



Life in isolated oases

Western Australia's shelf-edge atolls



A major biological survey of Western Australia's remote offshore atolls has revealed a diverse assemblage of more than 1500 species of marine plants and animals, with many not previously recorded in the State and several new to science.

by John Huisman and Sue Morrison

Western Australia's remote north-west offshore atolls lie on the edge of the continental shelf in deep, clear oceanic waters far from the mainland. The biodiversity of these atolls is still poorly known to scientists. Such remote places are always of great interest to biologists, as their isolation often leads to the development of unusual communities. The interplay of environmental conditions such as large-scale current systems and local climate all affect these communities, the former largely dictating what species might make the journey, the latter what might survive in the new home. Once a species is established, isolation from the source population may eventually lead to the evolution of new species, endemic to that location.

Research in such remote places is expensive. So, when Woodside Energy Limited agreed to sponsor a WA Museum survey of Mermaid Reef Marine National Nature Reserve (in the Rowley Shoals), Scott Reef and Seringapatam Reef, the news was received with much excitement. The aim of the survey in September 2006 was to document the presence, distribution and, where possible, the abundance of the major groups of marine animals and plants. Specialist marine scientists were invited to survey and study seaweeds, seagrasses,



sponges, corals, crustaceans, molluscs, echinoderms and fish. For some groups, such as fish and corals, this was a chance to revisit and update earlier surveys. For others, such as marine plants and sponges, it was an opportunity to make the first known collections.

In the past, marine scientists and researchers from the WA Museum, Department of Environment and Conservation (DEC), Australian Institute of Marine Sciences (AIMS) and CSIRO have made visits to the northern atolls to study their habitats and ecology.

Left on the shelf

The three most southerly shelf atolls, located north-west of Broome, are known collectively as the Rowley Shoals. From south to north, they are Imperieuse Reef, Clerke Reef (both in the DEC-managed Rowley Shoals

Marine Park, first declared in 1990 and extended four-fold in 2004) and Mermaid Reef, a Marine National Nature Reserve under Commonwealth legislation. Regarded as Australia's best examples of shelf-edge atolls, the Rowley Shoals provide some of the best diving and nature-based tourism found in WA.

Scott and Seringapatam reefs lie more than 300 kilometres north-west of Cape Leveque and rise steeply some 400 to 500 metres from the sea floor. Scott Reef is comprised of South Scott Reef, a large crescent-shaped formation, and North Scott Reef, with a roughly circular shape. They are substantial structures with a combined area (including the lagoons) of some

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Main Gorgonians, soft corals and sponges at Scott Reef.

Insets Colourful gorgonian coral; false clownfish and its anemone home; sunset over Scott Reef.

Above Researchers survey the vast expanse of Seringapatam Reef at low tide, with the brown seaweed spiny tops in the foreground.

Below left Smith's weed.

Below The green seaweed *Halimeda* sometimes forms luxuriant meadows.
Photos – John Huisman



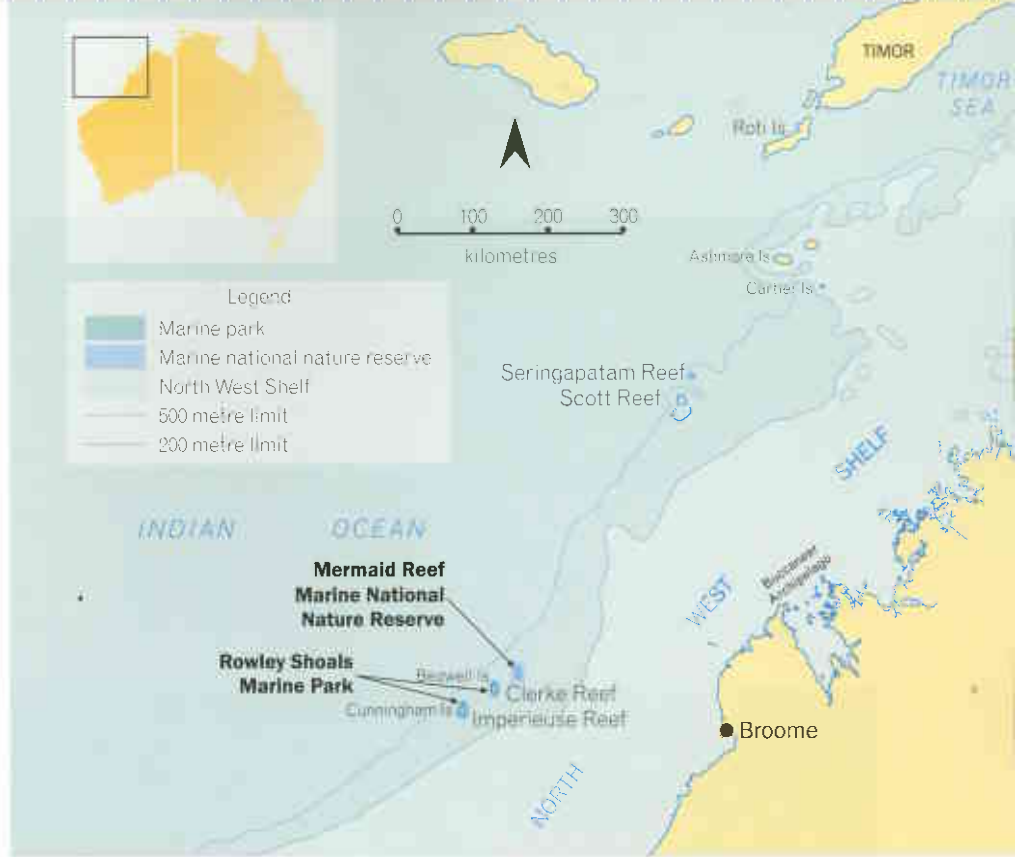
250 square kilometres, Seringapatam Reef, 23 kilometres north of North Scott Reef, is a smaller circular reef with an area of 55 square kilometres.

Scott Reef has also been of interest to marine scientists for less positive reasons. In 1998 it suffered a severe bout of coral bleaching caused by unusually warm sea temperatures. Coral bleaching occurs when the living tissue of the coral loses its pigmented symbiotic algal cells, which often kills the coral but leaves its white skeleton behind. AIMS scientists reported that about 80 per cent of Scott Reef's coral cover was lost in this 1998 event. In 2004, the reef bore the full brunt of Cyclone Fay. Three hundred kilometre per hour winds uprooted coral colonies and tore huge reef boulders up to five metres in diameter from the reef's edge. AIMS scientists are monitoring the reef's slow recovery from this double blow of rare events.

The Rowley Shoals, Scott Reef and Seringapatam Reef lie on the very edge of Australia's continental shelf. Around 15 million years ago the shelf probably formed the shore of the mainland, which was fringed by a reef. The atolls were possibly once reefs surrounding former headlands. As a result of changes in sea level and other geological processes (probably related to the collision of the Australian and Asian continental blocks), these subsided into the sea, slowly enough for the fringing coral reefs to be maintained. As a result, the reefs built up from the sea floor like high turrets, each enclosing a shallow lagoon. The growth of similar reefs along the shelf was not sufficient to keep pace with subsidence and there are a number of drowned reefs along the shelf, including one south of Imperieuse Reef.

Marine plants

None of these atolls had ever been systematically surveyed for marine plants, so the expedition provided a great opportunity for seaweed expert John Huisman to make new discoveries. Each species was photographed and representative specimens collected and preserved for DEC's WA Herbarium, where they will form an important part of the State's marine plant collection. More than 100 species of seaweeds



Above Purple anthias at Scott Reef.
Photo – John Huisman

and three species of seagrasses have so far been recorded, but the list will no doubt grow once the smaller, cryptic species, mostly growing on the larger seaweeds, are examined in detail. It is the first time many of these species have been found in WA waters, although they have been recorded from tropical reefs in Indonesia and the Philippines.

The marine plants come in all manner of shapes and sizes. Some, such as encrusting coralline algae, are extremely important in consolidating reef crests and therefore play a major role in reef ecology. Others inhabit the gaps in reefs, presumably as a refuge from the many grazing, herbivorous

animals. Others dominate rocky sections of the reef flat, with the brown seaweed spiny tops (*Turbinaria ornata*) almost completely covering parts of Seringapatam Reef. There are plants that grow only in the sandy, mobile sediments of the lagoon. Some, such as lobed halimeda (*Halimeda maculosa*) and grey-green udotea (*Udotea glaucescens*), form massive, sand-binding holdfasts to help keep them in place. These plants are also calcified, providing an unusual defence against herbivorous fish that is not just due to their crunchy texture. When calcified green seaweeds are

crushed, as might happen in the stomach of a parrotfish, the calcium carbonate would combine with acids in the plant tissue, producing carbon dioxide gas. For a fish, this is undoubtedly a very unpleasant experience! Other marine plants—such as *Caulerpa* species and the seagrasses paddleweed (*Halophila*) and turtle grass (*Thalassia*)—have horizontal stems that creep across the sand and attach wherever possible. Some plants defy categorisation, such as the mucilaginous Smith's weed

(*Gibsmithia hawaiiensis*), with its jelly-like body growing from a firm stalk. In many cases, the evolutionary pressures that led to the unusual appearance of these plants can only be guessed at.

Fish

The reef fish of the north-western atolls overload the senses with their stunning range of colours and sheer abundance. Body shapes and sizes vary from gigantic, solid potato cods hanging around the deeper parts of the

outer reef, to squadrons of triggerfish and surgeonfish cruising along the outer reef perimeter. Elongated painted moray eels slither in and out of crevices in the intertidal reef flats and dainty damselfish school around the corals in the lagoons. Tiny, slender whip gobies shelter between the polyps of sea-whips on the outer reef.

Fish experts Glenn Moore and Sue Morrison recorded 433 species of fish during the surveys, representing 59 families. Their diversity tended to increase towards the more northerly atolls, with 290 species recorded at Mermaid Reef and 376 species at Scott and Seringapatam reefs, which agrees with the results of earlier surveys. Typically, the outer reef habitats had a greater diversity of fish species than the lagoons. The most abundant and diverse fish families recorded from all reefs were the damselfish, wrasse, surgeonfish, triggerfish, butterflyfish, rock cod and goatfish.

The fish fauna at these atolls has more in common with fish communities of clear-water reefs in Indonesia than with those of the more turbid coastal reefs of north-western Australia. According to Barry Hutchins of the WA Museum, around 36 per cent of the fish species occurring at these atolls are not recorded from coastal reefs of WA. Scott and Seringapatam reefs are likely to be important 'stepping stones' for fish dispersal between Indonesia and the Rowley Shoals, and possibly regions further south.

Molluscs

Many molluscs are cryptic, nocturnal and/or mobile, so are difficult to observe. WA Museum mollusc experts Clay Bryce and Corey Whisson recorded 373 mollusc species at the atolls. As with the fish, these species have a greater affinity with mollusc communities of the Indonesian Archipelago than with those of coastal waters of north-western Australia. Of



Above left The Rowley Shoals are famed for their large potato cod.

Left The spectacular tiger cowrie.
Photos – John Huisman



Top Barrel sponge.

Above A delicate comb jelly (*Ctenophora*).

Photos – John Huisman

Above right Porcelain crab on an anemone at the Rowley Shoals.

Photo – Ann Storrie



particular interest are the depleted populations of giant clams (*Tridacna* species) at Scott and Seringapatam reefs where, under a Memorandum of Understanding, traditional fishers from Indonesia may harvest limited quantities.

Corals

Reef-building hard corals are the essential 'building blocks' of these north-western atolls. They also provide complex structures in which other marine life live or take shelter and form a food source for many species. Both the physical structure of the atolls and the health of associated marine life therefore depend on the health and diversity of the hard corals.

Being sedentary animals, corals are in some ways easier to record than mobile species but they are often

difficult to identify. Although corals have been well documented during earlier surveys, coral biologist David McKinney recorded new distribution records for 23 species at Mermaid Reef and 18 species at Scott/Seringapatam reefs, plus a new record for the region—finger coral (*Montipora digitata*)—and one new record for WA—Moluccan mushroom coral (*Fungia moluccensis*).

A total of 273 hard coral species from 14 families were recorded. When combined with historical records, this brings the overall total recorded for the region to 291 species. Most coral species found in the atolls are widespread Indo-Pacific species with clear affinities with coral assemblages of Ashmore Reef and Indonesian provinces to the north.

Sponges

Identifying sponges can be difficult, as some species are extremely variable in shape and colour. To make matters worse, most species need to be examined under a microscope before they can be identified. This made it necessary for sponge expert Jane Fromont to collect samples, for later study, from every sponge she saw

during this survey that she believed may belong to a different species.

The sponges of Mermaid, Scott and Seringapatam reefs were documented for the first time in this survey. A total of 137 species from 36 families were recorded. In contrast to fish and corals, most of the sponge species were rare, supporting indications that many species are endemic (only found in one region). These limited distributions are probably due to their short-lived larval stages, which means the larvae cannot travel very far, restricting their dispersal.

Crustaceans

Crustaceans are particularly difficult to observe because most species are cryptic, many are nocturnal, most can move quickly, and some live hidden within or on the surface of other animals, algae or the seabed. Collecting and identifying crustaceans was therefore very time consuming and required the input of two researchers, Melissa Titelius and Christine Hass.

The crustacean fauna of the north-western atolls was poorly known and Mermaid Reef had not been surveyed at all. This survey documented 153



Above The orange marble sea star (*Fromia monilis*).

Above right Courting olive sea snakes. Two males vie for the attention of a female (top snake).
Photos – John Huisman



species of crustaceans, including an amazing 98 new records for the region plus two new species. The most diverse families at these reefs were the black-fingered crabs, coral crabs, spider crabs, hermit crabs and swimming crabs.

Stars of the sea

Echinoderms—sea stars, brittle stars, feather stars, sea urchins and sea cucumbers—were not thoroughly surveyed as there was no specialist available. However, a new species of sea star was discovered at South Scott Reef. The limited results indicate that sea cucumber populations at Scott and Seringapatam reefs may have suffered from habitat degradation (after severe cyclones and possibly ongoing global warming) and fishing pressures (they are a favoured food in parts of Asia) from Indonesian fishers. This degradation could detrimentally affect the reef ecology.

Habitat descriptions

A video method devised by AIMS was used to document the habitat at each site. Video recordings were taken by Peter Morrison and later analysed to determine the percentage cover of each

of 15 habitat types (corals, rock, algae, sponges and so on). The images provide a permanent record of each habitat and can be compared with those from similar surveys in the future.

The results showed distinct differences between the lagoon and outer reef habitats, largely related to the level of wave action. The outer reefs generally supported more robust and encrusting coral species, while fragile coral species inhabited the lagoons.

More to uncover

The diversity recorded in this survey is undoubtedly an underestimate, as many nocturnal species, species that live in holes or crevices in the reef or under the sand, small cryptic plants and animals and wary pelagic species will not have been observed. Whole groups, such as the worms and soft corals, were not recorded due to the unavailability of specialists during the field work. Even some clearly visible species will have been missed because it was impossible to survey a sufficient number of sites to be sure of documenting all species in the time available. It must also be remembered that all such surveys are just a 'snapshot' in time—there are often seasonal variations in numbers and species possibly related to breeding times and movement, variations due to currents, storms and cyclones, plus the effects of human impacts through

fishing and tourism. It is important to use a survey method repeatable in regular monitoring programs to establish an understanding of such complex and changeable ecosystems.

Such surveys are extremely important. Despite their remoteness, the reefs are of increasing commercial interest, as they sit upon a huge gas reservoir that could potentially generate billions of dollars in revenue. It is therefore imperative that detailed surveys of the region are undertaken to ensure adequate protection of this delicate ecosystem.

John Huisman is a contract seaweed specialist at the WA Herbarium and a research fellow at Murdoch University. He is an international expert on seaweeds, having studied WA's marine plants for more than 20 years and written several books on marine plants in various parts of the world.

Sue Morrison of the WA Museum has coauthored the DEC books *The Marine Life of Ningaloo Marine Park and Coral Bay*, *Wonders of Western Waters*, *Beneath Busselton Jetty* and *The Turquoise Coast*. She is a regular contributor to *LANDSCOPE* and can be contacted on (08) 9212 3743.

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