

Interactive comment on “Sensitivity towards elevated $p\text{CO}_2$ in great scallop (*Pecten maximus* Lamarck) embryos and fed larvae” by Sissel Andersen et al.

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F. Gazeau: ".....That being said, I have few comments and suggestions I would like the authors to consider before potential acceptance by the editor.

I know the experimental procedure has been published in previous papers but I would strongly recommend the authors to provide more details on how pH was controlled (this appears on Figure 1, but a small paragraph in the text would be useful for the reader) how were pH and total alkalinity measured (I believe these are the 2 "measured" parameters as opposed to $p\text{CO}_2$ that is computed) and how did you compute the non measured parameters, CO_2 -sys? which constants were used? "

C1

Authors: A new section has been added to Material and Methods after review1 (2.1., pg 3 lines 18-31) which describes all the above 1)-3): 2.1. Seawater parameters Seawater was pumped from 160 m depth and filtered through a sand filter before temperature was adjusted in a heat pump. The water was aerated and finally filtered through a 50 μm filter. Temperature was recorded every 10 minutes using a four detector (one in air and three in exposure tanks) EBI – 1 Ebro 4 temperature logger. The overall mean temperature (\pm SD) calculated from recordings every 10 minutes in three tanks (at the three treatments), was 15.48 ± 0.16 oC (n=3903). Daily means based on recordings every 10 minutes for each treatment (table 1) was used to calculate $p\text{CO}_2$ values. Salinity was checked daily using a WTW LF330 Conductivity meter. The pH-level in each exposure tank was measured daily in a 100 ml sample using a Mettler Toledo equipped with a Mettler Toledo InLab[®]ExpertPro pH-probe, calibrated with 4.00 and 7.00 buffers (Certipur[®] buffer solutions, Merck KGaA, 64271 Darmstadt, Germany) traceable to standard reference material from NIST (NBS). The daily means for each treatment (table 1) was used to calculate $p\text{CO}_2$ values. Total alkalinity (AT) was analyzed in the three treatments at the start and end of experiment (n=6) by a Titralab, Radiometer, and the mean value 2321.5 $\mu\text{mol kgSW}^{-1}$ was used when calculating $p\text{CO}_2$ values. The $p\text{CO}_2$ -values (μatm) corresponding to the pHNIST-values (table 1) were calculated based on the means of temperature (oC), pHNIST, salinity and AT, and using the macro taken directly from Ernie Lewis' "CO2SYS.BAS" Basic Program (Pierrot et al., 2006) with the set of constants K1, K2 from Mehrbach et al. (1973) refit by Dickson and Millero (1987), the constant for KH_2SO_4 from Dickson and Millero (1987) and for total Boron (BT) from Uppstrom (1974). Also, since this section describes the connection between pHNBS and pH NIST, we changed NBS to NIST in the manuscript to avoid confusion. NIST is used in Andersen et al. 2013a.

"Please also explain how "live" larvae were identified in your formalin preserved samples. "

A new sentence has been added on p 5 line 1-2: Larvae were classified as "live"

C2

when the shell was filled with soft tissue, and as “dead” when the shell was empty or contained little soft tissue.

“I deeply regret that the authors did not measure and did not report pH on the total scale. For marine environments (their salinity level is 35.1), this is the recommended scale to use. This makes it harder to compare to other studies performed in marine waters as there are no easy way to convert between the 2 scales. Please have a look at the “Best practices guide” that has been released already some years ago: <https://www.iaea.org/oceanacidification/act7/Guide> and please consider using this scale for future studies. Anyway, what is done is done, therefore I would strongly recommend to refer whenever possible to their treatments as offsets from the control: i.e. -0.2 and -0.4 pH units, this would be easier for the reader to quickly understand what are the imposed perturbations.”

We appreciate the advice and will indeed consider using pH on the total scale in future studies. This work was carried out in 2013 and was focused on comparability with the published work from 2012 (Andersen et al., 2013a). We will refer to offsets from the control (ambient) in both Abstract and Table 1 to show the imposed perturbations.

“The authors mention that these species is “commercially important” but do not provide justifications for it. Please clarify why this is a commercially important species and provide numbers (yield, income) for it.”

We mention that this is “a commercially exploited species” (Introduction, p2, line 5-6), and not that it is “commercially important”. References to “a commercially exploited species” are added.

“As a concluding remark, the authors rightly recommend to conduct future studies considering variable levels of pH/pCO₂ as it is the case in many coastal areas, they should further indicate that not only the magnitude of pH variability is potentially different as compared to the open sea but also average levels (especially for these epibenthic species) are certainly far from offshore levels. Just an occasion to insist on the fact

C3

that coastal monitoring stations are cruelly missing!”

We strongly agree with F. Gazeau to further indicate that not only the magnitude of pH variability is potentially different as compared to the open sea but also that average levels are far from offshore levels. This is included in the Discussion followed by a reference. We also agree that coastal monitoring stations are cruelly missing. We added 3 sentences to the Discussion (now p 11, line 4-9): “Not only are the fluctuations different between open ocean and coastal areas, also average levels in coastal areas are different from open ocean levels. The few reports on the situation in near shore waters show pH values as low as 7.6, already exceeding the expected average values for the open ocean within year 2100 (e.g. Thomsen et al. 2010; Gazeau et al. 2011; Reum et al. 2014). These data are so far based on very few coastal monitoring stations, and effort should be made to increase the monitoring of highly productive coastal areas in the future to reveal the pCO₂ levels the coastal epibenthic species in fact are exposed to.”

“Minor comments: - Please note that a space is always required between a number and its unit. I will not list them, but many spaces are missing. “

Many spaces have been added (now p 8 and 9).

“- P1L27: Not sure this is the right study to cite here, as this is limited to the Arctic. You could cite the meta-analysis of Kroecker et al. (2013) in GCB for instance. – P2L1: Same as above. This will look as self-publicity but you could consider citing Gazeau et al. (2013) in Marine Biology here.”

We agree with F. Gazeau, and have changed the reference from AMAP (2013) to Kroecker et al. (2013) in GCB. Also, we added Gazeau et al. (2013) in Marine Biology.

“- P2L31: correct to: “in 38 L exposure tanks” “

Corrected.

C4

“- P2L33: the authors should mention the levels projected by 2100: -0.06 to -0.32 (by heart, check the right values) according to IPCC 2013.”

Based on IPCC 2013 (FAQ – p 15) we added the sentence: IPCC (2013) has projected the pH levels by 2100 to be 0.06 to 0.32 lower than it is today.

“- P6L25: in the standard range of what?”

We added “. . .described by (Magnesen et al., (2006) and Andersen et al., (2013b).” (now pg 7, line 30)

“- P7L7: survival at day 7 seems higher than what is mentioned here, please check”.

F. Gazeau are right. The numbers for survival were changed due to a correction in sampling volume, but was not changed in the Discussion. The numbers in Discussion are now corrected (now pg 8 line 9 and 13)

“- Table 1: What is CO₂ in ppm?”

It is the mole fraction (also called ppmv), but calculated in CO₂SYST as part of dry air. It was included due to old reports that used ppm.

“This is still a partial pressure to me (or a fugacity?)” No, it is not fugacity.

“- Figure 1: same comment as Reviewer1”

The figure has been changed accordingly

“- Please consider presenting Figure 3 as Figure 2 is presented, i.e. Days in x-axis and pCO₂ with different colours.”

Figure 2 does not have pCO₂ with different colours, just shades of grey. All measurements for the first group (“Unshelled”) was from day 2, and for the second measurements (Protruded velum) from day 3, but not with a direct link between the two (no indication that the unshelled larvae on day 2 ended up with a protruded velum on day 3). We think therefore the original figure 3 is the best way of presenting these data.

C5

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C6