The degradation of reefs is affecting more than just the corals and the numerous species which depend on reefs: it may also directly affect our economy. Reefs not only protect long stretches of coastline and beaches from the full force of the oceans; they are also the basis for tourism and fishing industries – worth $5.4 billion annually and employing 63,000 people in the Great Barrier Reef alone.

UNKNOWNS

Research on oceanic acidification is in its infancy and scientists cannot be conclusive about its effects on complex marine ecosystems and food webs. Many scientific findings have arisen from dose–response laboratory experiments on isolated species. How these relate to entire ecosystems is complex.

But, as the urgency and deleterious potential of ocean acidity is being recognised, governments are mobilising. For example the European Project on Ocean Acidification, begun in 2008, is studying the effects of acidity on living systems from cells to ecosystems.

National research programs on acidity are being funded on most continents including Australia. Even with research support, isolating the field effects of acidity is complicated by confounding parameters such as global warming and changes in nutrient levels and dissolved oxygen. Such questions are starting to be addressed through the use of large, floating experimental chambers (called mesocosms) exposed to varying levels of CO₂. But many important questions remain.

ADAPTATION

Can species adapt to increasing acidity? Unfortunately, the fossil record shows many species became extinct about 55 million years ago when seawater acidity reached levels similar to those predicted by scientists for the end of this century. Acidification now is progressing 10 times faster than then, so it seems unlikely that today’s calcifying species could adapt quickly enough to survive.

Scientists are also asking whether one species’ loss is another’s gain. Can one species be simply substituted by another, more resistant, species to maintain the essential functioning of ecosystems? Losses of the coccolithophorid phytoplankton, mentioned earlier, might be balanced by non-calcifying phytoplankton which, in the presence of increased CO₂, could thrive, perhaps absorbing excess CO₂ and minimising acidification. Similarly, some species benefit from acidification, it appears that seagrasses in acidified water grow three to four times more shoots and roots than in normal conditions.

RISK

Despite these uncertainties, scientists have produced plausible scenarios, supported by theory and measurement, that have serious implications for future human generations and their life support systems. Governments would therefore be prudent to rate the acidification issue as both urgent and important. Any risk analysis of the projected rate of acidification and its effects would indicate that action is needed.

But what can be done? While ocean acidification itself appears to be a fast process, the projected impacts are less certain. They present a challenge to shape the future using the same human ingenuity that ushered in the Anthropocene in the first place.

But fundamental change is needed, including an attack on the root cause of acidification – the rate at which CO₂ concentration is increasing in the atmosphere. Many countries are now starting this politically difficult process as part of programs to limit the effects of global warming.

We need to use economic instruments to not only limit carbon emissions, but to develop green technologies and conserve energy. We need to accept that economic and population growth in a finite world is ultimately not sustainable.

We also need a better understanding of the effects of acidification. Such knowledge will help us to make choices directed towards achieving a high quality of human life and the protection of nature.

As the World Resources Institute stated in 2000, the challenge for the 21st century is to understand the vulnerabilities and resilience of ecosystems so that we can find ways to reconcile the demands of human development with the tolerances of nature.

This requires wisdom as well as knowledge — the communal wisdom to act and, as one wise man once said, to restore harmonious relations among elements of the world.

The capacity for wisdom is, after all, a human trait that our Latin name, Homo sapiens, embodies. Can we pass the acid test?

Further reading


LETS VISIT ANTARCTICA!

Antarctica is the southern-most continent in the world and encompasses the South Pole. It is surrounded by the Southern Ocean and, at twice the size of Australia, is the fifth-largest continent in the world. Over 98% of Antarctica is covered in ice, and at its deepest point the ice is 3 to 4 kilometres thick.

On the cover

Quick Quiz 1

Despite their huge size, many whales feed on tiny plants and animals that they filter from the water using a structure called baleen. One of the following whales found in Antarctica is not a baleen whale - can you find out which is the odd one out?

Southern Right Whale
Sperm Whale
Blue Whale
Minke Whale

Quick Quiz 2

Which bird is found in Antarctica but not in the Arctic? Re-arrange the highlighted letters to find the answer.

MYSTERY BIRD

FIND-A-WORD

See how many Antarctic words you can find below, then choose any three and investigate them using your school library or the internet. Use the highlighted letters in the puzzle to find the mystery bird (right).

iceberg
icicle
king
glacier
mawson
ozone
volcano
delif
weddell

Quick Quiz 2

How much of Antarctica is covered in ice?

a 28%
b 48%
c 78%
d 98%

Quick Quiz 2

Which bird is found in Antarctica but not in the Arctic?

Antarctica is the windiest, coldest, driest place on Earth! The temperature reaches −89ºC, the wind reaches 300 knots (555 kilometres per hour) and the continent receives little more than 5 centimetres of rain a year.

What to do

1. Make about 50 ice cubes of different sizes - completely fill one tray with water but only partially fill the second tray and freeze.
2. Sprinkle salt on a tray and arrange 12 large ice cubes in a circle, then place in freezer.
3. Later, add a second layer. Dip each cube into the salt and place salted side down between two base cubes.
4. Pour some of the slushie mix into the gaps, then refreeze.
5. Repeat to make a dome. Use smaller cubes from the partially filled tray towards the top of the dome. Refreeze the tray from time to time.
6. Continue until you have just a small hole in the centre at the top of the igloo.
7. Make the doorway walls: line up two rows of ice cubes sideways, remembering to dip them in salt first.
8. Place smaller ice cubes on top of the doorway walls.
9. Once the igloo is made, apply a thin layer of slushie mix over the whole igloo and refreeze for a couple of hours.

Why does it work?

Pure water freezes at 0ºC, but salt water freezes at about −1.8ºC. Because of its lower freezing point, the salt melts the ice slightly, helping to secure the blocks in place when you refreeze it. The dissolved salt in seawater helps prevent the ocean from freezing in all but the very coldest water in the Arctic and Antarctic circles.

What you need

- two trays of ice cubes
- cooking salt
- a baking tray
- water
- space in your freezer
- a teaspoon
- a ‘slushie mix’ (two ice cubes blended with a little water).

MAKE AN IGLOO!

Until recently Antarctica was completely uninhabited - by people at least. Now many nations have set up research bases on the continent, some of which are lived in year-round. You won’t find igloos in Antarctica, but they are fun to make anyway!

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**QUICK QUIZ 2**
How much of Antarctica is covered in ice?

- a 28%
- b 48%
- c 78%
- d 98%

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LET’S STICK TOGETHER!

Science reporter Jasper, aged 6, grilled the Museum’s Jaynia Sladek about her work in the bird collection.

JASPER: Why did you become an ornithologist and how did you become one?

JAYNIA: I started studying biology at Macquarie University and while at Uni did volunteer work on invertebrate animals. A couple of years later they offered me a full-time job as a research assistant. Then I came up to the Museum as a technical officer in the invertebrate collections. I completed a Master of Environmental Science then moved to the Science Division as an executive officer before moving to the bird collection full time. That was six years ago and I’ve been here ever since! So while I’m not strictly an ornithologist, my role is (acting) Collection Manager of the Ornithology (Bird) Collection.

JASPER: What kinds of specimens of Antarctic birds does the Australian Museum have?

JAYNIA: Well we have a lot of different kinds of specimens: study skins, mounted specimens, skeletons, eggs, nests, tissue samples (parts of birds kept frozen for DNA analysis) and specimens preserved in alcohol. Of all those specimens we have a lot of the different species found in Antarctica: penguins, albatrosses, gulls, terns, prions, shearwaters, fulmars, diving petrels… goosh, too many to list. We actually have over 700 specimens collected during Dawson's expedition to the Antarctic in 1912, which is pretty special.

JASPER: How many different species of penguin are found in Antarctica and which is the most common?

JAYNIA: Of the 17 species of penguins in the world, you can find the Emperor, King, Chinstrap, Gentoo, Adelie, Rockhopper and Macaroni in the Antarctic region. There’s also the Royal Penguin, which was originally thought to be a subspecies of the Macaroni Penguin. The most common, well, that’s a hard question, though the Macaroni Penguin can reach about 11 million breeding pairs. But penguins are also found in some other places – right up to the equator, in fact.

WEBLINK

Check out Jaynia, Jasper and their feathered friends at www.australianmuseum.net.au/explore-museum

Jaynia and Jasper with an unfortunate albatross that died after colliding with a chimney in suburban Sydney. Photo Stuart Humphreys.

XPLANATIONS

Send your query to the Search & Discover team, email sand@austrmus.gov.au

Q. What is this beastly worm we found in Chichester State Forest (northern NSW)? With the help of Museum invertebrate specialist Anna Murray, we found out about terrestrial nemertean or ribbon worms in the genus Asmussenia such as this one.

The bright orange tube is pharynx or throat which it uses to grab and ingest food items. It can also use it to surprise predators and help it escape when disturbed or threatened. Nemertean or ribbon worms survive in cool, dark and damp habitats such as leaf litter and rotting logs.

KELLY HARRIS

Chris Hodges

Q. I have found a long, thin, green snake in my home. What is it?

This is one of the more common species that people encounter in Sydney. It’s the Green Tree Snake, Dendrelaphis punctulata and, if you don’t see the snake itself, you might find its beautiful paper-thin skin on your verandah or in your roof. Despite its common name, it is often found on the ground in low vegetation as well as in trees, and it comes in yellow and blue, not just green.

It belongs to a group called the colubrids, which have relatively low numbers of species in Australia compared to other groups of snakes. It is venomous to the frogs and lizards it preys upon but is not considered dangerous to humans.

STEVE VOGEL

Q. We found this caterpillar on private property near the Springbrook National Park (Qld). Can you tell us about it?

According to Museum entomologist Dr Dave Britton the caterpillar is from an endangered species, the Pink-underwing Moth, Phyllodes imperialis. More than this, it’s an as-yet undescribed southern subspecies which is also endangered!

Orchidists consider them pests, naming them ‘fruit piercing moths’ – incorrectly, as the butterflies and caterpillars lack the mouthparts to do more than suck up the juices of already damaged fruit. Sightings of endangered species like these should also be reported to State conservation authorities to help protect our unique biodiversity.

STEVE VOGEL

Answers from previous page

Quick Quiz 1 Baleen whales
b) The Sperm Whale is toothed and preys on fish, whales and other marine mammals. You can see the skeleton of a Sperm Whale in the Museum’s main entrance – if you look up!

Mystery bird: Penguin
Quick Quiz 2 Antarctic ice
c) Over 98% of Antarctica is covered in ice.

Caterpillar of the Pink-underwing Moth can suddenly display a two-like appendage when alarmed by predators. Photo © Jodi Rowley.

The Green Tree Snake grows to two metres. Photo © Elizabeth Buxton.

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Jaynia and Jasper with an unfortunate albatross that died after colliding with a chimney in suburban Sydney. Photo Stuart Humphreys.

Emperor Penguin

The Emperor Penguin, Aptenodytes forsteri is the tallest, heaviest penguin in the world reaching 120 cm and 45 kg. Emperor Penguins are also the heaviest penguin breeding colonies. At the colony, the female lays one egg, which she keeps on top of her feet and under her mantle belly. She lifts the egg to the mouth of the male while she seeks food by rolling it from her feet while the young anime couples the egg if they drop it or his mates breedwell and get it right. In the young grow in the nest.

Photo © Craig S National Science Foundation.