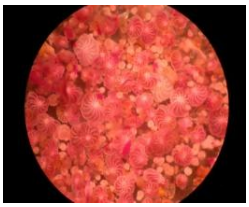
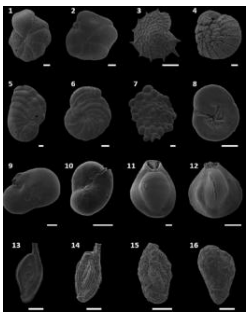
Volcanic CO_2 vents reveal the ecosystem effects of ocean acidification

J Hall-Spencer, V Johnson, L Pettit, MG Graziano, M Hart, C Smart & R Rodolfo-Metalpa, University of Plymouth
School of Marine Science & Engineering & School of Geography, Earth & Environmental Sciences

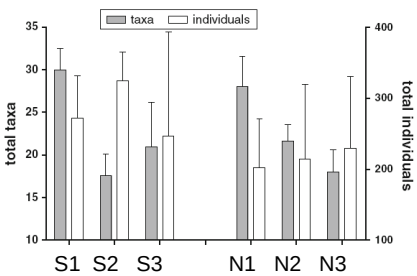
The oceans currently absorb over 25 million tons of human-made CO_2 every day causing unprecedented changes to ocean chemistry. As well as lowering pH, increasing CO_2 levels cause a decline in carbonate ions, an increase in bicarbonate ions and lower calcium carbonate saturation states. We are using coastal CO_2 vents as 'natural laboratories' to investigate how these changes in water chemistry affect coastal ecosystems.





Sampling stations off Ischia[2]. Foraminifera were diverse and abundant in sand at normal pH (24 species at stations N_1 and S_1) but only four species occurred at mean pH 7.8.

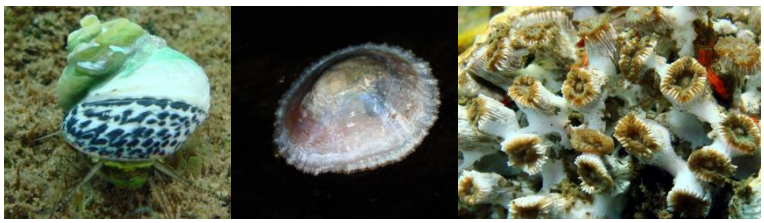
Major ecological changes occur at mean pH 7.8. Invertebrate recruitment is severely impaired compared to normal (pH 8.1) conditions. However, seagrasses, invasive macroalgae and jellyfish are resilient to long-term exposures to the CO_2 levels predicted for the end of this century.



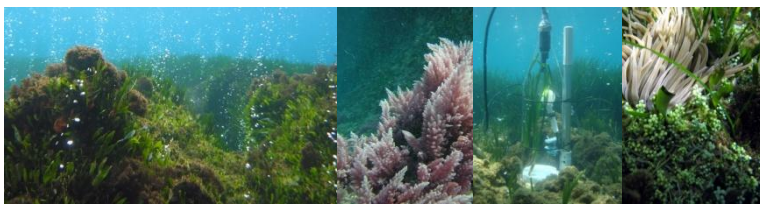
Recruitment to scouring pads after 1 month off Ischia showed that increased CO_2 levels caused significant reductions in spring settlement from the plankton[5].

Usually, marine gas vents are hot and contain toxic sulphur. Vents off Ischia (near Vesuvius in Italy) are at ambient temperature, lack toxic compounds and are hundreds of years old. They have marine communities that are tolerant of long-term high CO_2 conditions[1].

A wide range of organisms, including protists, seaweeds, seagrasses, invertebrates and fish have been investigated at shallow CO_2 vents off Ischia. At mean pH 7.8 and below most calcifiers (e.g. coralline algae, corals, molluscs, spirorbids, foraminifers, echinoderms) are either absent or strongly reduced in abundance. Shells dissolve and benthic biodiversity is 30% lower than in normal conditions.



***Losers:** sea urchins die and snail and limpet shells dissolve at mean pH 7.8 near the CO_2 vents. Transplantations of corals and bryozoans show that the combined effects of abnormally high summer temperatures and ocean acidification are detrimental to these key organisms[3].*



***Winners:** the vents reveal which communities and species are tolerant of long-term high CO_2 levels, such as* Posidonia oceanica *seagrass[4], invasive macroalgae (*Asparagopsis armata *and* Caulerpa *spp.) jellyfish (*Pelagia noctiluca*) and anemones (*Anemonia *spp.).*

Our *in situ* observations are beginning to show what levels of biodiversity loss and what ecosystem changes to expect under different CO_2 emission scenarios.

References: 1. Hall-Spencer et al. (2008) *Nature* **454**, 96-99. 2. Dias et al. (2010) *Journal of the Geological Society, London* **167**, 843-846. 3. Rodolfo-Metlpa et al. (2010) *Marine Ecology an Evolutionary Perspective* **31**, 447-456. 4. Martin et al. (2008) *Biology Letters* **4**, 689-692. 5. Cigliano et al. (2010) *Marine Biology* DOI: 10.1007/s00227-010-1513-6

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