Acropora

Fluoro

Climate Change, Global & Glowing Coral

In the last edition of SCOTTISH DIVER, Billy Sinclair and Katrina Farrell reported that a voluntary stop on commercial fishing off Queensland was offering hope to the coral reefs. However in this article Billy, this time writing with Alison Jones, highlights recent coral problems and highlight that we can't afford to be complacent ...

THERE DOESN'T seem to be a day that goes by without climate change or global warming featuring on television news or in the newspapers. Climate change refers to the variation in climate over time - the changes in the state of the atmosphere. Global warming is the increase in the average temperature of the earth's surface air and water bodies. Green house gases are components of the atmosphere, some of which occur naturally in the atmosphere, others result from human activities.

To many of us, these are essentially meaningless concepts, they don't interfere with us doing what we do, however as divers, they are becoming increasingly important players in a game we enjoy.

Across the globe, we are now experiencing rapid climate change, in this respect at least, Scotland and Australia are no different. Since the middle of the 20th century, Australian temperatures have, on average, risen by about 1°C with an increase in the frequency of heatwaves and a decrease in the numbers of frosts and cold days. Rainfall patterns have also changed - the northwest has seen an increase in rainfall over the last 50 years (coming from Scotland I can certainly empathise with that!) while much of eastern Australia and the far southwest have experienced a decline in annual rainfall.

So how does this actually affect what we see as divers?

Well, for those that have dived or snorkelled on coral reefs across the world, many report it as being one of the most breathtakingly beautiful sights they have ever seen - the amazing sight of coral 'fluorescence' has been occurring on reefs around the world for decades. Since the 1980s, this phenomenon has been studied around the Keppel region, to be found in the southern section of the Great Barrier Reef - essentially our backyard, here at Central Queensland University.

The reef flats that fringe the Keppel Islands (like many of the islands on the Great Barrier Reef) are home to thousands of pin-cushion shaped colonies of *Acropora millepora*. Members of the staghorn corals, the Acroporas are the largest group of staghorn corals and are also one of the most structurally important groups. They occur on tropical and subtropical reefs throughout the world, often creating a dramatic and spectacular reefscape

The brightly coloured blue, purple, pink and green pigments (and every other shade in between, plus some that are not visible to the naked eye) can be seen through the translucent coral tissue when some form of stress causes the green-brown symbiotic algae to be expelled - this is the process known to us as coral bleaching. We don't yet know why corals have these different coloured pigments, but they are thought to be involved in controlling the amount of sunlight exposure for damage protection and to enhance their ability to produce energy.

In reality, this coral 'fluorescence' is actually a sign that all is not well on the reef! Generally, coral reefs are able to flourish in water which is relatively poor in nutrients because of their association with symbiotic algae (specifically called a dinoflagellate). The relationship is successful because these algae provide up to 95% of the energy reserves that the coral needs to survive.

However, because corals live in a narrow window of temperature toler-

Above: effects of bleaching & right: reefscape

Warming

Billy Sinclair & Alison Jones

ance, increases in temperature (as little as 1-2°C above the normal range) can result in the breakdown of this relationship, essentially what we know as coral bleaching.

Temperatures on the reef flat are often significantly higher than the deeper water because of the combined effects of UV radiation and shallow water (we all know that as we go deeper it gets colder). Normally, corals can survive summer bleaching events if the temperature of the water doesn't get too high, for too long and if their evicted algae are replaced when water temperatures return to normal. However, the current patterns of global warming and climate change are causing higher than the average normal summer water temperatures in some parts of the world.

Increased UV radiation also plays a part in the process of coral bleaching because of the weakened state of the algae's photo-systems from high water temperature.

The situation gets worse as current predictions are that coral bleaching will become an annual event within 30 to 50 years time if climate change causes temperatures to continue to rise.

Down here in the Keppel region of the Great Barrier Reef, coral bleaching episodes have been occurring about every 4-6 years since the early 1980s but until recently, the reefs have, overall, been relatively unscathed - the hard coral cover around the Keppels is the highest found on the entire GBR. Previous events caused up to 100% bleaching, even in the deeper sections of the reefs, however, almost all the corals survived these bleaching episodes.

In part, this is because Keppel corals can have a number of different types of symbiotic algae and can change type when water temperatures become higher than normal. Following the bleaching event in 2002, almost 40% of the corals changed to the tougher type 'D' algae. Unfortunately, over time as temperatures return to normal in the absence of any further bleaching events, the corals drifted back to almost all having the less resilient type 'C' algae that is the preferred symbiont.

During the most recent event in January 2006, temperatures reached up to 30.6°C and stayed at that temperature for weeks. Over 43% of the corals died in the months following the bleaching event. Of the corals that survived, over 60% changed to the tough type 'D' algae following the bleaching. The trade-off for surviving and changing to the tougher, more temperature tolerant symbiotic algae type is lower energy reserves for growth and reproduction. In the short term this change isn't noticeable, however in the long term this can mean changes to the overall structure and robustness of coral reefs.

Even with the loss of such a large percentage of coral in 2006, we are still lucky! The Keppel region is still remarkably high in coral cover, but the resilience of these and other spectacular fringing reefs will be tested even further in the coming years if there are repeated bleaching events. Certainly, more frequent or severe bleaching events will result in loss of biodiversity as the less resilient corals are eliminated and only those that can adapt survive. The Keppel region may survive as one of the last pockets of hard coral reef on the GBR because of the symbiotic algal types which exists there and the ability of these corals to change algal type. Other regions of Australia's Great Barrier Reef and other reef ecosystems across the world may not be so lucky!

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Alison Jones is a PhD student at CQU and is writing her thesis on 'The costs and benefits of changing symbiont type on the physiology and ecology of reef corals'. More information on our research projects and what we are doing can be found at
http://ahs.cqu.edu.au/schools/biolenv/
Marine_Genetics.htm