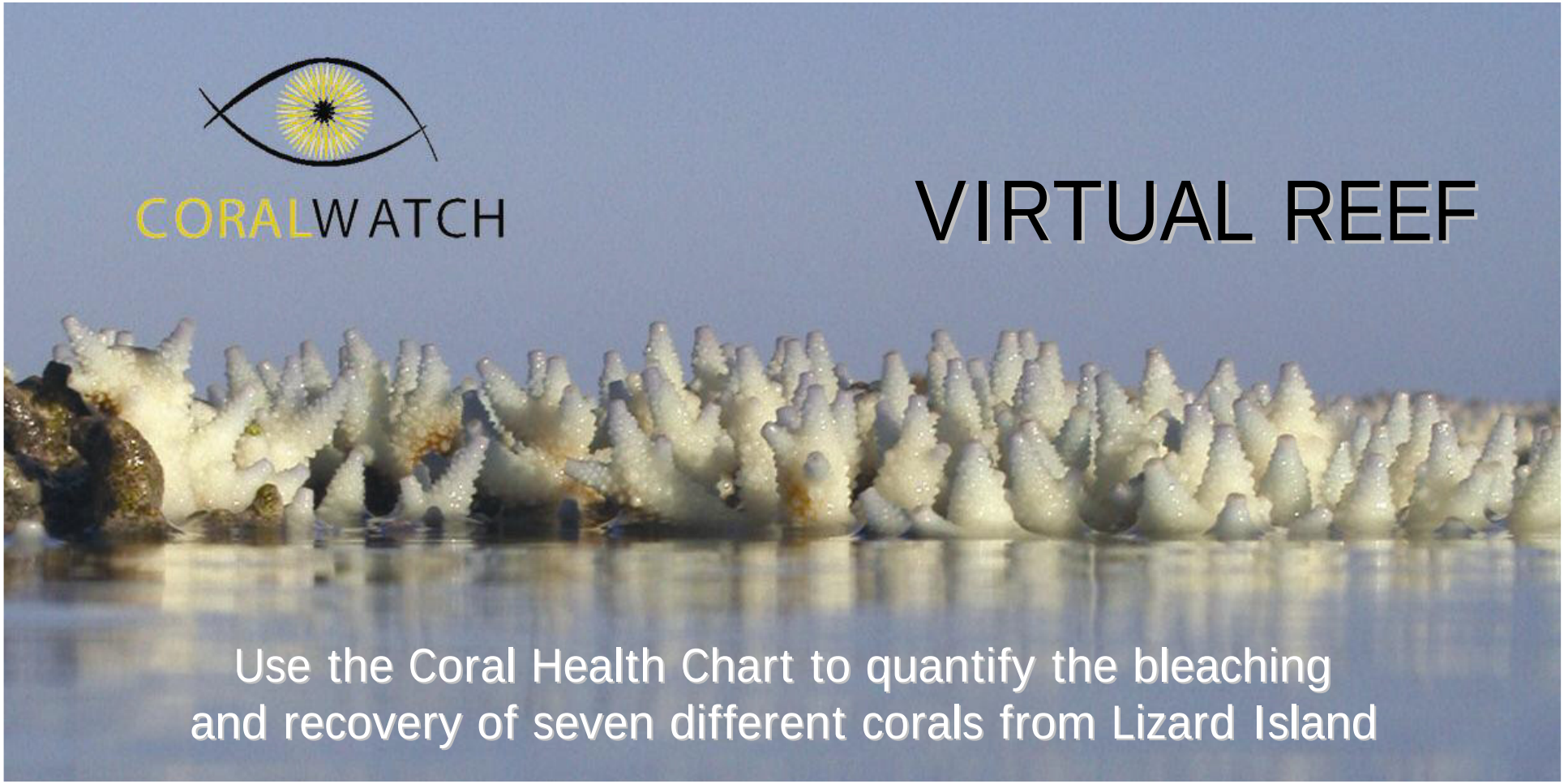
CORALWATCH

VIRTUAL REEF



Use the Coral Health Chart to quantify the bleaching
and recovery of seven different corals from Lizard Island

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.

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.

Bleaching can be classified into two major categories:

- **Localised bleaching** occurs over small geographical regions and can be caused by any of the above factors.
- **Mass bleaching** occurs over large geographical regions and is caused by increased water temperature over extended periods of time, together with increased levels of ultraviolet light.

Mass bleaching

During the 2002 mass bleaching event, an estimated 60-90% of corals on the Great Barrier Reef, Australia bleached however the majority of these corals recovered.

Other parts of the world, such as the Maldives, Sri Lanka and the Seychelles, also experienced extensive bleaching but much of the reef did not recover and they lost up to 90% of coral cover.

Mass bleaching events are predicted to escalate and reefs may be completely lost within the next 50-100 years. Monitoring of coral health and increased awareness of coral bleaching has never been of greater significance!

What is the virtual reef?

The Virtual Reef provides an opportunity to learn about coral bleaching and collect scientific data without visiting the reef - it can be used to prepare for a reef field trip or as a valuable alternative.

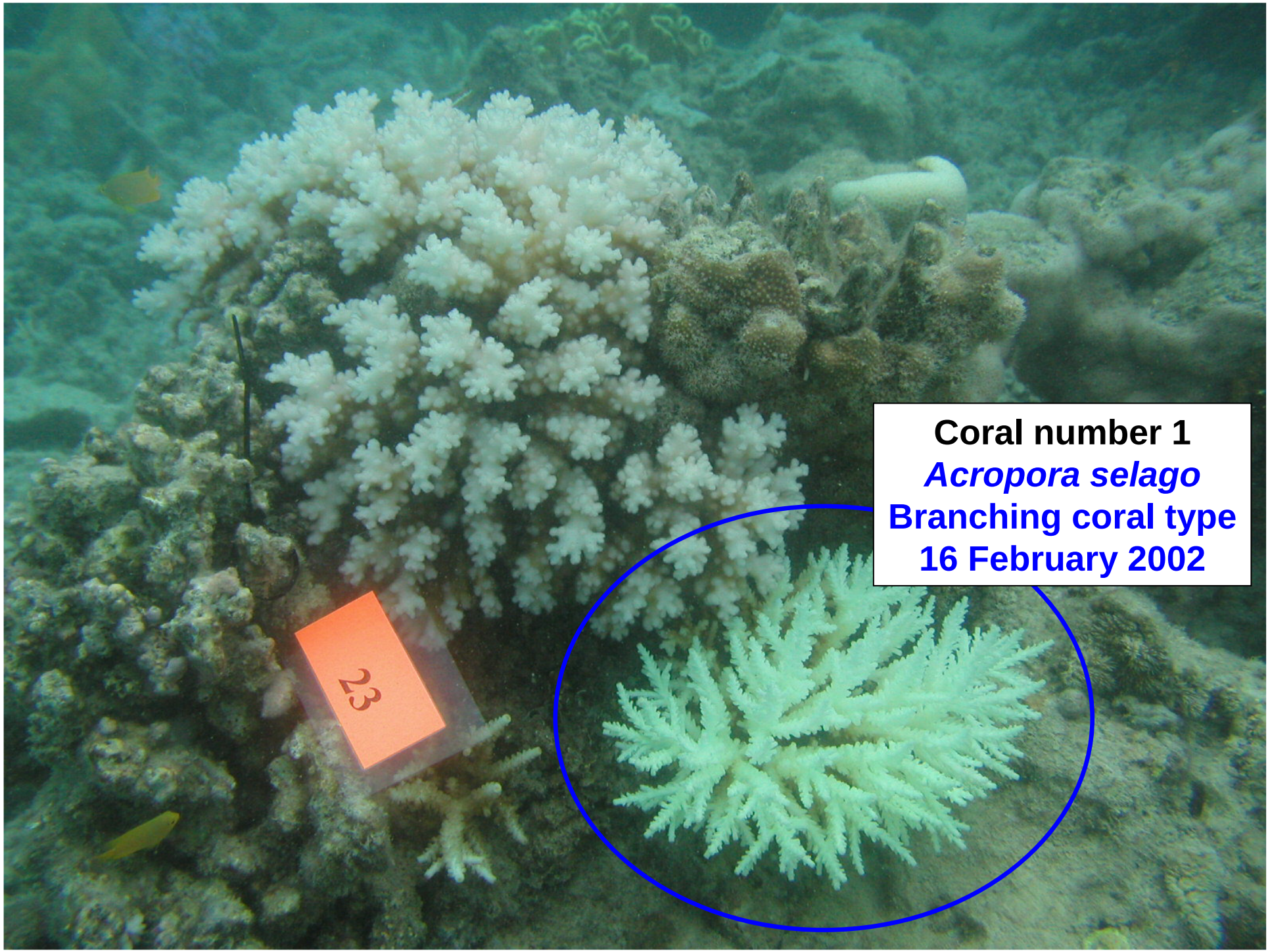
The Virtual Reef includes photos of seven different corals from Lizard Island, northern Great Barrier Reef. The photos were taken during and after the 2002 mass bleaching event.

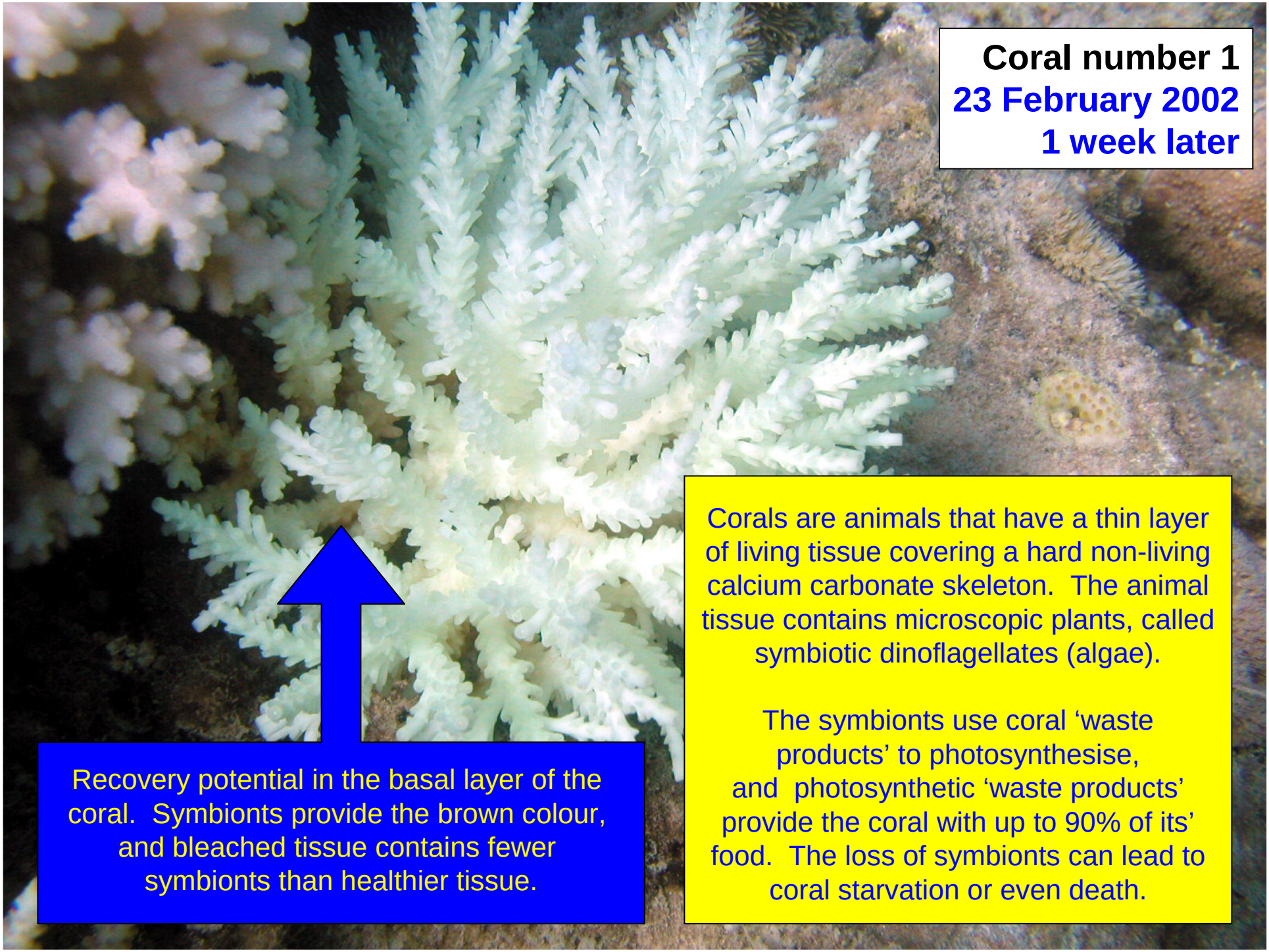
How to use the virtual reef

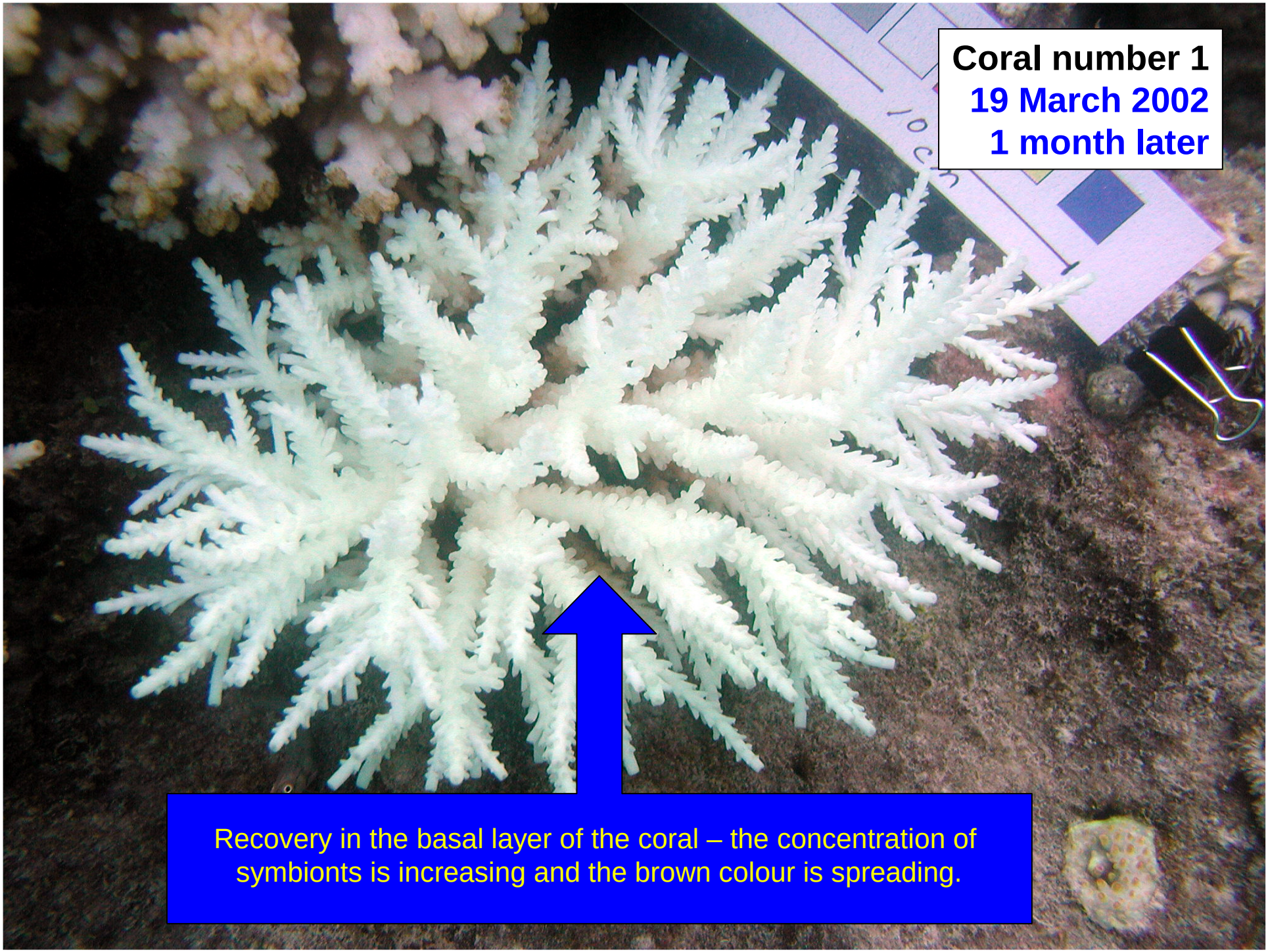
Use the Coral Health Chart to quantify the extent of bleaching and recovery by placing the chart up against the computer screen or print outs and recording the colour score on the Virtual Reef Data Sheet.

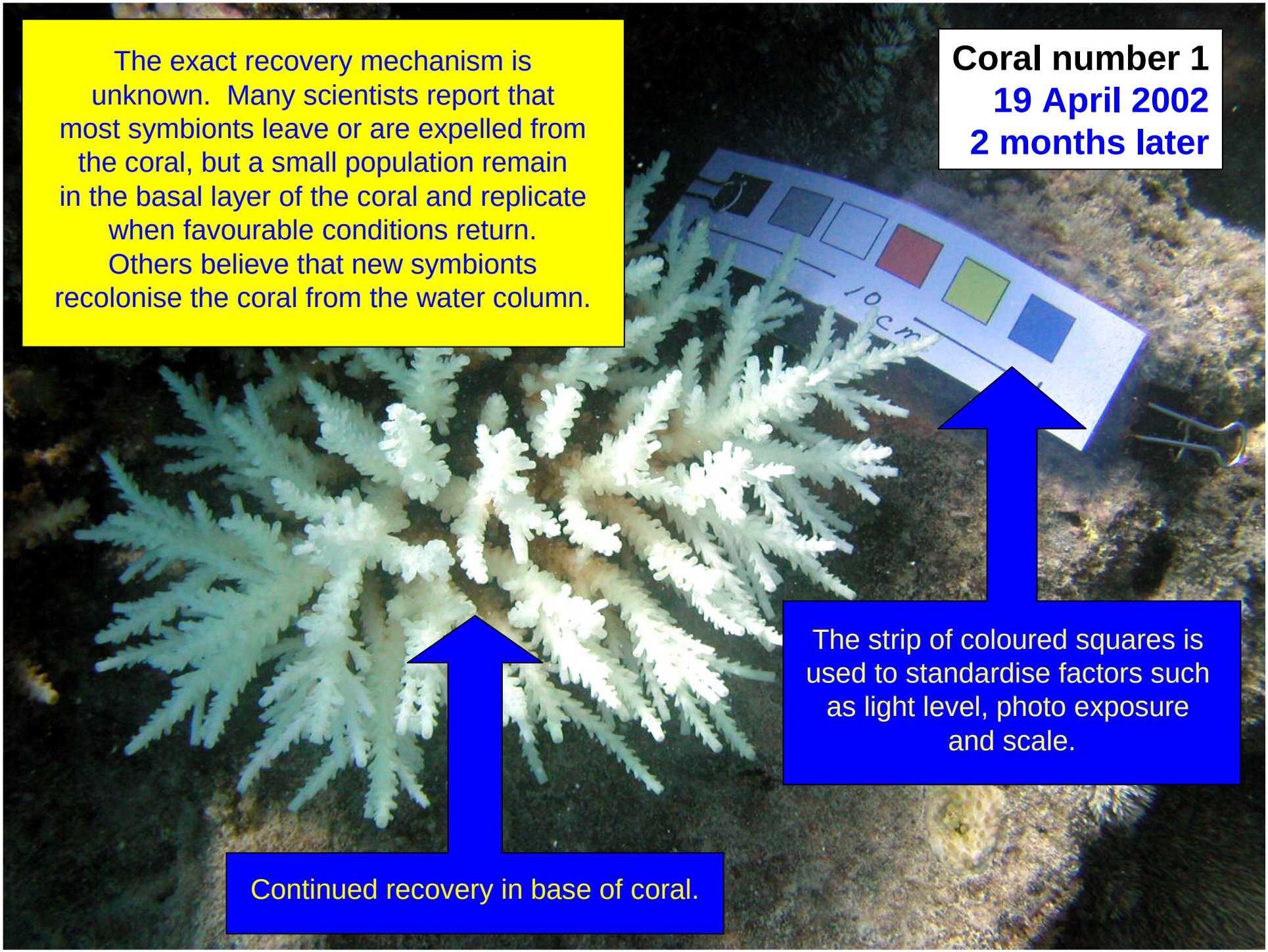
Remember to record the coral number and photo date so you can compare your results with class mates.

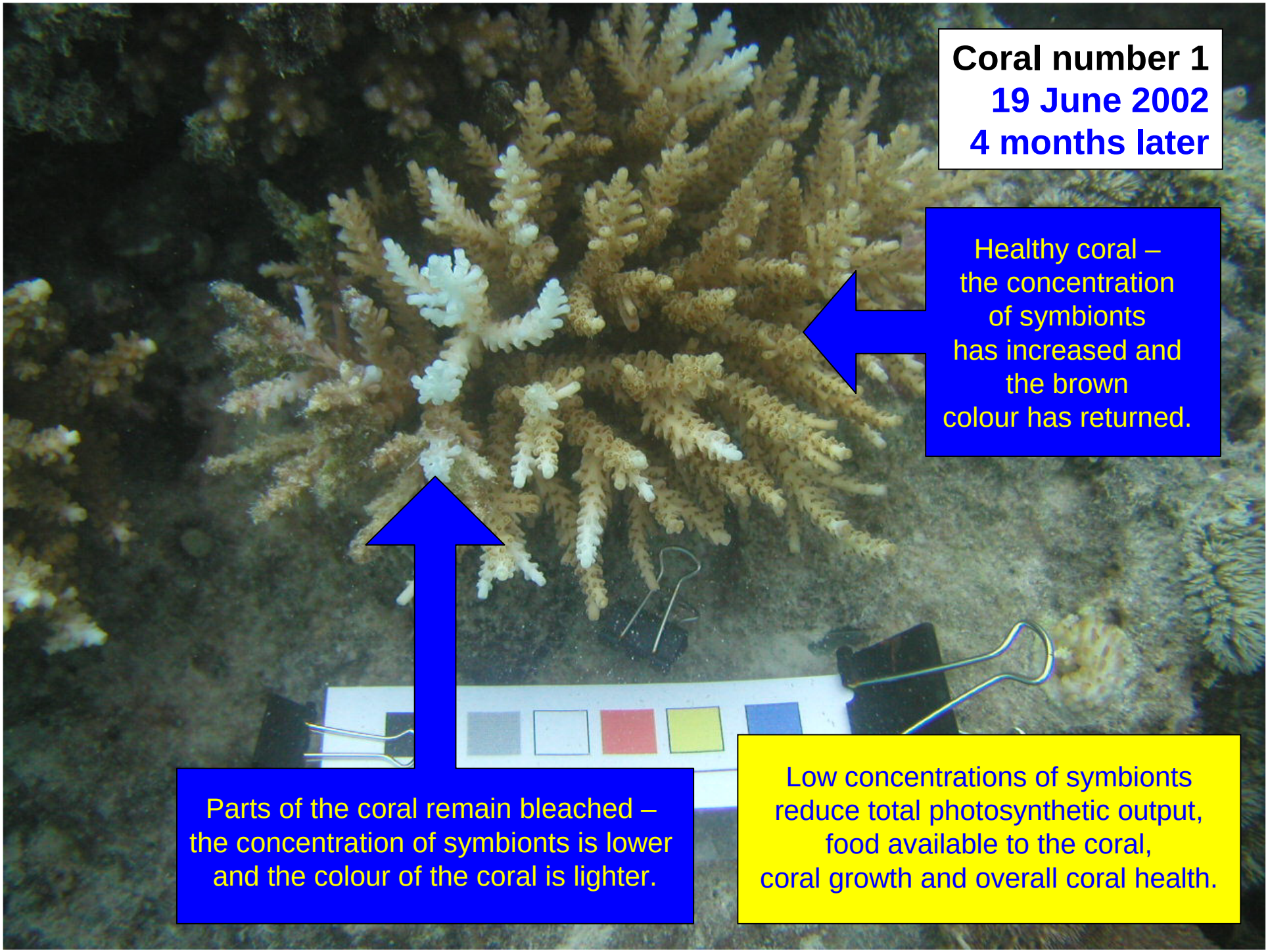
Colours often appear different on different computers and printers, hence you can only compare data that has been obtained from the same screen or print outs.

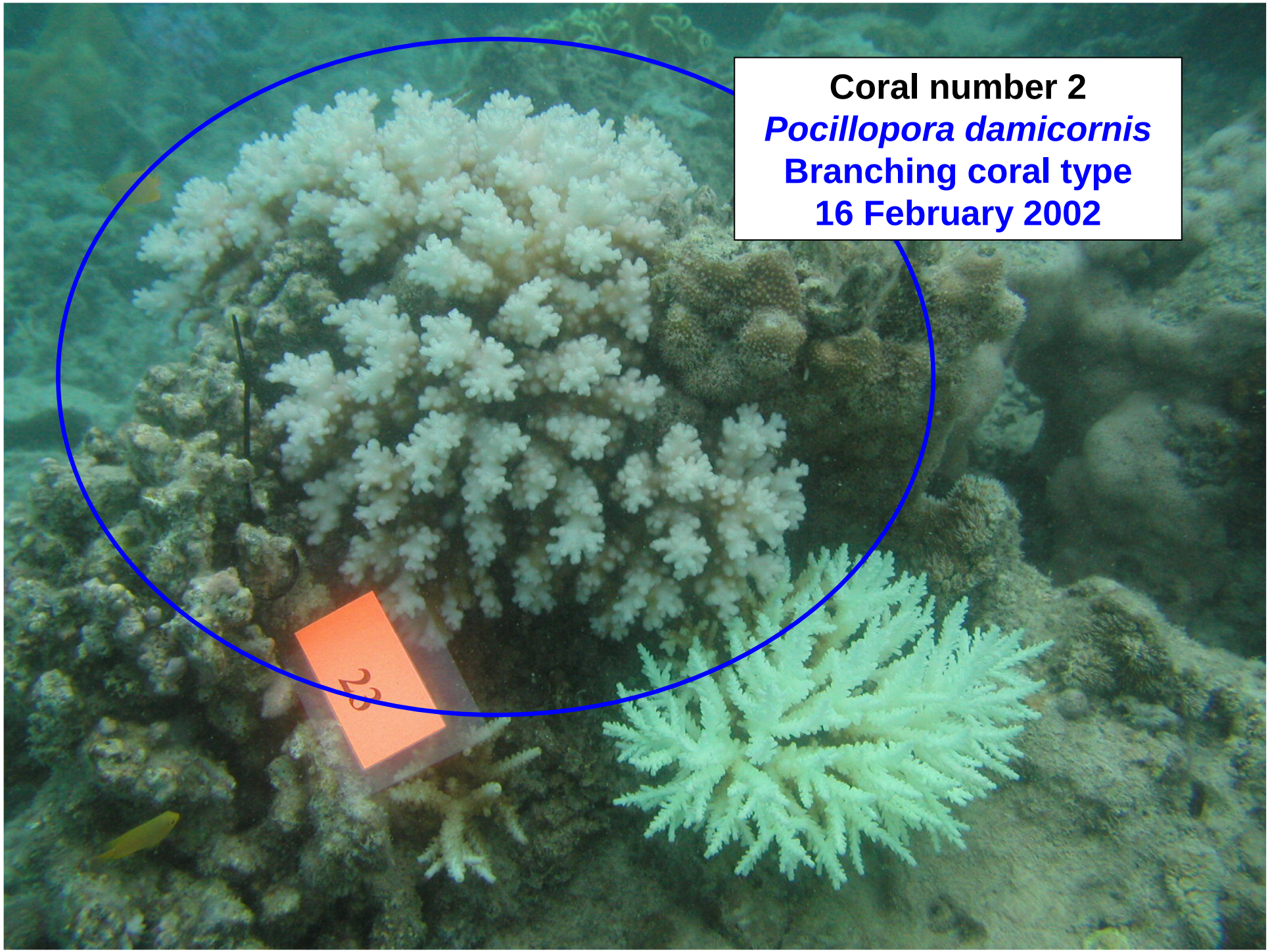

Coral number 1
Acropora selago
Branching coral type
16 February 2002
23

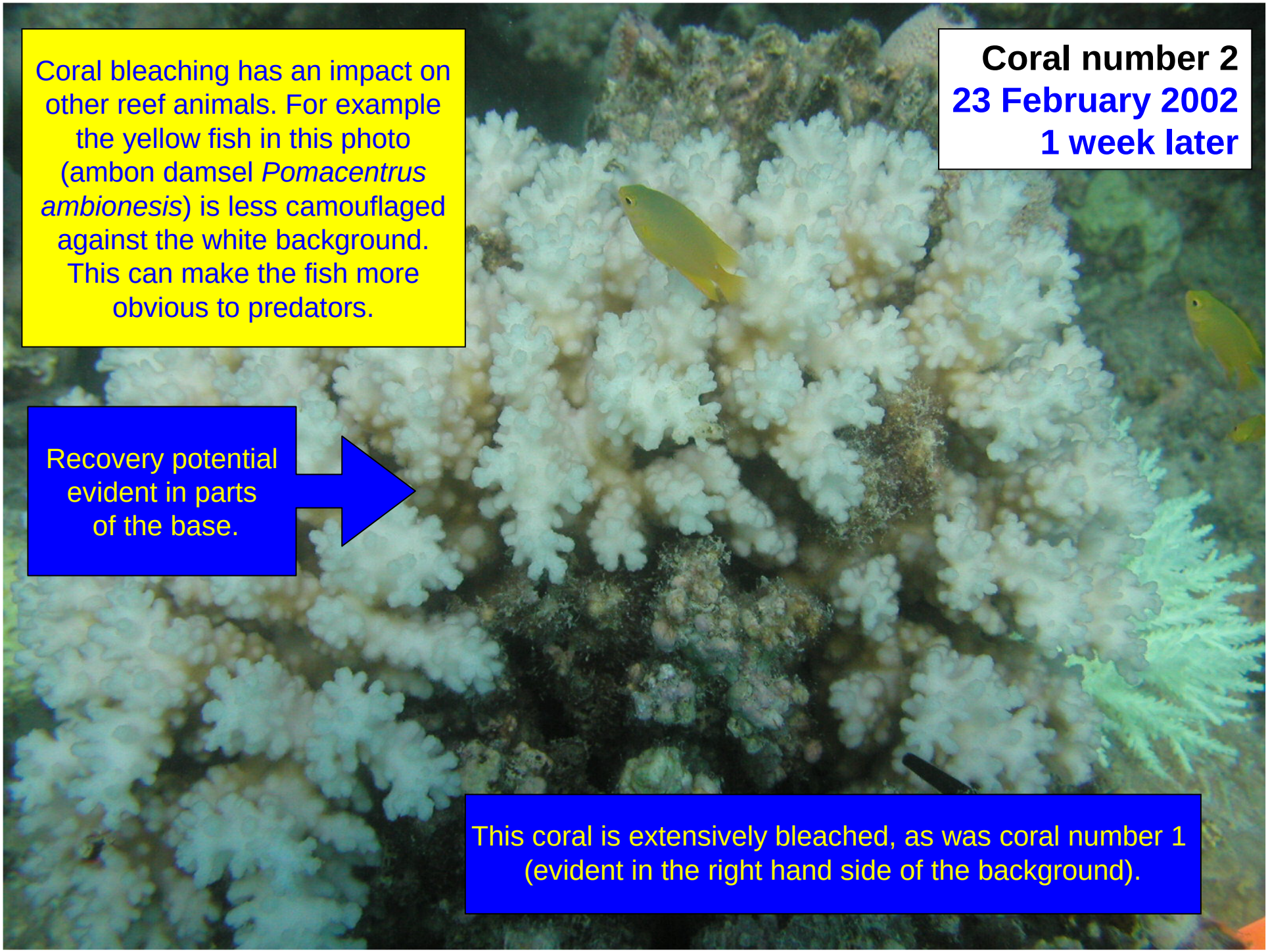

Coral number 1
23 February 2002
1 week later
Recovery potential in the basal layer of the coral. Symbionts provide the brown colour, and bleached tissue contains fewer symbionts than healthier tissue.
Corals are animals that have a thin layer of living tissue covering a hard non-living calcium carbonate skeleton. The animal tissue contains microscopic plants, called symbiotic dinoflagellates (algae).
The symbionts use coral 'waste products' to photosynthesise, and photosynthetic 'waste products' provide the coral with up to 90% of its' food. The loss of symbionts can lead to coral starvation or even death.

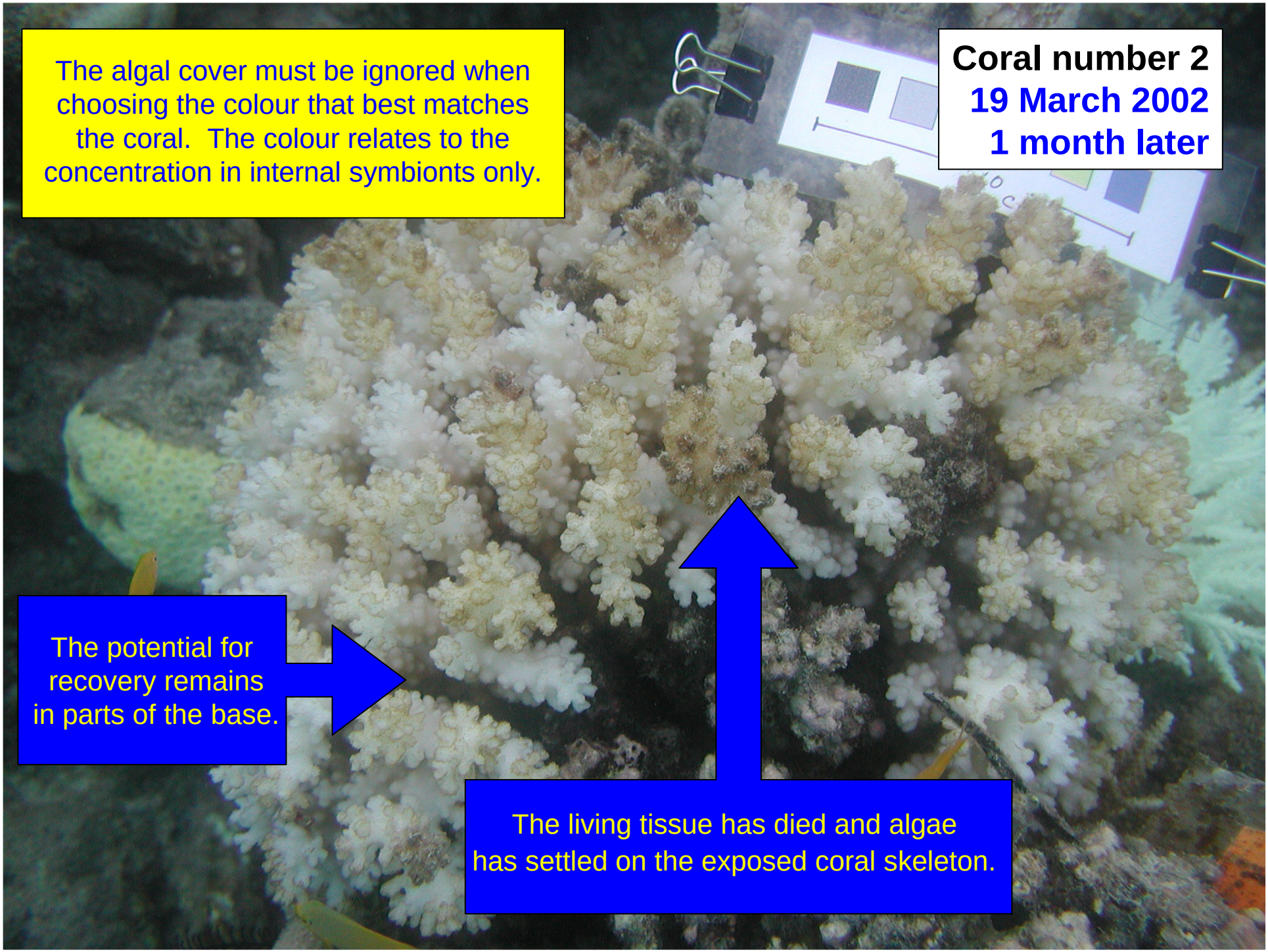

Coral number 1
19 March 2002
1 month later
Recovery in the basal layer of the coral – the concentration of symbionts is increasing and the brown colour is spreading.

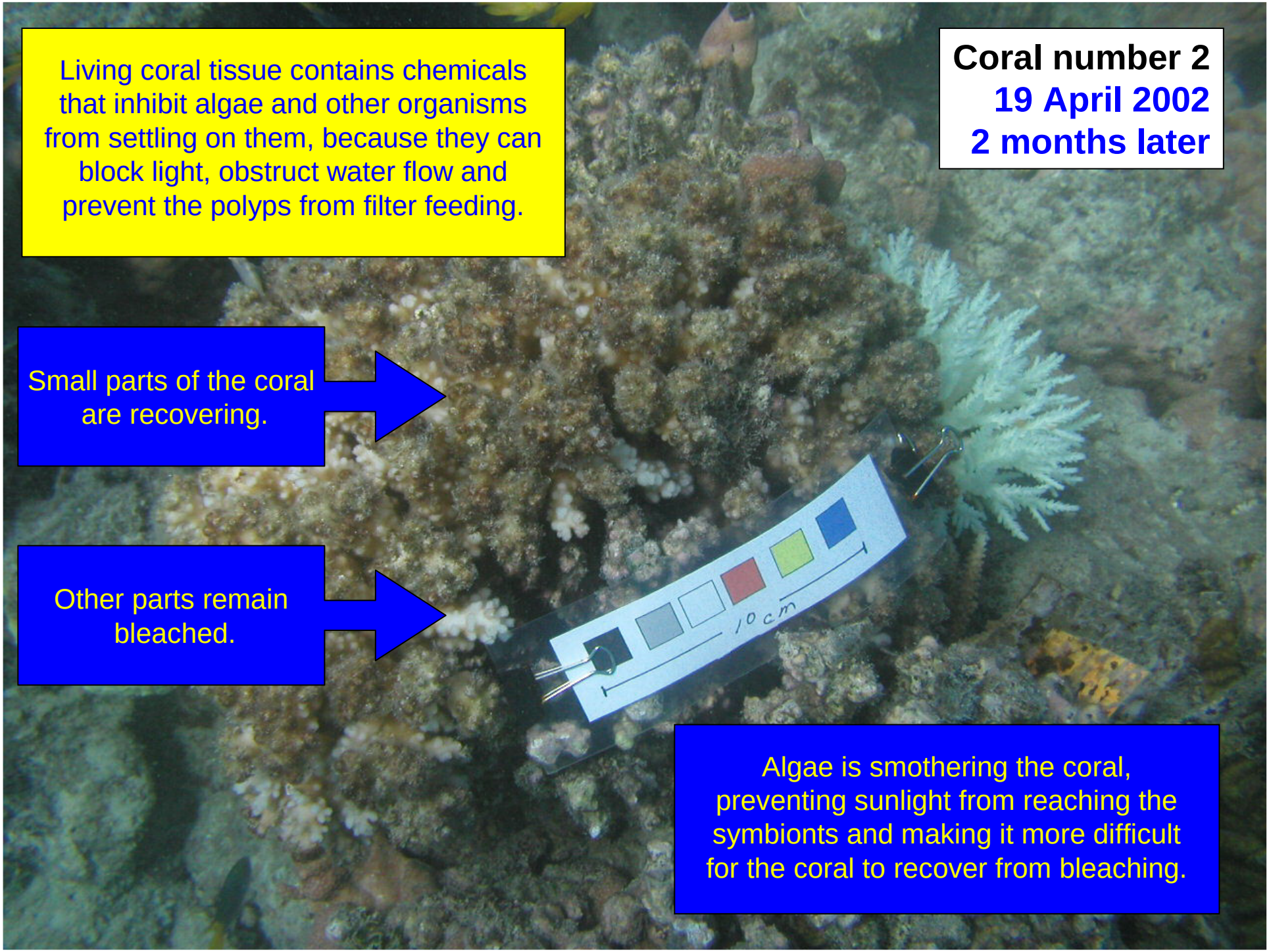

The exact recovery mechanism is unknown. Many scientists report that most symbionts leave or are expelled from the coral, but a small population remain in the basal layer of the coral and replicate when favourable conditions return. Others believe that new symbionts recolonise the coral from the water column.
Coral number 1
19 April 2002
2 months later
10 cm
The strip of coloured squares is used to standardise factors such as light level, photo exposure and scale.
Continued recovery in base of coral.

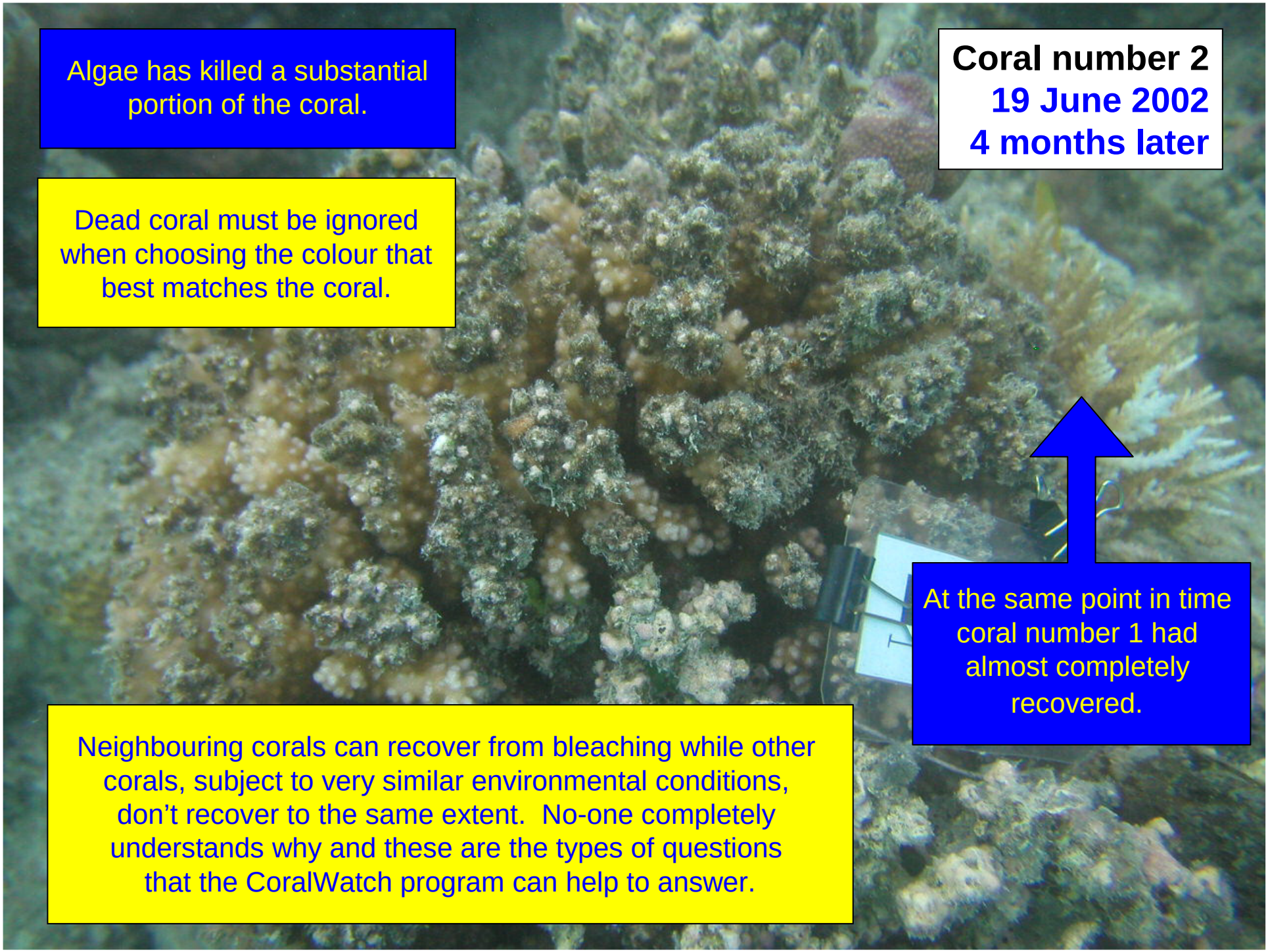

Coral number 1
19 June 2002
4 months later
Healthy coral – the concentration of symbionts has increased and the brown colour has returned.
Parts of the coral remain bleached – the concentration of symbionts is lower and the colour of the coral is lighter.
Low concentrations of symbionts reduce total photosynthetic output, food available to the coral, coral growth and overall coral health.

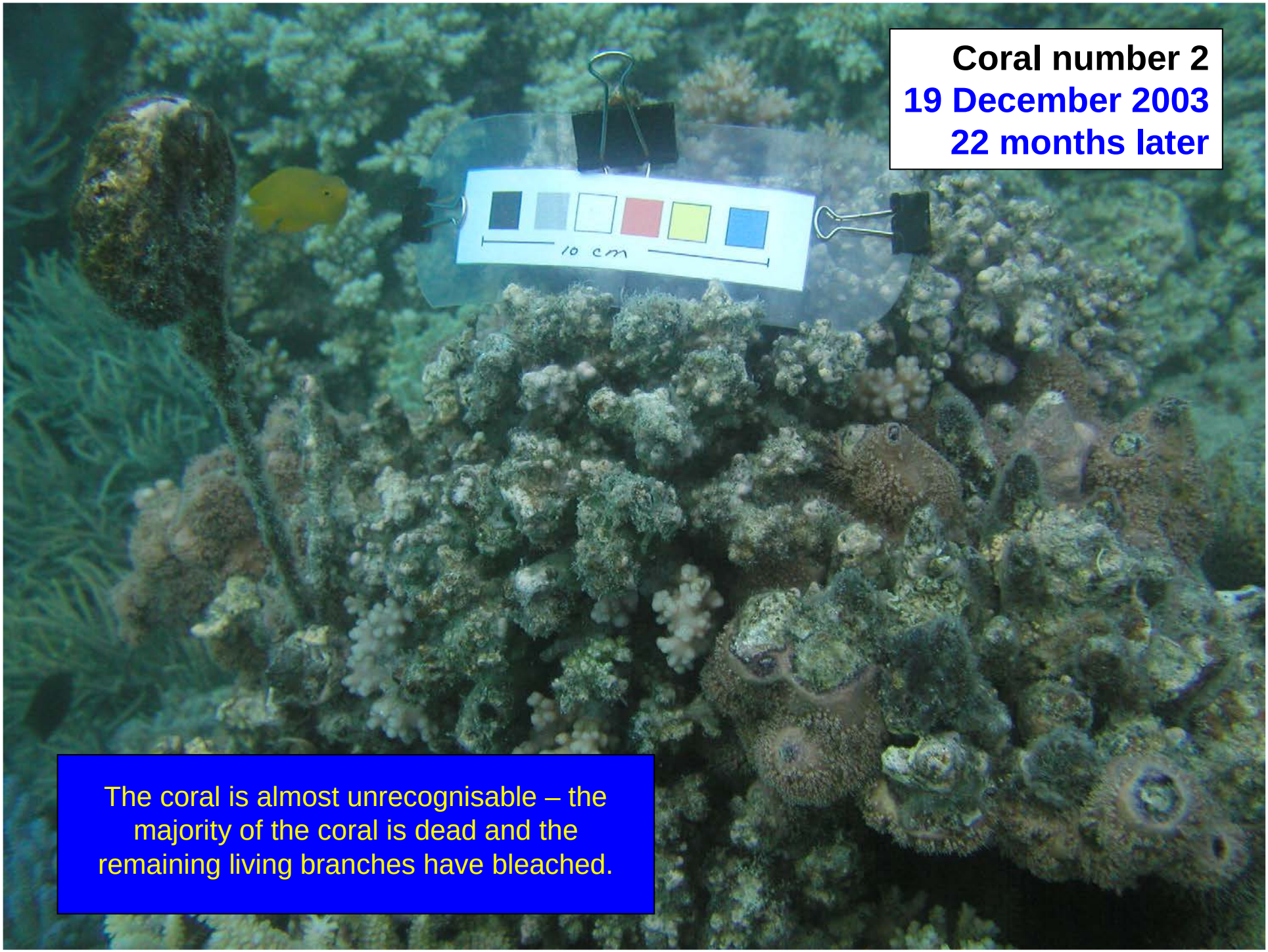

Coral number 2
Pocillopora damicornis
Branching coral type
16 February 2002
23

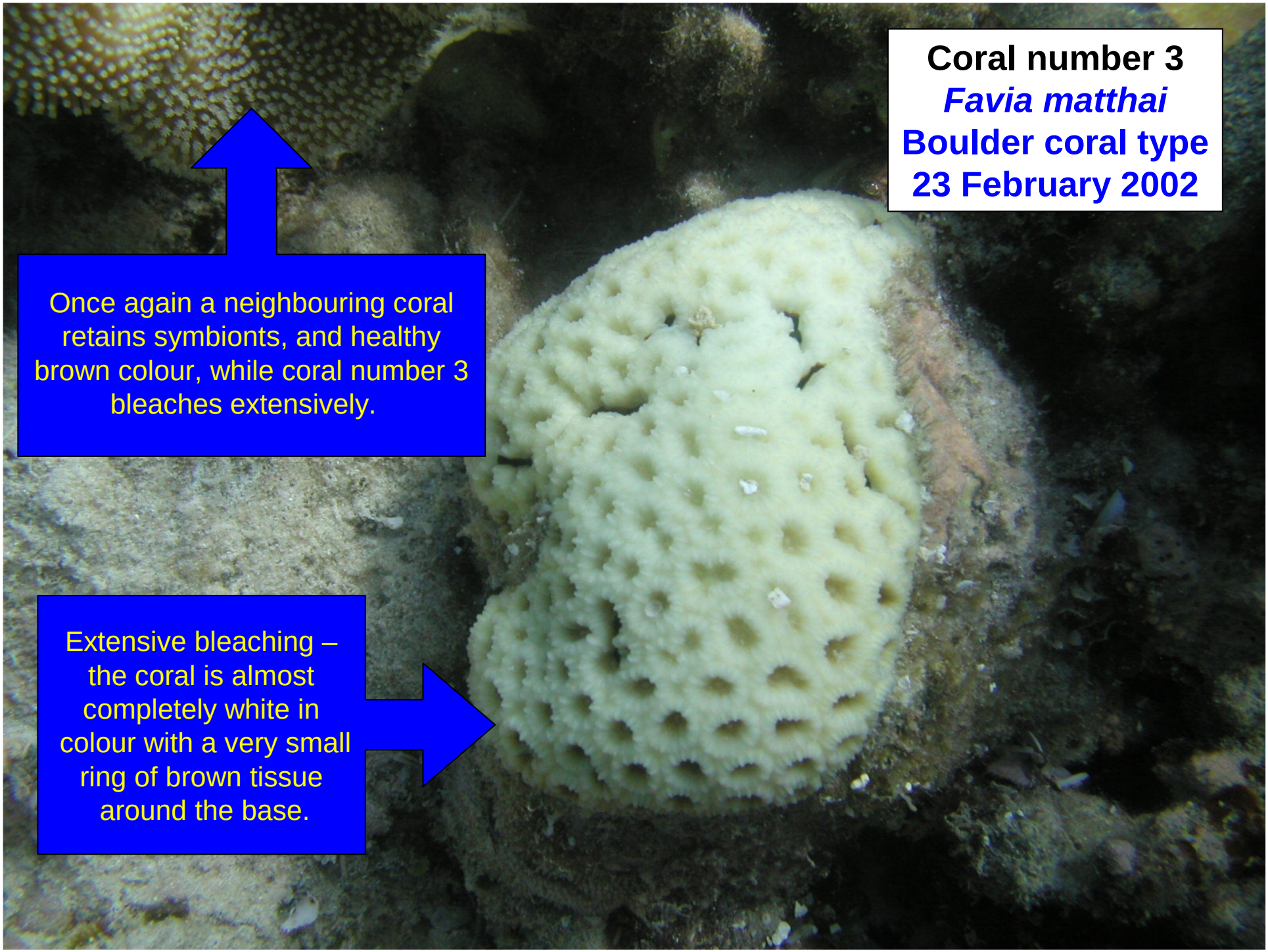

Coral bleaching has an impact on other reef animals. For example the yellow fish in this photo (ambon damsel *Pomacentrus ambionesis*) is less camouflaged against the white background. This can make the fish more obvious to predators.
Coral number 2
23 February 2002
1 week later
Recovery potential evident in parts of the base.
This coral is extensively bleached, as was coral number 1 (evident in the right hand side of the background).

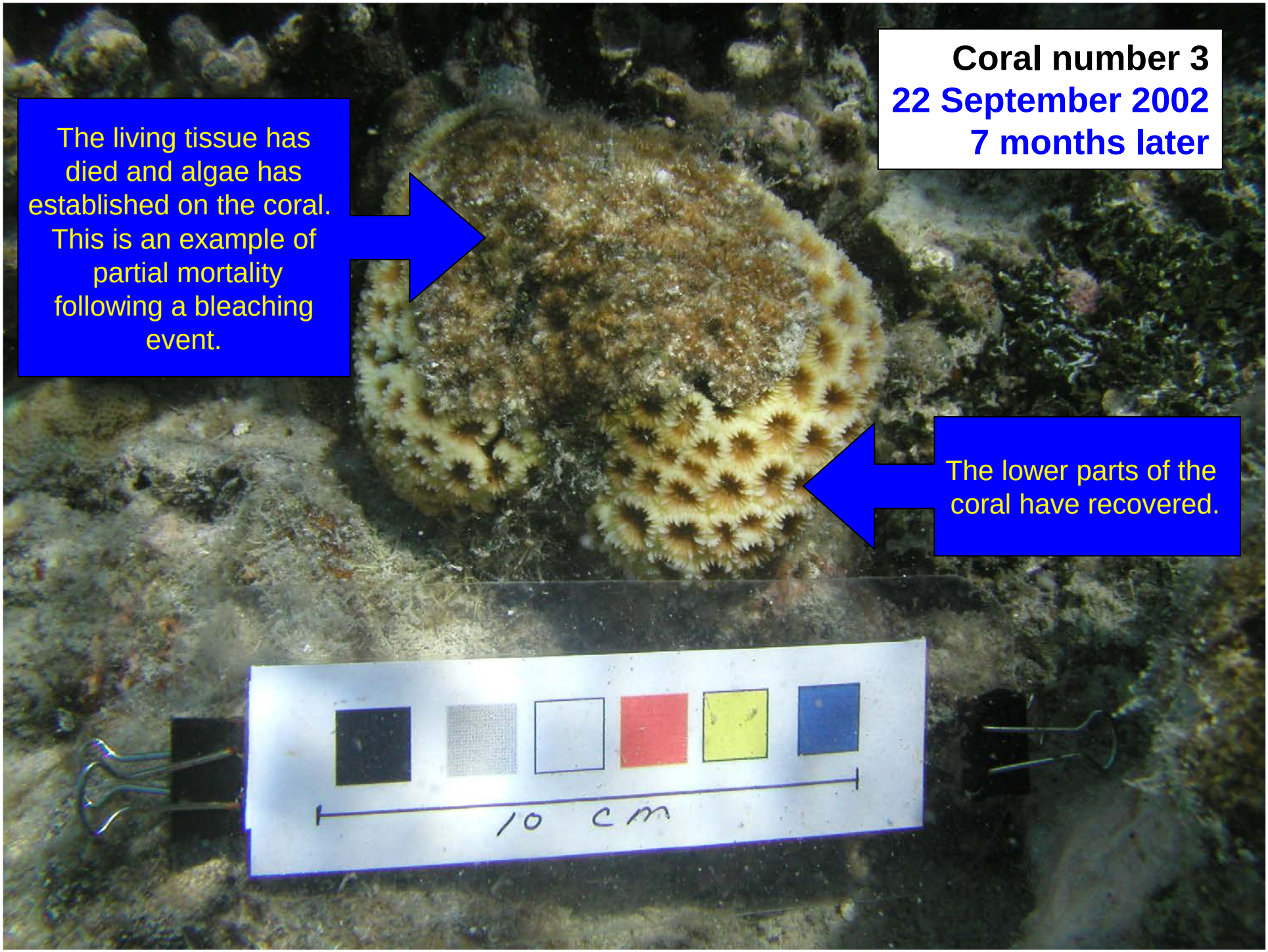

The algal cover must be ignored when choosing the colour that best matches the coral. The colour relates to the concentration in internal symbionts only.
Coral number 2
19 March 2002
1 month later
The potential for recovery remains in parts of the base.
The living tissue has died and algae has settled on the exposed coral skeleton.

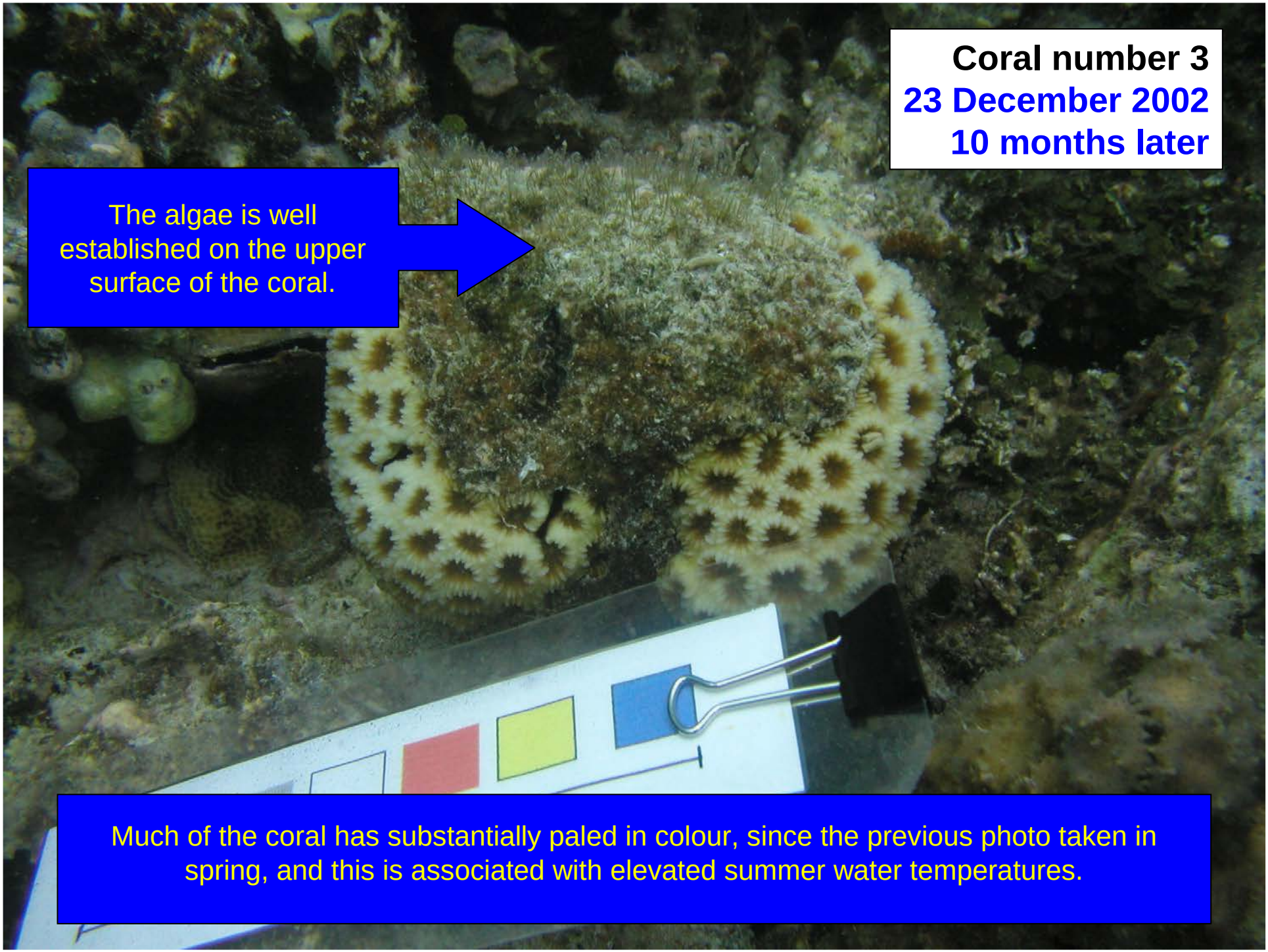

Living coral tissue contains chemicals that inhibit algae and other organisms from settling on them, because they can block light, obstruct water flow and prevent the polyps from filter feeding.
Coral number 2
19 April 2002
2 months later
Small parts of the coral are recovering.
Other parts remain bleached.
10 cm
Algae is smothering the coral, preventing sunlight from reaching the symbionts and making it more difficult for the coral to recover from bleaching.

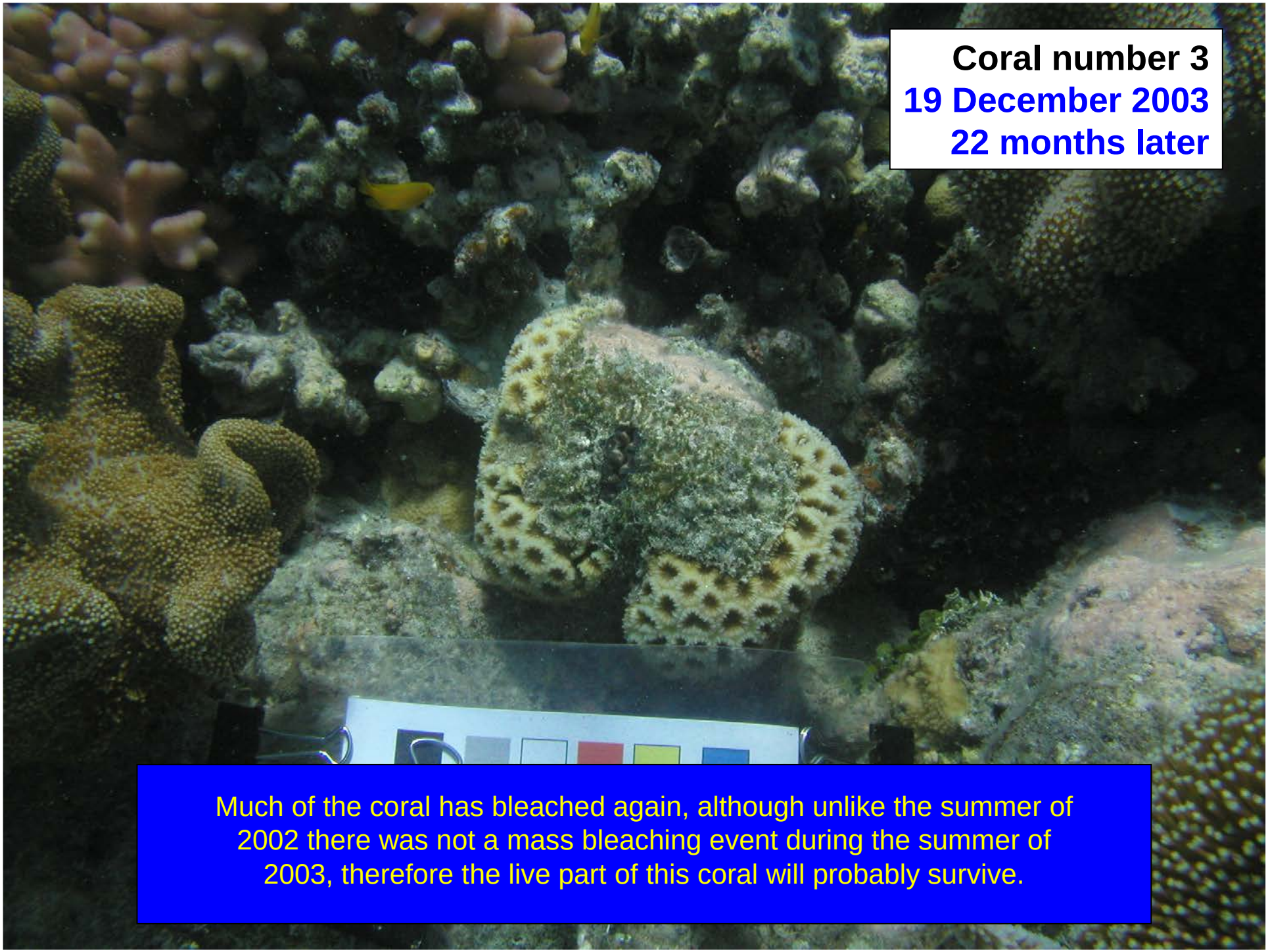

Algae has killed a substantial portion of the coral.
Coral number 2
19 June 2002
4 months later
Dead coral must be ignored when choosing the colour that best matches the coral.
At the same point in time coral number 1 had almost completely recovered.
Neighbouring corals can recover from bleaching while other corals, subject to very similar environmental conditions, don't recover to the same extent. No-one completely understands why and these are the types of questions that the CoralWatch program can help to answer.

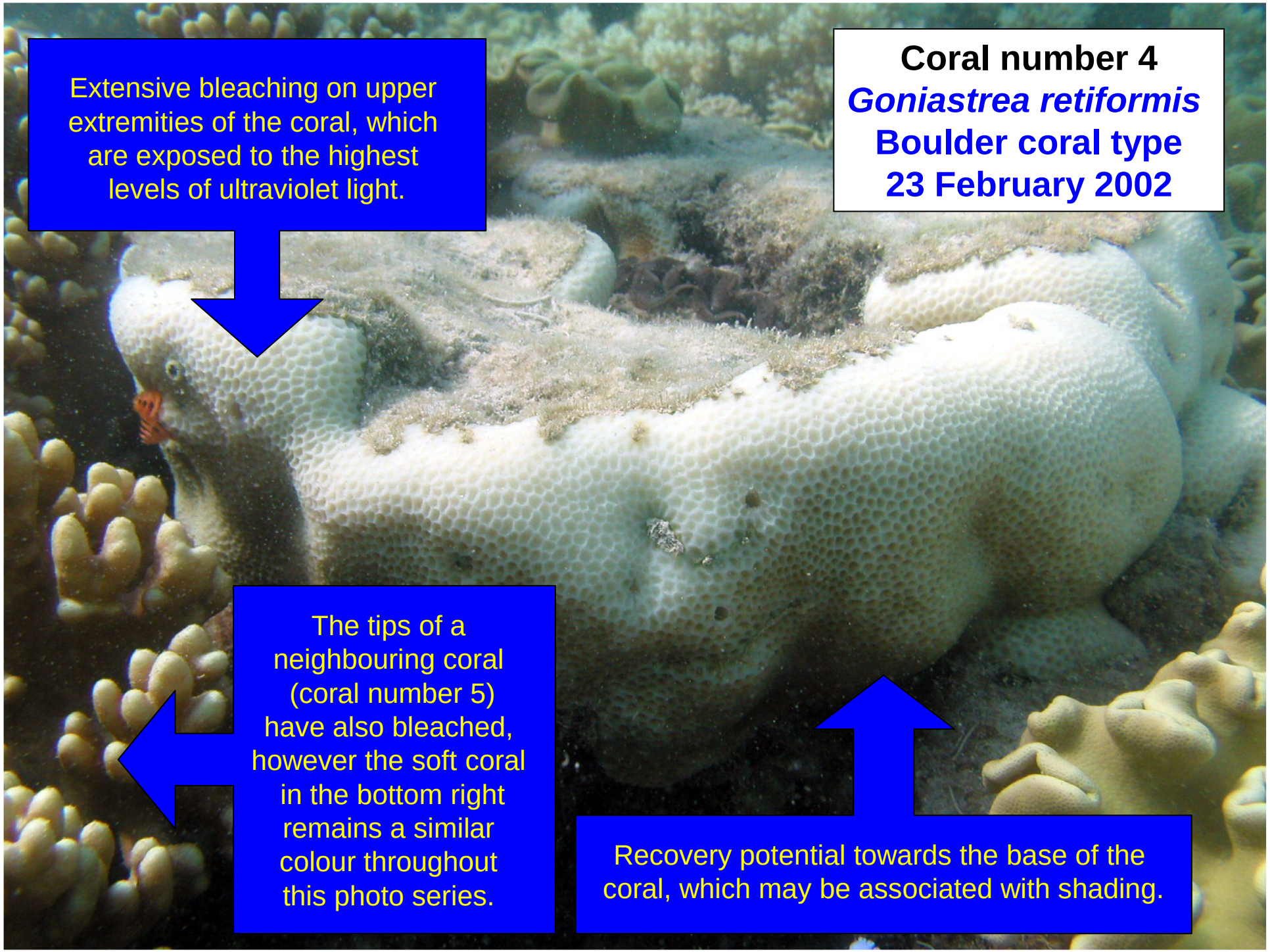

Coral number 2
19 December 2003
22 months later
10 cm
The coral is almost unrecognisable – the majority of the coral is dead and the remaining living branches have bleached.

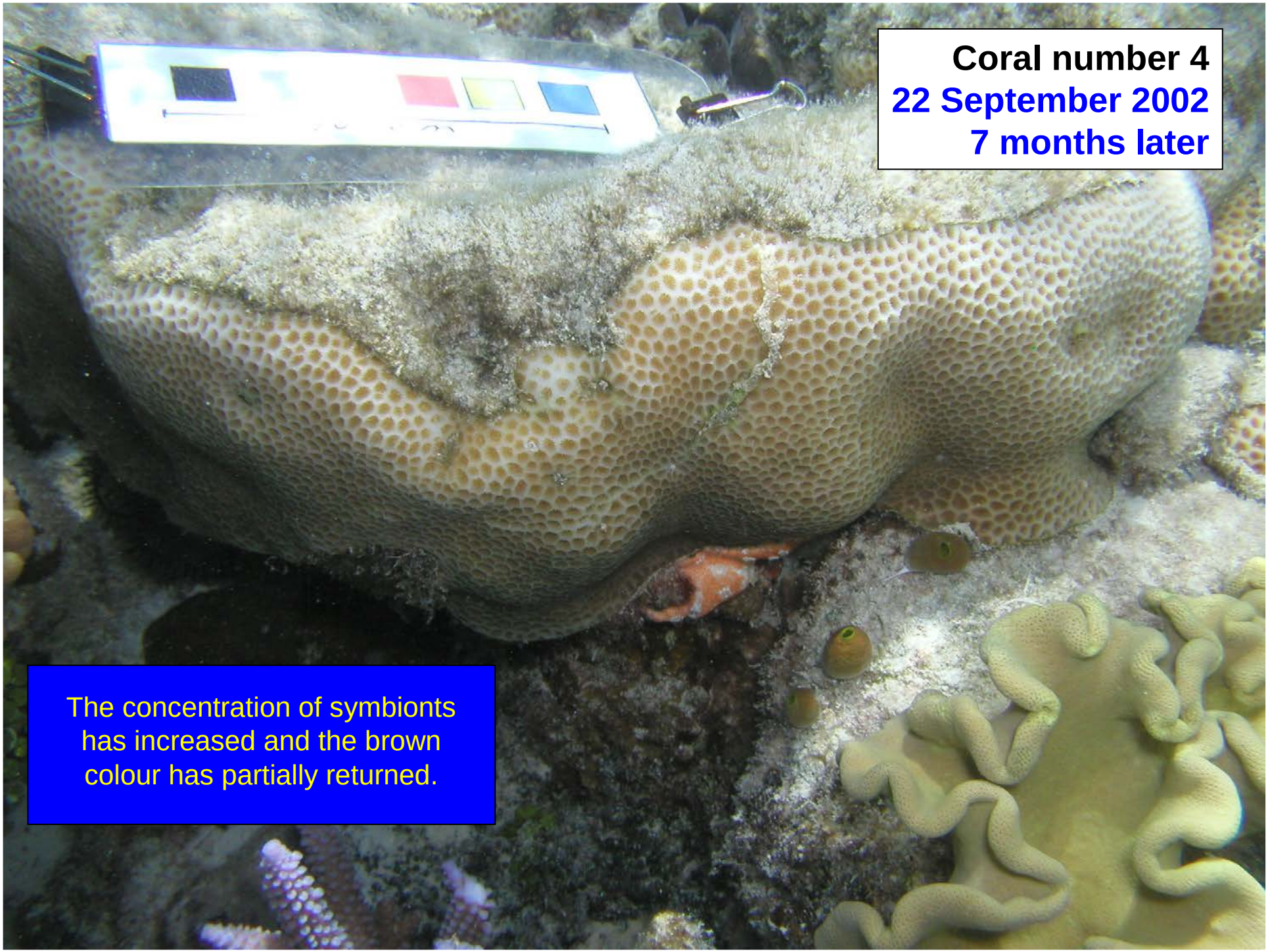

Coral number 3
Favia matthai
Boulder coral type
23 February 2002
Once again a neighbouring coral retains symbionts, and healthy brown colour, while coral number 3 bleaches extensively.
Extensive bleaching – the coral is almost completely white in colour with a very small ring of brown tissue around the base.

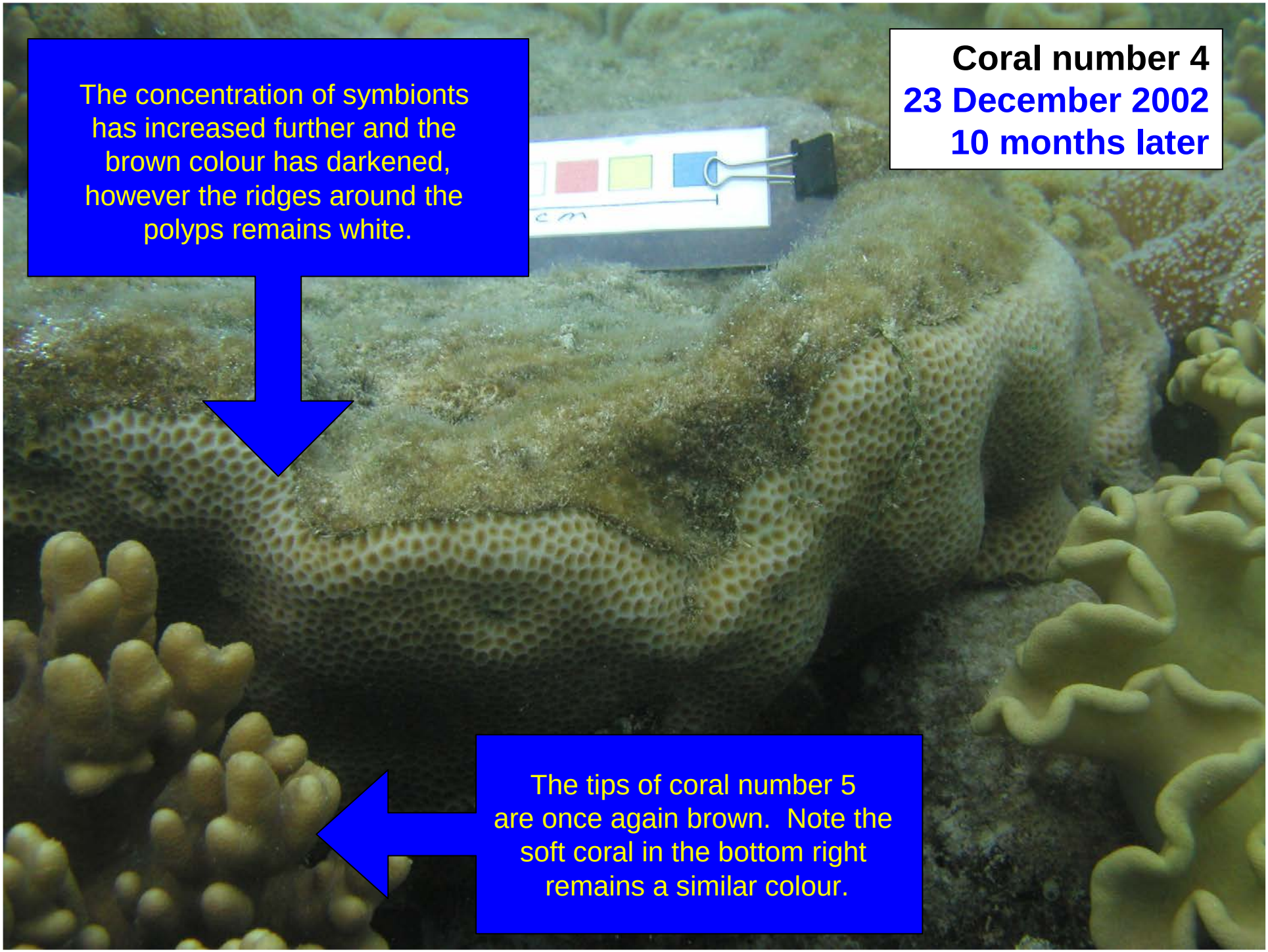

Coral number 3
22 September 2002
7 months later
The living tissue has died and algae has established on the coral. This is an example of partial mortality following a bleaching event.
The lower parts of the coral have recovered.
10 cm

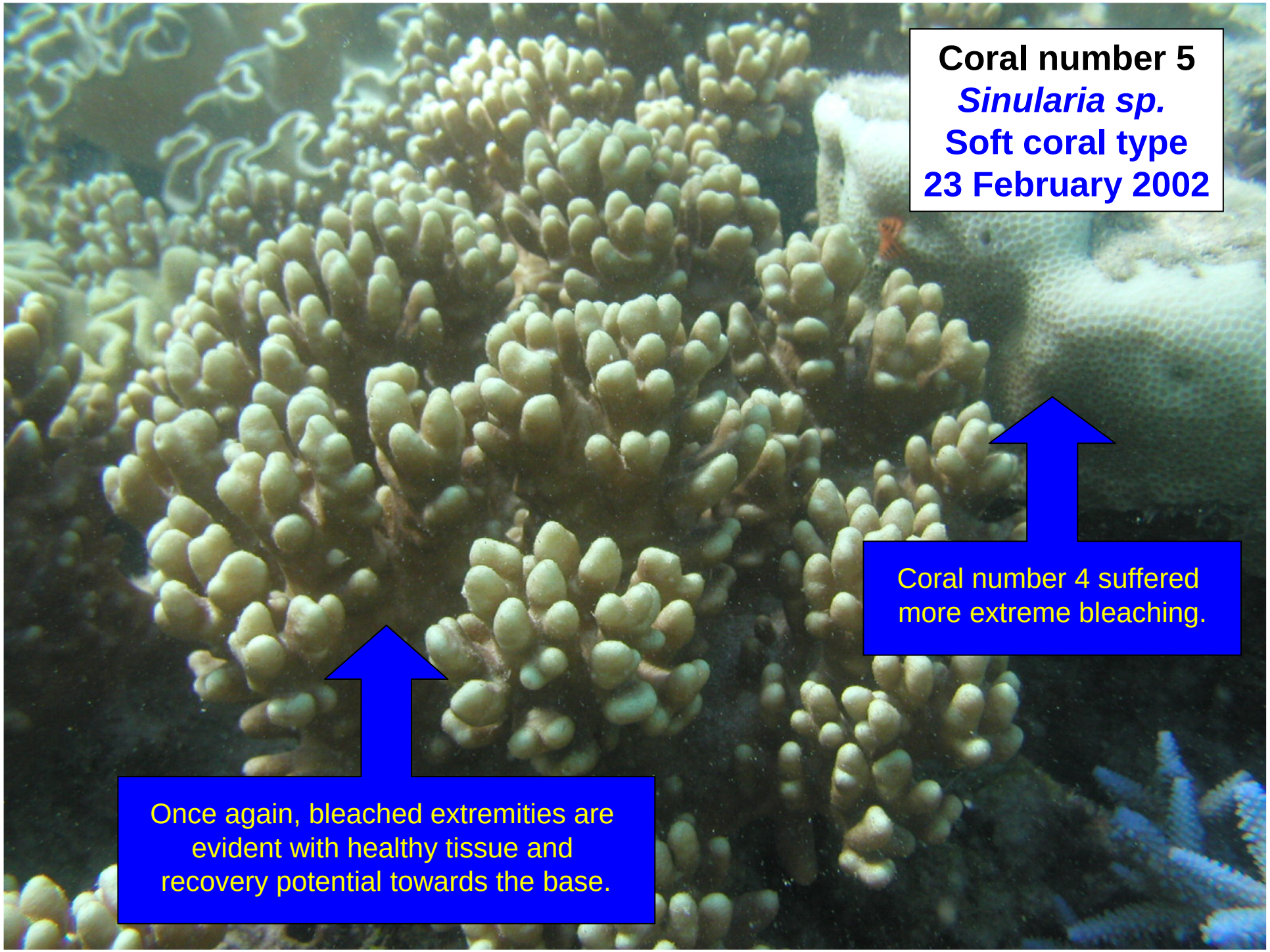

Coral number 3
23 December 2002
10 months later
The algae is well established on the upper surface of the coral.
Much of the coral has substantially paled in colour, since the previous photo taken in spring, and this is associated with elevated summer water temperatures.

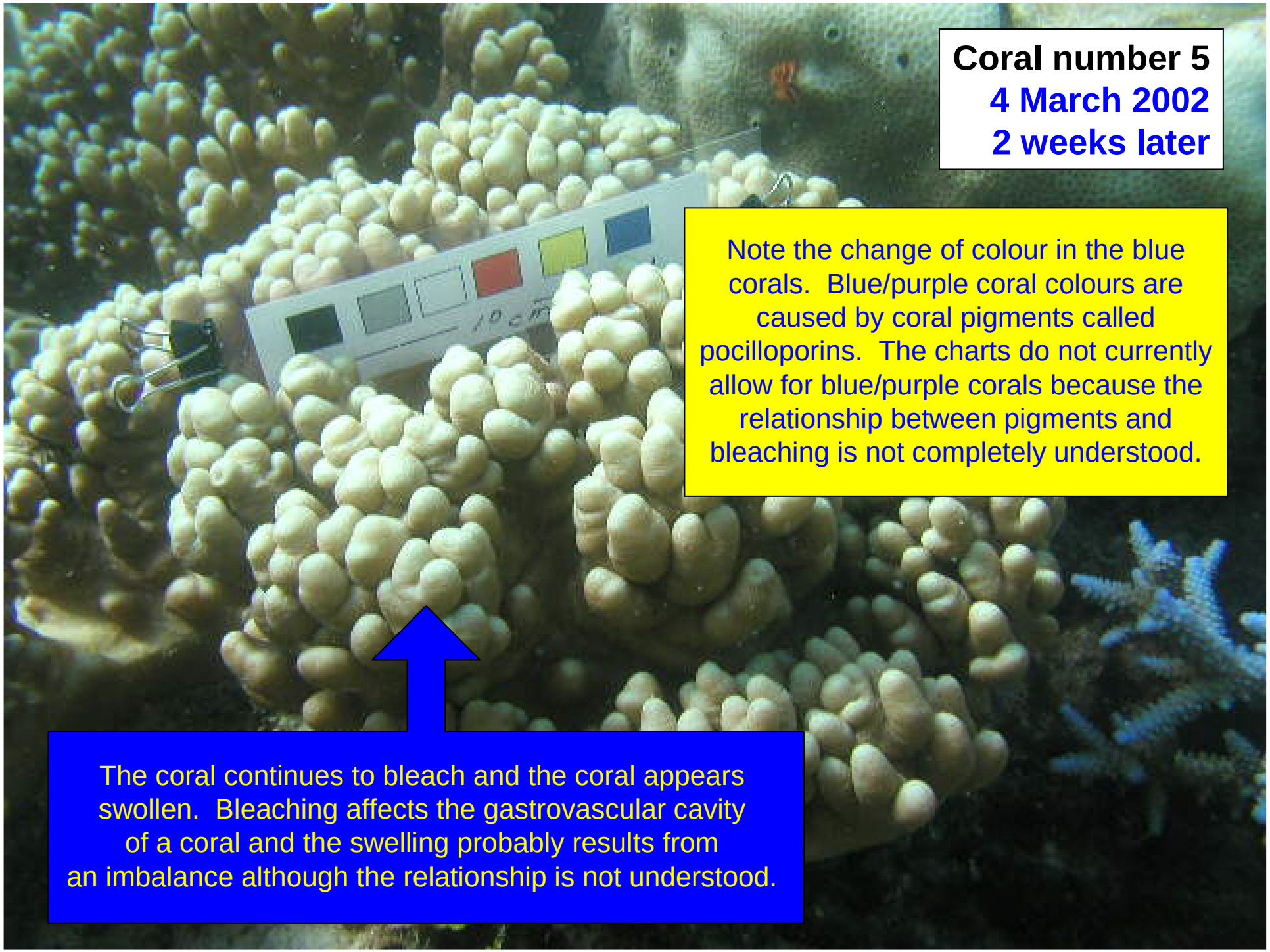

Coral number 3
19 December 2003
22 months later
Much of the coral has bleached again, although unlike the summer of 2002 there was not a mass bleaching event during the summer of 2003, therefore the live part of this coral will probably survive.

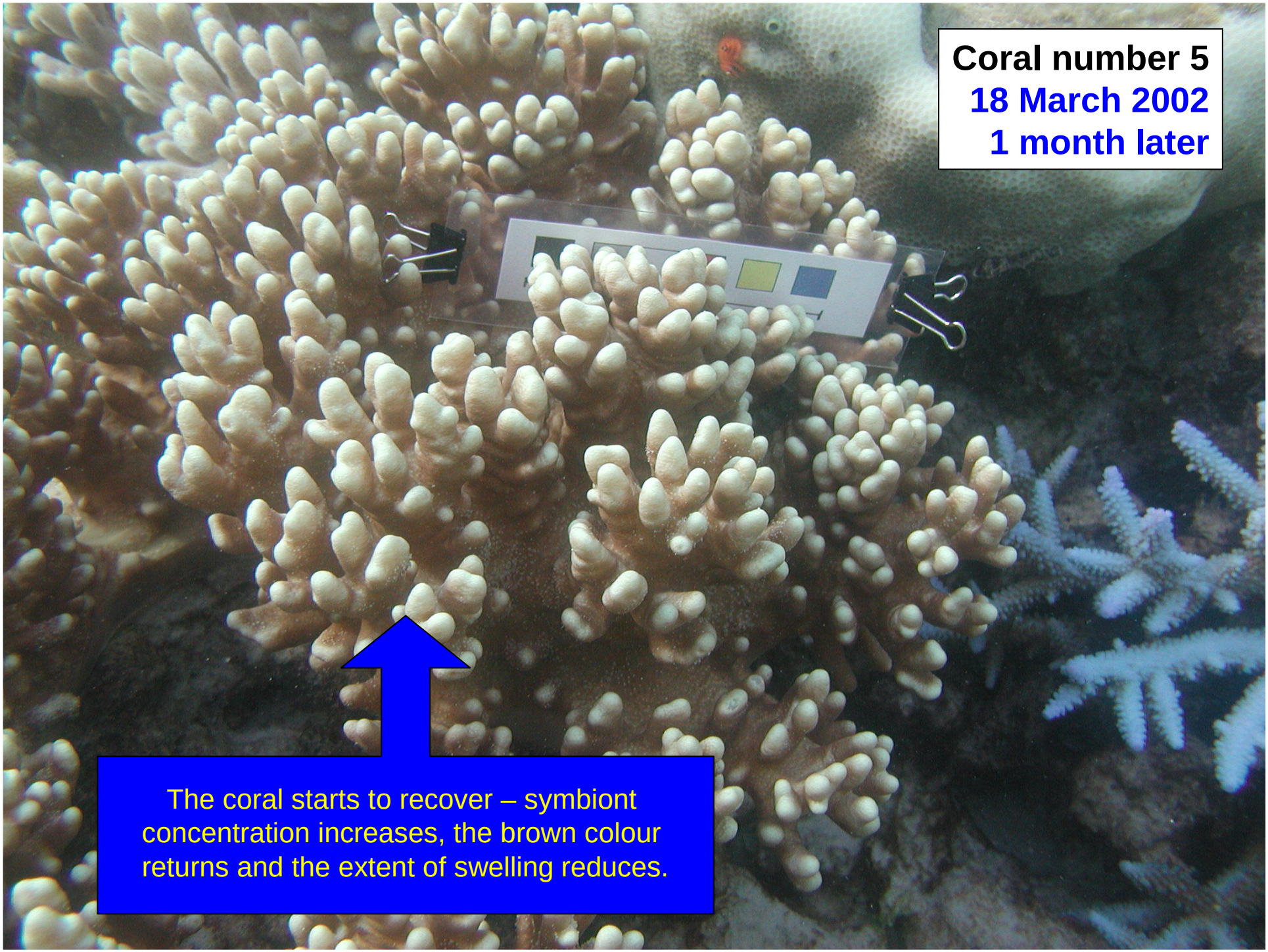

Extensive bleaching on upper extremities of the coral, which are exposed to the highest levels of ultraviolet light.
Coral number 4
Goniastrea retiformis
Boulder coral type
23 February 2002
The tips of a neighbouring coral (coral number 5) have also bleached, however the soft coral in the bottom right remains a similar colour throughout this photo series.
Recovery potential towards the base of the coral, which may be associated with shading.

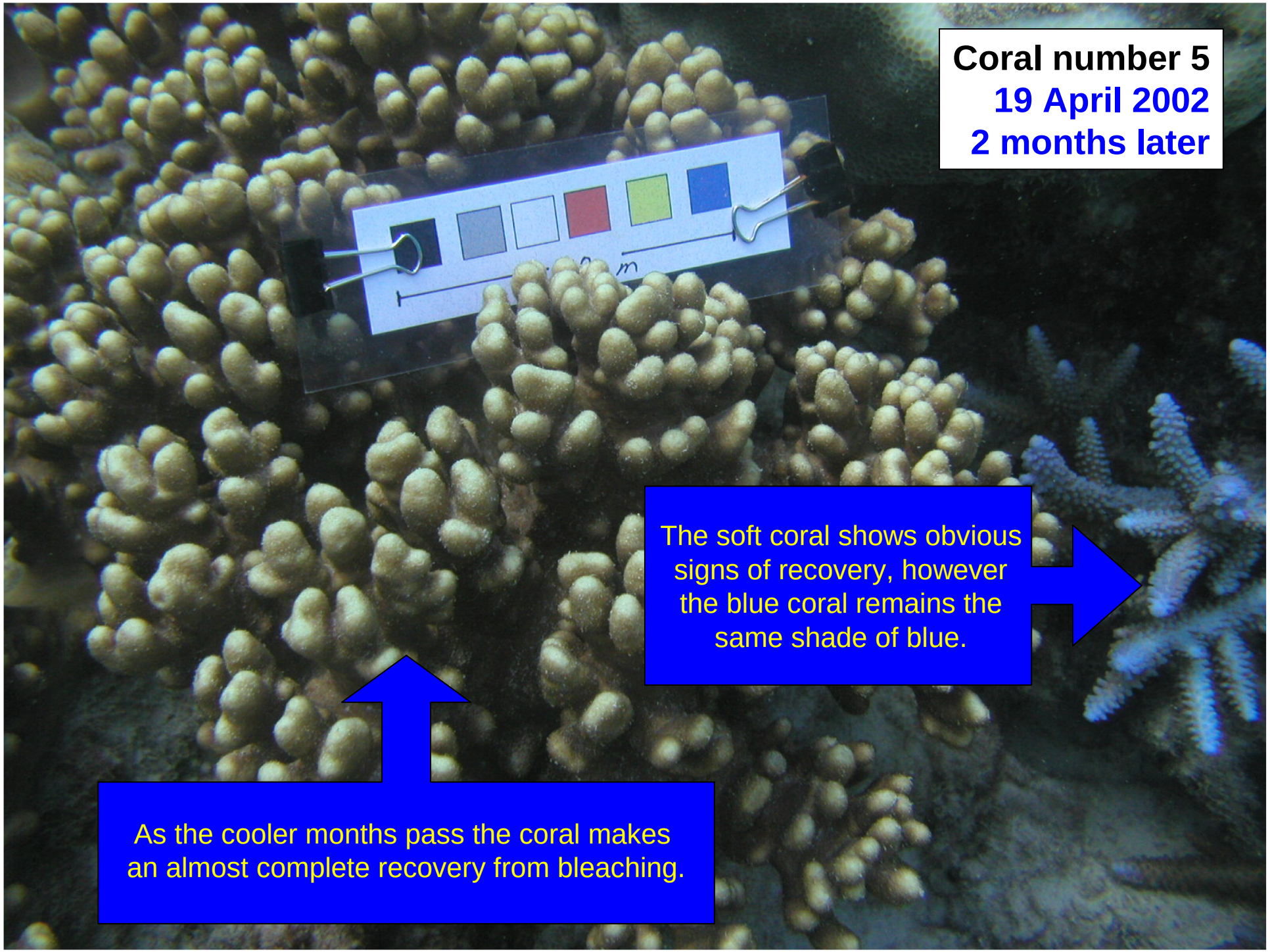

Coral number 4
22 September 2002
7 months later
The concentration of symbionts has increased and the brown colour has partially returned.

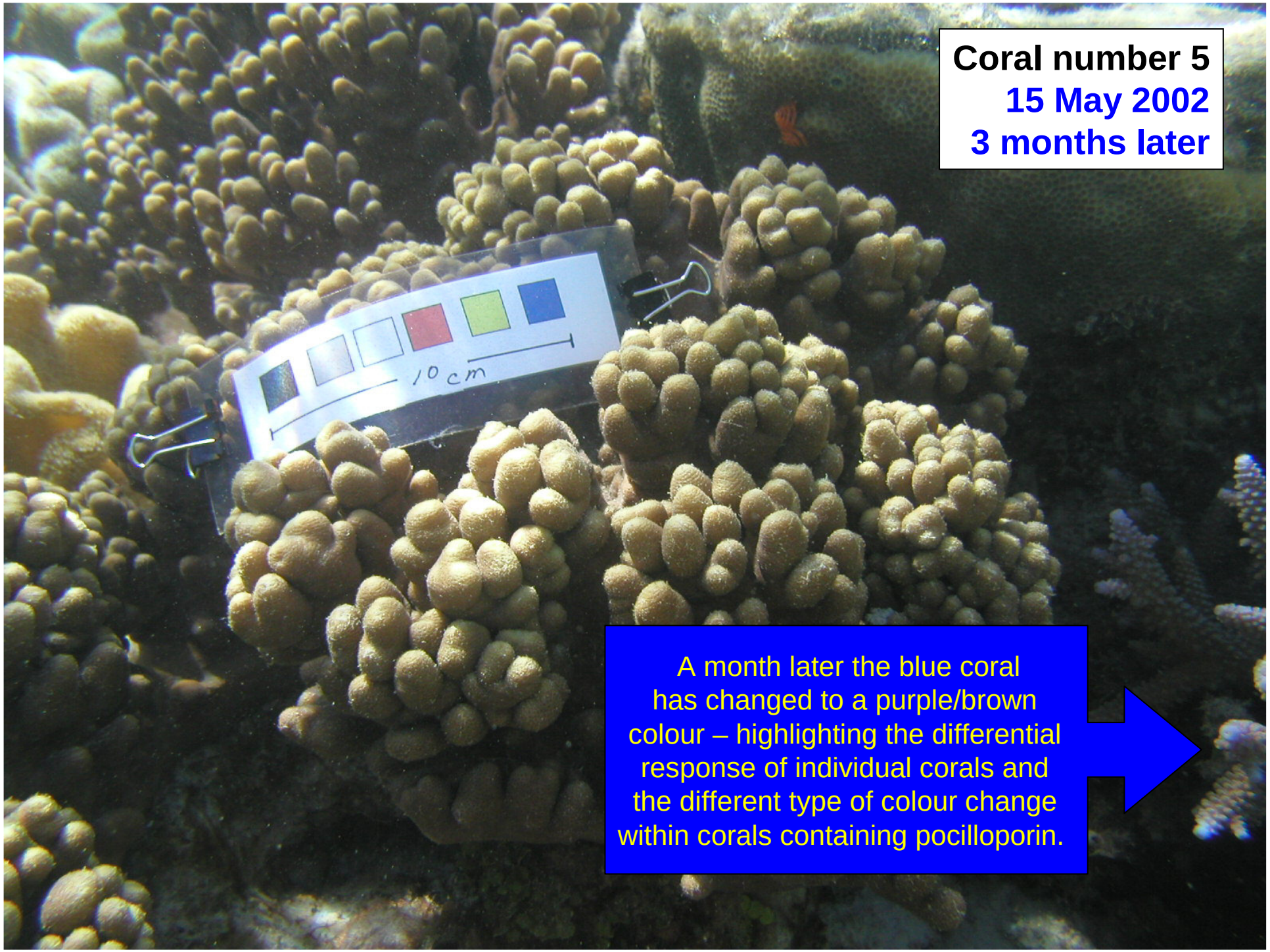

Coral number 4
23 December 2002
10 months later
The concentration of symbionts has increased further and the brown colour has darkened, however the ridges around the polyps remains white.
The tips of coral number 5 are once again brown. Note the soft coral in the bottom right remains a similar colour.

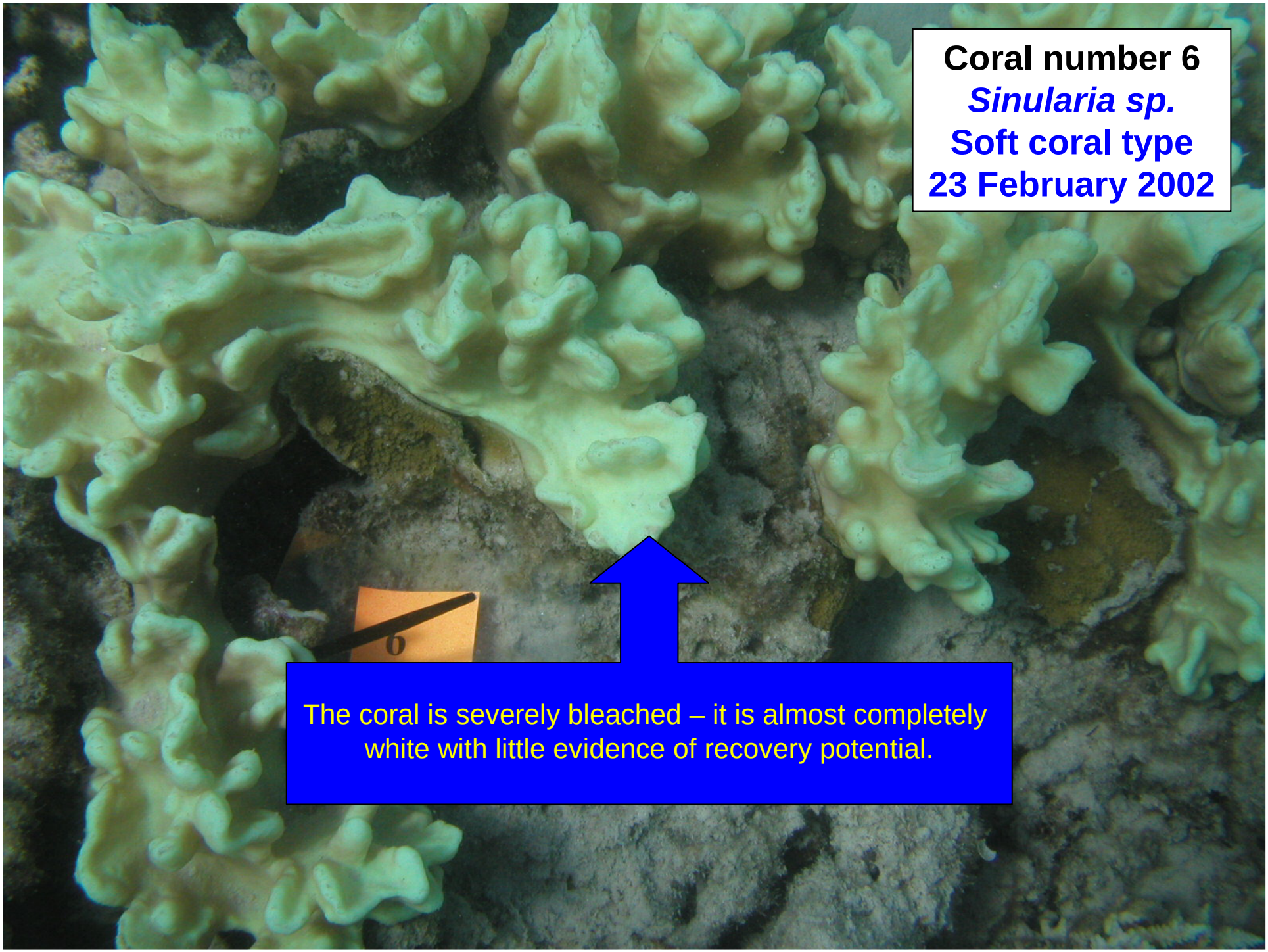

Coral number 5
Sinularia sp.
Soft coral type
23 February 2002
Coral number 4 suffered more extreme bleaching.
Once again, bleached extremities are evident with healthy tissue and recovery potential towards the base.

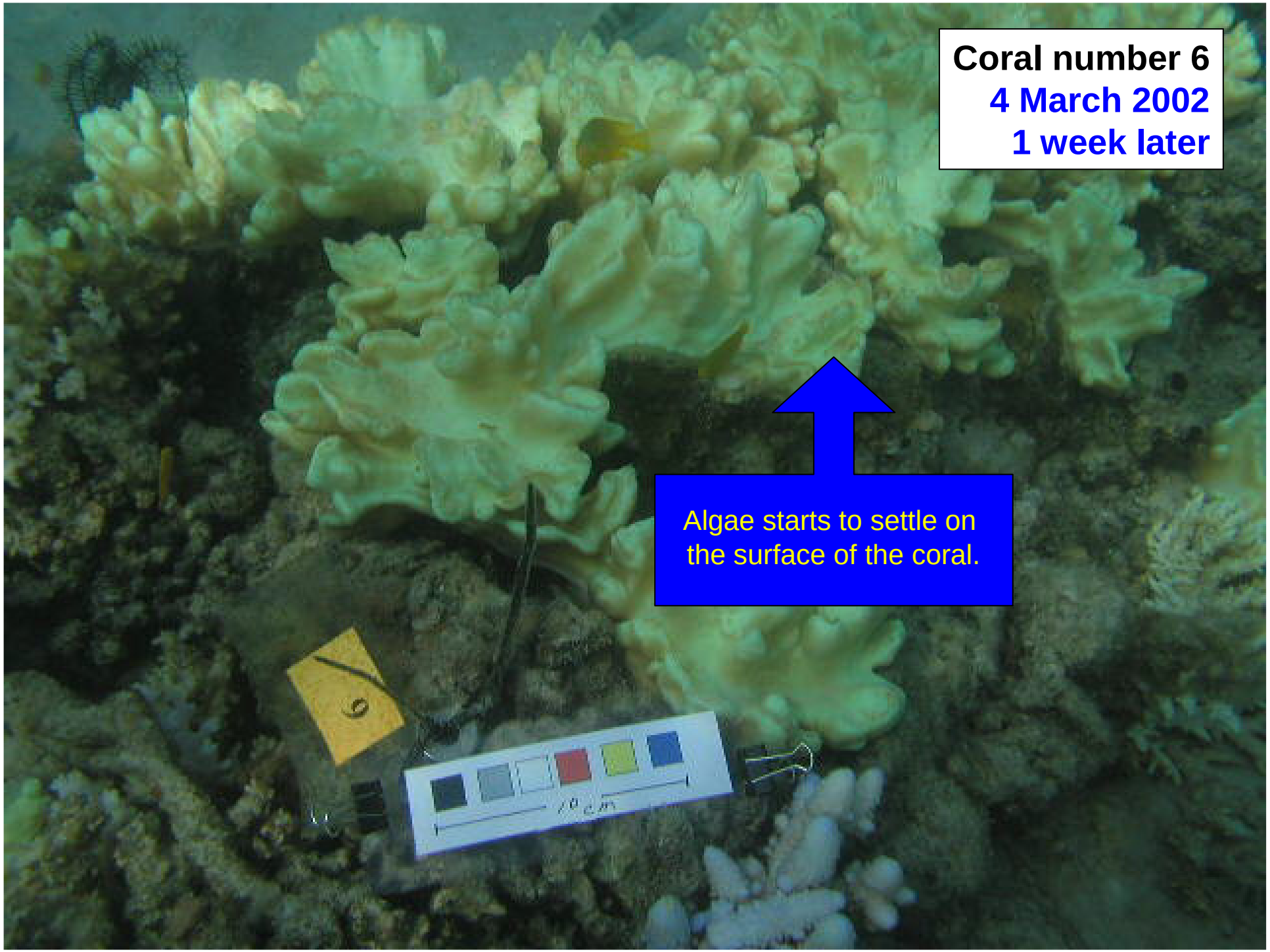

Coral number 5
4 March 2002
2 weeks later
Note the change of colour in the blue corals. Blue/purple coral colours are caused by coral pigments called pocilloporins. The charts do not currently allow for blue/purple corals because the relationship between pigments and bleaching is not completely understood.
The coral continues to bleach and the coral appears swollen. Bleaching affects the gastrovascular cavity of a coral and the swelling probably results from an imbalance although the relationship is not understood.

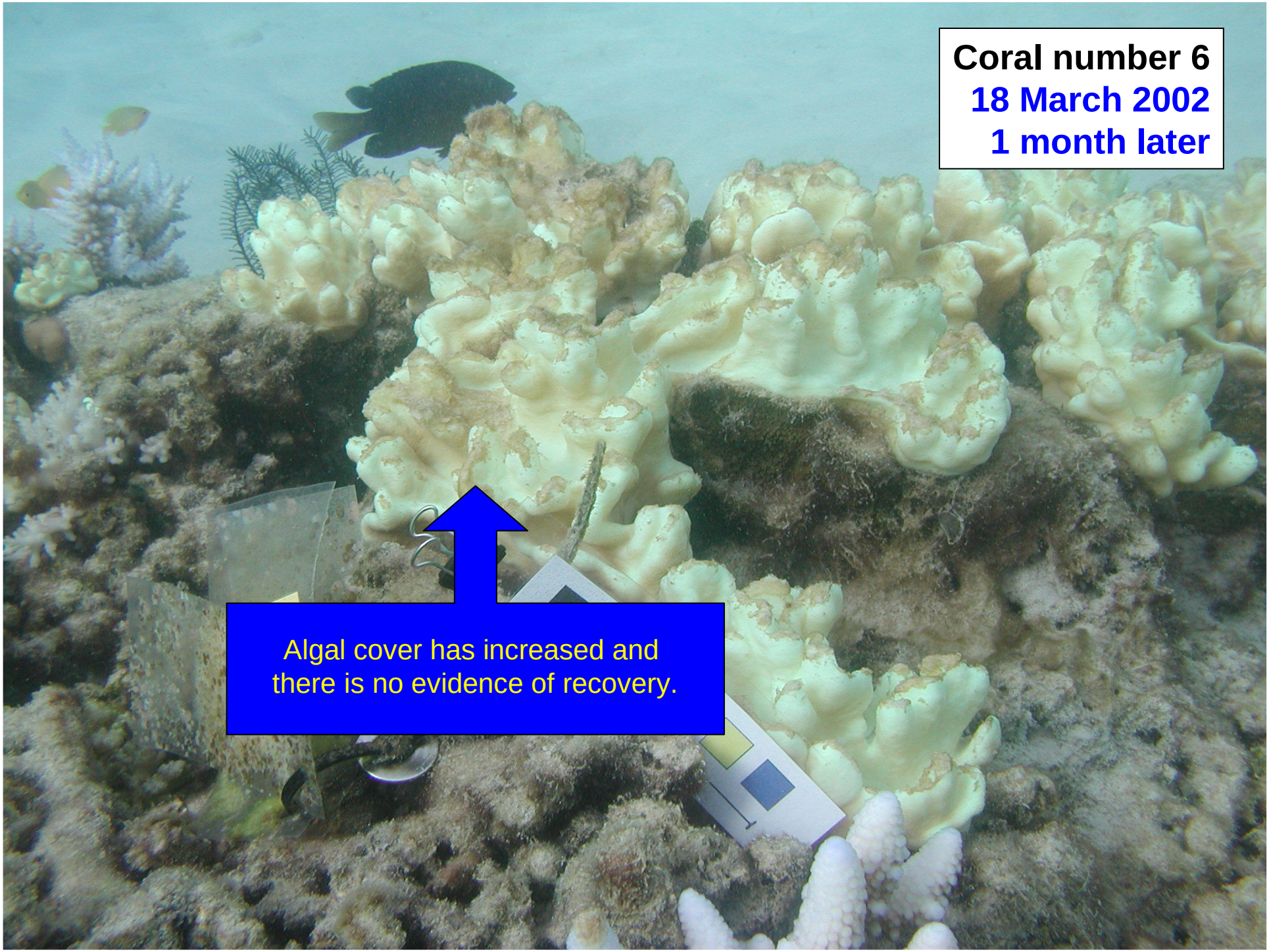

Coral number 5
18 March 2002
1 month later
The coral starts to recover – symbiont concentration increases, the brown colour returns and the extent of swelling reduces.

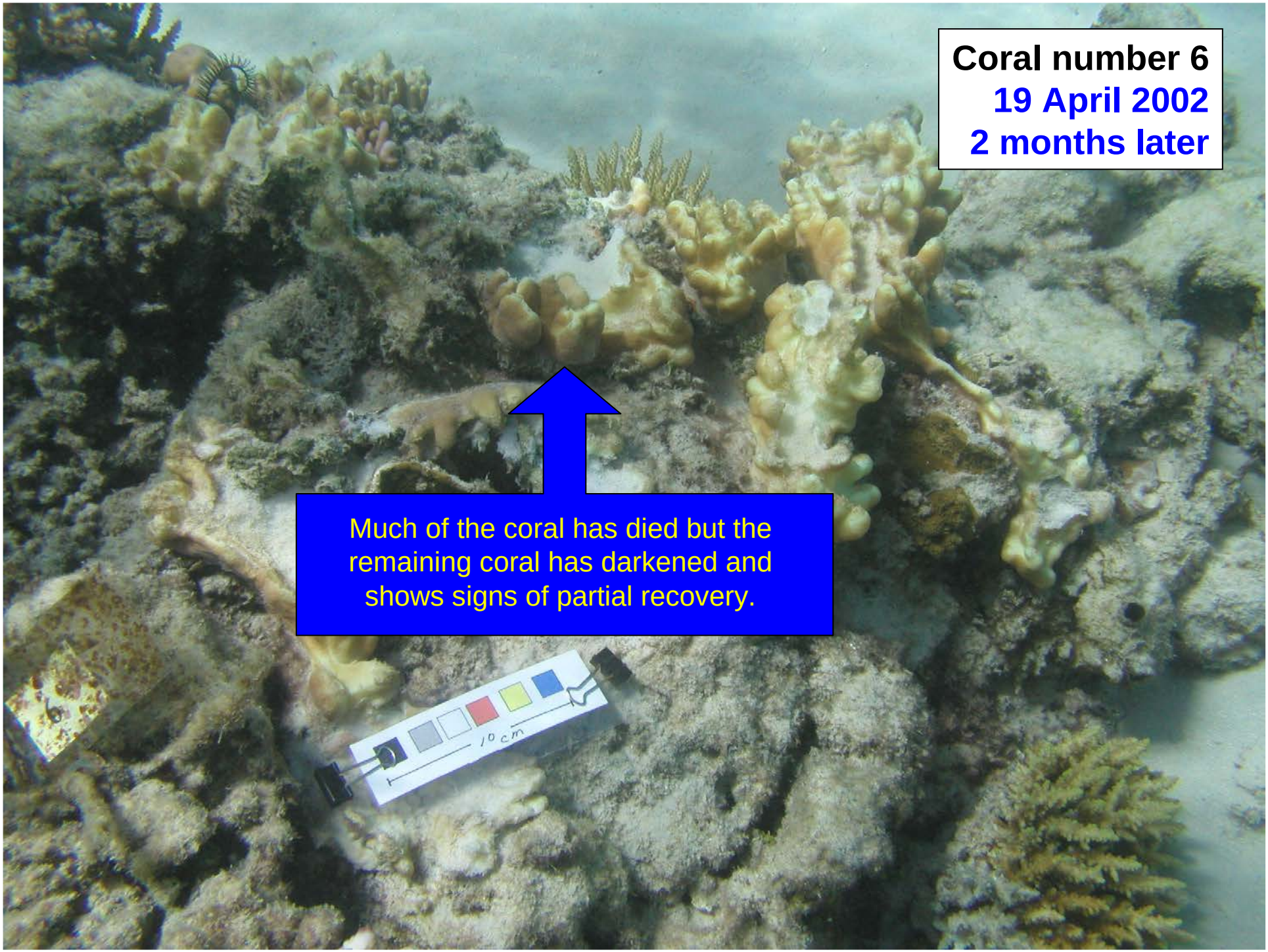

Coral number 5
19 April 2002
2 months later
The soft coral shows obvious signs of recovery, however the blue coral remains the same shade of blue.
As the cooler months pass the coral makes an almost complete recovery from bleaching.

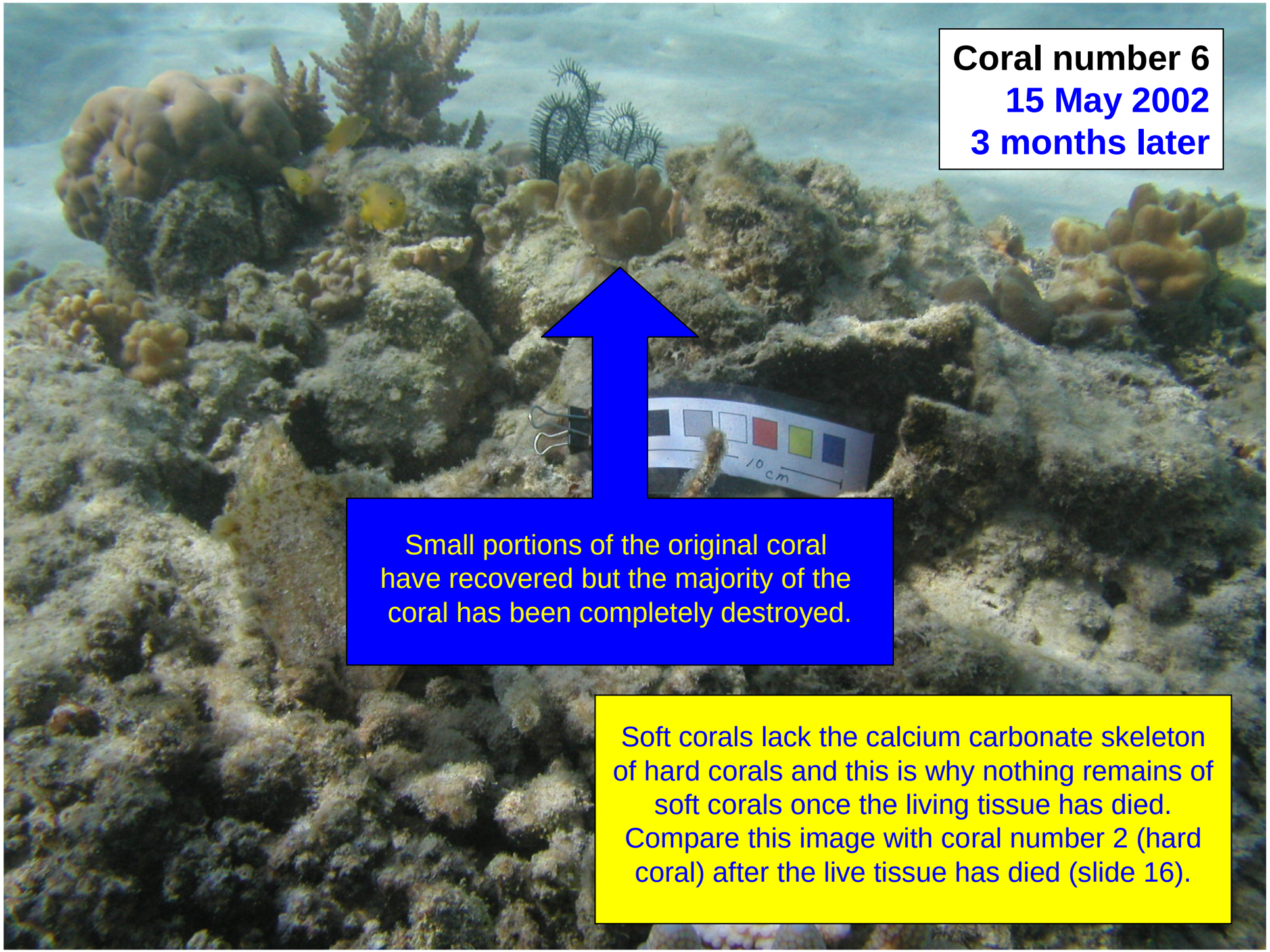

Coral number 5
15 May 2002
3 months later
10 cm
A month later the blue coral has changed to a purple/brown colour – highlighting the differential response of individual corals and the different type of colour change within corals containing pocilloporin.

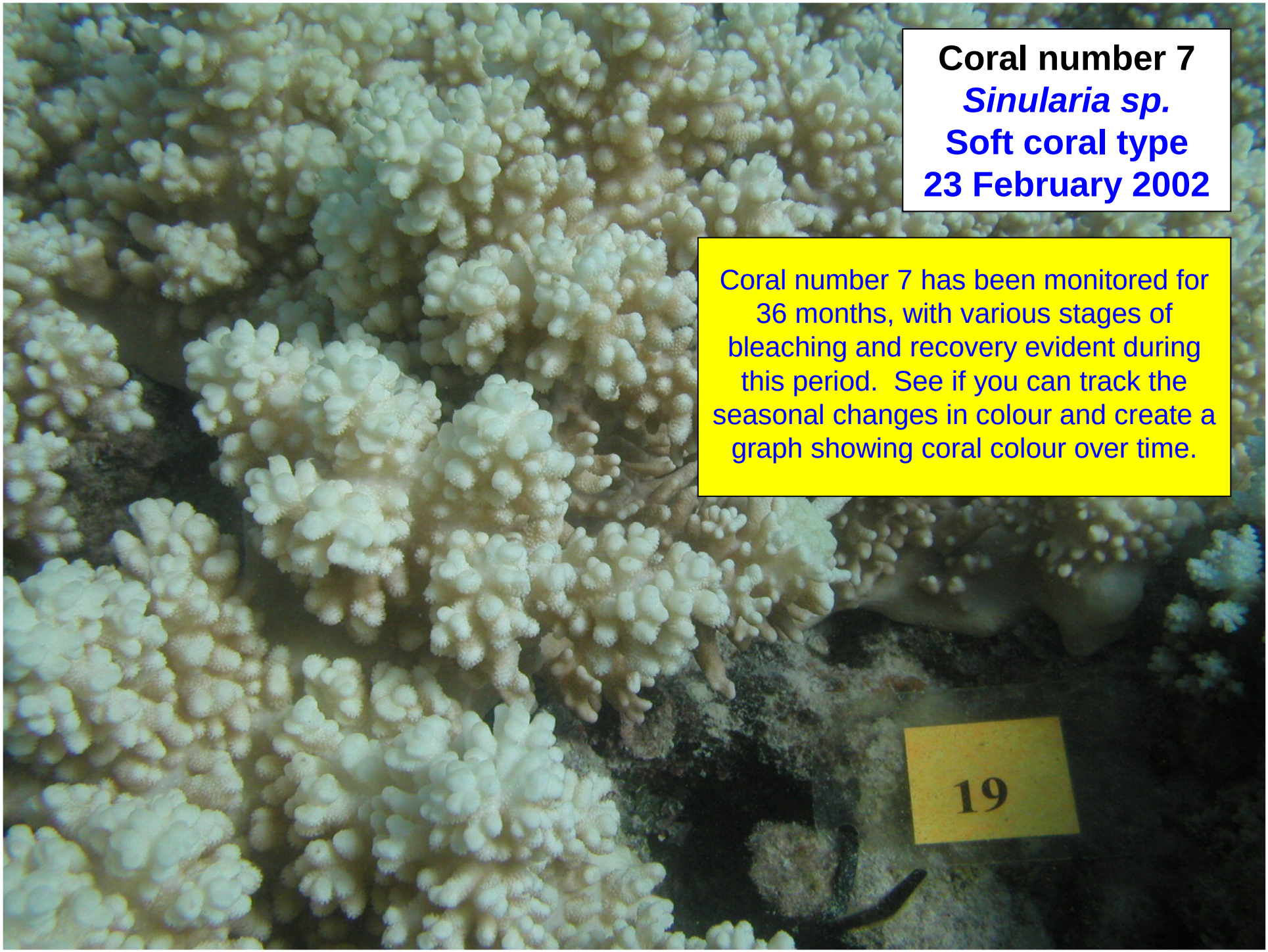

Coral number 6
Sinularia sp.
Soft coral type
23 February 2002
6
The coral is severely bleached – it is almost completely white with little evidence of recovery potential.


Coral number 6
4 March 2002
1 week later
Algae starts to settle on the surface of the coral.


Coral number 6
18 March 2002
1 month later
Algal cover has increased and
there is no evidence of recovery.

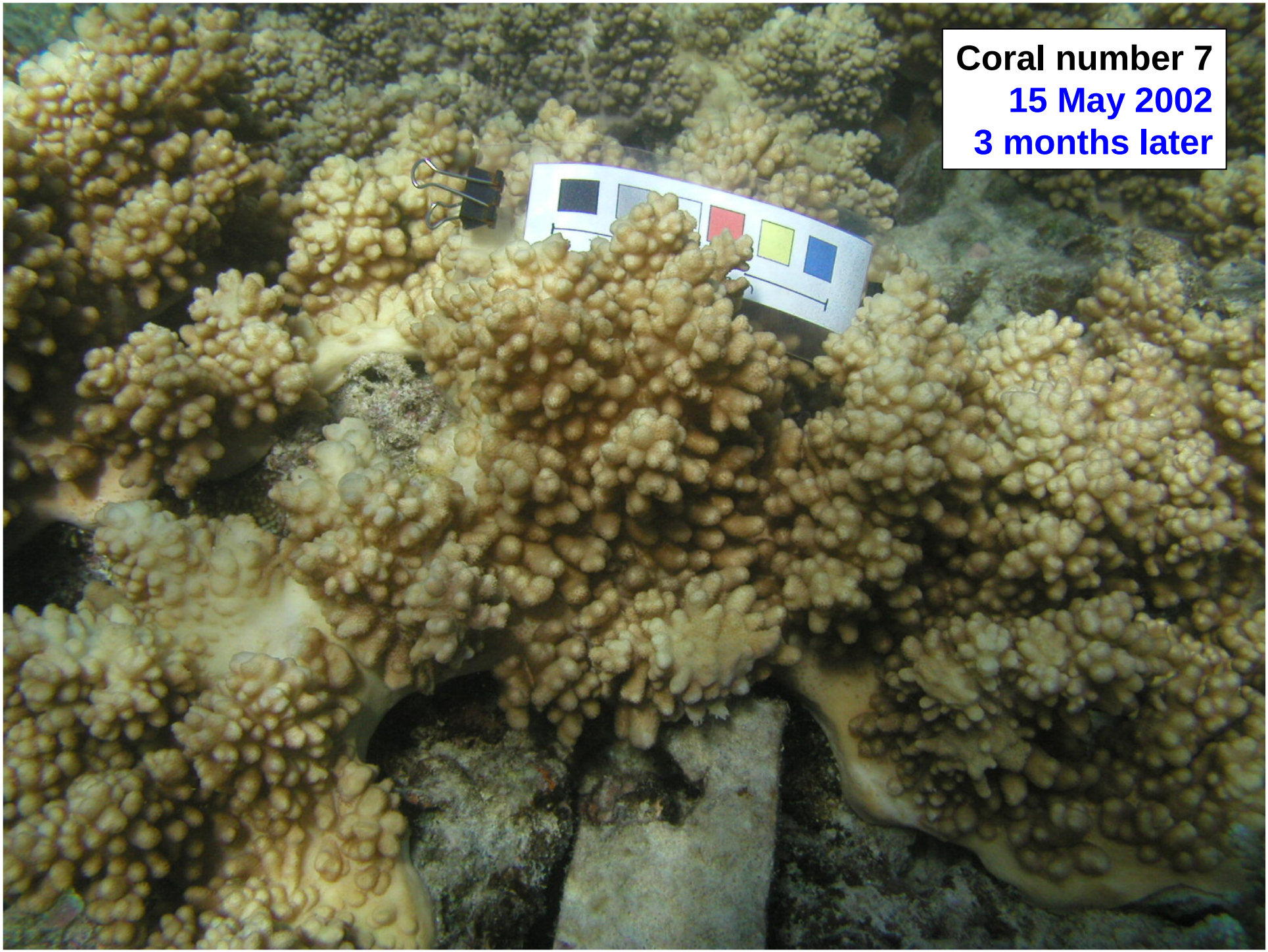

Coral number 6
19 April 2002
2 months later
Much of the coral has died but the remaining coral has darkened and shows signs of partial recovery.
10 cm

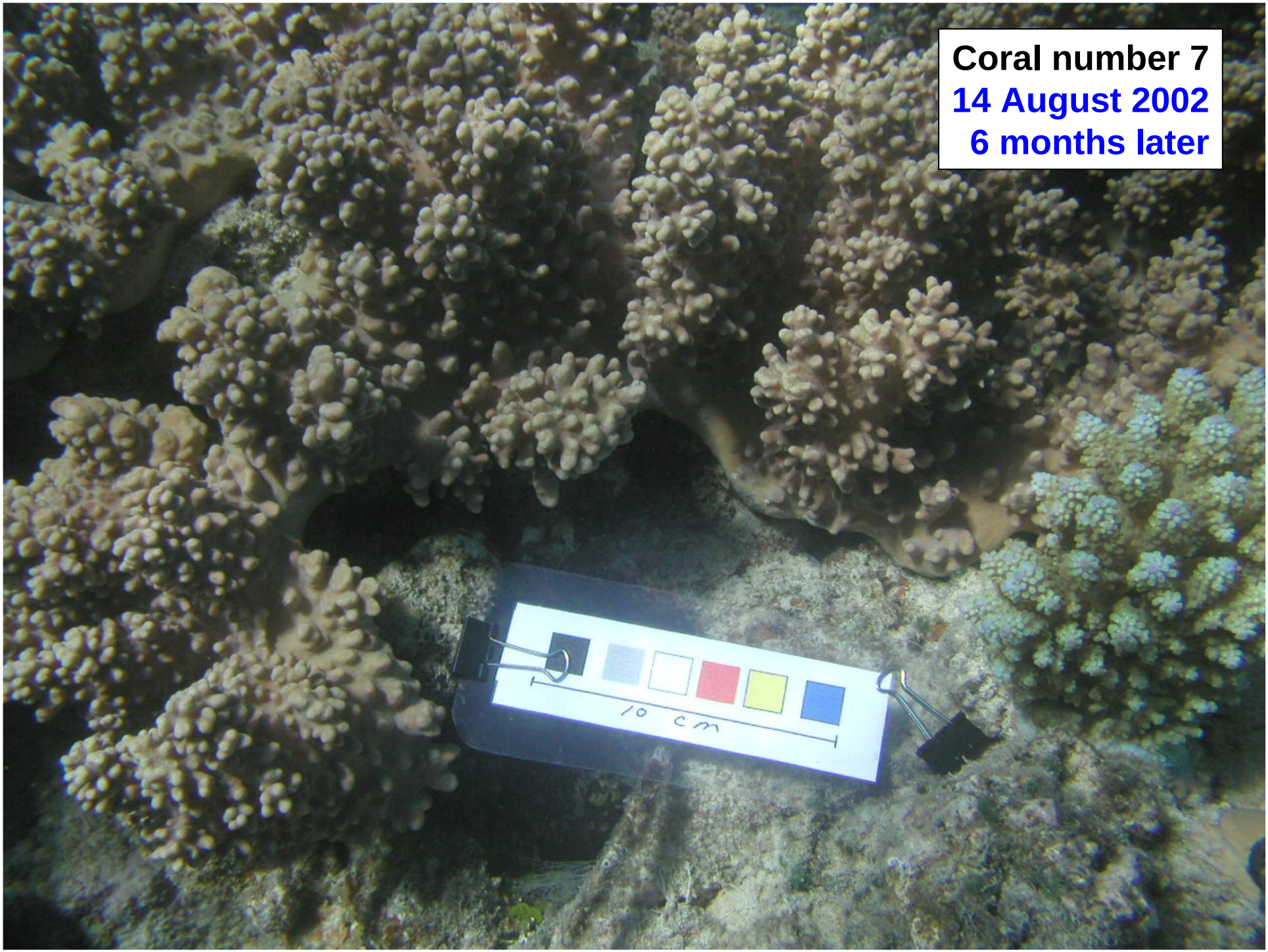

Coral number 6
15 May 2002
3 months later
10 cm
Small portions of the original coral have recovered but the majority of the coral has been completely destroyed.
Soft corals lack the calcium carbonate skeleton of hard corals and this is why nothing remains of soft corals once the living tissue has died. Compare this image with coral number 2 (hard coral) after the live tissue has died (slide 16).

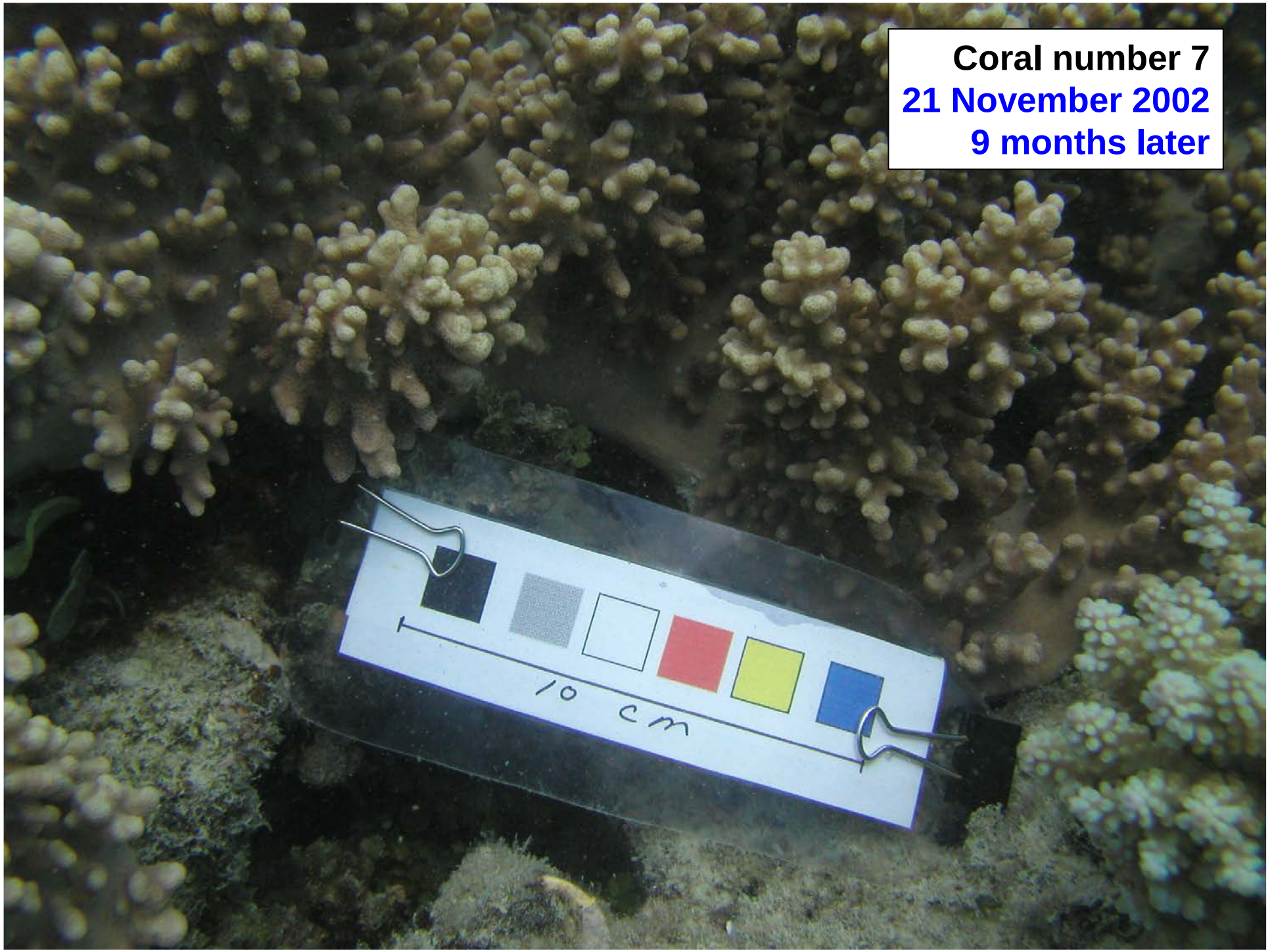


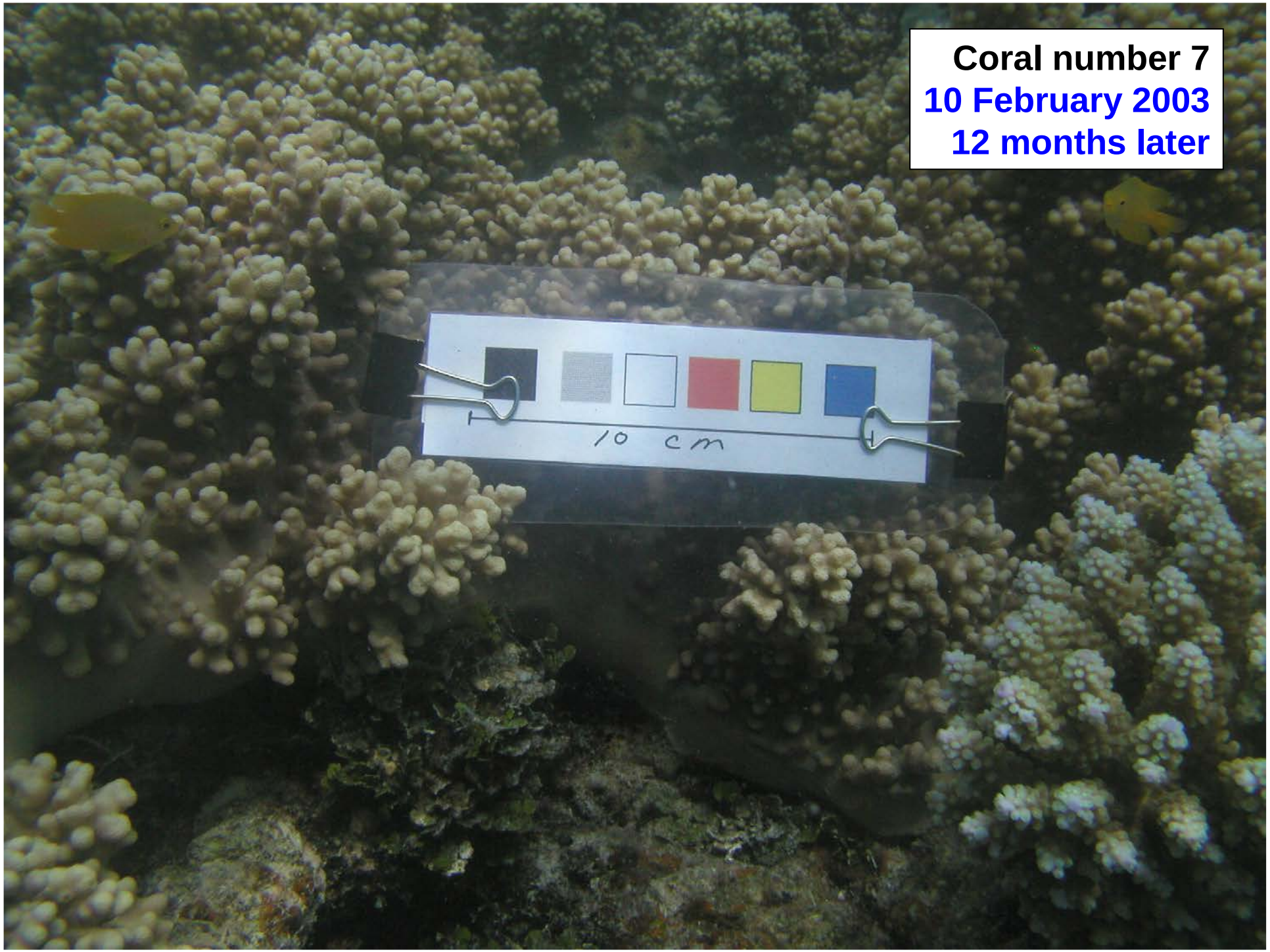
Coral number 7
Sinularia sp.
Soft coral type
23 February 2002

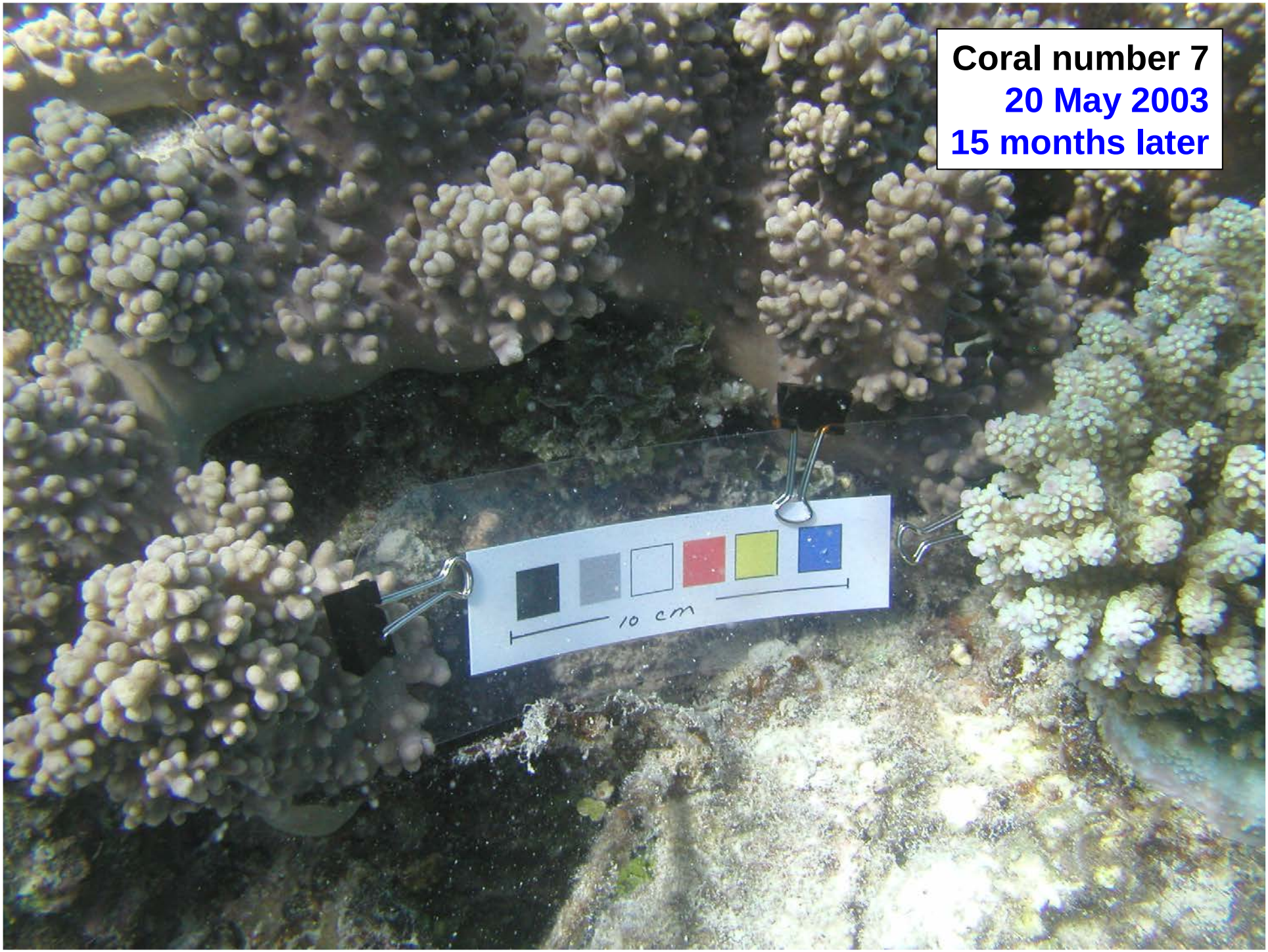
Coral number 7 has been monitored for 36 months, with various stages of bleaching and recovery evident during this period. See if you can track the seasonal changes in colour and create a graph showing coral colour over time.

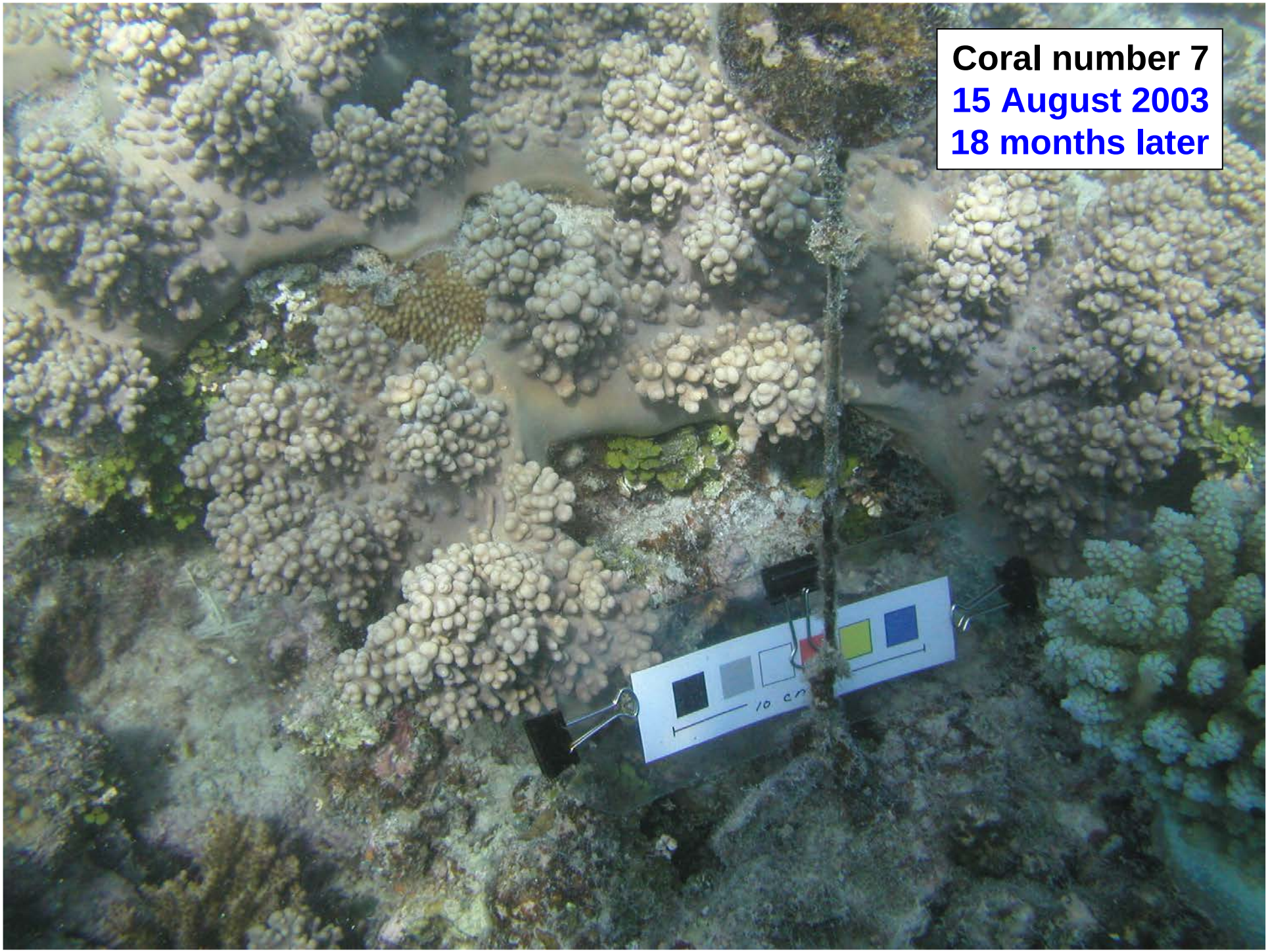

Coral number 7
15 May 2002
3 months later

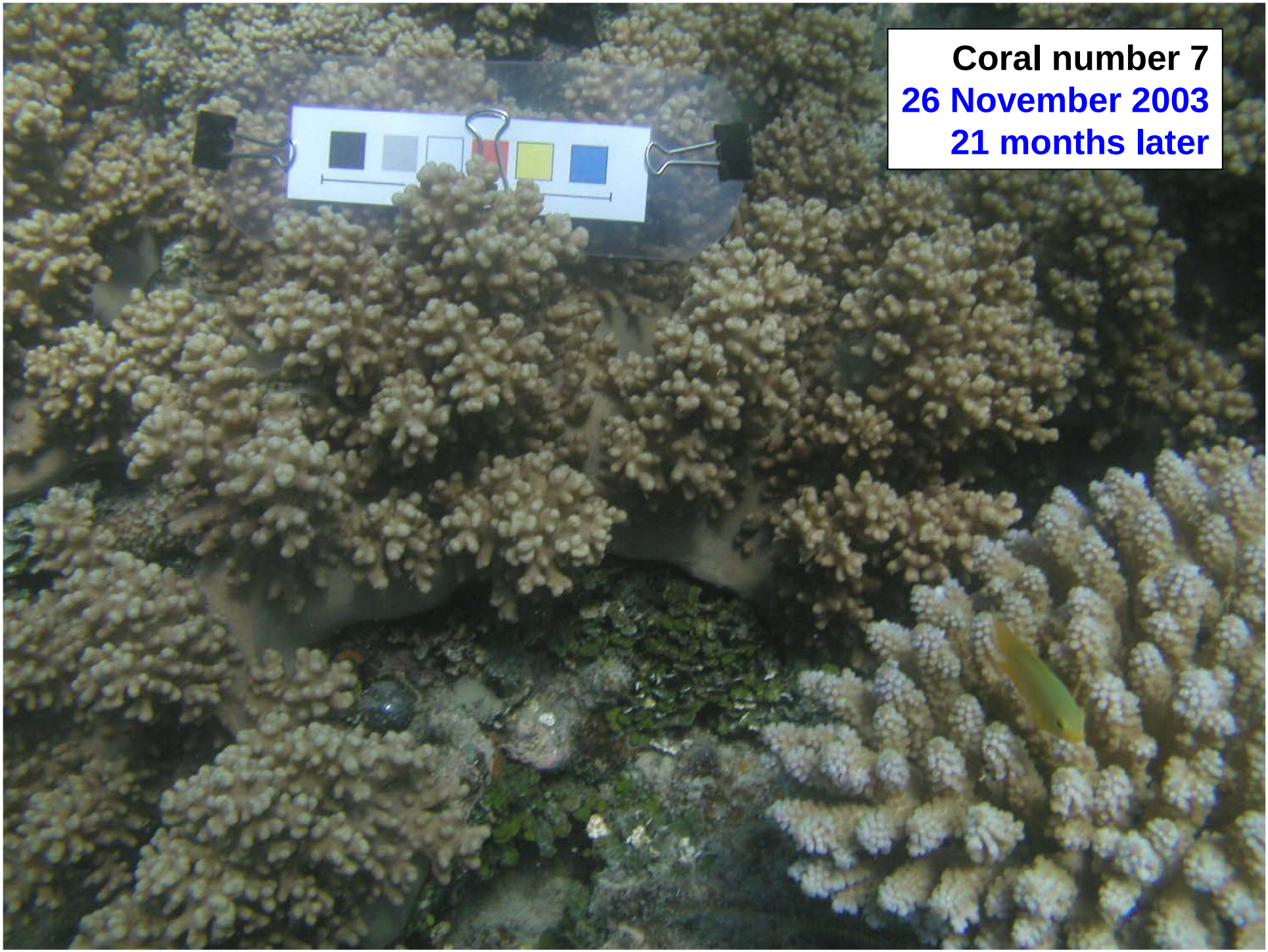

Coral number 7
14 August 2002
6 months later
10 cm

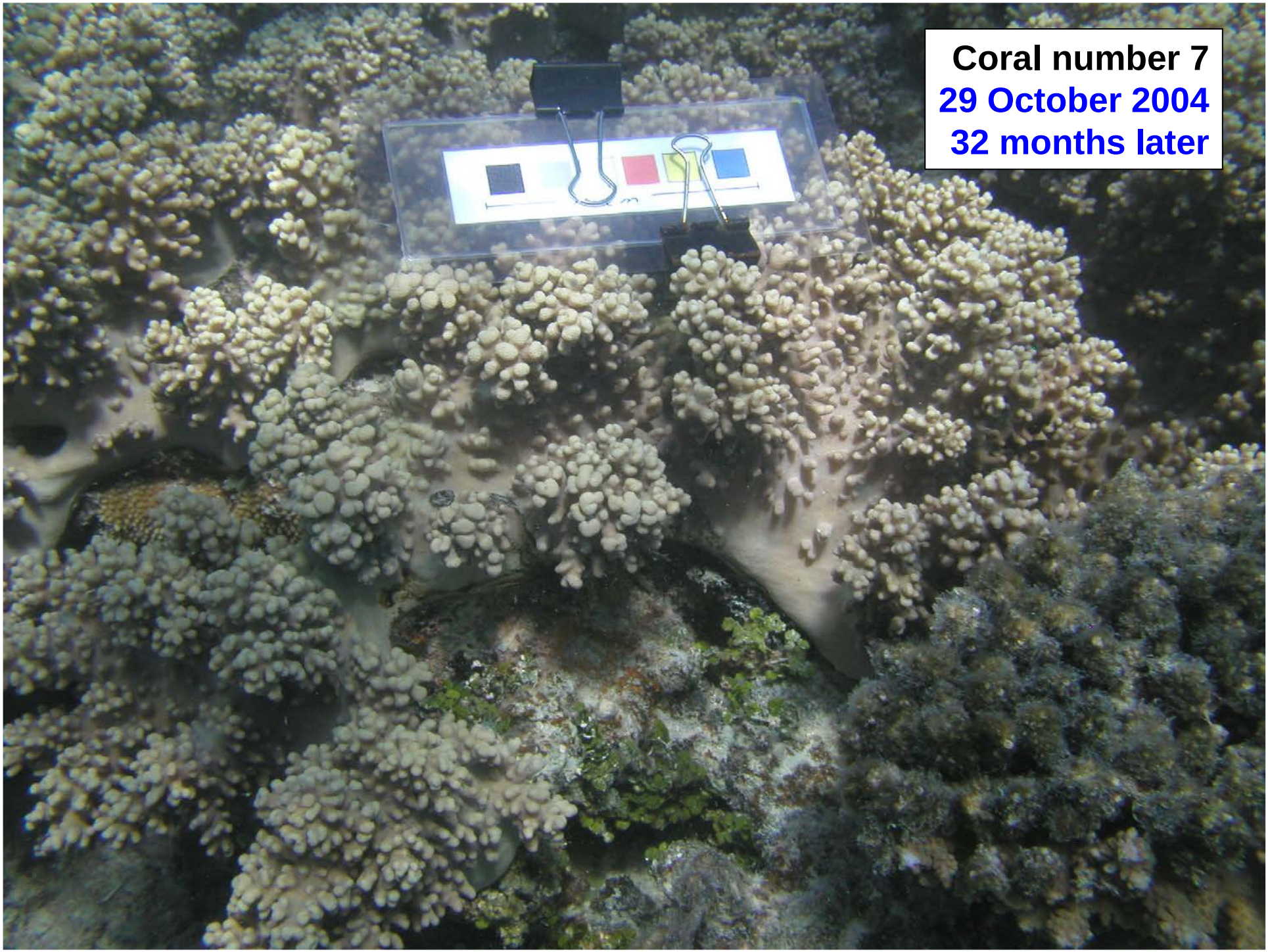

Coral number 7
21 November 2002
9 months later
10 cm

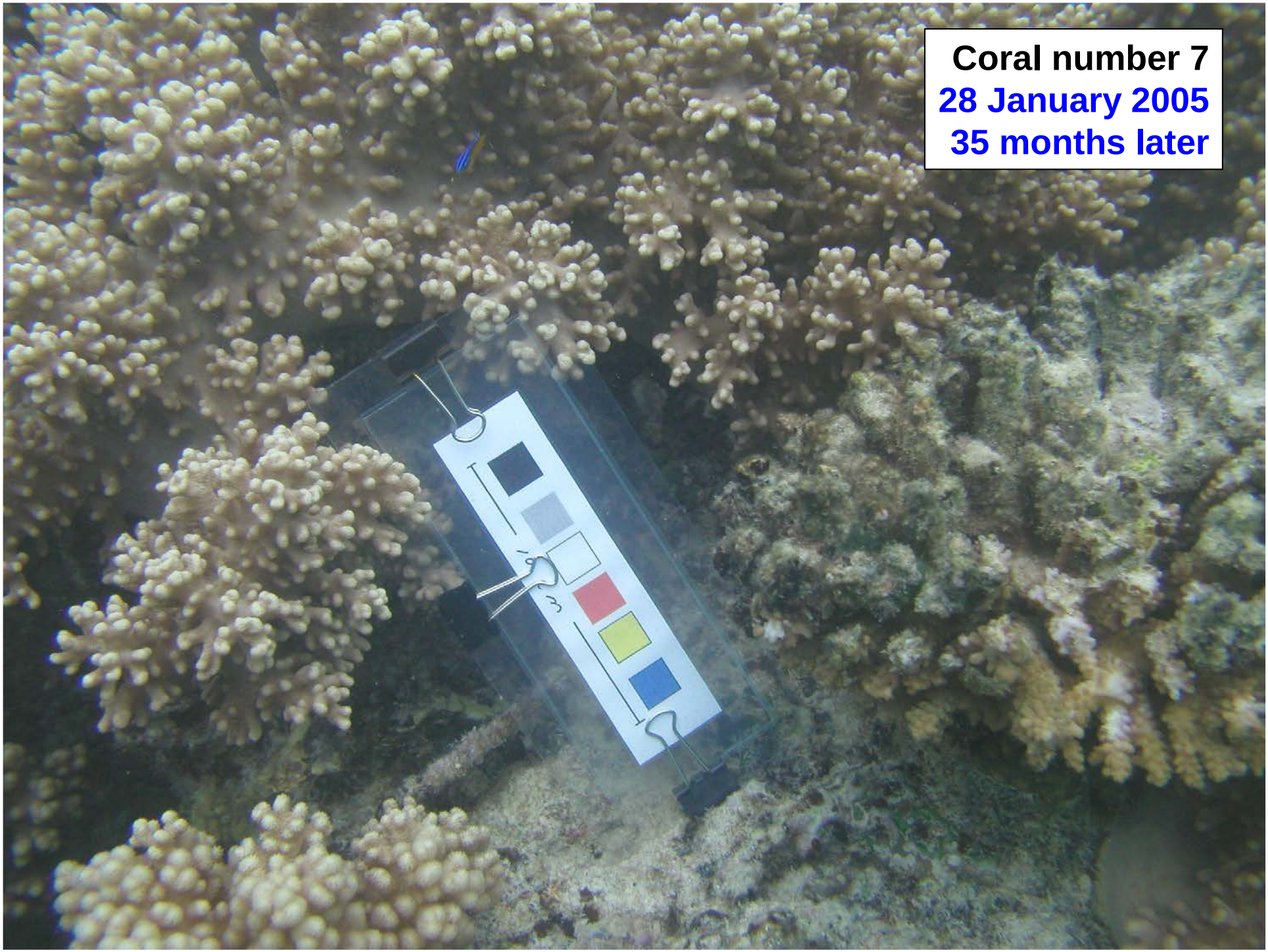

Coral number 7
10 February 2003
12 months later
10 cm


Coral number 7
20 May 2003
15 months later
10 cm


Coral number 7
15 August 2003
18 months later


Coral number 7
26 November 2003
21 months later


Coral number 7
29 October 2004
32 months later


Coral number 7
28 January 2005
35 months later

Acknowledgments

- Photos were reproduced with the kind permission of **Lyle Vail** and **Anne Hoggett** from the Lizard Island Research Station; A Facility of the Australian Museum.

- Thank you to **K-le Gomez** from the Centre for Marine Studies, University of Queensland and **Phil Aldersdale** from the Museum and Art Gallery of the Northern Territory for scientific advice.

- The Virtual Reef was collated by **Kylie McPherson** from the Vision, Touch and Hearing Research Centre, University of Queensland.