Biogeosciences Discussions

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Comment on bg-2021-298

Anonymous Referee #1

Referee comment on "Geodiversity influences limnological conditions and freshwater ostracode species distributions across broad spatial scales in the northern Neotropics" by Laura Macario-González et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-298-RC1, 2021

Review of "Geodiversity primarily shapes large-scale limnology and aquatic species distribution in the northern Neotropics" by Macario-González et al.

Summary: In this study 76 aquatic ecosystems from Mexico to Nicaragua were used to investigate drivers of ostracod species diversity and composition. Macario-González et al. classified sites via cluster analysis to limnological regions based on 23 geological, limnological, sedimentological and mineralogical variables. Principal Component Analysis identified water chemistry and sediment composition as important parameters for classification. NMDS revealed 5 species associations which are related to limnological regions. Structural equation modelling (SEM) revealed that geodiversity, characterized by carbonate and TOC content in the sediment, influences ostracod species diversity by changing water chemistry (conductivity and HCO3).

General comments: The **work's strength** is its holistic approach to study species diversity and composition. The comprehensive data set includes parameters describing the type of bedrock, sediments of water bodies, water chemistry, physical properties and occurrences of ostracods. A further asset of the study is the large spatial scale and the fascinatingly diverse landscape of the study area. The methods used in this study appear to be appropriate for the objectives of the study and also the results are to a large extent thoroughly discussed.

However, there are two major **shortcomings** which need to be addressed before the paper is ready for publication:

- Parts of the manuscript are difficult to understand mainly because its language is often not precise enough, the sentence structure is confusing and the grammar is erroneous. Understandability could be improved by reducing different terms for the same purpose, examples are non-biotic/environment, principle component/dimension, elevation/altitude, orography/topography, limnological (sub)regions/limnological (sub)groups, aquatic systems/aquatic ecosystems/aquatic environments/lakes, etc. Some examples of confusing sentence structures and grammatical errors are given in the specific comment section; however, many more issues will remain unlisted and should be edited by the authors, potentially with the help of a native speaker or proofreading service.
- The next issue is partly a consequence of the previous issue but not solely: The way how the SEM was set up and how the authors derived their final model is diffuse and not well explained. The parameters which are used to describe geodiversity and limnology, the choice of exogenous and endogenous variables as well as some relationships described by the SEM are not intuitive. For example, (i) in model 2 (Sect S1 in the Supplement), geodiversity (latent variable) is described only by elevation and latitude (observed variables), despite available parameters about the type of bedrock and the mineral composition of lake sediments; (ii) the usage of altitude as endogenous variable (i.e. variables that are dependent in at least one equation), (iii) certain paths in the SEM such as the effect of geodiversity on altitude, the effect of limnology on conductivity, although conductivity was used as parameter describing limnology throughout the manuscript, the effect of conductivity on species diversity but not on species associations and the effect of altitude on species associations but not on diversity (see Fig. 6, further obscurities are addressed in the specific comment section).

To improve SEM sections in the manuscript, it needs (i) a more consistent usage of terms normally used in the context of SEM (i.e. exogenous, endogenous, latent, observed variables), (ii) a rework of Fig. 6 which should include observed variables describing latent variables (geodiversity and limnology), (iii) a construction of paths in the SEM based on clearly stated hypothesis and (iv) a more straightforward selection of observed variables to describe latent variables (limnology, geodiversity). The latter could be achieved for example by using environmental variables which were forward selected in the CCA, which was used to examine effects of environment on species composition.

Specific comments

Abstract

32: What exactly do you mean with the term “biological composition”? In Fig 6 you use the terms species diversity and species associations. According to Fig 6., the effect of limnology on species associations is not significant, the direct effect of elevation (in Fig 6 called altitude) on species diversity is not tested.

33: From which result do you derive that geodiversity is the most important driver? Geodiversity is a fundamental driver because it shapes limnology. Hence, I consider geodiversity on a different hierarchical level and difficult to compare to limnology (exogenous vs endogenous variable).

Introduction

45 is difficult to understand: What do you mean with “biodiversity is dynamic” and “faster rates”; faster than what?

61: it is unclear what you mean with “biological structure”

71: Confusing sentence structure

80: Although the study is very comprehensive, it would greatly benefit from an additional layer consisting of data about land use/human activity

88: Confusing sentence structure

94: ostracods are a well-suited group

94: The study is not investigating traits.

94: singular: ostracod, plural: ostracods. Rephrased sentence: Ostracods are bivalved microcrustaceans which are abundant, diverse and widely distributed in recent environments.

103: You are also looking at effects on species diversity.

In general, terms like diversity, composition, assemblages, associations, species distribution, biological structure, are not well defined and often used synonymously. To avoid confusion, please stick to the same expression throughout the manuscript if the purpose is the same.

Material and Methods

156: Here you use "non-biological" and in other parts "environmental", I suggest to stick to either "environmental" or "abiotic" throughout the entire manuscript, also in figures.

186: How did you handle missing data?

200: The maps do either not represent the measured data or it is not visible. Please add the measured data. Also, a reference to the figure is missing.

218: Clarify how you distinguished species groups. Was it manually done by visually examining the graph?

221: Here you use "relating non-biological variables" and later in the paragraph "environmental variables", take care of consistency.

221: Besides geological effects, you also assessed limnological effects (temperature, conductivity, etc.)

231: What do you mean with "related environmental variables"?

231: You also assessed the influence of geodiversity on species diversity not only on the composition (in Fig 6 called "species association").

235: It is not clear that you use elevation gradients, latitude and bedrock as observed variables to explain geodiversity (latent variable). The same applies for limnology and its observed variables.

236: It is not clear if geodiversity is assumed as indirect, direct or both, the same for

limnology

237: It is not clear, how you take vulcanism, precipitation and marine-freshwater interactions into account and where the major anion and cations belong to in the SEM.

Results

Results are normally written in simple past tense

253: Here and in Table 1 the term "(sub)groups" is used, in the text mainly "sub(regions)". In general, I think the terms "limnological classification" and "limnological regions" are confusing as you also use the term "limnology" as hypernym for water chemicals and physical properties of the aquatic ecosystems. The "limnological classification", however, is based next to limnological variables also on geological, sedimentological and mineralogical variables.

Fig 2 (c): It is difficult to track dots to site abbreviations. Also, site 65 appears two times once with the site abbreviation CHI and once with CH1

271: Are the "thirteen variables" those which were selected based on "superimposed arrows"? Please clarify

Fig 3 and 4 (b-d): Could you show sites with colours according to the observed values to see how well they fit into the predicted surface. Write the variables which are mapped in the graphs also in the legend or put them as title.

300: You write about "sedimentology and geology" as important variables. However, there are no variables called like this. In order to make that point clear, I think it would help, if parameters in Fig 3 (a) and Fig 4 (a) are coloured according to their type (i.e. limnology, sedimentology, geology, mineralogy). This would also help to not confound carbonate measurements derived from the water with measurements derived from the sediment.

358: "supporting NMDS ordination" or supporting group selection?

361: Are you deriving the tolerance to high conductivity from the literature or from your CCA? If the latter is true, you should refer to Fig. S3.

397: In S1 you mention five models instead of six.

Also, in S1 you write "… we assume that **elevation gradients**, **bedrock** and **latitude** were primary factors determining biological composition in aquatic systems. These three factors were then used as exogenous variables…" Here you state that initially **geodiversity**, **limnology** and **elevation** were your three exogenous variables. It is not clear which variables describe geodiversity and limnology.

408: Why do you test the influence of species associations on diversity? What is the hypothesis?

408: Why "indirect" when there is a "direct" link from limnology to species associations?

Fig. 6: instead adding "environmental variables" to limnology, add observed variables which describe limnology, the same applies for geodiversity. Why are you not looking at the direct effect of limnology on species diversity?

S1

In general, it is a good idea to provide details about all SEMs, however, the text in S1 often explains the same as the main text, but in a different way, which adds to the confusion.

Paragraph 3: "Geodiversity was constructed only with elevation and latitude as predictors, whereas limnology only with conductivity. The selection of these variables resulted from the fact that elevation was directly related with water temperature in lakes and latitude with presence of carbonates given reduction in precipitation and increase evaporation" I don't understand why elevation and latitude were used as observed variables for geodiversity. First of all, if elevation was related to water temperature and latitude to the presence of carbonates, why not take water temperature and carbonates as observed variables, instead of related variables. But secondly, water temperature was always part of the variables describing limnology and not geodiversity.

Paragraph 4: Model 4 "was constructed on the basis of the model 2 and 3 with respect of predictors of geodiversity and limnology". It is not clear, which observed variables are actually used for geodiversity and limnology.

Discussion

419: What do you mean with “Geology and associated variables”?

493: Your results show a different picture, see line 277: "pH was highly correlated (>0.73) with the second component (PC2), suggesting that it is the second most influential variable of the YG aquatic environments (Fig. 3a, Table S2.1)"

Chapter 4.1. is well written

511: I suggest to state this more carefully as you are only looking at a handful of lakes without applying any statistical analysis to test this pattern.

539: The obvious spatial pattern of species composition may also be a hint to dispersal-related processes which are not at all touched in this study. A potential statistical way to incorporate spatiality in this study would be to include space as exogenous latent variable in the SEM with latitude and longitude as observed variables. The possibility of dispersal limitations acting as additional driver structuring ostracod communities should at least be discussed.

546: What is the indirect effect of limnology on species composition? In Fig 6. I see a direct effect of limnology on species associations (I guess this is meant with species composition), and a questionable (see other comments) indirect effect via conductivity on species diversity.

556: “elevation” is not used as a variable in the CCA

575: “as evolutionary trait”?

Technical comments

20: driver of ecosystem characteristics and biodiversity

34: influence of geodiversity on the limnological structure

60: the relationship between

82 final disposal sites of

84: therefore suitable (no comma)

85: on the current configuration of the regional species pool

86: The influence … landscape attributes

87: assumption that species adapt to

112: Species representatives of North and South America converge in this region

271: For the YG region

277: "PC2" as abbreviation for the "second component" is already introduced, same applies for line 291

Fig 3 and 4: Try to improve the quality of plots, especially of the biplot.

281: "13" not "12 variables"

Results 3.2 and 3.3 could be shortened or partly transferred to the supplementary

material

348: 74 out of 76 aquatic systems (and more examples in this paragraph)

411: rounded to 68%

448: whereas other lakes were

S1: output table of model 5 is displaced

Fig S2: instead of d) it should be B)