Fatal ATTRACTION

The term "gourmet snails" assumes a new meaning in the reefs of Ningaloo Marine Park. Hundreds of millions of coral-eating snails consume the area's diverse and colourful corals, leaving large areas of dead coral covered in a green-brown carpet of algae. Marine scientist Dr Jim Stoddart describes the destruction they have caused in only a few years and the prospects for future recovery.

IN past decades, there have been great changes in ecological theory; notions of well buffered ecosystems showing little change have given way to an ideology that accepts massive changes over a relatively short time (less than 10 years). This has been most apparent in tropical marine systems. The scale of change detected recently in these systems is so large that scientists and managers are faced with a dilemma. They must decide whether our greater involvement with these environments made this discovery possible or whether it caused the changes.

Three separate waves of crown of thorns starfish infestation have swept down Queensland's Great Barrier Reef over the past 20 years, causing immense damage to individual reefs. Scientists are divided about whether the phenomenon is a human-induced 'ecocatastrophy' or an integral part of the Reef's natural cycles.

Now, similar events are taking place at Ningaloo Reef, adjacent to Western Australia's North West Cape. In this case the coral's nemesis is not a large spiny starfish, but a small knobbly snail that strips the living veneer of coral from the reef.

The snail's choice of reef is particularly unfortunate. Ningaloo Reef was declared W.A.'s second marine park in 1987 because of its rich coral communities. In the late 1970s and early 1980s the Reef's beauty rivalled that of the Great Barrier Reef and other expensive tourist destinations but, unlike most coral reefs anywhere else in the world, the reefs of Ningaloo can be visited cheaply by campers with small dinghies. Sadly, the most accessible reefs in the shallow protected lagoons have been worst affected by the snail.

Reports of damage to coral at Ningaloo began to appear in the early 1980s and before long the culprit was identified as a snail belonging to the genus *Drupella*. This group of 4 to 6 snail species is widely distributed on coral reefs of the Indian and Pacific Oceans and elsewhere. Isolated

Waves pounding the outer edge of Ningaloo Reef are excluded from the back reef and lagoon. It is in the calm back reef areas (the darker areas to the right of the picture) that *Drupella* causes the most damage.
Photo-Robert Garvey ▶

The gourmet snails eating a highly favoured plate coral; they tend to congregate in lines between the live and dead (white) coral.
Photo-Jiri Lochman ▲▲

University of Western Australia researcher Mike Ford examines snails on a massive *Porites* coral; one of the less preferred species.
Photo-Robert Garvey ▲

outbreaks of snails had been reported from reefs around islands to the south of Japan and at Cebu in the Philippines. There, the snails reached extreme densities, caused the loss of coral in an area usually less than a hectare, then returned to normal densities, after which corals recolonised the area. It seemed likely that a similar cycle would occur at Ningaloo.

Yet the snails did not return to normal levels. Damage became more widespread and severe. A 1987 survey of reef-fish revealed massive coral damage along at least 100 km of reef. That survey and most other reports of coral damage focused mainly on the Park's north-western reefs. To fully assess the snail-damage, the Department of Conservation and Land Management (CALM) recently surveyed the entire Ningaloo Marine Park. The task took 12 divers working from three boats more than two weeks to complete, with help from volunteers and Fisheries Department staff.

THE PRESENT REEF

The survey painted a bleak picture for the immediate future of much of the Reef's coral. Snail numbers were high over the entire Reef. Coral cover in the back-reef zone (the shallow reef flats adjacent to the sandy lagoon) had been reduced by more than 75% in two-thirds of the reef. The northern part of the Reef was worst affected; large areas were simply dead coral skeletons covered in algae. Only Bundegi Reef, on the north-east side of the Cape in Exmouth Gulf, was relatively untouched, although there were many snails. The central section of the Reef also contained large expanses where most coral had been eaten, but they were interspersed with sites containing lush growths of coral.

Coral loss on this scale has enormous implications. Coral is the major habitat builder on reefs, like trees in a forest.

When it dies, species dependent on it for food and shelter are lost. In many of Ningaloo's northern reefs, species of small colourful fish associated with living coral have been replaced with large schools of grazing fish which eat the luxuriant algae which covers dead coral and rubble.

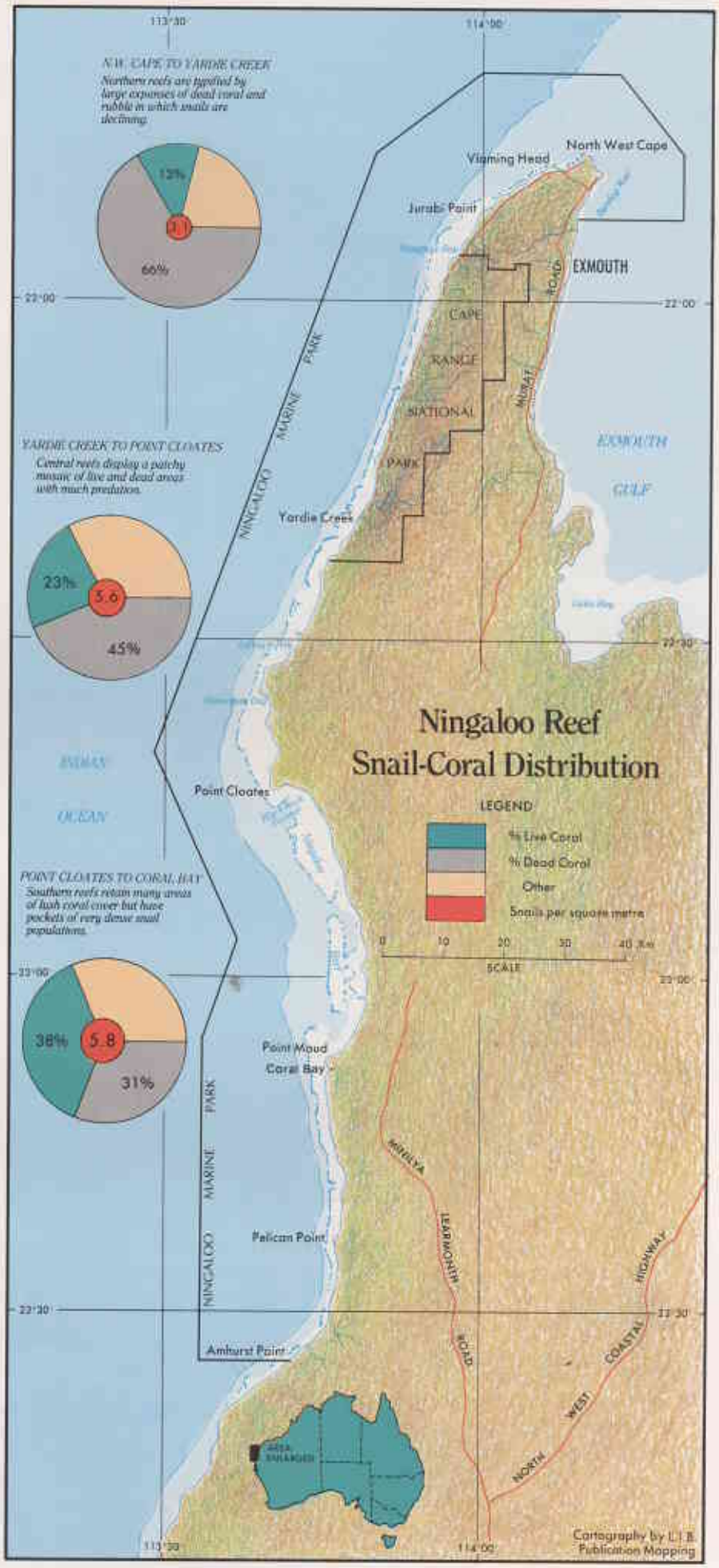
"...large areas were simply dead coral skeletons covered in algae"

Southern sites around the resort town of Coral Bay have not yet felt the full impact of snails. Only a few sites were severely depleted of living coral. Yet many of the area's dense coral carpets had a checkerboard covering of white splotches eaten away by hungry snails. These areas, with their abundant food supply, contained the most dense populations of snails in the Park. The snails prefer the fast-growing *Acropora* corals, such as staghorn and plate corals, which often dominate the back-reef. Only when these are gone do snails turn to less favoured species such as the massive brain corals. At most southern sites predation was restricted to the tastier species, but looked set to expand rapidly.

In the fore-reef zones, where the reef's sloping front is exposed to powerful oceanic waves, snails were widespread and common, much like on the back-reef. However, coral cover was generally diverse, with few patches of dead or scarred coral. How this reef zone supports high snail numbers without any noticeable impact is a mystery. Do snails eat less here, or are the results of their feeding swept away by strong waves? There are certainly less of their preferred prey here. Have they eaten it already?

WHY HERE?

Drupella has increased from an estimated 100-200 snails per kilometre of reef to the present 1-2 million per kilometre. This leaves no room for complacency. At present the alternative views, that the increase in snail numbers is either a natural part of the Reef's



SHIFTING FORTUNES ON A CORAL REEF

Colourful coral:
Attractive living coral with isolated dead patches and a few *Drupella*.

Early outbreak:
There is as much dead coral as live coral and large numbers of snails.

A new beginning:
Snail populations have disappeared after their food has run out. New corals colonize old coral skeletons.

Full-scale attack:
Huge numbers of snails devour the few, remaining areas of live coral.

The aftermath:
Older dead coral starts to crumble into rubble. Small pockets of snails feed on non-preferred species of coral.

ecology or an imbalance caused by human influence, must be considered equally probable.

Any future action will depend on which theory is validated by research. Research must determine "Why here?", "Is this a 'new' phenomenon?", "What caused it?", and "What will make it stop?" Studies of outbreaks in Japan, the Philippines and the Marshall Islands have been largely descriptive and offer little help in selecting between alternatives.

NATURAL EXPLANATIONS

All ecosystems are in a continual state of flux. Predator-prey systems often display a cycle where predator numbers increase because of an increase in prey numbers, devour most available prey, then decline dramatically through malnutrition, allowing prey numbers to build up and start the cycle again. The illustration above describes a possible *Drupella*-coral cycle. This cycle may be a critical part of the Reef's ecology, periodically clearing it of fast-growing corals which would otherwise smother slower growing species. (Bushfires play a similar role in many terrestrial ecosystems.) This function has been proposed for outbreaks in the Philippines.

Cycles are not always simple. The period of the cycle and the relative time spent at or between each state are important. Coral reefs on the Great Barrier Reef are thought to recover from destruction by starfish in 10-15 years (i.e. go from state 4 to 1), but present waves of starfish are recurring at shorter intervals. In this case, a large part of the reef may spend much more time at state 3 or 4 than the much prettier state 1. Even if we found from fossils that outbreaks at Ningaloo were part of a natural cycle it would not guarantee that man was not distorting the present cycle, or that 1 was not a relatively short-lived state.

Large thickets of staghorn coral in calm shallow lagoons present a unique visual experience for divers.
Photo-Chris Simpson◄

DRUPELLA: COMMONLY ASKED QUESTIONS

How do the snails kill the coral?
The snails scrape their radula, a large many-cusped tooth like a rake, across the live coral, dragging the soft tissue into their mouths. The white calcium skeleton that is left is soon covered by algae which turns yellow-green then brown.

Are the outbreaks part of the Reef's natural ecology?
We don't know yet. It may be that just as bushfires clear out old wood to make room for new trees, *Drupella* outbreaks clear out large thickets of a few fast-growing species, enabling new and diverse corals to colonise the area.

Where do the snails come from?
At least six species of *Drupella* occur on the world's coral reefs. One or more will be present wherever extensive areas of coral occur. In WA, four species have been identified so far, one found as far south as the Houtman Abrolhos Islands and three at Ningaloo Reef.

Why have large outbreaks occurred at Ningaloo?
Nobody knows. Perhaps outbreaks are related to human activities, such as overfishing, boating activities or pollution. Other theories suggest they are regular events that have only recently been noticed. Research will help to decide between such hypotheses.

Stands of live coral are inhabited by large numbers of small colourful fish, many of which feed on mucus produced by the coral. ▲▲

Can we control outbreaks?
Very unlikely, except for small areas. Snails tend to be well hidden, have very robust shells and are estimated to occur in their hundreds of millions at Ningaloo. Elsewhere, multimillion dollar programs for crown of thorns starfish removal have been largely ineffective. Physical control of *Drupella* would be much more difficult. Until we can be sure that outbreaks are not an intrinsic part of the Reef's ecology large-scale control programs are not on the agenda.

The many small fish clustered in front of this large expanse of dead coral will not survive unless they can find a nearby refuge of live coral.▲

The crown of thorns starfish that has devastated much of Queensland's Great Barrier Reef is scarce at Ningaloo.
Photos-Robert Garvey ◄

Is anyone doing anything about the problem?
CALM and the University of Western Australia's Zoology Department are studying snail/coral interaction to determine the history of the present outbreaks, how snails multiply, how outbreaks spread, if coral communities will recover and whether predators control snail numbers. CALM has applied to the Australian National Parks and Wildlife Service for funding for further research.

WHAT IS CORAL?

Reef-building stony corals are in the same animal group as jellyfish and sea-anemones. Most are made up of many genetically identical modules, or polyps. Each polyp contains numerous tiny single-celled algae which take in the coral wastes. In return, the algae supplies the energy necessary for the polyp to form its massive limestone skeleton. Stinging tentacles supplement the food supply by catching microscopic plankton. Other corals have no symbiotic algae or limestone skeleton. These are soft corals or the fan and whip corals often used as jewellery.

HUMAN INFLUENCES

Humans engage in so many activities affecting the environment that there are many plausible causes of snail outbreaks:

- Boats break pieces of coral when anchoring or crossing reefs. Snails are attracted by broken coral, causing local density increases which may alter reproductive biology or attract planktonic snail larvae to an area. To date, we know too little of the snail's reproductive biology to assess this theory.
- Pollution may raise nutrient levels in seawater, and increase survival of planktonic snail larvae by enhancing the growth of plankton they use as food. Outbreaks in Japan correlate with heavy rainfall and siltation from runoff. However, the waters of Ningaloo Reef receive little runoff which contains fertilizers, and other sources of pollution seem equally unlikely, as most of the land adjoining Ningaloo Reef is arid and part of it is within Cape Range National Park.
- Fishing may play an important part. Many people long associated with the area say that today's reef fish are not as numerous or as large as they were 10 years ago. Juveniles and even adult snails seem wary of fish and spend much time hidden deep within coral branches, only emerging to feed at night. Large fish such as emperors, gropers and tusk fish can probably crack the shells of adult *Drupella* and many other fish may prey on juveniles. However, predators may have little role in regulating prey numbers.

WHAT CAN BE DONE?

When the Ningaloo Reef was declared a marine park in 1987 CALM took over its management. CALM aims to conserve the area's natural resources while allowing recreational use consistent with its conservation. The back-reef corals are an important part of the Park and worth conserving. Or are they? Perhaps the back-reef areas of Ningaloo spend more time as algal covered beds of dead coral and this is the state we should conserve!

Is conservation really about keeping an ecosystem in the one state we believe is 'natural'? As if we could! No, change is as much a part of these systems as any animal or plant. We can be sure that, well before humans evolved, coral reefs sustained major impacts: cyclone-produced waves that stripped coral from the length of the reef; weather conditions such as the recent onshore wind pattern that trapped the output from the annual coral spawning in Coral Bay, killing millions of fish, coral and other invertebrates; and low tides which exposed reefs to the midday sun. It is this capacity for the system to change we must conserve.

The best management response may be to do nothing. Attempts to 'enhance' nature by short-circuiting the cycle may produce completely unpredictable results. On the other hand, existing human pressures may already have done just that, or at least interfered with the cycle's pattern. Evidence from the 1989 survey was ambiguous. Snail numbers in some of the northern reefs had declined since the 1987 survey, suggesting that recovery (stage 4 to 5) was on track. Yet in other parts of the northern and central reefs new coral growth was being wiped out by residual high density populations of snails (stage 4 or 5 regressing to stage 3).

We need to know a lot more about *Drupella*. Over the next 3 to 5 years, research projects will provide more information about the snails' larval stages, movements, reproductive biology and possible predators; coral distribution, recruitment and growth; and snail-coral interaction. Until then, the risk of disturbing a natural cycle with inappropriate management outweighs the risk of worsening the existing coral predation or prolonging recovery of lush coral. While researchers busy themselves, management intervention will be confined to the better known impacts of human use.

LANDSCOPE

VOLUME 4 NO 4 WINTER EDITION 1989

Effluent disposal ponds from industry disfigure an idyllic strip of coastal land. But restoration work and a new conservation park are planned for the Leschenault Peninsula, near Bunbury. *Turn to p.8.*

Wood that was once only suitable for firewood can now be used to make high grade furniture. *Find out how on p.24.*

With spring approaching, the bush beckons...but without proper planning your walk could turn to disaster. *See p.40.*

A spectacular landscape, with an astounding array of plants and animals lies inland from Jurien Bay. *Read about the Mt Lesueur area on p.28.*

A population explosion of coral-eating snails threatens the unique reefs of Ningaloo Marine Park. How does CALM plan to counter their attack? *See p.14.*

COVER

In W.A.'s far north, Aboriginal rangers with ties to land now in national parks draw on the traditional wisdom of their people for use in Park management. Photo-Robert Garvey

FEATURES

REGULARS

SPECIALS

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