



WELL-ARMED
A new pygmy
octopus species,
Lizard Island

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WHAT LIES BENEATH

A prize-winning global submarine census reveals
the dazzling inventory of Australia's oceans.

Spotted handfish, Tasmania



Undecorated zoanthid, Heron Island

Solitary sea squirts, Southern Ocean



Pink or Drysdale's handfish, Tasmania



Nine species of handfish that “walk” on the sea floor instead of swim, mostly off Tasmania; a pygmy octopus on North Queensland’s Great Barrier Reef; a Jurassic shrimp on a deepwater mount in the Coral Sea; and two squat lobsters off Western Australia’s continental margin. . .

That’s a small snapshot from the list of new species found in Australian waters during the first global Census of Marine Life. A massive scientific task of unprecedented scale and unparalleled global cooperation, the decade-long census officially came to an end late last year, but marine researchers are still sorting through the mammoth load of data and specimens collected during the venture. And they’ll be doing so for many years to come.

The international endeavour grew, as often happens in science, from casual discussions in the late 1990s between a few of the world’s leading marine experts. Initial funding of \$US75m from the New York-based philanthropic Alfred P Sloan Foundation kicked off the project in 2000, but the commitment leveraged 10 times that amount around the world during the ensuing decade.

In Australia, BHP Billiton became one of the biggest benefactors to add to the initial fund when, with little fanfare, but much genuine philanthropic intent, the company dug deep to come up with a multimillion-dollar grant to support local tropical reef research.

Ultimately, 2700 scientists from more than 80 countries took part. Australia took a leading role in key areas, with 167 local marine researchers working on census projects. For the final few years, the global chief for the census was marine biologist Dr Ian Poiner, CEO of the Australian Institute of Marine Science (AIMS), appointed chair of the International Scientific Steering Committee in 2008.

Next month in Osaka, the census receives the 2011 International Cosmos Prize, a global science award for excellence in researching relationships between living organisms. Poiner remains staggered and exuberant about the scale of the discoveries. Australian tropical reefs offered up hundreds of new species; as did Antarctica. Worldwide, the tally of new species should top 6000.

“Everywhere we looked, be it the bottom of the ocean or the coral reefs, or under the ice at the poles – the abundance of life, the richness, was extraordinary. Life was everywhere and it really was the riot of species, the sheer diversity of life, that was just so astounding,” says Poiner. “It didn’t matter whether you were at 4000m in the dark, cold depths of the oceans or near the surface on the Great Barrier Reef.”

The world’s official total of known species of marine vertebrates (from whales and seals to fish and turtles) and invertebrates (from sea slugs and starfish to lobsters and worms) is now about 200,000. But, as Poiner explains, that is just the proverbial tip of the iceberg.

There are mathematical rules about how scientists determine what’s yet to be discovered, based on graphical plots and computations of what is already known, ongoing discovery rates and the level of scientific effort put into finding them. Poiner reckons it is likely that the calculations will show at least 2.2 million species may live in the world’s saltwater habitats. “So there is another two million to be discovered – and we suspect that is being conservative.”

HANDFISH PHOTOGRAPHY: © KAREN GOWLETT-HOLMES; SEA SQUIRT: AUSTRALIAN ANTARCTIC DIVISION; ZOANTHID: JAMES DAVIS REIMER © UNIVERSITY OF THE RYUKYUS; CHRISTMAS TREE WORM: GARY CRANITCH © QUEENSLAND MUSEUM



A new species of *Serpula* Christmas tree worm, Ningaloo Reef



Worldwide, the tally of new species is likely to top 6000 once all the data is sorted



Squat lobsters of Western Australia (clockwise from top left): *Munida andamanica* (new to WA); a new species of the *Raymunida* genus; an unidentified *Munida*; *Galathea amboinensis*

Australia is certainly one of the world's most species-rich regions. "Anyway you look at it," says Bax, "Australia's marine environment is very, very biodiverse."

That's partly due to the expansive array of marine habitats around Australia, ranging from deep ocean to the unique fringe of coastal temperate water skirting the southern coastline, largely isolated from the rest of the world for millions of years, to the warm seas that bathe the country's north and support 17 per cent of the world's tropical reefs.

FOR DR JULIAN Caley, a marine evolutionary ecologist at AIMS, the most extraordinary outcome of the project has been its revelations about what's yet to be found and how little is truly known about the oceans.

In a country such as Australia, which earns more than \$40b a year from marine-based industries – from tourism and fishing to shipping and offshore oil and gas operations – the shortfall in basic knowledge is particularly relevant.

Caley was one of three principal investigators on the census' CReefs project that focused on tropical reef biodiversity. In Australia, that involved surveying three well-known locations with relatively high visitation rates: Ningaloo (WA) and the coral-based communities around Lizard and Heron Islands on Queensland's Great Barrier Reef.

Although Caley's team is still working on the numbers, they believe they've found more than 1200 new species. "These places are not remote atolls that no-one has ever been to," stresses Caley. "They've had research stations and resorts on them for decades; people have been swimming over these places for years. In spite of that, it seems we've never really learned what lives there. Yes, we know about the corals and fishes, but that's just two per cent of a tropical reef's potential diversity. For the rest we have huge knowledge gaps."

The Antarctic proved to be another region of spectacular discovery and the international scientific team that worked on the census project in the waters of the southern continent was also headed by an Australian, the former chief scientist of the Australian Antarctic Division, Dr Michael Stoddart. Like Poiner, he was taken aback by the rich number of species that the project encountered. ➤

Even for fish, one of the best-known of marine animal groups, it is expected that another 5000 could still be awaiting discovery. "You'd expect that probably a lot of those would be found in Australia, where so many places have yet to be scientifically explored," says Poiner.

When it comes to land species, Australia has long been recognised as one of the most biodiverse nations. According to the best available figures, Australia's marine realm is also up there on a world scale. As the census drew to a close last year, a team of Australian scientists published a paper, *Marine Biodiversity In The Australian Region*, on the open-access on-line science journal *PLoS ONE* (www.plosone.org/home.action). It was a wrap-up of all the available relevant numbers from the most reliable databases documenting exactly what's living in Australian marine jurisdiction. So far, it reported, Australia could claim 33,000 marine species, but a further 17,000 known species weren't yet in the relevant databases; and the total number of marine species in Australian waters could be as high as 250,000.

Dr Nic Bax, a University of Tasmania professor who chaired the Australian component of the census and was one of the paper's authors, says the census confirmed that in the marine domain



Marine animals of the Antarctic may actually be feeding biodiversity to the rest of the world

Australian research ship *Aurora Australis* in the Southern Ocean



AUSTRALIA HAS THREE scientific bases in east Antarctica. Many other countries have a presence at the South Pole, including the US, China, Finland, Germany, India and Spain.

“Certainly when you look at the terrestrial environment, the closer you get to the poles, the less rich the ecosystems become compared to the tropics,” says Stoddart. But life underwater in Antarctica doesn’t reflect the paucity of species diversity seen up on the ice. “The water is not as extreme an environment down there as the land. Yes, you get the surface layers freezing and that means they’ll go down to about two degrees centigrade; but once you go down to the depths, you’ve actually got an environment that’s pretty stable.”

One study, led by German researchers, found high numbers of tiny crustacean species – more than 700 in one component of the work – previously unknown to science. Another project – involving the rigging of high-definition, high-resolution video cameras and strong lights to the front of sampling trawls – identified two huge new areas of deep-sea reefs. Each is about 800m down, 400sq km in area and, according to researchers, “showed a growth of animals and plants that appears to be as rich as the Barrier Reef in terms of luxuriance.”

The census team was successful in having the newly discovered areas listed for protection with the International Convention on the Conservation of Antarctic Marine Living Resources. It should ensure that deep-sea Antarctic fishing fleets keep their distance.

Other census work in the Antarctic identified the importance of thermohaline currents that spin out from the pole carrying species northwards on a kind of underwater conveyor belt. It suggests that far from the marine animals of the Antarctic being globally isolated, they may, in the evolutionary sense, actually be feeding biodiversity to the rest of the world. Antarctic biodiversity, scientists now think, may represent a steady supply of new species and their genes that are being slowly and steadily conveyed northwards to the tropics.

“We’ve known for a long time that the Antarctic is ultimately and completely fundamental for the climate cycle of the world,” says Stoddart. “Now it seems it may play a part in populating the oceans of the world with new species.”

Census discoveries haven’t all been good news. Poiner’s passion and enthusiasm for the richness of life uncovered is tempered by findings by the venture’s history component, including that of researchers at Murdoch University (Perth). “Sadly, their work showed our impact on the oceans has been quite dramatic, particularly with species that we have fished,” he says. That impact, research revealed, began much earlier than previously thought – in some cases, in Roman times.

“From the 1600s, when fishing really began to take off, our impact has been quite substantive,” says Poiner. “It’s been particularly concerning on some things like the sharks, the ground [bottom-dwelling] fish, some of the reef fish, the large pelagics [in the open ocean], seals, otters, whales, turtles and so forth. There have been 70 to 90 per cent depletions from historical bases in many of these.

“But there are messages of hope, of showing we can do something about it. Look at animals such as whales and seals, for example. In some species there have been significant recoveries and those have come with human intervention. It is gratifying that Australia is a world leader in sustainable fisheries.”



Aurora Australis amid Antarctic pack ice

