Initial results of long-term OA exposure on the biology of intertidal benthic foraminifera

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Talk Outline:

- Introduction: Foraminifera and Ocean Acidification
- Details on Experimental System
- Sampling Regime and Foraminiferal Picking Methods
- Preliminary Results
- Future Work

1. Foraminifera & Ocean Acidification:

Changes in seawater chemistry due to ocean acidification will have severe implications on marine organisms that construct carbonate shells and structures, including foraminifera.

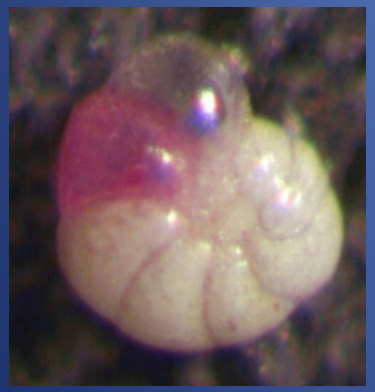
Foraminifera are unicellular organisms that construct a shell (test) which, when the animal dies can remain in the sediment as a fossil

Shells (tests) hold the potential to record information on changing ocean chemistry, often leaving a microfossil record that permits reconstruction of environmental history

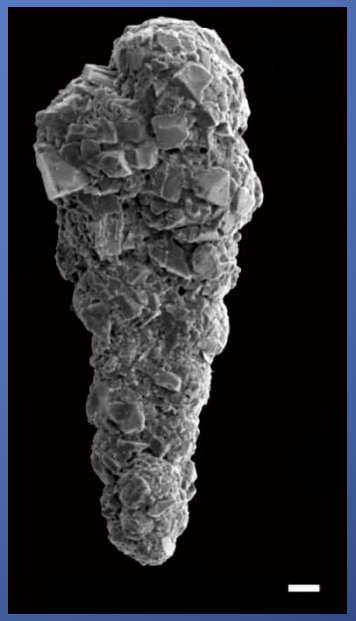
2. Foraminifera:

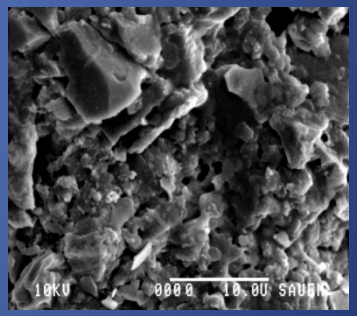
- Constitute one the most diverse groups of shelled microorganisms in modern oceans
- The type of shell material can determine where various species or their remains can survive
- Varying wall compositions = different sensitivities to dissolution

Calcareous forms secrete a $CaCO_3$ test



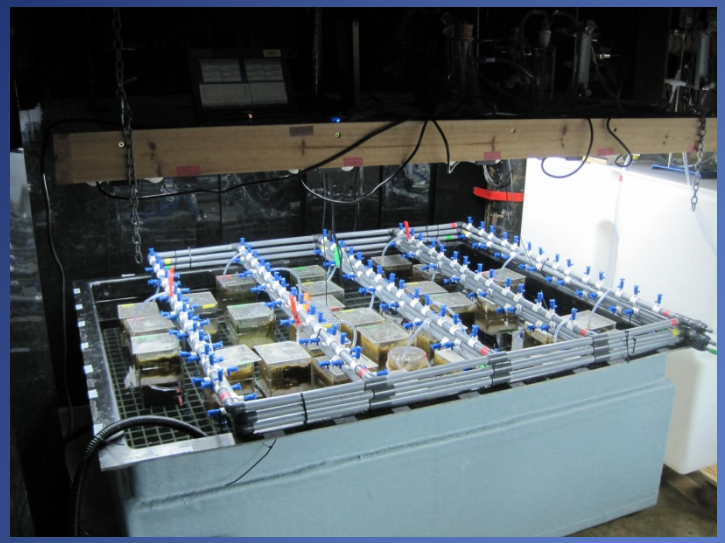
Hyaline **Porcellaneous**





Agglutinated forms build tests by cementing detrital material

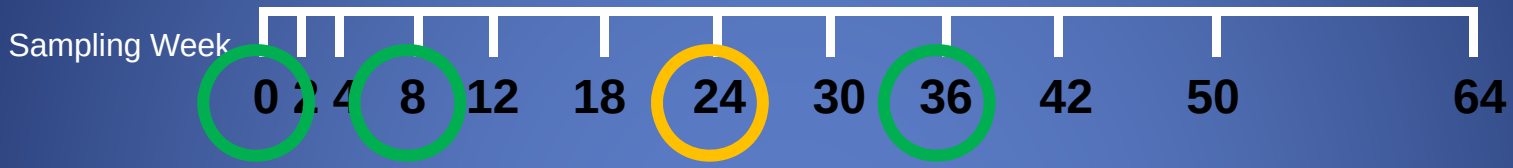
3. Experimental System:



- Samples taken from long-term exposure experiments at Oceanlab, Aberdeen (now at University of Southampton)
- Mud sampled from Ythan Estuary, NE Scotland (Dec 2010)
- CO_2 treatments maintained by bubbling from a air-CO_2 mixing system
- Sub-samples from sediment cores to investigate the foraminiferal response over time

4. Sampling Regime:

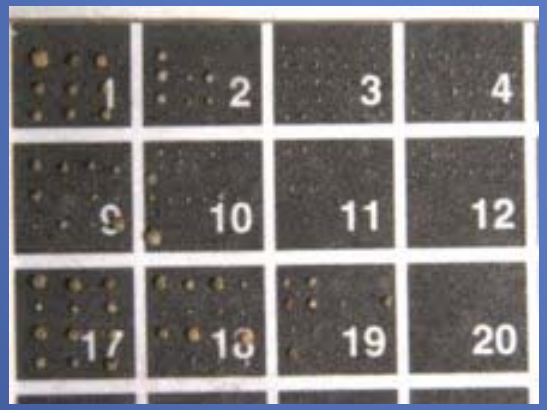
- Samples taken at 12 time points (January 2011 – March 2012)



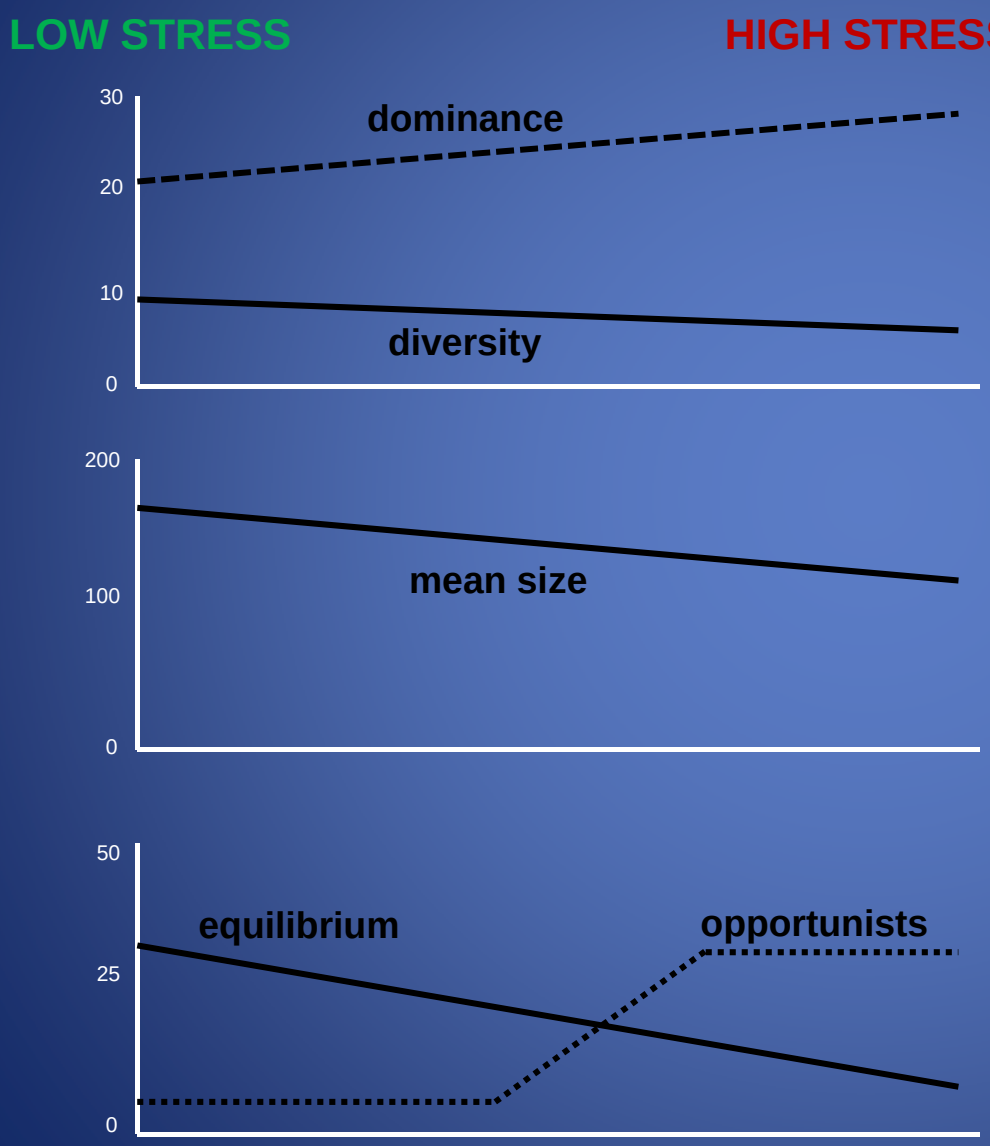
- CO_2 Treatments: 380, 750 and 1000 ppm
- Temperature: 10°C and Ambient
- Four replicates for each (combination of surface scrapes from three points within core)
- Same area never sampled twice

5. Sample Processing & Foraminiferal Picking Methods:

- Samples fixed and stained with Rose Bengal at time of sampling
- Sediment sieved (>63 µm), washed & dried (< 40 °C)
- Dry weights determined & samples stored
- Foraminifera extracted using standard micropalaeontological techniques



6. Predicted trends under environmental stress:



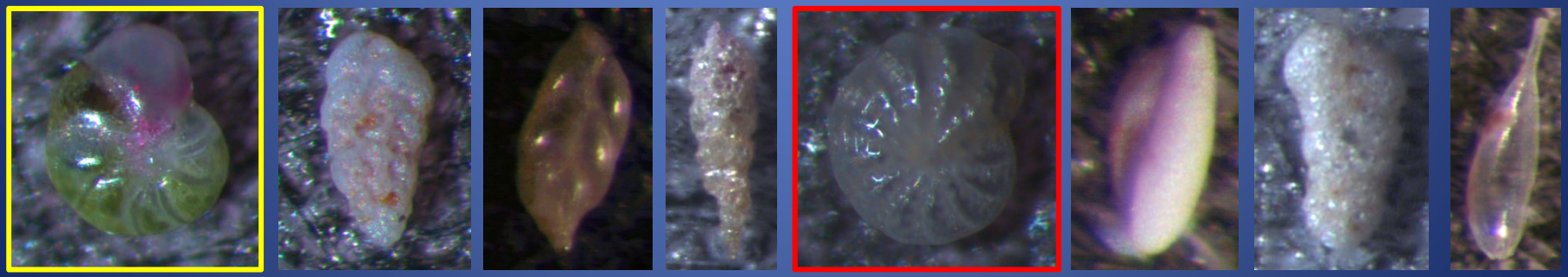
Redrawn from Murray (2000)

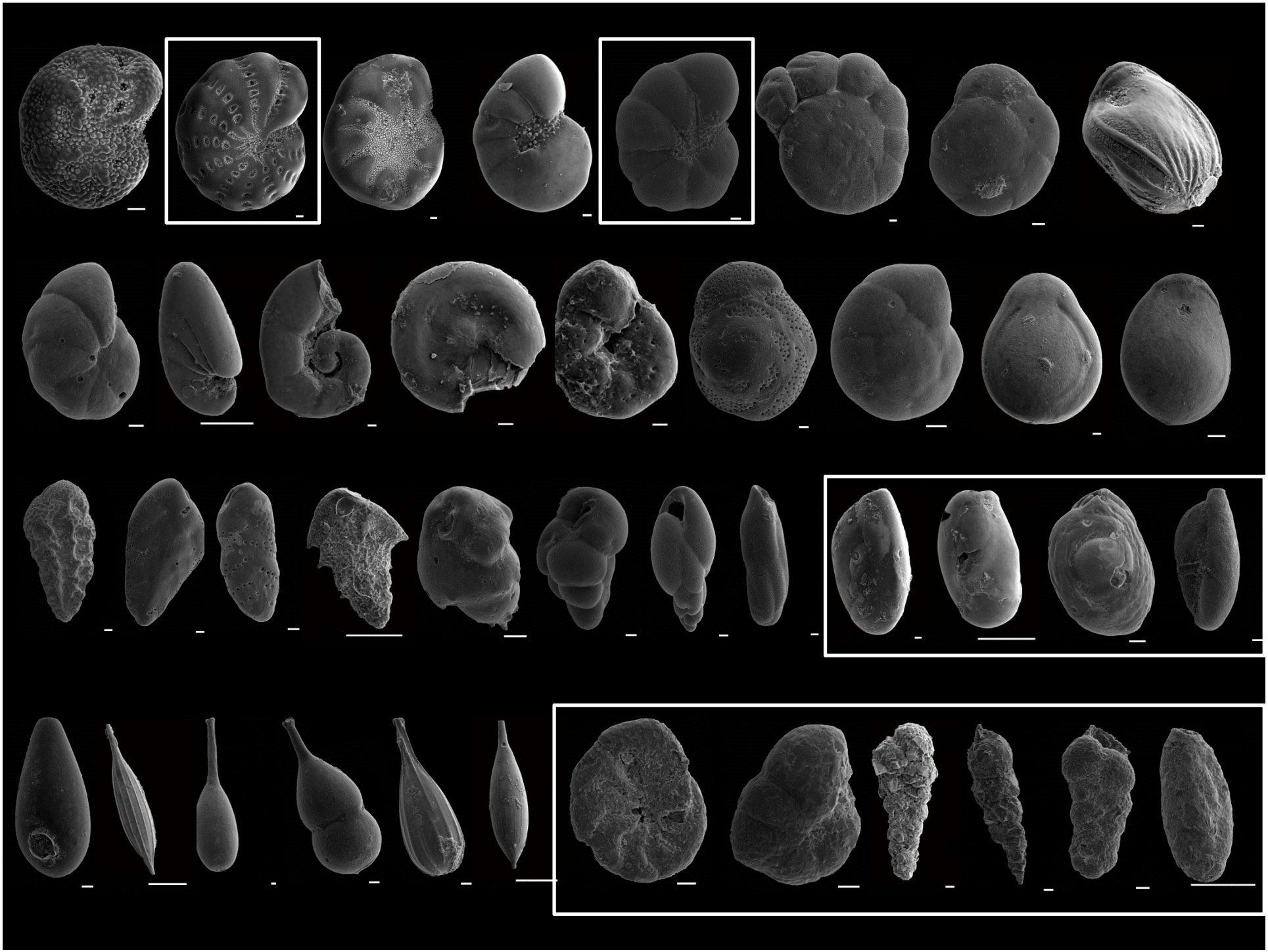
Data collection on:

- Species dominance
- Species diversity
- Species presence/absence
- Species abundances
- Biometry

7. Preliminary Observations (1):

- 44 species identified from total (live + dead) assemblages
- Live foraminifera account for 1 - 22 % of total populations
- Two dominant species in live populations:
  - *Haynesina germanica* *
  - *Elphidium williamsoni* *

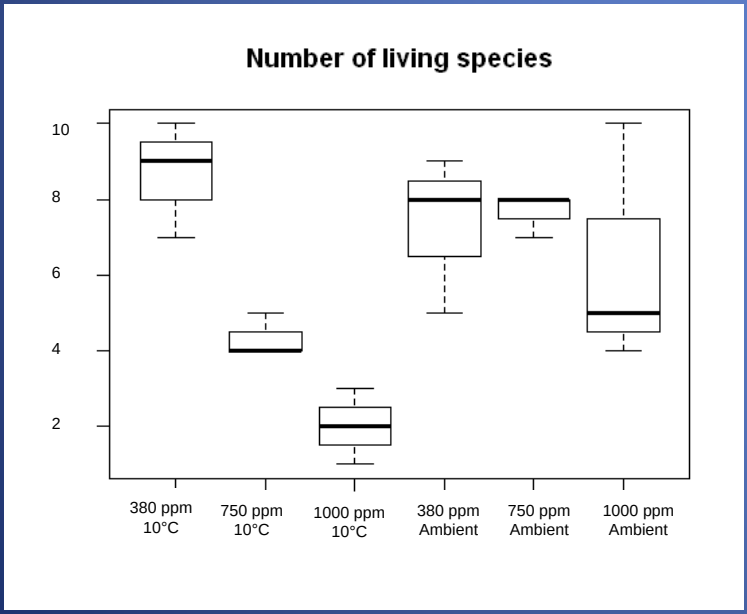


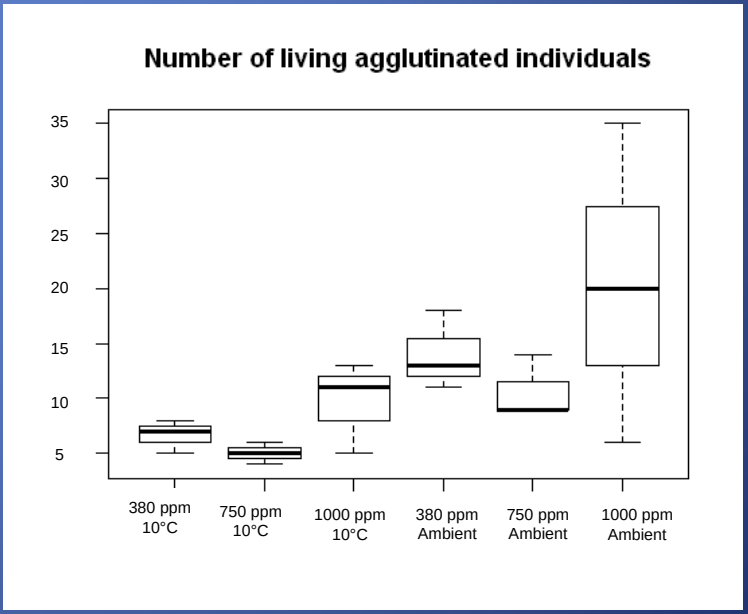


Preliminary Observations (2):

- Highest number of living species present at 380 ppm
- Fewer live individuals in highest CO_2 treatments
- More agglutinated individuals in highest CO_2 treatments

Initial plots for week 36:



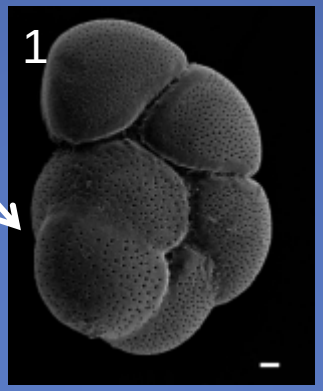


($df_1 = 2$, $df_{12} = 12$, $F = 4.411$, $p = 0.037$)

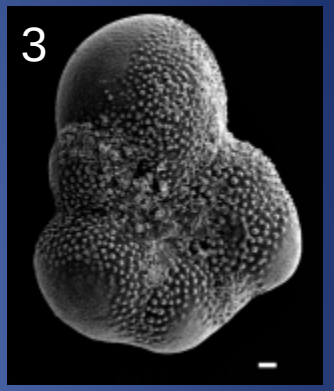
Preliminary Observations (3): Deformation and dissolution

Several different modes of abnormality in test morphology observed:

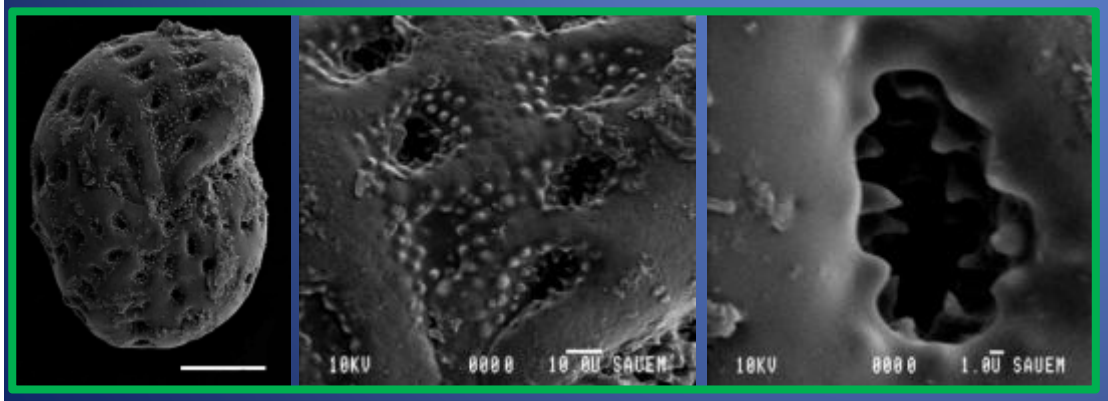
- Abnormal chamber additions
- Aberrant chamber shape
- Distorted chamber arrangement
- Reduced chamber size
- Reduction in ornamentation



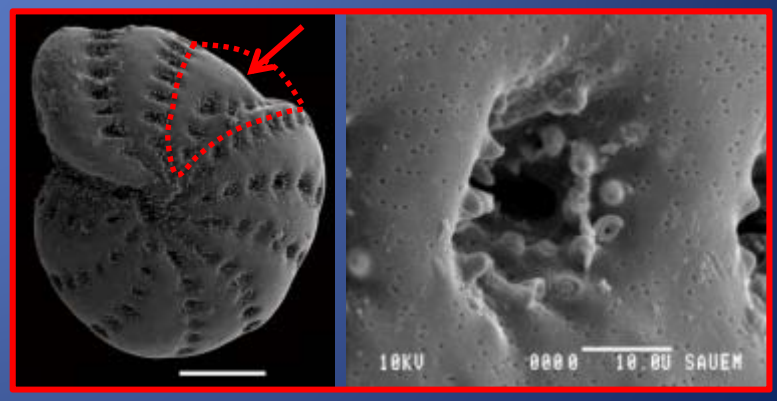
380 ppm



1000 ppm



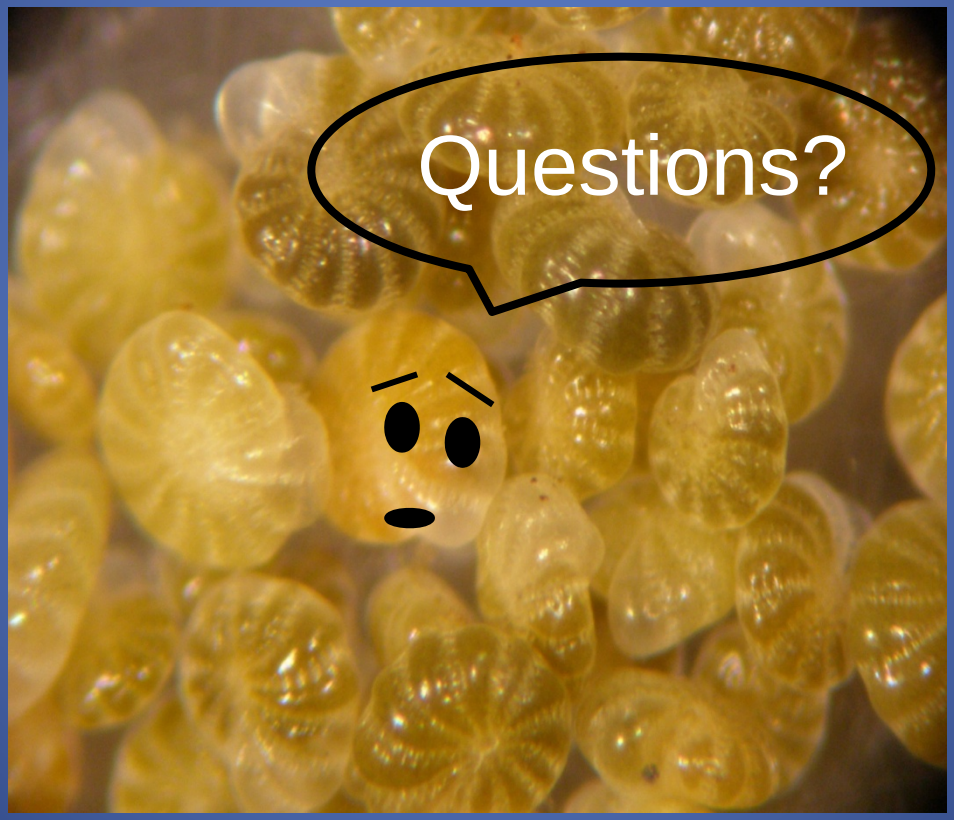
380 ppm



1000 ppm

8. Future Work:

To provide valuable insight into foraminiferal response to ocean acidification:

- Keep picking forams! (Complete time-series)
- Establish a dissolution index
- Identify species specific sensitivities to changing pCO_2 & temperature
- Document changes in dominance and species diversity
- Quantify growth effects e.g. Maximum test diameter, test thickness

Thank you for your attention