

Dear Dr. Emma Cross,

We want to thank very much Emma Cross for the very constructive, helpful and valuable comments and corrections, which helped us to ameliorate the manuscript. Please find below my responses to all comments:

Title: Variation in brachiopod microstructure and isotope geochemistry under low pH–ocean acidification–conditions

Authors: Facheng Ye, Hana Jurikova, Lucia Angiolini, Uwe Brand, Gaia Crippa, Daniela Henkel, Jürgen Laudien, Claas Hiebenthal, and Danijela Šmajgl

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The responses to referees are structured following this sequence using different colors:

(1) Comments from Referees;

(2) Author's response;

(3) Changes in the manuscript: original sentences/revised sentences

Comments from E. Cross

e.l.cross@cantab.net Received and published: 27 September 2018

Firstly, it is great to read that other researchers are using living specimens of this highly calcium-carbonate-dependent group to address outstanding questions of biological responses to ocean acidification. I look forward to future publications from this lab. I have a few minor comments in relation to correctly citing previous research on ocean acidification impacts on brachiopods:

1) Page 2, Line 21-23: Please add to this sentence about previous findings of ocean acidification impacts on brachiopods that Cross et al. (2018) also found that punctae have become thinner over the last 120 years, which partially explained the increase in shell density over this time period.

Answer:

We have added this sentence in the revised manuscript.

Page 2, Line 21-23:

The few studies that examined brachiopods or brachiopod shells suggest that the latter suffered increased dissolution under lower seawater pH conditions, whereas the organism either exhibited no changes, or an increase in shell density [calculated as dry mass of the shell (g)/shell volume (cm<sup>3</sup>)], but otherwise no changes in shell morphology and trace chemistry (Table 1).

changed to

The few studies that examined brachiopods or brachiopod shells suggest that the latter suffered increased dissolution under lower seawater pH conditions, whereas the organism either exhibited no changes, or an increase in shell density [calculated as dry mass of the shell (g)/shell volume (cm<sup>3</sup>)], but otherwise no changes in shell morphology and trace chemistry (Table 1). Cross et al. (2018) also found that punctae have become thinner over the last 120 years, which partially explained the increase in shell density over this time period.

2) Page 2, Table 1: Please specify that shell growth rates and shell repair frequencies of *Calloria inconspicua* were not affected by low pH in the row related to Cross et al. (2016) in the column stating “not affected by lower pH”.

Answer:

We have indicated it in the revised manuscript.

Page 2, Table 1 column 3 row 2:

not affected by lower pH

changed to

shell growth rates and shell repair frequencies were not affected by low pH

3) Page 3, Table 1: Please correct the number of specimens used in the row related to Cross et al. (2018). 389 adult specimens were used in the shell morphology analysis. A subsample of 40 brachiopods (2-5 specimens per decade over the last 120 years) were used for further shell analysis on shell density, punctal width, punctal density, shell dissolution, shell thickness and shell elemental composition.

Answer:

We have corrected it in the revised manuscript.

Page 2, Table 1 column 1 row 3:

N = 389 (adults)

changed to

N = 389 (adults) for shell morphology analyses\*.

And we have added the note below the table:

\*A subsample of 40 brachiopods (2-5 specimens per decade over the last 120 years) were used for further shell analysis on shell density, punctal width, punctal density, shell dissolution, shell thickness and shell elemental composition.

4) Please also add that no changes were found in shell dissolution over the last 120 years.

Answer:

We have added it in the revised manuscript.

Page 3, Table 1 column 3 row 3:

add:

no changes were found in shell dissolution over the last 120 years.

5) Page 3, Table 1: Please specify that shell growth rates and shell repair frequencies of *Liothyrella uva* were not affected by low pH and temperature in the row related to Cross et al. (2015) in the column stating “not affected by lower pH”.

Answer:

We have specified it in the revised manuscript.

Page 3, Table 1 column 2 row 4:

not affected by lower pH

changed to

not affected by lower pH and temperature

Page 3, Table 1 column 3 row 4:

not affected by either low pH conditions or temperature

changed to

shell repair frequencies were not affected by low pH and temperature

6) Page 31, Line 9: To avoid confusion, please add in that these specimens are from the same locality in New Zealand (Paterson Inlet, Stewart Island, New Zealand).

Answer:

We have added it in the revised manuscript.

Page 31, Line 9:

One response, however, appears to reinforce the shells of *C. inconspicua* by laying down a denser shell compared to specimens from New Zealand over the last 120 years while subjected to a slight decrease in pH (by 0.1) and 2°C increase in temperature over the last two decades (Cross et al., 2018).

changed to

One response, however, appears to reinforce the shells of *C. inconspicua* by laying down a denser shell compared to specimens from the same locality in New Zealand (Paterson Inlet, Stewart Island, New Zealand) over the last 120 years while subjected to a slight decrease in pH (by 0.1) and 2°C increase in temperature over the last two decades (Cross et al., 2018).

7) Page 31, Line 10: Please also add that the pH decrease by 0.1 pH units occurred over the last two decades whilst the 2°C increase in temperature occurred over the last 60 years.

Answer:

We have added it in the revised manuscript.

Page 31, Line 10:

while subjected to a slight decrease in pH (by 0.1) and 2°C increase in temperature

over the last two decades (Cross et al., 2018).

changed to

while subjected to a slight decrease in pH (by 0.1) occurred over the last two decades whilst the 2°C increase in temperature occurred over the last 60 years. (Cross et al., 2018).

8) Page 32, Line 5-8: Majority of the studies listed here did not investigate brachiopod growth rates. To avoid confusion and strengthen the authors point that there is a limited database on ocean acidification impacts on brachiopods, only include studies here on brachiopods.

Answer:

As we mainly discussed the effects of acidification on the growth rates of marine calcifiers, we have corrected the word 'brachiopod' to 'marine calcifiers' in the revised manuscript.

Page 32, Line 5-8:

show no or little impact of acidification on brachiopod growth rates

changed to

show no or little impact of acidification on the growth rates of marine calcifiers