Comment on bg-2021-1
Anonymous Referee #2

Referee comment on "Experimental production of charcoal morphologies to discriminate fuel source and fire type: an example from Siberian taiga" by Angelica Feurdean, Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-1-RC2, 2021

General Comments:

Feurdean presents a dataset of experimental charcoal produced from 17 species endemic to boreal Siberian. Using these experimentally produced charcoal, Feurdean makes insights into the reliability and applicability of charcoal morphologies as a proxy of fuel type. Additionally, the author shows how charcoal mass is retained as a function of combustion temperature for these samples.

The manuscript is very interesting and presents a promising dataset for the paleofire field. Its efforts towards proxy calibration of charcoal morphology and morphometry represent a key advance. Its experimental characterization of charcoal produced from several new fuel types and taxa, as well as replication of previous experimental productions of charcoal, make it a useful contribution to the field. Mass retention during charcoal production represents a key gap in our understanding of the source to sink controls of sedimentary charcoal, and this manuscript helps to bridge this gap. Lastly, it improves on some of the methodological approaches of earlier experimental productions of charcoal particles.

However, the manuscript falls short in several ways. Although the bulk of the manuscript is in good order, and the study itself is robust and scientifically sound, the discussion and conclusions are, in my opinion, woefully underdeveloped, especially in light of the novelty of the dataset and approach. In a broader sense, the manuscript fails to fully deliver on the potential conclusions and insights that could be gained from a dataset which is truly brimming with potential. I recommend moderate revision prior to publication and have outlined, in my opinion, the manuscript's primary shortcomings and areas needing improvement below.

Firstly, it lacks in-depth comparison to prior work, which will surely undermine its impact. For example, several of the taxa tested by the author have also been directly tested in previous experimental studies (e.g., Eriophorum vaginatum in Pereboom et al. (2020), Pinus sylvestris in Crawford and Belcher (2014)), yet there is no discussion of the similarities and differences of the morphometrics of the charcoal produced from these taxa. Similarly, previous experimental studies have used a variety of techniques (and temperatures) to produce charcoal, but limited comparison is made with these studies and their conclusions. How and why do the values differ and compare between this and other experimental charcoal studies? Although the Discussion focuses on the findings of this
study, it does not sufficiently contextualize these findings within those of the published literature. For example, section 4.2 refers to several other studies, but only vaguely compares findings of charcoal particle elongation between these studies. The published aspect ratio data of these experimental studies should be more thoroughly discussed and explored if this is to have a veritable impact on the field.

Secondly, the manuscript does not make actionable conclusions for the paleofire field. Besides a somewhat unconvincing (see specific comments below) description of the potential utility to use charcoal aspect ratios to distinguish fire and fuel types, the manuscript does not provide explicit descriptions of the morphometric values that be used to constrain interpretations of sedimentary charcoal. What is the cut-off for elongation indicative of graminoids? What are the ranges of morphometric values that can be indicative of fuel types? What are the mean values of the aspect ratios of the fuel types that can be distinguished (wood, graminoids, and leaves, as indicated in the Conclusions section)? What is the quantitative relationship between temperature and charcoal mass retention? More specific and worthwhile conclusions need to be made from the dataset. At present, the manuscript is intriguing but does not provide explicit values and tools that can be applied to actual sediment samples, and in turn, inform paleofire interpretations.

Lastly, the author should provide the morphometric values derived from the experimental charcoal in Table 1 (or in the supplement) to enable others to more directly compare with this dataset. As it stands, future work will have to estimate values from the figures. To my knowledge, provision of explicit data value ranges is the norm in these types of studies. I strongly suggest the author provide these values to facilitate use of the insights provided by the manuscript.

Specific Comments:

L103-104: What was the rationale for this sieve size, given the wide range of sieve sizes used in the paleofire field?

L203-206: Shouldn’t this be irrelevant given that the sampled were uniformly dried before combustion?

L243: Neither of these citations are provided in the references list. The Clark (Clark 1988) and Higuera (Peters and Higuera 2007, Higuera et al. 2007) models of charcoal dispersal do not actually incorporate particle shape. To my knowledge, the model of Vachula and Richter (2018) is the only one to directly test the effect of charcoal particle shape on dispersal distance.

L248: Aleman et al. did not experimentally produce charcoal particles. The values referred to here were derived from environmental samples. This comparison is not appropriate, in my opinion.

L297-311: This conflation of fuel type and burn temperature is not convincing. Although the data presented in this paper clearly show the ability to differentiate fuel types, it seems a stretch to suggest that burn temperature might be inferred from fuel type assemblages and charred mass. How would this work for an environmental sample? How could charred mass be differentiated from total fire activity? Why isn’t Figure 2H referred to and discussed in this section? It should be useful in making these conclusions.

L359: Where are the morphometric measurement data? How can future researchers actually use these data to better inform their interpretations if they are not provided?
Figures 2 and 3: The figure captions indicate that the boxplots summarize the median aspect ratios, lengths, and areas of particles for each taxa (i.e., each box plot depicts the median, standard deviation, and range of the median values of the measurements). If I understand correctly, though, these boxplots are actually summarizing the individual measurements. The medians are just one component of the boxplots? This ought to be clarified.

Technical and typographical corrections:
L14-15: “Graminoids, Sphagnum, and wood”
L38: End parenthesis is missing from citation.
L48: Consider rephrasing. No fires are ‘cool’. Consider using more specific fire regime characteristics (e.g., intensity, severity).
L71: “paper” singular
L85: “tests”
L248: “Mustaphi”
L287-288: “influence”
L292: “cool, surface fueled”
L293: “Anderson”
L297-300: Please consider revising this sentence. Its present wording is difficult to decipher
L310: “reveal”

References cited in this review: