is not the sum of intra and inter variations because there is covariance between intra and inter variations ( $SS_{covariance}$  in **eq.4 Page 7, Line 20**). In Figure 4, the space between the top of the column and the bar corresponds to the effect of covariation. We have provided more information in the figure legend (Figure 4; S3). **Page 28, Line 4-6** for detail.

p. 2, l. 2: “are the key traits” is far too broad a statement; I suggest “are two key...”

p. 2, l. 5: insert “a” after leaving

p. 2, l. 8: replace “expanding” with “encompassing”

p. 2, l. 13: change “climates” to “climate”

p. 2, l. 14: change “nutrient” to “nutrients”

p. 2, l. 2: replace "explained more intraspecific one,." with "explained most of the intraspecific variation."

p. 3, l. 1: delete "the" before energy

p. 3, l. 22: replace "rate" with "rates"

p. 4, l. 1-2: I think the colour highlight (in the manuscript) refers to a strange sentence construction -

I agree. This part of the sentence needs revision or deleting.

p. 4, l. 3: replace "difference" with "differences"

p. 4, l. 10: "prior to others" - I'm not sure what you mean. This needs changing.

p. 4, l. 13: "simultaneous" is not needed here

p. 4, l. 22: "Shrubland is the climax vegetation adapted to the drought" needs modification. Stated this way implies that "drought" is permanent, in which case it would not be "drought" but simply a dry or arid climate. Perhaps you meant "arid climate", or some such?

p. 4, l. 24: replace "on" with "of"

p. 4, l. 25: insert "the patterns" before "in"

p. 5, l. 1-14: These need to be in the past tense, as they were introduced as such in the preceding sentence.

p. 5, l. 2-4: I had to reread this to understand what you meant. Insert "increasing" before precipitation.

p. 5, l. 12-14: Better to restructure the sentence in the form of "We hypothesized that...should be less likely...and hence are more adapted to..."

p. 5, l. 22: better to use an x symbol instead of \*

p. 5, l. 24-25: The grammar of the sentence needs addressing. I suggest something like: "the dominant life form... was "shrub"..."

p. 6, l. 3: replace "the depth" with "a depth". Replace "meter" with "m"

p. 6, l. 5: delete "the" from "the depths". The latter half of this sentence could be combined (via a ;) with the next sentence.

p. 6, l. 12, 14: Insert "the" before "0-10"

p. 6, l. 20: delete "for"

p. 6, l. 21: replace "property" with "properties".

p. 6, l. 22: replace "N concentrations and" with "N and P concentrations, and leaf"

p. 6, l. 24-25: The latter part of the sentence is not really necessary.

p. 7, l. 12: replace "attribute" with "attributed".

p. 7, l. 24: replace , with ;

p. 7, l. 25: delete "the"

p. 8, l. 3: replace "compare" with "compared". No hyphen necessary in the first "main-effects"

p. 8, l. 6: replace "scale" with "scales".

p. 8, l. 20, 24: replace "conducted" with "calculated the".

p. 8, l. 24: delete "the".

p. 9, l. 1: insert "the" before "K"

p. 9, l. 5: replace "signal" with "signals".

p. 9, l. 6: replace "of mean" with "for mean".

p. 10, l. 9: rephrase "temperate shrubland and desert shrubland" to "temperate and desert shrublands"

p. 10, l. 10: delete "the"

p. 10, l. 11: insert a comma before "separately". Replace "The temperate shrubland" with "Temperate shrublands".

p. 10, l. 12: replace "with" with "to". Replace "shrubland" with "shrublands".

p. 10, l. 14: replace "shift" with "shifts".

p. 10, l. 18: insert "a" before "significant"

p. 10, l. 24: delete "the"

p. 11, l. 1: This paragraph needs to be consistently in the past tense when referring to your results.

p. 11, l. 1: delete "also"

p. 11, l. 6-10: the sentence needs revision: I suggest "runs from life strategies characterized..., to life strategies characterized by..."

p. 11, l. 6-10: replace "distinct" with "differences in"

p. 11, l. 19: "dessert" with "desert". This occurs elsewhere.

p. 11, l. 22: replace "rate" with "rates"

p. 11, l. 25: insert "resulting in succulent plants having leaf" after "therefore"

p. 12, l. 1: Dust transport can also provide a very significant component of soil P, particularly if the soils are poor in P. Replace "increase" with "increases"

p. 12, l. 2: delete "the" before P. Replace "litters" with "litter". It would be better to have a reference for this statement. Replace "region" with "regions".

p. 12, l. 3: Final section of the sentence is not necessary and doesn't follow from the decomposition point.

p. 12, l. 3-5: I would suggest removing the superfluous parts of this sentence and simply stating (after a ;) that 301 of the study sites had an aridity index of < 1.

p. 12, l. 4: You didn't use "AI" again, so remove the acronym.

p. 12, l. 7: Replace "shrubland" with "shrublands".

p. 12, l. 8: insert "a" before hypothesis

p. 12, l. 11: Replace "rate" with "rates". Replace "inconsistent" with "in contrast to".

p. 12, l. 13: Replace "Most" with "Many"

p. 12, l. 17: Replace "allow" with "allowed"

p. 14, l. 1: Replace "on" with "at the"

p. 14, l. 4: insert "explained by" after "than that". The final part of the sentence is a somewhat redundant.

p. 14, l. 8: insert "these" after "but".

p. 14, l. 9: delete "the"

p. 14, l. 14-16: These final two sentences don't make a lot of sense when taken with the previous sentence.

p. 14, l. 24: Replace "gradient" with "gradients".

p. 15, l. 14: Replace "nutrient" with "nutrients".

p. 15, l. 15: Replace "uptaking" with "uptake".

p. 15, l. 21-27: Use the past tense for the results summarised in this paragraph.

p. 16, l. 1: Replace “utilize” with “to acquire”.

p. 16, l. 4-9: These highlighted final sentences are somewhat out of place in the conclusion: such limiting factors would be better placed in another part of the discussion.

p. 24, Table 1: See comments about significant figures and confidence intervals. Also check all superscripts (e.g. mg g-1)

p. 25, Table 2: It would be far better to label each section with N, P and N:P, rather than a), b) and c).

This applies to other tables as well (in the supplement).

p. 27, Figure 2: This legend seems to obscure some data. Replace “logarithm transferred” with “logtransformed”.

These comments also apply to Figure 3.

#### Supplement

p. 1 l. 22: By significant do you mean  $p < 0.05$  or  $p < 0.001$ ? This will need updating in the main manuscript as well.

p. 6 l. 2: “soil intervals” – do you mean depth intervals? (units are required).

Table S2 and S3 – see comments about Table 2.

p. 6 l. 2: Replace “shrbland” with “shrubland”

**Response:** Thank you for your corrections. We have revised accordingly.

**Referee: 2**

**General comments:**

*In this new version of the manuscript (bg-2015-414), authors have answered all my previous comments in a very satisfying way. I greatly appreciate the efforts the authors made to better include soil pH in their analyses. I only have a few additional minor comments. Thus, I strongly support a future publication of the manuscript in BGS.*

**Response:** Thank you for the comments.

**Specific Comments:**

*Here are my minor concerns:*

*- L9p5 In the following sentence, ‘3. Finally, we hypothesize that leaf N concentration is less phylogenetically conserved than leaf P concentration.’ Following the points of authors, I would rather say that LNC would be more phylogenetically conserved, wouldn’t do?*

**Response:** Thank you for mentioning up the mistake. We have revised it in the manuscript as “we hypothesized that leaf N concentration is **more** phylogenetically conserved than leaf P concentration”. **Page 5, Line 11-12** for detail.

*- L6-7p13 However, leaf N concentration did not increase with soil N concentration, since N is not limited in soil.*

*I would suggest a less affirmative sentence as N limitation has not been properly tested here*

**Response:** Revised. **Page 13, Line 12-14** for detail.

*- Figure 4: I still don’t understand why total variation is not the sum of intra + inter or why the bar that is the total variation is either below or above the sum of intra + inter? Please give more details for the interpretation of the figure.*

**Response:** Total variation is not the sum of intra and inter variations because there is covariance between intra and inter variations ( $SS_{covariance}$  in **eq.4 Page 7, Line 20**). In Figure 4, the space between the top of the column and the bar corresponds to the effect of covariation. We have provided more information in the figure legend (Figure 4; S3). **Page 28, Line 4-6** for detail.

*- L19p11 Please correct ‘dessert’ by ‘desert’. Please check the word throughout the manuscript.*

*- L15p14 Please correct ‘shrbland’ by ‘shrubland’*

**Response:** Thank you for your corrections. We have corrected accordingly and checked the word throughout the manuscript.