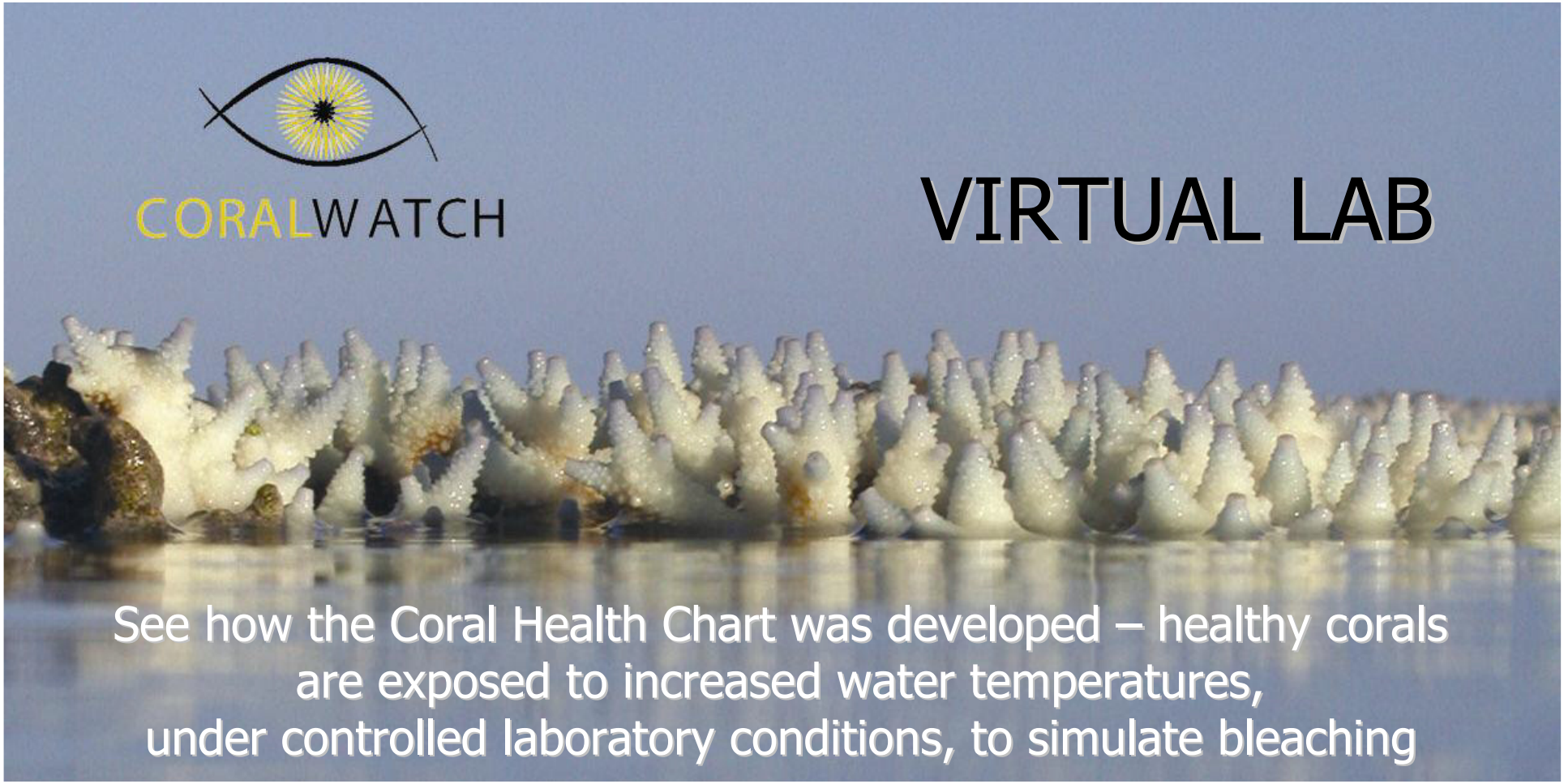


SUSTAINABLE TOURISM CRC

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

What is coral bleaching?

Coral bleaching occurs when corals change colour, generally from dark brown to a lighter shade of brown or white.

The colour change is associated with a loss of symbiotic dinoflagellates (algae) from the coral's tissue. Symbionts provide the brown colour in corals, and bleached tissue contains fewer symbionts than healthier tissue.

Bleaching can be caused by a variety of environmental factors including increased or decreased water temperature, exposure to ultraviolet light, changes in salinity and exposure to chemicals.

What is the Virtual Lab?

The Virtual Lab shows you how researchers created the CoralWatch Coral Health Charts.

It contains photos of four different species of corals that have been exposed to elevated water temperatures for one, three and seven days.

You will see for yourself how increased temperature affects the concentration of symbionts, and consequently the colour of the corals.

Thermal stress experiment

Coral fragments (nubbins) were placed in temperature controlled aquaria (pictured below).

On the first day of the experiment, water temperature was equal to that on the reef flat. Temperature was increased on day two to simulate a ‘natural’ bleaching event.

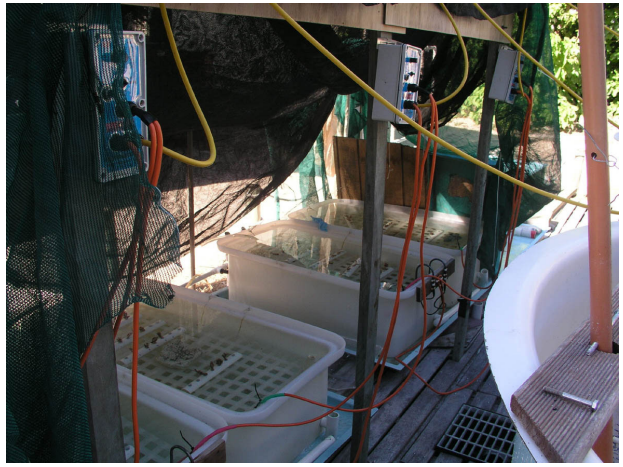


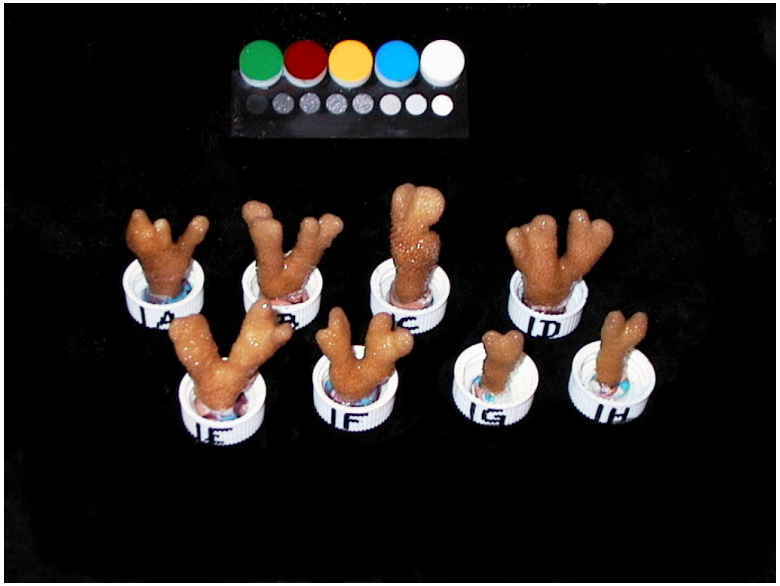
Photo: Jez Roff

Photo: Mark Davey

Thermal stress experiment

The coral nubbins were photographed daily, as pictured below and featured throughout the Virtual Lab.

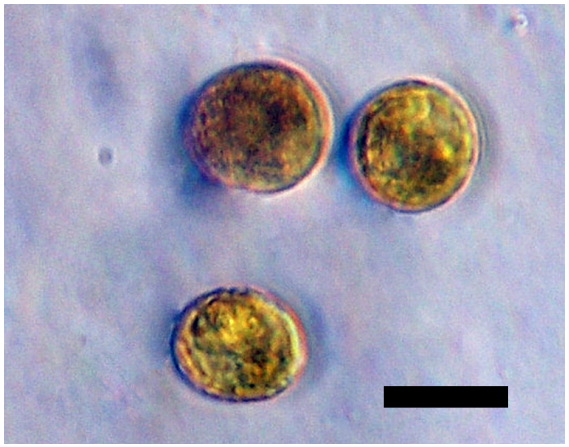
Each day one nubbin from each species was removed to quantify symbionts and colour change.



Quantifying the symbionts

Symbiont density was determined by:

1. Blasting the living tissue from the nubbin using a jet of water.
2. Counting the number of symbionts within the resulting ‘slurry’.
3. Determining the surface area of the nubbin by covering it with aluminium foil.
4. Calculating symbiont density as symbiont number divided by the surface area of the nubbin.



Light microscope image of the coral ‘slurry’ containing isolated symbionts. The green colouration is due to the presence of the photosynthetic pigment chlorophyll. Scale bar 10µm.

Image: Jez Roff

Quantifying colour change

Colour was quantified using:

1. Reflectance measurements.
2. Photographic analysis.

1. **Reflectance measurements** using a spectrometer.

- A spectrometer quantifies the spectrum of light reflected by the coral.
- We perceive the spectrum of light reflected from an object as that object's colour.

Equipment used to quantify colour. A fibre optic cable is connected to the spectrometer (right-hand unit). The cable is used to collect light reflected from that object. The information is processed by the spectrometer and stored in the hand-held computer (left-hand unit).

Quantifying colour change

2. **Photographic analysis** using digital camera and *Adobe Photoshop*
   - Standardised illumination
   - Standard exposure and gain
   - Colour / grey standards to check exposure
   - Calculation of RGB values for each nubbin

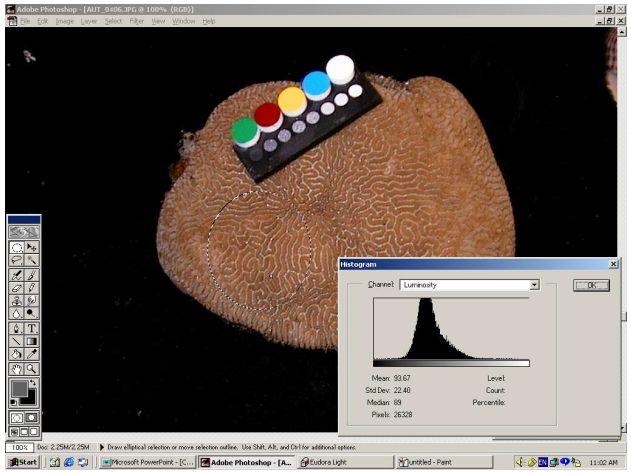
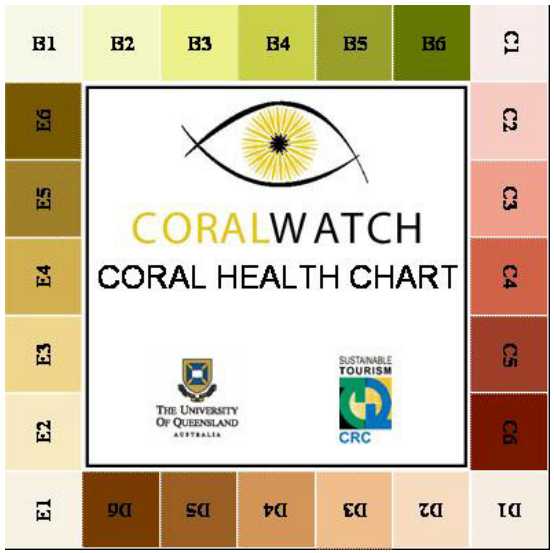


Image taken from the *Photoshop* analysis, showing the RGB values in the bottom right window. RGB represents the amount of red, green and blue light making up an image.

Creation of the charts

Colours were recorded during a natural bleaching event that occurred on Heron Island, Australia during 2002.

Colours obtained during the thermal stress experiment and the natural bleaching event were sorted by hue.



The four most common hues were identified – B, C, D and E on the Coral Health Chart (pictured left).

The brightness and saturation of the four hues were altered to create six colours (1-6) per hue as seen on the Chart.

How to use the Virtual Lab

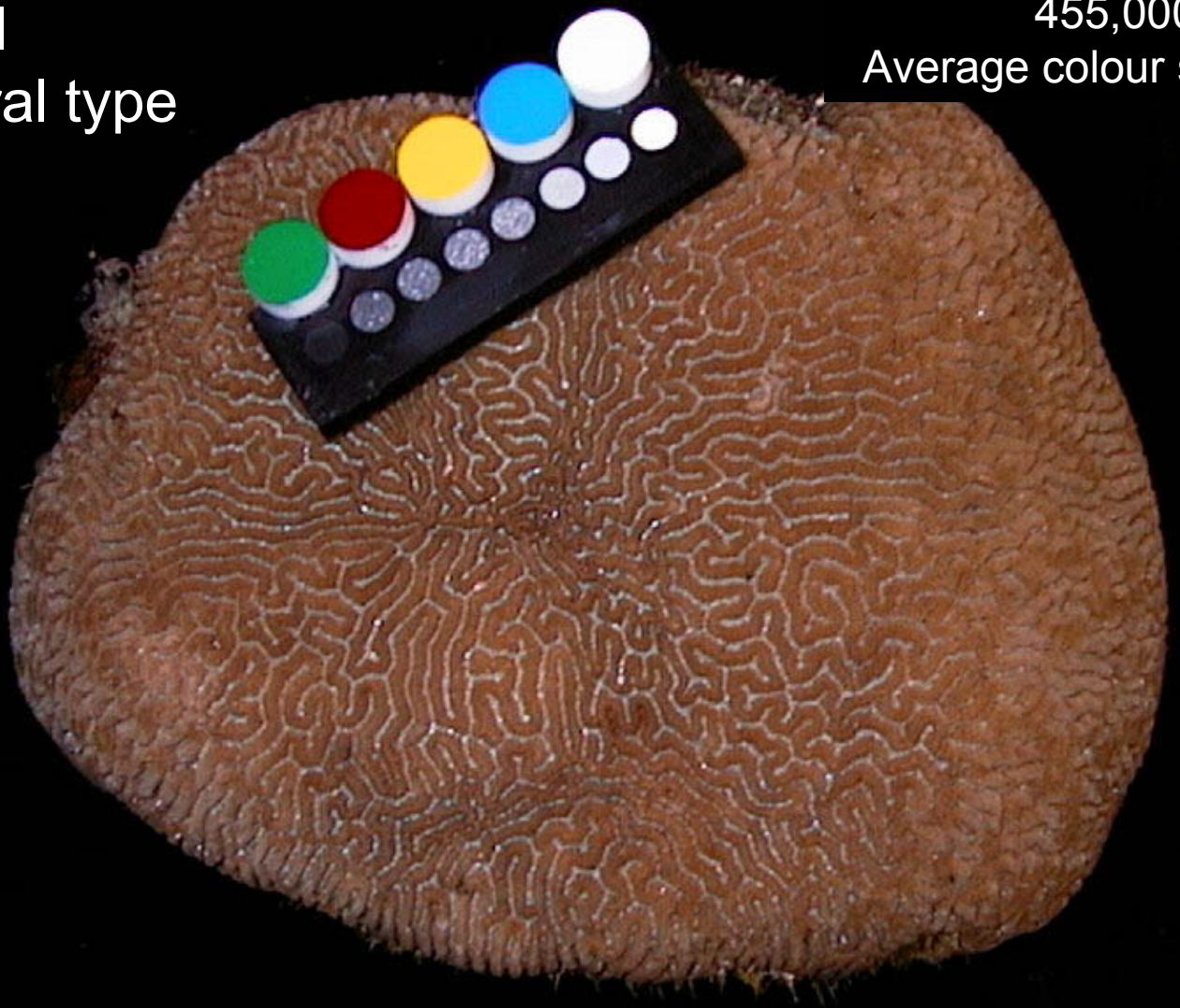
Use the Coral Health Chart to quantify the extent of bleaching and recovery by placing the chart up against the computer screen or print outs and recording the colour score on the Virtual Lab Data Sheet.

Remember to record the coral number and day of experiment (i.e. 1, 3 or 7) so you can compare your results with class mates.

Colours often appear different on different computers and printers, hence you can only compare data that has been obtained from the same screen or print outs.

Coral 1
Brain coral
Boulder coral type
Day 1

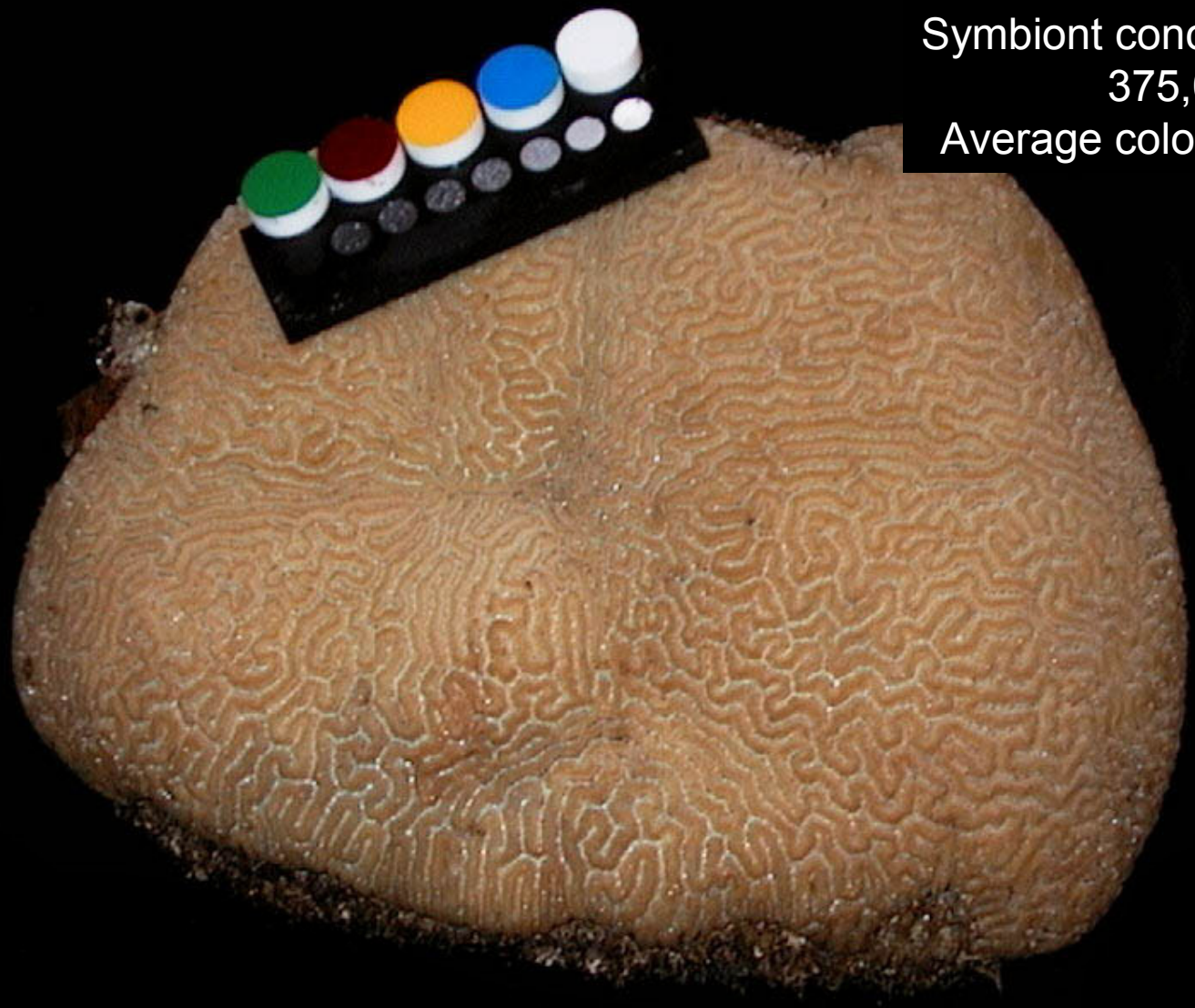
Symbiont concentration =
455,000 per cm^2
Average colour score = 4



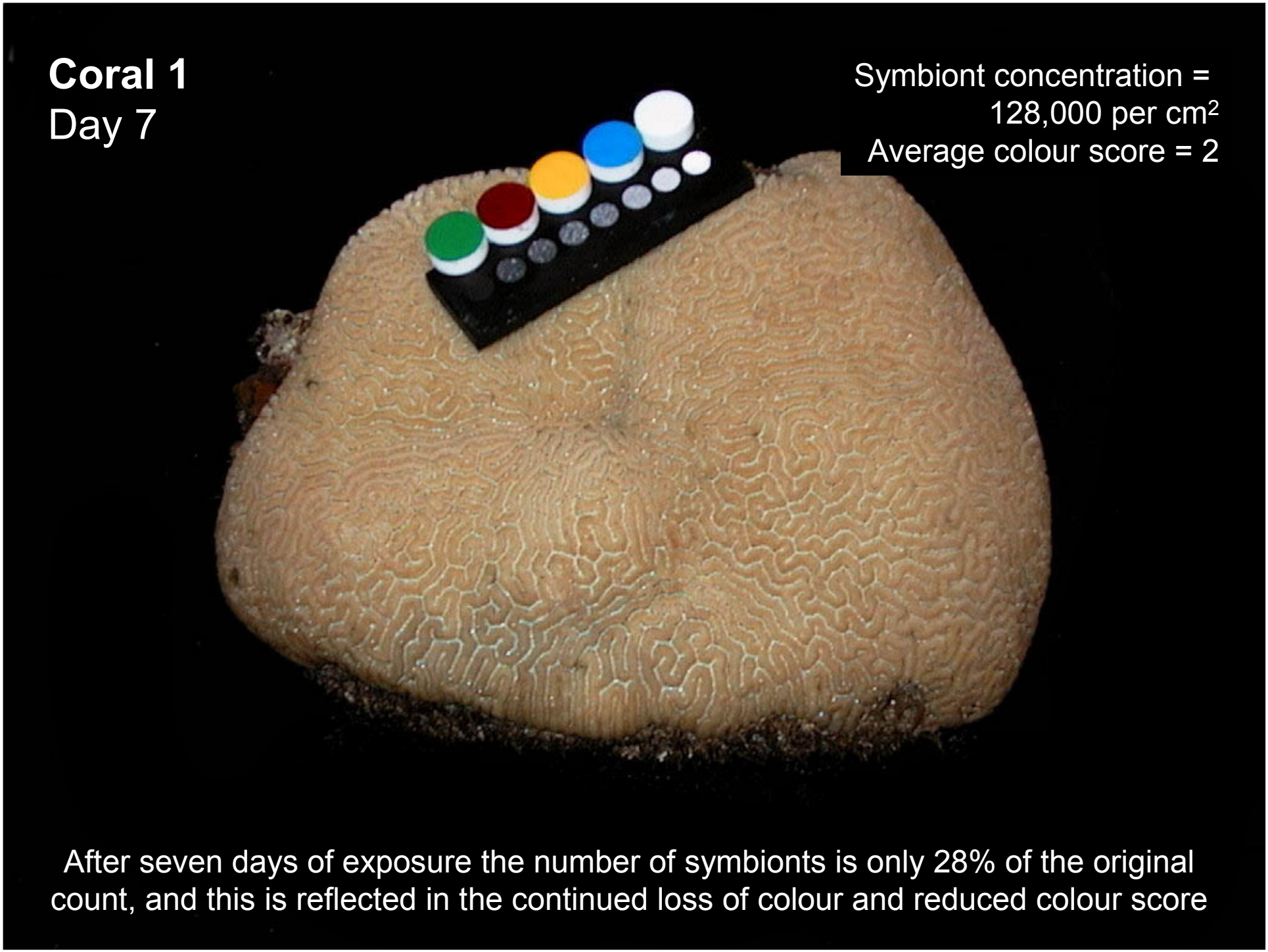
A healthy brain coral is subject to elevated water temperatures to quantify the relationship between symbionts and temperature

Coral 1
Day 3

Symbiont concentration =
375,000 per cm^2
Average colour score = 3



Increased exposure to elevated water temperature reduces the number of symbionts, and the intensity of the colour of the coral reduces. Coral bleaching has commenced.

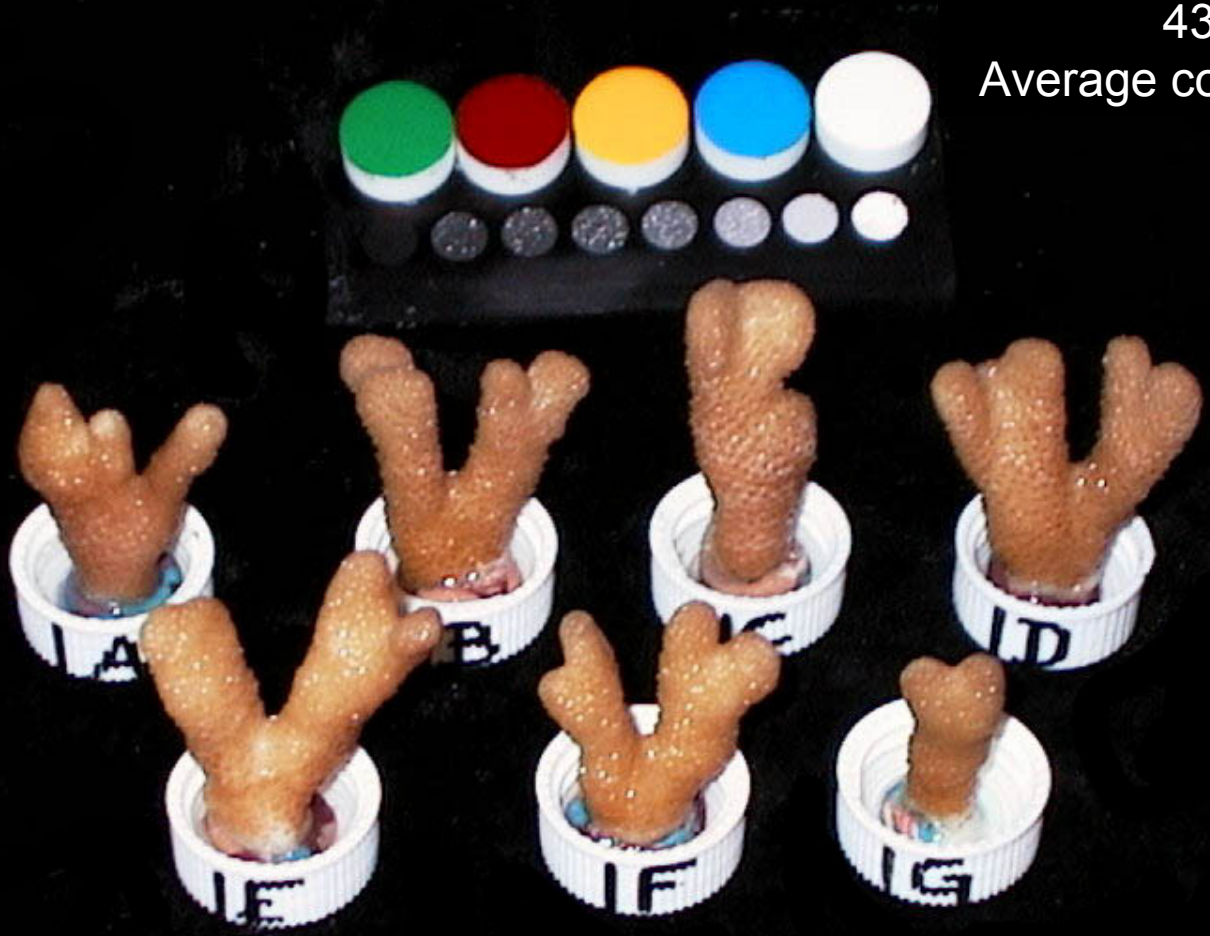

Coral 1
Day 7
Symbiont concentration =
128,000 per cm2
Average colour score = 2
After seven days of exposure the number of symbionts is only 28% of the original count, and this is reflected in the continued loss of colour and reduced colour score

Coral 2
Stylophora pistillata
Branching coral type
Day 1

Symbiont concentration =
744,000 per cm^2
Average colour score = 3

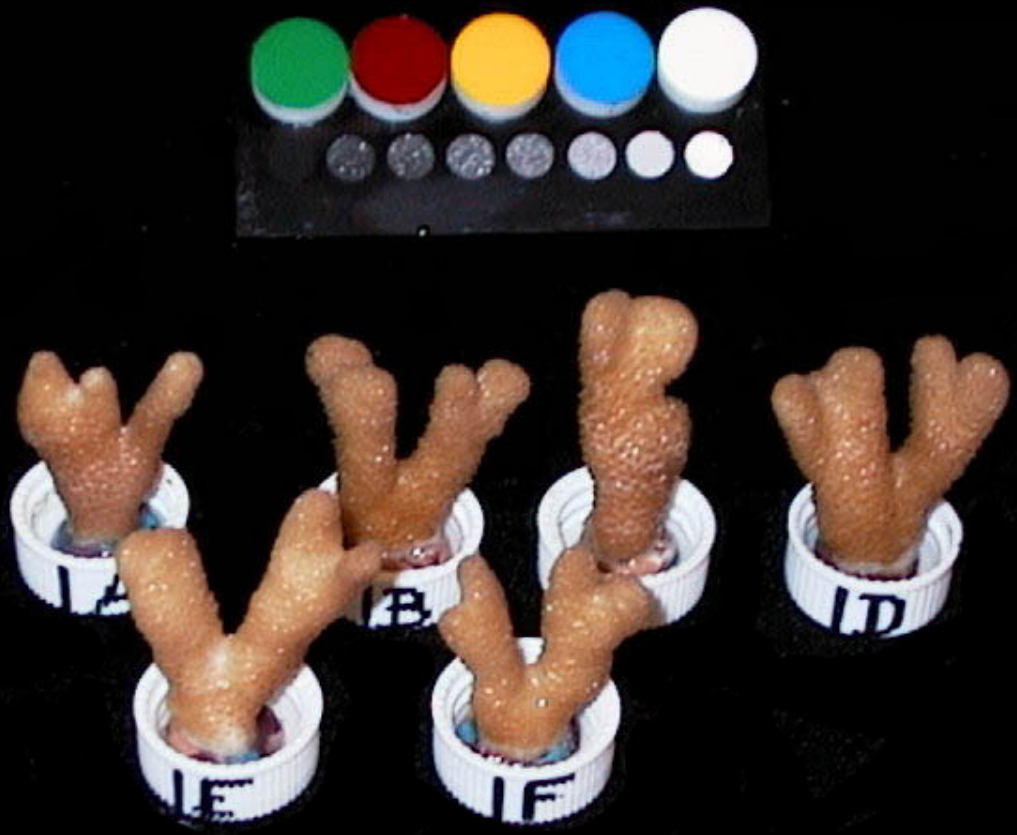
Coral 2
Day 3

Symbiont concentration =
430,000 per cm^2
Average colour score = 3



Coral 2
Day 7

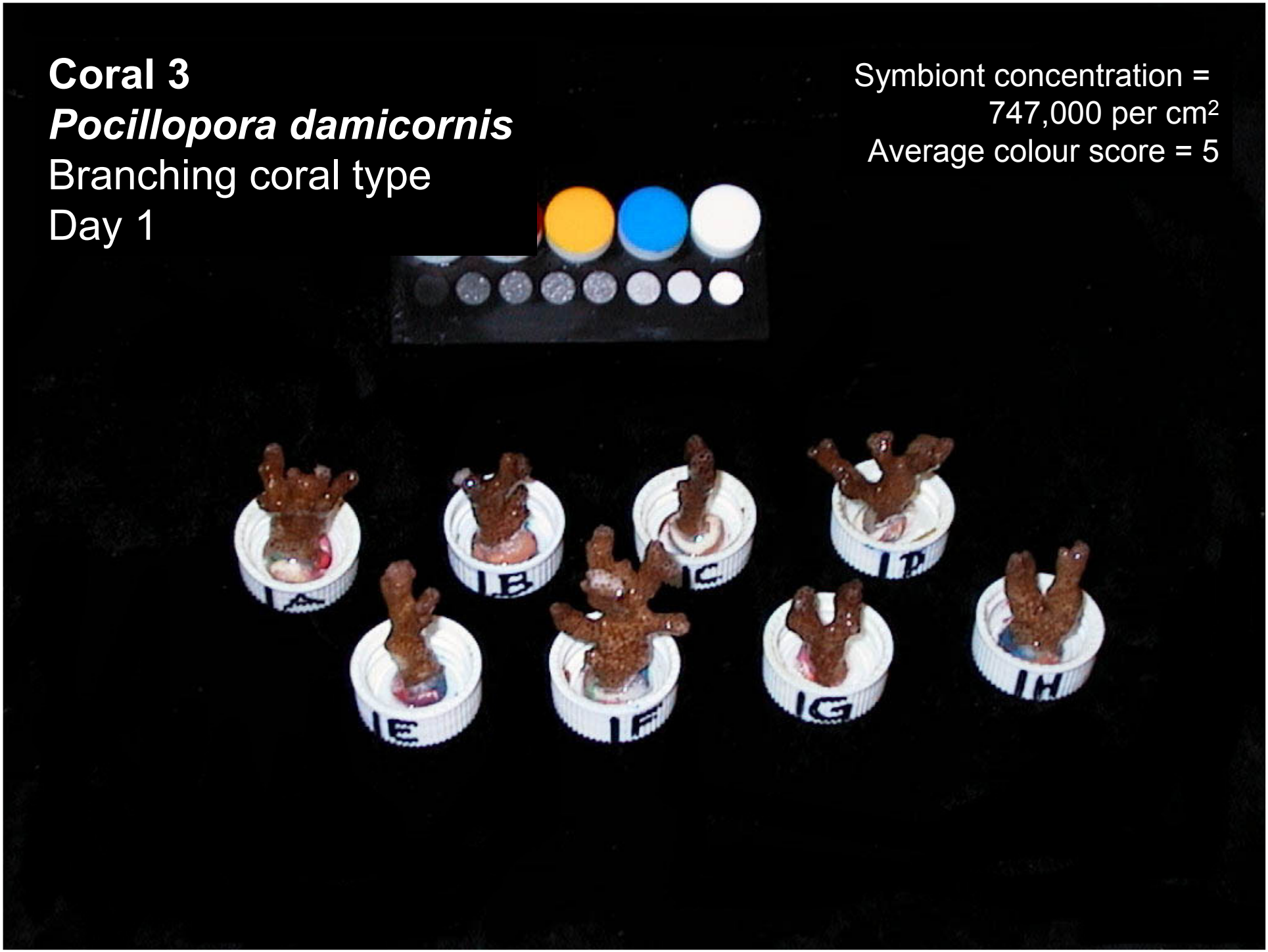
Symbiont concentration =
82,000 per cm^2
Average colour score = 2



After seven days of exposure the number of symbionts is only 11% of the original count, and the average colour score has reduced from 3 to 2

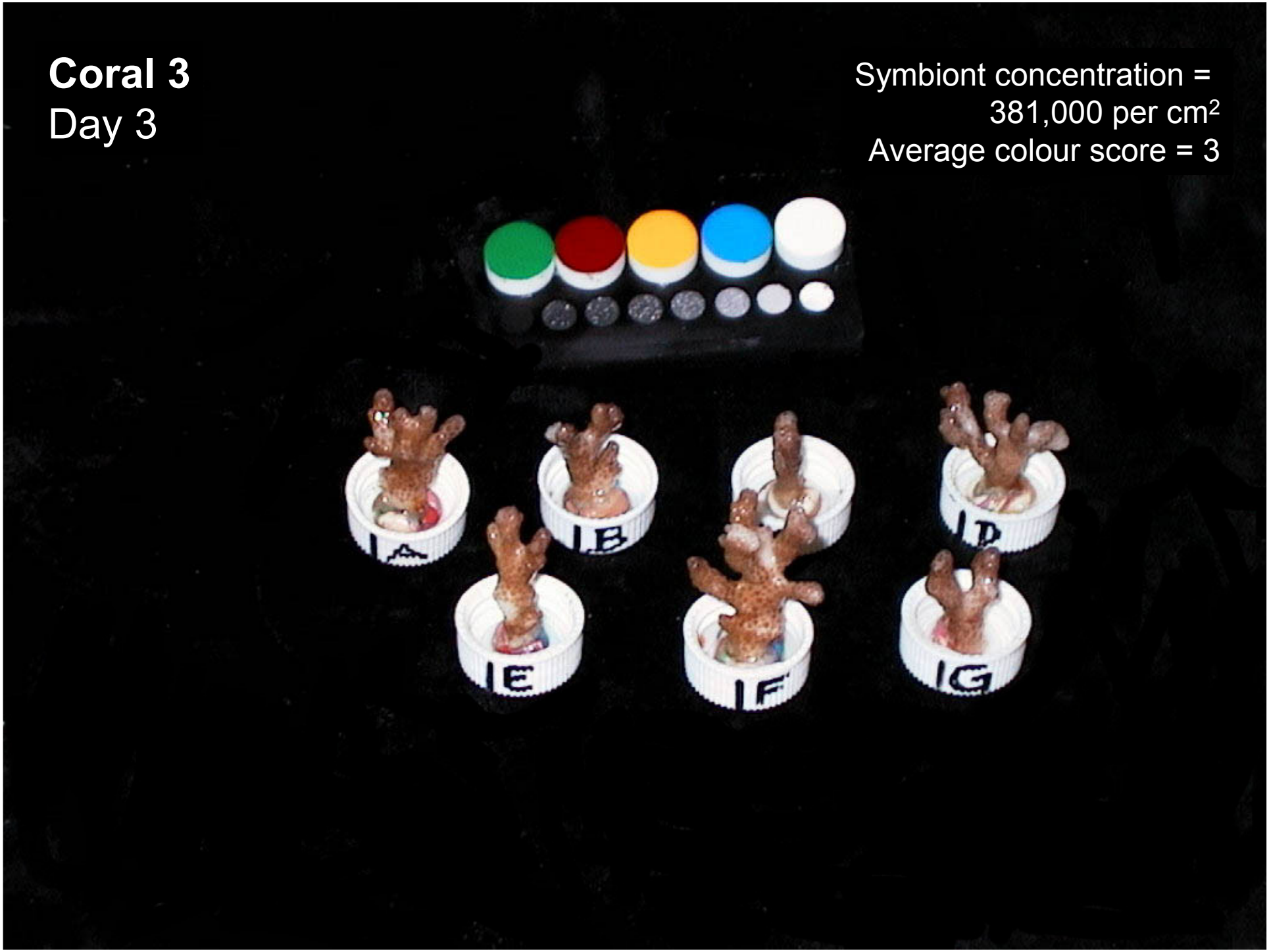
Coral 3
Pocillopora damicornis
Branching coral type
Day 1

Symbiont concentration =
747,000 per cm^2
Average colour score = 5



Coral 3
Day 3

Symbiont concentration =
381,000 per cm^2
Average colour score = 3



Coral 3
Day 7

Symbiont concentration = 43,000 per cm^2
Average colour score = 2

After seven days of exposure the number of symbionts is only 6% of the original count - this species experienced the largest loss of symbionts and reduction in colour score.

This species appears to have a high mortality rate following bleaching.

After the 2002 mass bleaching event this species was almost removed from the Heron Island reef flat, and this appears to be associated with poor recovery.

Coral 4
Porites sp.
Boulder coral type
Day 1

Symbiont concentration =
1,216,000 per cm^2
Average colour score = 4

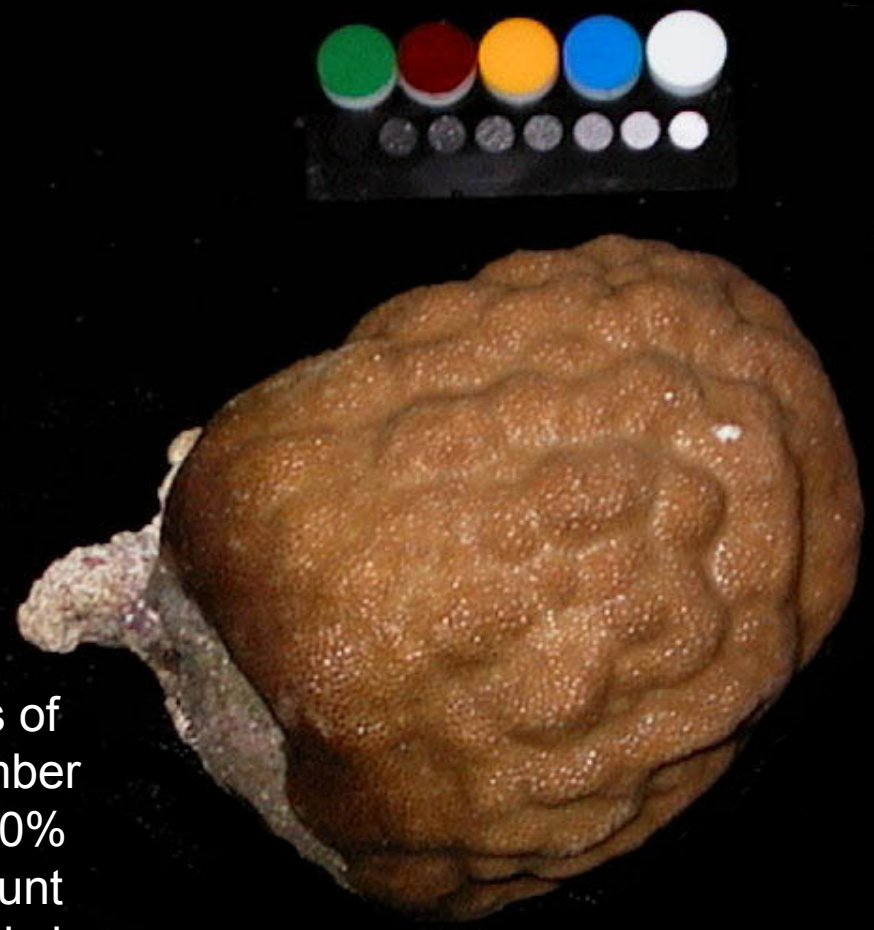
Coral 4
Day 3

Symbiont concentration =
983,000 per cm^2
Average colour score = 2

After three days of exposure, symbiont concentration has decreased and the colour has become brighter and less saturated, although to a lesser extent than the other corals.

Coral 4
Day 7

Symbiont concentration =
857,000 per cm^2
Average colour score = 2



After seven days of exposure the number of symbionts is 70% of the original count and once again this is reflected in the loss of colour and reduced colour score.

Porites spp. **lose less symbionts and recover faster than other coral types, and are considered a more resilient genus.**

There is no conclusive evidence, however researchers agree that one of the factors influencing the resilience is that tissue penetrates deep inside the skeleton, which may allow the symbionts to migrate deeper and avoid damage.

Acknowledgments

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