Review of manuscript by Zhang et al. Lake Ohrid

The paper by Zhang et al. provides a diatom record from Lake Ohrid, Macedonia, spanning the last 12,300 years. In general the paper is well written, and the majority of the corrections I suggest are really quite minor in nature. The record from Lake Ohrid is unique from this location, in that such a deep lake has allowed continued sedimentation in the lake over such a long timescale. Due to the lake's depth, it is unlikely to be responding to shifts in effective moisture (as do other shallow lakes in the region) over such a timescale. This offers the chance for the authors to investigate what is driving ecological response when the precipitation signal appears to be muted. As part of this the authors focus very heavily on temperature (of what nature? Air, water, summer, winter, maximum or minimum) and temperature-dependent productivity. It is also a relief(!) to see that multiple cores from such a large lake also record the same changes!

My only real criticism of the manuscript is this focus; there is no exploration of other potential drivers of change. I'm not quite convinced that temperature alone is the major driver of the changes observed in the record, and in places the discussion surrounding drivers and response (temperature-nutrients-diatoms) seems to become a little circular. Where responses differ through the record, these are then referred to as 'anomalous' or 'unpredictable', rather than exploring other mechanisms. It would be useful to see some opening up of the discussion (light, ice cover etc) and not just focus solely on a temperature and productivity interpretation.

Other than this, I feel the manuscript would make a valuable contribution to the literature, and it would be of broader scientific interest to see the manuscript fully published. In addition to the major point above, I also list some minor comments (and questions for my own curiosity!) below.

<u>Specific comments</u>

Introduction

Needs some context in terms of why this region is a key site in the north eastern Mediterranean region perhaps? What is it that is contentious or interesting in other records that exist (outside of Lake Ohrid)? What are the other records showing over this time frame to provide some kind of climatic context - this would then link aspects of the discussion (e.g. MIS 2, ice rafted debris, 8.2 event, 4.2 event, Mediaeval Climate anomaly etc) to the information in the introduction. This can then lead in to the specifics of previous work undertaken on Lake Ohrid, and then your aims/objectives for this paper.

Site description

14347 Ln3 Is the >1.2 Ma sedimentary record continuous? If so, can you state this – I think this is amazing!

14347 Ln21 I just wonder what quantities the percentages refer to, and over what time frame? Is this the average over 1 year, 10 years etc? What is the volume of water that totals 100%? 10L, 1000GL? It's difficult to get a perspective of how much water is moving through the system without knowing the volumes. What's the lake water residence time, can this influence the internal nutrient cycling?

14348 Ln5/6 What is the driver of the 7 year complete turnover – the return interval of severe storms (which I think you allude to in the discussion)? A brief mention of the mechanism would be useful/interesting.

14348 Ln11 You give the 'mean' TP and TN values throughout the water column in the centre of the lake, but then proceed to provide a range (not a mean?). How does this vary through the profile? Where are the highest concentrations? When do the highest concentrations occur (in epilimnion in autumn for example) – could easily be represented in graph form? How typical was 2000-2001 of longer term concentrations (I appreciate these data might not exist – just curious!).

Material(s) and methods

14348 Ln 22 Replace 'Not taking into account' with 'Excluding…'

14348 Ln 24 Replace 'revealed' with 'identified'

14349 Ln6 Why did you use the 0.1 smooth – what happened to age model with other smooth values – how did it affect the age-depth relationship, and associated errors?

14349 Ln7/8 Not sure it is correct to say 'radiocarbon age of fish remains is apparently too old' without qualifying? It's clear that in conjunction with multiple dated horizons either side, it appeared there was an issue with the material dated, but you kind of dismiss it out of hand in the text? Why did you get an odd date for this which is older (I always find it easier to explain erroneously younger dates!)?

14349 Ln13 You really cannot claim this is a high resolution record. Not in terms of sampling (104 samples out of 785 cm) nor in terms of age intervals (ranges from 40 years to 350 years), if your samples are 8 cm apart, the resolution of record is quite low temporally. Remove the phrase and just stick with the actual values already in text.

14350 Ln 21 It would be much better to phrase as '…diatom preservation, the F index of Ryves et al (2001) was used to calculate the dissolution of the dominant endemic taxon…'

14350 Ln21 Did you use the four stage approach of Ryves? If so, would be nice to include photos in a supplement to see how the dissolution changed (even though it actually looks pretty good throughout the core?!)

14350 Ln24 Ordination techniques, maybe just include a line or two of additional detail? Did you / how did you transform your count data? Square root or percentage? DCA didn't give the largest gradient length of 1.85, you used DCA to calculate the gradient length so that you could decide whether to use a linear or unimodal ordination?

14350 Ln 29 '…the influence of sedimentation rate was factored out…', I'm not sure what you mean here, as in you corrected for sedimentation rate?

Results

From this point onwards, you have capitalised words such as 'Axis' and 'Subzone' and 'Zone', I don't think there is any need for this. Can these be changed to lower case?

14351 Ln8 This sentence reads a little muddled. I think some punctuation is needed? 'F values for endemic are >0.75 throughout the record'. What does the >500 valves refer to, or are you just stating that's what you counted? Are you saying that concentrations were generally high (exceeding 2 x 10^7 *valves*?? g^{-1}) and you've already made the point that preservation was good. Just rephrase this section to make more sense.

14351 Ln21 *S. transylvanicus* 'occurs' as in it appears for the first time? Maybe rephrase? What reaches peak diatom concentration in this zone? Clarify, I'm not sure what you're getting at.

14352 Ln3 'by **an** increased…'

Interpretation

Just out of interest, is there not a temperature record from this region to which you could directly compare your data? If there is, it would certainly help to support you temperature interpretation?

14353 Ln7/11 You choose an interpretation 'in contrast' to other studies? Why? What is the reason for this? Can you expand a little?

14353 Ln9 Low organic matter may be reflecting nature of the catchment, if poorly vegetated, more clastic input might dilute algal signal? This might easily be seen if the diatom data were converted to flux data – algal input might not change, just the quantity/nature of the terrestrial material?

14353 Ln16 is 'putative the right word to use here?

14353 Ln15 The sentence starting Diatom PCA axis 1 scores…' is very long and confusing. I suspect there is a word or two missing around the phrase '…high positive scores **are coincident** with the dominance of epilimnetic taxa…' Please clarify.

14354 Ln11 Two problematic taxa S. pinnata and P. brevistriata (I am no fan of these two)! No clear habitat preference, usually a sign of instability/fluctuating conditions in a lake system (kind of weedy species the world over…)

14354 Ln 20 'Thus, erosion-induced external nutrient input would also have been high?' Not necessarily? Would be really good to bring in/refer to the palynological record here, it might be a poorly vegetated catchment with few pioneer species, which require little in the way of nutrients/nitrogen (as they may fix their own) – this would mean a nutrient poor catchment, so even if material input from catchment was high, it may not have been nutrient rich? Which then leads to…if increased input is coming from the catchment (nutrient rich or not), what does this do to the **turbidity** of the system and **light availability**, and how does this affect the diatoms? And, I guess if it's cold, what role does (extended/permanent?) **ice cover** have to play?

14355 Ln4 If temperature is increasing diversity of samples too, then it wouldn't just be diatom diversity increasing? How would the response of increased temperatures on **zooplankton/grazers** work in favour of selection for smaller cell-sizes in diatoms? Can **increased competition** also favour smaller cell sizes? What about **stability in stratification**? **Changes in wind regime** if catchment vegetation increases etc (again references to palynological record useful here too)? These kinds of issues are pertinent to and could be raised through the rest of the discussion too!

14355 Ln17 Is it not unsurprising that the response is muted in Ohrid? It's a *really* deep lake! Other lakes you mention are much shallower, so their response would be more amplified? **Just in general**, what role does catchment size and groundwater play in mediating any responses observed in the lake? Do you have any lake water balance modelling?

14555 Ln27 Yes, certainly potential – assuming we have a good grasp of the functioning and response of the modern system. I suspect this is where the geochemistry work of Lacey et al will really help in the long run.

14356 In section 5.3, you often refer to 'high' temperatures. What kind of shift in temperature are we talking about? And what is the nature of this temperature? Air? Surface Water? Mean annual? Summer max etc. Need to clarify and may be avoid the use of high (at worst case, replace with higher; best case quantify or use alternative description altogether).

14356 Ln 11 Again, probably a more **general comment** for consideration, spurred by this section. If productivity is causing centric species to bloom, won't these also affect light availability, reducing light to species that prefer the hypolimnion? How would this interplay affect the abundance of the various species?

14357 With regards to the tephra, can you really make the conclusions you do given the resolution of your record? Assuming your sample resolution is at best 40 years per sample or worst 350 years per sample (or scaling up at every 4 cm interval 160-1400 years or at every 8 cm interval 320-2800 years). First 'Mercato tephra' (Ln12) if the impact/response is short-lived it would be highly unlikely that your record would capture it, so it's probably not fair to say it had no impact? Your sampling just didn't pick it up – or your integrated sample was just that, and couldn't differentiate? Could the same be said for the 8.2 ka event? Or are diatoms not completely driven by temperature changes? On page 14358 Ln24 could the same apply to the 4.2 event?

14358 Ln6 What is 'high' for temperature?

14358 Ln8 Just because it doesn't fit a 'temperature' explanation, doesn't make the response anomalous. It means that something other than/as well as temperature is really driving the diatom response, and that it is totally plausible for the factors to shift through time.

14359 Ln9 What is this human activity you speak of?! Can you qualify what the impact might be? Catchment clearance? Atmospheric N deposition, agriculture, groundwater abstraction etc.

14359 Ln15 Not sure of the use of the word 'predictable' please change – a response largely depends upon many things (antecedent conditions, internal thresholds, buffer etc), so may not be 'predictable' at all…

14360 Ln4 Mediaeval Climate Anomaly (not MWP) – again, sample/study resolution may play a factor in this.

Conclusions

Will need modification in response to changes in the discussion.

Figures

Figure 3 & 4 Does axis label for diatom concentration need to state if it is valves or frustules?

Figure 5 Shows the dominant species from 2 cores, can the species be placed in the same order (where they are similar) just to make it a little quicker/easier for the reader to see.

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