Tropical Topics

An interpretive newsletter for the tourism industry

Challenges facing the Great Barrier Reef (GBR) No.70 November 2001

Notes from the Editor

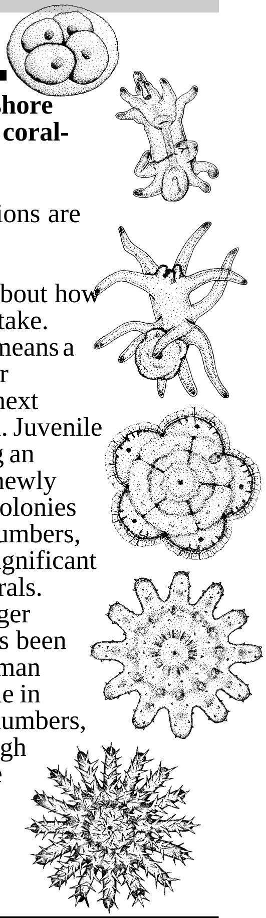
Coral reefs throughout the world are under threat and are being rapidly degraded by a combination of factors from dynamite fishing to climate change. Here in Australia our coral reefs have escaped many of the pressures found elsewhere but we cannot be complacent. A number of issues are of concern and it is the job of researchers and research institutes to evaluate those issues and to advise on courses of action which could be taken to protect the reef.

The CRC Reef Research Centre is a co-ordinating body for researchers and many of the research priorities involve those issues which are of most concern. This *Tropical Topics* therefore draws on reports and research produced by the CRC Reef.

There is a limit to how much information can be packed into one *Tropical Topics* so what you find here is an overview of the subject. In recent years many of the research findings have been posted on the web. If you would like more detail on these topics, check out the sites listed in Bookshelf, page 8.

Battling the COTS

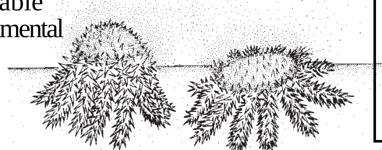
For the past few years tour operators, particularly in the offshore Cairns and Port Douglas areas, have been battling armies of coral-munching crown-of-thorns starfish.



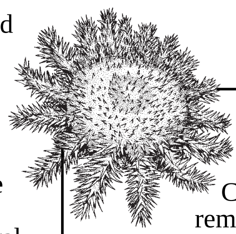
Crown-of-thorns starfish (COTS) have been causing alarm since they were first noticed in vast numbers, destroying large areas of coral at Green Island, in 1962. Since then there have been several outbreaks of unusually high numbers, typically at 15-17 year intervals. These intervals gave the corals time to recover but the latest outbreak, which peaked during 2000, came just five years after the previous one. It was also unusually widespread, covering 4 degrees of latitude; previous outbreaks had begun in the north and taken a decade to move south along the GBR.

Government money has been committed to the problem. A three-month pilot program of removal during which 12 000 COTS were removed from a number of sites, finished at the beginning of October. The aim was to demonstrate that reefs could be protected, given sufficient effort, and it is hoped that further funding will allow the work to continue.

The future is uncertain. Recent surveys on nine reefs between Lizard Island and Port Douglas have indicated lower numbers of COTS juveniles, but it appears that live coral cover of only 5-10 percent on these reefs is insufficient for development of young COTS. On the other hand, the presence of large numbers of different age groups suggests that the latest outbreak was not the result of one single event but that favourable environmental factors and conditions are persisting.



There is concern about how long recovery will take. Limited live coral means a limited potential for production of the next generation of coral. Juvenile COTS are showing an alarming taste for newly developing coral colonies and, even in low numbers, they are causing significant loss of remnant corals. Looking at the bigger picture, since it has been suggested that human practices play a role in increasing COTS numbers, these issues are high priorities for future research.

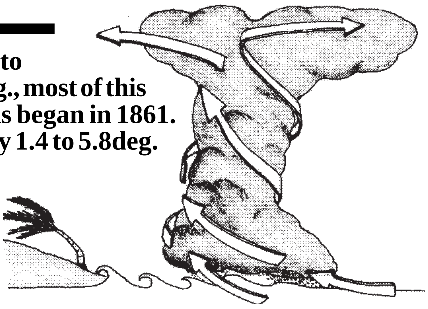


Controlling the COTS

The total number of COTS killed or removed in the Cairns/ Port Douglas area during the latest outbreak has reached about 450 000. Larger animals are injected with sodium bisulfate, a chemical which will not harm the reef environment. Smaller animals are removed, using a hook, collected in bags and killed later. Buffer zones are maintained around cleared areas because the animals move quickly. A chemical stimulus produced by COTS when they feed seems to attract others to join the feast.

Illustrations show life stages of COTS

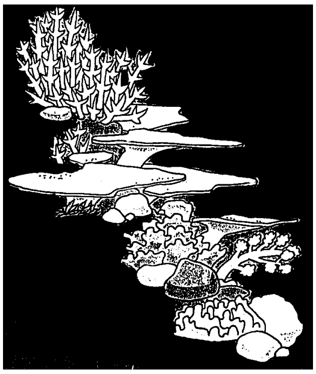
Climate change



Greenhouse gas levels in the atmosphere have increased over the past 200 years, largely due to human activities. As a result, during the twentieth century, the Earth warmed by about 0.6deg., most of this increase occurring during the last 50 years; the 1990s was the warmest decade since records began in 1861. During the next 100 years it is anticipated that average surface temperatures will increase by 1.4 to 5.8deg. As a result of global warming, sea levels will rise by between 9cm and 88cm by 2100.

Rainfall is expected to become more patchy and more variable. Both dry and wet periods may become more intense. Heavy rainfall events will be heavier because warmer air holds more water. Cyclones are expected to become more intense with wind speeds increasing by 5-20 percent by the end of the century. More intense cyclones, coupled with higher sea levels, will lead to higher storm surges.

The Great Barrier Reef (GBR) is likely to suffer physical damage as cyclones become more intense. Larger floods, delivering greater volumes of freshwater and lowering salinity levels, may also affect marine plants and animals while higher atmospheric carbon dioxide levels will change ocean chemistry, possibly leading to a reduction in coral growth rates. However, the most immediate and most drastic threat posed by climate change is an expected increase in rates of coral bleaching.

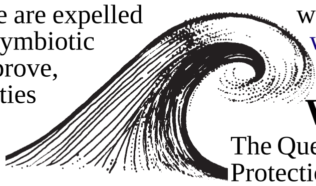


Coral bleaching

Higher than usual water temperatures are the main cause of coral bleaching although intense sunlight and excessive amounts of freshwater also play a part. Increases in ocean temperatures of just 1-2 deg. higher than normal can cause bleaching.

Bleaching is the term used when hard corals lose the algal (plant) cells which give them their colour, thus exposing the white hard skeleton below. Known as zooxanthellae, these tiny cells are present within the tissue of the coral animals at densities of up to 5 million per square centimetre. Zooxanthellae more than pay their rent. Like most plants they utilise sunlight for photosynthesis to produce food, a large proportion of which feeds their coral host.

When the temperatures go up, however, the going gets tough. Energy which has been captured from sunlight by the zooxanthellae cannot, in overheated conditions, be used to create food (sugars). Instead it is diverted into the production of oxygen radicals. Like the radicals which cause problems for aging humans, these are very corrosive and damage the zooxanthellae. Corals also suffer from heat stress and the net result is that the zooxanthellae are expelled from their hosts. However, since corals depend on functioning symbiotic algae for food, they suffer from their departure. If conditions improve, the zooxanthellae within the coral tissue – some remain, at densities of about half a million per square centimeter – can quickly reproduce and save the day, but if heat stress continues for too long the corals eventually die. Although many corals do recover, studies of bleached soft corals have shown that their reproduction can be disrupted for up to two years afterwards, an effect which may well apply to hard corals. Corals which recover from bleaching may also be vulnerable to disease.



A world-wide rise in sea temperatures in the summer of 1997-98 caused widespread bleaching. During just nine months, 16 percent of the world's coral reefs were destroyed. Recovery is slow, especially in isolated regions such as the Maldives and the Seychelles where the potential for recruitment of new corals is limited. Relatively speaking, the GBR was not so badly affected and has been recovering well. Nonetheless, at the time it was possible to map the extent of the bleaching from the air: 67 percent of inshore reefs and 14 percent of offshore reefs were badly affected, with 80 percent of corals on the worst hit areas dying.

What concerns lovers of coral reefs are prospects for the future as temperatures continue to rise. More coral bleaching is inevitable with conditions similar to, and probably more extreme than, those in 1998 likely to occur much more frequently.

Researchers hope that the corals may be able to adapt. Those which bleach easily may die out and be replaced by species which are more resilient, with consequent changes in reef communities. Coral reefs may even move to higher latitudes, as water temperatures there become warmer and therefore more hospitable. There is even hope that some zooxanthellae may be better at resisting high temperatures and could take over from those which are more vulnerable – although there is no evidence for this.

Monitoring conditions

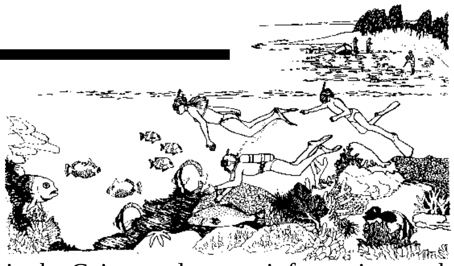
Weather stations set up by the Australian Institute of Marine Science (AIMS) at various points along the Reef are able to transmit information about weather conditions and sea temperatures, thus raising the alarm when conditions become stressful. At the end of January 2000 conditions conducive to bleaching were recorded at Myrmidon Reef near Townsville and, as predicted, some minor bleaching occurred. However, although very similar conditions were recorded at Agincourt Reef near Port Douglas, at the same time, no bleaching occurred – even though the species which bleached at Myrimidon were present at both sites. This suggests that corals have made local adaptations. You can find data from these weather stations, on the AIMS website at www.aims.gov.au/weather.shtml

Waves on the web

The Queensland Environmental Protection Agency (EPA) uses a number of Waverider buoys to measure the heights of waves at sea along the Queensland coast. Wave direction and, at some sites, water temperature are also measured and the data is processed by computer. Anyone boating in the area can use the system to check sea conditions. Details and background information are on the EPA website at: www.env.qld.gov.au/waves

A network of storm tide gauges measures tides at 20 locations around the Queensland coast, monitoring the regular rise and fall. Their primary purpose, however, is to record the magnitude of storm tide events, associated with cyclones. When a cyclone is approaching the coast, EPA officers provide advice to the State Counter Disaster Organisation on the potential impact of waves on coastal communities. The Storm Tide web site is at: www.env.qld.gov.au/tides

Tourism



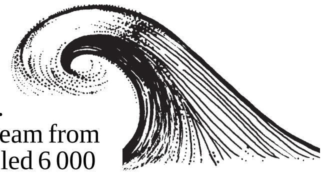
Tourism is one of the most benign uses of the reef, although associated coastal development can have a negative impact. It is also the most lucrative reef industry, earning in the region of $1 billion a year and bringing additional indirect financial benefits to the region as a whole. A total of 16 500 jobs in the Cairns and Port Douglas area are directly related to tourism, with the Great Barrier Reef (GBR) the main draw card. This represents 20 percent of employment in the area but as many as one in three jobs are indirectly dependent on tourism.

The CRC Reef Research Centre has funded a number of projects aimed at understanding tourism. A number of surveys have been designed to gauge visitor satisfaction, expenditure and motivations for reef visits. Specific enquiries aim to understand their satisfaction with wildlife interactions, their feelings about reef pontoons and levels of concern over impacts on the reef. Media, both in Australia and overseas, has been monitored to evaluate the coverage given to the GBR as a travel destination. To find out more about this research check the CRC Reef website at: www.reef.crc.org.au/research/sustaintour/index.shtml

With coral bleaching a major concern for the future, researchers are helping tour operators by developing regional projections of sea temperatures. By predicting where hot and cooler patches of water will occur during summer months in a decade or more, they can help the tourism industry to plan ahead. An element of the research is to determine the economic value of each reef-based enterprise at risk over a specified period.

Another important area of tourism research has involved in-water encounters with minke whales. This topic will be dealt with in more detail in a future *Tropical Topics* but extensive information can be found at: www.reef.crc.org.au/aboutreef/wildlife/minkewhale.shtml

Predicting the waves



It is now possible to log on to your computer and catch a wave. As part of a CRC Reef project, a team from James Cook University has modeled 6 000 virtual cyclones and calculated the wave energy, frequency and direction of waves at 150 000 points throughout the GBR. Although wave-measuring equipment has been set up at several points, the researchers didn't have to wait for a cyclone. Instead a computerised model was developed to simulate cyclonic conditions. The result is a wave atlas which can be used to prepare for the worst. Tour operators and managers can use the information to design mooring systems and to choose suitable sites for pontoons, while biologists can better understand the reef ecosystem – why fish and corals thrive in some places but not in others. In future, non-cyclonic waves as well as tidal and wind-driven currents and water levels will be added. You can find the wave atlas on the CRC Reef's website at: www.reef.crc.org.au/research/engineer/waveatlas.shtml or the JCU website at mmu.jcu.edu.au

Science for sustaining coral reefs – where does it come from?

Bryony Barnett, CRC Reef

Much of the information in this issue of *Tropical Topics* has come from research co-ordinated by the Cooperative Research Centre for the Great Barrier Reef World Heritage Area (CRC Reef), based in Townsville.

CRC Reef is one of almost 80 Cooperative Research Centres around Australia, established and supported by the Australian Government's Cooperative Research Centres Program. Each CRC is a partnership of scientists, managers and industry leaders.

The eight partners of CRC Reef include research institutions (the Australian Institute of Marine Science, James Cook University, Queensland Department of Primary Industries), managers (The Great Barrier Reef Marine Park Authority), non-government organisations (Great Barrier Reef Research Foundation), and industry associations (Association of Marine Park Tourism Operators, Queensland Seafood Industry Association, Sunfish Queensland Inc).

The research programs cover a huge range of topics (over 80 tasks) to improve our understanding of the reef, to ensure its conservation and sustainable use (The word 'reef' is used here to include all the different marine environments such as mangroves, seagrass beds, open ocean and the deep sea floor). Major issues at the moment are crown-of-thorns starfish, water quality, coral bleaching, use and conservation of biodiversity, as well as the sustainability of tourism, fishing and shipping industries.

As well as promoting research, CRC Reef sponsors a number of post-graduate students, providing them with research opportunities and training to equip them for the workforce – maybe as an industry employee or marine park manager.

An important part of doing research is to make sure the results reach those who are interested, such as reef industry groups, other researchers and management agencies. This is done through CRC Reef publications, conferences, workshops, the media, the internet and an active extension program.

Research takes time and money to do a good job. Funding for CRC Reef, valued at more than $75 million over seven years, comes from many sources including reef industry groups, state and commonwealth governments and research institutions. Some projects are jointly financed by a group of partners as well as other external sources, including international organisations.

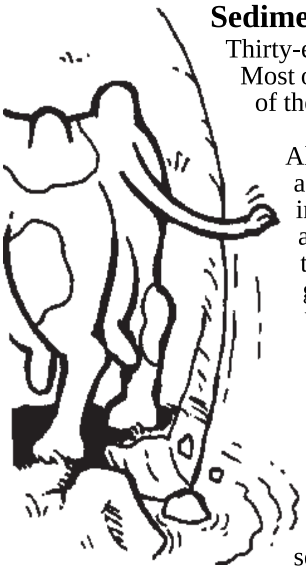
Find out more about CRC Reef on the website: www.reef.crc.org.au

Detecting the infiltrators

Early detection of introduced organisms (see page 4/5) is the key to control. In November 2000, a baseline survey of marine organisms in the port of Townsville was carried out by CRC Reef researchers. This functioned as a health check, but also added to a growing database from port surveys around Australia. Over 1300 different marine organisms (plants and animals) were collected and so far, although identification is not finished, no pests have been found. Townsville port waters will continue to be monitored. With this baseline information, future introductions of exotic organisms should be quickly detected. A Cairns Port survey is being carried out in November 2001.

What we put in …

The impact of changes in water quality, resulting from changes in landuse over the last 200 years, is possibly the single greatest environmental threat to the Great Barrier Reef.



Sediment and the sea

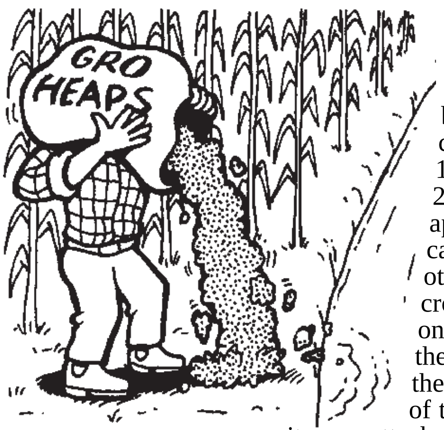
Thirty-eight rivers, draining one quarter of Queensland (424 000sq km), flow into the GBR World Heritage Area. Most of the catchment areas are small but two, the Burdekin and the Fitzroy Rivers, together comprise 64 percent of the total.

Along with the water comes sediment. This has always been the case and ocean environments have adapted to a certain load of sediment in the water. However, there is a limit to tolerance. Since the introduction of European-style agriculture, there has been an estimated three- to four-fold increase in the amount of sediment reaching the sea. Plant roots bind soil and protect it but about half the vegetation of the GBR catchment has been removed. Destruction of vegetation, whether by clearing, cultivation, over-grazing or frequent burning, leaves the soil vulnerable to erosion by heavy rain. Destruction of melaleuca wetlands and mangroves which effectively trap much sediment, further exacerbates the problem.

Studies have shown, however, that due to northward moving winds and water currents, much of the sediment discharged into the sea is prevented from moving too far from land. River plumes – trails of water carrying dark sediments – hug the coast, most of them extending less than 20km from land. Eventually, after being repeatedly resuspended, much of the sediment is trapped in northward facing bays such as Bowling Green Bay, Cleveland Bay, Trinity Bay and Princess Charlotte Bay. This is good news for the outer reefs but leaves inshore reefs, 750 of which are located within 10km of the coast, to bear the brunt. Hardy coral species living in coastal zones have, to a certain extent, adapted to cope with sediment loads. However, recent volumes may have pushed their tolerance limits and at some locations they have become severely degraded. There is also concern that the sediments may spread, low in the water column, to mid-shelf reefs.

Estimates of actual amounts of sediment discharged into the GBR vary from 14 to 28 million tonnes per year. Even the most conservative figure equates to 1.7 million dump truck loads of sediment a year – an average of 4 800 loads a day.

Sediments also carry problematic hitchhikers. Contaminants – nutrients such as nitrogen and phosphorus, as well as heavy metals and pesticides – bind themselves to sediment particles and are transported to GBR waters. It is these hitchhikers which cause most concern.



The nutrient link

Fertilisers are used extensively by farmers in the GBR catchment. Approximately 100 000 tonnes of nitrogen and 20 000 tonnes of phosphorus are applied per year mainly to sugar cane but also to bananas and other crops. Studies of sugar crops have shown that only about one third of the fertiliser ends up in the plants. The rest is lost either to the atmosphere or in water. Much of the phosphorus and some of the nitrogen attaches itself to sediments, but, particularly in rivers in the wet tropics, a large proportion of the nitrogen is exported in the dissolved form. Unfortunately this form is more easily taken up by living organisms. Although small doses of these nutrients are needed by reef animals, they have adapted to the low levels available in the reef environment. Excessive amounts can be harmful, just as excessive eating in humans can lead to ill-health.

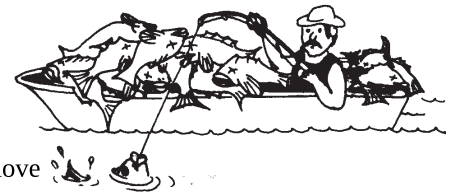
Infiltrators

Over 200 species of marine animals have arrived in Australian waters from elsewhere. Most of these have been introduced accidentally, having hitched a ride in ballast water, as fouling organisms on the hulls of vessels or through mariculture. Only a few of these organisms have become pests – but when they do, the problems they create can be severe as they prey on native animals, compete for food or spread disease. (See *Detecting the infiltrators*, page 3.)

Acid input

Many coastal zones have large amounts of iron sulphide minerals (usually iron pyrite) in the soil. Undisturbed, they create no problems but if exposed to air, they oxidize to produce sulfuric acid which, along with associated heavy metals, creates major biological damage. Increasing coastal development is creating more of these highly toxic acid sulfate soils.

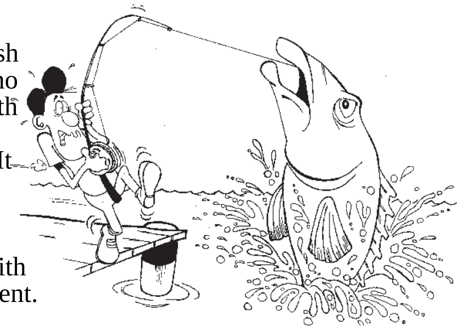
… and what we take out



Fishing is the main extractive activity in the GBR. With trawls, lines, nets and traps, humans remove fish, prawns, crabs, crays, sea cucumbers and trochus shells. Much of the catch is sold commercially but, with a total of 25 000 privately registered boats in the region, a significant proportion of fish is taken by recreational fishers.

It is essential that the GBR is fished sustainably and management agencies have been focussing research on achieving that aim. A decrease in trawling effort aims to reduce damage to the lagoon floor and the amount of wasted bycatch. A major project has been the Effects of Line Fishing Project which began in 1995. A collaboration between researchers, managers and fishers, the project is a 10-year experiment which has involved the opening and closing of certain reefs to line fishing. Fishers have been asked to keep an accurate record of fishing effort, catches (and releases). An essential part of the experiment has been the opening of reefs which were formally zoned Green – ie. no-take reefs – to fishing. By opening and then closing these reefs, researchers should be able to judge how quickly fish stocks on reefs recover.

Who are the fishers?



Research is being carried out not only on fish stocks and biology but also on people who catch them. Commercial fishing is the fifth largest primary industry in Queensland with a gross value of $361 million a year. It supports 2 000 vessels and directly employs over 6 000 people. It is therefore important to be able to assess potential social and financial impacts associated with changes in fisheries policy and management.

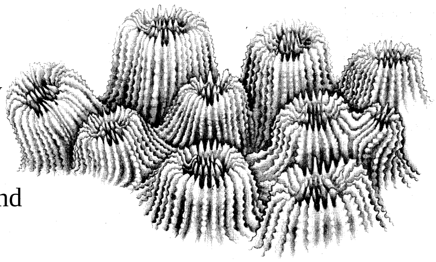
Social profiles of Queensland fishers have been compiled in three new reports, produced by the CRC Reef. Collectively entitled A Guide to the Fishers of Queensland, the reports describe the social and financial characteristics of three groups of commercial fishers – those involved in the commercial, the harvest and the charter fishing industries. The findings are based on interviews conducted with fishers along the Queensland coast and the data is presented separately for 22 town clusters.

These reports – CRC Reef Research Centre Technical Reports No. 36 (Commercial Fishing Industry), No. 37 (Harvest Industry) and No. 38 (Charter Fishing Industry) – are available in town libraries and on the CRC Reef website at: www.reef.crc.org.au/publications/techreport/index.shtml

Algal update

It was thought that an increase in nutrients in the water would feed algal growth, causing coral reefs to be overgrown by large seaweeds, such as sargassum, as nutrient loads increased. Algae do indeed quickly recolonise areas where corals have been killed by impacts such crown-of-thorns starfish outbreaks and then disrupt or slow the re-establishment of corals. However, studies have shown that algal cover on healthy reefs is more closely related to the numbers of herbivores, particularly plant-eating fish. It has been shown that algal domination of reefs overseas was related primarily to declines in herbivores – for example the death of sea urchins in the Caribbean due to disease, or from overfishing. Herbivorous fish are not caught in great numbers on the GBR.

What are the effects?

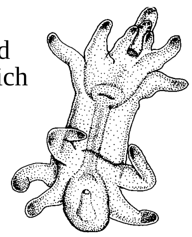


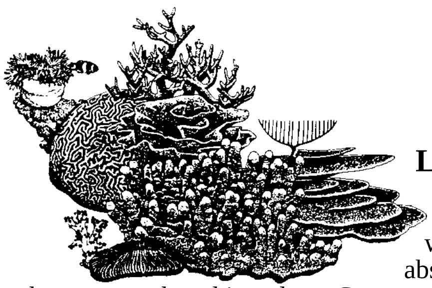
Corals do not, on the whole, like sediment. The polyps can remove small amounts – but at an energy cost to the animal – while large amounts can smother colonies altogether. Muddy water may prevent adequate light from reaching the symbiotic algal cells (zooxanthellae) in their tissues (see page 2), thus starving both parties of food. This is a problem not only for corals but also for other animals, such as clams, which have similar relationships with symbiotic algae. Sediment-covered surfaces are also unsuitable for the settlement of coral and other larvae.

The contaminants which bind to sediments are even more of a problem. In some cases, microbes grow on nutrient-enriched sediments, which smother corals with a sticky 'marine snow'. Experiments have shown that artificially high levels of nutrients cause decreases in calcification rates in corals as well as other changes in growth patterns. They also dramatically reduce fertilisation rates, cause problems in embryo development and even affect the settlement success of larval corals (planulae). Many other reef organisms also demonstrated ill-effects from excessive nutrient loads.

Seagrasses, like all plants, need sunlight in order to photosynthesise but muddy water restricts this essential ingredient for growth and large amounts of sediment can bury the seagrass plants. Flooding from the Mary River in 1992 is blamed for the sudden loss of 1000sq.km of seagrass beds in Hervey Bay. The actual volume of flooding was not very unusual, so it is assumed that the amount of sediment carried into the sea by these floods was much higher than previous levels. There is also concern that herbicides, from agricultural sources, have a negative impact on seagrasses. Since dugongs as well as many other creatures such as prawns and fish depend on seagrasses, damage sustained by these productive beds can have serious reef-wide consequences.

Crown-of-thorns starfish (COTS) larvae thrive in nutrient-rich waters. Extra nutrients feed microscopic floating plants (phytoplankton) which are the food source for newly spawned COTS larvae during the three weeks or so they spend floating in open waters before settling on coral reefs. Studies comparing COTS outbreaks with weather records have suggested a link between periods of high rainfall and the beginning of outbreaks. The larvae seem to do well in conditions of low salinity, when large amounts of fresh water dilute the sea water, but their liking for larger sizes of phytoplankton, which don't usually occur in GBR waters except after large floods, may be the key factor. In the case of COTS outbreaks, the high rainfall was preceded by periods of drought, which would maximise the amount of sediment in the floodwaters. Since nutrients bind to sediments, more sediment means more nutrients, which mean larger phytoplankton and many more satisfied – and developing – COTS larvae. Although none of this is proven, it does suggest that increased sediment and nutrient loads have the potential to change the balance between species by benefiting some at the expense of others.





Long term effects

It is difficult to quantify the true impact of increased volumes of land-based contaminants arriving in GBR waters. There is no data from the days preceding European settlement with which to compare the current situation and it is difficult to assess how much of the input is absorbed by the natural system without causing harm. However, there are concerns that subtle changes may be taking place. Communities of animals on reefs could be gradually transformed as those adversely affected by changed conditions die off to be replaced by more resilient ones. This would lead to a change in species composition with a consequent loss of biodiversity. The true impact could be hidden until a major impact, such as a cyclone reveals an underlying weakness. Excessive damage, and/or a failure to recover could demonstrate that changes have been taking place – changes that could be difficult to reverse. For this reason, research is being conducted by all agencies concerned with the future of the reef. Studies examine the effects of inputs on the reef environment and methods for improving land-use practices to minimise impacts. Knowledge is the key to avoiding future tragedies.

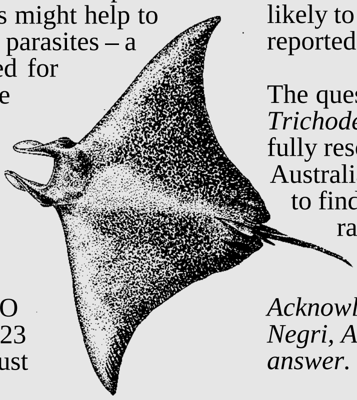
Questions & Answers

Q When a rat has fed on a rat poison such as Ratsac or Talon, does this affect any animal, such as python, which eats the rat?

A Yes, secondary poisoning is likely when the bait is present in the gastro-intestinal tract of the rat, particularly where single feed baits have been eaten. Multi-feed baits are less likely to affect predators, since they would then need to eat a number of poisoned rats to ingest enough of the poison to affect them.

Q Why do manta rays do loop the loops? Is it to help concentrate prey?

A Manta rays are filter feeders which eat plankton – mainly small crustaceans and tiny fish. When feeding they open up their mouths and, using the prominent fins at either side, direct water inside. Water is then passed out through the gills leaving the edible contents in the mouth. When these fish happen upon a particularly rich patch of food in the water they direct themselves back through it several times by swimming in slow somersaults. Manta rays, which may measure as much as six metres from fin tip to fin tip, can also leap clear of the water, landing back with a hard splash. It is thought that this might help to rid them of skin parasites – a reason suggested for humpback whale breaching.



An interesting article on manta rays by Michael Aw was recently published in GEO Australasia Vol 23 No 2 June-August 2001.

Q Can you delve into the names *Trichodesmia erythraea/ Oscillatoria erythraea* – are they the same?

A They are different names for the same algae. It was originally called *Oscillatoria erythraea* but following a taxonomic revision it was assigned to a new genus, *Trichodesmia.* There are two species recognised in open tropical waters – *T. erythraea* and *T. thiebauti* – so the algae are generally called simply *Trichodesmium* sp. The former species is the most common in Queensland waters, however.

Although individual plants are tiny, these algae can form massive slicks on the water surface, usually between August and December. Some are so big they can be seen from space. The algal cells join up to each other in strings and clumps. As they age they rise to the surface, and when they start to decay can become very smelly. The slicks, which are rusty brown with grey, green or purple streaks, are often mistakenly reported to authorities as oil slicks. If you come across a slick, get hold of some, if possible. If it washes off your hands in water it is *Trichodesmium* – or coral spawn, which also forms slicks. If it does not wash off your hands in water, it is likely to be oil and should be reported.

The question of whether *Trichodesmium* is toxic has not been fully resolved. Extensive tests on Australian *T. erythraea* have failed to find any toxins, but the much rarer *T. thiebauti* is potentially toxic.

Acknowledgements to Dr Andrew Negri, AIMS, for his help with this answer.

Tourist talk

ENGLISH	GERMAN	JAPANESE	
crown-of-thorns starfish	Dornenkrone Seestern	onihitode	鬼ヒトデ
to control	unter Kontrolle halten	chosetsu suru	調節する
climate change	Klimawechsel	kikou henka	気候変化
to bleach	bleichen	hyohaku suru	漂白する
catchment	Flußgebiet	shusui	集水
sediment	Ablagerung	chin den butsu	沈澱物
fertiliser	Dünger	hi ryo	肥料
nutrients	Nährstoffe	eiyo butsu	栄養物
waves	Wellen	nami	波
fishing	Fischerei	sakana tsuri	魚釣り

Facts and stats

On average 380 billion cubic metres of rain falls on the Great Barrier Reef World Heritage Area (GBR WHA) catchment annually. About a fifth of this (70 cubic metres) reaches the sea. That is, very roughly, the equivalent of a pond 70km long, 70km wide and 70km deep; 70 km is roughly the distance from Cairns to Port Douglas (or almost as far as Townsville to Ayr). Discharge from the Burdekin and Fitzroy Rivers accounts for 25 percent of the runoff.

Compared with 150 years ago, there is estimated to be at least three times as much nitrogen and at least 10 times as much phosphorus reaching the GBR WHA.

In the Burdekin catchment, 95 percent of the land is used for grazing. Sixty percent of the melaleuca wetlands and 50 percent of rainforest have been removed.

Over 400 000ha of land were cleared in Queensland in 1999. This was the highest clearing rate ever recorded in Queensland and accounted for over 90 percent of Australia's total land clearing that year.

Atmospheric concentrations of carbon dioxide have increased from 280 ppm (parts per million) in 1861 to 367 ppm in 2000.

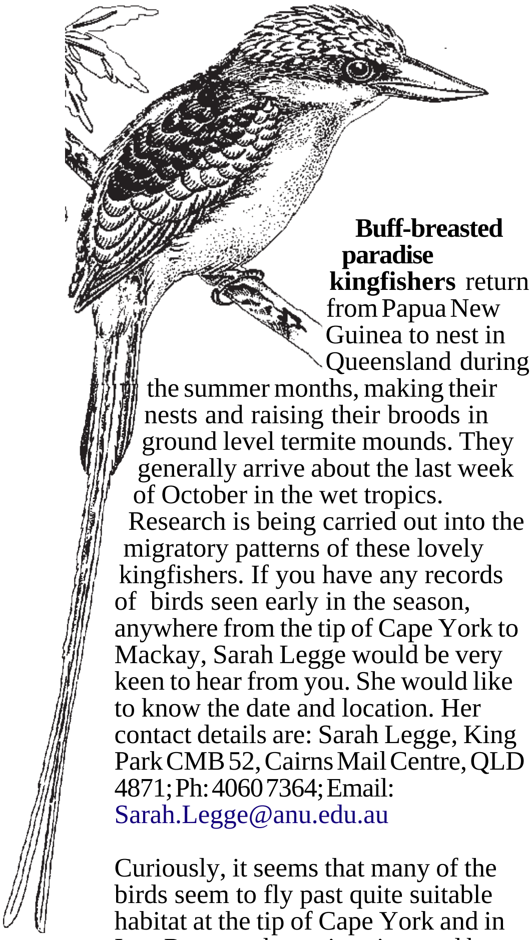
Currently the average number of days in the year with temperatures exceeding 35deg. is three for Brisbane and Cairns and two for Townsville. By 2070 this average is anticipated to increase to between four and 35 days in Brisbane, 4-75 days in Townsville and 5-75 days in Cairns.

Large numbers of introduced black striped mussels were discovered in Darwin marinas in March 1999. This species is closely related to the European zebra mussel which, following introduction to North America, causes immense problems by clogging pipes and waterways. This species costs US$600 million in control each year. Luckily the mussels in Darwin were brought under control.

Biodiversity of soft corals has been shown to decrease in muddy water conditions.

In places up to two dozen crown-of-thorns starfish have been found clustered under a single plate coral, in layers three deep. Only skilled staff are used to control them partly because spikes from the toxic spines can cause severe flesh wounds and allergic shock reactions.

Out and about



Buff-breasted paradise kingfishers return from Papua New Guinea to nest in Queensland during the summer months, making their nests and raising their broods in ground level termite mounds. They generally arrive about the last week of October in the wet tropics. Research is being carried out into the migratory patterns of these lovely kingfishers. If you have any records of birds seen early in the season, anywhere from the tip of Cape York to Mackay, Sarah Legge would be very keen to hear from you. She would like to know the date and location. Her contact details are: Sarah Legge, King Park CMB 52, Cairns Mail Centre, QLD 4871; Ph: 4060 7364; Email: Sarah.Legge@anu.edu.au

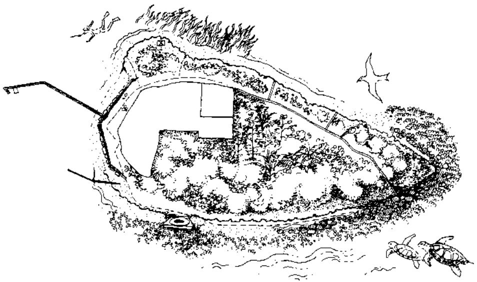
Curiously, it seems that many of the birds seem to fly past quite suitable habitat at the tip of Cape York and in Iron Range, when migrating, and keep going to the wet tropics. Given that their lovely tails are a bit of an aerodynamic handicap, there must be something worthwhile in the wet tropics to inspire them to keep flying so much further.
Acknowledgements to Sarah Legge.

Please note that the **CRC Reef Research Centre** moved recently. They are now located at Level 6, Northtown Tower, 280 Flinders Mall, Townsville, QLD 4810. The postal address is PO Box 772, Townsville, QLD 4810; Ph: (07) 4729 8400; Fax: (07) 4729 8499. The website is www.reef.crc.org.au

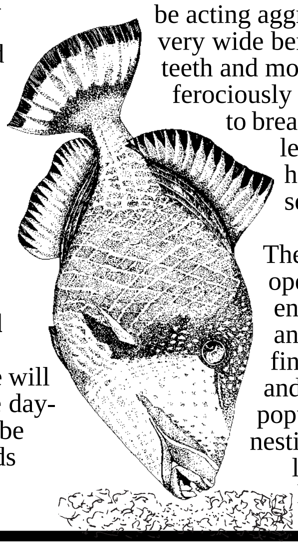
The national park **campground at Carnarvon Gorge National Park** has been closed. The site will be converted into an attractive day-use area and camping will still be available at commercial grounds outside the park.

The draft management plan for **Green Island** has been released. The plan covers Green Island Recreation Area and Green Island National Park and provides the framework and guidelines on how the area will be managed. It sets out the considerations, outcomes and strategies proposed to form the basis on which management decisions will be made.

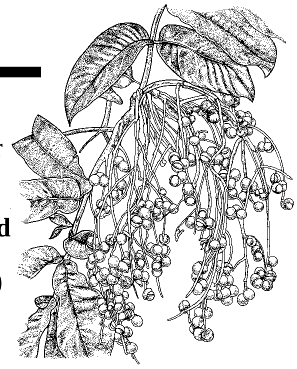
Publication of the draft plan is a major opportunity for public involvement in helping to manage this area. Landholders, local governments, Aboriginal and Torres Strait Islanders, interested groups and members of the public are invited to comment. Copies of the Plan are available from the QPWS office in Cairns at 10-12 McLeod St, Ph: (07) 4046 6600. It is also on the EPA website at: www.env.qld.gov.au/environment/park/managing/ Comments are due by 17 December.



Out on the reef, **triggerfishes** are beginning their summer nesting season. Titan triggerfishes are to be avoided at this time as the females are ferocious defenders of their nests. It is well worth learning to identify this species. The largest of the triggerfishes, it can grow up to 75cm in length and weigh up to 7kg. It has a yellowish face with a dull cross-hatched scale pattern on the rest of its body, and pale fins. Look out for these fish with their noses down in their nests in the sand, and if they seem to be acting aggressively, give them a very wide berth. They have strong teeth and move very fast. They bite ferociously and have been known to break masks and camera lenses. A blow to the head could be very serious for a diver.



These fish nest out in the open. Nest-building entails removing rubble and fanning the site with fins to blow away sand and create a depression; popular areas with many nesting fish can end up looking like a lunar landscape.

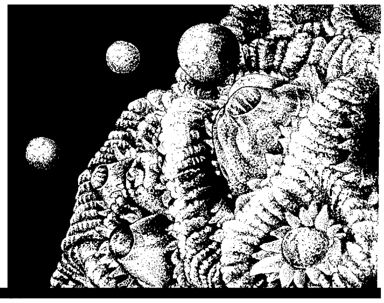


Towards the end of the year fruits dangle down from the **native tamarind** (*Diploglottis cunninghamii*) in dense clusters. The pale skin on each splits to reveal a bright orange-yellow flesh surrounding a single large seed. The structure of the fruits is similar to lychees or longans, which belong to the same family. The flesh is juicy but sour and is very popular with birds and flying foxes – the ground below is littered with discarded seeds which actually germinate better than those in fruit picked from the tree. Despite its name, this tree is not related to the commercial tamarind tree.

An Introduction to the Great Barrier Reef
Informative and entertaining slide show talk by marine biologist, Paddy Colwell.
Every evening, Monday-Saturday
Time: 6.15-8.30pm
Venue: 14 Spence St, Cairns
Cost: $13 (includes tea/coffee/biscuits)

ALSO:
Great Barrier Reef Tourism Certificate
GBRMPA certified
One-day course, 8am-5pm
Held twice a month (next, 22 November)
Cost: $50
Enquiries/bookings: Ph: 4031 7794

Coral spawning is expected to happen on most reefs around the 3-6 December, following the full moon on the first. There were expectations that the corals would spawn early in November, but little activity was recorded, except at Magnetic Island, where the corals, in warmer water, usually spawn a month ahead of other reefs.



Bookshelf

Oceanographic Processes of Coral Reefs: Physical and biological links in the Great Barrier Reef
Editor: E. Wolanski
CRC Press 2000

There is much of relevance and interest in this comprehensive book which looks at different aspects of ecosystem functioning and human impacts.

CRC Reef Research Centre leaflets and brochures
Available from CRC Reef, details page 3.
Port of Townsville Baseline Survey update June 2001
Crown-of-thorns starfish on the Great Barrier Reef
Current state of knowledge April 2001
Land Use and the GBR WHA
Current state of knowledge Nov 2001
Coral bleaching and global climate change
Soon to be published

Exploring Reef Science (leaflet series)
August 1998
River sediment stays close to the coast
April 1997
Ballast research to kill shipping hitch-hikers
February 2001
Underwater hitchhikers on the bottom of boats
October 1997
Visitor survey helps tour operators understand travel trends
June 2001
Reef visitors who take part in more interpretive activities show better understanding of reef topics

Climate change in Australia
A series of brochures produced by CSIRO can be found on the web at: www.marine.csiro.au/iawg/impacts2001.pdf

Reef Research Vol 10 No 1 March 2000
This GBRMPA publication contains a number of relevant articles on inshore reefs, weather stations, aquaculture, COTS and ballast water.
It is available on the GBRMPA website www.gbrmpa.gov.au

Impacts of Terrestrial Run-off on the GBR WHA
David McB Williams
On the web at: www.reef.crc.org.au/aboutreef/coastal/waterqualityreview.shtml

Great Barrier Reef Catchment Water Quality Action Plan
A Report to Ministerial Council on targets for pollutant loads
September2001/www.gbrmpa.gov.au/corp_site/key_issues/water_quality/action_plan/index.html
Note; This report will soon be available on CD.

The State of the Great Barrier Reef 1998: Water Quality
www.gbrmpa.gov.au/corp_site/info_services/publications/sotr/water_quality_frame.html

Great Barrier Reef Pollution Report Card
World Wildlife Fund report on the GBR
June 2001
Available under Publications on the WWF website: www.gbr.wwf.org.au

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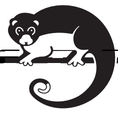

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