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SEA CHANGE WITH PLYMOUTH UNIVERSITY

MedSeA
MEDITERRANEAN SEA ACIDIFICATION UNDER CHANGING CLIMATE

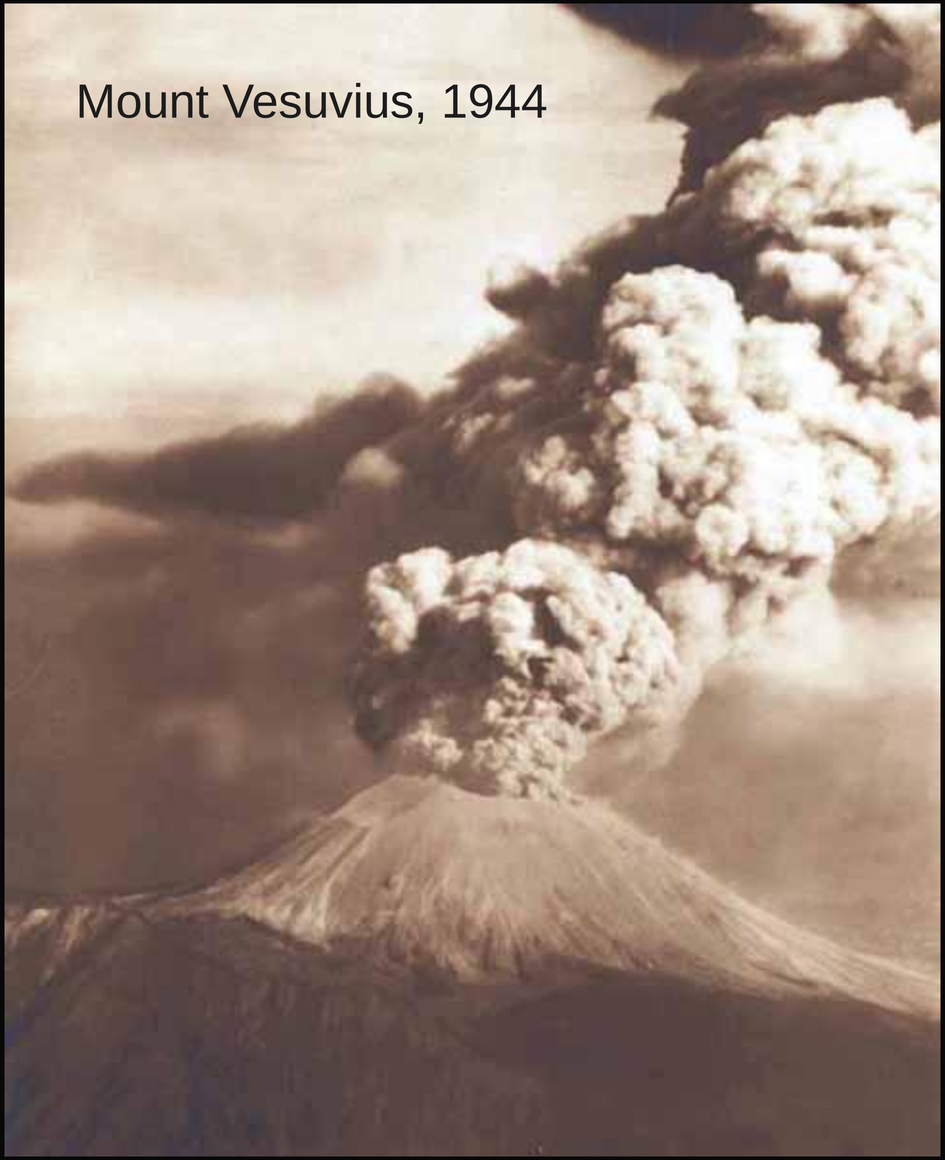
UK Ocean Acidification Research Programme

It is difficult to scale-up from laboratory studies as we can not imitate ocean acidification conditions *in situ* for long enough to affect whole marine communities.

However..

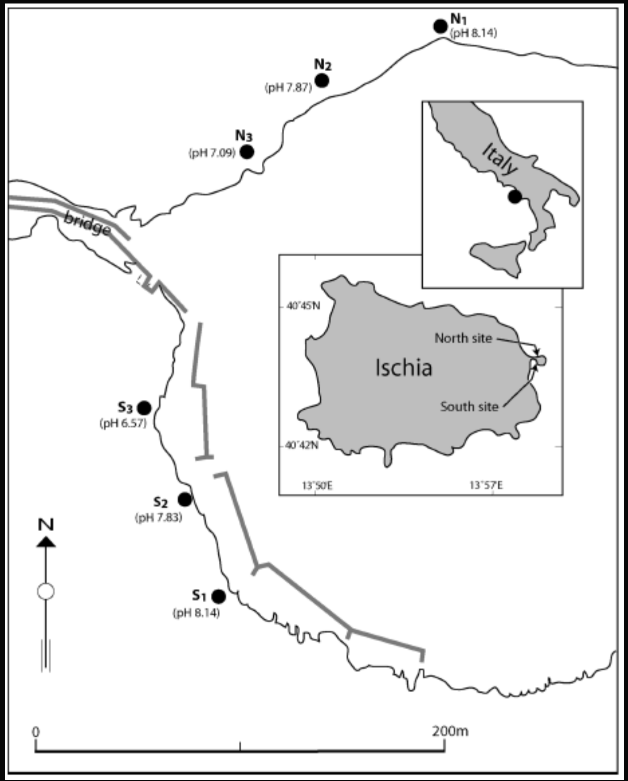
Areas with naturally high CO_2 show how ecosystems respond to long-term exposures to CO_2

Experiments at such sites are revealing the underlying mechanisms that drive ecosystem change.



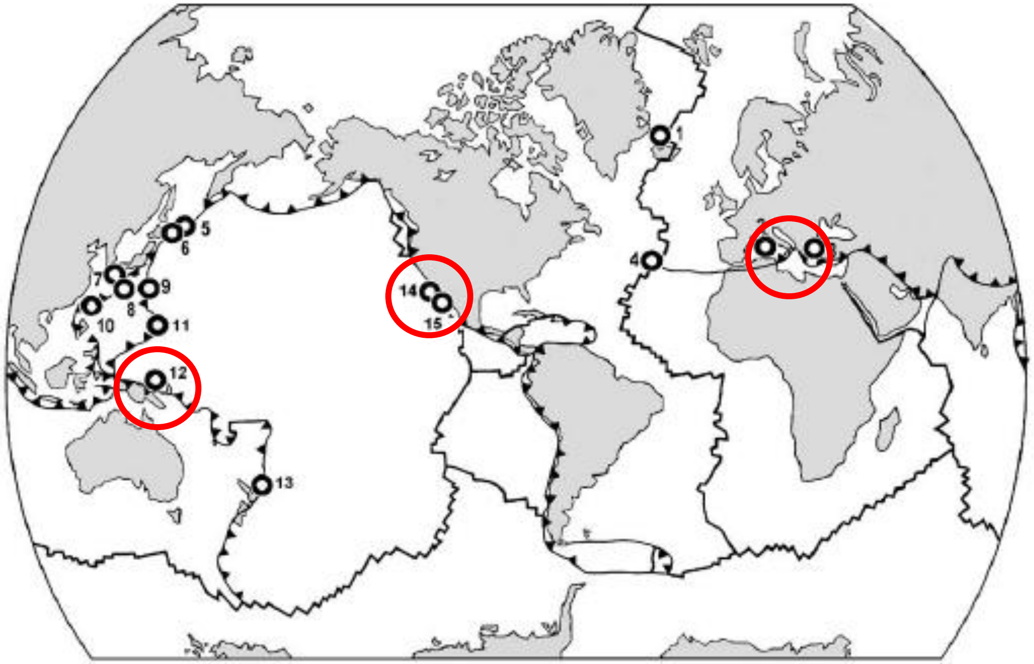
Italian volcanoes are of global significance in geological CO_2 flux…..*ca* 10^8 kg d^{-1}

Etna alone produces 10% of annual global flux from sub-aerial volcanoes.



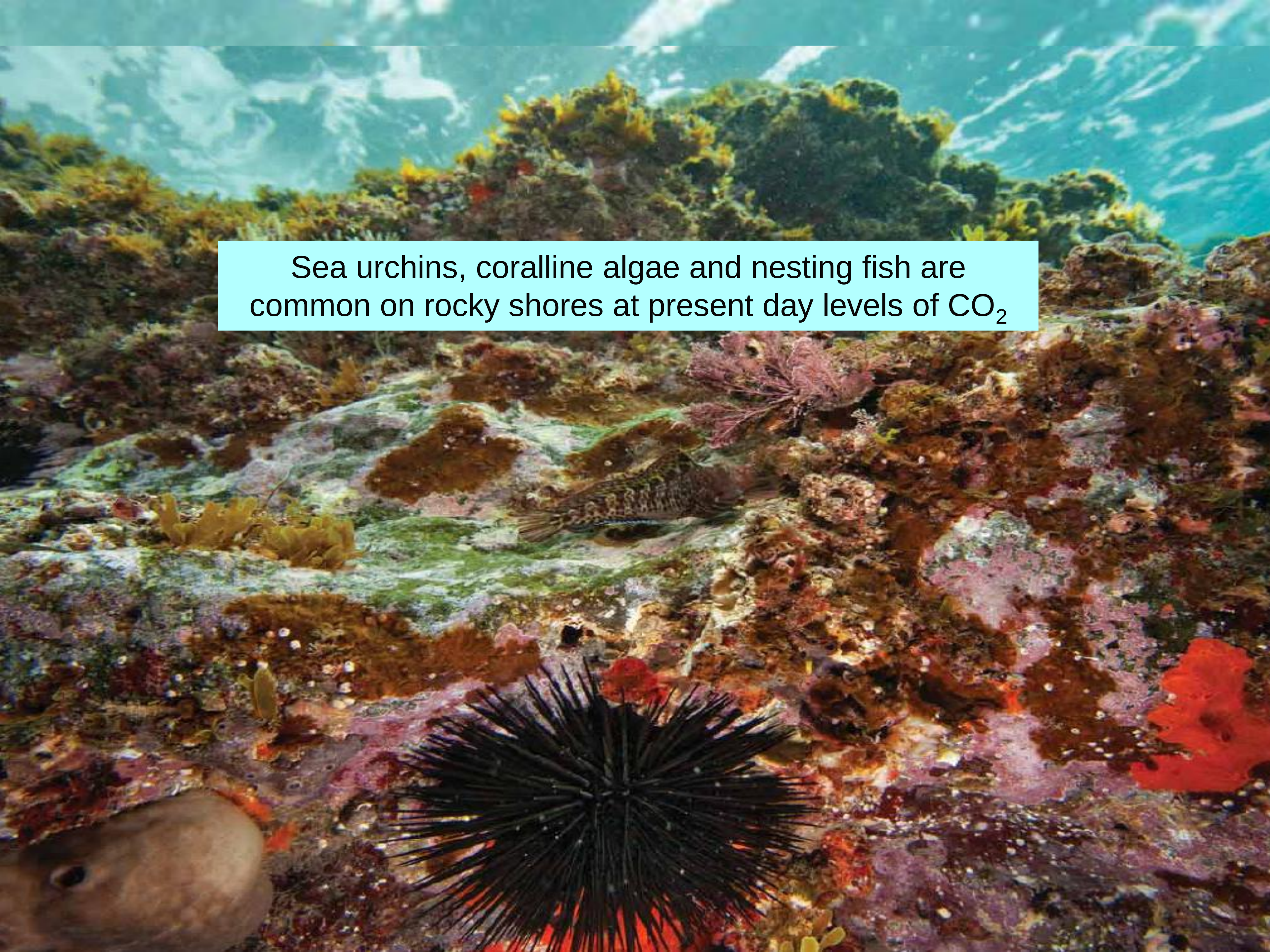
Only a few vent systems are well suited to ocean acidification studies as most have confounding gradients in temperature, total alkalinity and toxic chemicals such as H_2S

High CO_2 / low pH / low carbonate saturation systems occur worldwide



We're investigating vent systems (circles) to find out what ocean acidification can do to coastal habitats in tropical and temperate regions.

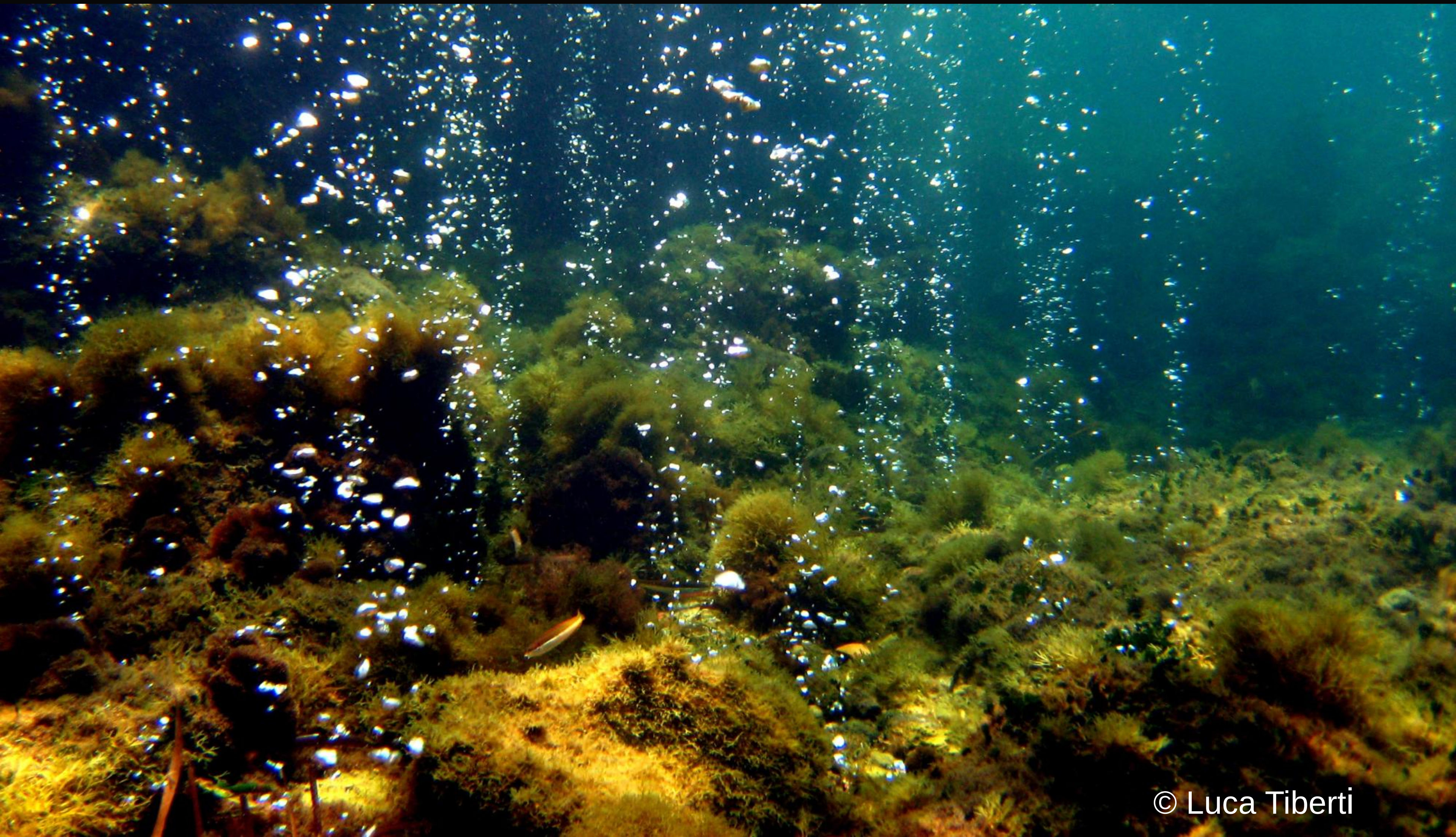
CO_2 causes dramatic biodiversity loss off Papua New Guinea, Baja California (unpublished) and in the Mediterranean - but a few types of organisms, including corals, can survive.



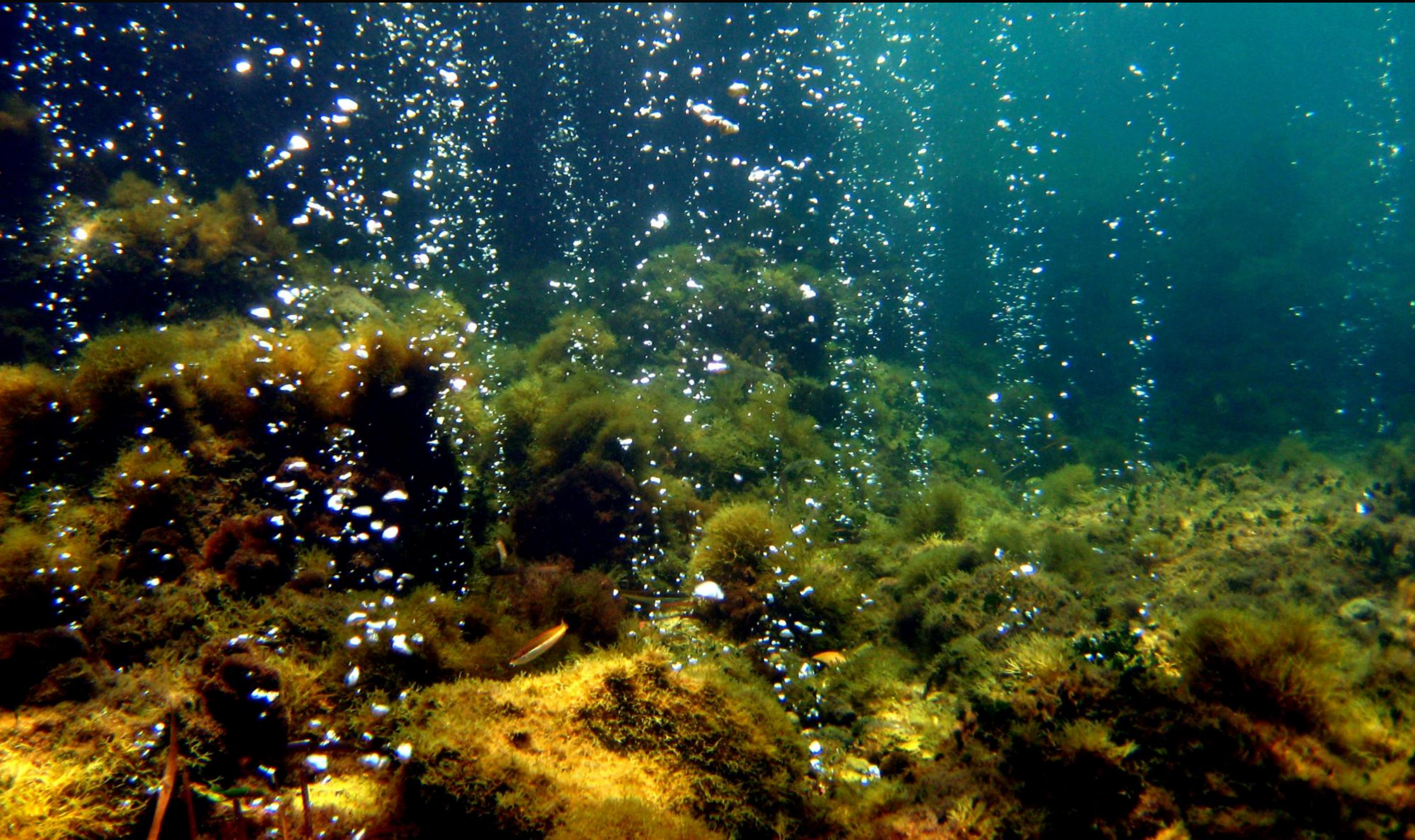
Sea urchins, coralline algae and nesting fish are common on rocky shores at present day levels of CO_2

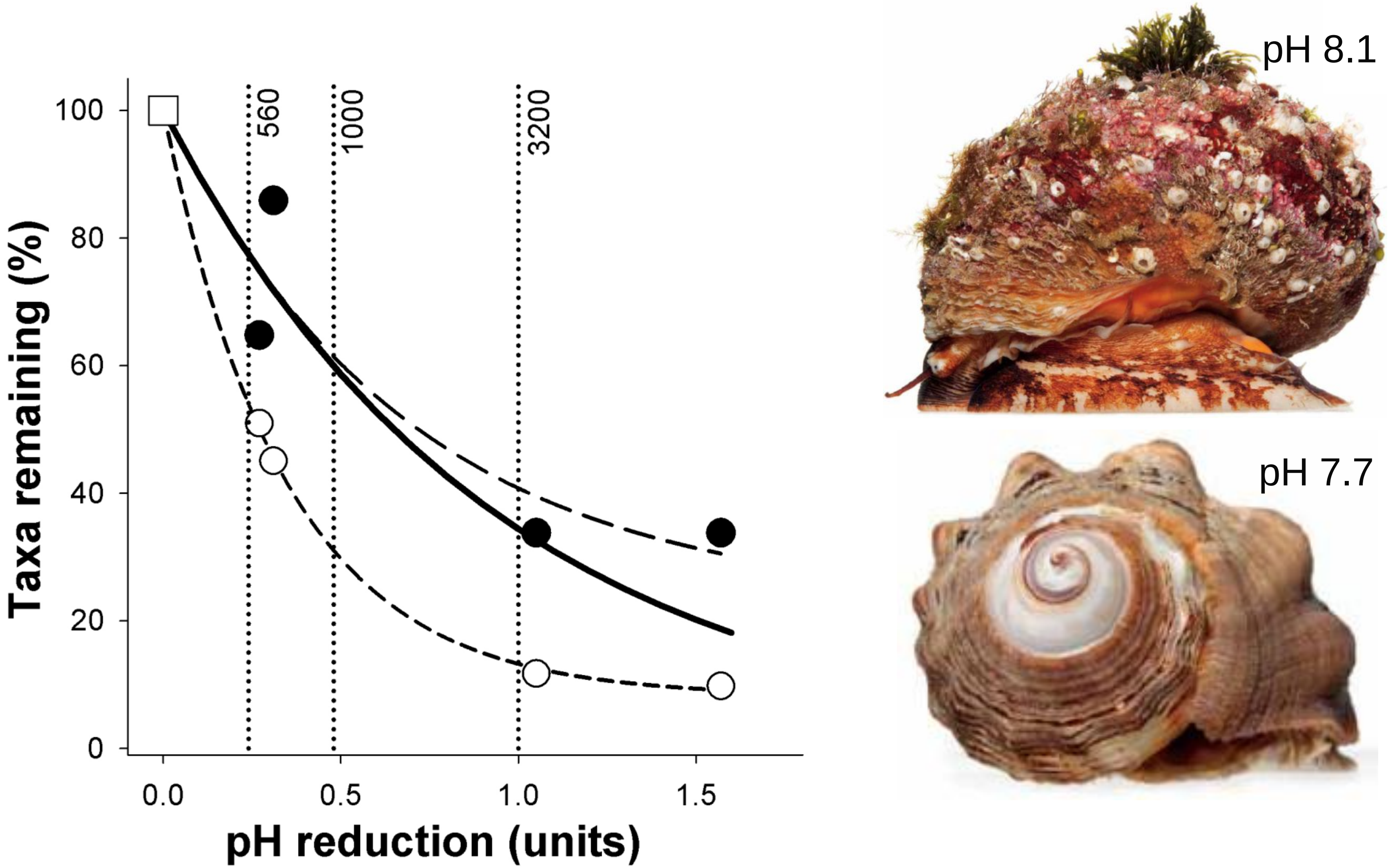
They disappear at CO_2 levels predicted for 2100.

We have examined the effects of increasing CO_2 on 400 tropical and temperate species, including interactions between microalgae, macroalgae, seagrasses, foraminiferans, sponges, nematodes, polychaetes, molluscs, crustaceans, chaetognaths, bryozoans and fish.



Fleshy seaweeds, invasive species and jellyfish tolerate acidification; corals, mussels and sea urchins are absent and the fish don't lay eggs



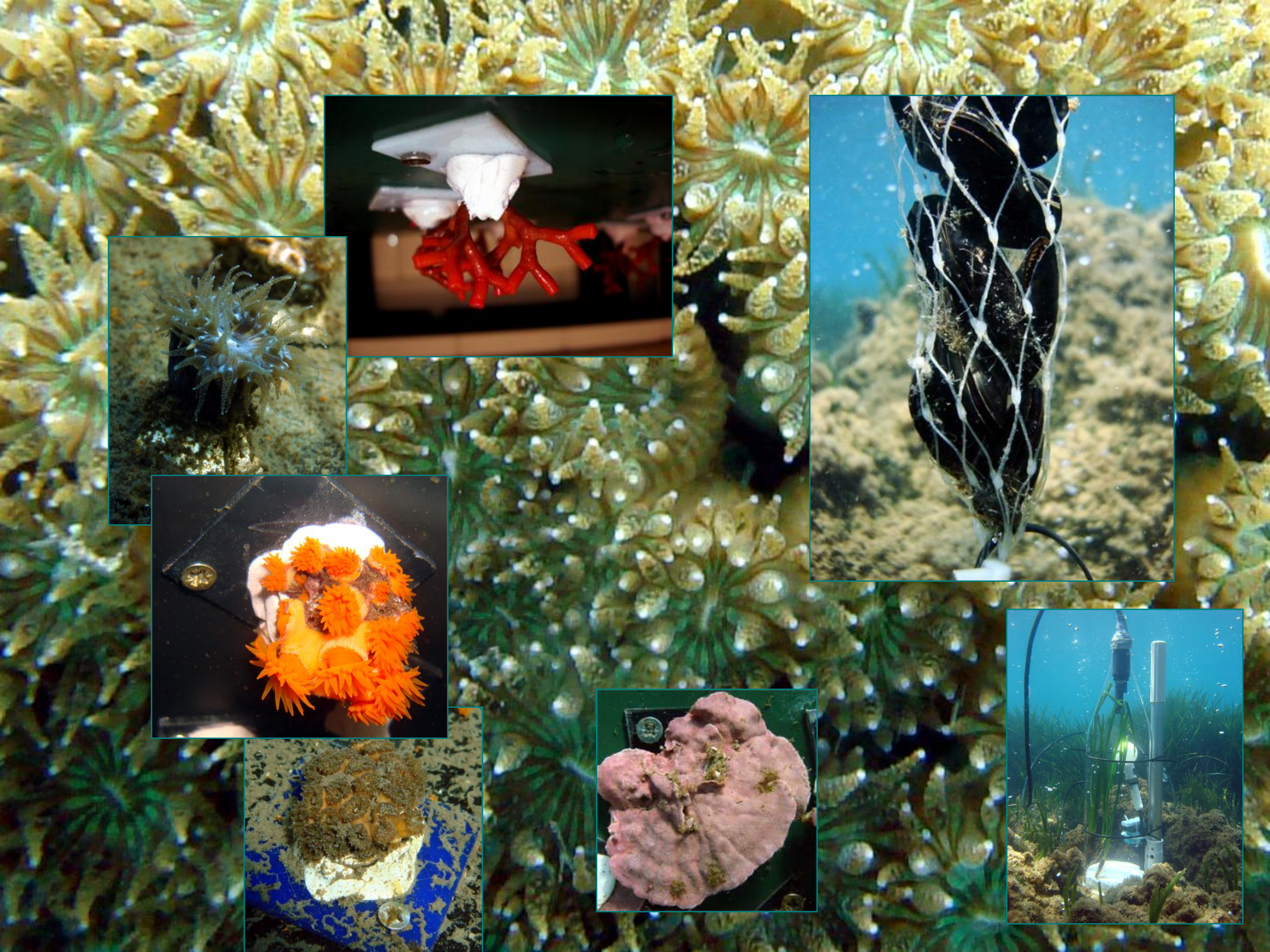


% taxa that occur in areas with no pH reduction (open square) for calcifiers (51 taxa, white circles) and non-calcifiers (71 taxa, black circles). Vertical lines show atmospheric ppm CO_2 required to cause pH changes observed along the pH gradients. Photographs of molluscs collected at mean pH 8.1 and mean pH 7.6 showing reduced biodiversity and shell dissolution in the acidified area.

Mean pH 7.8

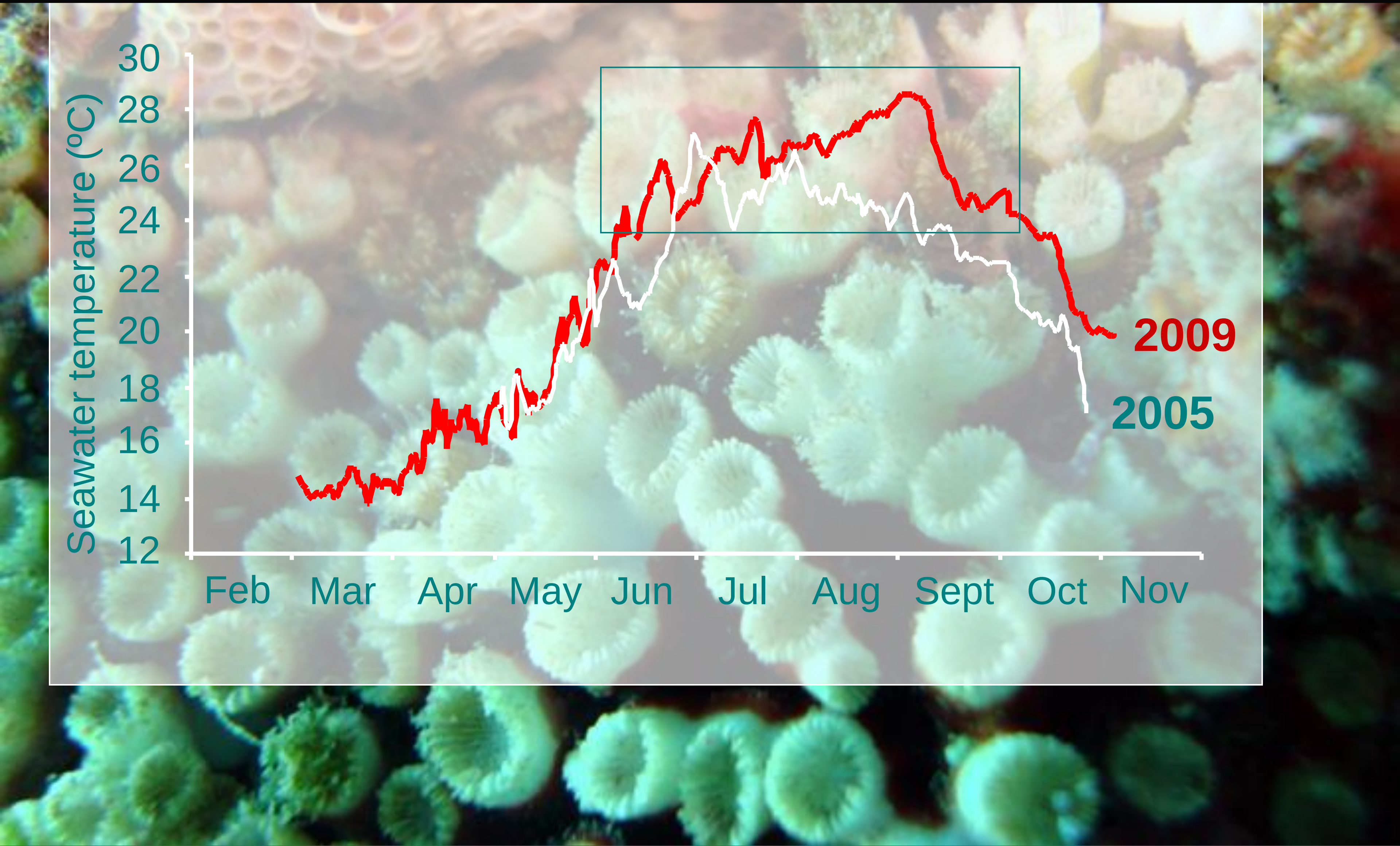
At first sight it looks fine…… but recruitment from the plankton is severely disrupted, the seagrass is less able to defend itself from grazing fish and invasive algae thrive

So what happens when you transplant organisms into high CO_2 areas?



Calcification can occur *faster* in water that is under-saturated with calcium carbonate, but if the organisms can not protect themselves, or are stressed (e.g. by lack of food) then they dissolve

Multiple stressors: organisms can adapt and upregulate their calcification in the face of high CO_2 but die when this is combined with warming



In summary - naturally high CO_2 areas

- integrate the long-term effects of ocean acidification
- identify ‘winners’ e.g. jellyfish and invasive algae
- show where and why tipping points occur along gradients of increasing CO_2 levels
- demonstrate the combined effects of ocean acidification with other common stressors (e.g. warming)
- the vents studies so far show remarkably similar ecosystem effects (sea urchins and coralline algae are especially vulnerable groups) – but even these systems are too small to predict effects on highly mobile fish, turtles and mammals


CO_2 Can Seriously Damage
Marine Biodiversity

This talk is based on these papers; many thanks to my coauthors.

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