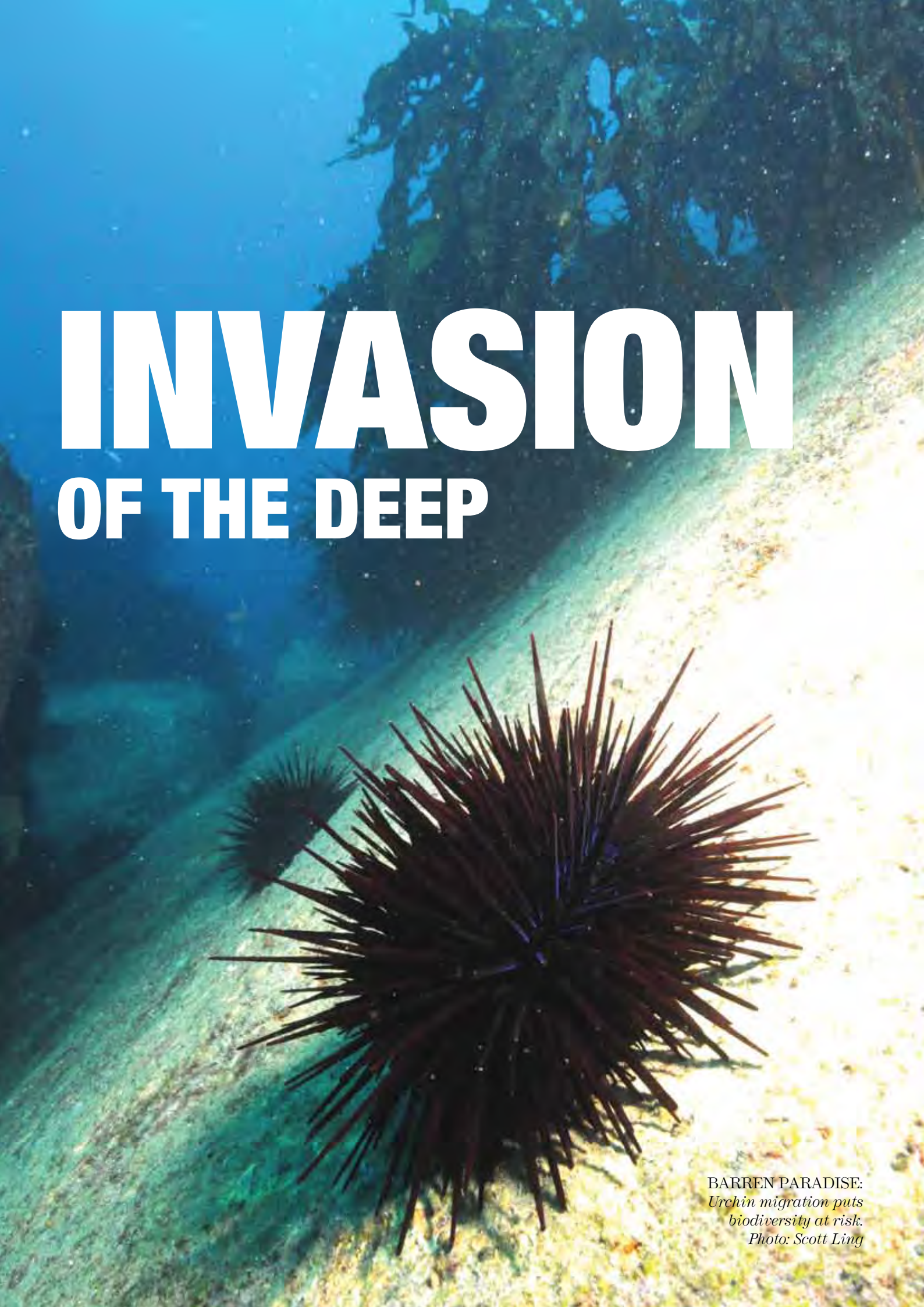
INVASION OF THE DEEP



BARREN PARADISE: *Urchin migration puts biodiversity at risk. Photo: Scott Ling*

EVIDENCE ABOUT A BIODIVERSITY SHIFT IS EMERGING FROM AUSTRALIA'S OCEAN FLOOR.

Story: **Simon Grose**

In the waters off the east coast of Tasmania, an invasion has taken place.

Sea urchins have moved in en masse to occupy a marine habitat that some 50 years ago had never seen these creatures.

And while urchins are a favourite food of rock lobsters, which should now be enjoying their abundant seafloor buffet, lobster numbers are dwindling.

Scientists point to the combined effects of climate change and fishing activity to explain this apparent contradiction. It's an early example of how the physical and biological dynamics of our seas are being altered and how climate change is jeopardising levels of marine biodiversity.

Data on this urchin migration was published by researchers from the University of Tasmania, the Australian National University and CSIRO in the *Journal of Experimental Marine Biology and Ecology*. They note the first signs of urchin movement southwards from their usual home in the coastal waters of New South Wales were recorded in the 1960s, when individual urchins were discovered in the waters of the Bass Strait islands. By 1978 urchins were being found off northeast Tasmania, but that was just a portent of the mass migration that was to follow.

"Surveys conducted between 2000 and 2002 at locations along the entire east coast of Tasmania demonstrate subsequent expansion of populations to the urchin's current status as a common and, in some places, dominant invertebrate on shallow subtidal rocky reefs," the scientists report.

According to one of the paper's authors, Dr Gretta Peccl of the Institute for Marine and Antarctic Studies at the University of Tasmania, sea urchins are part of a veritable Sydney-to-Hobart fleet of underwater migrants.

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"That's one example of several dozen species that were not recorded in Tasmania 30 to 40 years ago that are now common in Tasmanian waters," Dr Peccl says.

This invasion has been driven by a southwards extension of the East Australian Current (EAC), a change attributed to global warming. The EAC is strongest in summer and now peters out around 350km further south than it did in the middle of last century.

It has carried sea urchin spawn and juveniles across Bass Strait and down Tasmania's coast where it has also caused a rise in ocean temperatures, which suits sea urchins.

Once established the urchins have prospered on rocky seafloors where they feed on algae and other seafloor denizens which are also food for lobsters and black-lip abalone. They prosper so well that they create 'barrens' which they have denuded of up to 150 species of seafloor flora and fauna, causing the numbers of lobsters and abalone in those areas to fall. Sea urchins, however, can survive on their barrens by feeding on microalgae and other lower-order food sources.

The story of their Tasmanian invasion is analogous to the first human inhabitants of Australia who found a bounty of protein in the form of herbivorous marsupial 'megafauna'. They plundered this abundant food source, contributing to the eventual extinction of the megafauna, and then adapted to survive on what was left.

So why don't big rock lobsters march into these new Tasmanian barrens and feast on sea urchins, bringing the seafloor communities back towards a new balance? Because humans like eating rock lobsters and the only ones they are allowed to harvest are the big ones.

Dr Peccl writes there are not enough large lobsters left in the area to stop the invasion of sea urchins and the creation of barrens habitats, which in turn further reduces lobster numbers and weakens the natural protection they provide.

"The climate-driven establishment of sea urchins in eastern Tasmania provides the first documented example for Southern Hemisphere temperate reef systems of cascading ecological effects stemming, at least in part, from oceanographic change.

"Coupled with potential effects on population parameters of key commercial species such as abalone and

rock lobsters dependent on reef ecosystems, the combined influence of climate change on eastern Tasmanian rocky reefs, and the humans that depend on them, is already manifestly large."

Public understanding of the challenges to Australia's biodiversity arising from global warming is generally based on media reports that are most likely to focus on what is happening, and predicted to happen, on land. The eruption of sea urchin populations on Tasmania's east coast is a reminder that the effect of global warming is just as powerful in our seas, a phenomenon that has come to the fore in evidence supplied to the House of Representatives Climate Change Committee for its inquiry into Australia's biodiversity in a changing climate.

In its submission to the inquiry, the Australian Marine Sciences Association (AMSA) says global warming will cause changes in the ranges of individual species, the elimination of some species from their current geographic habitats, and the total extinction of some species.

It notes Australia's temperate marine environments have a very high proportion of species that are endemic — they occur nowhere else. Their options to move southwards to survive are limited by the fact that the Southern Ocean is deep and wide, offering no coastal shelves as potential new habitats.

"As the ocean warms, these species will increasingly be restricted to a smaller portion of Australian waters, and range shifts will be limited by the southern extent of our coastline," AMSA's submission says.

"The same is true of marine species within Australia's Antarctic Territory that are living close to their physiological limits and for which habitats are disappearing.

"Many Australian endemic marine species are predicted to become endangered and some will become extinct, including many species of commercial and recreational importance.

"This represents a major challenge for Australia in the area of biodiversity conservation."

UNIVERSITY OF TASMANIA

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BIGGER IS BETTER:
Large lobsters needed to fight invasion

AMSA also points out that as most marine species are cold-blooded, rising ocean temperatures will cause their metabolisms to speed up.

"Increased metabolism will decrease the duration of larval stages, and will likely decrease the geographic scale of population connectivity of marine species," it says.

"Increased metabolism will also increase the requirement for food per unit time: food may become limiting, and vulnerable life history stages may starve or lose condition, making them more vulnerable to disease and predation and less likely to disperse successfully."

How this heightened vulnerability could lead to extinction was highlighted in evidence to the committee at a hearing in Perth by Dr Jane Fromont, Head of the Department of Aquatic Zoology at the Western Australian Museum.

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"We were catching species that we would not normally catch south of Exmouth"

"You will get a recruitment on a strong, warm, southward-flowing current, but that does not necessarily mean you have a population established at the new site that can now start self-recruiting to that area," Dr Fromont told the committee.

"The fact that you might see different species there does not necessarily mean that they are now stably in that environment — a few cold cycles may mean that those adults die off and that is the end of it.

"So I am not sure that these species are going to be able to keep in front of climate change as much as we would hope that they could."

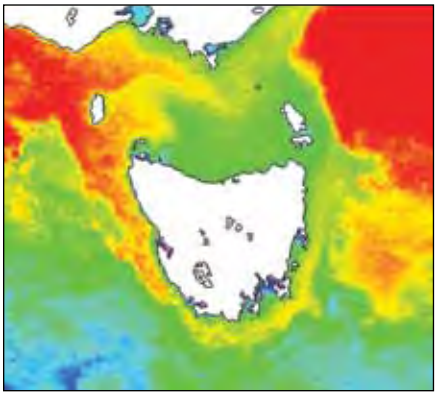
Deputy chair of the committee, Dr Mal Washer (Moore, WA), provided anecdotal evidence of the southwards movement of species off the WA coast from a recent ocean fishing excursion.

"We were catching species that we would not normally catch south of Exmouth — coral trout and fish like that," Dr Washer said.


THINKSTOCK

"It doesn't take Einstein to figure out that there are already major changes happening"

GO WITH THE FLOW:
Ocean currents shaping the underwater battle for dominance


CSIRO

AUSTRALIAN OCEAN CURRENTS

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"There were things like mud crabs, which you would never find much south of Carnarvon, now going as far as Bunbury and Bussellton."

Unlike the southwards migration on the east coast, this phenomenon on the west coast is not being driven by an extension of the Leeuwin current which is showing signs of weakening as the waters warm.

Gretta Peccl says sealife are moving south to keep pace with the southwards shift of their preferred temperature ranges.

"In some species it's the adults that are moving very actively and spawning, in other species the larvae are moving into an environment and it's a survival-mediated process.

"The fact that we are getting so many species in different systems all shifting in the way that we would predict with climate change is very strong evidence that they are being affected by climate change."

In his evidence to the committee at a hearing in Canberra, Climate Commissioner Professor Will Steffen said failure to reduce global fossil fuel emissions compared to business-as-usual trends over this century would result in atmospheric temperatures rising by at least four degrees Celsius between 2000 and 2100.

"There is a lot about how the ecosystem works that we don't fully understand"

TIPPING POINT:
Major changes predicted for the ocean floor

Gretta Peccl says there would be "winners and losers" in our oceans if that were to occur. Most likely to survive and prosper would be "generalist" species that are not too choosy about what they eat. Squid and octopus are generalist front runners.

"A squid will eat anything that moves," Dr Peccl says. But how much biodiversity will be moving around for squid to eat?

"A temperature change of that magnitude would have a very large impact on our marine life.

"There is a lot about how the ecosystem works that we don't fully understand so it's hard to predict with accuracy what the exact impacts will be — but it doesn't take Einstein to figure out that there are already major changes happening." •

FOR MORE INFORMATION on the House of Representatives Climate Change Committee's inquiry into Australia's biodiversity in a changing climate, visit **www.aph.gov.au/ccea** or email **ccea.reps@aph.gov.au** or phone **(02) 6277 4580**.