

Biogeosciences Discuss., author comment AC2
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Reply on RC2

Roberto Velázquez-Ochoa et al.

Author comment on "An analysis of the variability in $\delta^{13}\text{C}$ in macroalgae from the Gulf of California: indicative of carbon concentration mechanisms and isotope discrimination during carbon assimilation" by Roberto Velázquez-Ochoa et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-50-AC2>, 2021

Authors have collected and measured an impressive number of samples to establish the relationship between $\delta^{13}\text{C}$ -microalgal and biological as well as environmental parameters. The statistical analyses are robust and help to understand the correlation. However, one of the major flaws of this work is that the authors only focused on describing the numbers, but do not go beyond the dataset. The underlying processes behind the observed relationships are required to be explained to gain a bigger picture. I believe that the manuscript has a scope to improve and can provide useful concepts related to this field. Thereby, I suggest to accept the manuscript after moderate revision if authors agree to incorporate the given suggestion.

R.The Reviewer's criticisms referent to go beyond the dataset is right. We appreciate the time and recommendations to improve our MS.

In this revised version we focused on three objectives. Based on a large inventory of specimens collected during five years along Gulf of California coastlines,

1) we pretended to explain the $\delta^{13}\text{C}$ -macroalgal variability in function of taxonomy (phylum, genus, and species) and morpho-functional groups (e.g., thallus structure, growth form, branching pattern, and taxonomic affinities), and with the interaction to environmental conditions in shallow marine habitats. The taxon-specific photosynthetic DIC acquisition properties related to the intrinsic characteristics of each morpho-functional group of macroalgae (e.g., thallus structure, growth form, branching pattern, and taxonomic affinities) are determinants for the $\delta^{13}\text{C}$ -macroalgal signals. Changes in the habitat features and environmental conditions also influence on $\delta^{13}\text{C}$ signal. The full model considering the combined effect of the life form, coastline sector, and environmental conditions explains 62% (morphological groups) and 72% (genus) of the variability. The effect of the coastal sector, pH ranges, and emersion level were significant, while for salinity and temperature negligible.

2). By using the $\delta^{13}\text{C}$ -macroalgal to infer carbon uptake strategies in macroalgal shallows communities of the Gulf of California. In agreement to the literature 4 carbon uptake strategies have been identified. We used our number to identify those strategies in each specimen. The facultative uptake of HCO_3^- and CO_2 (strategy 2: $-10 < \delta^{13}\text{C} > -30\text{‰}$) is the most common strategy identified in

macroalgal shallow communities in the GC and worldwide. The carbon uptake strategy 1, which uses only HCO_3^- , was the second in importance. A higher proportion of CCM species (HCO_3^- users) was expected because we focused on intertidal and shallow subtidal habitats featured by high-light intensities. Only three non-calcifying species (*Schizymenia pacifica*, *Halymenia* sp., *Gigartina* sp.) belonging to Rhodophyta (3%) were CO_2 exclusive users (strategy 3: $\delta^{13}\text{C} < -30\text{‰}$). Calcifying macroalgae genera *Amphiroa* and *Jania* using HCO_3^- and diffusive CO_2 influenced by the calcifying process, represented strategy 4.

3) we explored any geographical pattern in the $\delta^{13}\text{C}$ macroalgal along and between the GC bioregions. Literature reports significant correlations between $\delta^{13}\text{C}$ signal and latitude, mainly related to the light and temperature. In the latitude range (21° - 31°N) in our study, the linear regression analyzes showed a low correlation for the $\delta^{13}\text{C}$ macroalgal dataset. Because the shallow habitats occupied by macroalgal communities in the GC were high-light environments with narrow ranges in temperature, not clear patterns along the GC latitudes. However, detectable changes were observed in the $\delta^{13}\text{C}$ -macroalgal and in the proportion of specimens with different carbon uptake strategies among coastal sectors.

Our research is the first approximation to understand the $\delta^{13}\text{C}$ macroalgal variability in one of the most diverse marine ecosystems in the world, the Gulf of California. We did not pretend to resolve the intricate processes controlling the variations of $\delta^{13}\text{C}$ or $\Delta^{13}\text{C}$ -macroalgal during carbon assimilation and respiration and determine the isolated influence of each environmental factor. Controlled experiments in laboratory and mesocosm type in combination with field studies are required to elucidate the complex processes controlling the $\delta^{13}\text{C}$ -macroalgal.

The minor comments are listed below:

Specific comments

Abstract

Line 18: Replace 'C' by carbon

R.Done.

Line 22 and throughout the text: The stable isotopic composition should be referred up to one decimal point.

R.Done.

Line 22 or 26: Kindly mention the environmental parameters included in this work.

R.Done.

Line 36: The ending of the abstract seems very abrupt.

R.Done.

Introduction

Line 42: The information should be substantiated by appropriate references.

R.Done.

Line 60: closing bracket is missing.

R.Done.

Line 71: The information should be substantiated by appropriate references.

R.Done.

Line 87: The information should be substantiated by appropriate references.

R.Done.

Line 88: The comparison between microalgal and terrestrial plant d13C is useless unless the authors describe the later with facts and references.

R.The sentence was deleted, it was not relevant for the MS.

Line 96-102: This section must come before the previous to justify the study site selection.

R.The paragraph was moved in agreement with the Reviewer's recommendation.

Study area

Line 111: Please mention a few of the endemic specimens to lure broader audience.

R.Examples of endemic specimens includes Chlorophyta (*Codium amplivesiculatum*), Rhodophyta (*Laurencia papillosa*, *Chondracanthus squarrulosa*, *Gracilaria spinigera*, *Gracilaria subsecundata*), and Ochrophyta (*Cutleria hancockii*, *Sargassum herphorizum*, *Sargassum johnstonii*). A paragraph mentioning these endemic specimens was included in section 3.1. Taxonomy and morpho-functional groups

Line 158: Please maintain a consistency referring GC.

R.Done.

Methods

Authors have performed the statistical analyses in detail. Such great length of description actually helps to understand the work. Impressive! Just a soft suggestion, please refer the relationship only in terms of adjusted R2, else it would be difficult to follow at places.

R.Done.

Section 4.2

Line 552-554: Weird sentence construction. Please re-phrase the lines.

R.Done. The sentences were rephrased.

Just don't mention the correlation coefficient. Dig deeper to explain why does pH have a weaker relation with the measured d13C values.

R.Done. A poor but significant correlation was observed between $\delta^{13}\text{C}$ and pH ($R^2 = 0.04$) (Table 4).

Figures

Most of the figures are very difficult to follow. Authors must improve the representations in graphical format.

R.In agreement with the Reviewer's comments, and to obtain a better interpretation of our results, we revisited our complete dataset and statistical analysis, Figures were improved in graphical format and new Figures constructed.

Figure 6. Replace $\delta^{13}\text{C}$ by $\delta^{13}\text{C}$ in the y-axis legend.

R.Done.

Figure 6 and 7: It is not understandable why does the authors provide trendline for a near-zero correlation ($R^2=0.04$ to 0.07). Kindly, remove them. Also, the inset texts are not readable.

R.The reviewer is right. The trendline was removed.