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Discussions

Interactive comment on "Calibration of Mg / Ca and Sr / Ca in coastal marine ostracods as proxy of temperature" *by* Maximiliano Rodríguez and Christelle Not

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RC1: Anonymous Referee 2 Received and published: 27 November 2020

We appreciate the positive comments of reviewer 2 on our manuscript We understand that the main concern is the short range of temperatures used in our calibrations. We will provide more statistical analyses to show that the error in the temperature measurements and/or Mg/Ca ratios do not invalidate our calibrations. We may also include more specimens of *S. impressa* from Japan, in order to broaden the temperature range. We have a few *S. impressa* specimens from the Yatsushiro Bay in Japan, collected during the first week of July and

November by Dr. Gengo Tanaka. The calibration must be performed using water temperature during shell calcification. Considering that these specimens have both valves with preserved soft parts, we think the water temperature of 1 or 2 months before collection may be representative of the water temperature during shell calcification. We do not have a continuous monitoring of water temperature at the sampling site. However, we can provide an estimation by using the water temperature recorded by marine stations (buoys). Data from surrounding buoys in the Yatsushiro sea show surface water temperatures in the previous months before collection. The water temperatures during October and May ranged from 22°C to 26°C and from 17°C to 23°C respectively. This can help us to estimate the water temperature during shell calcification of these new specimens and extend the temperature calibration of *S. impressa* in a few Celsius degrees. These samples are already in our laboratory and we are processing them to obtain the ostracod Mg/Ca ratios.

RC1: This paper contains significant results relating to geosciences by using biotic carbonate. Original point of this paper is that Mg/Ca paleotemperature reconstruction was done by using brackish and very shallow marine species. This is a new approach and important for not only ostracod researchers but all paleoceanographers. However, some revisions are required. I showed my comments as below. 1) Water temperature ranges for Mg/Ca-temperature correlation in this MS was 2ËŽC that is too small to establish the correlations between Mg/Ca and temperature. It is doubtful that the new regression lines for two species could really calculate 1 ËŽC (or less than 1 ËŽC) difference in the past water temperature. For instance, 1 ËŽC easily differs depending on measurement methods and technical errors for bottom water temperature. The best way for revision is that additional ostracod shells from samples in lower or higher water temperatures will be measured. Both species inhabit in the modern seas within wider temperature ranges in the East Asia. If this is impossible, I suggest that the authors will show the basis that the new regression lines could calculated the 1 ËŽC differences of the past water temperature exactly.

Reply: The main concern of reviewer 2 is the short range of temperatures used to produce temperature calibrations. We agree with the suggestions of the reviewer. We will add an analysis to estimate the error of Mg/Ca ratios mean values and temperature estimations. We can estimate the error of Mg/Ca mean values in each station at a certain confidence level by using estimations of margin of error (Holmes, 2008). For *S. impressa*, we realized that at 95 % confidence, the margin of error for Mg/Ca in all the stations ranged from 1.5 to 4.1 mmol/mol. Considering the annual and spring calibrations, the temperature mean errors are 0.7°C (0.4°C to 1°C) and 1°C (0.6°C to 1.5°C), which are lower than the temperature difference between the stations (1.6°C). Therefore, we think we can estimate differences at 1°C with the calibration curves of *S. impressa*. For *N. delicata*, the margin of error for Mg/Ca ranged from 1.1 to 5.7 mmol/mol. Annual and spring calibrations have the same slope, which produce temperature mean errors of 1.9°C (0.7°C to 3.6°C). This error is similar to the difference in temperatures between the stations. Therefore, we think more shells at different temperatures would be needed to estimate differences in 1°C. Unfortunately, we do not have more specimens of *N. delicata* from other regions. We will show and discuss these analyses in the revised version of the manuscript. Moreover, in order to broaden the range of temperatures for *S. impressa*, we may add more specimens in our dataset. Dr. Gengo Tanaka, from Kanazawa University, collected *S. impressa* specimens from the Yatsushiro Sea in Japan, which we may incorporate in the revised version of this manuscript. It will allow us to extend the temperature range of the calibration to cover a broader temperature range.

RC1: 2ïijL'ãAËŸ ALine 78: Authors used mean values for the last 20 years from the collection ËŸ time of the samples. Please describe the reason that the last 20 years are the best for this research.

Reply: We used the last 20 years from 2011 in order to avoid the bias that single temperature measurements can produce regarding monthly values due to natu-

ral variability. This allows us to have enough data to determine a robust monthly mean value. Our decision was made considering that a) we have only 1 data in each month per year in the different Hong Kong stations. This implies that we can calculate the monthly value of each Hong Kong station using around 20 data points, b) the average of the last 20 years produces a more representative value for the monthly data, c) the EPD records started in 1986, so we could not consider a longer time period (e.g 30 or 40 years), and from 1991 we have data of temperature in all the sampling sites where we collected sediment samples. We will add a sentence explaining the choice of the last 20 years temperature data set in section 2.1.1. The sedimentation rate in Hong Kong varies from 0.2 to 5 cm yr-1 from open to more enclosed areas. Due to resuspension and bioturbation, samples from the uppermost centimeter probably have ostracod populations from the last 5 years before their collection. Because we do not know exactly when the calcification of the shell occurred, we adopted monthly mean values to produce our calibrations. We will add more details about this in the revised version of the manuscript.

RC1: 3ïijL'Water conditions including temperature, salinity and pH vary in a wide ranges within a few days in very shallow marine and brackish lakes as authors described in the MS. This is a large problem for temperature calibration because ostracod shells are calcified within a few days. I think comparisons between Mg/Ca in ostracod shells and annual mean values are reasonable methods. However, authors should show the variations in water condition for shorter time scales such as daily mean.

Reply: Unfortunately, our data set do not contain daily data (i.e. 30 or 31 values per month). Water parameters (temperature, salinity, pH, among others) have been recorded once per month since 1986 and therefore it cannot resolve daily/weekly variations. Therefore, the temperature correlation at a monthly scale is the shortest temporal resolution we can achieve by using this data. We can estimate bottom water temperature variability per month by using the Coper-

nicus satellite product at a daily scale. We performed this calculation on stations NS6, SS3 and MS13, which are located at the lower section of the Pearl River Estuary, outside the Pearl River Estuary southward Hong Kong Island and eastward Hong Kong island, respectively. The mean standard deviation per month considering daily data from 1993 to 2018 on the locations of EPD stations NS6, SS3 and MS13 are 1±0.4°C, 0.8±0.5°C and 0.7±0.5°C respectively. We think this variability does not invalidate the temperature calibrations to Mg/Ca as it is lower than the difference in the mean annual temperature observed in the different stations in Hong Kong (1.6°C). However, we agree with the reviewer in the importance of short time fluctuation in the temperature and therefore we will include this information in the revised manuscript.

RC1: 4) Figures 2 to 6 are low quality. Please make circles and lines clear to see. Particularly, circles for individual sample in fig. 2 are blurred. This problem might be due to the resolution in web systems. Please check them.

Reply: We apologize for this inconvenience. Our figures are produced in high resolution (1000 DPI). Usually, 300 DPI is enough. We think it may be a problem of the generation of the final file. In Fig 2, we did the single shell values blurred to clearly show the mean values. We understand that this may cause problems to read the figure. We will change the blurred dots to clear dots. For Fig. 6, we will change the dotted lines for solid lines.

RC1: 5) Line 203: It is better that all data of the correlation between the 24 parameters and Mg/Ca will be opened in the supplementary files or the appropriate web sites. Furthermore, data that authors used in the figures of the MS containing Mg/Ca, Sr/Ca values of ostracod shells, temperature and salinity. . .etc are as well.

Reply: We agree with the reviewer. We will add the correlations with the 24 parameters in the supplementary material. We will also add our data to an online repository.

RC1: 6ïijL'Line 217: Authors noted that "the elemental composition of marine waters of HK do not seem to control the ostracod Mg/Ca and Sr/Ca ratios according to our data.". Mg/Ca values in water are not enough to identify relationships between Mg/Ca in water and that in ostracod shell in this MS. Further, ecological records of the two species are lack in the present. Usually, periods that the ostracod specimen calcified its shell are unknown in the field study due to duration of life of ostracods as at least a few months. This means that we cannot compare Mg/Ca of individual ostracod shell to Mg/Ca in water when the specimen calcified its shell exactly excepting for cultural experiments. Particularly, water temperature and Mg/Ca of water shifted frequently in brackish and very shallow marines. Hence, I think the sentence shown above says too much.

Reply: We recognize that this statement at the beginning of the paragraph may be too strong because we do not have data of Mg and Ca concentrations in seawater in the different stations where we collected ostracods. There may be also short-time fluctuations we cannot visualize. We also agree with the reviewer that our dataset do not allow us to identify direct relationships between Mg/Ca ratios in seawater and ostracod shells. Indeed, we had stated "do not seem to control" as we were aware of our lack of E/Ca ratios in seawater. However, we think the interpretation of Fig. 4 allow us to suggest that Mg/Ca and Sr/Ca ratios may not control ostracod Mg/Ca and Sr/Ca ratios. First, we observed an ostracod Mg/Ca inverse correlation with salinity (Fig. 4). Assuming a dominant control of seawater Mg/Ca ratios on ostracod Mg/Ca ratios, lower ostracod Mg/Ca in areas of high salinity should be related to lower seawater Mg/Ca ratios. Previous studies on seawater trace elements have shown that Mg and Ca are mostly conservative in Estuarine systems (e.g. Millero, 2006 and Patra et al., 2012), where these seawater concentrations vary linearly with salinity. This suggests that high changes in seawater Mg/Ca ratios at different salinities are unlikely. Second, lower Mg/Ca are unlikely produced by higher Ca concentrations in comparison to Mg, because then we should also observe a decrease in Sr/Ca ratios. This suggests

that variations in ostracod Mg/Ca and Sr/Ca ratios are not produced by changes in seawater Ca concentrations. Third, lower Mg concentrations over Ca are also unlikely as seawater Mg and Ca concentrations increase with salinity. Finally, monthly salinity is relatively stable (>25 psu) in the stations of the Environmental Protection Department of Hong Kong (EPD), which suggest that changes in Mg, Sr and Ca concentrations are limited. In order to make clearer that our conclusion is part of our interpretation of Fig. 4 we will remove the first sentence and modify this paragraph to express better the ideas we just mentioned here.

RC1: In addition to the comments above, several mistakes are indicated directly in the pdf file. Please check them. This MS is good quality and contains useful records. I hope it will be published in the journal soon.

Reply:We will address the comments stated in the supplement.

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