

Biogeosciences Discuss., referee comment RC1
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Comment on bg-2021-107

Anonymous Referee #1

Referee comment on "Geodiversity and biodiversity on a volcanic island: the role of scattered phonolites for plant diversity and performance" by David Kienle et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-107-RC1>, 2021

The authors present an experimental study conducted on the island of La Palma, where they studied the effect of different substrates in the form of phonolitic and basaltic rocks on plant performance and species abundance. I think the study is relevant, the experiment well set-up and the conclusions interesting. I do have suggestions to potentially improve the paper, particularly regarding the framing and discussion of the results presented in the paper.

The first point of attention is that the overall conclusion of the paper, formulated as 'Phonolites host distinct vegetation compared to equivalent areas of neighbouring basaltic rocks', is not supported by the data, in particular the Detrended Correspondence Analyses presented in Figure A3, which shows 'no clear difference between phonolite and basaltic rock vegetations'. I think the conclusions of the paper should be reformulated to better reflect the results of the study.

A second point of attention is the lack of detail provided in the differences in the petrographic and geochemical differences of the phonolites and basaltic substrates. I think that in particular, the availability of nutrients in these two substrates should be reported, as this information is key to the interpretation of the results discussed in 3) (L.243-253). It would be preferable to conduct and report measurements of the nutrient contents in the plots, but if not possible, I would at least expect a more detailed description of the chemical differences in nutrient availability reported in literature. Given the results of this study and its potential to reach a more biologically minded audience, I also think it is worth elaborating how phonolites differ from the basaltic substrates in their chemical composition (in L.74 for example), which is mentioned, but not elaborated on. Also, the presence of heavy metals is discussed in L.281-287 to explain the differences that are reported in the paper, which calls for these to be measured as well.

I think the introduction can be streamlined. Currently, the introduction works towards the knowledge gap that is introduced in L.109. However, in between the introduction and the

knowledge gap there is a considerable amount of text that introduces the study site of La Palma, which in my opinion, breaks the flow of the introduction. I would suggest to bring the paragraph where the knowledge gap is formulated forward, then following with a statement along the lines of: 'To this end, we investigated the occurrences and traits of plant species in a comparative study matching basaltic and phonolitic rock formations on the island of La Palma.' Followed by an introduction of the study site and its relevance to this study. Also, I think the paragraph in L.113-122 lead to the knowledge gap and should be integrated in the previous paragraph, and should be directly followed by the knowledge gap.

I object to how the second hypothesis is currently formulated. The hypothesis is currently introduced with species *reproductive* fitness, which is then stated to be proxied with plant height and canopy diameter. I fully understand the choice to measure these two metrics due to the time constraints of a field work abroad, I don't think these can be used as a proxy for *reproductive* fitness. Instead, I suggest presenting these as proxies for plant performance, or maybe as proxies for plant fitness (not reproductive fitness), stating that these metrics are good proxies for the different components that make up plant fitness (e.g. survival and reproduction, see Laughlin 2020). I would also introduce the use of plant height and canopy diameter as proxies for plant performance/fitness in the methods section.

Laughlin, D. C., J. R. Gremer, P. B. Adler, R. M. Mitchell, and M. M. Moore. 2020. The net effect of functional traits on fitness. *Trends in Ecology & Evolution*.

I fail to see the relevance of the specific introduction and discussion of the SIE *Cheirolophus junonianus* to the story of this paper. Appendix A1 shows that more species occur on only basalts or phonolites, but this is only discussed in the context of this one species. I would expect this to lead to differences in the species composition of the different substrates, yet the data presented in appendix A3 shows no compositional differences between substrates. This is highly relevant to the paper, and I would like to see this discussed more, and maybe also analysed in more detail. In the paper, the authors also mention that the basaltic rocks house more generalists, but no analysis is presented that shows the what species are considered specialists or generalists.

I would suggest restructuring the discussion The wording in L.226 suggests that these four drivers are expected to have an effect, so I was disappointed to then read the conclusions on the first two paragraphs (1. and 2.), telling me that these aspects didn't play a role. While not irrelevant, I would start with the points 3 and 4, which are more relevant to the discussion, and then bundle points 1 and 2 into a paragraph highlighting some other drivers that were not expected to play a role in this system.

I think the point discussed in 4) is very relevant and interesting, and I see an opportunity to place this research into a broader context that the authors didn't explore in full. I think the result on species abundances can be caused by either a lower than expected species richness on the basalts, or a higher than expected species abundance on phonolites, or both. The age difference between these two substrates might suggest that there are

unfilled niches in on the basalt substrates (which is mentioned, but I think can be elaborated on), but also that there might be an extinction deficit in the phonolite habitats due to habitat decrease and habitat fragmentation. I think this opens up the possibility to discuss how geological history affects evolutionary processes. In line with that, I think the discussion can come back to the relevance of this work to understand how geological diversity affect biodiversity, as introduced in the opening paragraphs of the introduction.

I also have some specific and technical comments:

L.40: chemical composition

L.55: Omit 'also'

L.56-59: I think this sentence needs to be rewritten to better connect to the previous sentence and align with the rest of the paragraph. Perhaps change the other of the sentence? 'This underlines the relevance of understanding the importance of geodiversity for insular biodiversity, which is particularly vulnerable to extinction due to restricted ranges and small population sizes of insular endemic species (Paulay, 1994).'

L.65: 'Distinctive to phonolites is fine-to-medium grain size'- Is there any relevance of this characteristic to this study?

L.97: What does hyper-endemic means in this context? I suspect the authors mean this is a single-island endemic, and I would refer to it as such. (Note that hyper-endemic is a term used in epidemiology, referring to persistent, high levels of disease occurrence).

L.153: Move '(northernness and easternness)' to the first mention of aspect.

L.163-164: 'Height, diameter, and species abundances were measured for species to ensure that vegetational differences evolved through long-term processes and did not reflect the short-term variability of environmental conditions' – On its own, this statement is not correct. In short-lived annuals, these metrics will most certainly reflect short-term variability in environmental conditions. I suspect the plant species living on these rocks to be long-lived perennial species, and therefore one can assume that the height, diameter and abundance of individuals reflects long- term processes and is not solely influenced by short term environmental variability.

L.221: 'This makes the greater number on phonolite even more remarkable.' I find this statement a little out of place, given that the results align with your hypothesis, and with the statement that follows.

L.223-224: I think this result can be caused by either a lower than expected species richness on the basalts, or a higher than expected species abundance on phonolites, or both.

L.226: I would suggest changing 'colour' to 'temperature'

L.269: I would omit the clause 'though the numbers of endemic species were significantly higher.' I would focus on relative abundance of endemics, which is the relevant metric for the discussion.

L.270: 'and the functioning of phonolites as islands of speciation within a sea of basalt does not seem to apply.' Which makes sense given the geological history of the island?

L.271-273: 'However, as most individuals of the typical variety of *Cheirolophus junonianus* occur on one isolated outcrop and individuals of var. *isoplexiphyllus* on another one (personal observation), a very local allopatric speciation by adaptive radiation or an ongoing genetic drift could be the underlying cause.' Given the geological history of the island, I would expect the occurrence of these species on one single outcrop to be caused by habitat fragmentation and subsequent extinction in other habitats, rather than speciation on these two outcrops. This is discussed in the subsequent sentence, but the order suggests the authors think speciation is the most likely cause, with which I disagree.

L.293-295: 'Contrasting, plants growing only on phonolites did not experience larger environmental gradients. In accordance, we observed plants on basaltic rocks to be more generalist than plants on phonolitic rocks.' Neither of these aspects are shown in the results, I suggest to either omit these statements or show the data to support them.

L.305: 'plant growth responses' be consistent in your terminology, this was called reproductive fitness in the rest of the paper.

L.306: 'of these rocks for the vegetation on these islands which are globally dispersed', I was a bit confused by this sentence. The grammar suggests the islands are globally dispersed, can you mention why is that relevant?

L.307: 'Despite the small area covered by phonolites they play a significant role in enhancing plant biodiversity' add 'on the island of La Palma.'

L.307-308: 'Our results contribute to a better understanding of the distribution and plant diversity drivers on islands through exceptional rock outcrops like phonolites' I suggest toning down this statement. The results suggest that these outcrops play a role in the formation of plant diversity on volcanic islands such as La Palma, but the lack of additional data on, in particular, the chemical composition of the different substrates means that your results do not directly contribute to a better understanding of the drivers that lead to this effect.