

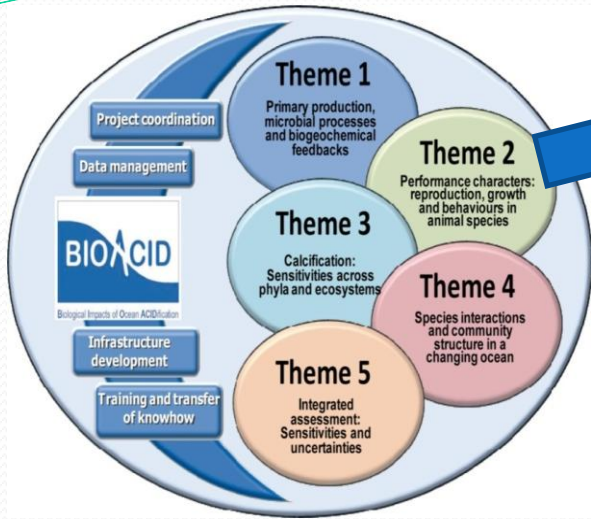
Effect of ocean acidification on fertilization success of *Strongylocentrotus droebachiensis*.

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Prof. Dr. Angela Köhler
P.D. Dr. Ulf Bickmeyer



Biological Impacts of Ocean ACIDification



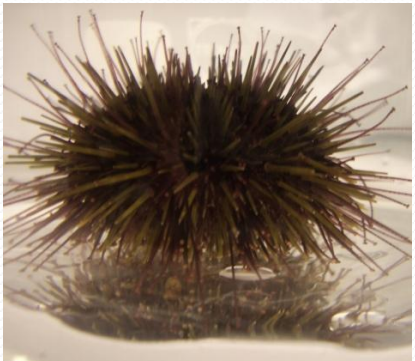
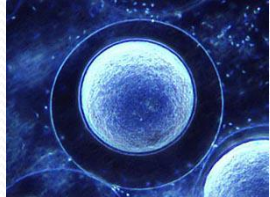


Ocean acidification and reproduction: Is the beginning of life in danger?

Reproduction



Gametogenesis
Fertilization



Strongylocentrotus droebachiensis

Water Temperature
May: -2 to 0°C
June: 1 to 2°C
July: 4°C

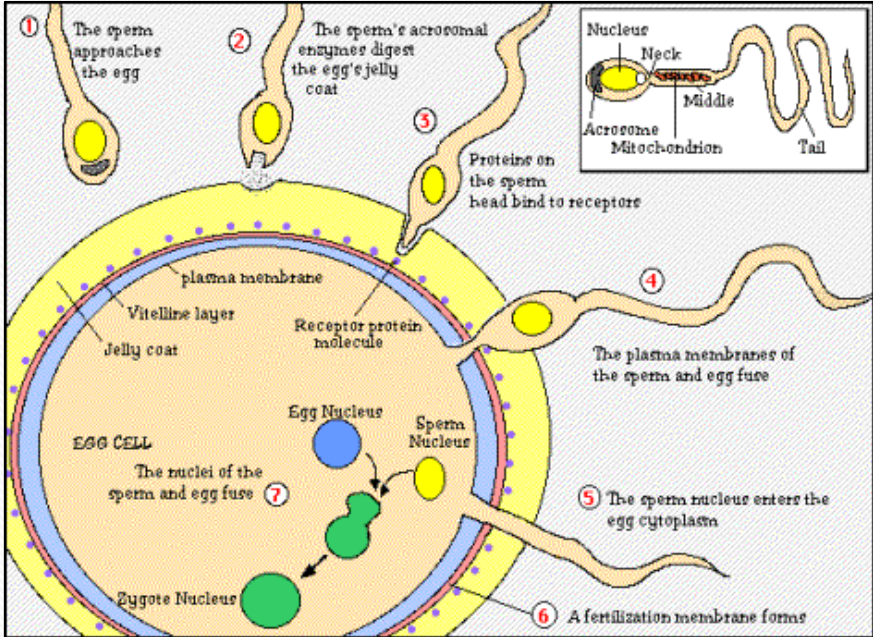


FERTILIZATION

**CAPACITATION
CHEMOTAXIS**

**ACROSOME
REACTION**

DEPOLARIZATION



**CHANGE IN Ca^{2+}
CONCENTRATIONS
AND pH_i ,
SIMULTANEOUS
ACTIVATION OF
ENZYMES**

**CORTICAL
REACTION**

**FORMATION OF FERTILIZATION
MEMBRANE
BLOCK TO POLYSPERMY**

CHALLENGES FOR FERTILIZATION UNDER OCEAN ACIDIFICATION CONDITIONS

Exogenous stressor:

- CO₂/pH

Endogenous stressors:

- Risk of ROS effects
- Alteration of intracellular redox conditions

Experimental design

Selected pCO₂ :

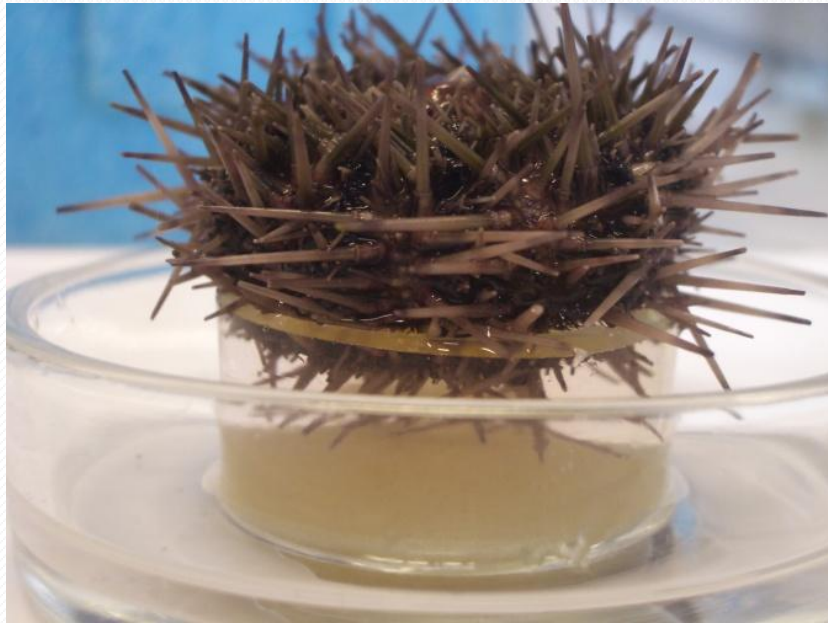
- 180 μatm
- 380 μatm
- 980 μatm
- 1400 μatm
- 3000 μatm

Air Temperature: 2.8°C
Water Temperature: ~3°C

Sea water carbonate system was controlled by measuring pH, DIC and TA



Experimental design



FERTILIZATION TESTS

Without pre-
incubation of
the eggs

With pre-
incubation of
the eggs

End point : 1 hr, 3 hrs
To follow development: 24/48/72 hrs

SAMPLE COLLECTION

- Histology
- Histochemistry
- Immunolocalization


MEASUREMENTS OF pH_i
of exposed eggs
with (BCECF/AM)

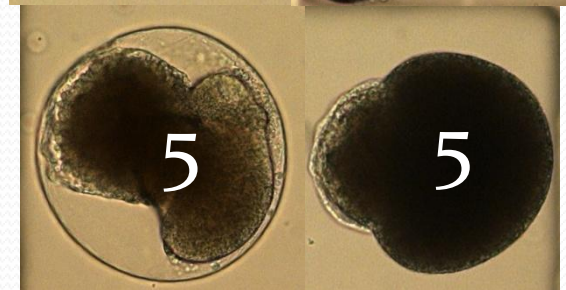
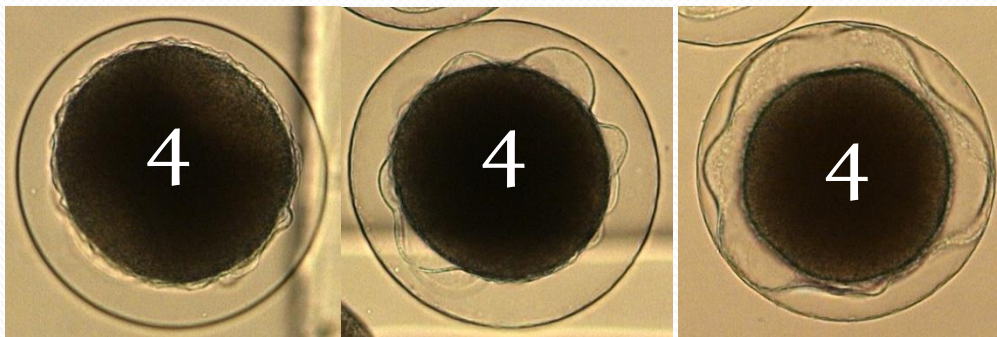
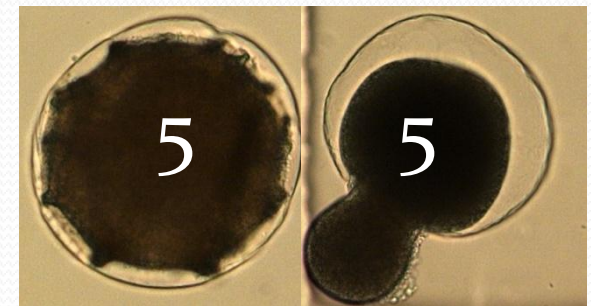
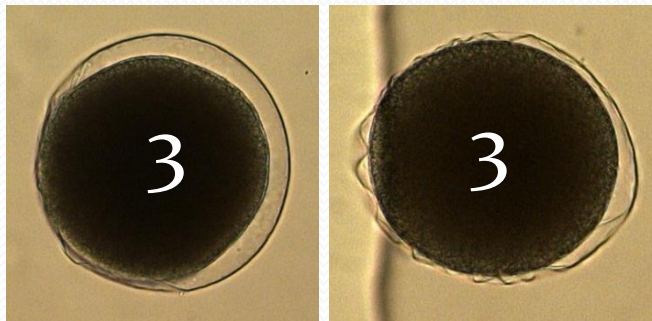
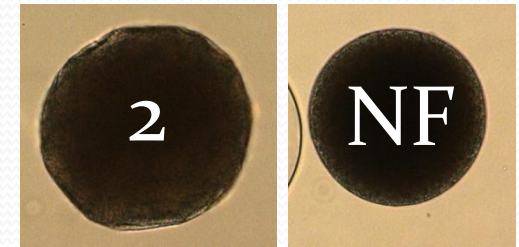
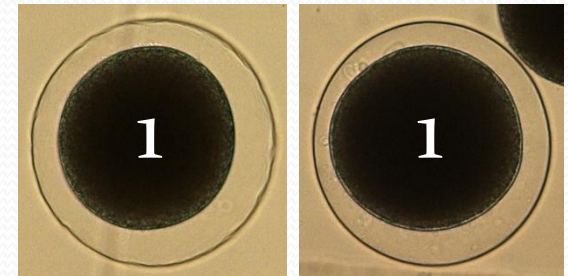


RESULTS

Fertilization experiments without pre-incubation of the eggs

Degree of damage observed:

- 
1. Fertilized with healthy condition
 2. Fertilization membrane not formed
 3. Partially lifting of fertilization membrane
 4. Blebby hyaline membrane
 5. Cytoplasmic constriction or degeneration



Experiments with pre-incubation

1 hr

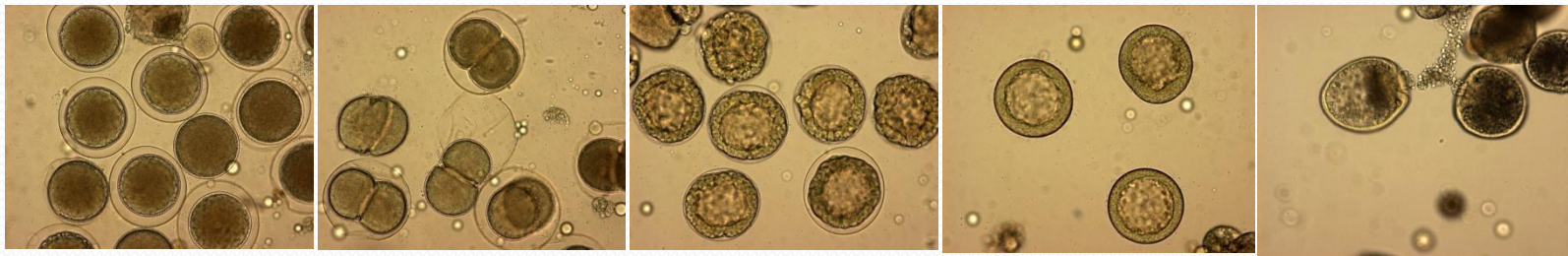
3 hrs

24 hrs

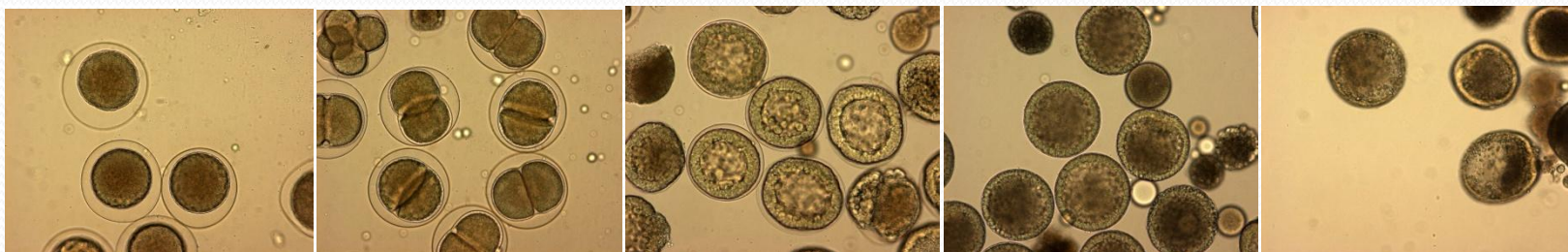
48 hrs

72 hrs

FSW



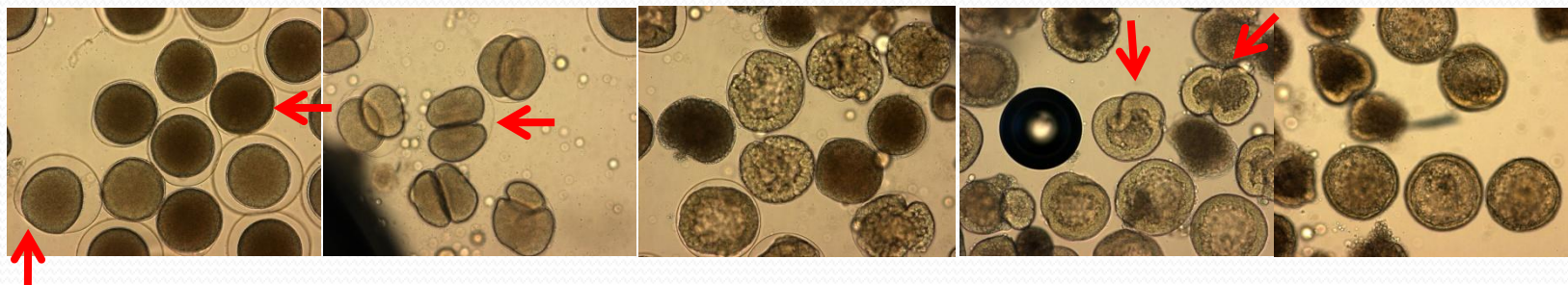
380 μatm



180 μatm



980 μatm



1400 μatm

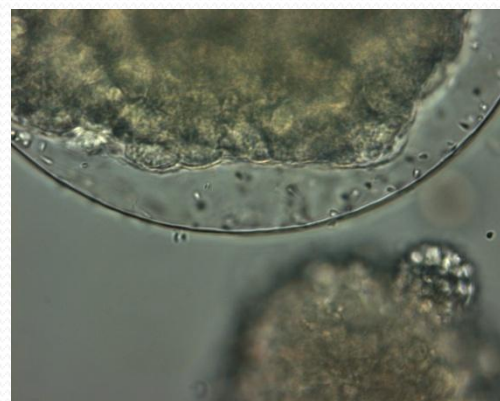
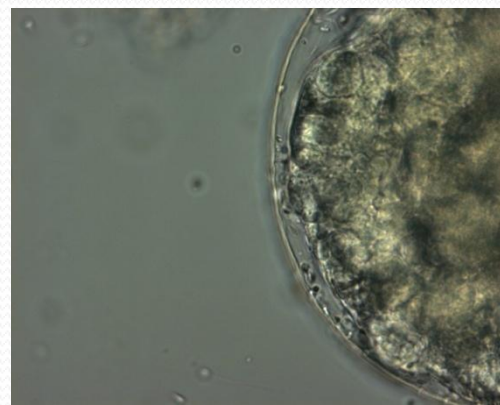
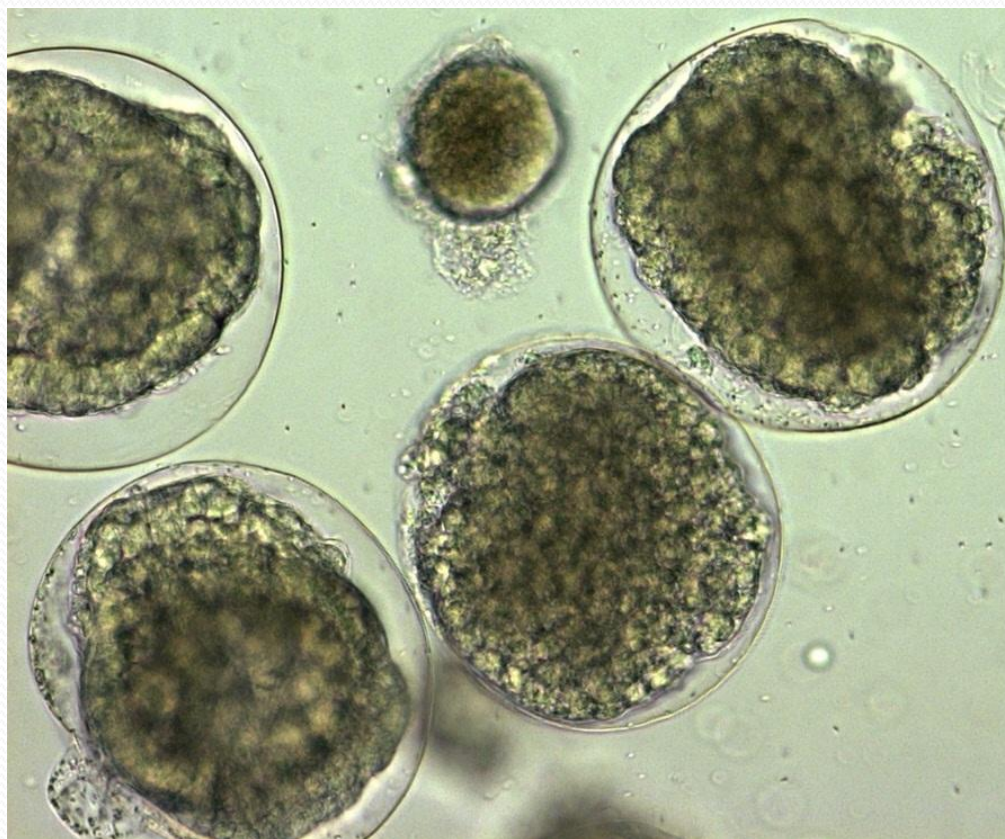
1 hr

3 hrs

24 hrs

48 hrs

72 hrs

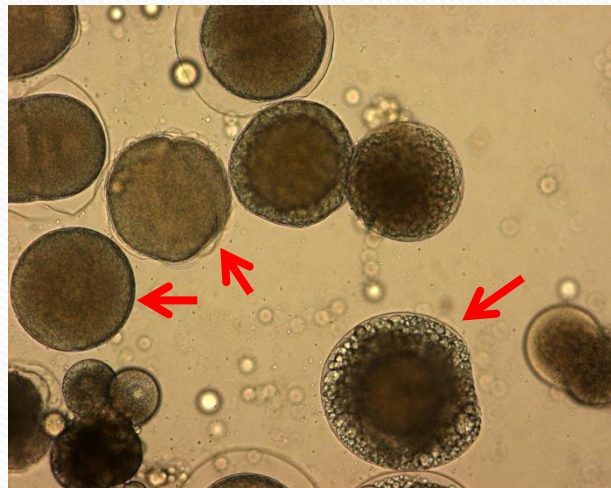


3000 μ atm

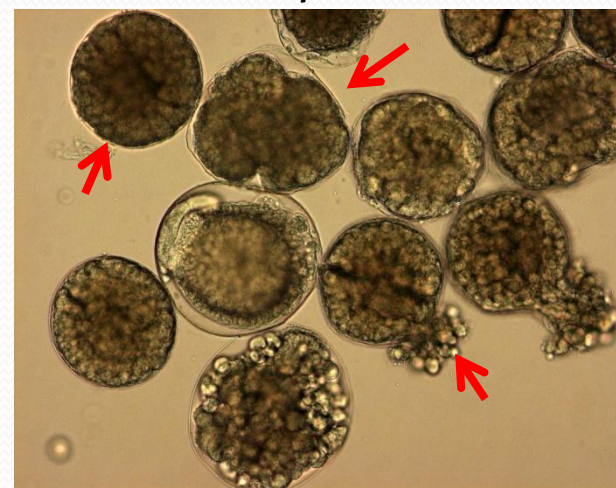
1 hr



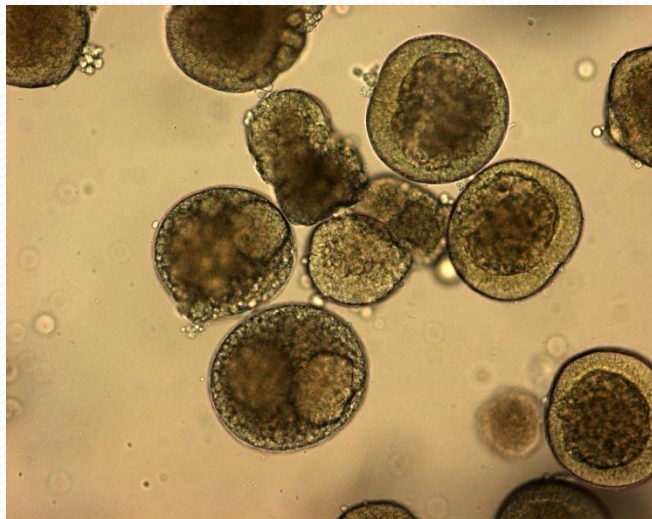
3 hrs



24 hrs



48 hrs

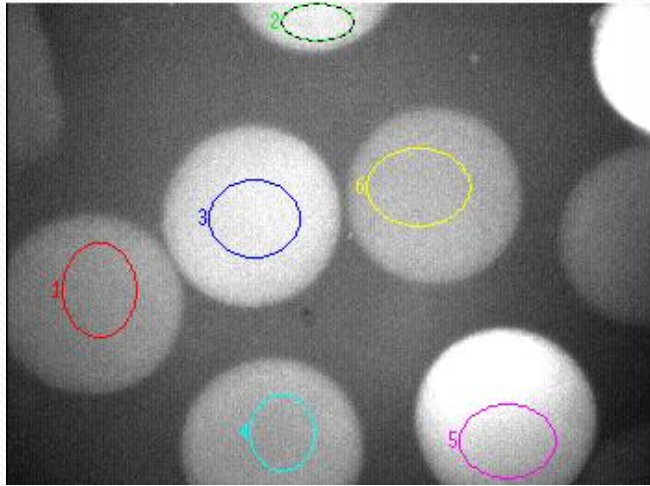


72 hrs

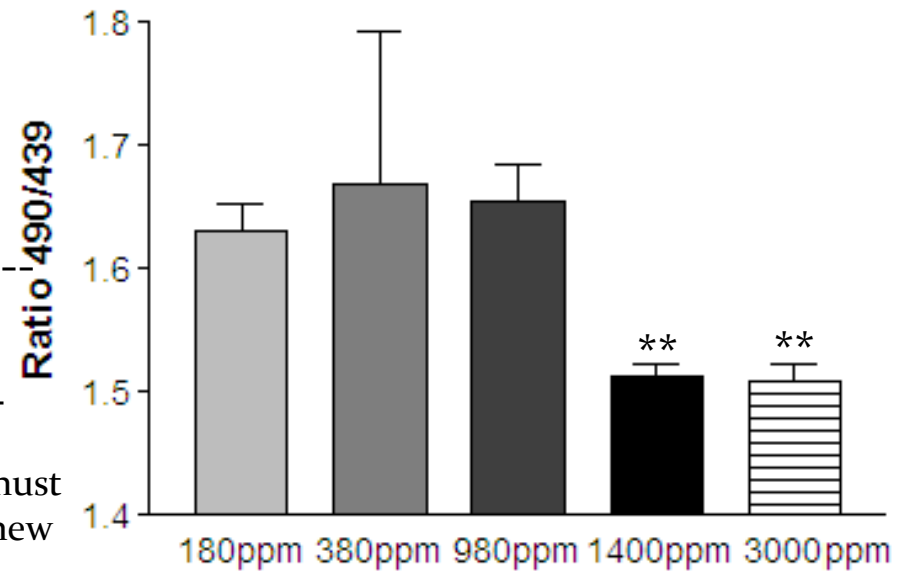


RESULTS

Intracellular pH measurements



~ pH_i 7.0 -
~ pH_i 6.7 -
-
(The exact pH_i must be validated by new calibration)



Conclusions

- Intracellular pH changes were detected at CO₂ concentration of 1400 μ atm and 3000 μ atm .
- Acidified sea water up to 1400 μ atm , enhances the risk of polyspermy.
- Exposition of the eggs to acidified sea water up to 980 μ atm , reduces the fertilization success and survivorship of the zygotes.
- Up to 48 hours the zygotes start to move, in acidified sea water up to 1400 μ atm, movements and development in general are highly reduced.
- As much time are the eggs exposed to acidification, as greater are the observed effects of the different CO₂ concentrations used: the number of unfertilized eggs increases and morphological pathologies are more evident.



ACKNOWLEDGMENT

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THANK YOU!