

Interactive comment on “Long term trends in aquatic diversity, productivity and stability: a 15,800 year multidecadal diatom study from Lake Baikal, southern Siberia” by Anson W. Mackay et al.

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Reviewer 2 comments

10. Figures – several of the figures are wanting for reproducibility or interpretability. If they are to be produced at the size provided in the review copy, they are unacceptable for publication. A reader should not have to get a hand lens out to interpret a figure. This is especially apparent in Figs 2, 3, 6. A few other notes, what is meant by the (agg) in *Aulacoseira skvortzowii* in Fig 3, *meyeri* misspelled in Fig 3, units on seasonal BVAR

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does not use a mu symbol for μ and the μ 3 and cm2 do not have superscripted exponents in Fig. 3. In Figure 4 and 5 the record is truncated at about 14500 yBP. The core is clearly shown to be 15800 yBP old, why the truncated records in Figs 4, 5?

Authors Response – The review makes important points re. reproducibility & interpretability of some of the figures. These figures will have to be redrawn anyway to make way for changes in recommended new analyses, and we ensure that all labels etc meet requirements for CP. Other minor corrections have been made, and Figs 4 and 5 no longer exist.

11. M&M – the section on diatom analysis is strangely variable in detail. Diatoms are described for a general audience, but then their analysis is described as though everyone knows how they are treated in sediment analysis. For example, what is meant by 5 mm resolution? Valves per gram of what. Add that they “possess a silica shell called valves: :”

Authors Response – We have adapted the methods section for diatoms, to take account of these concerns: Lines 197- onwards.

12. Taxonomic names – care should be taken to make sure taxonomic names are correctly spelled and formatted throughout the manuscript. *Stephanodiscus meyeri* (single -i at end), the v. in variety *radians* should be in Roman font, not italicized

Authors Response – We have corrected the spelling for *S. meyeri*, and unitalicized v.

13. Discussion – has there been similar detailed approaches taken on other long records? This seems to be a novel approach for considering the relations between diversity/ stability and climate, but that aspect is not highlighted by the authors and it should be! Has this approach of melding resource ecology and diversity been applied to other climate records, perhaps from varved lakes and accounting for Holocene scale records (LIA, MCA, HCM)?

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Authors Response – As far as we are aware, there are few detailed records as ours, hence the novelty and value of this study. And there has not, as far as we are aware, been other studies which have looked at relations between diversity/ stability and climate over such long timescales. We think we highlight this novelty in the Introduction, Lines 96-100 “This constitutes an important gap in our knowledge because in terms of climate change, PDR and resource use efficiency (Gross and Cardinale 2007; Ptasnik et al. 2008) will be fundamentally different over long (e.g. climate and landscape evolution) and short (e.g. pulse disturbances such as climate disturbance events (Kéfi et al. 2019)) timescales.”

– But we will emphasise the novelty of this record again in the Discussion

14. Discussion – earlier efforts by Khursevich et al. (2001, 2005) and Edlund (2006) have considered the longer Baikal records, but in lower resolution and with fewer measures of diversity and productivity. How does this new record compare or contrast with those earlier approaches to examine the full Baikal record. Is the Pleistocene/Holocene transition unique? For example, this paper suggests higher valve flux and BVAR in glacial times (T1) vs Holocene (see Table 1). This seems to contrast with many of the diatom depauperate regions characteristic of other glacial periods in Baikal’s history

Authors Response – The reviewer makes a really useful suggestion in comparing our records to previous studies done on Lake Baikal, albeit at lower resolution. We will add a new section (see below) which brings in the three studies that they highlight, plus Bradbury et al. 1994, which covers a very similar timescale as our own, with cores from off the shoulder of the Selenga Delta spanning the past 15,000 years or so. Thank you.

New section to be added: 4.4 Comparison of Vydrino record with other long diatom sequences from Lake Baikal

It has long been recognised that Quaternary biogenic silica and diatom concentrations in Lake Baikal sediments mirror changes in insolation (Khursevich et al. 2001), such that very low concentrations characterise glacial periods, likely due to a number of

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factors including lower productivity and higher rates of diatom dissolution as well as dilution due to increased inputs of clastic material (see Mackay 2007 for a review). The Vydrino late glacial – Holocene record has an almost identical diatom assemblage to those identified for the same time period in long cores extracted from both the Posolskaya Bank (BDP-99) and Academician Ridge (BDP-96-2) to the north (Khursevich et al. 2005) (Fig. 1). In another study of Quaternary Lake Baikal diatoms, this time from the Buguldieka Saddle (Fig. 1), Edlund (2006) found that although earlier glaciations also contained few remaining diatoms, the “Sartan glaciation”, i.e. MIS2, still contained at least 10 species of planktonic taxa, and an assemblage again very similar to our Vydrino sequence. Bradbury et al. (1994) produced a similar but much lower resolution record for diatom changes spanning the past 15,000 years from the Posolskyaya Bank, where both the assemblage and sequence of diatoms are similar to Vydrino. Therefore, observations and conclusions drawn in this study related to productivity diversity relationships are likely applicable to other regions of this vast lake at least during the same time period.

15. Discussion – the Baikal diatom community is characterized by high endemism. Is there any reason to believe that this endemic flora drives the patterns shown in your data, i.e. is the resiliency a by-product of endemism? In 521-533

Authors Response – This is a very interesting question. Rather than the endemism per se, it's likely the length of time spanned by the continuous sedimentary records found in ancient lakes that is the primary factor promoting resiliency. Of course, as endemism needs a lot of time to develop, ancient lakes have generally high endemism. We will include this concept in our discussion, drawing in work from the recently published paper by Luethje & Snyder (2021, *Phytotaxa*) in which they discuss how climate events appear to drive morphological transition within a “species complex” (in that case *Pantocsekiella*, i.e. the species around the “*Cyclotella ocellata/comensis* complex) on a long time-scale (0 to 1.2 Ma) in Lake El'gygytyn. In their study, they identify a morphodeme as a distinct species, partly on the basis that its occurrence in the record

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corresponds with stable climatic conditions during a 180 ka-long interglacial (when the lack of competition from other diatoms allowed the speciation of this large-sized morphodeme). The idea is, given sufficient time and opportunity (i.e. the demise of a competitor for a particular niche), morphological variants of a species (in their case, a large-celled variant) will be allowed to thrive and occupy the vacant niche. The *Cyclotella* (*Lindavia*) *baicalensis/ornata/minuta* complex in Lake Baikal is another example of speciation as the different sizes allow them to occupy different habitat/seasonal niches.

16. Minor corrections: In 52, understanding: : :is In 117, remove comma after “: : (2018) restricted: : :” In 130, change to “: : :diversity that is not experienced: : :” In 133, change to “: : :events disrupt these : : :” In 140/41, odd expression outside of UK, change to “: : :due to its diverse flora...” In 142, provide reference to endemism of Baikal In 145, italicize the ship’s name. She deserves that. In 149-50, add space before meter abbreviation in 3 places. Check rest of msc for same. In 160/61, superscript 14 in 14C, check rest of msc for same, also noted for _m3 (In 215), etc. In 222, clarify what is meant by PDR? Is PDR the relationship between paleoproductivity and N2 or is it N2? If it is the relationship, how is it calculated? Fig 5 seems to be reporting this “PDR” but PDR is not described or connected to Fig 5. What am I missing as a reader here? Is Fig 6b also related to PDR? In 399, “: : :Bolling, the pre-Bolling diatom: : :”

Authors Response – We have taken all of these onboard

17. In 415, why is there a delay in the N2 diversity decline? Would be worth some speculation.

Authors Response – We actually speculate on this from lines 418... “The lag in N2 diversity decline suggests that available resources for diatom growth were not initially limiting; species composition at this time is dominated by the spring blooming *S. acus* v. *radians* and the autumnal blooming *C. inconspicua* (Fig. 3h,k), and therefore these species may not be directly competing for the same resources (Interlandi & Kilham 2001).”

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18. Ln 456, skvortzowii misspelled In 475, close parenthesis after 2011) In 475, verb agreement “shows” In 509, check msc for formatting of N2, N0, N1, italicized N and Roman 2 seems the standard. In 541, close parenthesis after Fig. 3)

Authors Response – We have corrected these errors.

References used in this report, and now added to the manuscript

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