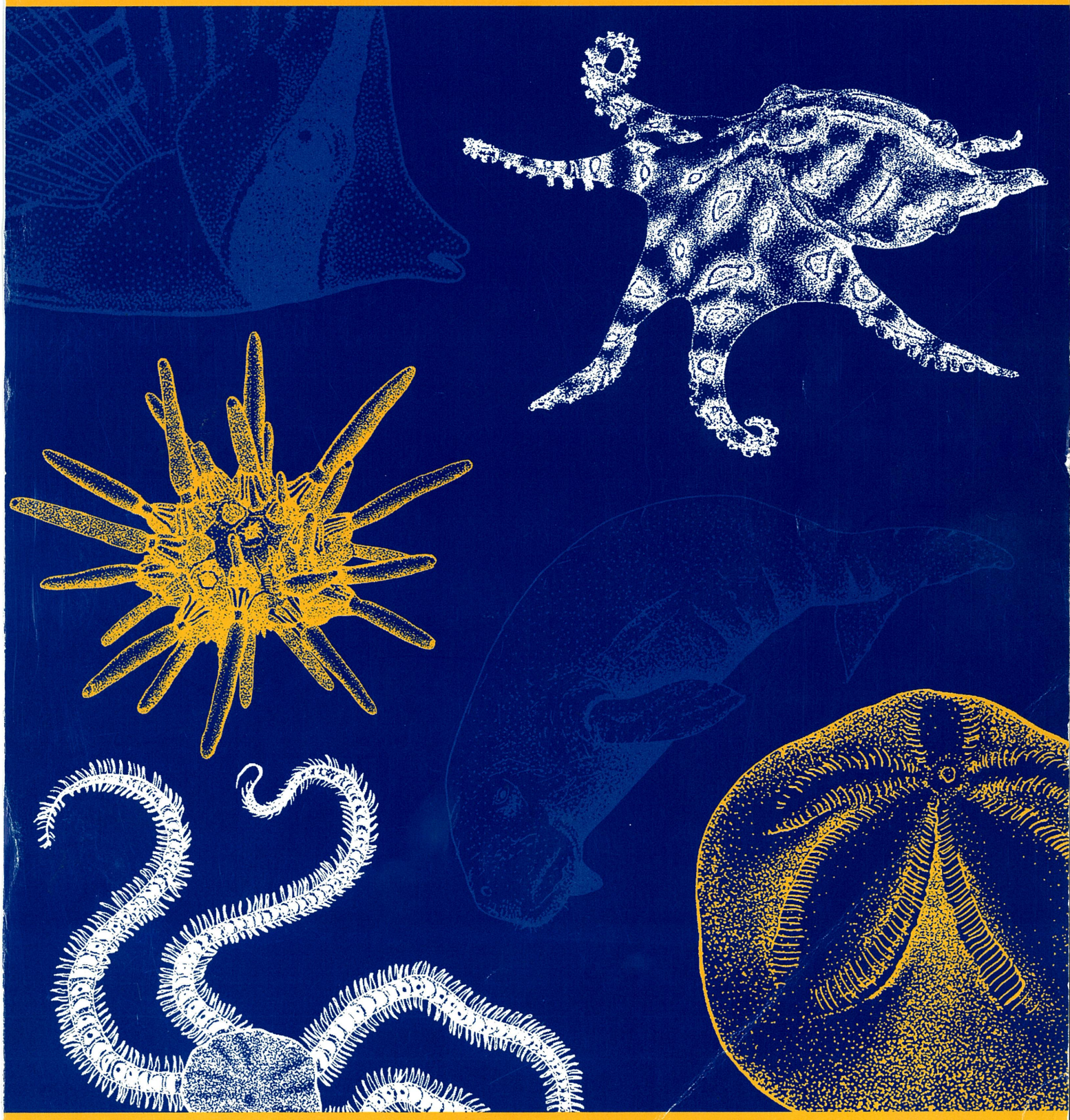
Reef Manual

understanding • essentials • communications

GREAT BARRIER REEF
MARINE PARK AUTHORITY



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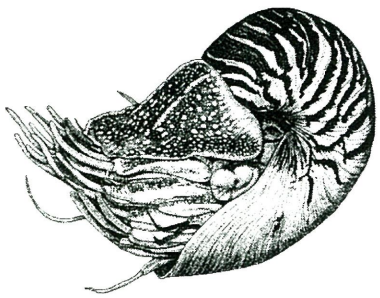
Reef Manual Insert

Some of the information on pages 2 and 3 of *Reef Essentials* is out-of-date; please refer to the following updated and correct text.



Local Marine Advisory Committees (LMACs)

There are now 11 Local Marine Advisory Committees established in regional centres adjacent to the Great Barrier Reef World Heritage Area.

How is the Great Barrier Reef World Heritage Area Managed?

Zoning Plans - who can do what, and where can they do it?

Part of the GBRMPA's job is to work out what people can do in the Marine Park, and where they can do it. The GBRMPA manages this by zoning the Great Barrier Reef Marine Park. The Marine Park Zoning Plan divides the Marine Park into coloured zones, which specify the types of activities that can occur in each coloured zone. Zoning allows the GBRMPA to protect special areas, areas that are threatened and areas representative of the plants and animals in the Marine Park by placing limits on the use of these areas. Zoning may also be used to separate activities that may conflict with each other, such as commercial fishing and tourism.

Each Marine Park zone has specific management objectives, which determines which human activities may or may not take place in that zone.

The 'Pink' Preservation Zones exclude all activities. The Preservation Zone makes up less than one percent of the Marine Park.

The 'Green' Marine National Park Zones are 'no-take' areas and extractive activities like fishing or collecting are not allowed without written permission. The Marine National Park Zone makes up about 33 percent of the Marine Park.

The 'Orange' Scientific Research Zones facilitate research by providing areas, primarily around scientific research facilities, that allow studies to occur in areas relatively undisturbed by extractive activities. The Scientific Research Zones make up less than one percent of the Marine Park

The 'Olive Green' Buffer Zones provide for the protection and conservation of areas of the Great Barrier Reef Marine Park in their natural state, while continuing to allow the public to appreciate and enjoy the relatively undisturbed nature of the area. The Buffer Zones make up approximately 2.9 percent of the Marine Park.

The 'Yellow' Conservation Park Zones allow for increased protection and conservation of areas of the Marine Park, while providing opportunities for reasonable use and enjoyment, including limited extractive use. The Conservation Park Zones make up approximately 1.5 percent of the Marine Park.

The 'Dark Blue' Habitat Protection Zones protect and manage sensitive habitats and ensures they are generally free from potentially damaging activities. The Habitat Protection Zones make up about 28 percent of the Marine Park

The 'Light Blue' General Use Zones allow most commercial and recreational activities. Thirty-four percent of the Marine Park is zoned for general use.

The *Great Barrier Reef Marine Park Zoning Plan 2003* is the primary planning instrument for the conservation and management of the Marine Park. It also provides for a range of recreational, commercial and research opportunities and for the continuation of traditional activities. The Zoning Plan was developed through the Representative Areas Programme. Community members, interest groups, indigenous communities, relevant industry groups and other management agencies participated in formal consultative processes to make sure the Plan took into account everyone's specific needs and issues.

The Plan provides increased protection for the plants and animals of the Marine Park by protecting examples of each of the major habitats found in the Marine Park within a network of Marine National Parks (green) Zones.

Plans of management - managing special areas of the Marine Park

Plans of management complement zoning by addressing issues specific to the area, such as certain species or the ecological community. The preparation of the plan takes into consideration the natural, cultural and scientific values and use of the area.

Plans of management are developed in consultation with communities and users of the area. Consultation is undertaken by inviting all stakeholders to provide information and comments on any issues relevant to the area before a plan is prepared. Stakeholders are again given an opportunity to comment once the draft plan has been prepared. In light of comments made, the GBRMPA amends the plan accordingly.

What areas of the Marine Park have a Plan of management?

Plans of management are in place for:

- The Cairns Area, to manage impacts of high-density tourism and provide a variety of natural experiences.
- The Whitsundays, to manage the impacts of high-density tourism and provide a variety of natural experiences.
- Shoalwater Bay, to protect and conserve the resident dugong population.
- The Hinchinbrook region, to allow for a variety of low-key tourism opportunities, whilst ensuring the nature conservation values of the area are maintained.

For more information on Plans of management, visit www.gbrmpa.gov.au.

Site management arrangements

Site management arrangements are localised plans for use of a particular site. They concentrate on specific user issues and impacts at a site. They are developed in consultation with community members, interested groups and other management agencies. Site management arrangements identify significant values of a specific site and determine the appropriate balance of private and public access opportunities consistent with the values of the site. Occasionally, issues arise at certain sites that require further management direction or explanation. Examples include multiple permit applications for moorings, conflicts between user groups, species and/or habitat conservation, or simply changes in use patterns. Site management arrangements are subsequently prepared in consultation with relevant stakeholders including, the Queensland Parks and Wildlife Service, Maritime Safety Queensland, Traditional Owners, tourism industry, commercial and recreational fishers and local communities.

Site management arrangements identify values, use, structures and specific management issues at the site. Depending on the issue, management arrangements may include identifying anchoring and mooring areas, location of reef protection markers and snorkelling areas or separating different user groups.

For more information or to view site management arrangements visit www.gbrmpa.gov.au.

Permits

A permit application form is also available on the web.
Visit www.gbrmpa.gov.au.

Great Barrier Reef Marine Park

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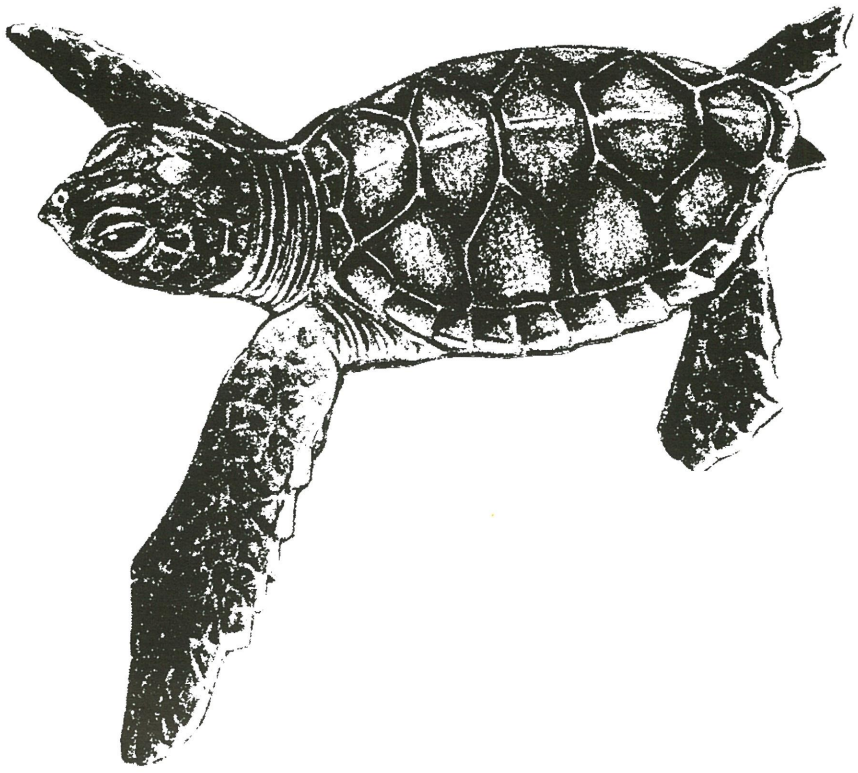

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MARINE PARK AUTHORITY
let's keep it great

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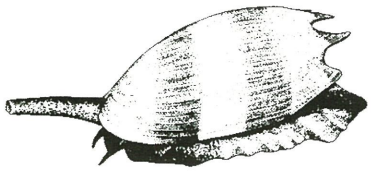


from the Chair

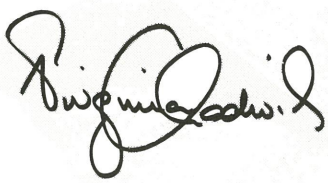
The Great Barrier Reef in all its majesty and magnificence is truly one of the greatest natural wonders of the world. So many people are eager to visit the resource that tourism has become the main commercial use of the Great Barrier Reef. In 1999 tour operators carried over 1.6 million visitors to the Marine Park. Growth in the number of visitors to the region is expected to increase at about 10% each year.

The Great Barrier Reef Marine Park Authority's (GBRMPA) obligation is to ensure that tourism is conducted in concert with World Heritage commitments and the Authority's principles for managing the Area's natural and cultural values. In the past the GBRMPA's role in managing tourism use focussed on managing the ecological impacts of individual operations. Although this remains a prime obligation, it is now clear that in order for the GBRMPA to properly meet its World Heritage obligations, it must adopt a more strategic approach to the management of the Great Barrier Reef. This approach will take into account both the individual and the cumulative impacts of tourism use on environmental, cultural and socioeconomic factors. The Great Barrier Reef Marine Park Manual contains important information on reef management and 'Best Environmental Practices' which will ensure that our use of the reef has minimal impact.

Under World Heritage obligations, the GBRMPA is tasked with the responsibility of ensuring the Great Barrier Reef Area is 'presented' to the community at large. The tourism industry brings people into contact with the living natural system and provides opportunities for individuals to experience this unique place in a variety of settings. This Manual will hopefully make your task easier as it provides important information on the natural systems that drive the reef and many stories about the creatures found there. All the information in the world is of little use if poorly communicated. For this reason experienced reef interpreters have provided advice on how to make presentations entertaining and informative.

The GBRMPA recognises the diverse range of opportunities that the tourism industry provides, but holds it important that the experience being offered remains nature based and educative. The GBRMPA will continue to work closely with the tourism industry to ensure a diverse range of settings and opportunities are maintained and in the establishment of standards for quality presentation. The GBRMPA will continue to develop educational material and training programs for the tourism industry in close consultation with operators.

Together we can manage the natural system of the Great Barrier Reef for tourists today and for the world community in the future.



Hon Virginia Chadwick
Chair
Great Barrier Reef Marine Park Authority

a message from Jean-Michel Cousteau

I grew up in the sea and have been fortunate to see much of our Water Planet. During my 50 years of diving, I have seen many changes in the vitality of the sea. Some of the changes have been good. But most give me cause for concern. The pace of change is more than the Earth's natural systems can bear. Today, the sea is threatened in many ways by human activities. Pollution, overfishing, and even diving harm its health and vitality. The oceans need help. And I am hoping that you will join me in the search for solutions. It is a challenge that affects us all, because, you see, everything is connected.

We humans are remarkably clever. With just our hands and brain we have overcome the harsh forces of nature. Yet for the most important aspects of our survival, such as health, food, water and air, we are still dependent on nature. And we cannot be healthy if our environment is unhealthy, for we are part of it.

Consider the coral polyp, an extremely simple animal which is little more than "organised water." What could we possibly have in common with this little organism? Well, a lot. For example, we are also made up largely of water. The blood that flows in our veins has a similar chemical make up to that of sea water which bathes the reef. This is no coincidence.

About three and a half billion years ago, organic molecules formed in the ocean. There was no life yet, just physical and chemical processes. The atoms of carbon, nitrogen, hydrogen, and oxygen joined and separated. Somehow they acquired the spark of life. These very same atoms are still here. In a process that has lasted for over three billion years, they have joined and separated countless times. Each time they created a different form of life. So the stuff of which you and I are made has probably been alive in polyps. It has settled in sediments. It has helped plants capture solar energy. It has flown in birds. And it has dived the depths of the oceans in whales.

Although our outer forms may appear different, we living creatures share a common heritage. In fact, we share a lot of the same genetic material. And in our basic functions, we are more similar than different. So we are literally, brothers, sisters, cousins, aunts and uncles.

What does all this mean to those who visit the reef? Knowing what we once were helps us understand who we are today. And it makes the visitor's experience more powerful. To swim eye to eye with a shark or a whale. To observe the private lives of territorial fish protecting their nests. To be engulfed in a school of jacks or trevally. All of this helps us reconnect with the drama of our origins. It is a thrill that only divers and snorkellers can really feel and understand.

It also means that the sea is our home as much as it is anyone else's. Ours to love. And ours to protect from careless destruction. I hope you will encourage visitors to spend as much time in the water as is safe and comfortable for them. I also hope you will ensure they dive responsibly.

The dance of evolution continues, and the coral a visitor destroys with a careless flick of a fin is actually part of his or her own family tree.

So encourage visitors to know their relatives. Our family is full of characters. Some can be pests. Some are funny. Some are powerful. And some are weak. But they are our family, so we MUST ensure visitors treat them kindly and with respect.

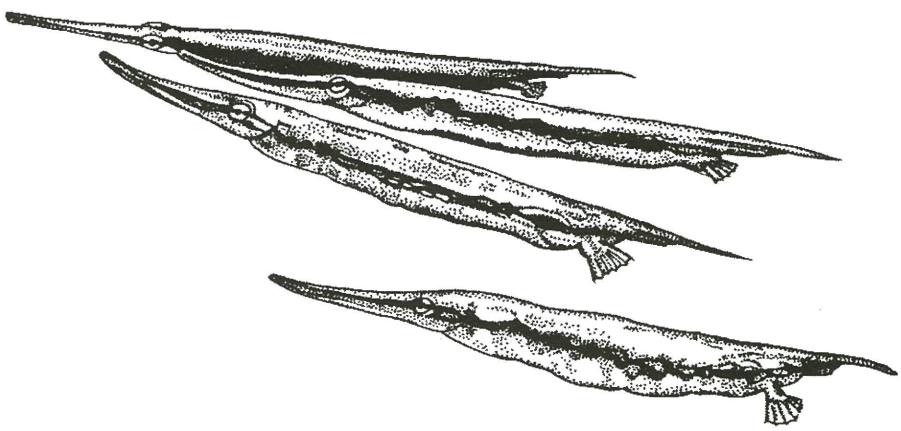
When it's time to go diving make sure people enjoy themselves. Encourage them to slow down and watch. There is a bustling city down there, full of life and energy and action. It will unfold if we have patience. If visitors want souvenirs, remind them to take photos, not shells or corals. Even empty shells are destined to be home to one of their relatives some day. Provide an atmosphere where people feel comfortable asking plenty of questions. Because the best souvenir of all is knowledge. Learn from the resource material and management staff.

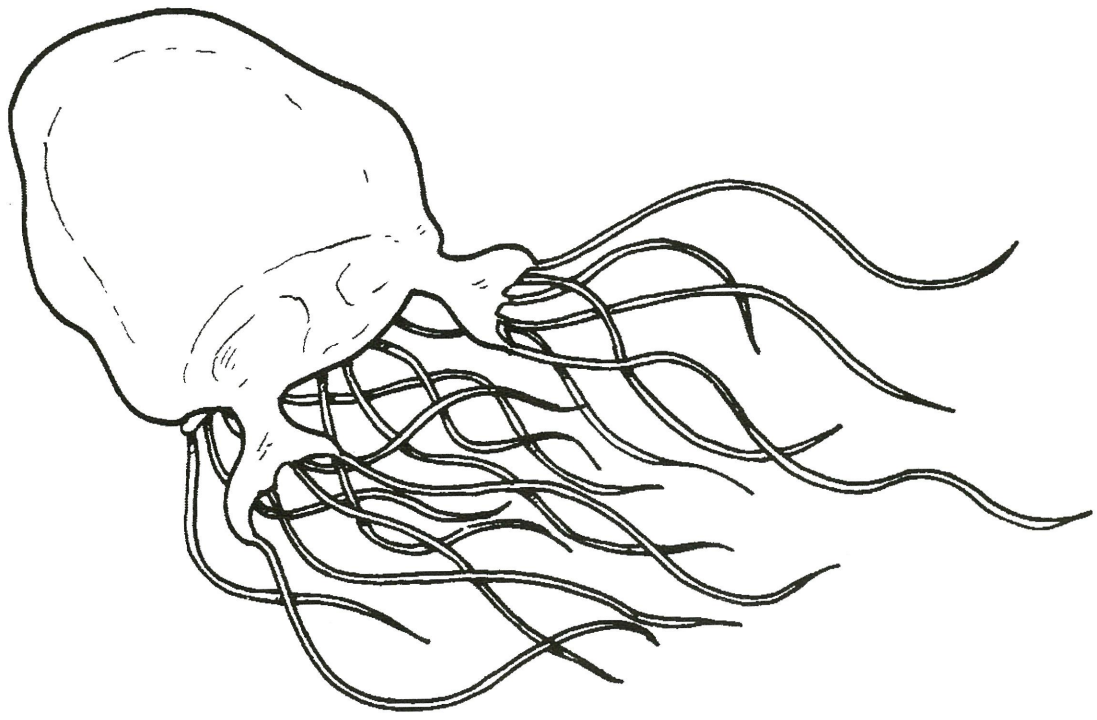
These resources are invaluable and reflect the accumulated knowledge of scientific investigation spanning more than 100 years.

I have become involved with the Great Barrier Reef Marine Park Authority in the hope that we can work together to better understand and protect the sea. We must do everything possible to spread the knowledge embodied in this program. As you interface with visitors on a daily basis, you are truly an "Ambassador of the environment". It is you who can make the most profound difference in the people who come to the Great Barrier Reef. By helping visitors understand the reef, our connections to all life and the importance in behaving responsibly in all aspects of life, you can have a profound impact on our future.

I applaud your commitment to the Great Barrier Reef and becoming Ambassadors of the Environment.

Jean-Michel Cousteau

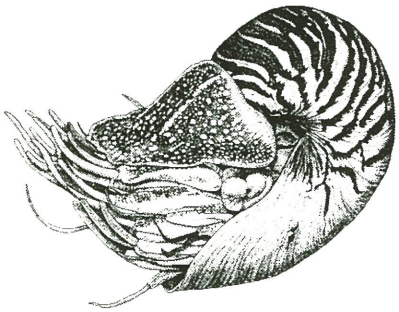


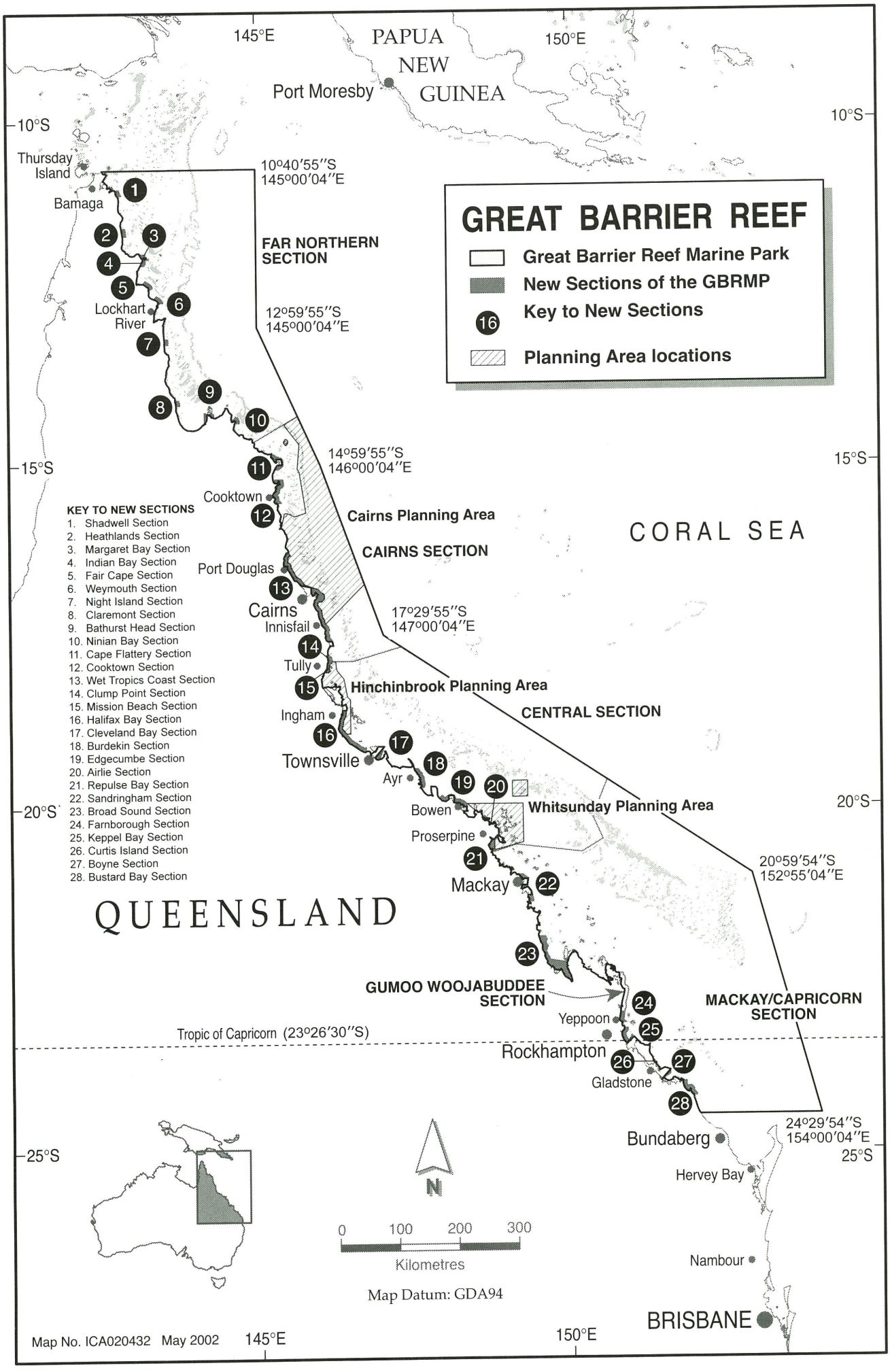


Contents

Part 1

reef**essentials**




GREAT BARRIER REEF
Great Barrier Reef Marine Park
New Sections of the GBRMP
Key to New Sections
16
Planning Area locations
KEY TO NEW SECTIONS
1. Shadwell Section
2. Heathlands Section
3. Margaret Bay Section
4. Indian Bay Section
5. Fair Cape Section
6. Weymouth Section
7. Night Island Section
8. Claremont Section
9. Bathurst Head Section
10. Ninian Bay Section
11. Cape Flattery Section
12. Cooktown Section
13. Wet Tropics Coast Section
14. Clump Point Section
15. Mission Beach Section
16. Halifax Bay Section
17. Cleveland Bay Section
18. Burdekin Section
19. Edgecumbe Section
20. Airlie Section
21. Repulse Bay Section
22. Sandringham Section
23. Broad Sound Section
24. Farnborough Section
25. Keppel Bay Section
26. Curtis Island Section
27. Boyne Section
28. Bustard Bay Section
PAPUA NEW GUINEA
Port Moresby
CORAL SEA
QUEENSLAND
145°E
150°E
10°S
15°S
20°S
25°S
Thursday Island
Bamaga
Lockhart River
Cooktown
Port Douglas
Cairns
Innisfail
Tully
Ingham
Townsville
Ayr
Bowen
Proserpine
Mackay
Yeppoon
Rockhampton
Gladstone
Bundaberg
Hervey Bay
Nambour
BRISBANE
10°40′55″S 145°00′04″E
12°59′55″S 145°00′04″E
14°59′55″S 146°00′04″E
17°29′55″S 147°00′04″E
20°59′54″S 152°55′04″E
24°29′54″S 154°00′04″E
FAR NORTHERN SECTION
CAIRNS SECTION
CENTRAL SECTION
MACKAY/CAPRICORN SECTION
GUMOO WOOJABUDDEE SECTION
Cairns Planning Area
Hinchinbrook Planning Area
Whitsunday Planning Area
Tropic of Capricorn (23°26′30″S)
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Kilometres
Map Datum: GDA94
Map No. ICA020432 May 2002

The Great Barrier Reef World Heritage Area

What is it, where is it and why is it important?

The Great Barrier Reef World Heritage Area consists of the world's largest system of coral reefs together with lagoon, seagrass, mangrove and estuarine communities. Stretching over 2000 kilometres along Australia's north-east coastline, the Great Barrier Reef World Heritage Area covers more than 38 million hectares (Figure 1). It represents one of the most complex and biologically diverse systems on earth and contains critical habitats for a number of rare, endangered and threatened species.

The Great Barrier Reef has evolved over millions of years. Aboriginal people were the first reef users and have had a close association with the Great Barrier Reef and surrounding area for over fifty thousand years. They developed a close cultural relationship with the marine environment and continue to live adjacent to, use and maintain strong cultural links with the area.

Since European settlement, use of the area has grown and intensified to include tourism, commercial fishing, scientific research, shipping and recreational pursuits such as boating, fishing and diving. During this period, there has also been significant urban and rural development of the mainland adjacent to the Great Barrier Reef World Heritage Area.

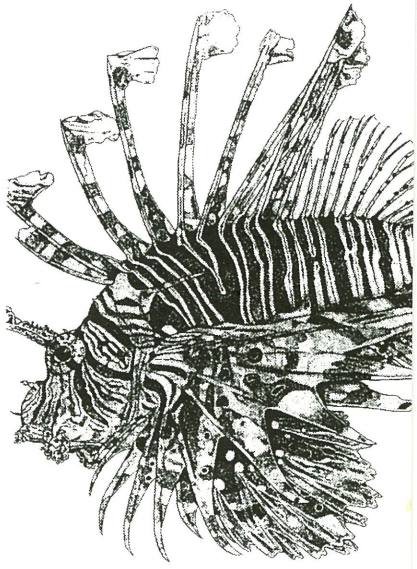
When did the Great Barrier Reef become a Marine Park and World Heritage Listed Area?

In response to growing public concern over the possible environmental impacts of mining on the Great Barrier Reef, the *Great Barrier Reef Marine Park Act (1975)* was passed by the Commonwealth Government in to provide a framework for the protection of the Great Barrier Reef. As areas of the Reef were proclaimed to be part of the Marine Park, management mechanisms were introduced to control use and the types of activity conducted in those areas.

In 1981, the Great Barrier Reef (including adjacent coastal areas and islands) were inscribed on the World Heritage List, on the basis of its outstanding universal value. Under the World Heritage Convention, Australia has international obligations to protect, conserve, present and transmit the Great Barrier Reef World Heritage Area to future generations.

Although activities in the World Heritage Area are managed by many agencies, prime responsibilities fall on the Great Barrier Reef Marine Park Authority. In undertaking these responsibilities, the Authority works closely with other agencies and stakeholders including Queensland state management agencies, indigenous peoples, user and interest groups together with the wider community. This coordinated approach to managing the Great Barrier Reef World Heritage Area is perhaps best reflected in the development of the 25–Year Strategic Plan for the Area.

Coordinated by the Great Barrier Reef Marine Park Authority, the Strategic Plan was developed by over 60 user and interest groups, indigenous peoples and government agencies. The Plan sets out a 25-year vision for the Area and details long- and short-term objectives to achieve that vision. The vision, which focuses on a healthy environment, multiple use and the maintenance of values, together with strategies outlined in the Plan, provides direction for the Authority in managing the Great Barrier Reef World Heritage Area.



Who is responsible for managing the Great Barrier Reef World Heritage Area?

The Great Barrier Reef Marine Park Authority (GBRMPA) in Townsville isresponsible for managing the Great Barrier Reef Marine Park, together with

the Queensland Parks and Wildlife Service. The Queensland Parks and Wildlife Service has offices in most regional centres along the Queensland coast. A contact list is provided in the back of this manual.

In meeting its responsibilities, the Great Barrier Reef Marine Park Authority's prime functions are planning, policy development, environmental impact management, coordination of research and education.

The Queensland Parks and Wildlife Service is primarily responsible for day-to-day management activities such as public contact, enforcement, monitoring, surveillance and education.

In undertaking these responsibilities the Great Barrier Reef Marine Park Authority and the Queensland Parks and Wildlife Service work closely with many agencies and stakeholder groups. These include the Queensland Department of Primary Industries, the Queensland Fisheries Service, the Queensland Boating and Fisheries Patrol, the Water Police, the Australian Customs Service and the Australian Maritime Safety Authority.

Local Marine Advisory Committees (LMACs) comprise representatives from a broad range of stakeholder groups including indigenous peoples, use and interest groups and the wider community. These committees advise management agencies on issues affecting local communities and provide a vital communication link between management agencies and the community. These committees have been established in 9 regional centres adjacent to the Great Barrier Reef World Heritage Area. A contact list for the LMACs is provided in the back of this manual.

How is the Great Barrier Reef World Heritage Area managed?

Zoning Plans

The main tool used in managing the Great Barrier Reef World Heritage Area is zoning. Zoning provides protection for areas which are critical for maintaining a healthy environment and sets a broad framework for the management of human use by designating where specific types of activities may take place. Each section of the Marine Park within the World Heritage Area has a Zoning Plan which acts as the basis for management. Different zones are represented by different colours on the Plans. Each Marine Park zone has specific management objectives which determines which human activities may or may not take place in that zone. 'Pink' Preservation Zones exclude all activities. Conversely, 'light blue' General Use Zones allow most commercial and recreational activities. 'Green' zones are 'look but don't take' areas – fishing, for example is not allowed in green zones (other than traditional hunting, gathering and fishing). Over 95% of the Marine Park is zoned for general use.

Zoning Plans are developed and reviewed in consultation with the scientific community, user and interest groups, indigenous peoples and the wider community.

Zoning Plans apply to all reef users – recreational and commercial. Commercial tourism operators are also required to hold permits to conduct activities in the Great Barrier Reef Marine Park and State Marine Parks. Failure to comply with the provisions set out in the Zoning Plans when undertaking any activities in the Marine Park is an offence.

Management Plans

To manage high use sites more effectively, the Great Barrier Reef Marine Park Authority has developed a number of Plans of Management (POMs). POMs complement Zoning Plans but are more detailed, providing extra tools for managing activities associated with tourism and recreation and for specific species conservation issues (e.g. Shoalwater Bay Dugong POM).

Plans of Management have been developed in consultation with reef users for the high use Cairns and Whitsundays Areas. These plans were released in June 1998 (and amended in 1999 and 2002) and contain new strategies for protecting the special values of the Cairns and Whitsundays Areas, most of which apply to all users. These include:

- recreational settings which allow for a range of recreational use. In some

settings there are limits on vessel length and/or passenger load;

- site plans for sensitive sites. Limits on access to specific sites may be applied through site plans;
- reef protection measures, such as limits on anchoring on coral, 'no anchoring areas', public moorings, restrictions on anchoring close to moorings and pontoons;
- other wildlife protection measures, such as access restrictions at seabird nesting sites, and designation of a whale protection area.

The Cairns and Whitsundays Plans also limit tourism growth in these areas through limits on the issue of additional permits for tourism operations in both areas.

Permits

The management of commercial operations within the Marine Park is 'fine-tuned' through permits. It is a legal requirement to obtain a permit to conduct commercial and some non-commercial activities (such as research) in the Marine Park and on island National Parks. Permit application forms and information packs can be obtained from the Great Barrier Reef Marine Park Authority or your local Queensland Parks and Wildlife Service office.

Permits may specify sites (reefs/islands) commercial operators can visit, the vessel they may use to conduct the operation, how often the vessel may visit a site, the number of passengers operators may take to any one site, and what activities an operator can conduct at that site. They also set the conditions under which that access can occur.

It is a legal requirement for permittees to abide by permit conditions. This includes ensuring that a copy of the permit is carried on board permitted commercial tourism vessels. If you are involved in a commercial operation it is important that you are aware of permit conditions at all times.

All permittees must pay an Environmental Management Charge (EMC). Some of the EMC revenue is used to fund research and education projects (such as the production of this manual) aimed at protecting the Great Barrier Reef while allowing for ecologically sustainable use.

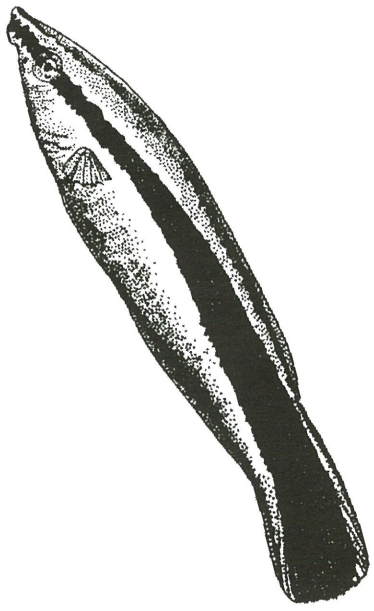
Education – Best Environmental Practices

Education is an integral part of managing the Great Barrier Reef World Heritage Area. To increase awareness of how to minimise the impact of activities on the environment, the Great Barrier Reef Marine Park Authority has jointly developed with reef users a guide to Best Environmental Practices for reef use. Practices address a number of activities including waste disposal, anchoring and diving.

Best Environmental Practices do not duplicate, but rather complement, existing legislation. Their purpose is to increase awareness of how to conduct activities in the most environmentally responsible manner. The development of one set of Best Environmental Practices ensures consistency in standards across all Marine Park users – commercial and recreational reef users alike.

Integrated Management

The Great Barrier Reef lies adjacent to the mainland and many of the activities carried out onshore can impact directly on the World Heritage Area. To minimise impacts on the World Heritage Area, the Great Barrier Reef Marine Park Authority works closely with adjoining management agencies to ensure the integrated development and implementation of management strategies to protect World Heritage values.



Ours to protect

The Great Barrier Reef World Heritage Area is recognised internationally for its outstanding natural and cultural values. Protection of this Area is everyone's responsibility. Please help Marine Park managers in keeping the Great Barrier Reef World Heritage Area a great place.

For more information on the Great Barrier Reef World Heritage Area, including the Great Barrier Reef Marine Park, please contact your local Queensland Parks and Wildlife Service office, or the Great Barrier Reef Marine Park Authority in Townsville. Contact lists are provided at the back of this manual.

While in the Great Barrier Reef
World Heritage Area

The following sections provide important information for everyone who conducts activities in the Great Barrier Reef World Heritage Area. A number of common activities have been listed. For each activity, the legal requirements (if any) and the Best Environmental Practices for that activity, have been listed.

Important information

Legal Requirements

Legal requirements relating to each activity is presented in boxes. These legal requirements are not necessarily exhaustive and may change. Users should make their own enquiries as to the law at any particular time, obtaining their own legal advice if necessary. For further information on legal requirements you should consult the *Great Barrier Reef Marine Park Act 1975*, Regulations, Zoning Plans, Plans of Management and any relevant permit. You also need to comply with Queensland legal requirements. If in doubt call a Queensland Parks and Wildlife Service office for information before heading out into the World Heritage Area.

Best Environmental Practices

Information contained in the Best Environmental Practices has been developed jointly by Marine Parks officers and reef users. We thank all those who took the time to read and comment on the draft practices. The purpose of the Best Environmental Practices is to increase awareness of how everyone can minimise the impact of their activities in the Great Barrier Reef World Heritage Area.

Best Environmental Practices outlined in the following sections, focus on activities conducted in the World Heritage Area such as anchoring and diving. There are, however, many activities outside the World Heritage Area, particularly onshore, which have the potential to impact on the Great Barrier Reef.

The Best Environmental Practices are not a substitute for compliance with legal requirements. We encourage all who operate in the World Heritage Area to adopt these practices as an integral part of their day-to-day activities.

The Great Barrier Reef World Heritage Area is so vast that legal enforcement can only go so far in ensuring that people 'do the right thing'. At the end of the day managers rely on education to increase people's awareness of what the 'right thing' is and how to operate in the World Heritage Area with minimal impact.

The Great Barrier Reef Marine Park Authority would appreciate input from anyone who, from first hand experience, has information on what works best in terms of conducting activities with least impact in the World Heritage Area. Hopefully, over time, Best Environmental Practices will continue to get 'better'. Protection of this magnificent resource is everyone's responsibility.

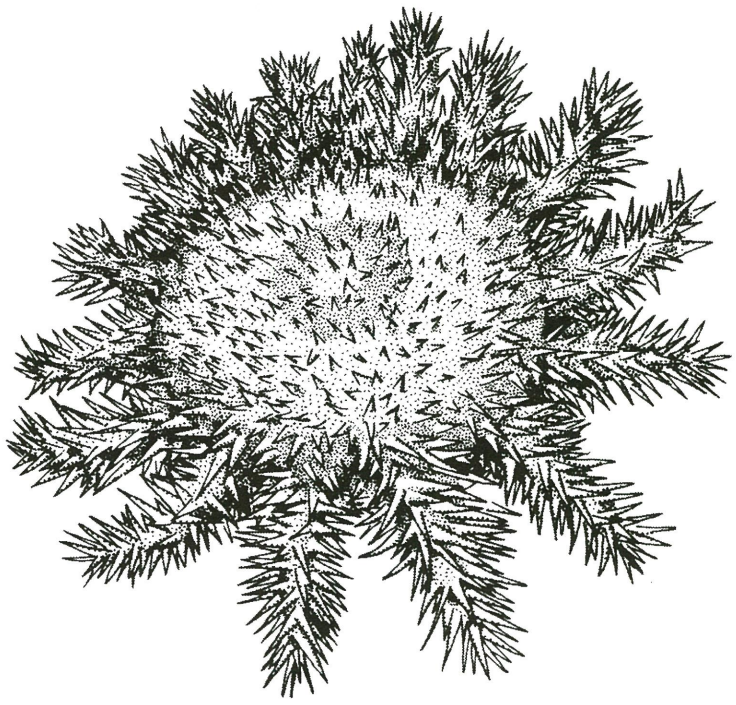
Help us to keep the Great in the Great Barrier Reef World Heritage Area.

Reporting Procedures

You can help manage the Great Barrier Reef World Heritage Area by reporting any of the following activities or incidents:

- any suspected breaches in law (including illegal fishing and collecting) to your nearest Queensland Parks and Wildlife Service office,
- oil spills or any form of marine pollution,
- marine mammal sightings or strandings,
- crown-of-thorns starfish sightings,
- natural history observations such as fish spawning, coral bleaching or algal blooms.
- sick injured or dead marine mammals and turtles via the Marine Animal Hotline (1300 360 898).

WARNING: The legal requirements described herein are not necessarily exhaustive and may change. Users should make their own enquiries as to the law at any particular time. The fact that Best Environmental Practices have been provided for the following activities in the Great Barrier Reef World Heritage Area does not mean that they are safe.



Best Environmental Practices

For all Activities

Best Environmental Practices for all activities:

- Respect other people using the Great Barrier Reef World Heritage Area.
- Be aware of the effect of your activity on the environment and the other people a nd avoid conflicting activities in the same area.
- Take the time to learn about the Great Barrier Reef World Heritage Area and how to minimise the impact of your activities.

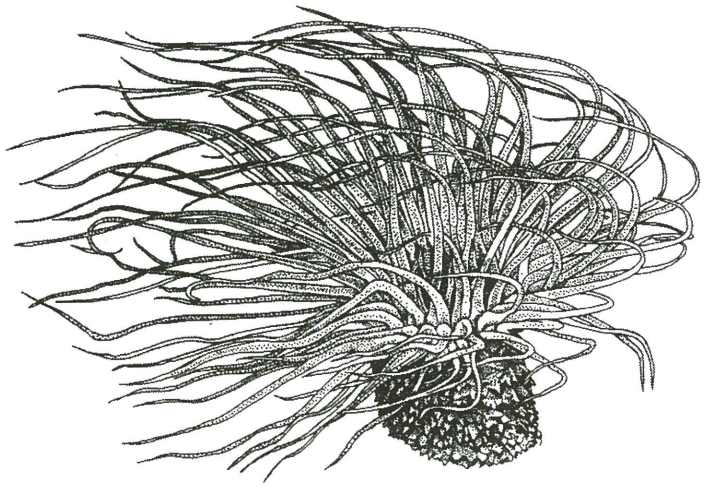
Research Activities

Understanding how the natural ecosystem works and the effect of human interactions with the environment is fundamental to the successful management of the World Heritage Area. Research activities do, however, have the potential to significantly impact on the environment. Please help to ensure the effects of research activities are minimised.

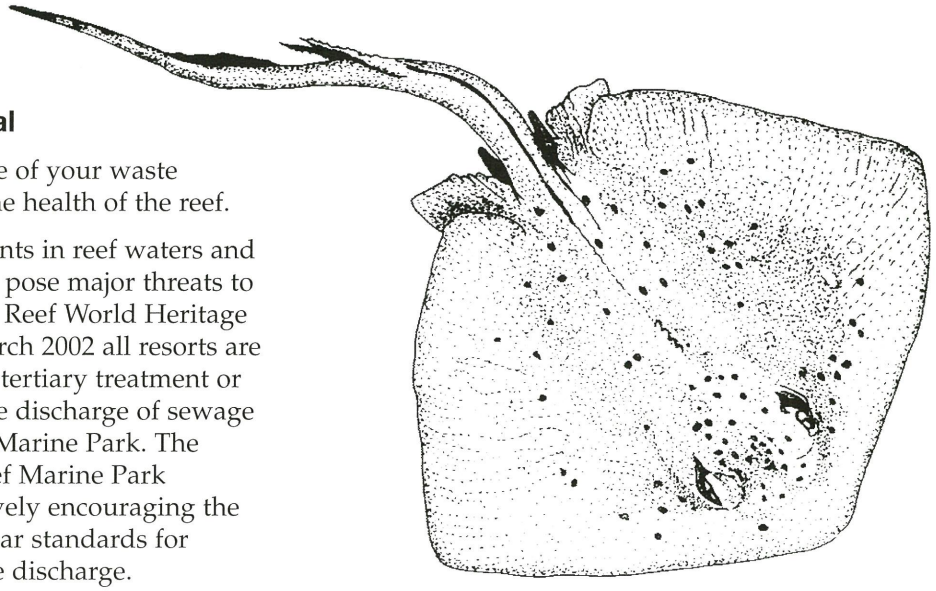
It is a legal requirement to obtain the necessary permission from the Great Barrier Reef Marine Park Authority and/or the Queensland Parks and Wildlife Services to conduct a research program in the Marine Park.

Best Environmental Practices for research activities:

- Ensure your research program is having minimal impact on the physical environment and the visual aesthetics of frequently visited sites.
- Consider what effect your research will have on the animals being researched and avoid harming animals at all times. If specimens need to be collected for research purposes, such as dissection, ensure the animals are killed as quickly and humanely as possible.
- Ensure your activities are not interfering with those of other reef users and assess potential dangers to other users e.g. protruding stakes.
- Explain the purpose of the research program to interested reef users and where appropriate provide the opportunity for community involvement.
- Provide updates on the progress of the study and feed back research results to those who have provided assistance in setting up and conducting the research program.
- Avoid using hardware wherever possible. Make use of natural markers, when available, in preference to installing site markers such as stakes.
- Remove any hardware from the study site following the completion of the research program.
- Take care when removing hardware, particularly at areas where corals have grown around or over hardware.



While on the Water



Waste Disposal

How you dispose of your waste directly affects the health of the reef.

Increasing nutrients in reef waters and marine pollution pose major threats to the Great Barrier Reef World Heritage Area. From 1 march 2002 all resorts are required to have tertiary treatment or equivalent for the discharge of sewage directly into the Marine Park. The Great Barrier Reef Marine Park Authority is actively encouraging the adoption of similar standards for mainland sewage discharge.

Further information on sewage discharge is available from the Queensland Transport, Waterways Management and Infrastructure Development Branch, Environment Unit.

Ensure your activities are having minimal effect by disposing of all forms of wastes correctly.

It is an offence to either litter or release waste in the Marine Park, "Waste" includes oil, oil mixtures, noxious liquid substances, packaged harmful substances, sewage and garbage.

Best Environmental Practices for waste disposal:

- Use pump ashore facilities, where provided, for sewage disposal from holding tanks.
- Where there are no pump ashore facilities, discharge sewage in open water away from reefs.
- If there is no holding tank, make sure visitors do not use toilets or urinate in the water when near reefs or in enclosed bays.
- Use biodegradable toilet paper and phosphate-free cleaning products.
- Petroleum products in the bilge should be broken down with biodegradable detergents and disposed of at recycling depots on shore.
- All litter should be brought back to the mainland and disposed of at a suitable waste disposal site.

Anchoring and Mooring

Anchors and chains wreck fragile coral environments. Frequent anchoring at popular sites can destroy the very attraction people have come to see. Familiarise yourself with the area you will be anchoring in before you leave shore and ensure you have the appropriate anchoring gear on board. Remember that the depth drops off steeply around many reefs to an average depth of 30 metres throughout the Great Barrier Reef lagoon. Remember coral is a living organism and each anchor makes a difference. Anchor with care.

- It is an offence to anchor in a 'no anchoring area'.
- Damaging or interfering with coral in the Marine Park is an offence unless expressely authorised under a Zoning Plan or plan of management.

Best Environmental Practices for anchoring and use of public moorings:

- Carry enough chain or chain and line for the depth.
- Check out the area before anchoring.
- Anchor in sand or mud away from corals.
- Motor towards the anchor when hauling in.
- Use approved public moorings in preference to anchoring. Public moorings are marked by white or blue buoys, identified by Marine Parks stickers which state limits of use.
- Before using public moorings, read and follow the advice given on an information disc attached to the mooring pick-up line.

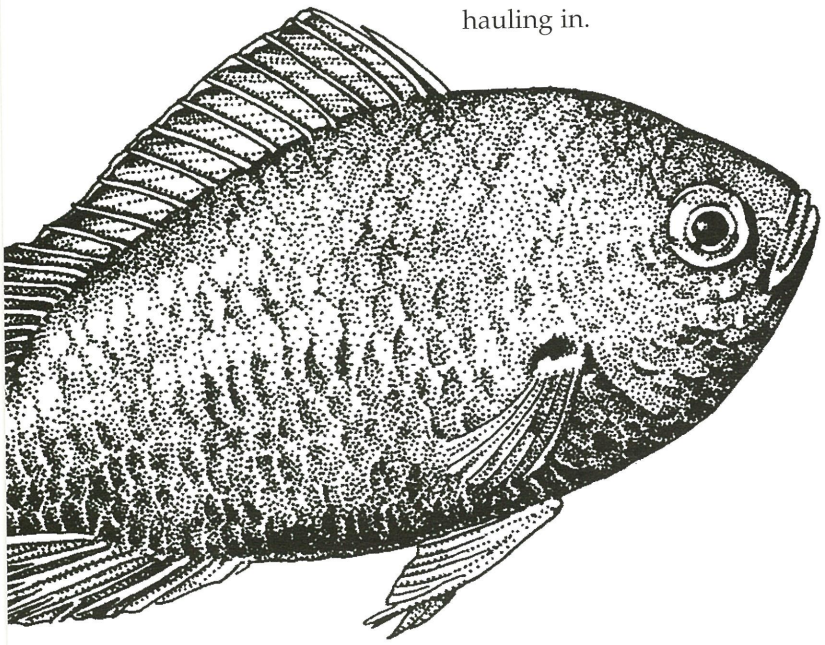
Fish Feeding

Fish feeding is often the highlight for many visitors to the World Heritage Area. Tour operators require special permission from the Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Service to carry out fish feeding and must follow the conditions on the permit.

It is important to be aware that fish feeding may result in undesirably aggressive behaviour in some fish and can be dangerous to the person feeding the fish or others close by in the water. Most food fit for human consumption, particularly bread and meat, is not suitable for fish and may damage their health. Remember you may not be the only person to feed fish at a site each day. Please help to ensure the effects of fish feeding are minimised by following the Best Environmental Practices outlined below.

Best Environmental Practices for fish feeding:

- Fish feeding in a tourism operation should be well supervised and conducted only by staff.
- Do not feed fish where fishing takes place.
- Fish should not be fed directly by hand, but by throwing food into the water.
- People should not be in the water during fish feeding.
- Feed fish with only raw marine products or fish pellets.
- Use no more than one kilogram of food per day per site.



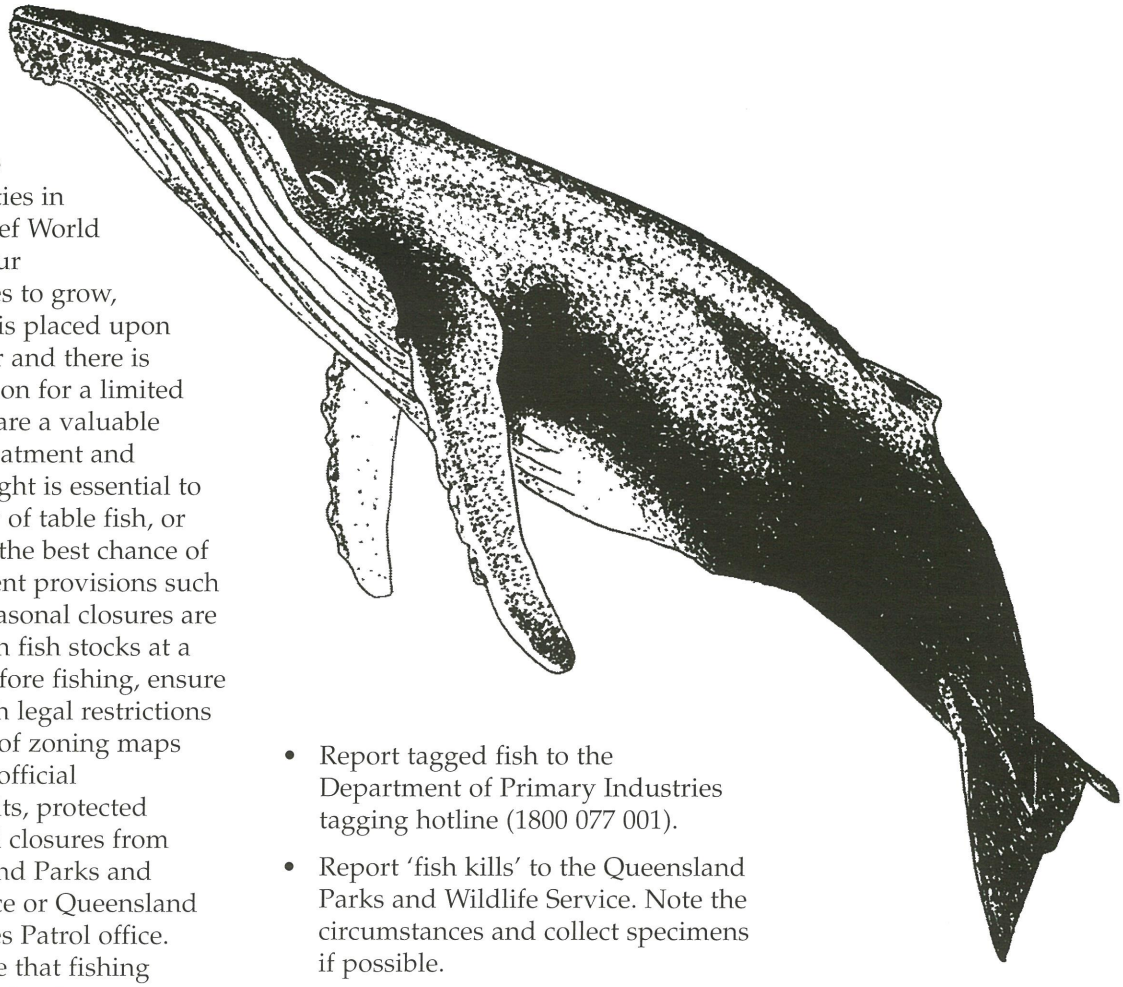
Fishing

Fishing is one of the most popular activities in the Great Barrier Reef World Heritage Area. As our population continues to grow, increasing pressure is placed upon fish stocks each year and there is increasing competition for a limited supply of fish. Fish are a valuable resource. Careful treatment and handling of fish caught is essential to maintain the quality of table fish, or give fish for release the best chance of survival. Management provisions such as size limits and seasonal closures are designed to maintain fish stocks at a sustainable level. Before fishing, ensure you are familiar with legal restrictions by obtaining copies of zoning maps and information on official bag/size/tackle limits, protected species and seasonal closures from your local Queensland Parks and Wildlife Service office or Queensland Boating and Fisheries Patrol office. Please help to ensure that fishing opportunities enjoyed today are maintained for future generations.

It is a serious offence to use or enter a zone of the Marine Park for the purpose of fishing where that fishing is permitted under the Zoning Plan. Ensure you comply with all zoning requirements (e.g. no fishing in green zones, restrictions in yellow zones), bag limits, size limits, tackle restrictions, seasonal closures, and other requirements under Queensland Fisheries legislation.

Best Environmental Practices for fishing:

- Take only what you need and stick to official bag and size limits.
- If you intend keeping a fish, remove it from the hook or net quickly and humanely.
- Return all undersized or unwanted fish to the water carefully and quickly.
- Do not fish where fish feeding takes place.
- Do not fish in areas where fish are gathering to spawn.
- Report tagged fish to the Department of Primary Industries tagging hotline (1800 077 001).
- Report 'fish kills' to the Queensland Parks and Wildlife Service. Note the circumstances and collect specimens if possible.

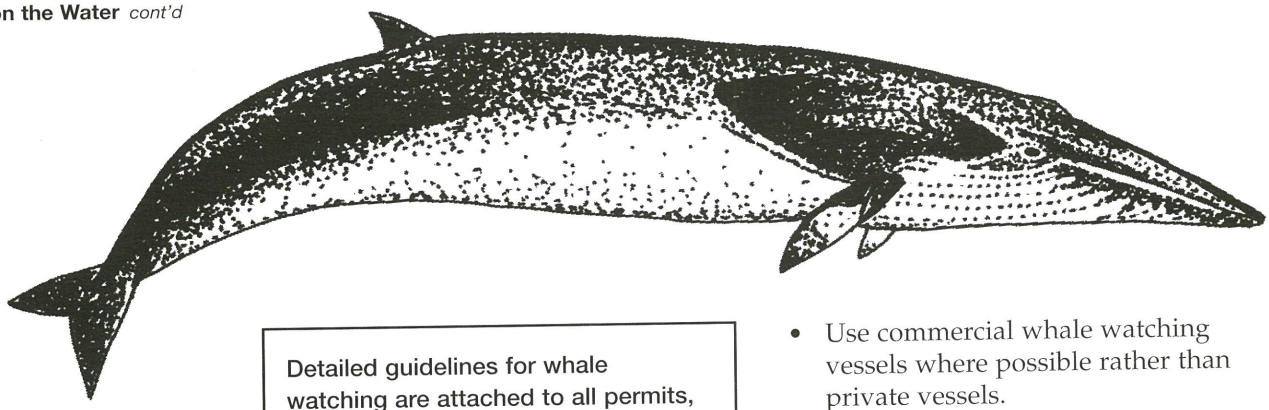


Whale and Dolphin Watching

The Great Barrier Reef Marine Park is an important breeding and feeding ground for whales and dolphins. There are special regulations for whale watching and it is a requirement that all commercial users obtain permission from management agencies before they conduct whale watching activities. Whale watching can be an exciting and educational experience. You can help ensure that human activities have minimal impact.

Whales and dolphins are protected under the Queensland *Nature Conservation Act 1992*, the *GBRMP Act 1975* and the *EPBC Act 1999*. Before whale watching contact the GBRMPA or Queensland Environmental Protection Agency for details of the latest information on whale watching regulations and policies.

The *EPBC Act 1999* prohibits killing, taking, injuring or interfering with cetaceans. Interference includes harassment, chasing and herding of whales.



Detailed guidelines for whale watching are attached to all permits, however the main points are:

- boats must be no closer than 100 metres to a whale;
- within the Whitsundays Whale Protection Area, boats and seaplanes must be no closer than 300 metres to a whale;
- where there are two or more boats within 300 metres of a whale, additional boats must remain at least 300 metres from the whale;
- a person must not approach closer than 30 metres to a cetacean;
- when a boat is closer than 300 metres to a whale the vessel must be operated at a constant slow speed with negligible wake
- avoid any operations which disturb the animal or cause it to change its behaviour.

Some whales or dolphins are known as 'specific interest cetacea'. They have unusual characteristics that make them likely to attract additional attention. Because of this intense interest special regulations are sometimes needed to prevent harassment, injury or death. Harassment and stress may lead to behaviour changes such as mothers abandoning their calves before they can survive on their own.

Best Environmental Practices for whale and dolphin watching:

- Avoid all contact with whales with calves.
- If there is a sudden change in whale behaviour, move away.
- Report sick, injured or stranded whales or dolphins to the Marine Animal Hotline (1300 360 898).
- Use commercial whale watching vessels where possible rather than private vessels.

Boating

By being alert and careful while boating in the World Heritage Area, you can minimise accidents to wildlife and people, and reduce the risks of damaging shorelines. Collisions with large marine creatures such as marine mammals and reptiles can kill the animal as well as severely damage a prop or hull.

Best Environmental Practices for boating:

- To avoid collisions with large marine creatures, stay alert for the following species at these times of the year:
  - Dugongs all year round in shallow inshore areas along the entire Queensland coast;
  - Humpback whales, principally from June to November, along the Queensland coast, and particularly from July to September around the Whitsunday Islands to avoid disturbance of mother/calf pairs;
  - Turtles all year round along the Queensland coast, and particularly during the summer breeding season.
- Use care when approaching shorelines, beaches and reef edges. Proceed slowly, and carefully choose where to come ashore or leave your vessel.
- Take care when transferring fuel. Refuel on land to minimise the risk of fuel and oil spillages.

Dugong protection

The Great Barrier Reef Marine Park is critically important for the survival of dugong. The 14,000 individuals that live within the Park comprise the largest regional population in the world. Some areas of the Park are zoned to protect dugongs.

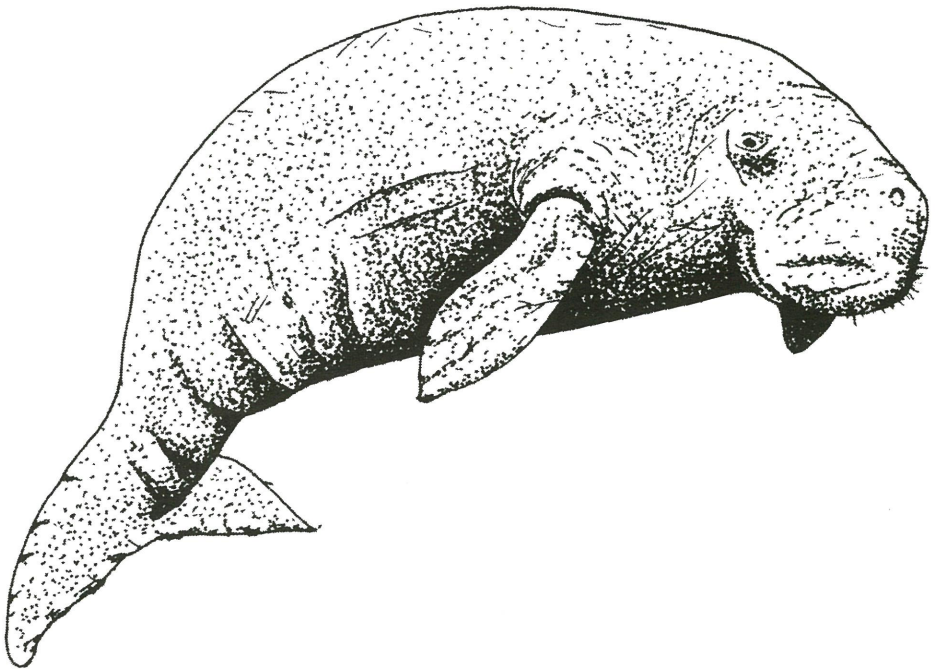
Sixteen dugong protection areas were established in 1997 within the Park and in vicinity of Hervey Bay-Great Sandy Spit. Transit lanes and voluntary speed limits apply in the Hinchinbrook area.

Dugongs live in shallow, coastal habitats, spend little time near the surface and are not easy to see. Speeding boats can kill or injure dugong, chase them from feeding areas, and disturb Mothers with calves.

Best Environmental Practices for the protection of dugong are strongly encouraged:

- Restrict boat speeds to 10 knots or less than planing speed in shallow seagrass areas and to 25 knots elsewhere;
- Do not approach within 50 m of a dugong at 10 knots or less;
- If you find yourself within 50 m of a dugong:
  - Immediately reduce speed,
  - Disengage the propeller if possible, and
  - Move away slowly at less than planing speed;
- Above planing speed, do not approach within 100 m of dugong;
- Do not swim or dive with a dugong;
- Move quietly in the presence of dugong. They are easily alarmed by loud noise and sudden movements;
- Never separate a female dugong from her calf;
- Dugongs always have right of way. Do not herd, chase or block the path of dugong, and do not approach them if they show signs of stress or alarm;
- Observe regulations on the use of fishing nets;
- Traditional hunting of dugong requires a permit;

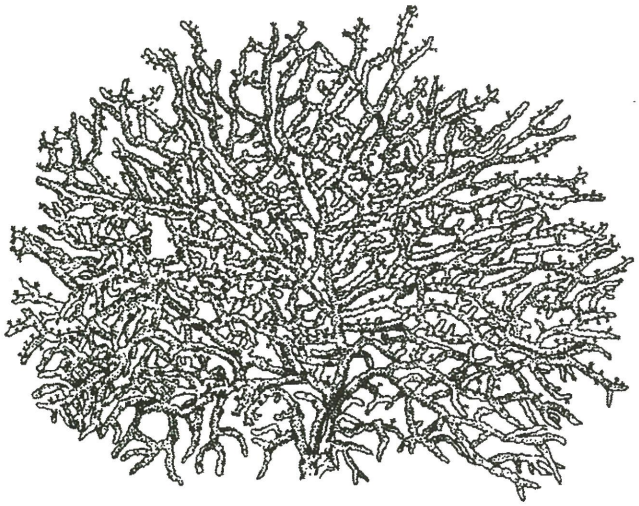
Report injured or dead dugong to the Marine Animal Hotline 1300 360 898, as soon as possible.



While in the Water

Diving and Snorkelling

Scuba diving and snorkelling are the most popular ways to experience the unique and beautiful underwater world of the Great Barrier Reef. Damage to coral by divers is most commonly in the form of fin damage, suggesting buoyancy control is a critical factor in minimising the impacts of divers on corals. Help to keep the impacts of diving to a minimum and ensure the underwater environment that people have come to look at retains its wonderful natural beauty.



Best Environmental Practices for diving and snorkelling:

- Check you are weighted correctly before diving and practise buoyancy control well away from coral (preferrably in sand areas).
- If you are a beginner, practice snorkelling techniques well away from coral, and dive over sand until you have mastered buoyancy control.
- Secure diving equipment such as gauges - do not let it drag.
- Do not rest or stand on coral. Take extra care when taking underwater photographs.
- Avoid touching anything with your hands or fins and try not to disturb sediment or coral.
- If you need to rest while snorkelling, try to use the rest stations where provided.
- Observe animals rather than handle them. Handling some animals may be dangerous.
- Do not chase or attempt to ride or grab free-swimming animals and avoid blocking their path.
- Do not prod any plants or animals.
- If you pick up anything under water, living or dead, always return it to exactly the same position.
- Learn about the underwater environment.

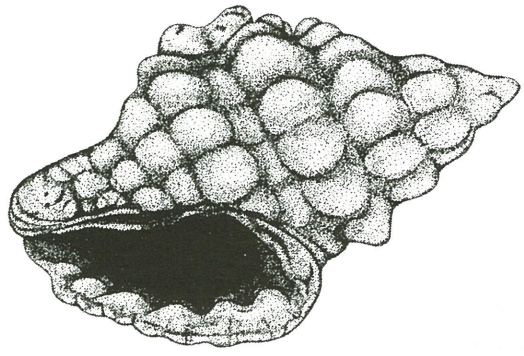
While Ashore

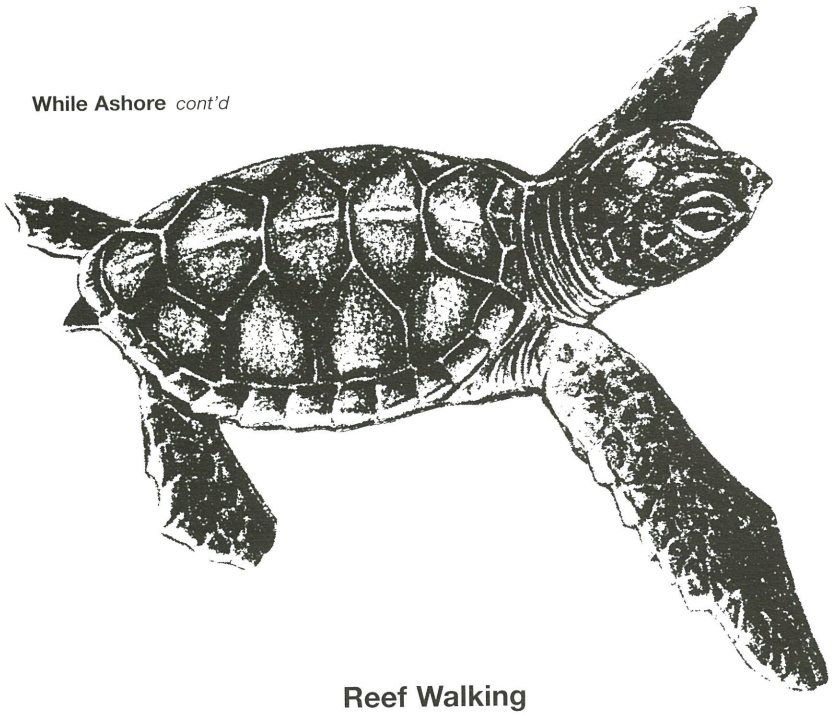
Visiting Islands

Islands within the Great Barrier Reef World Heritage Area are a popular destination for tourists and locals alike. Please help to ensure that the natural setting that people come to enjoy is not degraded by human activities.

Best Environmental Practices for visiting islands:

- Before visiting islands, check for special requirements and obtain national park camping permits from the Queensland Parks and Wildlife Service.
- Remove seeds of introduced plants from your clothing or shoes before landing on the islands.
- Camp only in designated camp sites.
- Check Marine Park zoning requirements before fishing or collecting.
- Take all litter or rubbish back to the mainland.
- Take care when washing and cleaning:
  - do not use detergents, toothpaste or soap in creeks, streams or closed waterways;
  - wash at least 50 metres away from water courses and use only biodegradable products;
  - use sand as a scourer to remove waste when cleaning dishes.
- Use gas or liquid spirit stoves for cooking. Campfires are not permitted on most islands.
- Always use toilets where provided. Where there are no toilets, use a spot at least 100 metres from campsites and water courses and bury all faecal waste in a hole at least 15 centimetres deep.
- Do not disturb vegetation or break off branches from trees and shrubs.
- Do not disturb nesting seabirds or turtles. Avoid making loud noises, using strong lights or making sudden movements near their nests.
- Do not take animals or plants to islands nor feed the native animals.
- Do not write or place graffiti anywhere.
- Do not use generators or compressors unless you have permission from the Queensland Parks and Wildlife Service. Do not play amplified music on island National Parks.
- Learn about the natural and cultural values of the island you are visiting.





Reef Walking

Reef walking has the potential to damage corals and other species which inhabit the reef flats.

- Damaging or interfering with coral in the Marine Park is an offence unless expressly authorised under a Zoning Plan or plan of management.
- Tourist operators can only include reef walking if expressly authorised under a permit from the GBRMPA.

Best Environmental Practices for reef walking:

- Be careful not to step on coral or living matter.
- Follow marked trails and avoid straying.
- If there is no marked trail, locate regularly used routes or follow sand channels.
- Use a pole or a stick for balance. Do not poke animals.
- It is best if you do not pick up animals.
- If you pick up anything, living or dead, always return it to the exact position where you found it.
- Do not pick up species which are attached to the reef flat.
- Be aware of restrictions on collecting in the Marine Park.

Additional Practices for guided reef walks:

- Ensure walkers stay in groups. Keep groups to under 15 people wherever possible.
- Follow marked trails and stay in single file formation.
- Learn about the reef environment and what to look for before reef walking.

All sea turtles are protected in Queensland and it is illegal to take any turtles or their eggs. Indigenous peoples can obtain permits to hunt green turtles in the Marine Park. Seasonal closures to some islands exist to protect nesting and turtle hatchlings.

Turtle Watching

The Great Barrier Reef is home to six of the world's seven species of sea turtle. It is a critical breeding ground for four of the species. Turtles come ashore at night to lay eggs and are easily disturbed by light, noise and movement. With care it is possible to watch the fascinating events of females laying eggs and hatchlings emerging from the sand without disturbing the turtles.

Best Environmental Practices for turtle watching:

- Keep lighting to a minimum.
- Lights should be no more than a three-volt, two-cell, hand-held torch.
- Do not approach closely or shine lights on turtles leaving the water or moving up the beach.
- Avoid shining lights directly on the turtle during egg laying.
- Avoid loud noise and sudden movements.
- Keep dogs away. Dogs are not permitted in National Parks or on most beach areas.
- Do not light campfires on turtle nesting beaches.
- Report the place and date of turtle sightings to the Queensland Parks and Wildlife Services.
- Learn about the habits and needs of turtles.

Observing Seabirds

The Great Barrier Reef is home to thousands of seabirds, with many islands filling a critical role as breeding and nesting sites. If you enjoy bird-watching, be aware of protected areas and seasonal closures and take special care to ensure the safety of the birds.

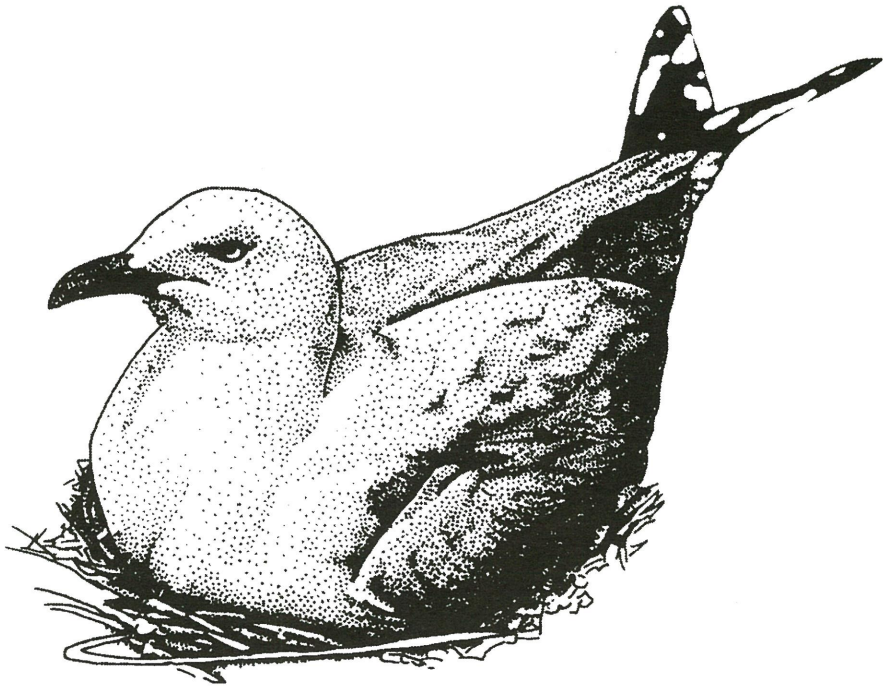
All seabirds are protected in Queensland and it is illegal to take any birds or their eggs.

Best Environmental Practices for observing seabirds:

- Avoid roosting or nesting seabird colonies.
- Don't approach close enough to stress birds. This may force them to move from their nests or young, or to take flight.
- If seabirds exhibit stressful behaviour overhead, such as raucous calling or swooping, leave immediately, taking care to avoid crushing well-camouflaged eggs.
- When approaching birds, be quiet, avoid rapid or sudden movement, crouch and use existing cover.
- Never attempt to touch birds, chicks or eggs.
- Avoid using lights near or in bird colonies.
- Take particular care on seabird islands at the following sensitive times
  - late afternoon and early evening
  - during the hottest part of the day
  - wet and/or cold weather
  - moonlit nights
  - when eggs, or naked or downy chicks are in their nests.
- Learn about the habits and needs of seabirds.

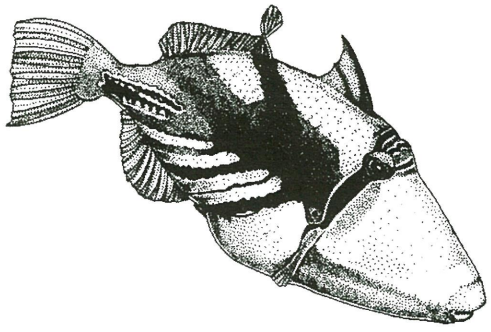
Cairns Area POM, Whitsunday Area POM and Hinchinbrook POM

Seabird restrictions Flight Height

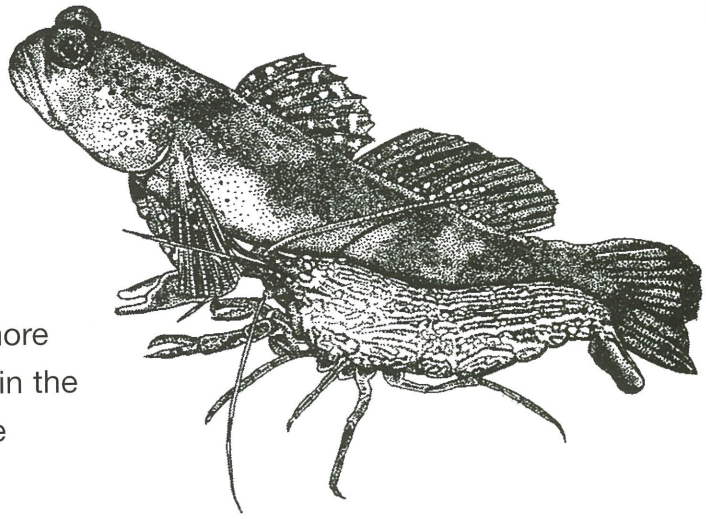


Part 2

reef**understanding**



The Basics of Life



Ours is a water world with oceans covering more than 70% of the earth's surface. Life evolved in the oceans and it is in the oceans that we see the greatest diversity of life.

While life in the ocean varies greatly in size, shape and function, the basics of life remain the same for all:

- the quest for food,
- the need for defence,
- and successful reproduction.

The way in which these basic needs are achieved defines the function a lifeform plays in the coral reef ecosystem.

The web of life

Coral reefs are powered by sunlight which provides the energy for marine plants and corals. These organisms in turn construct the reef that supplies habitat and food for the rest of the reef community.

Like most ecosystems coral reefs are a complex web of life. Marine plants form the basis of this web by producing organic material. This is achieved through the process of **photosynthesis**, where the energy of the sun is used to convert carbon dioxide and water into oxygen and carbohydrates. Because they produce their own food, plants are known as **producers**. About three-quarters of the total amount of carbon dioxide removed from the water each day on a reef is used directly in the process of photosynthesis. The remainder is utilised by marine algae and corals in the production of limestone allowing for the continual growth and expansion of the reef.

Much of the organic material produced by plants is consumed by **herbivores** (animals that feed upon plants) which in turn are consumed by **carnivores** (animals that feed upon other animals). Animals which feed upon both plants and other animals are known as **omnivores. Scavengers** feed upon dead organisms. Ultimately the left over dead plants, animals and wastes are consumed by the **decomposers** (mainly bacteria) which cycle organic matter back to carbon dioxide and nutrients.

All of the reef's organisms play a vital role in the reef ecosystem. The creatures of the reef cannot only be classified by their physical appearance but also by their function in the reef's ecosystem.

Producers: marine plants, zooxanthellae, phytoplankton

↓

1st order consumers (herbivores): parrotfish, surgeonfish, sea urchins, many shells, zooplankton

↓

2nd order consumers (carnivores): octopus, corals, sharks, predatory fish, crown-of-thorns starfish

↓

Scavengers: crabs and lobsters

↓

Decomposers: bacteria

Self sufficiency and the recycling of nutrients are vital for the survival of a coral reef. However, small but important losses and gains of nutrients occur within any reef system. The exchange of planktonic eggs and larvae between reefs ensures biodiversity, prevents inbreeding and allows for depleted species to be replaced. Plankton adds input into a coral reef as a source of food for corals, fish and a myriad of other creatures.

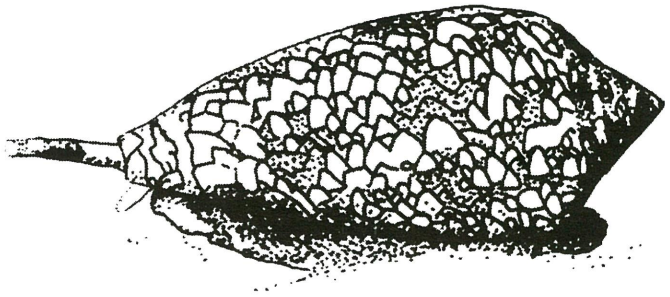
Even though plankton only comprises an estimated one per cent of the total food turnover on a reef, its input plays a vital role in maintaining the structure and balance of a coral reef community.

Classification

When communicating about animals and plants most people refer to a particular species by its common (non-scientific) name. Whilst being simple and familiar, these common names are not standardised throughout the world or even within one country. For example the venomous fish, *Pterois volitans* is known commonly as a lionfish, butterfly cod, scorpionfish and turkeyfish. Consider starfish, shellfish, cuttlefish and jellyfish. All these names end in the suffix 'fish' yet none are what we know as true fish.

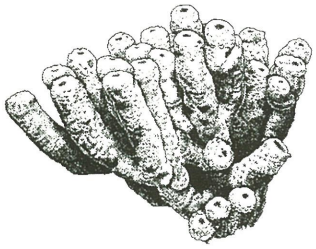
Scientific names allow for only one name to be assigned each unique species. This name is then used worldwide regardless of what language is being written or spoken. The system of scientific naming in use today was developed in the 18th century by Carl Linnaeus using Greek and Latin words.

It follows a hierarchical system starting with the broadest categories which reduce to a specific unique name. Every species is classified into one of the major groups called a phylum (plural phyla). These groups comprise all those animals which are thought to have a common evolutionary origin. Currently zoologists recognise some 39 phyla and with only one exception (Phylum Chordata) all are invertebrate animals (animals without a backbone).



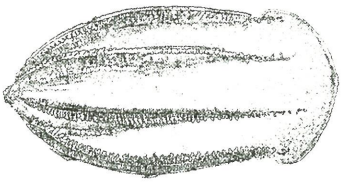
	Lionfish	Humpback Whale	Textile Cone Shell
Phylum	Chordata	Chordata	Mollusca
Class	Osteichthyes	Mammalia	Gastropoda
Order	Scorpaeniformes	Cetacea	Neogastropoda
Family	Scorpaenidae	Balaenopteridae	Conidae
Genus	*Pterois*	*Megaptera*	*Conus*
Species	*volitans*	*novaeangliae*	*textile*

A list of major animal groups and examples addressed in this manual.

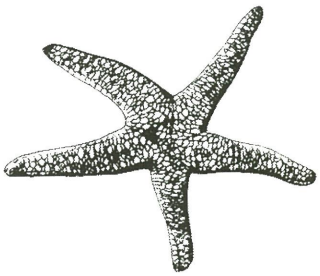


Phylum Porifera
Sponges

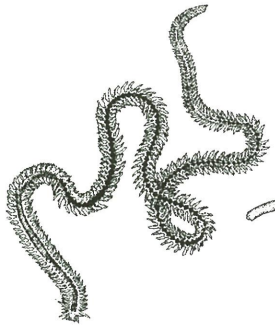
Phylum Cnidaria
Corals and Jellyfish



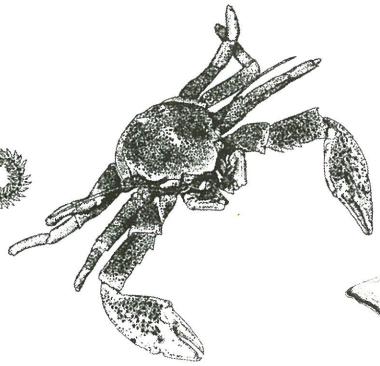
Phylum Ctenophora
Comb Jellies



Phylum Echinodermata
Echinoderms



Phylum Annelida
Segmented Worms

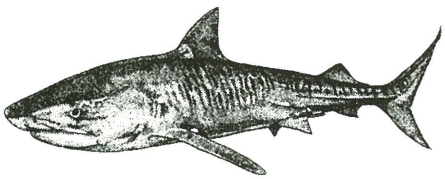


Subphylum Crustacea
Crustaceans
Phylum Arthropoda

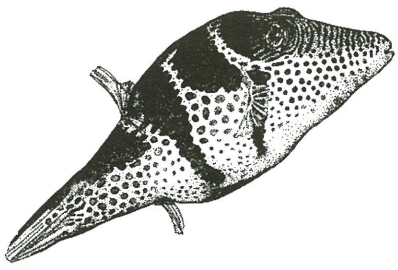
Phylum Mollusca
Shells, Nudibranchs and Squids

Phylum Chordata
Ascidians
Sea Squirts

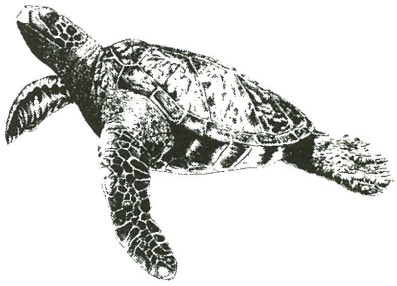
Phylum Chordata
Subphylum Vertebrata



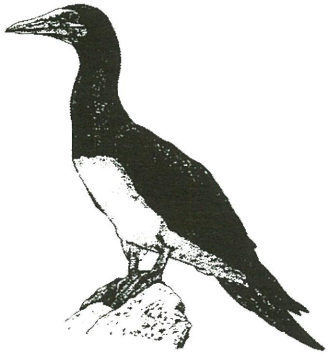
Sharks and Rays



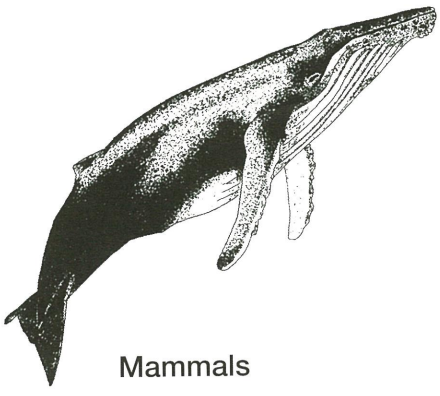
Fish



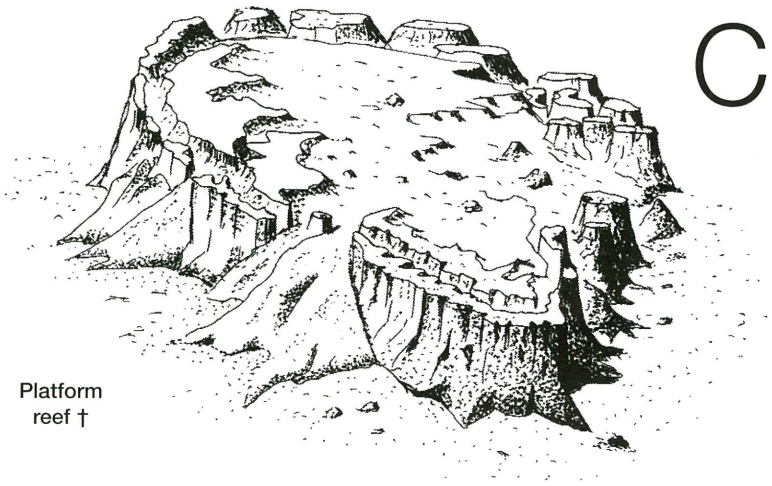
Reptiles



Birds



Mammals



Platform reef †

Coral Reefs

Australia's Great Barrier Reef is the world's largest and most complex reef system. It is visible from the moon.

Reefs are the result of a fine balance between the formation of limestone (produced by coral and marine algae) and the destruction of the reef by mechanical and biological activities.

coral reefs are only found in the shallow warm waters of the world, because they require:

- annual mean water temperatures of 22°–29°C for reef growth
- clear water to allow adequate light for photosynthesis
- firm substrate for attachment
- stable salinity (this is the reason why reefs don't occur near river outfalls)
- low levels of sedimentation (suspended sediment can reduce the amount of light and can also smother the corals)
- low nutrients levels (increased nutrients algal to growth over corals)

Evolution of the Great Barrier Reef

65 million years ago, the Australian continent formed a part of the landmass called Gondwanaland, which was located in the cold southern waters. As it broke away and drifted north into the tropical waters, a coral reef system started to grow on the continental shelf along the eastern coastline. The Great Barrier Reef is believed to be over 18 million years old in the north and 2 million years oldin the south. Through time, the warming and cooling of the earth together with changes in the size and shape of sea basins, have caused numerous sea level changes. During the last Ice Age (~ 18,000 years ago) sea levels dropped over 100m, turning what is now the Great Barrier Reef into grassy plains and limestone hills. The sea level started to rise 12,000 years ago as the ice caps melted, and reached its current level about 8,000 years ago. As the sea level rose, those corals that survived in the water off the continental shelf reproduced and started to recolonise the old remnant reefs. The amount of reef growth since the last Ice Age varies amongst locations.

Today three different developmental stages of reef growth can be seen.

- Juvenile reefs are still growing to reach present sea level.
- Mature reefs have reached sea level and are starting to fill in with sediment.
- Senile reefs are filled in with sediment, often having formed a coral cay.

Types of reefs

Fringing reefs grow around continental islands and along the mainland. Their proximity to land means that they are affected by run-off and sedimentation. Generally this results in a reduction in hard coral diversity and an increase in soft coral and algae cover.

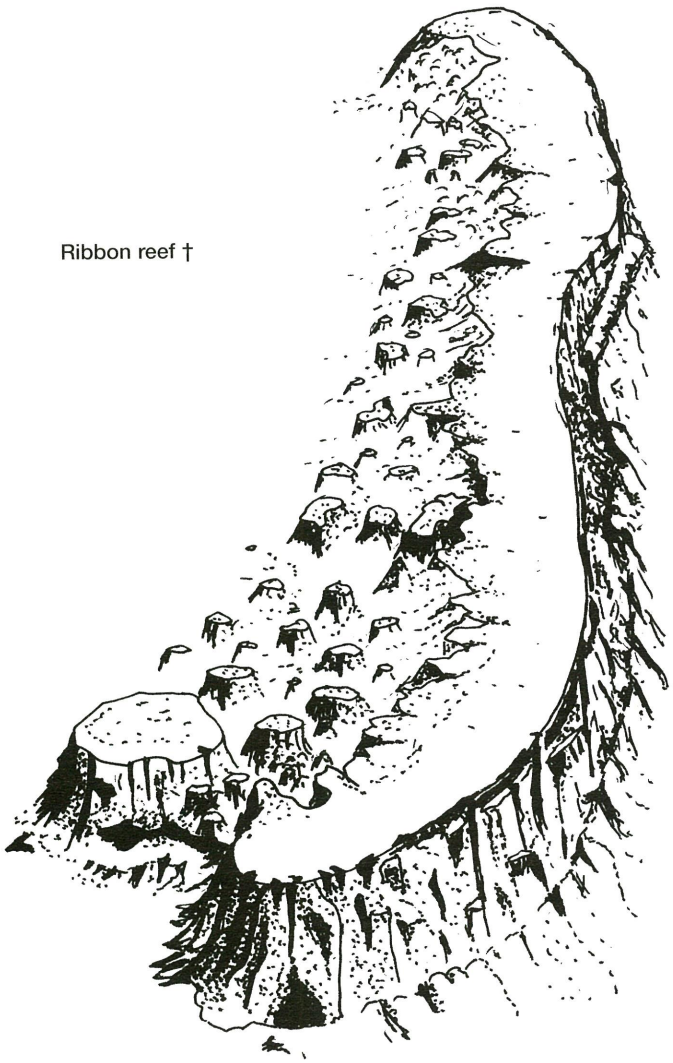
Platform reefs grow on the continental shelf away from the majority of influences of run-off from the mainland. Their shape is the result of wind and rain erosion during the Ice Ages and the growth and erosion of the reef under water.

During periods of low sea levels when the Great Barrier Reef was exposed, the reefs became dry limestone hills which were eroded by wind and rain. The large scale geomorphological formations such as gullies and sink

Fringing reef †

holes are the result of atmospheric erosion. The thickness of the coral veneer grown since the last Ice Age averages from 5 to 20 metres. Its morphology is a result of growth and underwater erosion.

Ribbon reefs grow along the edge of the continental shelf with the most spectacular stretch being nearly 670 kilometres long between Cooktown and the Torres Strait. They are essentially an elongated platform reef. Why they only occur in this area is unknown.



Ribbon reef †

Coral atolls initially form as a fringing reef growing around a volcanic island. As the volcano subsides, the coral keeps growing to meet the surface. Eventually the island disappears altogether leaving a circular reef around a lagoon. There are no coral atolls on the Great Barrier Reef.

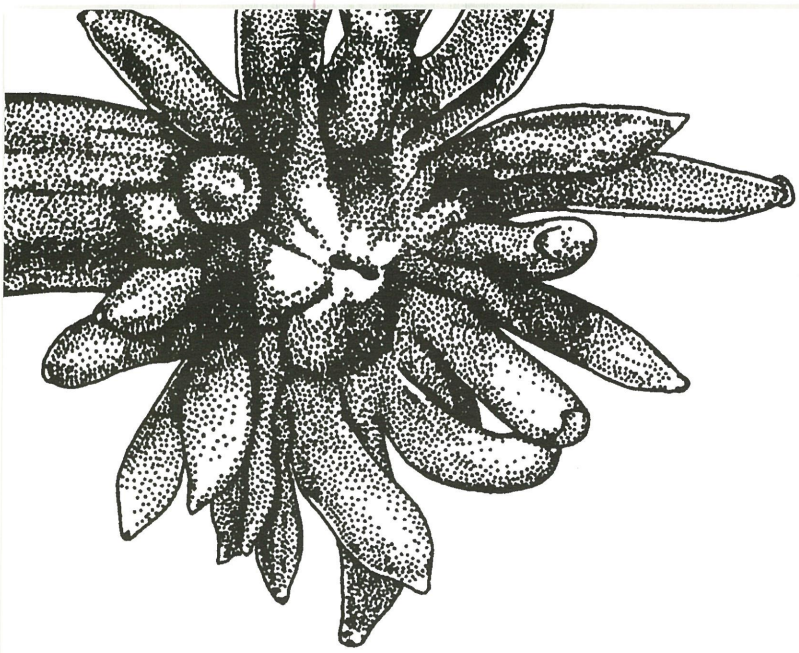
Types of islands

Continental islands were once hills and mountains sitting on Australia's continental shelf. As the sea level rose and the low lying land became flooded, these exposed land masses became isolated islands.

Coral cays are small islands of sand formed on top of coral reefs. The sand of coral cays consists of reef animal skeletons and other debris. As waves curve around reefs they deposit this sediment on the calm (leeward) end of the reef. Initially coral cays are little more than exposed sand banks. Cays are dynamic sand piles; their position constantly changes with weather conditions.

As the cay accumulates more sediment it grows larger and becomes more stable. Water flowing through the sediments may further deposit limestone to form beachrock. Similar to concrete, beachrock further stabilises the cays. Plant seeds reach the cay (by drifting in the ocean, or on birds' feathers), germinate and start to colonise the cay, further consolidating the sand.

Seabirds deposit droppings on cays when flying over or nesting on them. The gradual increase in nutrients supports the continued growth of plants which stabilises the cay further.



Coral

Corals, the ocean's master builders, form the living monumentof the Great Barrier Reef, which is visible from the moon. The diversity of life on coral reefs is unmatched by any other environment.

PHYLUM CNIDARIA
(Greek meaning 'having nettles')
Pronounced ny-dar'e-a

CLASS ANTHOZOA
(Greek meaning 'flower animal')
Pronounced an-tho-zo'a

Characteristics

- colonies consist of many individual coral polyps
- coral polyps have only a single opening for both food and wastes
- the opening is surrounded by tentacles
- hard corals secrete limestone skeletons
- have stinging cells to capture food

Coral reefs are made up of colonies of tiny animals called polyps. A coral polyp is a simple jellyfish-like animal that lives in a cup of limestone. Like other members of the phylum Cnidaria (jellyfish, anemones etc.) corals have tentacles armed with batteries of stinging cells.

Role on the reef

Coral reef structures are composed mostly of the 'dead' limestone skeletons of previous generations of corals. Only the thin outermost layer of the reef is alive with coral colonies. The structures built by corals provide a framework to the coral reef community supplying a habitat for creatures such as molluscs, crustaceans, echinoderms and fish.

Coral reefs do not grow everywhere. They have a number of specific environmental growth needs. These include:

- clear water, so they can get the necessary light
- low nutrients
- stable salinity
- a hard surface to grow on

There are very few fringing coral reefs growing along the mainland of Australia due to excess river run-off. Water from streams and rivers decreases salinity, increases nutrient levels and decreases water clarity with suspended sediment.

Feeding

Coral colonies are sessile, or stationary. Therefore they have to catch food that is drifting by. The stinging cells that cover the tentacles of the corals capture plankton. However, the main source of food for corals doesn't come from this prey. Coral polyps live in a symbiotic relationship with single-celled algae called zooxanthellae (pronounced zoo-zan-thel-ee). Zooxanthellae live in the tissue of coral polyps, and like all plants, they use the sun's energy to make sugars and starches. Polyps utilise these products as food. In return polyps give zooxanthellae a place to live.

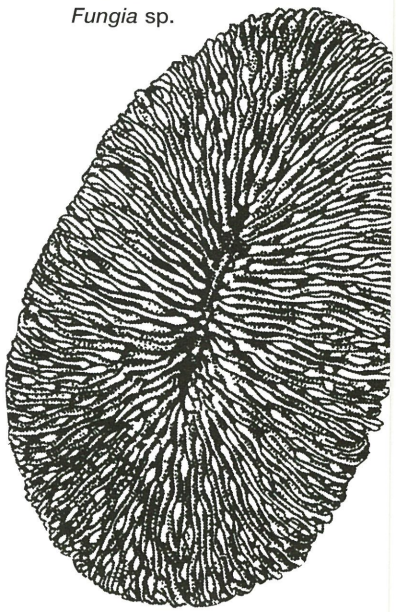
Defence

Space is a limited resource on the reef, and corals must constantly fight each other to survive. There are a number of ways by which corals try to out-compete their neighbours. Growing over neighbouring corals blocks out the precious light needed for their zooxanthellae. Some species simply digest their neighbours or use long tentacles called sweeper tentacles to kill others around them.

Reproduction - Asexual

Colonies of coral start with just one coral polyp. This 'founder' polyp reproduces asexually through a process known as budding. New polyp are genetically identical to the original polyp. This process is repeated over and over throughout the coral colony's life as it increases in size.

Mushroom coral
Fungia sp.



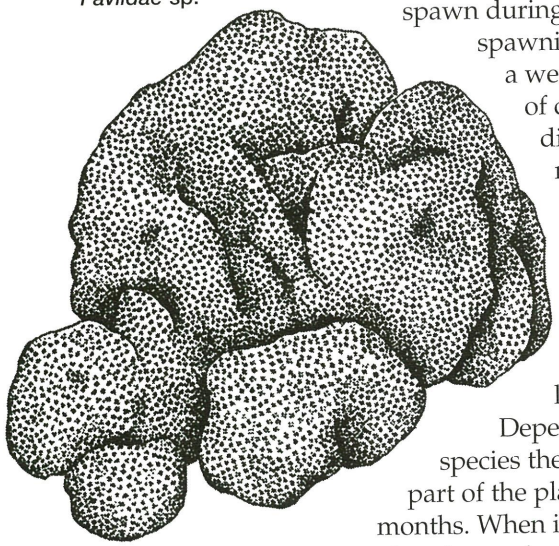
Coral spawning

As hard coral colonies grow, layers of limestone are laid down, and the polyps 'move' up to the new layer. The exact rate at which coral colonies grow varies amongst species. Staghorn (Acropora) corals can grow 30 centimetres each year while the massive Porites corals grow at an average of 1-3 millimetres per year.

Reproduction - Sexual

Many corals reproduce sexually just once each year during a mass spawning. The process actually begins six months before as the eggs and sperm start to develop within the polyps. The corals of inshore reefs usually start spawning six nights after the first full moon in October each year while those in the offshore areas, where the water is cooler, spawn during November. Mass spawning normally lasts about a week with different species of coral spawning at different times during the night and on different nights. Eggs and sperm float on the water surface, combine and develop into a planula, the free swimming planktonic larval stage of coral. Depending on the coral species the planula may stay as part of the plankton from weeks to months. When it's time to settle, the planula attaches itself to a vacant patch of reef and starts to grow into the founder polyp for a new coral colony.

Boulder coral *Faviidae* sp.



Human use and impacts

Coral reefs are under threat worldwide. Increased nutrient levels in the sea caused by agriculture, industry and urbanisation promotes algal growth. Algae may eventually out-compete and smother corals. Increased sediment loads from rivers and run-off not only decreases water clarity but also physically smothers coral. On a localised scale, anchors and divers, particularly in high-use areas can cause high levels of damage.

History

The first reef building corals appeared 230 million years ago on the shores of the Tethys Sea which was located where Europe and the Mediterranean Sea are today.

CORAL COLOUR

Many visitors to the reef make the comment that the coral isn't as colourful as the brightly coloured photographs in books and brochures. This is because these photographs were taken with a flash. White light is made up of all the colours of the rainbow. Water filters out these colours at different depths with red and yellow disappearing first leaving green and blue.

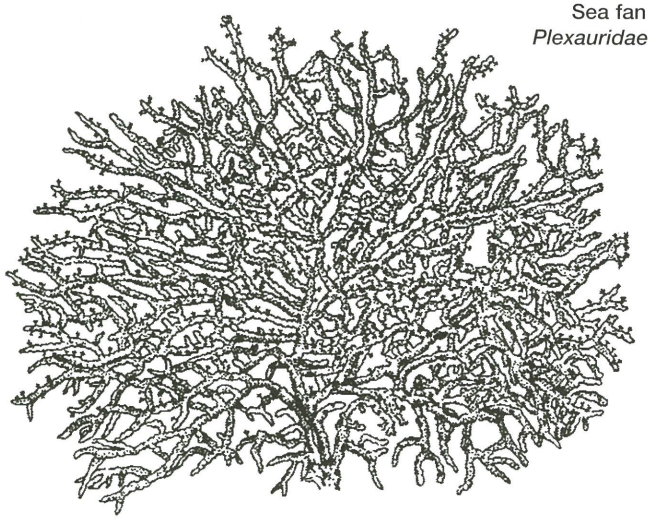
This gives the reef a predominantly blue-green appearance at depths over ten metres. The bright colours of the coral can be seen in shallow water, but in deeper water an underwater torch or flash on a camera is needed.

CORAL IDENTIFICATION

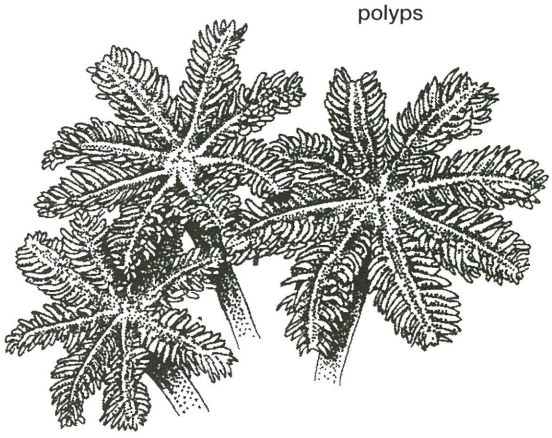
The easiest way to classify hard corals is by their appearance i.e.

- boulder
- branching
- plate
- table
- vase
- bushy
- solitary

Trying to identify corals to a species level is very difficult. What makes coral identification difficult is that a single species may appear in a branching form in calm water and as a plate coral in another area. Local environmental conditions, such as wave action, light levels and the amount of sediment in the water affect the shape of coral – it grows to suit local conditions.



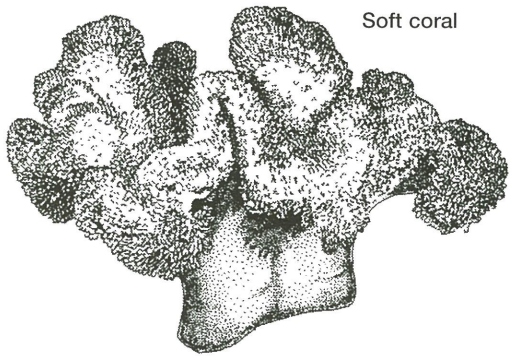
Sea fan
Plexauridae sp.



Soft coral
polyps

SOFT CORALS AND SEA FANS

Soft corals lack the hard external limestone skeleton of the hard corals. Their soft body is defended by chemicals called **terpenes** which make the corals toxic and bad tasting to predators. Some species also have sharp needle-like sclerites inside their tissue that help discourage predators. In addition to their swaying bodies, soft corals can be distinguished from hard corals in that they have a multiple of **eight tentacles** per polyp, with each tentacle having side branches giving it a feathery appearance. Hard corals have tentacles usually in multiples of six.



Soft coral

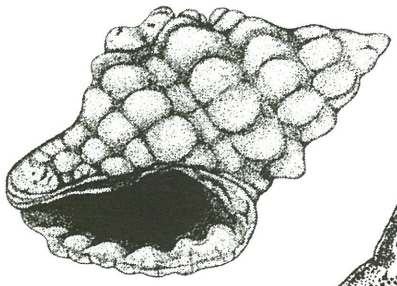
Sea fans (also called gorgonians), like soft corals, have only eight branched tentacles per polyp. Their colony is supported by a flexible skeleton made of a substance similar to fingernails called **gorgonin**.

Super sunscreen

Researchers from the Australian Institute of Marine Science have discovered that corals produce sunscreen with an equivalent sun protection factor (SPF) of 50 to protect the corals during exposure to the sun at low tide.

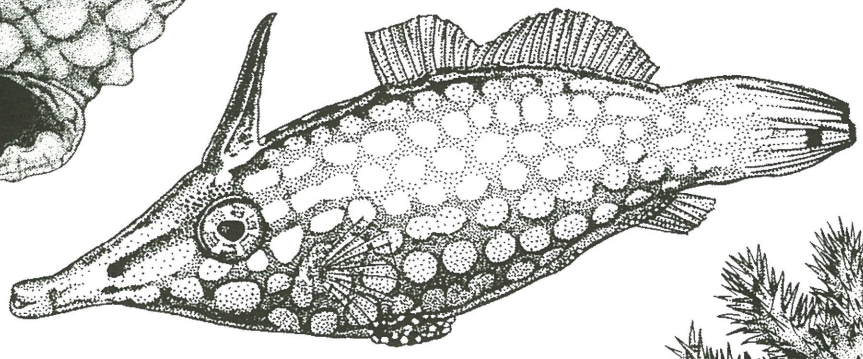
Coral bones

Some corals (Goniopora sp.) are being used to replace bone in humans where the bone has been damaged through accident or disease. The coral has the same porosity as human bone, allowing blood vessels and nerves to grow into the implant, increasing repair strength and rate of recovery.



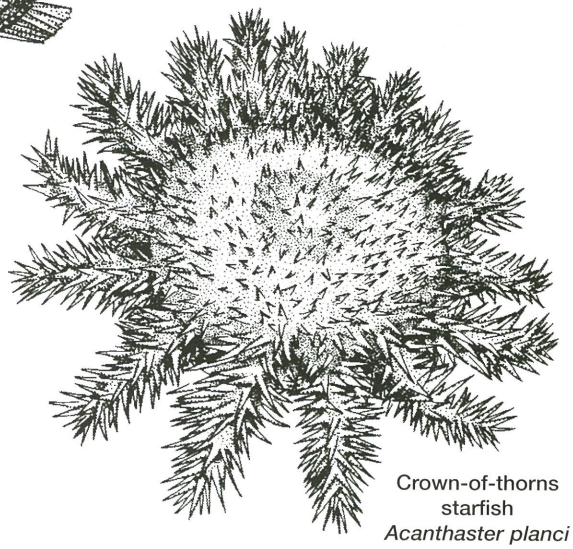
Drupella
Drupella sp.

Beaked leatherjacket
Oxymonacanthus longirostris



CORAL EATERS

Probably the most famous of all coral eaters, or corallivores as they are more appropriately known, is the crown-of-thorns starfish *(Acanthaster planci)*. This type of starfish pushes out its stomach through its mouth to digest coral polyps from the coral skeleton. Other predators include the drupella snail *(Drupella sp.)* which feeds by scraping polyp tissue from the skeleton, and a number of species of fish such as butterflyfish and the beaked leatherjacket *(Oxymonacanthus longirostris)* which pick at individual polyps.



Crown-of-thorns
starfish
Acanthaster planci

Marine Algae

The plants of the reef are often not very conspicuous. They lack roots, stems, leaves and even the green colour of the terrestrial plants with which we are familiar.

KINGDOM PROTISTA
(Greek Meaning 'first of all')
Pronounced pro-tis'-ta

Characteristics

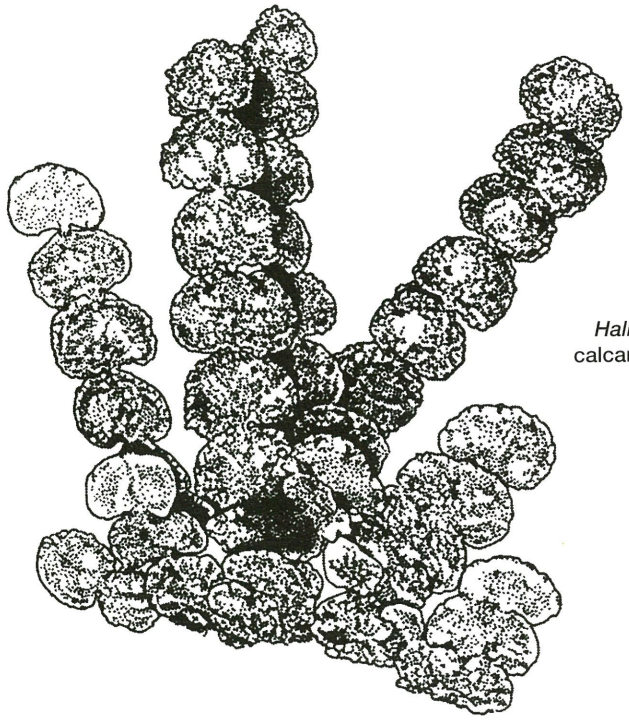
- can be brown, red or green
- do not have leaves or roots

Role on the reef

As in most ecosystems, plants form the basis of the reef's food chain. Some, like the single-celled zooxanthellae, live within the tissue of marine animals, directly supplying their host's nutritional requirements.

In addition to being the reef's primary producers, many species of marine algae greatly contribute to the overall structure of the reef. Coralline algae act as the reef's mortar. Like coral, they secrete limestone and by growing between coral fragments and rubble they help to bind the reef together.

Limestone-producing algae also make up a major component of the sand. Even though they are not visually striking, marine plants dominate the reef – as builders, consolidators and sediment producers. In fact, reefs could be termed 'algal reefs'.



Halimeda sp.
calcaneous algae

Feeding

Algae, like other plants, obtain nourishment by the process of photosynthesis, where the energy of the sun converts carbon dioxide and water into oxygen and carbohydrates.

Human use and impacts

Plants thrive on nutrients. The increased amount of nutrients such as phosphorus and nitrogen being released onto the reef through human activity has led to an increase in the amount of marine algae in many areas. Increased levels of algae can out-compete and grow over corals, robbing them of the light they need to survive.

History

Marine plants have been part of the marine ecosystem for over two billion years.

PHYTOPLANKTON

Phytoplankton are microscopic plants that make up part of the planktonic community. They are eaten by planktonic animals (zooplankton).

In most marine environments phytoplankton are the primary producers and the start of the food chain. Some scientists believe that phytoplankton is responsible for the production of over 70% of the world's oxygen through photosynthesis.

The clear, nutrient-free waters of the Great Barrier Reef support a low abundance of phytoplankton. As nutrient levels rise, due to storm run-off or from human activities, so does the abundance of phytoplankton. The resulting reduction in visibility and light penetration robs corals of the light necessary for survival, which can lead to coral death.

From August to December large rusty coloured blooms of algae can be seen on the surface of the water. Often referred to as sea sawdust, whale sperm, whale food and sea scum, this algae, known as *Trichodesmium* can often be confused with coral spawn and oil spills.

ZOOXANTHELLAE

Zooxanthellae (zoo-zan-thel-ee) are single-celled algae that live in the tissue of animals such as corals and clams. Like other plants, zooxanthellae obtain nourishment by the process of photosynthesis, where the energy of the sun converts carbon dioxide and water into oxygen and carbohydrates. The coral and other hosts use some of the carbohydrates for their own nutrition. It is the presence of zooxanthellae that gives anemones and hard and soft corals their brown colouration. When corals become stressed due to environmental changes, zooxanthellae are released into the water during a process known as bleaching, leaving the coral white.

CORALLINE ALGAE

Like corals, red coralline algae deposit calcium carbonate. By growing over coral rubble they act as cement to bind the reef together. In high wave energy areas, such as the reef crest, coralline algae dominates. They often form buttresses or ridges which reduce the wave energy, allowing the more delicate corals to grow in the areas behind.

HALIMEDA

Like coralline algae, *Halimeda* also produces calcium carbonate. The remains of the white disc-shaped *Halimeda* are responsible for over 50% of the coral sand found in many parts of the reef. *Halimeda* can produce calcium carbonate very rapidly, doubling its weight in as little as 15 days. It has been estimated that *Halimeda* flakes are capable of producing 13 centimetres of reef in less than 1000 years.

TURF ALGAE

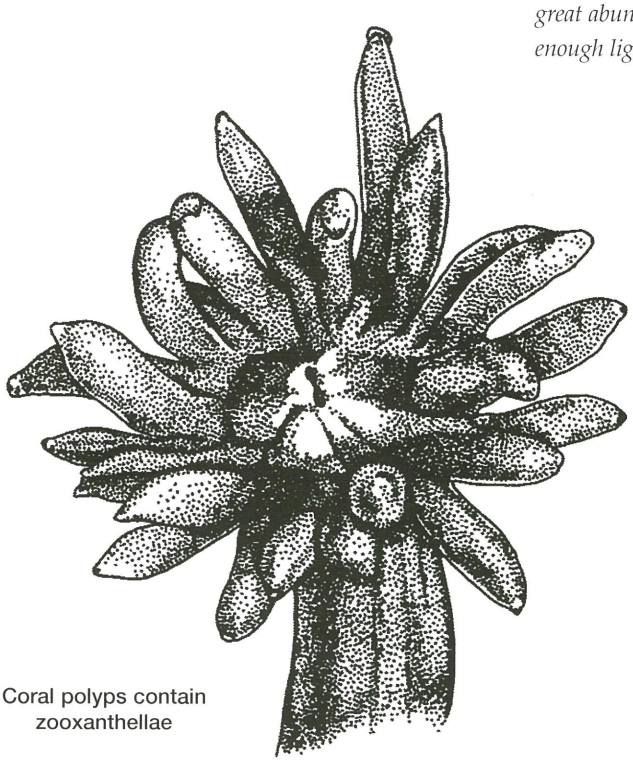
The brown surface of the reef flat is actually a thin layer of rapidly growing algal turf. This algae growing upon the reef flat is the primary food source for many of the reef's herbivores. At high tide many herbivorous species such as parrotfish, surgeonfish and damselfish can be seen feeding in this zone. In fact if it were not for their constant grazing pressure this algae would quickly grow forming a fuzzy algal layer.

No plants necessary

Some of the ocean's food chains do not rely on plants at all. About 2400 metres down in the Pacific Ocean, organisms have been found living in water heated up to 350°C. These creatures eat bacteria that feed upon chemicals dissolved in the super heated water.

Shining lights

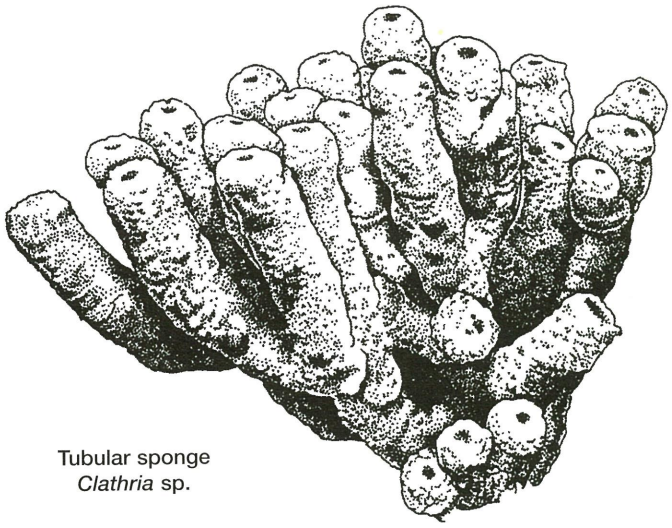
Some types of phytoplankton known as dinoflagellates produce light, known as bioluminescence. In parts of the Indian Ocean these tiny plants have been known to occur in great abundance giving off enough light to read by.



Coral polyps contain zooxanthellae

Sponges

'Sponges suck'; they filter an amount of water equivalent to their own volume every four to twenty seconds. In evolutionary terms they were the first creatures to get their cells together and become multicellular. From giant vase-like structures, to obscure creeping forms growing over rocks, sponges are important for more than washing the car.



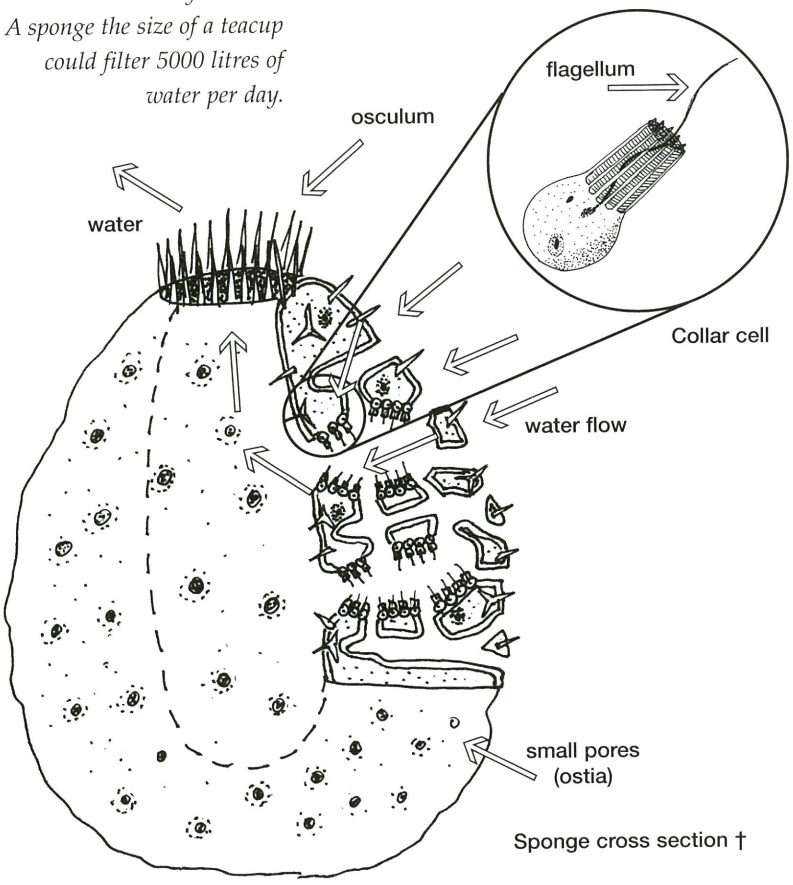
Tubular sponge
Clathria sp.

PHYLUM PORIFERA
(Latin meaning 'pore bearing')
Pronounced po-rif'er-a

Super suckers
Sponges can filter the equivalent of their own volume of water every four to twenty seconds. A sponge the size of a teacup could filter 5000 litres of water per day.

Characteristics

- body covered with tiny openings called pores
- food particles are filtered from the water
- skeletal structure consists of limestone or silica spines called spicules
- great range of colours and shapes
- attached to sea floor



Sponge cross section †

Role on the reef

Most sponges stand out from the reef community with their bright colours and range of shapes. Some of the most important sponges on the reef are those that you cannot see. Boring sponges break down the limestone skeletons of coral and use the created spaces as a home. This is one of the major ways coral is broken down into sand and rubble.

Feeding

A close inspection of a sponge reveals a surface covered by small and large pores. Water is drawn in through the small pores (ostia) and through a series of canals until it enters feeding chambers where food particles (as small as bacteria) are digested. Specialised cells (collar cells) line the feeding chambers and beat their whip-like tails (flagella, singular flagellum) to create currents and to capture food particles. The water is expelled from the sponge through large volcano-like pores called oscula (singular osculum).

Defence

The structure of a sponge is impregnated with spines made of either limestone or silica. These not only provide support but also deter predators. Coming in a wide range of shapes and sizes these spines, or spicules as they are more accurately known, are the only accurate way to identify particular species of sponges.

Many sponges also contain toxins for defence. One of the few predators of sponges are nudibranchs. Many nudibranchs specialise in feeding on a single species of sponge due to the complex nature of the toxins.

Reproduction

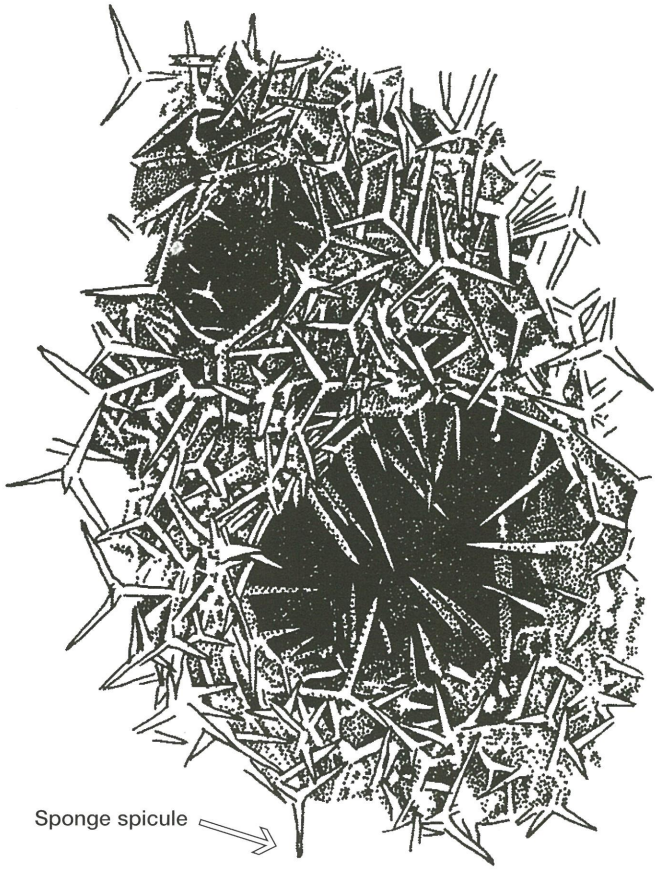
Sponges can reproduce asexually by budding and breaking off segments. Most sponges also have both male and female sex organs (they are hermaphrodites). During sexual reproduction sponges retain eggs. Sperm is released into the water and is taken in by other sponges to fertilise the eggs. Mass spawning has been observed in a few species of sponges.

Human use and impacts

Sponges should never be removed from the water as they are killed by even short exposure to air. Being filter feeders, sponges can easily become clogged by sand kicked up by divers and snorkellers.

History

Sponges are one of the most ancient forms of life inhabiting the reef, dating back more than 650 million years. Many fossil reefs consist of limestone produced by ancient sponges (stromatoporoid sponges). Examples of fossil reefs include parts of the Great Dividing Range and fossil reefs near Charters Towers.

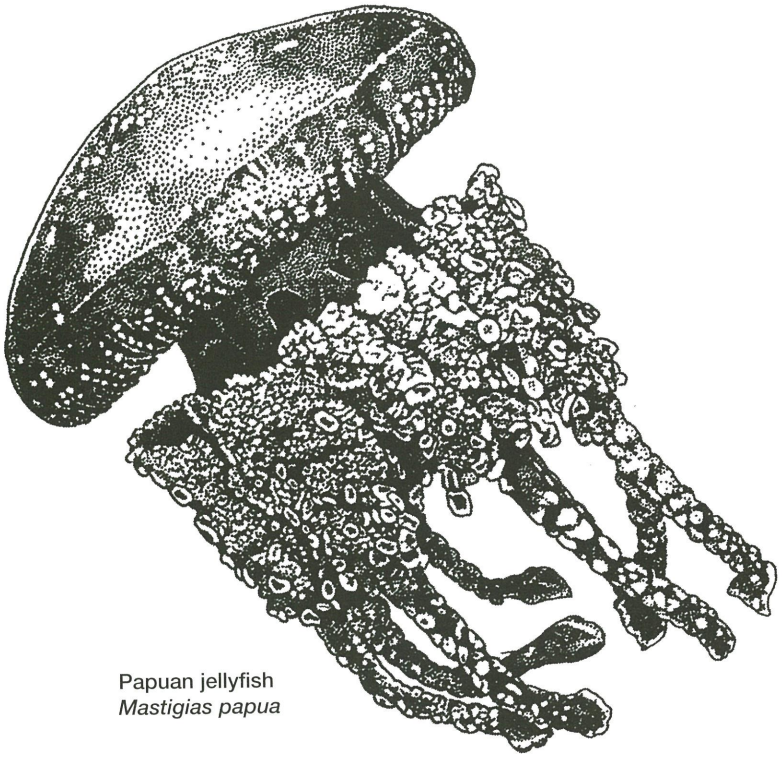


Solar power

Many sponges possess ***symbiotic*** *algae (zooxanthellae) that produce food for their host sponge, in a similar fashion to corals.*

Plant or animal?

Sponges were regarded as plants until the 19th century (when they were re-classified as animals) because there was no obvious way by which they fed and they grew from broken off pieces.



Papuan jellyfish
Mastigias papua

Other Cnidarians

With tentacles covered in millions of stinging cells, corals, anemones, hydroids and jellyfish are well armed to feed upon the planktonic community.

PHYLUM CNIDARIA
(Greek meaning 'having nettles')
Pronounced ny-dar'e-a

Characteristics

- radial symmetry
- stinging capsules (nematocysts)
- a body cavity with only a single opening for food and waste
- two basic body forms: polyp (attached) and jellyfish (free-swimming medusa)
- many have complex life histories involving the two body forms
- many have a symbiotic relationship with zooxanthellae algae

Role on the reef

Cnidarians make effective plankton feeders by using stinging tentacles to catch plankton as they drift by. Some, like anemones and zoanthids, are attached to the reef, while others are free-swimming using their tentacles like a trawl net to catch their prey.

Many of the reef animals such as fish, crabs and shrimp find protection from predators by living amongst the tentacles of anemones and jellyfish.

Feeding

Cnidarians use tentacles covered in stinging cells that shoot harpoons, called nematocysts, to catch prey such as plankton, shrimp and small fish. The tentacles draw the prey to the single opening that serves both as mouth and anus.

Many cnidarians such as corals, anemones and some jellyfish supplement their diet by nutrients produced by symbiotic algae.

Defence

The stinging cells of cnidarians are used for defence as well as obtaining food.

Reproduction

The life history of cnidarians is often a complex affair involving two different body forms, the attached polyp and the free-swimming jellyfish-like medusa. When attached to the reef most cnidarians reproduce asexually by budding. Eventually the polyp transforms into a free-swimming medusa which reproduces sexually by shedding eggs and sperm into the water column.

Human use and impacts

Cnidarians such as box jellyfish, fire coral and stinging hydroids are capable of stinging humans. The most common injury to people is coral cuts.

Corals are susceptible to damage through human activities such as anchoring, diving and decreases in water quality through pollution.

History

The earliest fossil records of cnidarians date back 600 million years. The earliest coral reefs started to form 450 million years ago.

STINGING CELLS

Nematocysts are small stinging harpoons used by cnidarians for both protection and catching food. They consist of a coiled up, hollow thread that explodes out of its cell when the trigger hair is touched. These firings can achieve a velocity of 2 metres a second with an acceleration of 40 000 times gravity. The thread penetrates its prey and injects a paralysing toxin. Cnidarians have many millions of these cells covering their tentacles. The use of vinegar on box jellyfish stings disables the nematocysts thus preventing any further injection of toxin. **Vinegar should not be used on blue bottle stings** as it actually increases the number of stinging cells activated – use only cold water and ice.

ZOOXANTHELLAE

Zooxanthellae (zoo-zan-thel-ee) are single-celled algae that live in the tissue of animals such as corals and clams. Like other plants, zooxanthellae obtain nourishment by the process of photosynthesis, where the energy of the sun converts carbon dioxide and water into oxygen and carbohydrates. The coral and other hosts use some of the carbohydrates for their own nutrition. It is the presence of zooxanthellae that gives anemones and hard and soft corals their brown colouration. When corals become stressed due to environmental changes, zooxanthellae are released into the water during a process known as bleaching, leaving the coral white.

JELLYFISH

Class Scyphozoa

(Greek meaning 'cup animal')
Pronounced sy-fo-zo'a

- medusa (swimming stage) dominant

Jellyfish, like most other cnidarians, have a two-part life cycle. The dominant stage is the familiar free-swimming bell-like medusoid stage. Lesser known is the polyp stage which forms just after egg and sperm combine. The polyp stage is normally very small and not free swimming. Prior to summer the polyp starts to shed parts of its body, each of which grow to form the swimming jellyfish stage. Large jellyfish are often accompanied by small fish which hide amongst the tentacles of the jellyfish for protection.

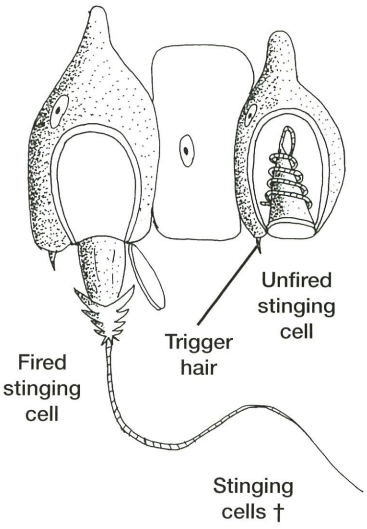
BOX JELLYFISH

Class Cubozoa

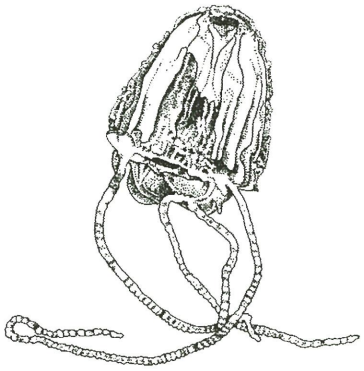
(Greek meaning 'cube animal')
Pronounced ku'bo-zo'a

- box jellyfish differ from the true jellyfish in that the bell is square in cross section, with tentacles hanging from each corner

The box jellyfish *Chironex fleckeri* (locally known as a stinger) has a complex life history involving both the jellyfish and polyp life stages. During the summer months the box jellyfish is found in the coastal waters north of Gladstone. At the end of summer the mature box jellyfish reproduce sexually by shedding eggs and sperm into the water. These combine to form a larval stage (planula). The planula swims into estuarine waters and attaches itself to the substrate. Box jellyfish planulae prefer to attach themselves to the underside of scoured out rocks. Once settled, the planula develops into a polyp. The polyp stage lasts all winter during which the polyp may bud asexually to form new polyps. During spring polyps detach and develop into a free-swimming medusoid stage to begin their adult life. Box jellyfish use their numerous tentacles which can stretch over two metres to feed upon small fish and shrimp. Upon contact, the tentacles quickly contract to only a few centimetres and bring the food to the mouth. Box jellyfish are capable of inflicting serious and even fatal stings. An antivenom is available.



Irukandji
Carukia barnesi

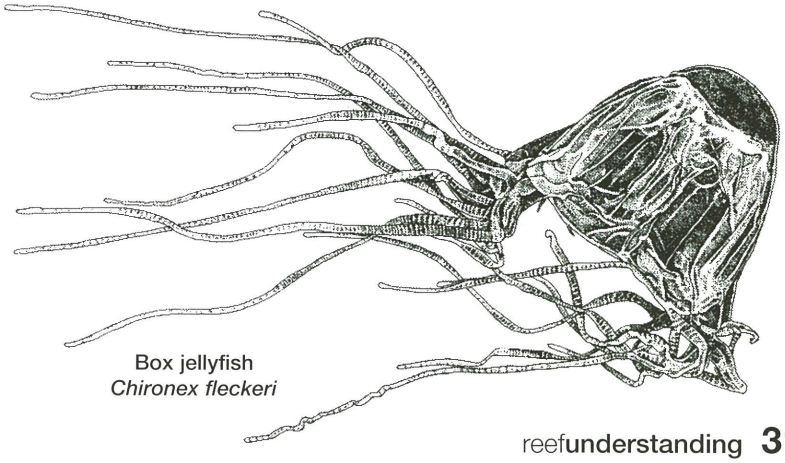


IRUKANDJI

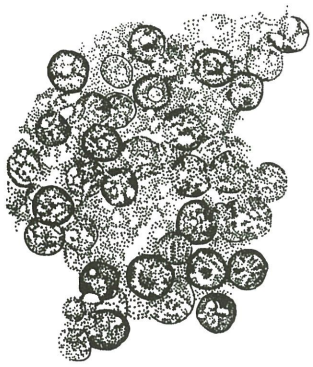
Irukandji *(Carukia barnesi)* are small members of the box jellyfish group, with a bell length of only 2 centimetres. The four tentacles vary in length from 4 centimetres to one metre in length. Irukandji are found in surface waters ranging from the coast out to the reef

Box Jellyfish and Irukandji stings

Douse with vinegar to prevent the further discharge of stinging cells. Vinegar does not prevent pain. Send for medical aid and be prepared to use artificial respiration.



Box jellyfish
Chironex fleckeri



Zoanthids

and are more numerous during summer months. Contact with these animals, which are rarely seen by victims, results in injuries that are proportional to the duration of contact with the tentacles. The sting is minor but 20-30 minutes later the victim experiences agony due to abdominal spasms and muscular aches. The name 'Irukandji' refers to the aboriginal tribe whose area around Cairns was the area in which irukandji was first described.

Dr J Barnes who pioneered research on stingers in north Queensland was quoted as saying –

'I should prefer a small box jellyfish sting to an untreated irukandji sting, any day.'

ZOANTHIDS AND ANEMONES

Class Anthozoa

(Greek meaning 'flower animal')
Pronounced an-tho-zo'a

- simple unbranched tentacles usually in multiples of six
- many contain the single-celled algae, zooxanthellae
- attached to substrate (sessile)
- no free-swimming jellyfish-like (medusa) stage in life cycle

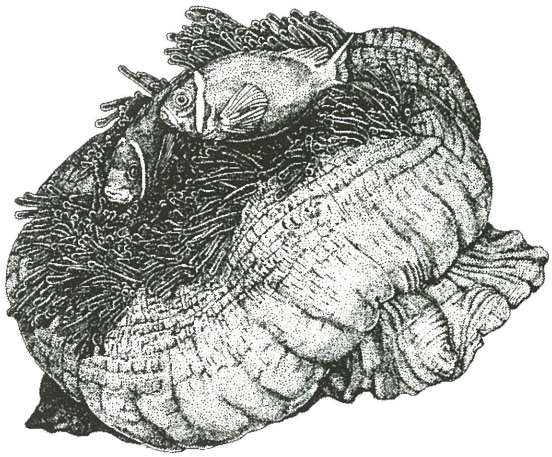
Anemones

Anemones are large, solitary polyps. They attach themselves firmly to the reef with their muscular base, but are capable of limited movement on substrate. This is especially common with anemones kept in aquariums where they regularly wander about trying to find a place to settle. Like corals, many anemones contain zooxanthellae; it is what gives them their brown colour. There are over 1000 known species. Only ten species have special symbiotic relationships with anemonefish. These fish hide amongst the tentacles of anemones to protect themselves from predators. Anemonefish are protected from the anemone's stings by coating themselves with the anemone's own mucous. The fish benefit by having a safe home. In return, anemonefish chase away butterflyfish which feed on the tips of anemone tentacles.

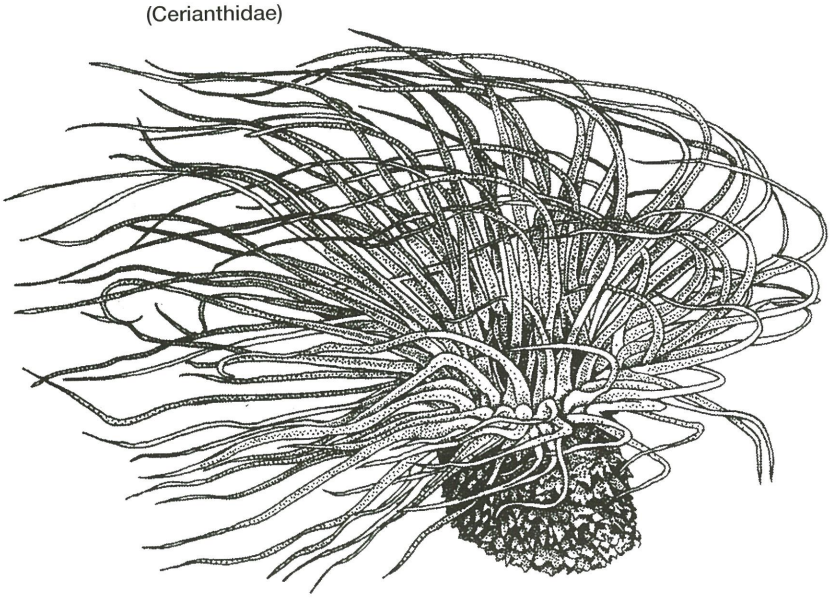
Zoanthids

Zoanthids live mostly in colonies, sometimes forming mats over coral rubble. Most individuals are 1-2 centimetres in diameter and do not secrete a skeleton. Colonial forms are actually connected to each other by a thin layer of tissue. They are distinguished from anemones by having only one fringe of tentacles surrounding the mouth as opposed to the numerous rows of tentacles which anemones have.

Magnificent sea anemone
Heteractis magnifica



Tube anemone
(Cerianthidae)



Tube anemones

Tube-dwelling anemones are most commonly encountered in sandy areas, particularly at night. They can burrow quite deeply into sand to prevent being washed away. The tube in which they live is actually made from extremely long threads from stinging cell-like organs. Tube-dwelling anemones can be distinguished from tube worms by the lack of side branches on each of the tentacles.

HYDROIDS

Class Hydrozoa
(Greek meaning 'water animal')
Pronounced hy-dro-zo'a

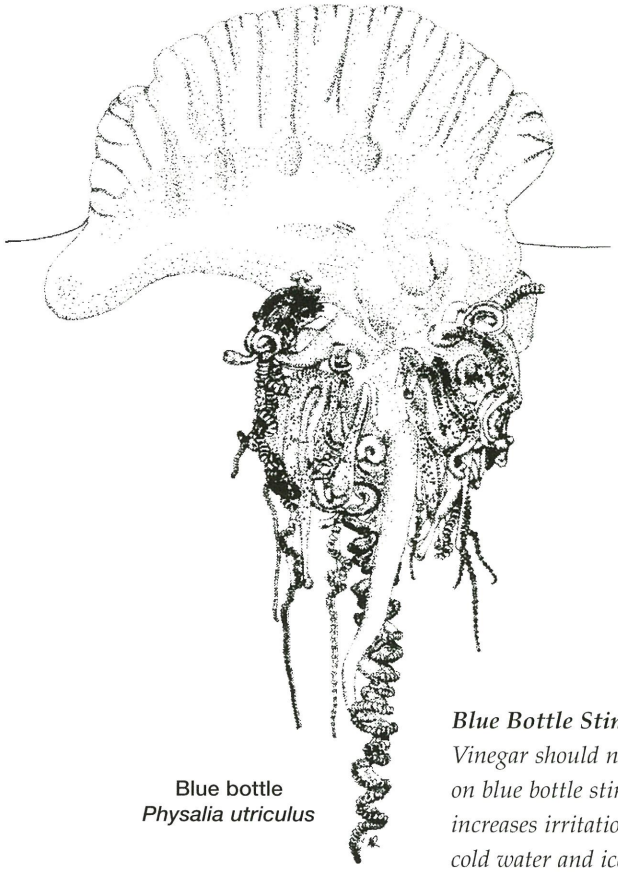
Reef hydroids are very diverse in appearance and include fire corals, stinging hydroids and blue bottles.

- both polyp and medusa stages
- polyps have specialised roles for defence and reproduction

STINGING HYDROIDS AND FIRE CORALS

Looking like colourful feathers growing out from the reef, stinging hydroids (family Plumulariidae) use their branches to filter food from the water. These branches are covered with stinging cells. Contact with these creatures can cause pain and swelling which may last up to a week.

Although it looks like coral, fire coral *(Millepora sp.)* is actually a hydroid. Its shape is variable, ranging from large sheets to branching staghorn-like forms. They have a skeleton of calcium carbonate that superficially resembles hard corals. Unlike hard coral the skeleton is relatively smooth and contains minute holes in which the hydroid polyps live. Fire corals give a strong burning sensation when touched. To relieve symptoms from both stinging hydroid and fire coral stings, apply ice.

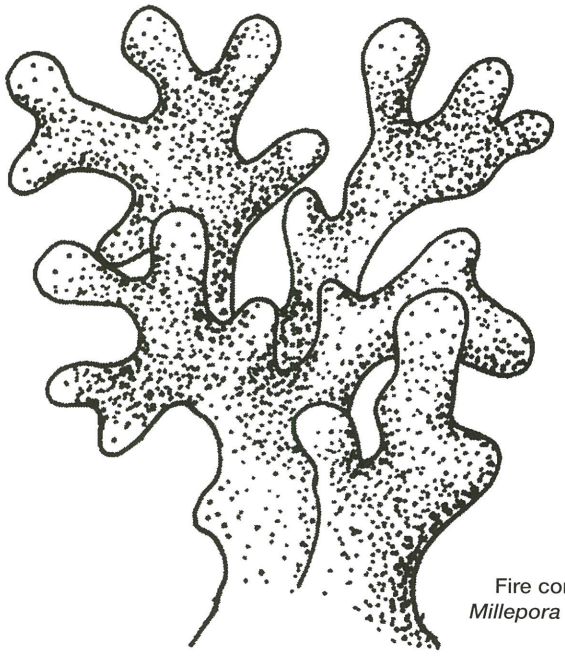


Blue bottle
Physalia utriculus

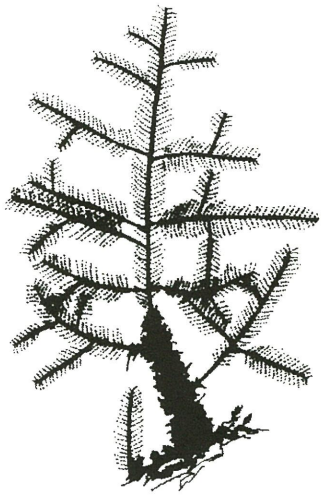
Blue Bottle Stings
Vinegar should not be used on blue bottle stings as it increases irritation – use only cold water and ice on the area.

BLUE BOTTLES

One of the most highly developed hydrozoans arethe blue bottles *(Physalia utriculus)*. Many people think that blue bottles are jellyfish. However, they are not – they are actually a colony of specialised individual polyps. Each individual is so highly specialised that they serve only one function – either reproduction, feeding, digestion or locomotion. Even the blue float is an individual polyp. They must, however, all live together to survive. The characteristic float is used as a sail to travel. Its shape causes the blue bottle to travel 45 degrees to the wind. There are two forms of blue bottle, those with right handed sails and those with left handed sails. This guarantees that some blue bottles will survive being washed ashore during a strong onshore wind. The dangling tentacles are used to 'fish' for food, with the primary tentacle trailing as much as 13 metres below the animal.



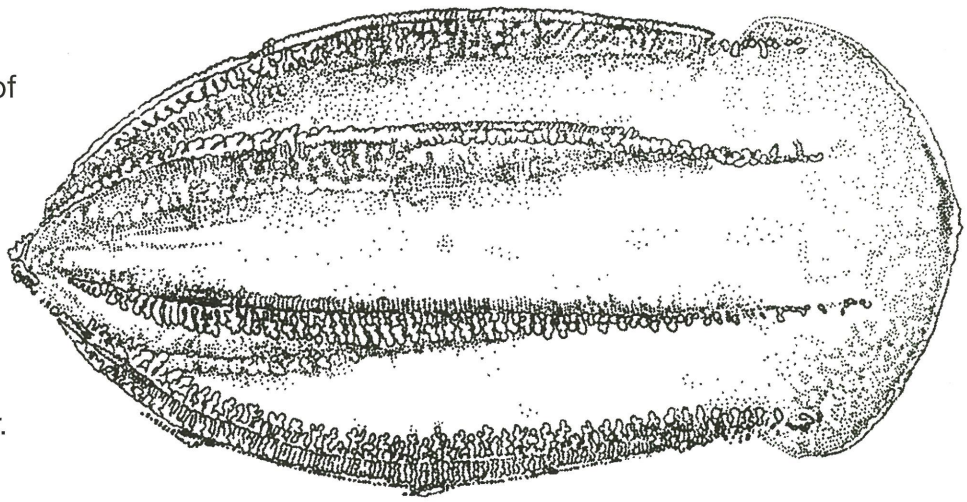
Fire coral
Millepora sp. *



Stinging
hydroid *
Millepora sp.

Comb Jellies

Comb jelly
Beroe sp.



Flashing all the colours of the rainbow as sun rays reflect off bands of beating hairs, comb jellies are some of the most intricate and delicate creatures to be encountered underwater.

PHYLUM CTENOPHORA
(Greek meaning 'bearing combs')
Pronounced te-nof'o-ra

Neon signs
The movements of the hairs (cilia) along the bodies of comb jellies catch sunlight and torchlight resulting in waves of all colours. Some species of comb jellies are bioluminescent - they produce their own light. This may help attract planktonic creatures that comb jellies feed upon.

Little known
Only about 80 species of ctenophores have been named. They are difficult to collect and study. Due to their delicate structure during long plankton trawls most comb jellies are destroyed.

Characteristics

- free-swimming
- eight bands of small hairs (cilia) are used for locomotion
- special glue cells (colloblasts) cover the two primary tentacles
- radial symmetry

Role on the reef

Comb jellies are one of the more noticeable members of the plankton community due to their relatively large size.

Feeding

Comb jellies are carnivorous, feeding upon zooplankton. The tentacles are covered in specialised cells (colloblasts) that produce glue that adheres to passing prey. The tentacles draw the food up into the mouth.

Defence

Comb jellies do not have any specialised defensive structures. They mostly rely on their transparency to avoid being detected by predators.

Reproduction

They are hermaphroditic with eggs and sperm being shed through the mouth into the ocean. A few species brood their eggs internally.

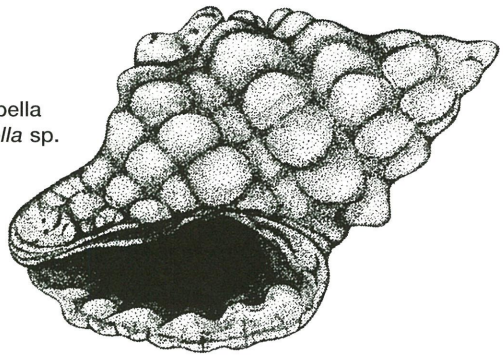
Human use and impacts

These creatures make beautiful subjects for night-time photography. Divers should be aware of the surrounding environment when photographing comb jellies, to ensure that their fins are not damaging corals and other organisms.

History

Unknown – there are no fossil records. The comb jellies were once classified with the cnidarians in the phylum Coelenterata. The two groups were later separated since comb jellies do not possess stinging cells (nematocysts).

Shells, Nudibranchs and Squids



Drupella
Drupella sp.

Elaborate and ornate, shells are the true jewels of the reef. This group of organisms range from giant clams to the intelligent and enchanting octopus.

PHYLUM MOLLUSCA
(Latin meaning 'soft')
Pronounced mol-lus'ka

Characteristics

- a muscular foot used for crawling, burrowing or swimming
- a flap of tissue called the mantle that secretes a shell
- specialised feeding apparatus – radula or rasping tongue
- most types protected by a hard shell

Role on the reef

Molluscs play many roles on the reef from coral burrowers and destroyers, to plant grazers and active hunters.

Feeding

There is a great range of food types and feeding adaptations amongst the molluscs. The radula, a tongue-like structure covered in teeth, is the basic feeding apparatus common to most molluscs.

Herbivorous molluscs, such as trochus, use the radula to scrape algae off coral rubble.

Carnivorous species scavenge and hunt food: some have special adaptations of the radula to drill holes in other shells. Others, such as cone shells, use a modified radula to fire poisonous darts.

Filter feeders including bivalves (clams and oysters), draw water into their body and filter out food using gill structures. Giant clams, like corals, have symbiotic algae (zooxanthellae) which supply extra nutrients.

Defence

The shell is a major form of protection for molluscs. Many snails have a bony plate called the operculum that acts like a door and closes after the soft body of the snail has withdrawn into its shell. Brightly coloured nudibranchs, which don't have shells, use their colour to advertise that they are toxic to potential predators. Nudibranchs rarely produce their own toxin but recycle the toxins and stinging cells absorbed from their prey (sponges and cnidarians). The octopus, cuttleto get away from predators.

Reproduction

Sexes are separate in most molluscs. Snails and nudibranchs have internal fertilisation. Eggs produced are deposited in a protective case. From the egg a swimming planktonic stage hatches, and in some species such as baler shells, miniature snails emerge. Parent cowries may stay with the eggs for up to two months until hatching. Male cephalopods (octopus, cuttlefish, squid) use a modified arm as a copulatory organ. Giant clams are hermaphroditic and release the eggs and sperm into the water column where they combine to form a planktonic larval stage; mass spawnings are triggered by other individuals spawning.

Human use and impacts

Shell collecting is regulated throughout the Marine Park by zoning plans which allow people to collect in some places, but not others. Visitors should be encouraged to leave shells behind, even dead ones to be used by other animals as homes. Many shells such as helmet, triton (trumpet), giant clam shells and all shells carrying egg masses may only be taken with a permit. Generally, permits are restricted to users such as scientific research or traditional hunting and gathering.

Giant clams are particularly vulnerable to harassment by divers and snorkellers. To minimise stress to these animals, visitors should be encouraged to "look not touch".

Giant clams have been heavily collected both legally and illegally throughout the Pacific and in parts of the Great Barrier Reef for food. Clam farming operations are now being established to raise clams to reduce the impact on natural populations.

Other commercially important molluscs include the trochus shell which is commercially harvested within the Marine Park.

History

Molluscs first appeared 530 million years ago. The voyage of James Cook to the Pacific region encouraged the European interest in shell collecting when many of the sailors returned home with shells to sell.

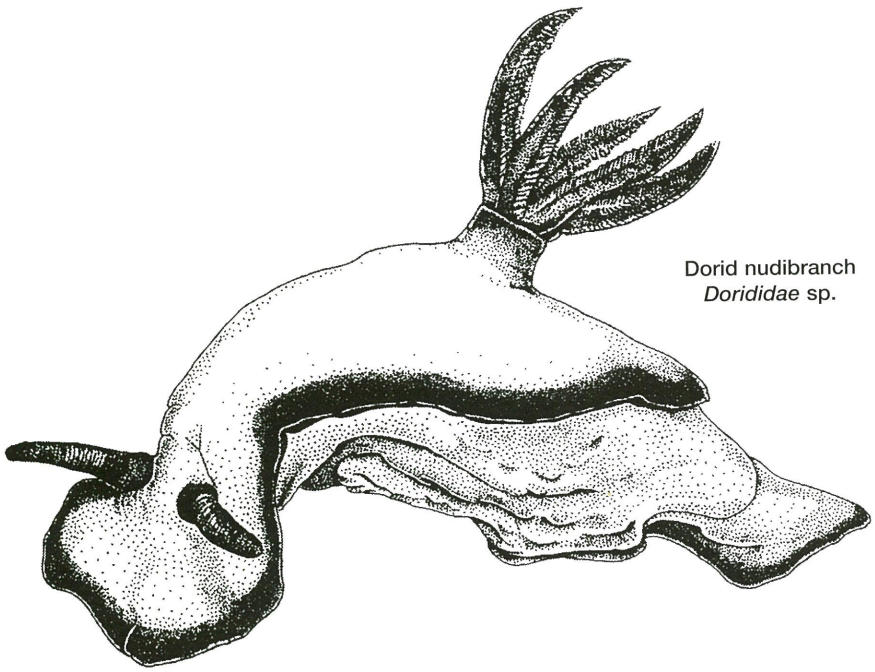
SNAILS AND NUDIBRANCHS

Class Gastropoda

(Greek meaning 'belly foot')
Pronounced gas-trop'o-da

- body usually in a coiled shell (shell uncoiled in some)
- head well developed, with radula (tooth-covered tongue)
- large flat foot

This is the largest class of molluscs and probably the most familiar of all the groups. It includes the garden snail.

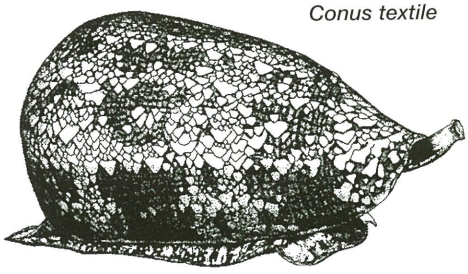


Dorid nudibranch
Doridae sp.

CONE SHELLS

The beautiful cone shell is a hunter that uses venomous harpoons to kill its prey. Most feed on worms but some species specialise in feeding on other shells and a few on fishes. These shells are capable of smelling prey a great distance away, and keep 'tasting' or 'sniffing' the water until they locate the prey. The rasp-like tongue has become modified into a hollow harpoon filled with venom. The venom is extremely potent, killing the prey almost instantly. Being slow moving, the cone shell needs a potent venom so the prey doesn't have a chance to swim or crawl out of reach. There have been a number of human fatalities due to cone shells as the fish feeding species have venom toxic to vertebrates including humans. The potentially dangerous cone shells include the geographer cone *(Conus geographus)*, tulip cone *(Conus tulipa)*, striated cone *(Conus striatus)*, magician cone *(Conus magus)*, textile cone *(Conus textile)*, marble cone *(Conus marmoreus)* and the court cone *(Conus aulicus)*.

Textile cone shell
Conus textile

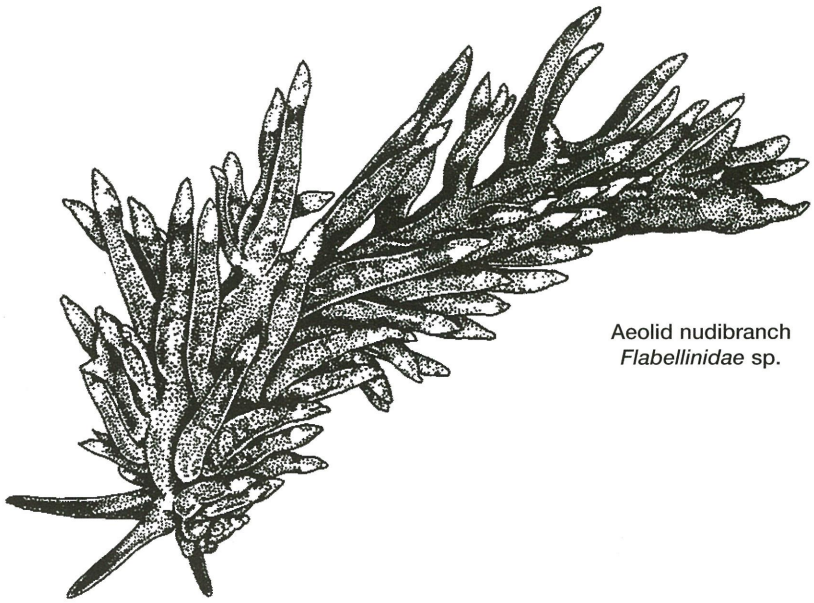


NUDIBRANCHS

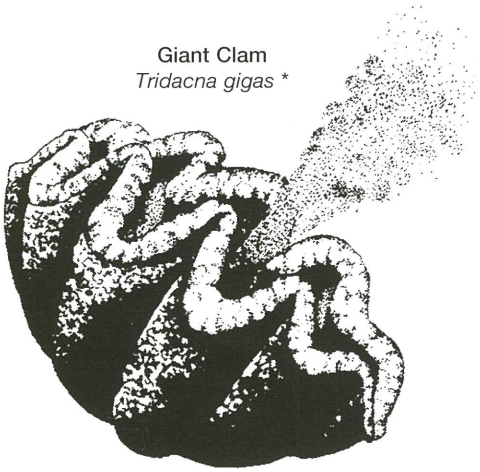
The colourful nudibranch has discarded the characteristic shell of other snails and relies on toxins within its skin for protection. For many nudibranchs their bright colour patterns act as a warning for potential predators. Other nudibranchs are cryptically camouflaged to their surrounds. The name nudibranch means 'naked gill' and refers to the gill structure on the back of these creatures.

There are two main groups of nudibranchs, the dorids and aeolids. Dorids mainly feed upon sponges. Many species reuse the toxins contained within sponges for their own protection.

Aeolids are easily identified by the tubular projections on their back called cerata. This type of nudibranch feeds on cnidarians, such as anemones, corals and hydroids. Aeolids are able to digest stinging cells and relocate them to the tip of each of the cerata where they are used for the nudibranch's own defence. Like corals some aeolids contain symbiotic zooxanthellae.



Aeolid nudibranch
Flabellinidae sp.



Giant Clam
Tridacna gigas *

CLAMS AND OYSTERS

Class Bivalvia
(Latin meaning 'two folding doors')
Pronounced bi-val've-a

- two shells with a hinge
- no identifiable head
- no radula
- foot normally wedge shaped

GIANT CLAM

The giant clam *(Tridacna gigas)* is only found in shallow, warm tropical waters of the Indo-Pacific region. Like reef-building corals, clams depend on microscopic zooxanthellae for their main source of nourishment. These plant cells are 'farmed' within the clam's body. Recent research indicates the giant clams rely wholly on zooxanthellae for nutrients.

Clams form seasonal growth bands in their shell much like the growth rings of a tree. These bands make it possible to age clam shells. Research has shown that clams have quite a fast growth rate. The oldest reliably dated clam was a large specimen which was 75 years old.

OCTOPUSES, CUTTLEFISH, NAUTILUS AND SQUIDS

Class Cephalopoda
(Greek meaning 'head footed')
Pronounced sef'a-lop'o-da

- shell often modified or absent
- head well developed with eyes
- foot modified into a funnel
- tentacles
- parrot-like beak used for feeding
- ink used for protection in all groups except the nautilus
- all capable of colour changes except nautilus

The cephalopods are the most highly advanced form of mollusc. They are the most intelligent invertebrate group; octopuses can easily be trained to open jars and perform simple tricks.

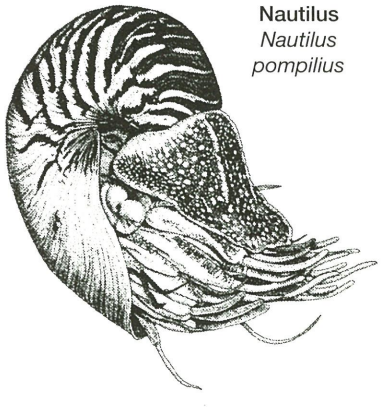
NAUTILUS

The nautilus is the only cephalopod with a true external shell. The inside of the shell is divided into many pearly gas-filled chambers. The nautilus usually spends the day living in the deep (600 m) cool waters off the edge of the reef. At night they rise about 70 m to feed on crustaceans on the reef.

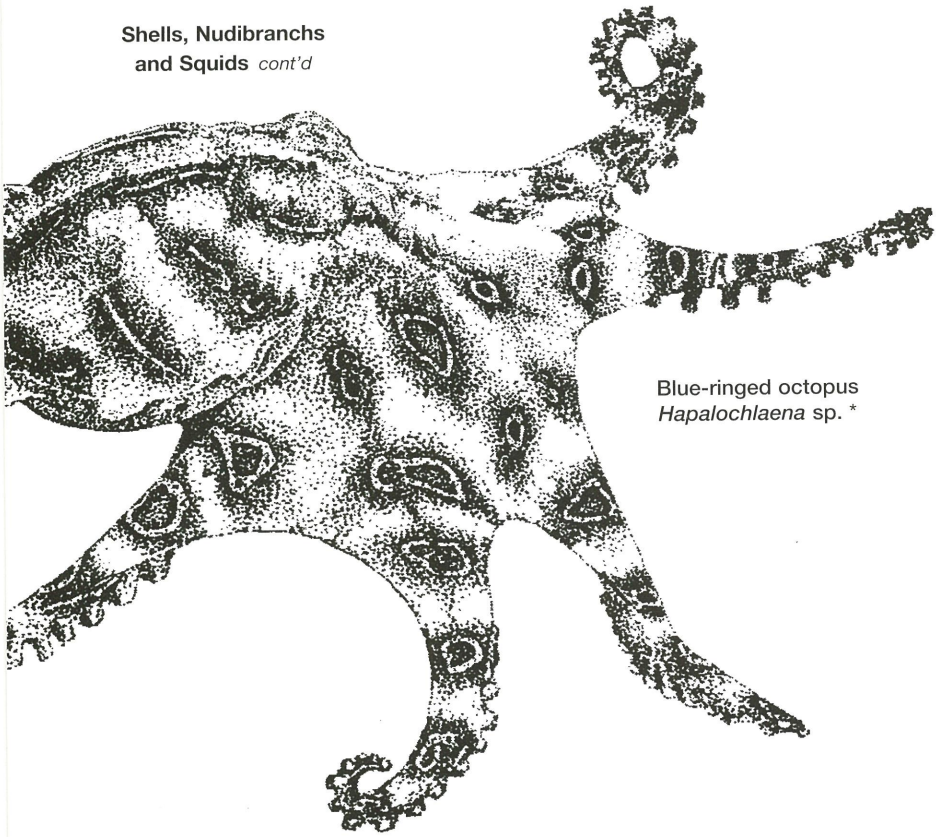
Nautilus have more than ninety tentacles, protected by a leathery hood that is formed by two specially folded tentacles. The eyes of the nautilus are less developed than in the other cephalopods. They do not have lenses -their eyes operate like a pinhole camera.

Largest pearl

Oysters and clams cover irritants such as sand grains in their shell with layers of calcium carbonate, eventually forming pearls. The largest pearl ever found came from a giant clam in the Philippines. It weighs over six kilograms, looks like a human brain, and is called the Pearl of Lao-tze.



Nautilus
Nautilus pompilius



Blue-ringed octopus
Hapalochlaena sp. *

Sea monsters
Giant squids are the largest animals without a backbone in the world. They can grow up to 20 metres long with eyeballs larger than a dinner plate.

Dying to love you
Cephalopods have elaborate courtship behaviours and unusual mating habits. The male octopus is identified by a modified third right arm which also serves as a copulatory organ. During mating the male inserts this arm through an opening in the female's head and sperm are pumped in to fertilise her eggs. This behaviour is often referred to as 'nasal sex'. The male of most species usually dies after mating. The fertilised female lays eggs in a den where she remains until they hatch. She dies soon after.

BLUE-RINGED OCTOPUS

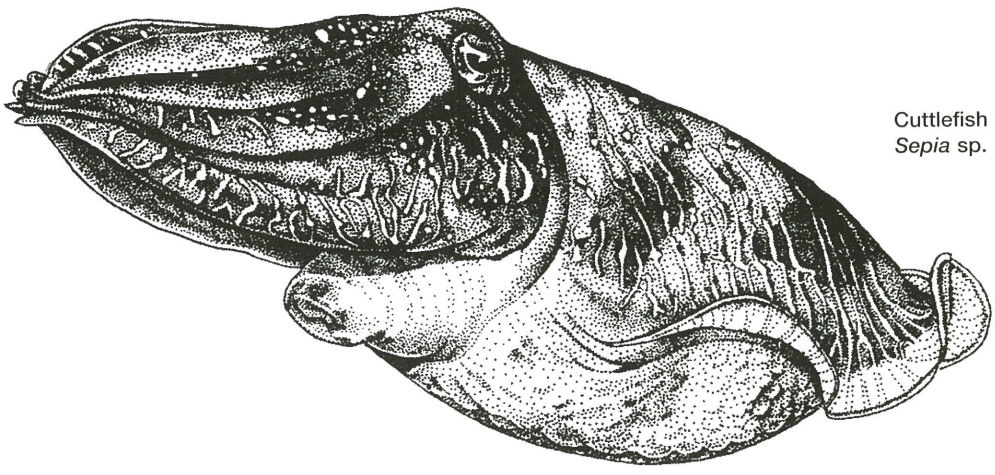
The blue-ringed octopus is the most lethal octopus in the world. A number of species occur in Australian waters, most of which do not exceed 20 centimetres from the top of their body to the tips of their arms. These octopus are normally drab in appearance with the blue rings only showing when the animal feels threatened or senses large animals approaching. Like all octopus, the mouth of a blue-ring has a parrot-like beak. When this beak pierces the skin, venom is injected. The venom of a blue-ringed octopus is the same venom that is found in pufferfish; known as tetrodotoxin or TTX. It causes paralysis, and there is, as yet, no antidote.

CUTTLEFISH

Cuttlefish are well known for spectacular colour and skin texture changes which can indicate their mood. Like other members of their family, the cuttlefish has a relatively short lifespan of approximately 18 months. This is due to their unusual circulatory system which involves three hearts and a copper (as opposed to iron)-based green blood. This system requires so much energy that the cuttlefish literally wears out after 18 months of living. Cuttlefish have eight arms and two tentacles. When feeding upon crustaceans and fish, two tentacles quickly snatch the prey and draw it up towards a beak-like mouth beneath the arms. The cuttlebone, well known by beach goers, is a porous internal structure used by the cuttlefish to control its buoyancy.

SQUID

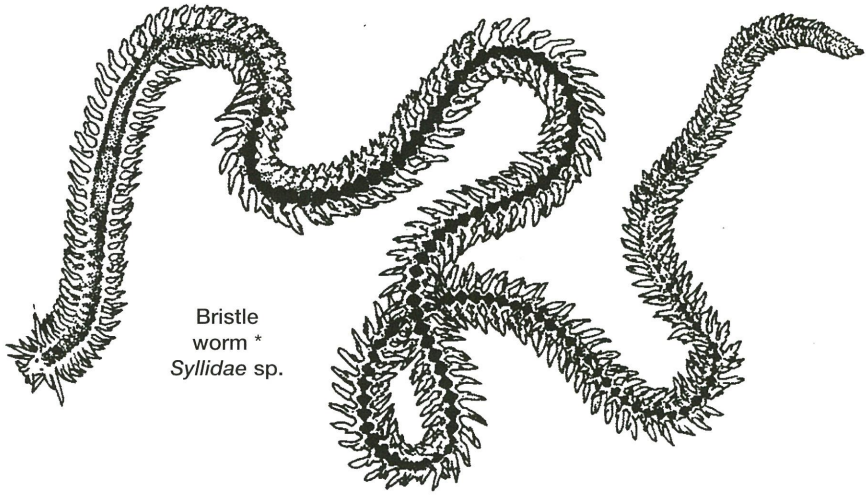
With their streamlined, torpedo-shaped body, excellent eyesight and active swimming life style, squid show more similarities to fish than to other molluscs. Unlike cuttlefish, which are mostly solitary, squid often move about in small shoals. They lack the internal chalky bone of the cuttlefish, instead relying on a thin membranous structure called the pen for support. When disturbed, squid squirt a cloud of black ink into the water to help mask their escape.



Cuttlefish
Sepia sp.

Marine Segmented Worms

Marine worms vary a great deal from the garden variety with which we are familiar.



Bristle worm *
Syllidae sp.

PHYLUM ANNELIDA
(Latin meaning 'little ring')
Pronounced an-nel'i-da

CLASS POLYCHAETA
(Greek meaning 'many long hairs')
Pronounced pol'e-ke'ta

Characteristics

- worm shape
- segmented body
- head distinct, bearing eyes and tentacles – reduced in tube-dwelling forms
- most segments have appendages, bearing bundles of bristles

Role on the reef

Worms play an important role in the breakdown of corals. In a research program conducted at Heron Island, a dead coral colony weighing over three kilograms was broken open. Over two-thirds of the organisms collected from the coral were worms; in fact there were 1441 worms belonging to 103 species.

Feeding

Free-living worms use their pincer-like jaws to feed on other organisms. Sessile species, such as tube worms, use their feather-like feeding appendages to filter and capture plankton and food particles from the water.

Defence

Some segmented worms are covered with bristles that act like the quills on an echidna to discourage predators. These bristles are very sharp, like fine needles, and can easily pierce the skin. When touched they tend to break off becoming embedded and causing painful irritation. Sticking plaster can be used to remove the bristles from the skin.

Reproduction

Most worms have separate sexes, however, some are hermaphroditic, having both male and female sex organs. Some species undergo mass spawning sometimes at the same time as coral spawning. These species often develop long swimming lobes which help them swim up towards the surface during spawning. As the adult nears the surface, their bodies rupture freeing eggs and sperm. The adults then die.

Human use and impacts

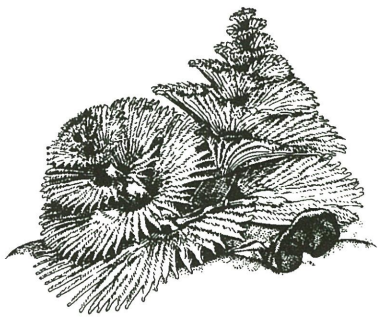
In Samoa, locals are able to establish the exact day of the palolo worm spawning and then catch them as they swim up towards the surface. These worms are regarded as a delicacy, tasting like caviar.

History

Segmented worms date back over 500 million years.

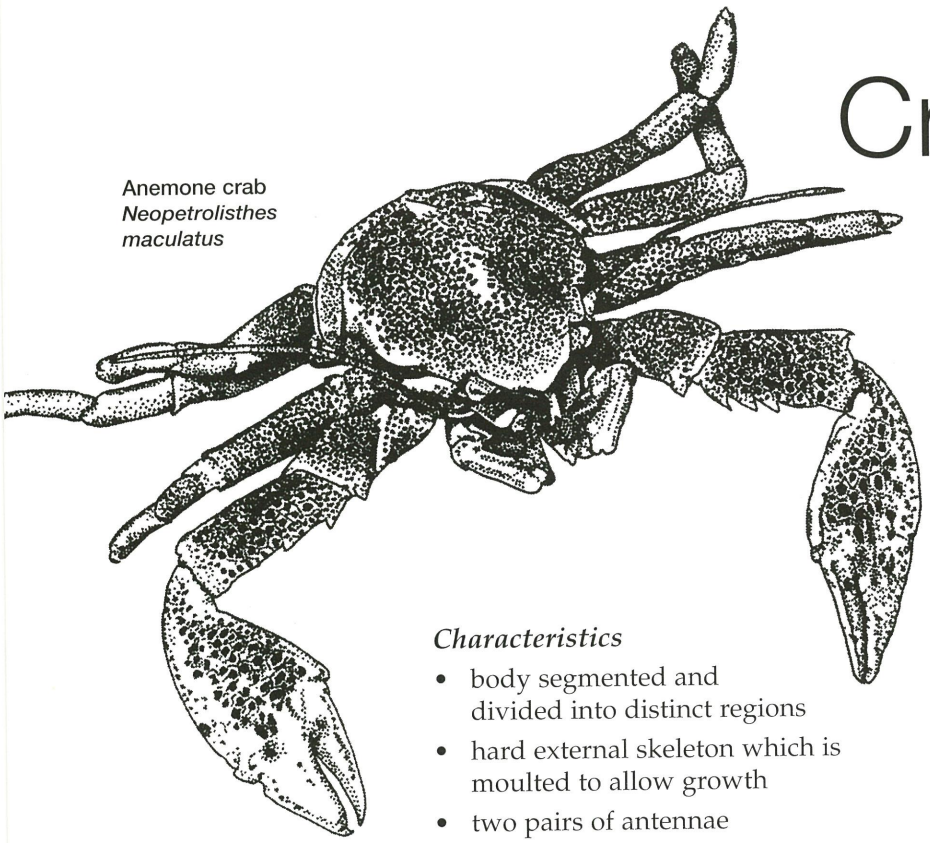
CHRISTMAS TREE WORM

A favourite with divers and snorkellers is the colourful Christmas tree worm *(Spirobranchus giganteus)*. It is usually found burrowed into the massive coral Porites sp. The 'Christmas trees' are gills which filter food from the water. These worms are very sensitive to shadows and vibrations – quickly pulling into their tube and closing a 'trap door' over the top. These worms spawn in the slack tide in the first lunar quarter in October. The larvae settle on coral colonies where a polyp has been damaged (e.g. from parrotfish scraping) and secrete a tube. The worm does not bore into the coral, rather the coral grows over the tube. The Christmas tree worm then grows at the same rate as the coral to stay on the coral's surface.



Christmas Tree worm
Spirobranchus giganteus

Crustaceans



Anemone crab
Neopetrolisthes maculatus

These crusty critters are one of the most loved invertebrates, particularly on the dinner plate.

PHYLUM ARTHROPODA
(Greek meaning 'joint foot')
Pronounced ar-throp'o-da

SUBPHYLUM CRUSTACEA
(Latin meaning 'shell group')
Pronounced crus-ta'she-a

Snap, crackle, pop (not a silent world)
The continuous clicking sound heard when diving, is produced by the reef's crustaceans. The snapping shrimp uses a modified claw to produce loud cracking sounds as a means to defend itself against predators.

Characteristics

- body segmented and divided into distinct regions
- hard external skeleton which is moulted to allow growth
- two pairs of antennae
- jointed appendages

Role on the reef

Crustaceans play a varied role on the reef, from scavenging on the bottom to cleaning parasites off fish. A close inspection of branching coral reveals brightly-coloured xanthid crabs at the base. It has been suggested that these crabs may help protect corals from crown-of-thorns starfish by nipping their tubed feet, making the starfish withdraw.

Feeding

Crustaceans have a wide range of food types and feeding mechanisms. Barnacles and anemone crabs use fine hairs on their appendages to filter food from the water. Most of the larger crustaceans are scavengers, feeding on dead matter and detritus. The cleaner shrimp is a highly specialised feeder, feeding on the mucus and parasites covering the skin and gills of fish.

Defence

Anyone who has tried to pick a fight with a crab soon realises how manoeuvrable the large nippers can be. The hard outer covering of the exoskeleton also acts as a suit of armour.

Most of the reef's crustaceans hide in crevices during the day, venturing out under the cover of darkness. Night dives are the best way to view these crusty critters.

Reproduction

Crustaceans can only mate when they are soft, not hard. The male usually has modified appendages to help clasp the female during mating which usually follows shortly after moulting. Moulting is the process that allows crustaceans to grow larger. They regularly shed their exoskeleton allowing the new one underneath to expand before it hardens. Most crustaceans hold their eggs until they hatch, the larvae swimming up to the surface where they live amongst the plankton until they're ready to settle.

Human use and impacts

Prawns are a very important commercial fishery worth over $150 million a year. Commercial fishing for tropical lobster exists in the Torres Strait where divers operate out of small boats. Northern crayfish, unlike their southern relatives, will not enter traps.

History

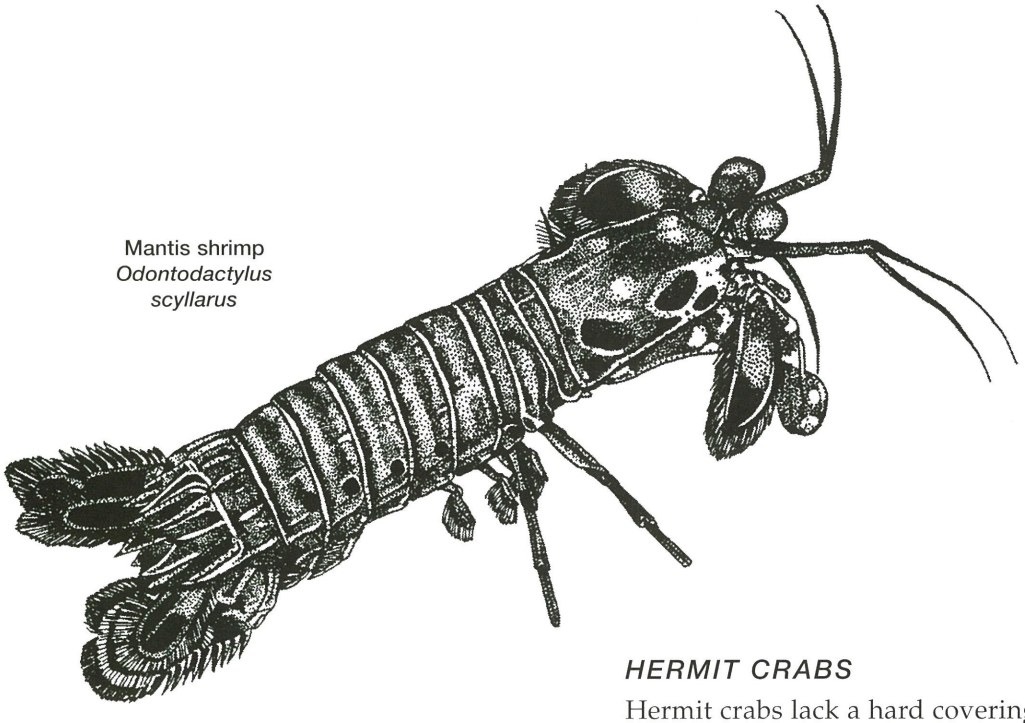
Crustaceans first appeared 530 million years ago.

CRABS, CRAYFISH, PRAWNS AND SHRIMPS

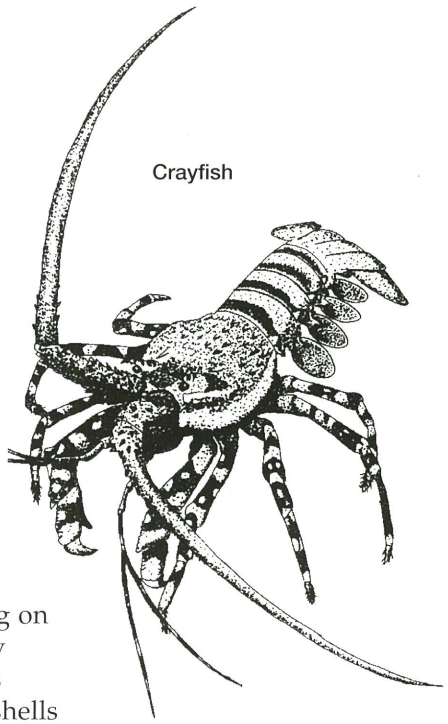
Class Malacostraca
(Greek meaning 'soft shell')
Pronounced mal-a-kos'tra-ka

Order Decapoda
(Greek meaning 'ten feet')
Pronounced de-cap'o-da

- five pairs of walking legs
- first pair of legs modified to form pincers



Mantis shrimp
Odontodactylus scyllarus



Crayfish

MANTIS SHRIMP

Also known as prawn killers, mantis shrimps are voracious predators feeding on other crustaceans and small fish. They live amongst the coral and in burrows in the sand. The claws of these creatures are quite formidable and come in two forms: clubs or spears. Their claws are 'cocked' back, ready to shoot forward at passing prey. Those mantis shrimps which possess clubs, use them to smash the legs off other crustaceans and to crack open their shell. They also break snail and clam shells with the power of a twenty-two calibre pistol to feed on the soft tissue inside. Those with spear-like claws can strike and kill fish and other animals at the speed of a 0.22 calibre bullet. In captivity, mantis shrimp have been known to smash glass aquariums.

HERMIT CRABS

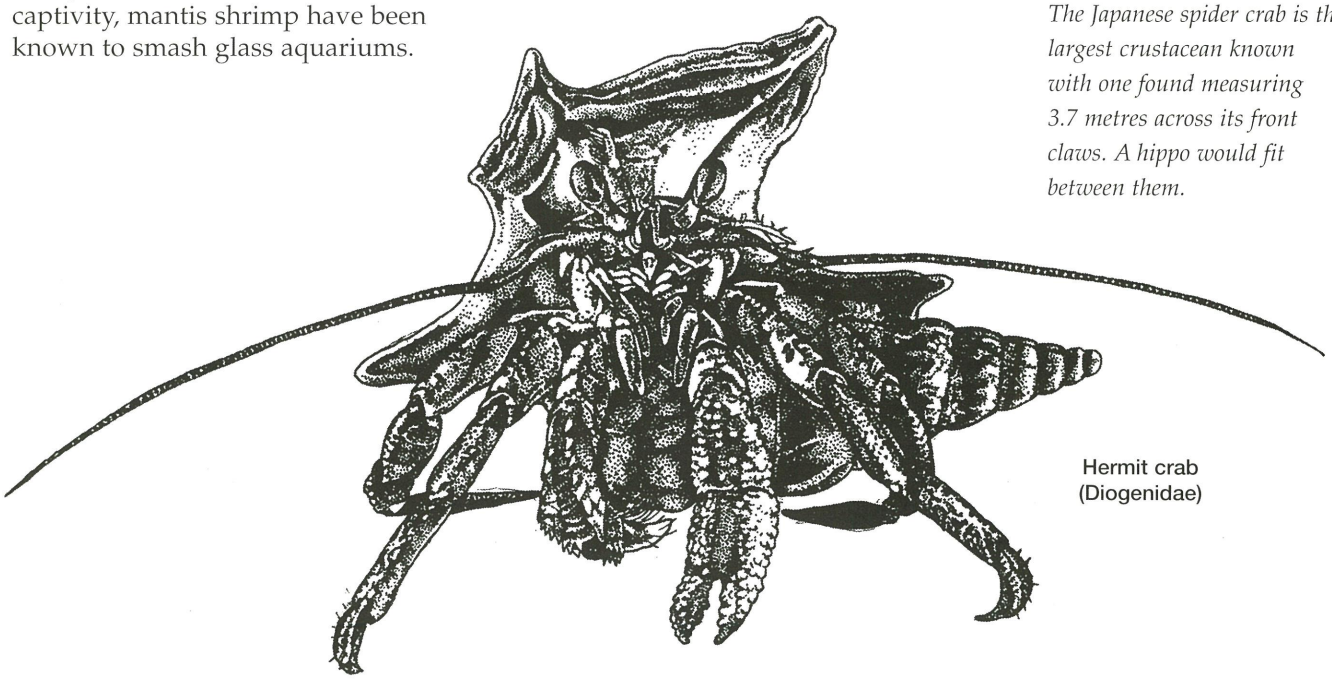
Hermit crabs lack a hard covering on their abdomen and rely on empty shells for protection. As the crabs grow larger they swap their old shells for new ones. In some cases they will kill the owner of the shell. Some hermit crabs are able to further enhance their protection through a symbiotic relationship with sea anemones, where the anemone lives on the shell of the hermit crab. The stinging cells of the anemone discourage the crab's predators and in return the anemone feeds on the food particles produced when the crab feeds. Other hermit crabs actively break off pieces of sponge and seaweed and put them on their shells for camouflage.

Anemone crab

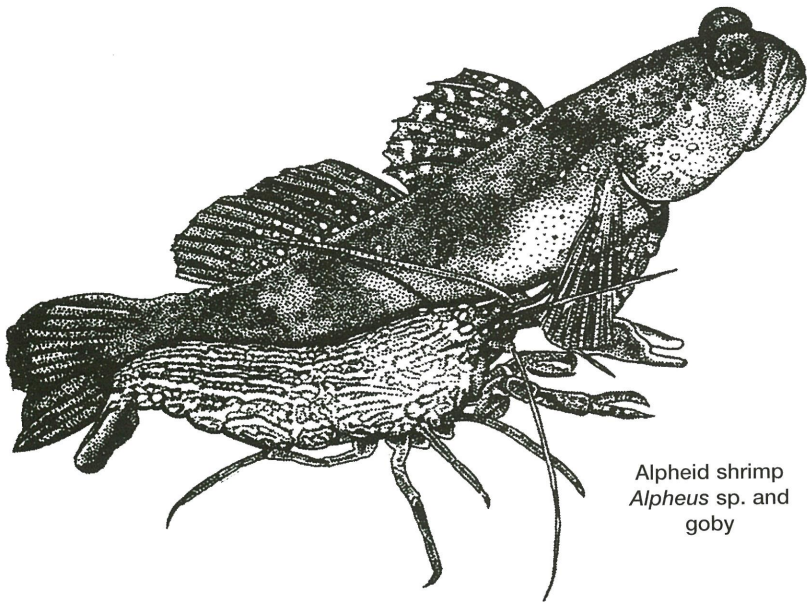
Like clownfish there are a number of crab and shrimp species that live with sea anemones. One crab species has anemones living on its claws which are used to box potential predators.

Biggest crab

The Japanese spider crab is the largest crustacean known with one found measuring 3.7 metres across its front claws. A hippo would fit between them.



Hermit crab
(Diogenidae)



Alpheid shrimp
Alpheus sp. and
goby

Well hung
Barnacles have the largest penis to body size ratio (30x) in the animal kingdom. This organ is used to reach into other barnacles during mating.

Fastest claw in the west
Mantis shrimp can strike their prey with their formidable claws at 1/125th of a second with the power of a 0.22 calibre bullet.

Decorators
Decorator crabs use assorted debris and living organisms to cover their bodies to aid in camouflage.

Good shot
Pistol shrimps can kill small fish up to 1.8 metres away by sending a shock wave through the water when they snap their large right claw.

CRAYFISH

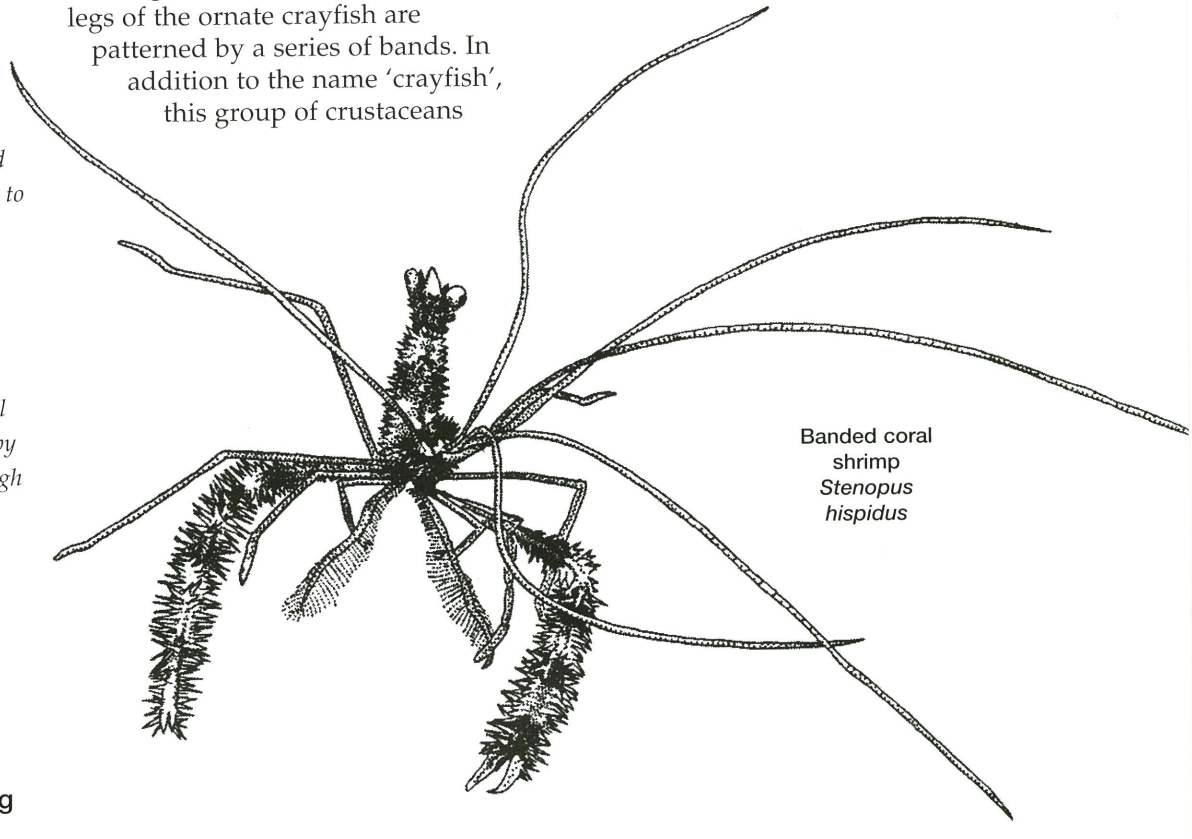
A pair of long slender antennae extending from under a coral ledge is generally the first indicator to the presence of a crayfish. The most commonly encountered species on the reef are the painted and the ornate crayfish, *Panulirus versicolor* and *Panulirus ornatus*, both of which are attractively coloured. Painted crayfish can be easily identified by a stripe running down their legs whereas the legs of the ornate crayfish are patterned by a series of bands. In addition to the name 'crayfish', this group of crustaceans has a confusing number of names: crayfish, cray, lobster, rock lobster and spiny lobster. Generally the name crayfish is used for those large marine crustaceans without claws.

BANDED CORAL SHRIMP

The banded coral shrimp *(Stenopus hispidus)* is one of the best known cleaner shrimp species. They clean parasites and excess mucus off fish. Their long antennae and red and white bodies are quite distinctive. Usually found in pairs, the male is normally smaller than the female. When reproductively active, the female has aqua blue coloured ovaries inside her abdomen which can easily be seen through her body.

ALPHEID SHRIMP AND GOBIES

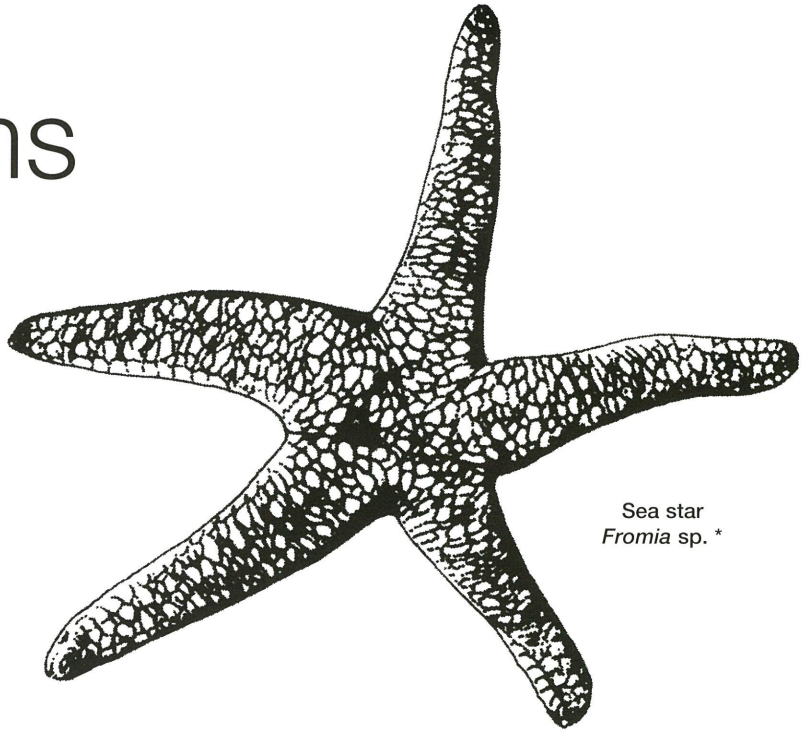
A number of alpheid shrimp live together in symbiotic relationships with different species of gobies. The shrimp normally shares a common burrow with a pair of gobies. The shrimp excavates and constantly tends to the burrow while the gobies act as sentinels. If there is any danger, the gobies retreat into the burrow giving the shrimp a warning.



Banded coral
shrimp
Stenopus
hispidus

Echinoderms

With five-part symmetry, hydraulically-controlled movement and spiny skin, the echinoderms are truly in a class of their own. The variations on these characteristics range from sausage to star shapes and to a ball of spikes.



Sea star
Fromia sp. *

PHYLUM ECHINODERMATA
(Greek meaning 'spiny skin')
Pronounced e-ki'no-der'ma-ta

Characteristics

- radial symmetry (5 rays)
- no head or brain
- unique water vascular system
- movement by tube feet
- skeleton of calcareous plates under the skin

Role on the reef

Echinoderms play varied roles on the reef. Sea cucumbers act as vacuum cleaners as they feed on detritus from the sand, while sea urchins graze upon algae and are one of the primary herbivores in reef communities. A mysterious die-off of sea urchins has caused some Caribbean reefs to become overgrown with algae.

The crown-of-thorns starfish plays a major role in the destruction of fast growing coral species. If left unchecked fast growing species of coral would eventually out compete the slower growing species on reefs. Cyclones and large aggregations of crown-of-thorns starfish prevent this by periodic culling of these species.

Feeding

Within this group of spiny-skinned creatures there is a great range of feeding techniques. Feather stars (crinoids) and some species of sea cucumbers use modified arms to filter food from the water. Sea urchins use a jaw structure known as 'Aristotle's lantern' to scrape algae from rocks.

Sea stars (starfish) don't send food to their stomach, they send their stomach to their food. When sea stars are sitting on top of their food the stomach everts through the mouth to cover and digest the food externally. This stomach, looking like jelly, can often be seen when sea stars are turned over. Like vacuum cleaners, sea cucumbers eat sand to extract food particles and pass out clean sand from the other end.

Defence

The characteristic spiny skin that covers many of these creatures is a major form of defence, with some groups such as sea urchins, having toxins covering the spines. Some sea stars and sea urchins have appendages with pincers called pedicellariae, also used for defence. In some cases these are venomous as in the flower fire urchin (Toxopneustes pileolus).

Sea cucumbers look harmless but they have a dramatic way of defending themselves. If threatened, they shoot out sticky, spaghetti-like threads which entangle the attacker. Beach-ball sea cucumbers and a few other species rely on the release of toxins to discourage predators.

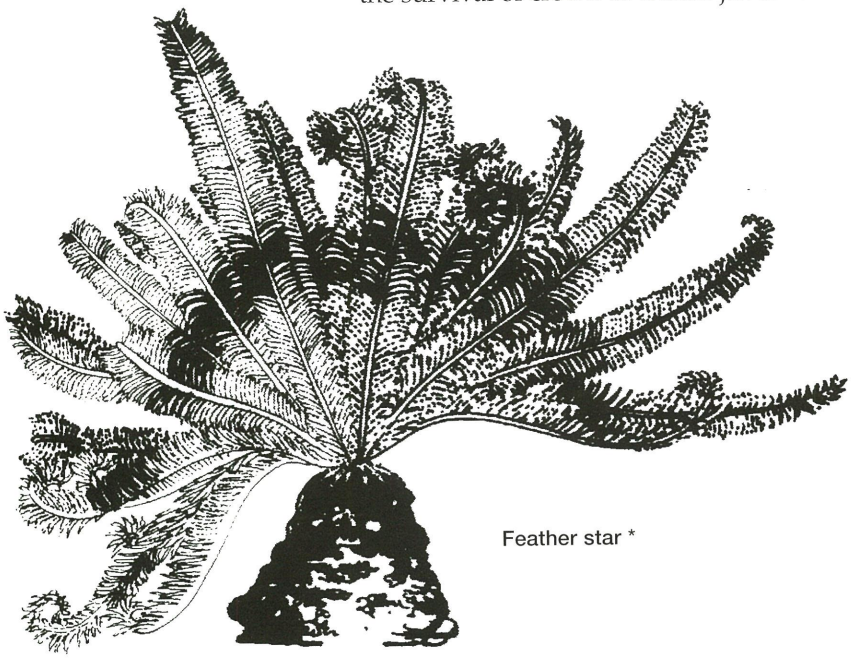
Reproduction

Many sea stars and brittle stars are able to reproduce asexually when parts of their bodies break off and grow. In some cases the leg of a sea star will simply walk away from the rest of the body.

Sexual reproduction usually involves mass spawning. Many sea cucumbers rear up like snakes and sway in the water as eggs and sperm are released from a pore on their head. The crown-of-thorns starfish is one of the ocean's most productive spawners releasing over 100 million eggs each year. Prior to reproduction almost the entire body cavity of sea stars, sea urchins and sea cucumbers are filled with gonads.

Human use and impacts

One theory why outbreaks of crown-of-thorns starfish occur is that increased levels of nutrient run-off from the mainland help increase the amount of planktonic algae. Crown-of-thorns starfish feed on this algae during their planktonic stage and any increase in the amount of algae may lead to increase in the survival of crown-of-thorns juveniles.



Feather star *

Sea cucumbers, or bêche-de-mer, were commercially harvested from the northern waters in the Great Barrier Reef long before European settlement. The sea cucumber fishery began as one of Australia's first export industries in the 1840s when they were sold mainly to Chinese markets. Today it is illegal to collect sea cucumbers without a permit.

Divers handling feather stars and sea cucumbers can easily stress and damage these animals. Some sea cucumber species expel sticky threads from their mouth as a defence mechanism. These threads are actually part of the stomach lining and can take a long time to regenerate.

Sea star or starfish?

Throughout this manual the more appropriate term sea star is used instead of starfish. However because of historical use, the word starfish in the name crown-of-thorns starfish has been maintained.

History

The first echinoderms started to appear around 570 million years ago. Some of the most ancient forms, called sea lilies or stalked crinoids, can still be found living at depths between 200 and 5000 metres.

WATER WORKS

The water vascular system of echinoderms consists of a series of canals and specialised tube feet. They use hydraulic pressure to move. The water pressure within the system is controlled by a valve-like mechanism called the madreporite. Muscles surrounding the top of each tube foot contract causing the foot to extend using water pressure. Relaxation of these muscles causes the tube foot to contract.

FEATHER STARS

Class Crinoidea

(Greek meaning 'lily like')
Pronounced krin-oi'de-a

- attachment of arms at the base
- mouth and anus on the upper surface
- filter feeder

The arms of these animals extend into the water column where they filter out food particles which travel down the grooves in the arms to the mouth. Unlike sea stars, the mouth of a feather star is located on top. Feather stars can often be found sitting on sea fans or in areas of high current. They attach themselves using legs, and have been known to stay in one spot with favourable currents for months. Specialised shrimp often live on the arms of the feather star and steal food as it travels down the grooves on the way to the mouth.

SEA STARS

Class Stelleroidea

(Latin meaning 'star like')
Pronounced stel'ler-oi'de-a

Subclass Asteriodea

(Greek meaning 'star like')
Pronounced as'ter-oi'de-a

- arms are not sharply marked off from the central disc
- tube feet are on the underside
- mouth located underneath

Sea stars come in all shapes and sizes on the reef. One of the most commonly

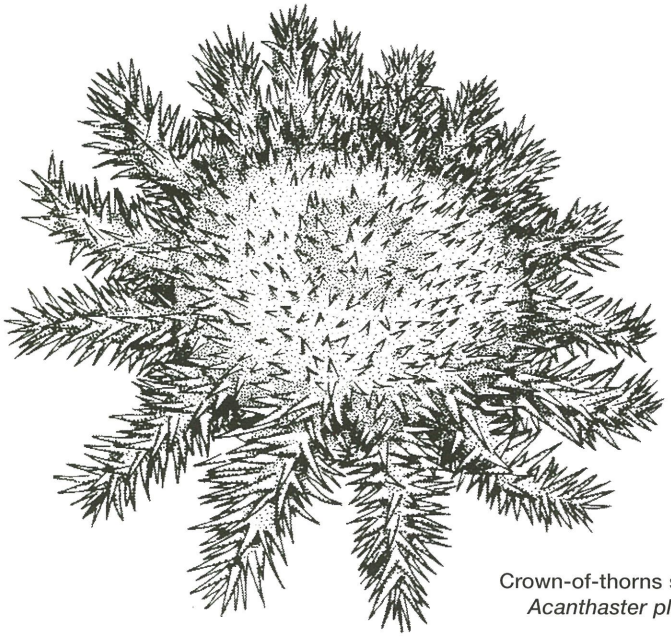
encountered is the cobalt blue, Linckia sea stars, often found on reef flats. Sea stars feed on a variety of foods ranging from algae and detritus, to living coral polyps as in the case of the crown-of-thorns starfish. During feeding the stomach is pushed out through the mouth allowing digestion to occur externally.

CROWN-OF-THORNS STARFISH

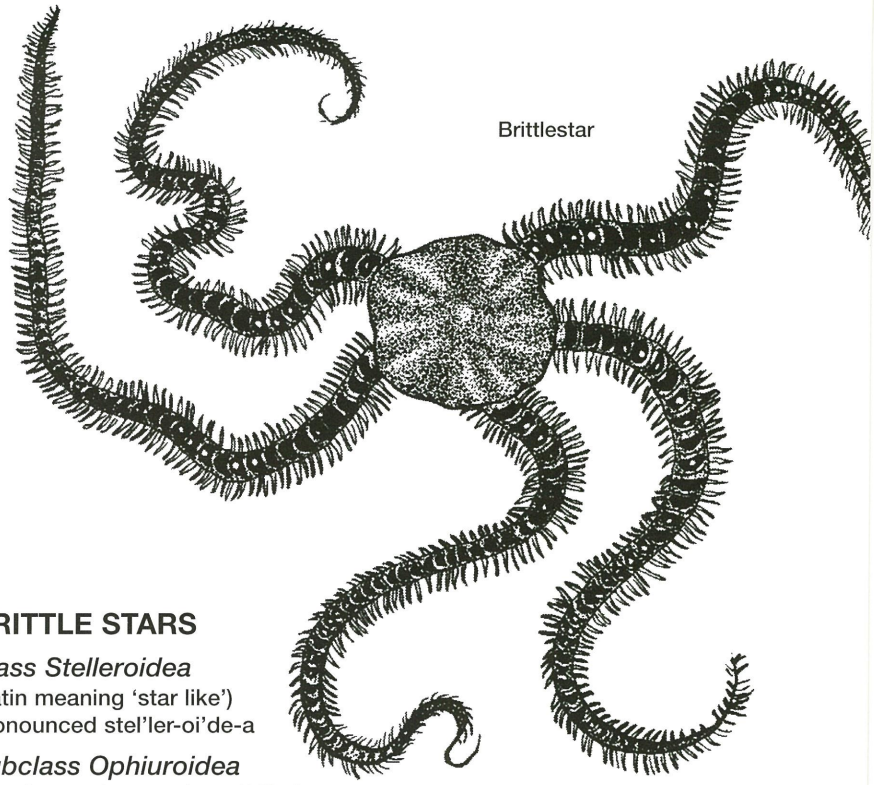
The crown-of-thorns starfish *(Acanthaster planci)* is a coral-eating species that can occur in large aggregations from time to time. The faster growing corals such as staghorns and plates are favoured by the crown-of-thorns starfish and it is for this reason that this sea star may be playing an important and natural role on the reef. If left unchecked, fast growing coral species would eventually overgrow a reef, leading to a decline in diversity. The periodic destruction of such corals by cyclones or crown-of-thorns starfish may help prevent this.

There are also theories that increased nutrients from human activities, linked with El Niño, may be causing the outbreaks by giving the planktonic larvae a better chance of survival. Natural predators of adult sea stars include the triton shell and triggerfish.

Crown-of-thorns starfish are aptly named as they are covered with sharp, venomous spines. These creatures should never be handled. The toxins on the spines can cuase severe pain and illness.



Crown-of-thorns starfish
Acanthaster planci



Brittlestar

BRITTLE STARS

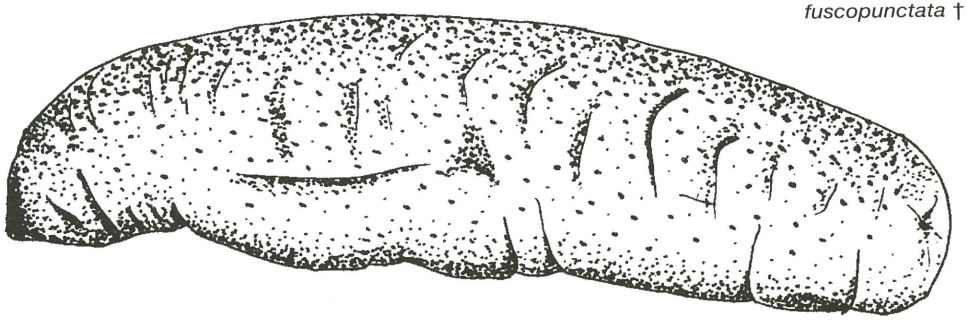
Class Stelleroidea
(Latin meaning 'star like')
Pronounced stel'ler-oi'de-a

Subclass Ophiuroidea
(Greek meaning 'snake-tail like')
Pronounced o'fe-u-roi'de-a

- arms sharply marked off from the central disc
- snake-like arm movements are used for locomotion

Brittle stars are often found living under rocks during the day. When disturbed they quickly move away using their arms in a rapid snake-like motion. A close examination of a piece of coral rock may reveal small species holding their arms up into the water to feed on plankton. Large specimens have been known to feed on fish caught while sleeping.

Sea cucumber
Holothuria fuscopunctata †



Relief
In some Pacific islands urine is applied to sea urchin wounds to relieve pain.

Living where the sun shines
Sea cucumbers sometimes have a commensal fish known as the pearl fish (Carpus sp.) living inside their anus during the day and emerging only at night to feed. When it wishes to re-enter the sea cucumber it waits for the anus to open (which is a regular event as sea cucumbers breath through their anus) and swims inside.

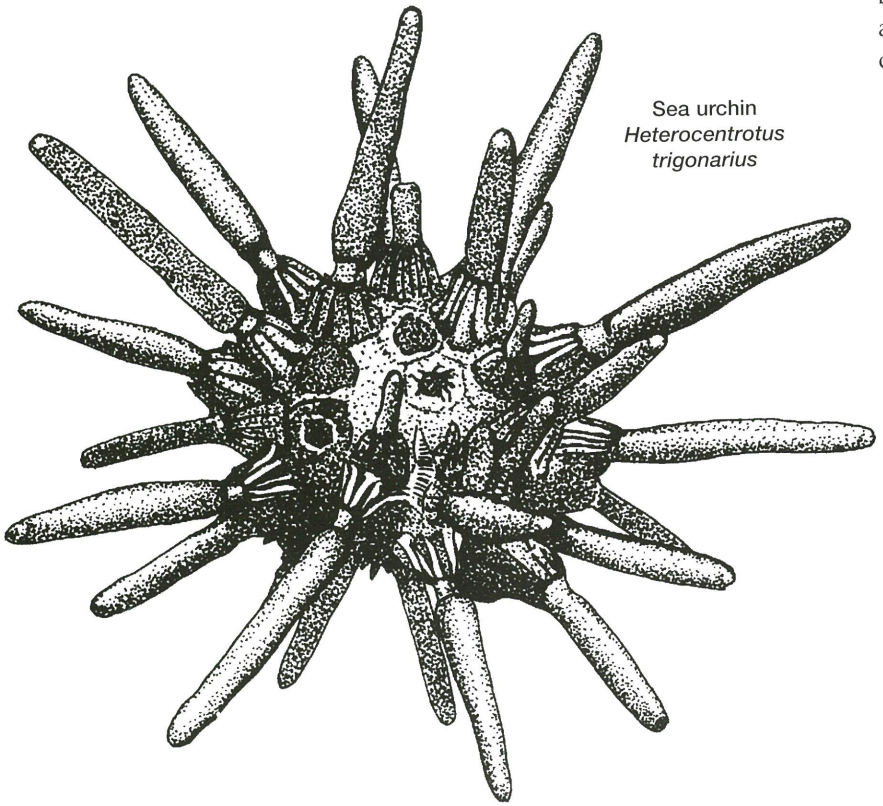
SEA URCHINS

Class Echinoidea

(Greek meaning 'spiny skin')
Pronounced ek'i-noi'de-a

- globe-shaped with no arms
- compact skeleton with closely fitted plates
- moveable spines with a 'ball and socket' joint
- powerful scraping jaws known as 'Aristotle's lantern'

Sea urchins are one of the primary herbivorous groups using their multi-toothed mouth to graze on algae on the reef. The anus, often surrounded with light receptors, is located on the upper surface. These animals are nocturnal, hiding in crevasses during the day and emerging at night to feed. Predators of sea urchins include octopus and triggerfish, which bite off the spines enabling the fish to crack open the body of the urchin.



Sea urchin
Heterocentrotus trigonarius

SEA CUCUMBERS

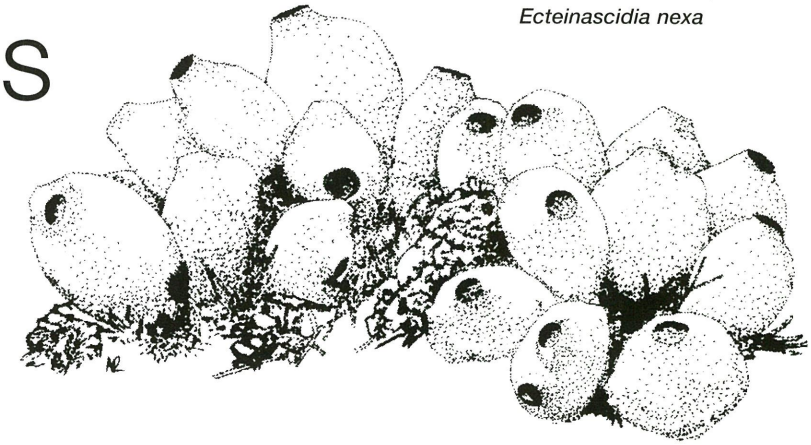
Class Holothuroidea

(Greek meaning 'sea cucumber like')
Pronounced hol'o-thu-roi'de-a

- cucumber-shaped with no arms

Most sea cucumbers feed on the detritus (dead plant and animal material) in the sand. The sand is taken in through the mouth, the detritus digested and the clean sand expelled through the anus. Others, like the beach-ball sea cucumber, use feather-like arms to filter food from the water. Sea cucumbers have an unusual method of respiration as they take water in through their anus to breath. When stressed, many species of sea cucumbers eject a mass of sticky white threads from the anus as a defensive response. These threads can entangle any small fish or crustaceans trying to attack the sea cucumber. In addition many sea cucumbers are also capable of releasing toxins. These toxins have been known to kill all creatures in aquariums including the sea cucumbers themselves.

Sea Squirts



Yellow bubble ascidian
Ecteinascidia nexa

These little squirts are very advanced in structure and are actually related to humans (belonging to the same phylum – Chordata). Their larval stage is very similar in appearance to that of a tadpole, complete with rod cells (notochord) running down its back just like that of embryonic vertebrates.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

CLASS ASCIDIACEA
(Greek meaning 'little bag')
Pronounced a'sid-e-a'se-a

Characteristics

- hollow body with two openings
- found either solitary or in colonies
- attached to reef
- no head

Role on the reef

Sea squirts (or ascidians) fill two roles on the reef. Firstly, they filter the waters of the reef, helping to keep them clear. Secondly, they strain minute plants and animals from the water for food and release the resulting nutrients in concentrated wastes which can be used by other organisms.

Feeding

Sea squirts are so called because of their feeding habits. They have two openings, called siphons. Water is drawn through one opening. As the water passes through the body of the sea squirt, food particles are filtered by a filter basket. It is then passed out through the other siphon.

Defence

The thick outer coat (or test) of sea squirts protects them from most predators. The test actually has a molecular structure similar to the cellulose found in plants.

Reproduction

Sea squirts are hermaphroditic, possessing both male and female sex organs. In some species the eggs are held within the body and sperm is drawn in from the water through the siphon to fertilise them. All solitary species release eggs and sperm into the water where fertilisation occurs.

After spawning, a tadpole-like larvae is produced. Like other chordates such as fish, reptiles and even mammals this larval stage possesses rod cells down its back. After a short free-swimming existence the larvae settle and transform into the adult stage. They lose the notochord as they develop.

Human use and impacts

In southern waters, sea squirts are used as bait for fishing. They are also of economic importance as they act as fouling organisms on ships and other marine structures.

History

Little is known about the fossil history of sea squirts. Earliest fossil deposits date back 500 to 600 million years.

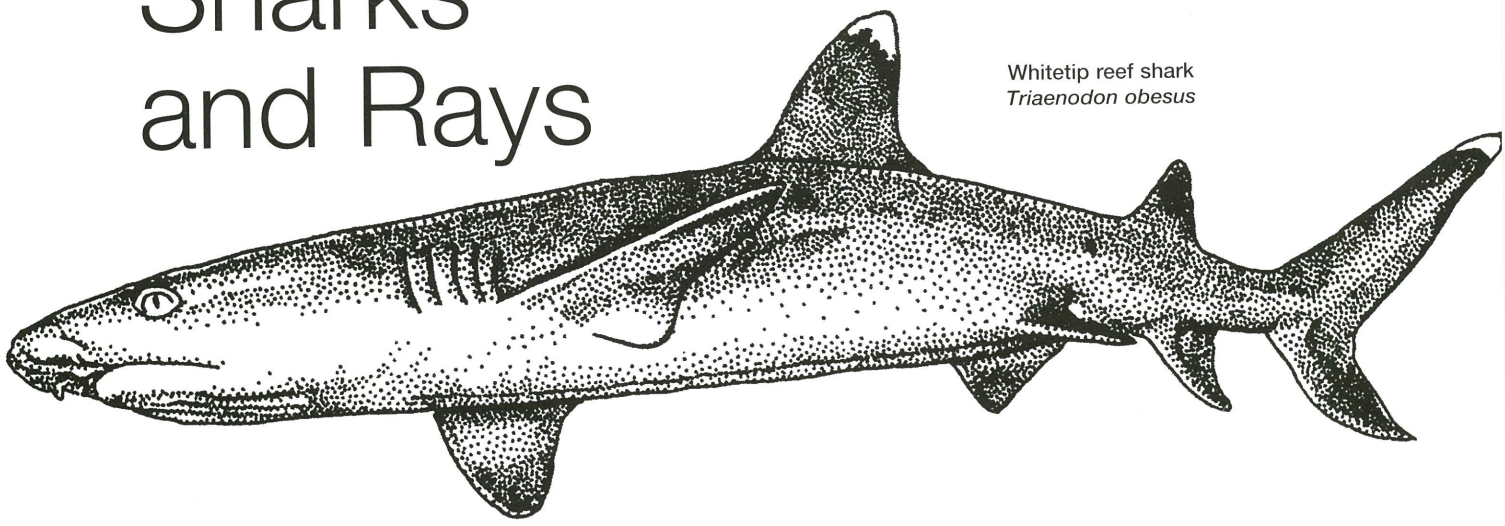
Quick developers

The larval stage of solitary sea squirts is less than six hours. That of some colonial species can be as little as ten minutes.

Little suckers

A small three-centimetre sea squirt can filter approximately one litre of water per hour.

Sharks and Rays



Whitetip reef shark
Triaenodon obesus

A lot of bad press (and movies) have made many people fear sharks, particularly sharks that look like the Jaws star, the Great White Shark. While some of the sharks encountered on the reef can be dangerous, they are a fascinating and important part of the reef ecosystem.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS CHONDRICHTHYES
(Greek meaning 'cartilaginous fish')
Pronounced kon-drik'thee-eez

A bit of history

William Dampier, on 7 August 1699, sailed into and named Shark Bay, WA. He wrote of an 11-foot tiger shark that they had caught and opened, 'In which we found the head and bones of a hippopotamus…'. The hippo was in fact a dugong.

Characteristics

- skeleton made of cartilage
- 5 to 7 gill slits (usually 5)
- no swim bladder
- renewable teeth
- skin covered in small teeth called denticles
- ability to sense electricity

Role on the reef

Like the lions of the African savanna, sharks play a pivotal role in the reef's ecosystem, being top predator. They remove the sick, the injured and the old, and help control animals whose populations are booming.

For millions of years, sharks have been on the top of the food chain, but this has now changed due to humans. The removal of millions of tonnes of sharks each year is upsetting the balance in the oceans.

Types of sharks

There are over 375 species of sharks (90 in Australian waters) and over 490 species of rays. Although there are 30 different families of sharks they can be divided into two main groups.

Bottom dwellers are normally found resting on the sea floor. They are easily recognised by an opening behind their eye known as a **spiracle**. Water is pumped through this opening and out through the gills. Examples include leopard and epaulette sharks and the wobbegong.

Mid-water sharks do not possess a spiracle and most rely on a constant flow of water through their mouth and across their gills as they swim. However, some species, such as the whitetip reef shark are able to lie motionless and pump water by opening and closing their mouths.

Senses

Sharks have often been referred to as being a 'swimming nose'. Their sense of smell is of great importance in sensing prey at long distances. Blacktip reef sharks have been found to be able to sense one part of grouper flesh in 10 billion parts of water.

In addition to taste, touch, hearing, smell and good eyesight, sharks have a sixth sense i.e. the ability to sense minute electrical fields generated by all living organisms. This is detected through the small black pores located on the snout of sharks. Sharks are able to detect voltages as low as a hundred-millionth of a volt.

Feeding

The rows of teeth of sharks constantly move forward to replace old or broken teeth just like a conveyer belt.

It is estimated that a shark may go through as many as 30,000 teeth during its lifetime.

Large sharks, such as the great white and tiger sharks, have very broad and serrated teeth like steak knives which help them cut and gouge flesh from large prey.

Wobbegongs, grey nurse and makos eat their prey whole. Their long slender teeth act like dinner forks to hold prey before swallowing. Whaler sharks such as the blacktip reef shark, have cutting-type teeth on the upper jaw and holding teeth on the lower allowing them to hold and cut pieces out of prey larger than their mouth.

Many bottom-dwelling species such as epaulette and leopard sharks feed on crabs and shells. Their teeth have become reduced in size to form an upper and lower crushing plate so, like a nutcracker, they can crack open their food.

The largest shark encountered on the reef is the whale shark. It swims through the water with its mouth open to capture small fish and other planktonic creatures in its sieve-like rakers.

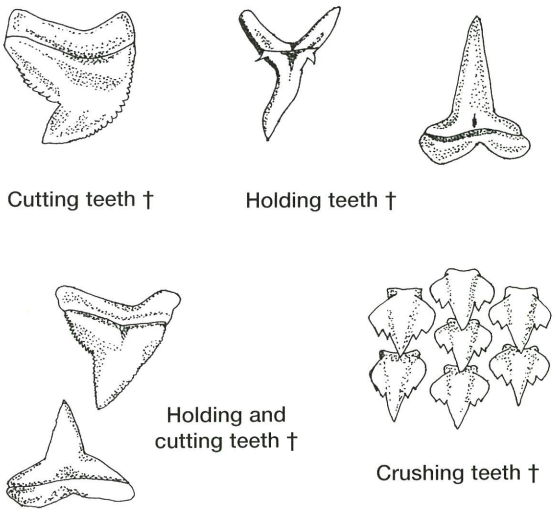
Defence

The main natural predator of sharks is other sharks such as the bull shark *(Carcharhinus leucus)*. Sharks are normally timid animals relying on speed for defence.

Reproduction

Male sharks are easily identified from females by the presence of two finger-like reproduction organs called claspers in the pelvic region. During courtship and mating, male sharks hold onto females by biting them. This results in numerous wounds over the female's body often referred to as "love bites". Unlike bony fish, sharks internally fertilise by inserting one of the claspers into the female.

Sharks can give birth in a number of ways. Some sharks lay eggs from which young hatch after a couple of months. Most reef sharks, such as whalers and tiger sharks, give birth to live young.



Cutting teeth †

Holding teeth †

Holding and cutting teeth †

Crushing teeth †

During development within the female's uterus these sharks receive nourishment through a placenta. In some species such as the great white, grey nurse and mako, development is internal and the young feed upon eggs (continually produced by their mother) and other young in the uterus.

Reef sharks generally reproduce during the summer months. Large female sharks will often enter the shallow waters of lagoons and bays to give birth. The females do not feed during this period to prevent cannibalism.

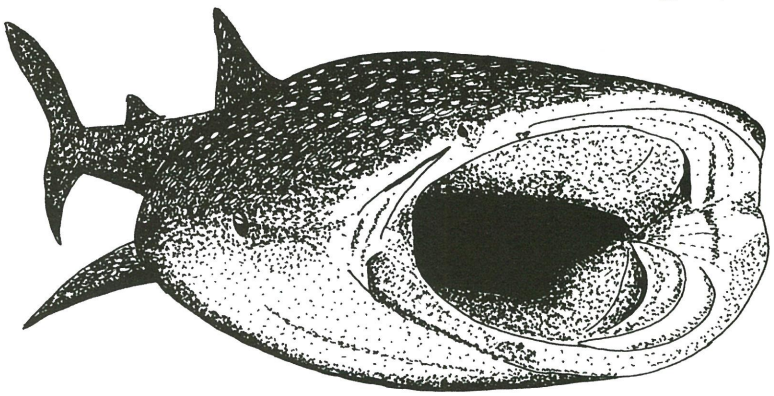
Human use and impacts

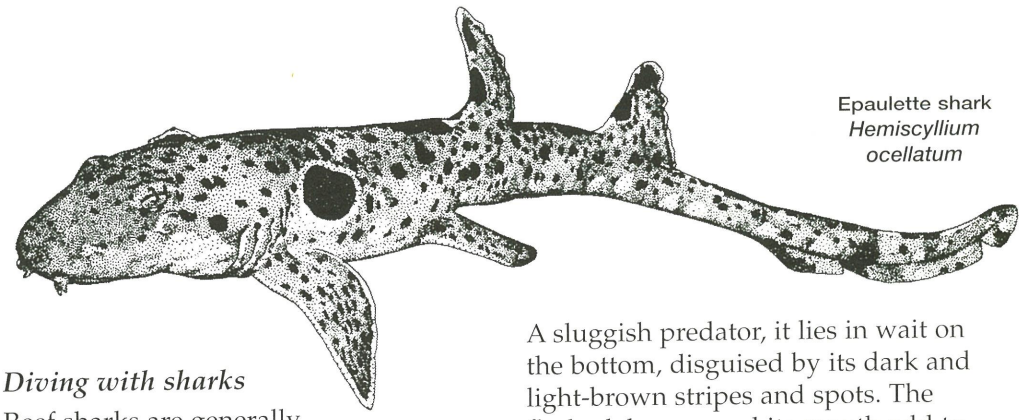
Sharks have been exploited by humans for food and recreation since the earliest days of fishing. As sharks only produce very few young they are susceptible to overfishing. Because of this, shark stocks have to be very carefully monitored and managed. Evidence of overfishing is already apparent with the collapse of the southern shark fishery and the reduction in numbers around the world of other species such as the grey nurse, great white and basking sharks.

Who's eating who?

For each person killed by a shark, over 23 million kilograms of sharks and rays are killed by people.

Whale shark
Rhincodon typus †





Epaulette shark
Hemiscyllium ocellatum

Diving with sharks

Reef sharks are generally very timid animals and tend to stay clear of divers. Three simple rules to remember when diving with sharks are:

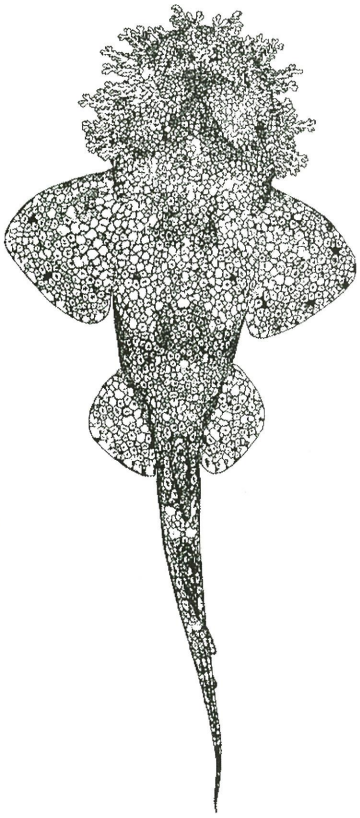
1) Don't corner them.
2) Don't hand feed them.
3) Don't hang onto them.

Whaler sharks, like the grey reef shark, show characteristic behaviours if they feel threatened. They start to swim in an exaggerated jerky manner with their back arched and pectoral fins lowered. If provoked, they will turn quickly and chase the intruder. Attacks on divers and snorkellers on the reef are extremely rare and in almost all cases have been attributed to the person spearfishing or feeding sharks. **Shark feeding is not permitted in the Marine Park.**

History

Sharks are an ancient group of vertebrates dating back over 400 million years (even before the dinosaurs). The sharks reached their greatest number of species about 10–25 million years ago. This was the period of the gargantuan shark *(Carcharodon megalodon)* whose teeth exceeded 18 centimetres and whose body length may have exceeded 12 metres.

Tasselled wobbegong
Eucrossohrinus dasypogon



TASSELLED WOBBEGONG

Eucrossohrinus dasypogon

The wobbegong is a beautifully camouflaged shark that lives in shallow coastal waters of Australia. A sluggish predator, it lies in wait on the bottom, disguised by its dark and light-brown stripes and spots. The fleshy lobes around its mouth add to this disguise by breaking up the shape of the mouth. When a potential meal swims by, the wobbegong simply snaps it up. If hassled by divers they can inflict a painful bite.

EPAULETTE SHARK

Hemiscyllium ocellatum

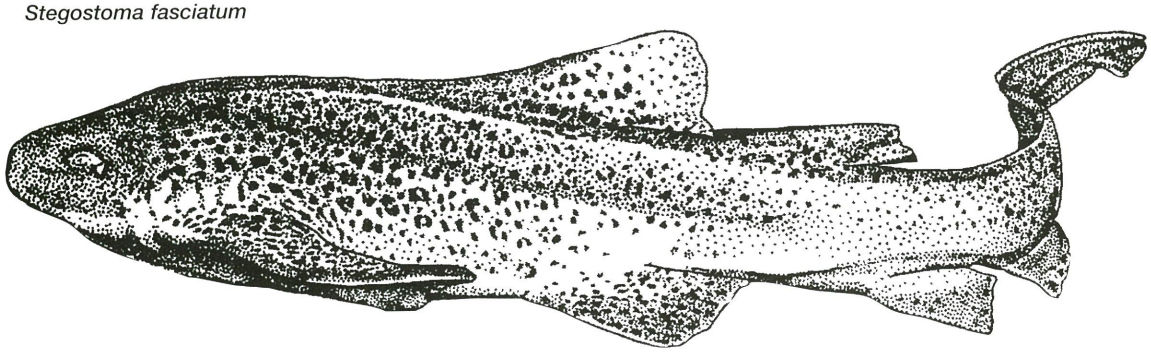
This elongated lizard-like shark is commonly found in tide pools and on the reef flat. They are often seen 'walking' on their pectoral fins at night-time as they hunt crustaceans and molluscs, and fish by using their keen sense of smell. During the day they can be found resting under corals, ledges and rocks. Their name is derived from the two large black spots above their pectoral fins which are similar to the epaulettes on the shoulders of uniforms.

LEOPARD SHARK

Stegostoma fasciatum

These beautiful, spotted sharks are easily approached when seen resting on the sea floor. This shark is also known as a zebra shark which refers to the black and white stripes found on juveniles. The long tail makes up half the total length of the animal. Like most bottom-dwelling sharks the teeth of the leopard shark are fused into two crushing by crushing molluscs, crustaceans and some fish. After mating, the female sharks lay several large, brown eggs with tufts of fibres that anchor the eggs to coral.

Leopard shark
Stegostoma fasciatum



WHALE SHARK

Rhincodon typus

The largest of sharks and indeed all fish, growing to over 18 metres, the whale shark is found in all tropical seas of the world. Even though it has over 300 bands of minute teeth, the whale shark sucks in small fish and planktonic creatures. These sharks will sometimes feed vertically by holding their head just above the surface, then lower it, allowing huge volumes of water containing prey to be sucked into the mouth. If large food items such as turtles are accidentally swallowed the sharks can evert their stomach. In 1953 a large egg case, 30 centimetres long, containing a near full-term 36 centimetre embryo was trawled up in the Gulf of Mexico. It is thought that this was an aborted egg as it is believed that the whale shark retains the egg internally until it hatches.

Whale sharks congregate in April each year around Ningaloo Reef in Western Australia. This coincides with coral spawning.

SILVERTIP SHARK

Carcharhinus albimarginatus

The characteristic silver markings on the fins of this shark make it easily identified from other whaler species. Normally growing to around two metres, silvertip sharks are generally found swimming near outer reef walls. These sharks are very curious and inquisitive and will approach divers. Tagging studies in the Indian Ocean showed that most of the sharks have a two-kilometre 'home range'.

BLACKTIP REEF SHARK

Carcharhinus melanopterus

One of the most commonly seen sharks in the Great Barrier Reef, the blacktip reef shark, is a small whaler growing to less than one and a half metres. They inhabit shallow waters and are often seen swimming over shallow reef flats with their dorsal fins exposed above the water.

These sharks have been known to enter brackish waters and are believed to have entered the Mediterranean from the Red Sea by swimming through the Suez Canal. Tagging studies in the Pacific have shown that most blacktip reef sharks have a limited home range of only a few kilometres.

A study in northern Australia showed that 23% of the blacktip reef shark's diet consisted of sea snakes. Females give birth to 2-4 pups after a gestation period of nearly nine months.

GREY REEF SHARK

Carcharhinus amblyrhynchos

Growing to a maximum of two and a half metres the grey reef shark can be found cruising near the bottom on reef fronts and deep back reefs and lagoons. It prefers deeper water than the blacktip reef shark. Radio tracking studies have shown that individuals living off reef drop-offs are more nomadic than those sharks in lagoons or back reef areas.

Grey reef sharks feed primarily on bottom-dwelling fish.

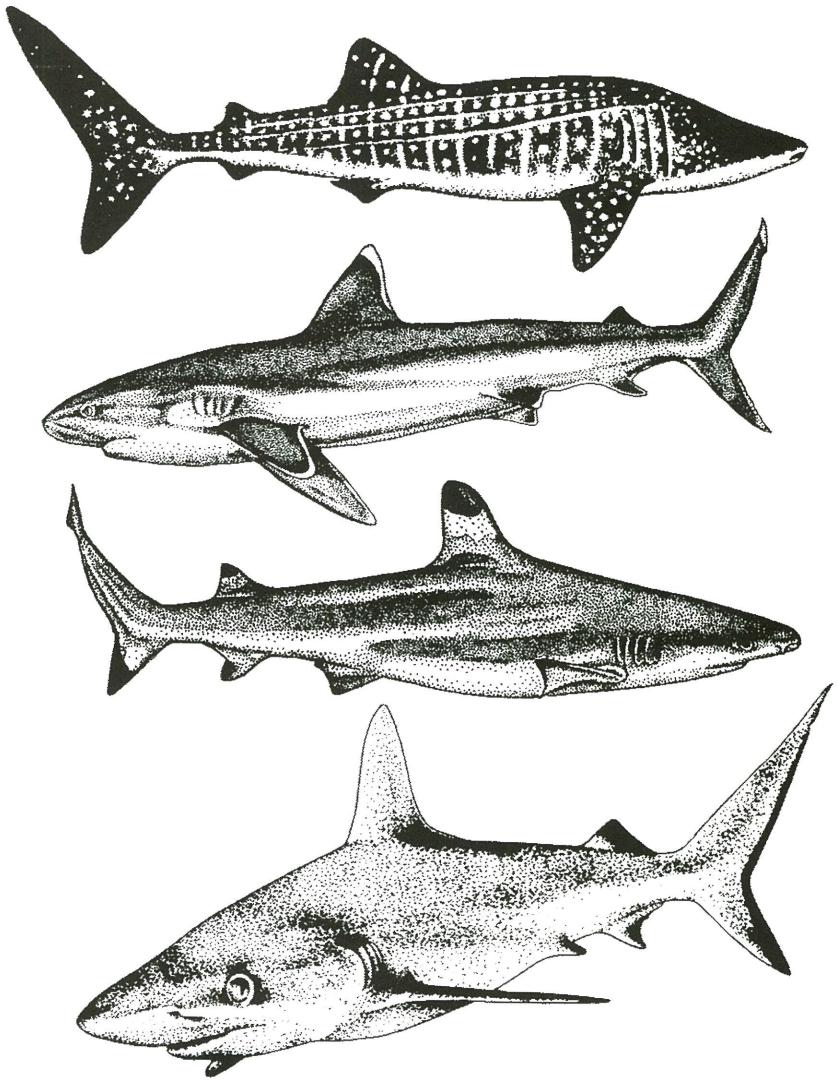
Below from top to bottom:

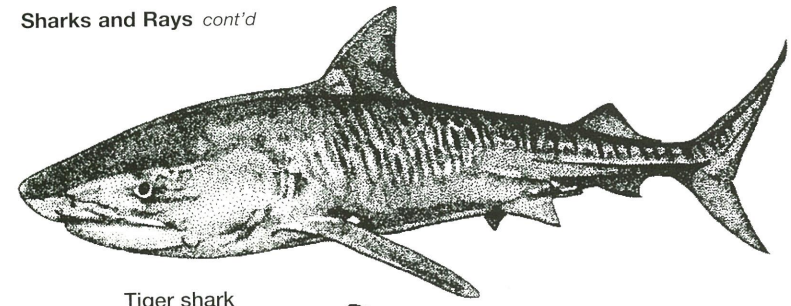
Whale shark
Rhincodon typus

Silvertip shark
Carcharhinus albimarginatus

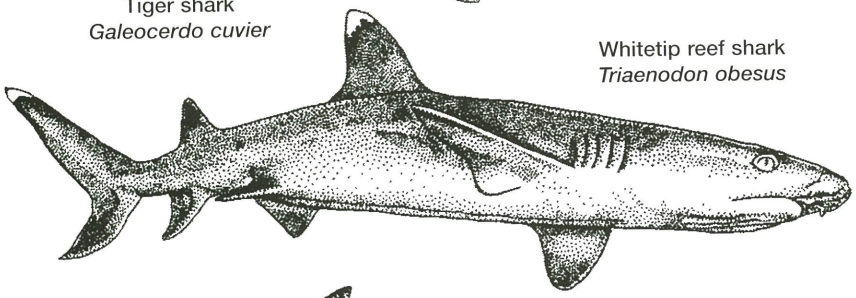
Blacktip reef shark
Carcharhinus melanopterus

Grey reef shark
Carcharhinus amblyrhynchos *

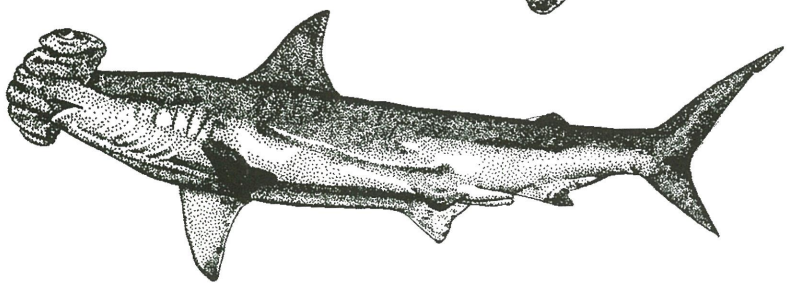




Tiger shark
Galeocerdo cuvier



Whitetip reef shark
Triaenodon obesus



Scalloped hammerhead
Sphyrna lewini

When threatened the grey reef shark performs the classic threat display which consists of wagging the head and tail sideways, arching the back, raising the head and lowering the pectoral fins. If pursued during threat behaviours, they may turn and attack. These sharks have been responsible for a number of attacks on people spearfishing. They are attracted to the blood of speared fish.

TIGER SHARK

Galeocerdo cuvier

The tiger shark is easily recognised by its squared-off snout and the dark, tiger-like stripes running across its back. It may reach over six metres in length, with individuals weighing over three tonnes. The tiger tends to be an aggressive and indiscriminate feeder that will eat just about anything: dolphins, seals, seabirds, fish, stingrays, other sharks, sea snakes and turtles. The ultimate junk food eater, tiger sharks have been found with tin cans, shoes, lumps of coal, car number plates and other strange items in their stomach.

The tiger shark is normally found in deeper waters during the day, moving to shallow lagoons during the night. A four-metre specimen tracked in Hawaii for two days moved about 80 kilometres a day and covered an area of about 100 square kilometres. The tiger shark has been responsible for a number of attacks on humans and should be treated with caution. Females enter nursery areas to give birth to 10–80 pups, each over 50 centimetres long.

WHITETIP REEF SHARK

Triaenodon obesus

Another commonly encountered shark on the reef, is the whitetip reef shark. They are often found resting on the sea floor, in caves or under ledges. They have a limited home range, often returning to caves and ledges to rest. Tracking studies have shown that individuals range 0.3 to 3 kilometres in a year.

They do not appear to be territorial as they share their home range with blacktip reef sharks and other whalers.

These sharks are most active at night using their senses of smell, sound and 'electricity' to capture prey from caves, holes and coral heads. One of the mysteries surrounding the whitetip reef shark is how it attained its present distribution from the western Indian Ocean all the way to the Pacific coast of Central America. It has never been found below 330 metres and is not known to swim over deep water.

So how did they traverse water over 4000 metres deep? Or is this evidence of a once much shallower Pacific Ocean with more island chains?

SCALLOPED HAMMERHEAD

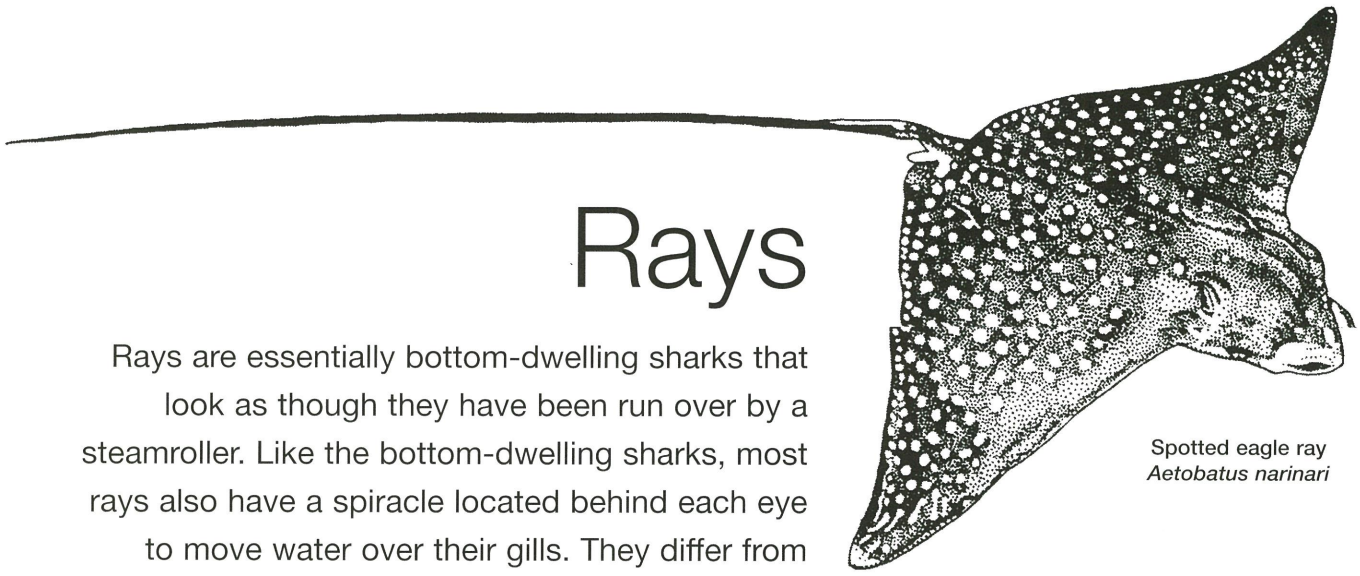
Sphyrna lewini

The hammerhead is a very distinctive and unusual shark with its eyes and nostrils placed on the far ends of its mallet-shaped head. This unusual head may enhance sensory capabilities and help stabilise the shark. The head shape provides a greater surface area for the electric receptors (ampullae of Lorenzini), giving the hammerhead an increased ability to detect fish and rays buried under sand. The nostrils are far apart which may allow the shark to better detect the scent of its prey.

The scalloped hammerhead is the most commonly encountered hammerhead, growing to over three metres in length. Juveniles are commonly found close to shore.

Rays

Rays are essentially bottom-dwelling sharks that look as though they have been run over by a steamroller. Like the bottom-dwelling sharks, most rays also have a spiracle located behind each eye to move water over their gills. They differ from sharks in having gill slits located underneath. The pectoral fins are expanded and attached to the head creating 'wing-like' appendages. A few species such as the manta ray swim in midwater, feeding on small fish and plankton.



Spotted eagle ray
Aetobatus narinari

Stingrays have the ability to thrust the tail upwards and swing it sideways if stepped upon. This action exposes the venomous barb which can easily penetrate flesh. Immersion of the injured limb in hot water (about 50°C) for 60-90 minutes will relieve the pain, but medical assistance should be obtained. When walking in lagoons, the feet should always be shuffled to prevent stepping on a ray.

BLUE-SPOTTED STINGRAY

Taeniura lymma

These colourful rays are generally very nervous of divers, always seeking a speedy escape. During high tide they enter the lagoon and sand flats to feed upon shells, particularly strombs and volutes. The tail is well armed with two or three spines.

Ulysses

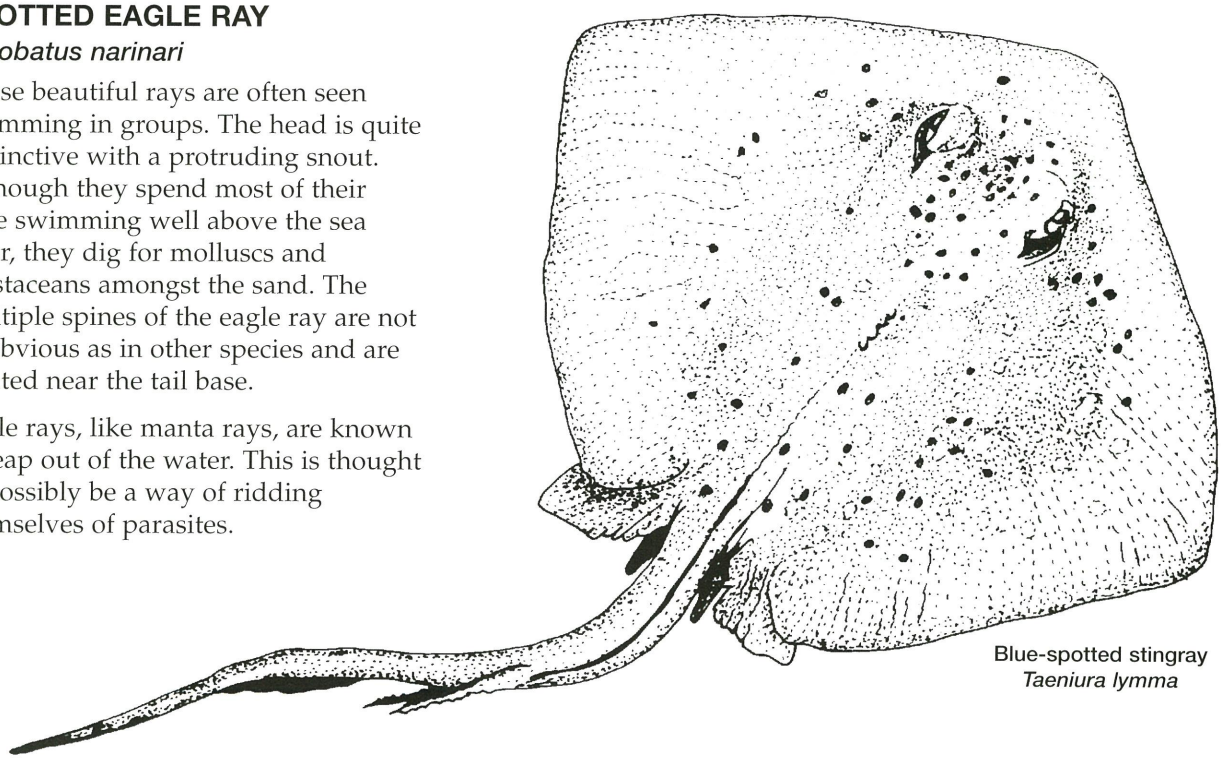
Ulysses was said to have died from a spear tipped with a stingray spine.

SPOTTED EAGLE RAY

Aetobatus narinari

These beautiful rays are often seen swimming in groups. The head is quite distinctive with a protruding snout. Although they spend most of their time swimming well above the sea floor, they dig for molluscs and crustaceans amongst the sand. The multiple spines of the eagle ray are not as obvious as in other species and are located near the tail base.

Eagle rays, like manta rays, are known to leap out of the water. This is thought to possibly be a way of ridding themselves of parasites.



Blue-spotted stingray
Taeniura lymma

Black-blotched stingray
Taeniura melanospila

BLACK-BLOTCHED STINGRAY

Taeniura melanospila

The largest of all the bottom-dwelling rays, black-blotched stingrays are not commonly seen. Some, however, become residents at different dive locations and can become quite unafraid of divers. They range from shallow lagoons to outer reef slopes with one specimen caught by a trawler at 430 metres.

In addition to the invertebrates normally eaten by rays, the black-blotched stingray hunts fish at night.

MANTA RAY

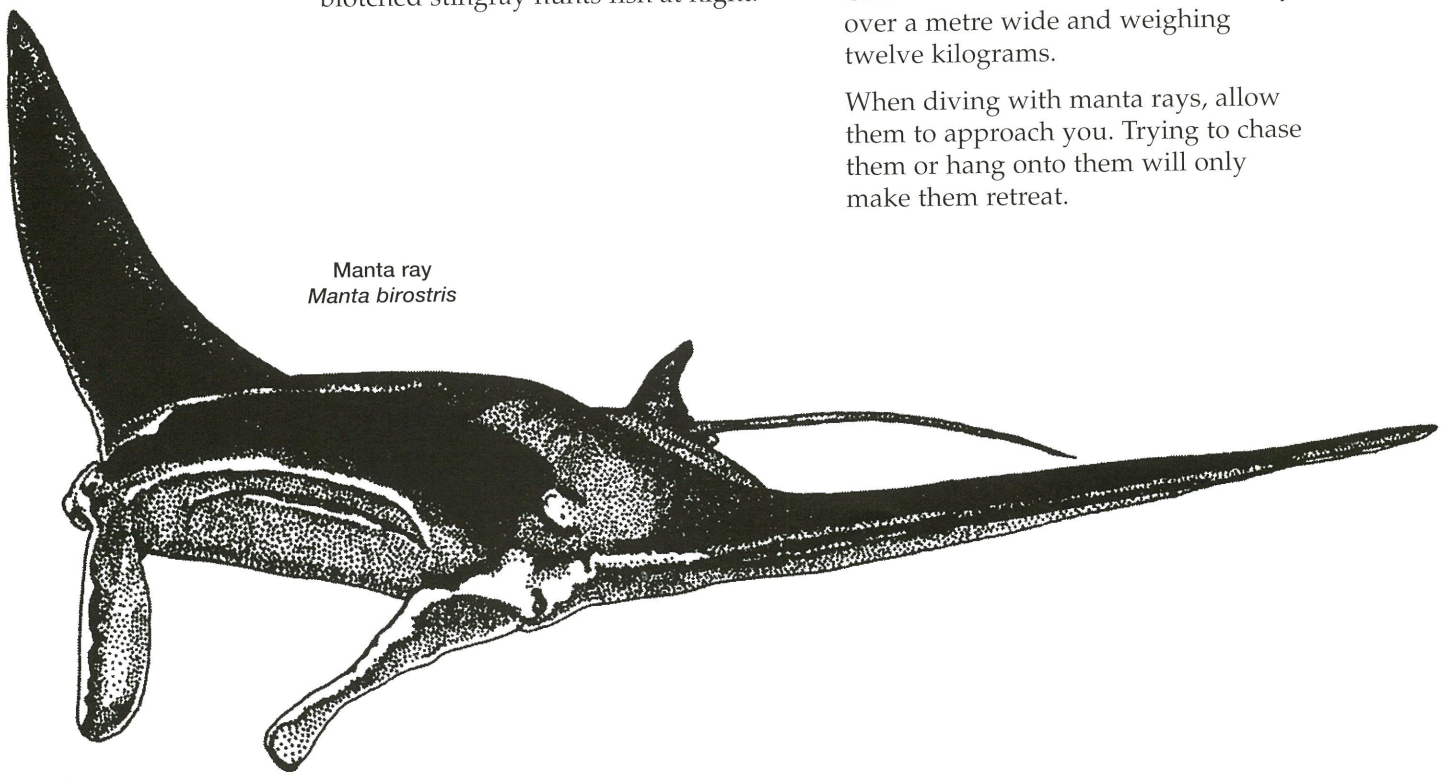
Manta birostris

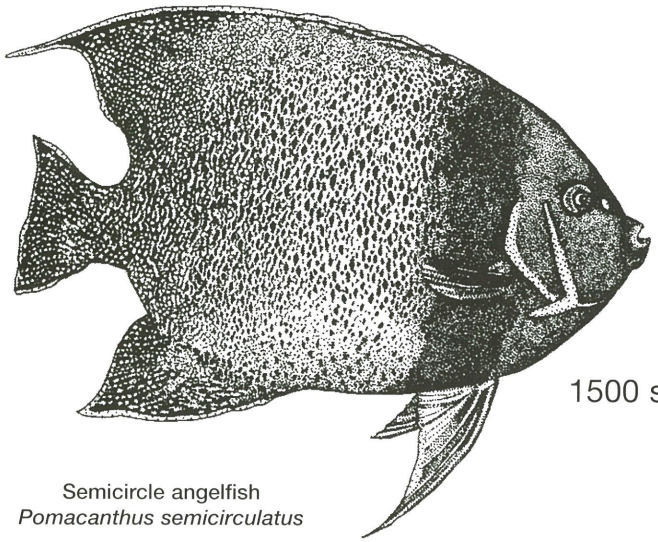
The manta ray is the largest of all rays, growing to over seven metres across and weighing over three tonnes. Like a whale shark, manta rays feed on small fish and plankton. The large cephalic flaps on either side of the head are used to direct planktonic food into the mouth where it is sieved by projections from the gills. These flaps can be rolled up and tucked back when not in use. Manta rays have no barbs on their tail.

One female was found with an embryo over a metre wide and weighing twelve kilograms.

When diving with manta rays, allow them to approach you. Trying to chase them or hang onto them will only make them retreat.

Manta ray
Manta birostris





Semicircle angelfish
Pomacanthus semicirculatus

Reef Fish

'What fish is that?' is probably one of the most commonly asked questions on the reef. This is for a good reason, as there are well over 1500 species of reef fish showing a myriad of shapes, colours and behaviours, that have made the Great Barrier Reef famous.

Characteristics

- skeleton made of bone
- one gill opening on each side of the head
- have a swim bladder
- reproduction through external fertilisation

Role on the reef

The tropical marine habitat contains more fish species than any other habitat. With such diversity, fish can become highly specialised in what they eat and where they live. As consumers, fish feed on almost all available food on the reef ranging from algae to other fish. Herbivorous fish are the major consumers of the thin turf of filamentous algae that grows on the reef flat. Parrotfish make significant contributions to the production of sediment on the reef as they graze for algae on coral rubble. Some species, like the bumphead parrotfish *(Bolbometopon muricatum)* feed on whole pieces of coral for the algae growing there.

Feeding

The feeding behaviours of most reef fish can be classified as follows.

Herbivores: Although it is not very obvious, the reef is covered in algae. The brown colouration of barren reef rock, particularly on the reef top, is due to a highly productive layer of algae that grows as turf. It is this turf algae that is grazed daily by a vast number of herbivorous fish. Parrotfish, like most herbivorous fish, have a small mouth connected to powerful muscles. The size of these muscles is indicated by the large distance between the eye and the mouth. Teeth of herbivores are often fused to form a strong beak which allows them to scrape at algal-covered rocks.

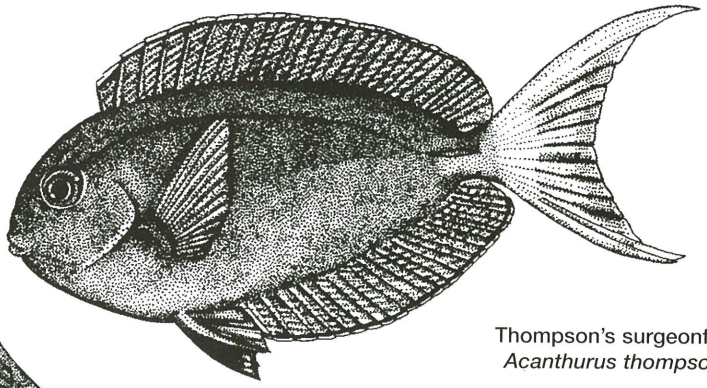
Large schools of herbivores, such as parrotfish, roam the reef like herds of cattle, grazing. Some species of damselfish defend territories in which they 'farm' the algae. By defecating on the algae they provide fertiliser to encourage their crop to grow.

Omnivores: Omnivores are animals that feed on both animal and plant matter. Butterflyfish tend to pick at their food while triggerfish and puffers crack open well-armoured invertebrates and graze on coralline algae with their powerful jaws.

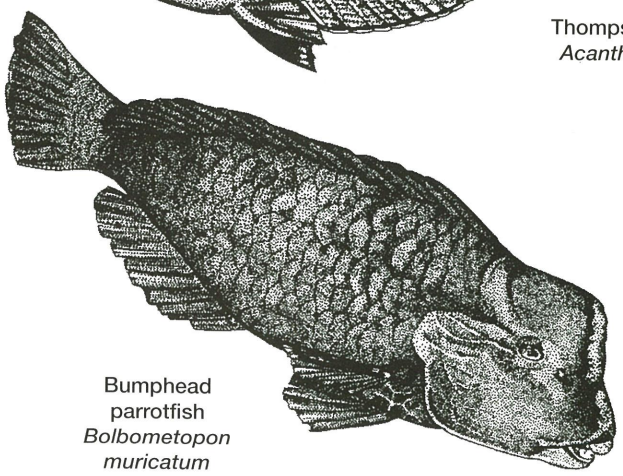
PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

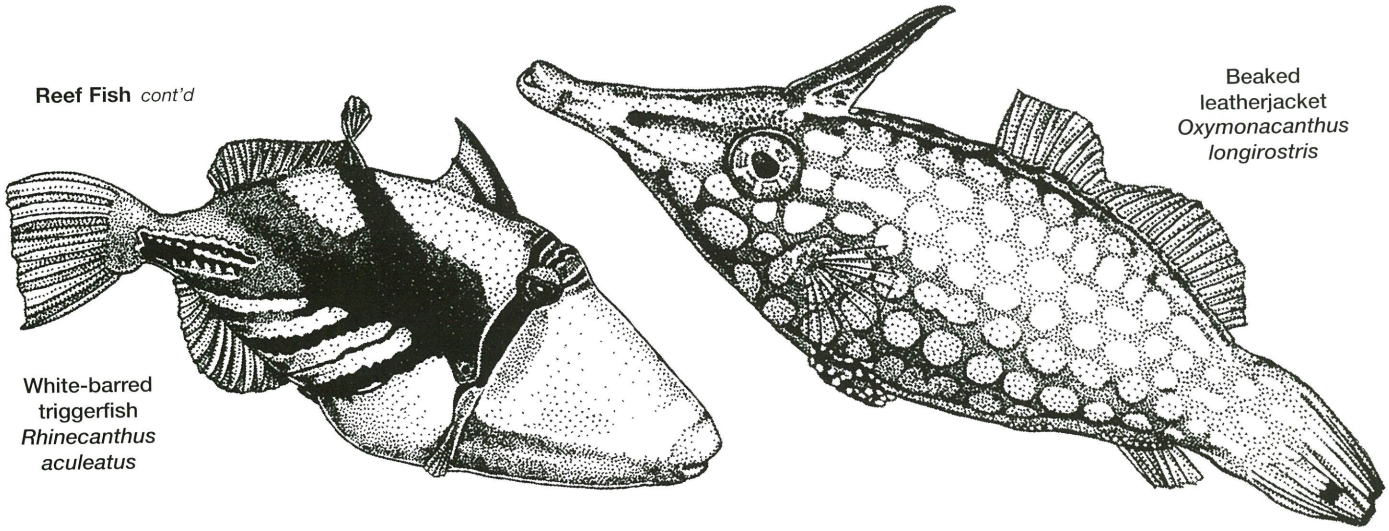
CLASS OSTEICHTHYES
(Greek meaning 'bony fish')
Pronounced os'te-ik'thee-eez



Thompson's surgeonfish
Acanthurus thompsoni



Bumphead parrotfish
Bolbometopon muricatum



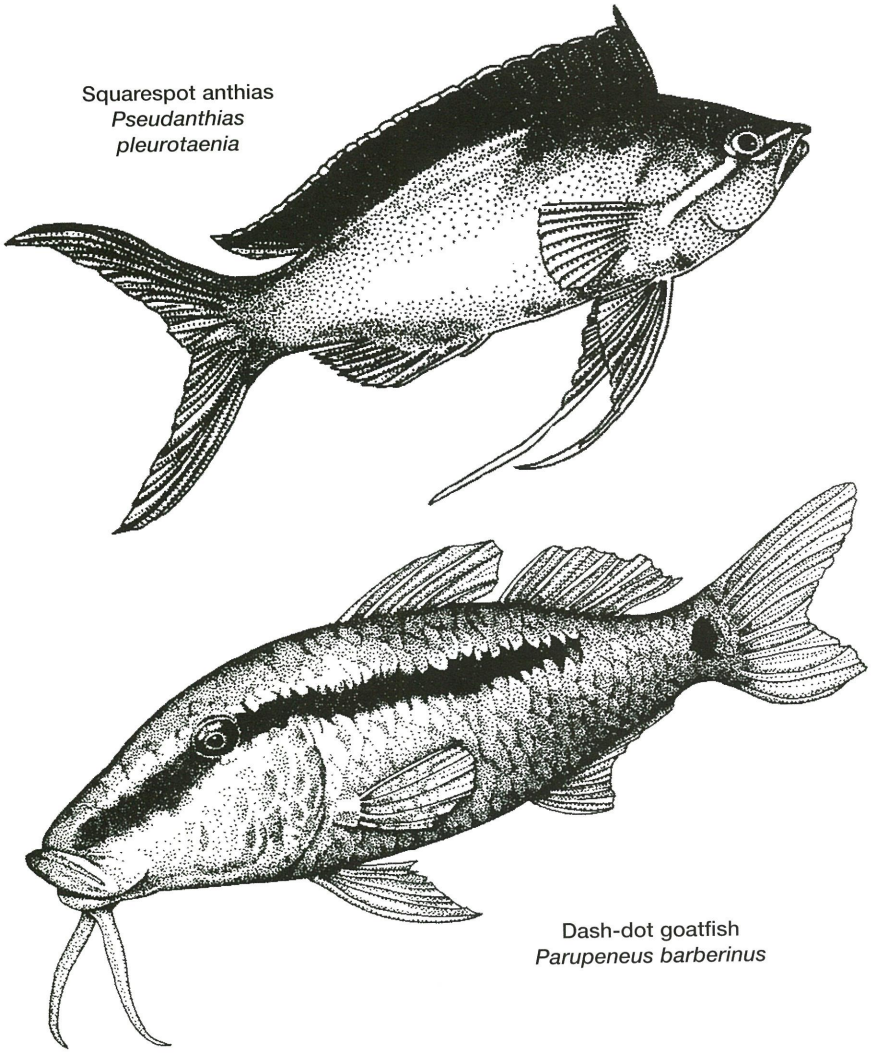
White-barred triggerfish
Rhinecanthus aculeatus

Beaked leatherjacket
Oxymonacanthus longirostris

Not that silent

Many fish make sounds. Many damselfish such as humbugs and anemonefish, actually make chirping sounds.

Corallivores are those omnivorous animals that feed exclusively upon living coral, which contains both the animal (polyps) and plant (zooxanthellae) material. A number of butterflyfish species and the beaked leatherjacket *(Oxymonacanthus longirostris)* feed exclusively by picking individual coral polyps. The bumphead parrotfish *(Bolbometopon muricatum)*, some triggerfish and puffers bite off chunks of corals, skeleton and all.



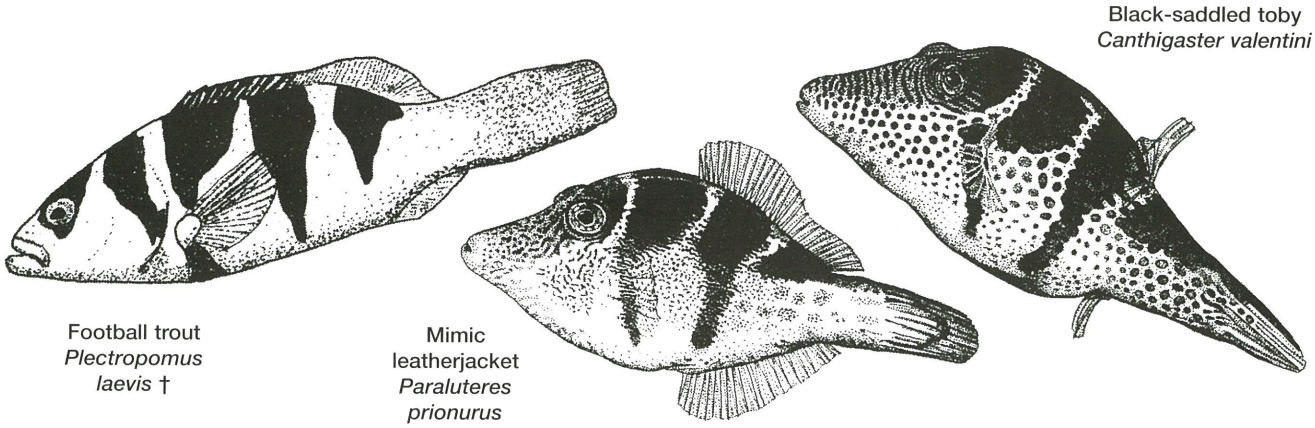
Squarespot anthias
Pseudanthias pleurotaenia

Dash-dot goatfish
Parupeneus barberinus

Carnivores: Carnivores come in all shapes and sizes. They range from species which feed on the tiny planktonic animals to cods and trout that feed on other fish.

Planktivores are those carnivorous fish which feed on the tiny animals that make up the **zooplankton**. Large schools of damsel fish and basslets swarm on reef fronts feeding on the individual planktonic creatures that are swept in by ocean currents. Planktivores are generally small in size with small mouths located very close to the eye so they can see the prey. Their body shape is generally built for speed – not for chasing prey, but to avoid becoming prey themselves. Planktivores that live further out from the reef front are generally much faster swimmers than those that don't venture far from the reef.

Other carnivores: Most reef fish are carnivores. They obtain their food by a wide range of feeding strategies. Most small carnivores feed on invertebrates such as crustaceans and molluscs. Goatfish are highly specialised, using whisker-like **barbels** that grow from under their mouths to stir up the sand in search of worms and other creatures buried there. The cleaner wrasse *(Labroides dimidiatus)* feeds upon the parasites on the skin of other fish. Fish which eat other fish are called **piscivores**. Most fish use suction to capture prey. The stonefish and lizardfish are camouflaged so they can ambush prey. Larger fish, like coral trout and groupers, stalk and lunge. Most piscivorous fish are more active at dawn and dusk when they are less conspicuous to the animals they are hunting.



Black-saddled toby
Canthigaster valentini

Football trout
Plectropomus laevis †

Mimic leatherjacket
Paraluteres prionurus

Defence

Fish use a great range of defensive mechanisms to avoid predation. Some of these mechanisms are described below.

Colour: Colour patterns can act as a warning to other creatures that certain animals are toxic e.g. the pufferfish. In one case a species of leatherjacket *(Paraluteres prionurus)* and the juvenile football trout *(Plectropomus laevis)* both mimic the colour pattern of the poisonous black-saddled toby *(Canthigaster valentini)* to help them avoid predation.

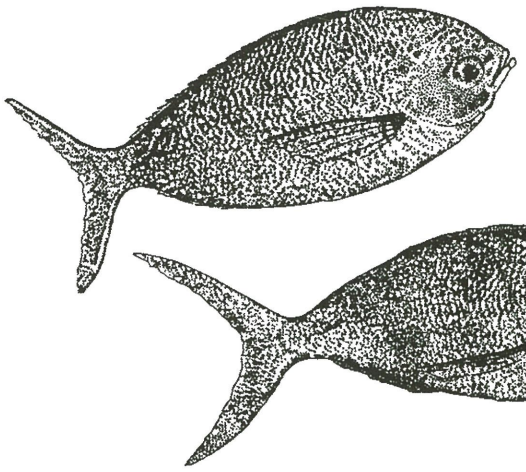
Many butterflyfish are able to confuse potential predators by having a false eye spot at the rear of their dorsal fin. Their real eye is masked by a black line making it blend in with the colour pattern of the fish. This may fool predators into attacking the wrong end of the fish and ending up with only a mouthful of fins.

Camouflage: Camouflage is not only used by fish to ambush prey but also to hide from predators. Flat fish such as soles and flounders are able to change their colour patterns to suit the colour of the substrate they are resting on.

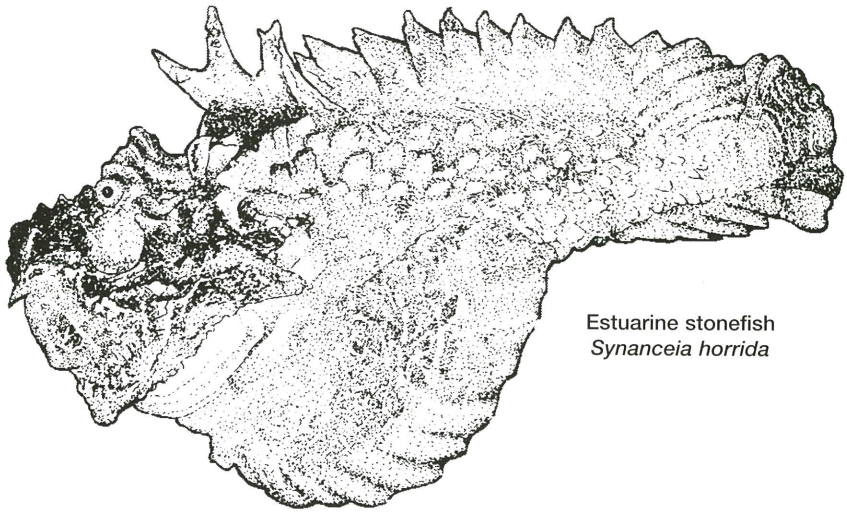
Spines: Spines are used by a number of different fish and for different reasons. The venomous spines of the lionfish and stonefish make good deterrents to predators. Triggerfish use their dorsal spines to lock themselves amongst coral rubble so they cannot be dislodged by predators.

Schooling: Schools of fish are most commonly encountered around the reef front. Safety in numbers protects fish, as large groups overwhelm predators, making the selection and attack of one individual very difficult.

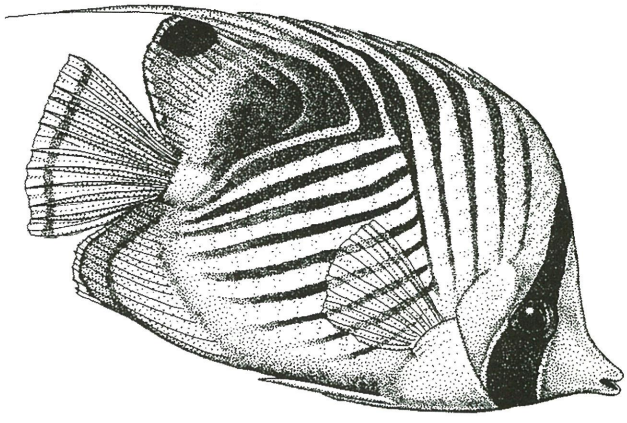
Size: When threatened, pufferfish and porcupinefish are able to increase their



Red-bellied fusilier
Caesio cuning



Estuarine stonefish
Synanceia horrida

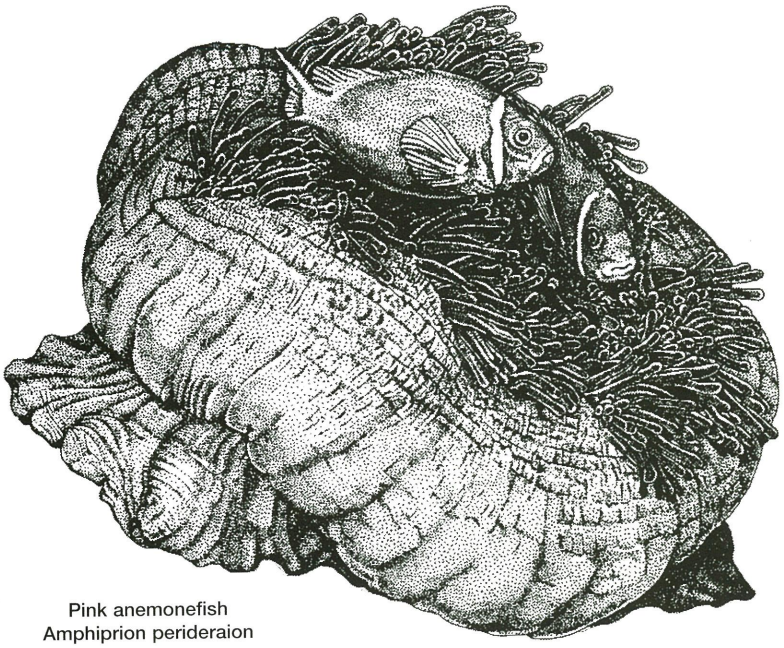


Threadfin butterflyfish
Chaetodon auriga

size by blowing themselves up with water making them more of a mouthful for predators.

Reproduction

Reproduction in reef fish is a highly variable affair and often quite complex. Fish reproduce through external fertilisation where they release vast quantities of eggs and sperm into the water. There the larval fish live as part of the planktonic community for weeks to months. Life for larval fish is like a lottery – there is no parental care. Of the thousands and even millions of eggs released, very few survive. There are a number of strategies and behaviours by which fish try to produce as many fertilised eggs as possible.



Pink anemonefish
Amphiprion perideraion

Partners for life: Monogamy is a rare practice amongst reef fish as most male fish have several partners during spawning. Some species of butterflyfish and rabbitfish pair for life. If they lose their mate they will not pair again.

Sweet dreams

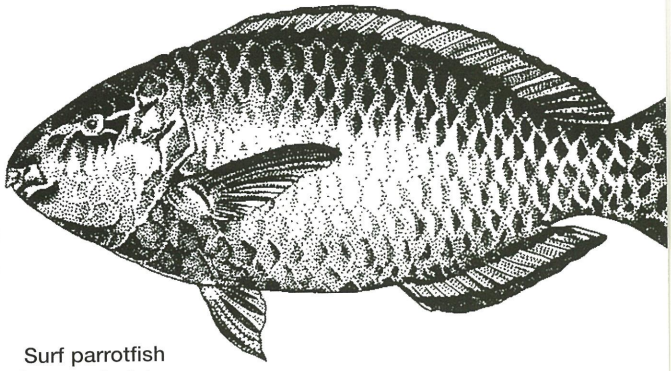
At night parrotfish construct a mucus sleeping bag in which they sleep. It most likely helps to prevent predators from smelling where they are.

Tropical transsexuals: Most reef fish change sex during their life to maximise their reproductive effort. The most common form of sex change is that from female to male, known as **protogyny**. Changing from male to female is called **protandry**. Once a sex change has occurred it cannot be reversed.

Female to male sex changes: This is the most common form of sex change, particularly among schooling fish and species that congregate for spawning. In large groups of fish it is best for the majority to be female to ensure the maximum amount of eggs are produced; only a few males are needed to fertilise a large number of eggs. Starting life as a female allows a fish to become sexually active as soon as it matures. If schools of fish were predominantly male, only a few males, usually the most dominant, would have the opportunity to mate. The other males in the school would not be sexually active. Sex change occurs when the dominant male is removed or killed. Usually it is the most dominant female that changes sex and in some cases colour pattern. Examples: parrotfish, damselfish (except anemonefish), fairy basslets, groupers, coral trout.

Male to female sex changes: Changing sex to become female is not as common amongst reef fish. Anemonefish (clownfish) are the only group of damselfish where the sex change is male to female. The most likely explanation for this difference may relate to the lifestyle and social behaviour of this fish. Most anemonefish normally live in pairs. When found in larger groups it is only the two largest fish that are sexually active; the other smaller fish are not. For a fish that normally lives in pairs it is better for the larger to be the female so she can produce more eggs. The female anemonefish is dominant over the male. She will chase him around and also nip at his fins. The male acts submissively during these behaviours. If the female dies, the male is no longer stressed and he changes sex to become the female.

Other species that change sex from male to female include flatheads, scorpionfish and snappers.



Surf parrotfish
Scarus rivulatus

Human use and impacts

Fish are a major resource on the reef for both commercial and recreational fisheries. Most of those species targeted by people have size and bag restrictions which are enforced by the Queensland Department of Primary Industries. Within the Marine Park there are a number of zones such as the green (Marine National Park 'B') zone where all fishing is prohibited.

Species such as the potato cod and grouper are totally protected if over 120 centimetres long. With the increase in popularity of home marine aquariums there are a number of commercial aquarium fish collectors operating within the Marine Park.

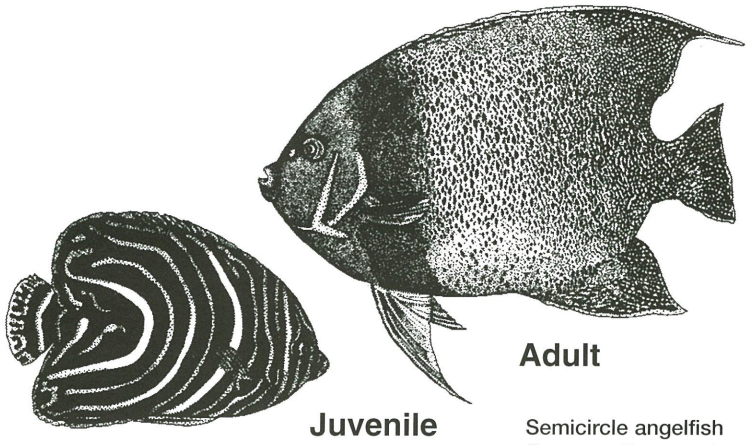
History

Reef fish had an explosive radiation of species around 50 million years ago which coincided with the development of the first modern coral reefs. Most present day species show little or no change from their ancestral forms.

FISH COLOURS

'Why are fish so colourful?' is one of the most commonly asked questions by tourists visiting the reef.

Reef fish are able to see colour. Their bright colours are important in species recognition and in the determination of sex. Some species such as angelfish have juvenile colour patterns totally different to that of the adults. The different colour patterns of juveniles may prevent the adults from seeing them as a potential threat to territories or to reproductive partners. The use of colour to blend with the environment is an important way to ambush prey and hide from predators.



Semicircle angelfish
Pomacanthus semicirculatus

MORAY EELS

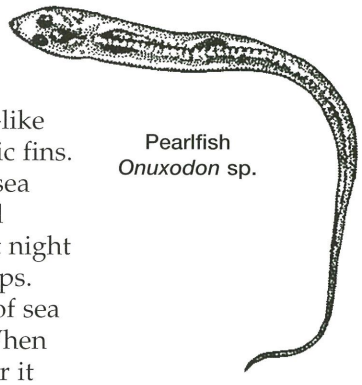
Family Muraenidae

Moray eels are normally encountered with their heads sticking out from under a ledge or cave. They are characterised by elongate bodies and the lack of any pectoral and pelvic fins. Although morays have an aggressive appearance with constantly opening and closing their mouths, they are simply pumping water in through the mouth and out through a small opening on the side of the neck. Eels, like all fish, must extract oxygen from water to breath. Most morays have long canine teeth for grabbing fish and octopus which are then swallowed whole. In addition they have teeth in the middle of their throat that also help prevent prey from escaping. A number of small reef morays have short conical teeth used to crush crustaceans. The tube-like extensions on the nostrils of moray eels allow greater sensitivity to any scent in the water. The largest species of moray eel is the giant moray which can reach lengths of over 2.2 metres. Moray eels should not be eaten as they can carry ciguatera.

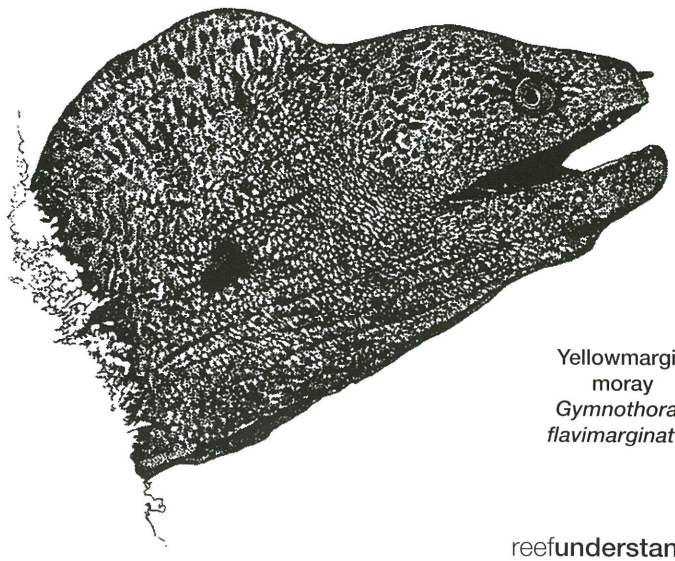
PEARLFISH

Family Carapidae

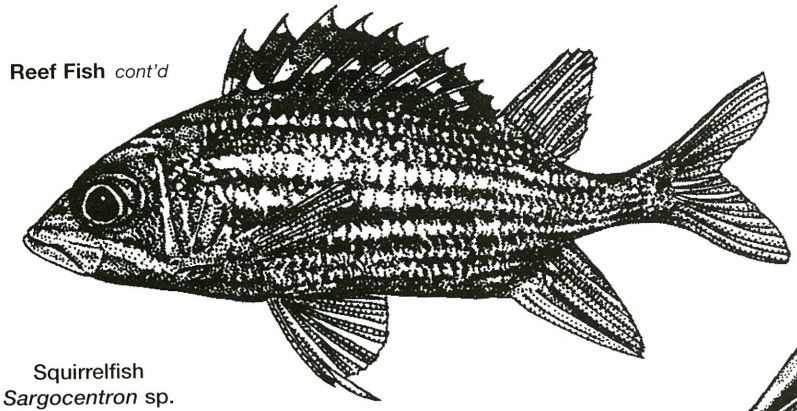
Pearlfish are highly modified eel-like fishes which lack scales and pelvic fins. Most live in the body cavities of sea cucumbers, giant clams and pearl oysters during the day, leaving at night to feed on small fishes and shrimps. Pearlfish enter the body cavities of sea cucumbers through their anus. When they try to enter the sea cucumber it closes its anus, but as sea cucumbers breath through their anus it must eventually open and in swims the pearlfish. Juvenile pearlfish are parasitic, feeding upon the gonads of sea cucumbers.



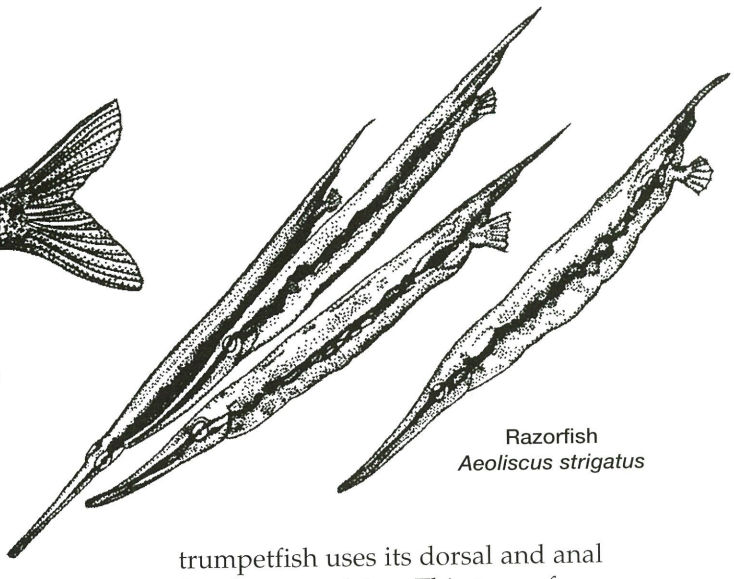
Pearlfish
Onuxodon sp.



Yellowmargin moray
Gymnothorax flavimarginatus



Squirrelfish
Sargocentron sp.



Razorfish
Aeoliscus strigatus

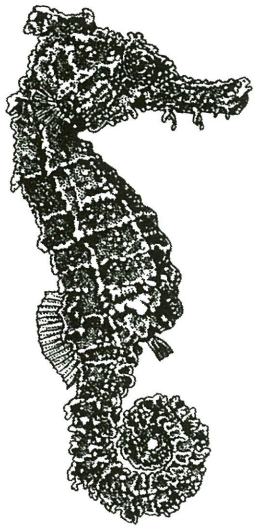
SQUIRRELFISH AND SOLDIERFISH

Family Holocentridae

Squirrelfish and soldierfish are relatively deep-bodied fish with large eyes and mouth, large, coarse scales, prominent fin spines and a red colouration. Mostly nocturnal, these fish tend to hide in caves or under ledges during the day, coming out at night to forage for fish and crustaceans. Their red colouration is ideal for nocturnal species. Since red is the first colour to be absorbed by water, red coloured fish are practically invisible at night. Squirrelfish and soldierfish are very ancient fish dating back over 50 million years. The heavy spines over their head are a primitive feature amongst fish.

Squirrelfish have a large venomous spine at the back of each cheek capable of causing a painful sting.

Spotted seahorse
Hippocampus kuda



TRUMPETFISH

Family Aulostomidae

These elongate fish have three colour phases: brown to green, mottled brown to green and bright yellow. The trumpetfish is a solitary predator relying on stealth and the ability to quickly change its colour for camouflage. They sometimes hide by swimming within schools of fish, such as parrotfish, to 'shadow stalk' their prey, like a detective following a criminal by blending into a crowd. They are often seen hovering upside down waiting to drop vertically onto prey before sucking it up into their tube-like mouth. Like triggerfish, the trumpetfish uses its dorsal and anal fins for propulsion. This type of swimming motion is called balistiform swimming, named after the triggerfish (family Balistidae).

RAZORFISH

Family Centriscidae

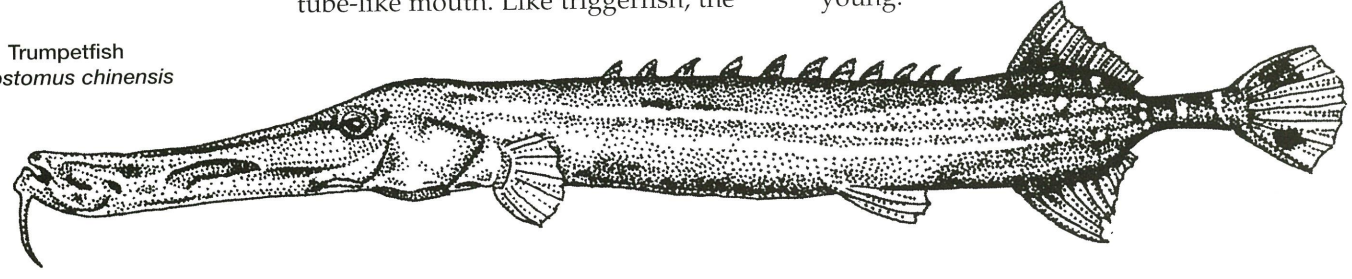
Looking like a school of swimming knives, razorfish swim in an unusual vertical posture. This allows them to hide amongst the spines of sea urchins or between branches of coral. The body of a razorfish is extremely thin, almost transparent and enclosed in heavy plates. Their swim bladder can easily be seen if a light is shone behind them. They are closely related to seahorses and pipefish and use their mouths to suck in zooplankton.

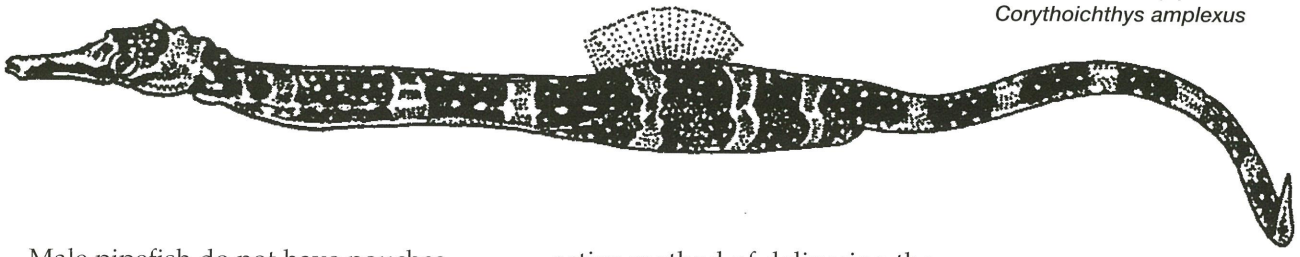
SEAHORSES AND PIPEFISH

Family Syngnathidae

Seahorses and pipefish are small elongate fish encased in bony plates. Looking like the knight on a chess board, the seahorse is characterised by its angled head. As they are not strong swimmers, seahorses rely on a prehensile tail to hold onto algae and coral. During mating the female seahorse deposits eggs into a pouch on the male's abdomen where they are fertilised and start to develop. After a few weeks, during which the male's pouch becomes quite swollen, he "gives birth" to up to one hundred young.

Trumpetfish
Aulostomus chinensis





Brown-banded pipefish
Corythoichthys amplexus

Male pipefish do not have pouches. Instead, the female adheres the eggs to the underside of the male's abdomen where they remain until hatching.

Both seahorses and pipefish undergo elaborate courtship rituals every day to re-establish bonds with their partners.

The tube-like mouth of seahorses and pipefish is used like a pipette to suck in tiny planktonic organisms.

SCORPIONFISH

Family Scorpaenidae

Like scorpions, this group of fish are armed with venomous spines and give powerful stings. The dorsal fin consists of 7–18 venomous spines. Other characteristics of this group include a bony ridge across the cheek and a large head covered in short spines. The stonefish has an unlucky number of 13 spines. There is no active method of delivering the venom. Stonefish have a large oblong gland at the base of each spine and pressure has to be applied for venom to be discharged through a duct in the spine. Lionfish do not have a venom duct in their spine and the venom is less powerful than the stonefish. The venom of scorpionfish is denatured by heat; **placing an injured limb in hot water (NOT BOILING) will relieve pain.**

Most scorpionfish are well camouflaged bottom-living predators dwelling in caves and crevices, waiting to ambush small fish and crustaceans. Scorpionfish engulf their prey with lightning speed. They have been timed engulfing prey in just 1/100 of a second. Unlike other scorpionfish, the lionfish is an active predator, stalking prey at night and living under ledges and in caves during the day.

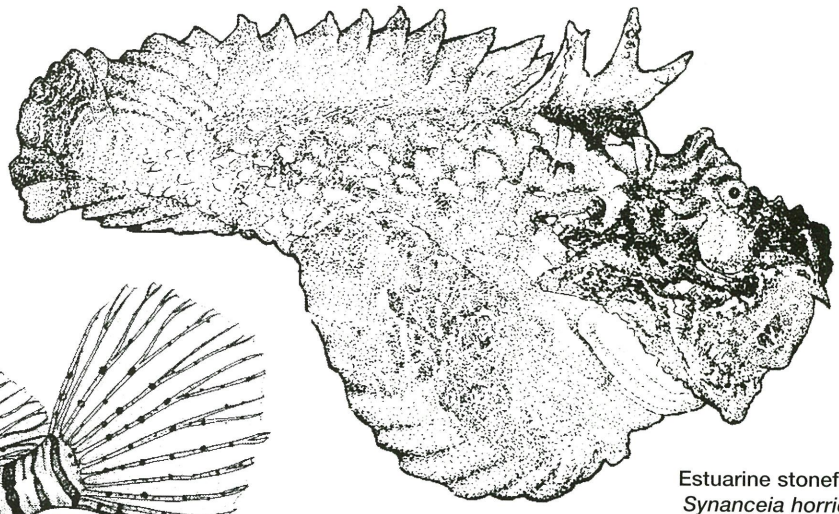
Slowcoach

The slowest fish is the seahorse. At top speed it would take a seahorse 2.5 days to travel 1 kilometre.

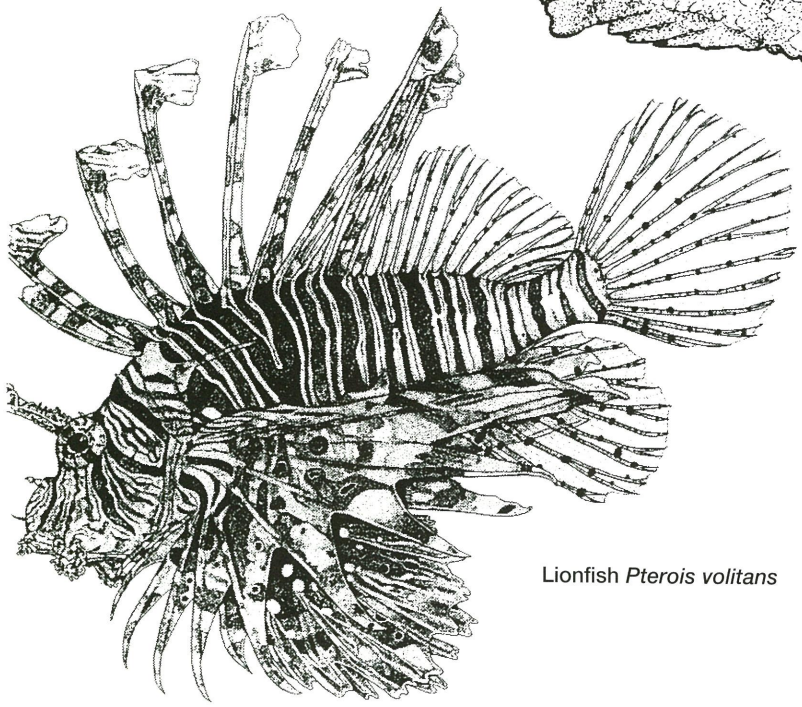
Top speed

These are the top speeds recorded for fish:

Sailfish	*109 km/h*
Bluefin tuna	*100 km/h*
Swordfish	*90 km/h*
Marlin	*80 km/h*
Yellowfin tuna	*74 km/h*
Flying fish	*56 km/h*
Barracuda	*43 km/h*
Mackerel	*33 km/h*



Estuarine stonefish
Synanceia horrida

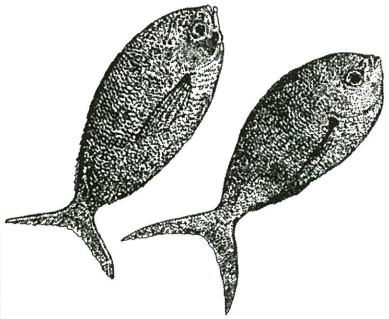


Lionfish *Pterois volitans*

ROCKCODS AND GROUPERS

Family Serranidae

This is a large group of fish ranging from the small, colourful fairy basslets to the large Queensland grouper. The majority of species have three spines on the gill cover (operculum) and a large mouth with more than one row of teeth. Generally these fish ambush prey using their colouration patterns for camouflage. The fairy basslets form large aggregations on reef fronts where they feed on zooplankton. When approached they quickly seek shelter amongst the coral.



Red-bellied fusilier
Caesio cuning

Most species are hermaphroditic, with adult females capable of changing sex to become male. Male fairy basslets are easily differentiated as they have a different colour pattern to the numerous females in a colony. In a large school there may be a number of males with separate territories within the school. During summer months, coral trout migrate to form spawning aggregations where, like most other members of the family, they spawn at dusk. After a courtship period the male and female rush towards the surface to release eggs and sperm.

Many species of this group are of commercial value. However, **fish of this group are among the worst offenders for causing ciguatera poisoning**. There are size and bag restrictions for these fish within the Marine Park. All potato cod and groupers over 120 centimetres in length are protected.

SNAPPERS

Family Lutjanidae

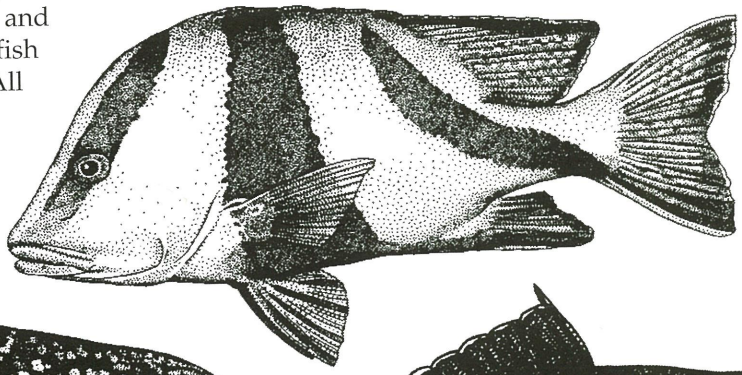
Snappers are small to medium sized reef fish. Most are nocturnally active predators feeding mainly on fish, crabs, shrimps, gastropods, cephalopods and planktonic organisms. Snappers, and in particular the red emperor *(Lutjanus sebae)* which is in the snapper family, not the emperor family, are a favourite angling species. **Chinaman fish *(Symphorus nematophorus)* are frequently implicated in ciguatera poisoning.**

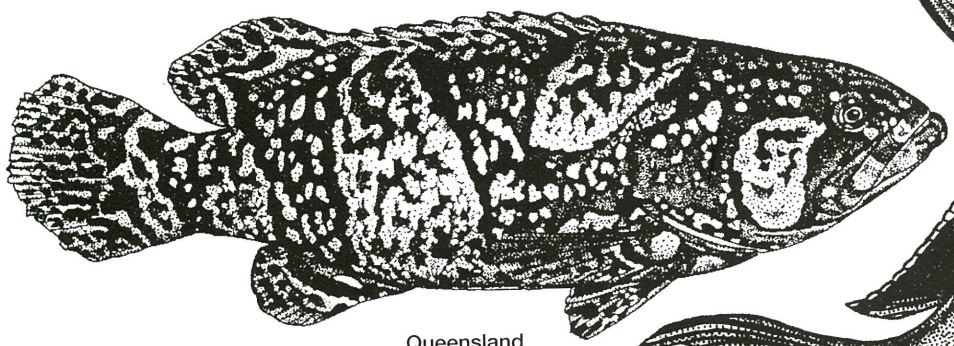
FUSILIERS

Family Caesionidae

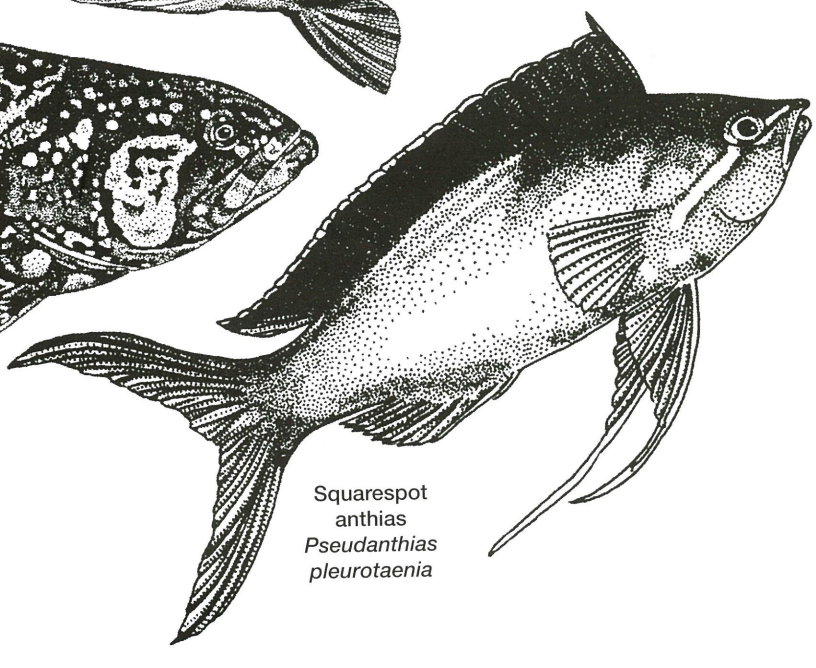
Fusiliers are often seen swimming in large schools off the reef front where they feed on zooplankton. They possess several adaptations for a pelagic, planktivorous mode of life, including an elongate fusiform body, small scales, a small terminal mouth and a deeply forked tail. These fish are designed for speed – not for catching prey, but to avoid becoming prey. During the night, fusiliers sleep amongst the coral where they develop a red colouration to their belly. Fusiliers are one of the most important food species amongst islands in the Indo-Pacific region.

Red emperor
Lutjanus sebae

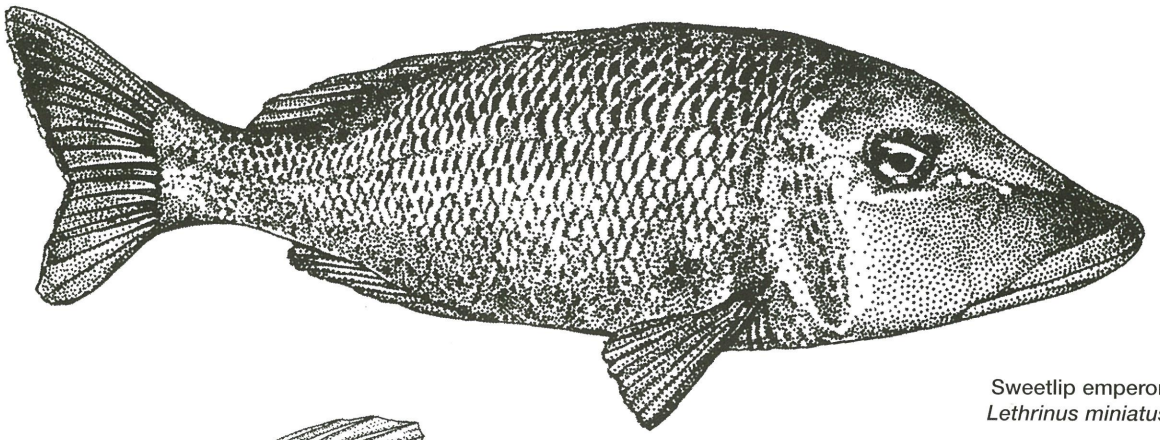




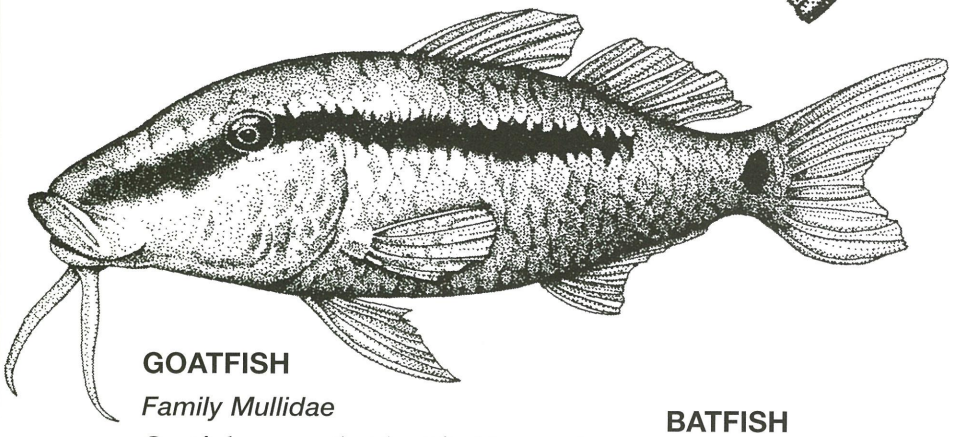
Queensland grouper
Epinephelus lanceolatus



Squarespot anthias
Pseudanthias pleurotaenia



Sweetlip emperor
Lethrinus miniatus



Dash-dot
goatfish
Parupeneus
barberinus

GOATFISH

Family Mullidae

Goatfish are easily identified by a pair of barbels on their chin which are used to probe the sand for food. They mainly feed on worms, crustaceans and echinoderms living in sediment. Some species use their barbels to chase fish from holes. Goatfish are often seen in schools feeding amongst the sediment with small wrasses and other fish following to pick up any food disturbed by the goatfish.

EMPERORS

Family Lethrinidae

Emperors are a keenly sought group by both recreational and commercial fisheries. They are normally found over sandy areas adjacent to reefs where they forage for crabs, sand dollars, fish and other bottom-dwelling organisms.

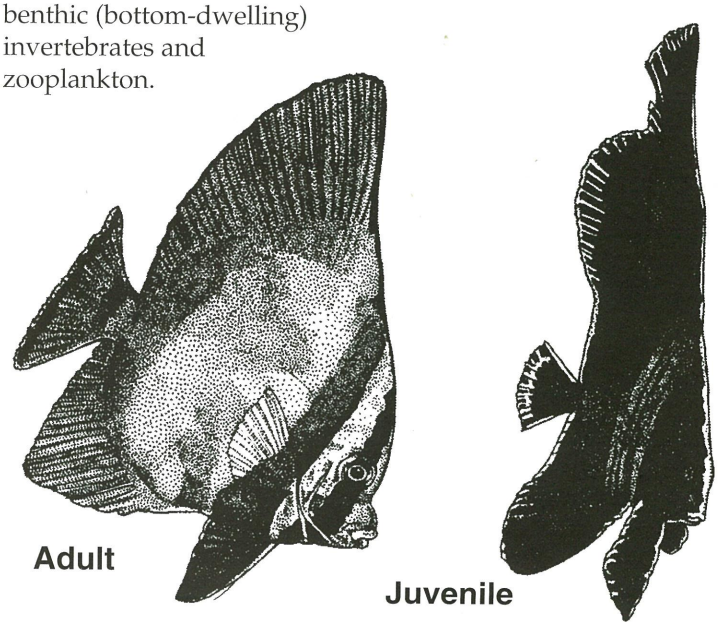
Spawning amogst the sweetlip emperor *(Lethrinus miniatus)* occurs nearly year round off Cairns, from June–August off Townsville and from October–November in southern waters due to variations of water temperature. Juveniles live in shallow water seagrass beds and mangroves, moving offshore as they grow. Sex changes from female to male occur as the emperor grows. Unlike the sweetlip emperor, the spangled emperor *(Lethrinus nebulosus)* has molar teeth which enable it to crush shellfish.

BATFISH

Family Ephippidae

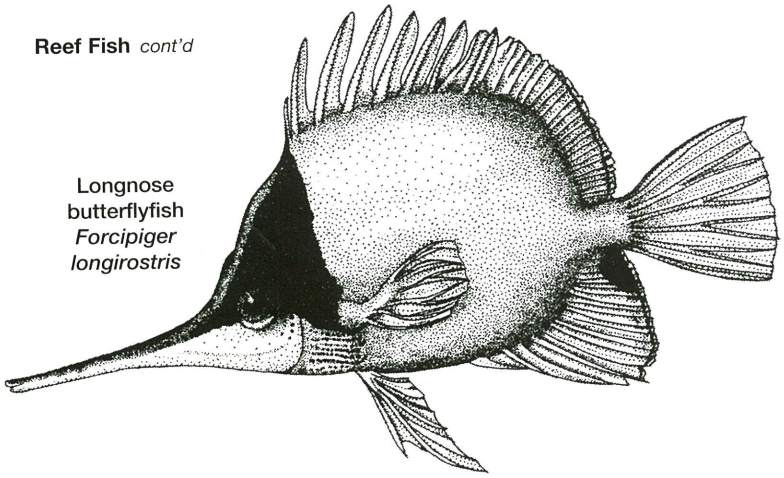
Batfish are very distinctive with their almost circular bodies. They can become extremely tame and curious, often swarming around divers. Juveniles have extremely deep bodies with greatly enlarged dorsal and anal fins and are often found in shallow reefs and drifting amongst sargassum. The juvenile pinnate batfish *(Platax pinnatus)* mimics the colour patterns of a toxic flatworm which is black with an orange border. Juvenile orbicular batfish *(Platax orbicularis)* mimic dead drifting leaves and are often found around boat harbours and jetties. Batfish feed on benthic (bottom-dwelling) invertebrates and zooplankton.

Pinnate batfish *Platax*
pinnatus



Adult

Juvenile



Longnose butterflyfish
Forcipiger longirostris

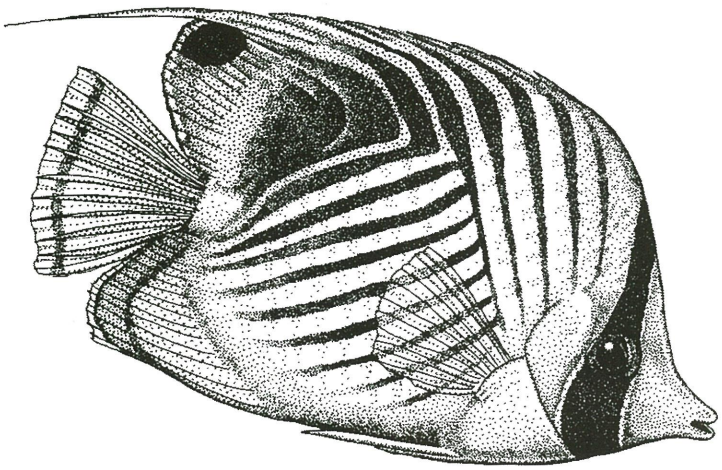
BUTTERFLYFISH

Family Chaetodontidae

Butterflyfish are renowned for their striking colour patterns, delicate shapes and graceful swimming movements. They have deep, compressed bodies with small mouths, scales that extend out onto the median fins and tiny bristle-like teeth; hence their family name Chaetodontidae which means 'bristle-like teeth'. Their shape allows for manoeuvrability in and around corals while feeding. The diet differs amongst species; many feed on a combination of coral polyps, small invertebrates, fish eggs and filamentous algae. These fish are active during daylight hours and seek shelter amongst the reef's structure at night, often assuming a drab, nocturnal colour pattern. Butterflyfish often form pairs that may stay together for periods ranging from weeks to life.

Butterflyfish are also characterised by colour patterns such as eye stripes and false eye spots which are used to confuse predators as to the direction in which the fish is swimming.

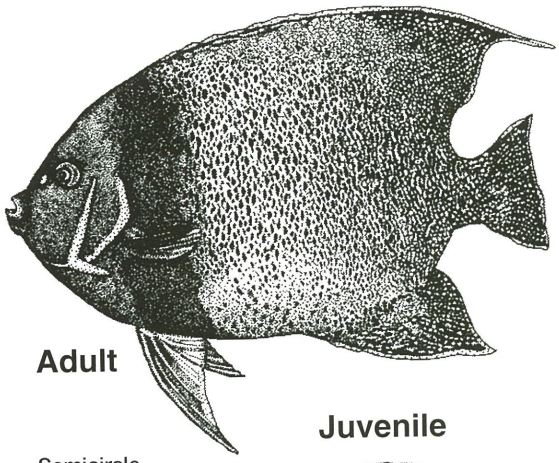
Threadfin butterflyfish
Chaetodon auriga



ANGELFISH

Family Pomacanthidae

These fish are closely related to the butterflyfish and share a number of similar characteristics such as deep, compressed bodies, scales that extend out onto the median fins and bristle-like teeth. They can, however, be identified by the presence of a spine in the corner of the gill covering (operculum). Typically most species are territorial and spend daylight hours near the bottom in search of food. The diet varies according to species; some feed on algae whilst others feed on sponges supplemented by a variety of benthic (bottom-dwelling) invertebrates. All species studied so far change sex from female to male. Each male defends his territory containing two to five females. Angelfish are also known for their dramatic colour changes from juvenile to adult stages, particularly in the genus *Pomacanthus*. The fish of this genus are also capable of startling divers with a powerful thumping sound which is produced by the airbladder of large adults.



Adult

Juvenile

Semicircle angelfish
Pomacanthus semicirculatus

DAMSELFISH

Family Pomacentridae

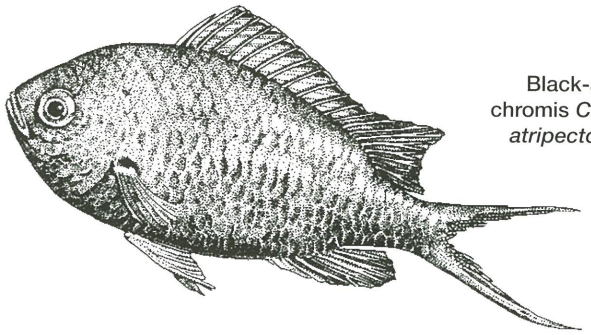
Damselfish are one of the most abundant groups of coral reef fishes. They display remarkable diversity in habitat preferences, feeding habits, behaviour and colouration. Most species are highly territorial. Algal feeding species zealously defend their

'plot' against intruders, regardless of size. These algal feeders generally have drab colouration patterns whereas the plankton feeding damsels are brightly coloured. Damselfish eggs are layed on coral rock and are guarded by the male until they hatch in 2-14 days. All damselfish, except the anemonefish (genus *Amphiprion* and *Premnas*), change sex from female to male. The anemonefish goes through a reverse sex change from male to female. Anemonefish live in close association with large sea anemones, each species having a preferred host. Anemonefish receive protection from predators by hiding amongst the tentacles of the anemone. In return they protect the anemone from butterflyfish which feed upon the tips of the anemone's tentacles.

A number of theories exist as to how the anemonefish prevent themselves from being stung. For example:

1) The fish smear anemone mucus over themselves during elaborate dances, thus tricking the anemone into thinking the fish are part of the anemone.
2) The fish lack components in their own mucus that causes the anemone to sting.

Anemonefish are normally found as a pair of adults and several juveniles. Being protandrous (change from male to female) hermaphrodites the larger is the female and the smaller the male. If the female dies the male changes sex and the largest juvenile becomes the new male. Eggs are laid at the base of the anemone and take up to 14 days to hatch.



Black-axil chromis *Chromis atripectoralis*

WRASSES

Family Labridae

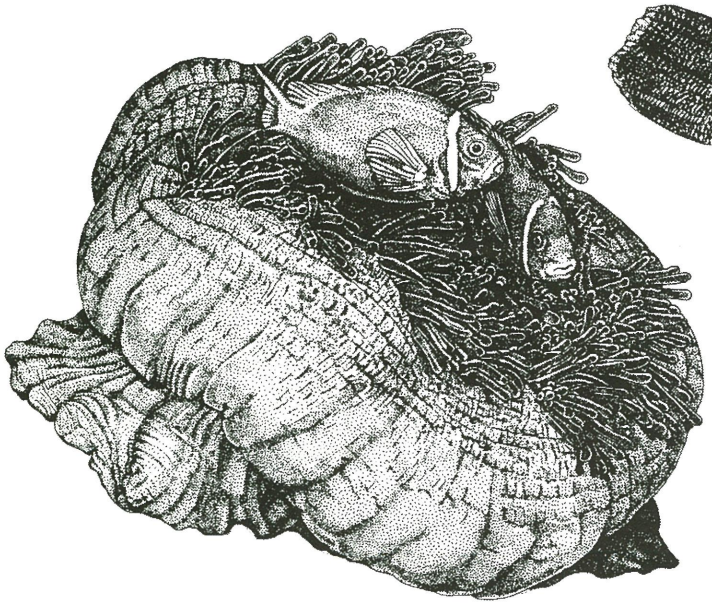
Wrasses are perhaps the most diverse group of fish in terms of size and form. They are the second most abundant group of fish, exceeded only by gobies. Wrasses have a second set of jaws located in their throat called a **pharyngeal** jaw apparatus. These jaws are primarily used for the processing of food (just like having a blender in the head). Sex-reversal seems to be universal, with wrasses changing from female to male. These sex changes are normally accompanied by distinct colour changes. Most wrasses are carnivores, feeding on invertebrates or fish; others are planktivores, corallivores, or cleaners that feed on the external parasites of other fish (e.g. cleaner wrasse).

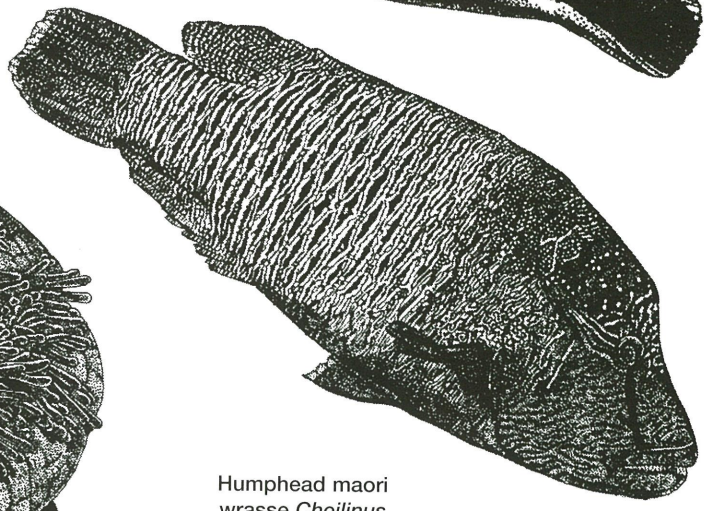
Sleepy time

Fish cannot close their eyes because they don't have any eyelids. However, they do sleep, some lying quite still on the seabed tucked between corals.

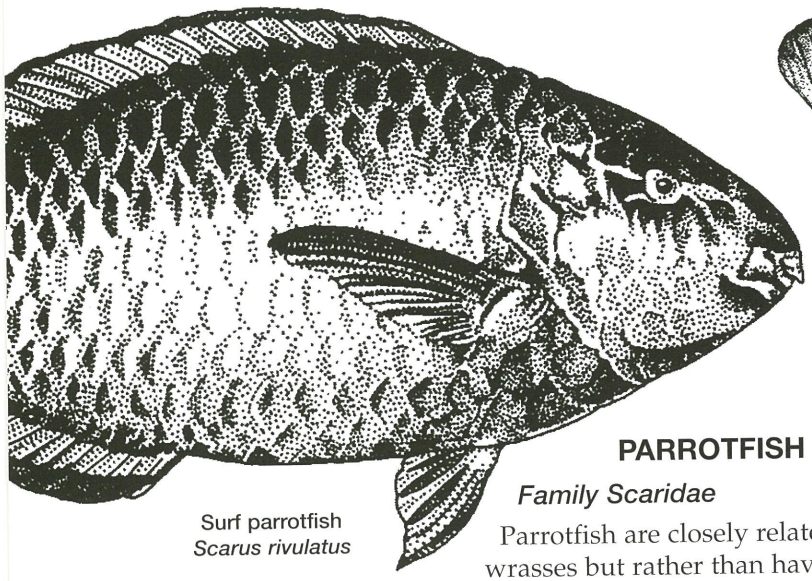
Cleaner wrasse *Labroides dimidiatus*

Pink anemonefish *Amphiprion perideraion*



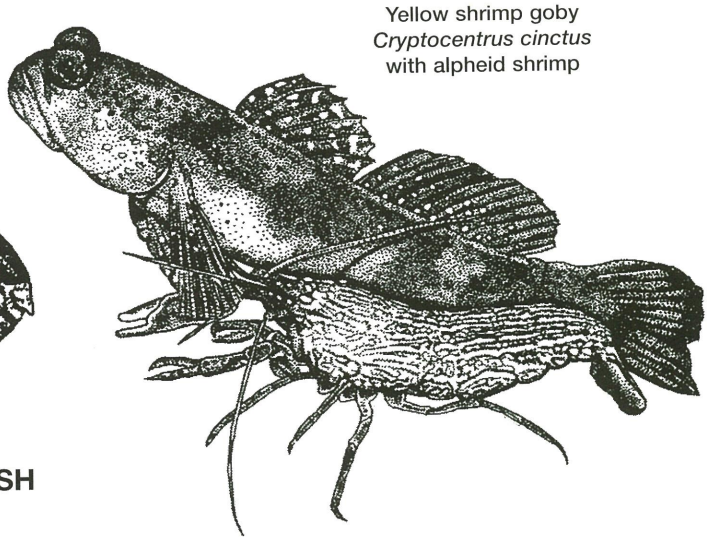


Humphead maori wrasse *Cheilinus undulatus*



Surf parrotfish
Scarus rivulatus

Yellow shrimp goby
Cryptocentrus cinctus
with alpheid shrimp



PARROTFISH

Family Scaridae

Parrotfish are closely related to wrasses but rather than having individual teeth in the jaws, their dental plates are fused to form a distinctive beak-like structure used for scraping algal food from the surface of the reef. Parrotfish often form large schools grazing over the reef and have often been likened to grazing cattle. The algae is crushed by pharyngeal jaws and processed in a very long intestine. They do not have a stomach. Parrotfish are a main contributor to the creation of sediment on a reef, as they expel fine particles of limestone that are consumed during feeding. Parrotfish exhibit the same reproductive and colour patterns as wrasses. Many species form a cocoon-like mucus structure at night to help mask their scent, making them harder for nocturnal predators to find.

Suckers

The remora attach themselves to large creatures such as sharks, manta rays and whales using a sucker on the top of their head. Remoras detach themselves to feed on leftovers from their host's meals. They are not parasites.

BLENNIES

Family Blennidae

These small, secretive fish live amongst coral and coral rubble. They often have fleshy crests, or cirri, as they are known, growing from above the eyes and nostrils. Most blennies are herbivorous, feeding upon filamentous algae. There are a few carnivorous species of blennies, the most notable being the mimic or sabre-toothed blenny. The sabre-toothed blenny mimics the colour patterns of the cleaner wrasse. As it approaches a larger fish it uses its large sabre teeth to take a bite out of the side of an unaware fish waiting to be cleaned.

GOBIES

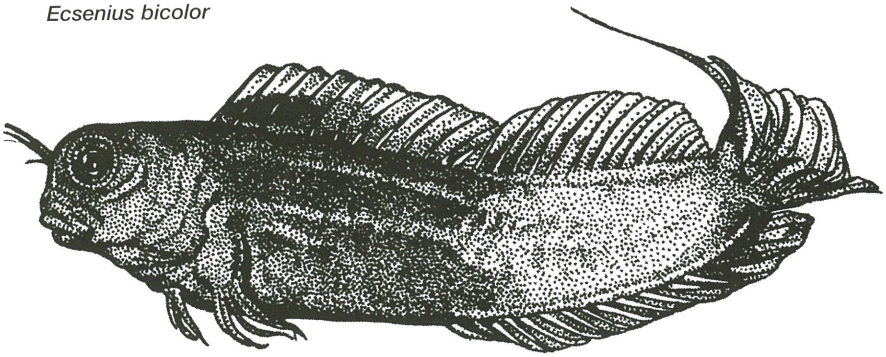
Family Gobiidae

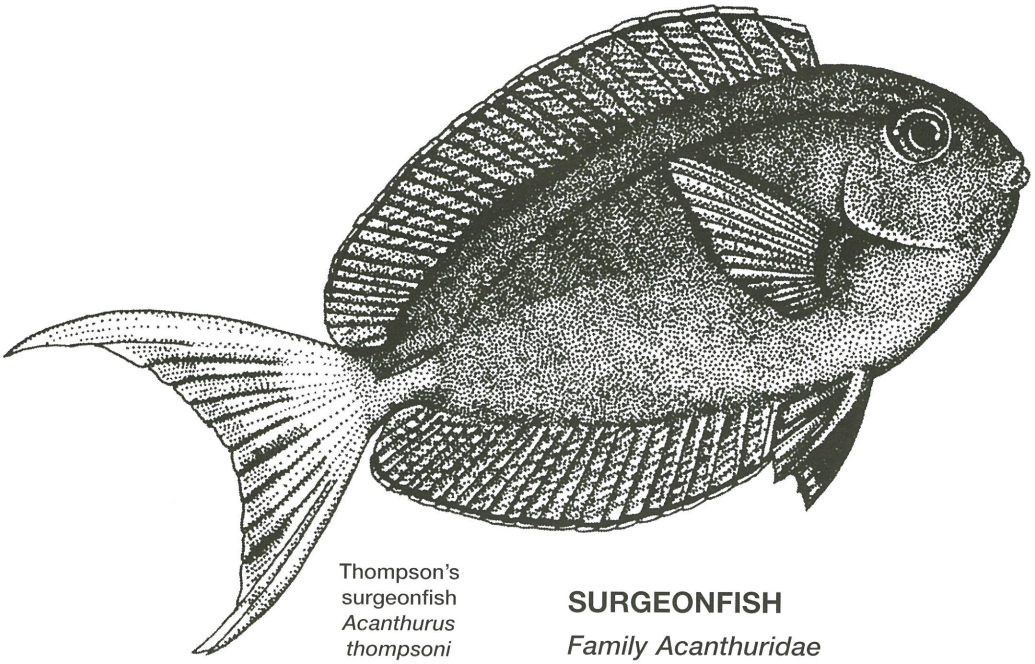
Gobies are small bottom-dwelling fish that often go unnoticed. With over 1600 species, gobies are actually the largest family of fish in the world. Living amongst coral rubble and sometimes in burrows in sand, gobies can be distinguished from blennies by their pelvic fins, which form a disc-shaped cup.

Gobies feed mostly on small invertebrates; many of the sand-dwelling gobies take large mouthfuls of sand and sift out invertebrates or minute algae.

A number of gobies live in symbiotic relationships with different species of alpheid shrimp. The gobies have good eyesight and are very alert. The shrimp, however has poor vision but remains in contact with one of the gobies by using its long antennae. Should danger threaten, the retreating fishes alert the shrimp and they all retreat into the burrow. In return, it is the role of the shrimp to do most of the making and maintenance of the burrow.

Bicolour blenny
Ecsenius bicolor





Thompson's surgeonfish
Acanthurus thompsoni

SURGEONFISH

Family Acanthuridae

This group derive their common name from the scalpel-like spine on each side of their tail base, which is sometimes used as a defensive weapon during territorial disputes. These fish can either be solitary or form schools. Most surgeonfish *(genus Acanthurus)* graze on benthic algae, however, there are a number of species like the unicornfish *(genus Naso)* which feed on zooplankton. The brown tangs *(genus Ctenochaetus)* feed on detritus that falls upon algae. Surgeonfish show a great range of digestive systems. Species of brown tang *(Ctenochaetus sp.)*, and several other surgeonfish *(genus Acanthurus)* have thick-walled, gizzard-like stomachs, while others use chemicals such as acids to aid in the breakdown of algae. Recent research shows that some species have a similar system to termites and use specialised symbiotic bacteria living in their digestive system to break down the cell walls of algae.

Telescopic mouth

When extended, the mouth of the slingjaw wrasse is over a third of its body in size.

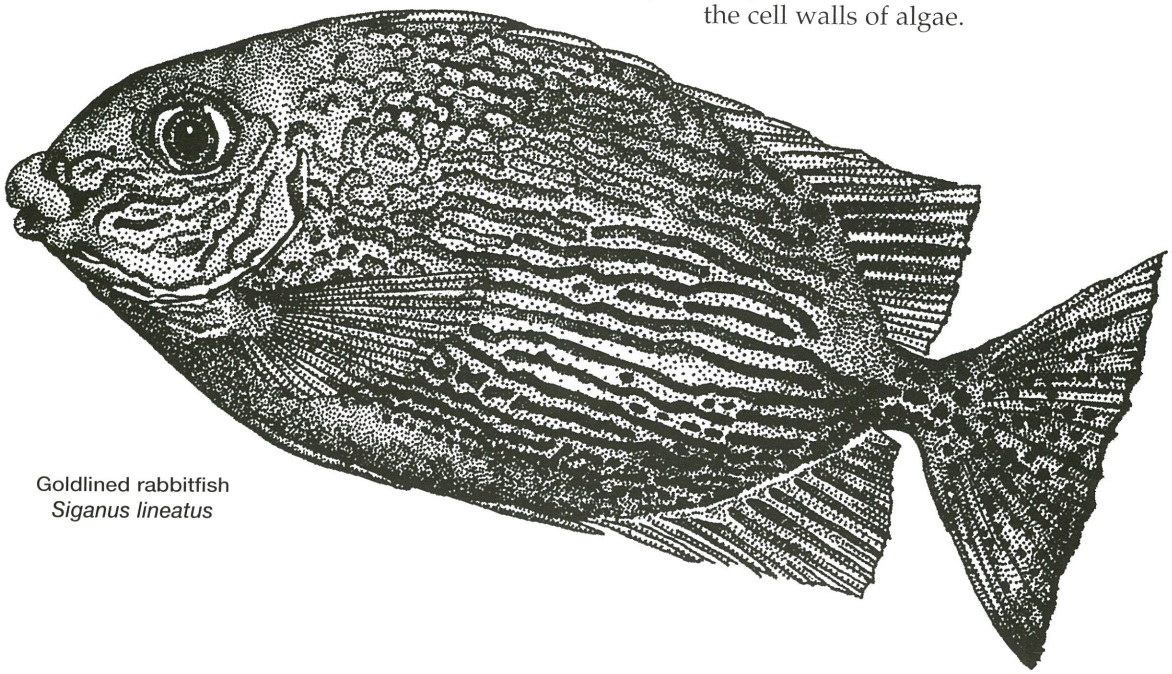
Biggest bony fish

The ocean sunfish (Mola mola) is the largest bony fish, growing over three metres and weighing over two tonnes. The sunfish, which is in the same group as triggerfish and puffers, has extremely powerful jaws, although it only feeds on jellyfish

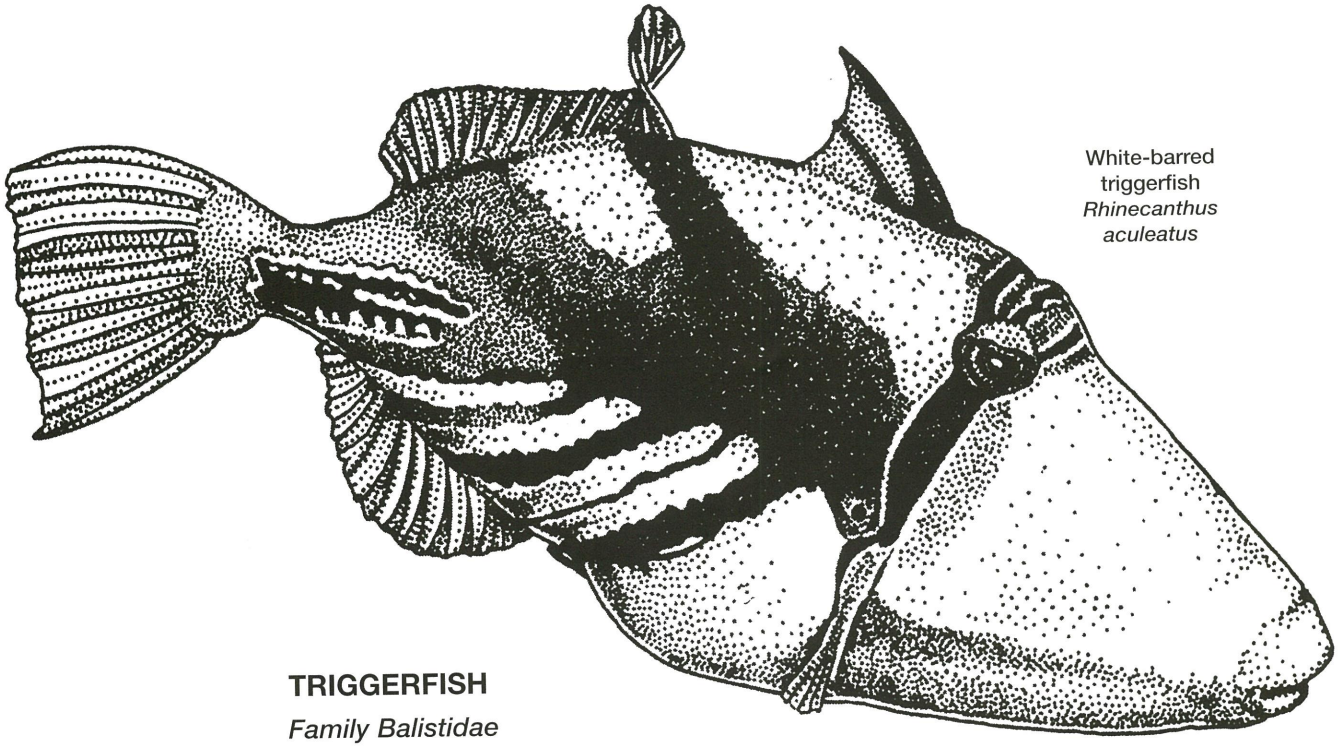
RABBITFISH

Family Siganidae

Rabbitfish are highly compressed, deep-bodied fish with venomous, grooved spines. Wounds from these spines are very painful, but not as serious as injuries from stonefish. The pelvic fins of rabbitfish are unusual with a spine at each end and three soft rays between. All species have 13 spines on their dorsal fin which is preceded by an embedded forward-projecting spine. Rabbitfish are diurnal herbivores feeding on algae and seagrasses.



Goldlined rabbitfish
Siganus lineatus



White-barred triggerfish
Rhinecanthus aculeatus

TRIGGERFISH

Family Balistidae

Triggerfish derive their common name from a stout first dorsal spine which can be locked into position by a small second spine (the 'trigger', for if it is pressed down the first spine can be 'unlocked'). This trigger apparatus is used by the fish to wedge themselves into coral crevices at night. These fish are also characterised by a leathery skin and a small mouth with powerful, crushing jaws. They swim by undulating the second dorsal and anal fins, bringing their tail into action only when speed is needed. Some of the larger species are a menace to divers at certain times of the year when breeding. The male parent viciously guards his nest and may aggressively charge other large fish and humans which may venture too close. Triggerfish feed on a wide variety of invertebrates including sponges, gorgonians, crabs, shrimps, molluscs and echinoderms. They are often seen head down 'blowing' water into the sand to excavate food.

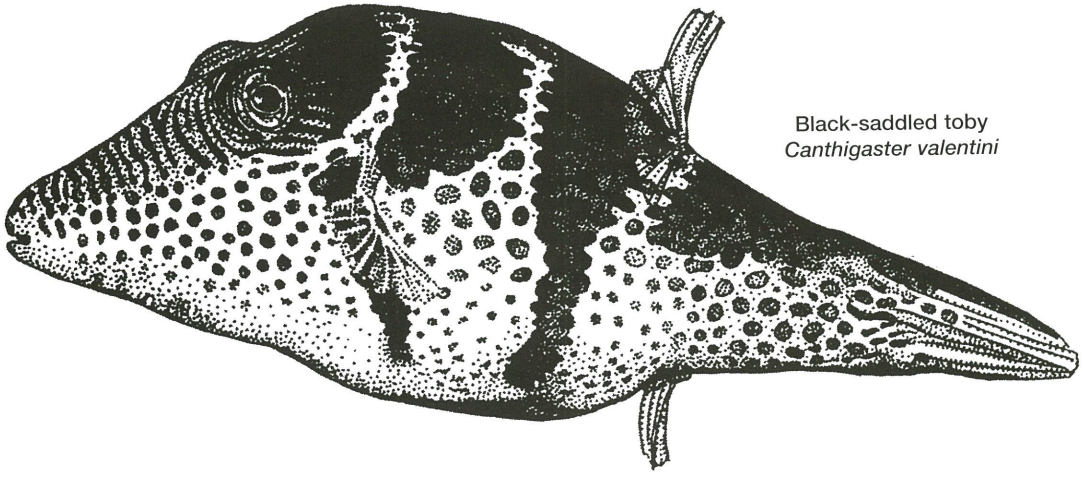
Life in a box

The unusual boxfish is a close relative of the pufferfish. Its body is encased in hard body plates for protection. In addition the boxfish releases toxin into the water if it is being harassed.

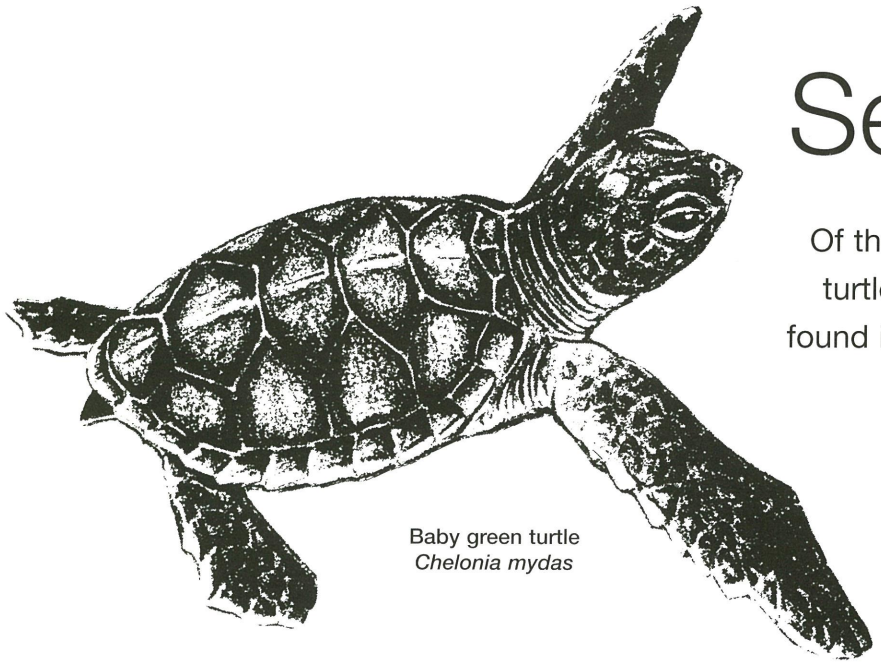
PUFFERFISH

Family Tetraodontidae

Pufferfish are known for their ability to inflate themselves by drawing water into their abdomen. They have a tough, scaleless skin (often with spines), beak-like dental plates, slit-like gill openings, no pelvic fins and no ribs. The flesh, and especially the internal organs, contain a potent toxin that has caused many human deaths when eaten. However, they are considered a delicacy (known as 'fugu') in Japan where they are prepared by specially trained and licensed cooks.



Black-saddled toby
Canthigaster valentini



Baby green turtle
Chelonia mydas

Sea Turtles

Of the world's seven species of sea turtle, six occur in Australia. All are found in the Great Barrier Reef World Heritage Area. The three most commonly seen are the green, loggerhead and hawksbill turtles. The flatback turtle only nests in Australia.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS REPTILIA
(Latin meaning 'to creep')
Pronounced rep-til'e-a

Characteristics

- enclosed by a shell
- limbs modified into flippers

Role on the reef

During summer a mass migration occurs as sea turtles return to breed on islands and beaches in the northern and southern parts of the Great Barrier Reef. These large congregations also attract a number of predators such as tiger sharks.

Feeding

The green turtle is mostly herbivorous, using its serrated beak to feed on seagrasses, algae and mangrove fruits. Juvenile green turtles are known to also feed on jellyfish. Leatherback, loggerhead and olive ridley turtles are carnivores, feeding on a wide range of invertebrates such as crabs, shells and jellyfish. Flatback and hawksbill turtles are omnivores, eating both plants and invertebrates.

Plastic bags drifting around in the ocean are often mistaken by turtles as jellyfish. The plastic blocks the stomach causing the turtle to eventually starve to death.

Defence

Unlike a tortoise, sea turtles are unable to hide their head and limbs in their shell. They rely on short bursts of speed to escape most predators.

Reproduction

Sea turtles mate during October and November. The female is able to store the sperm from multiple matings to be used later in the season. When it is time to nest the female crawls up onto a beach and digs a nest well above high-tide mark. Her powerful flippers excavate a body pit. Her rear flippers dig the egg chamber at the bottom of the pit, into which 50–150 (average 120) ping-pong sized eggs are deposited. After laying, the nest is filled back in by the female and she returns to sea. Female green turtles may have up to eight clutches of eggs in one season (loggerheads up to six).

The eggs take 6 to 8 weeks to develop in warm sand and up to 12 weeks in shaded areas. During this period the temperature of the sand around the nest determines the sex of the turtles. Warmer sand produces females, cooler sand produces male turtles. Eggs tend to hatch simultaneously, with the young remaining buried until they erupt from the nest to make a mad dash to the sea. On the way to the water's edge they must run a gauntlet of crabs and seabirds. Although the majority of hatchlings will successfully reach the water's edge, once in the water they fall easy prey to large fish and sharks.

Where the juveniles go after hatching is a mystery as they are not seen again on the reef until they're the size of dinner plates. When they become mature, these young sea turtles will return to the same region where they were born.

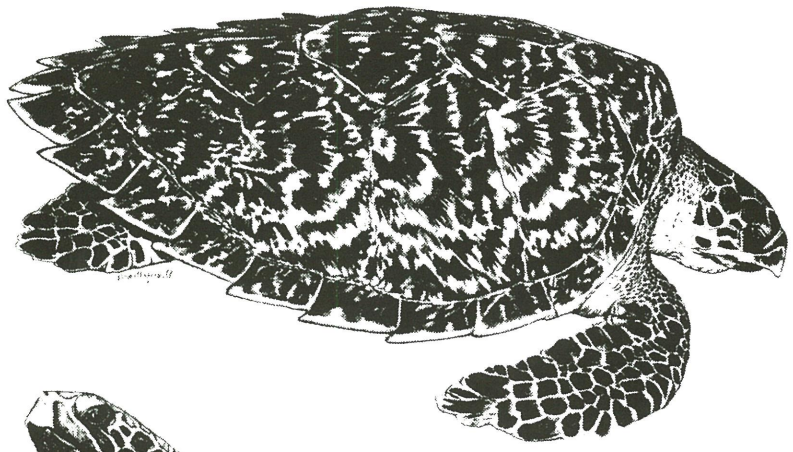
Human use and impacts

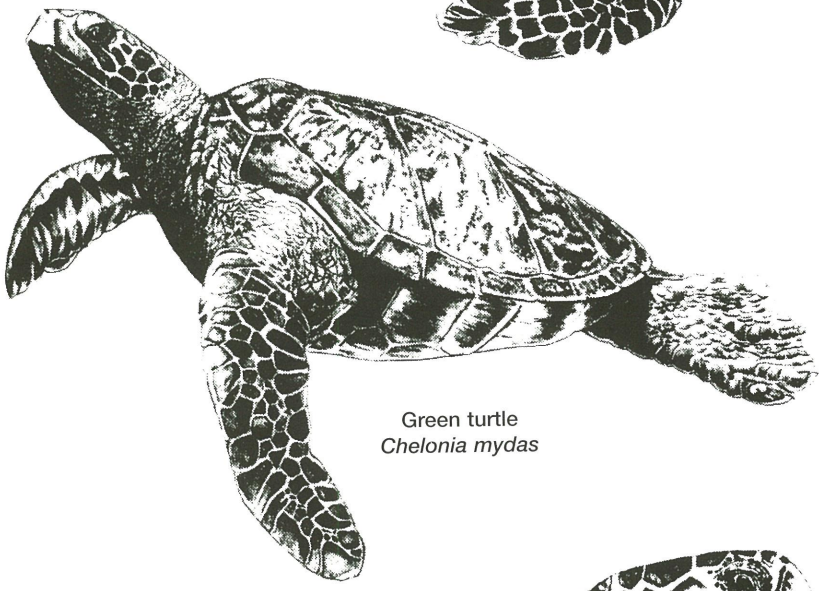
Heron and North West Islands in the Capricorn and Bunker Groups region were sites for turtle soup canneries in the 1920s and 1930s. During the

summer of 1924-25 over 1000 turtles were taken. The shell of the Hawksbill turtle is harvested in some countries for 'tortoiseshell' products, although domestic and international trade in all turtle products is now prohibited.

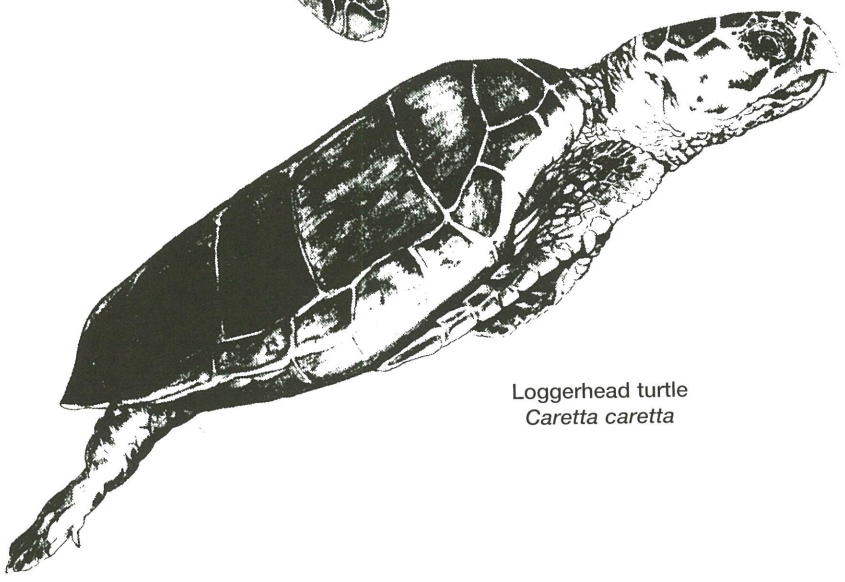
Sea turtles and turtle eggs are protected throughout Australian waters with only Aboriginal and Torres Strait Islander peoples being given permits for traditional hunting.

Hawksbill turtle
Eretmochelys imbricata





Green turtle
Chelonia mydas



Loggerhead turtle
Caretta caretta

One of the main dangers to turtles at sea is drowning after getting caught in commercial fishing gear. Turtle exclusion devises on trawl nets required in the Marine Park to minimise this problem. Turtles may also be killed as a result of collisions with boats. On land, changes to nesting beaches such as rock retaining walls may force turtles to lay their eggs below the high tide mark. Lights behind the beach can also attract hatchlings, making them head inland instead of towards the sea.

GREEN TURTLE

Chelonia mydas

The green turtle is the most commonly encountered turtle on the reef. Adults have a smooth, high-domed carapace (shell) that is green in colour with brown, reddish-brown or black highlights and a white underside. Green turtles reach maturity between 30 and 70 years with the mature female having an average curved carapace length of 107.6 centimetres. There are two genetically distinct breeding populations breeding on the reef, one in the northern Great Barrier Reef and one in the south. Green turtles are largely vegetarian, feeding on seagrass and algae.

LOGGERHEAD TURTLE

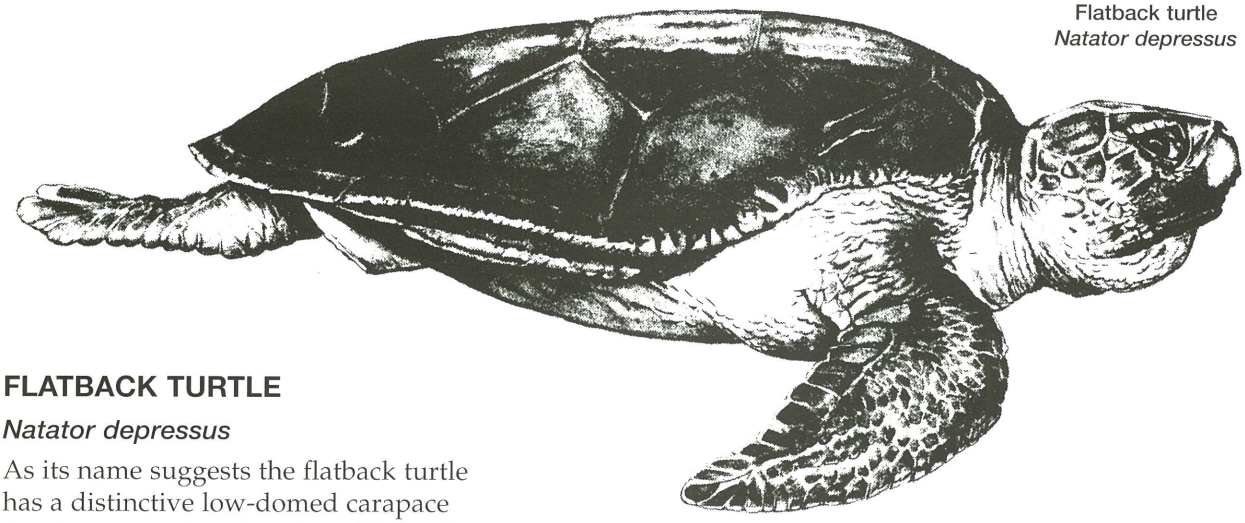
Caretta caretta

After the green turtle the loggerhead is probably the second most common turtle on the reef. It is distinguished from the green by its large size and large head. Adults are brown, highlighted with light brown, reddish-brown and black. The underside is yellow. They are carnivorous using their powerful jaws to feed on molluscs and crabs. Female loggerheads reach maturity at an average curve carapace length of 95 centimetres.

HAWKSBILL TURTLE

Eretmochelys imbricata

The shell of the hawksbill turtle is extensively patterned with brown and black lines. It is this species that was hunted for the tortoiseshell trade. The distinctive beak-like mouth is used to feed on a wide range of food including algae, molluscs, crustaceans, soft corals and sponges.



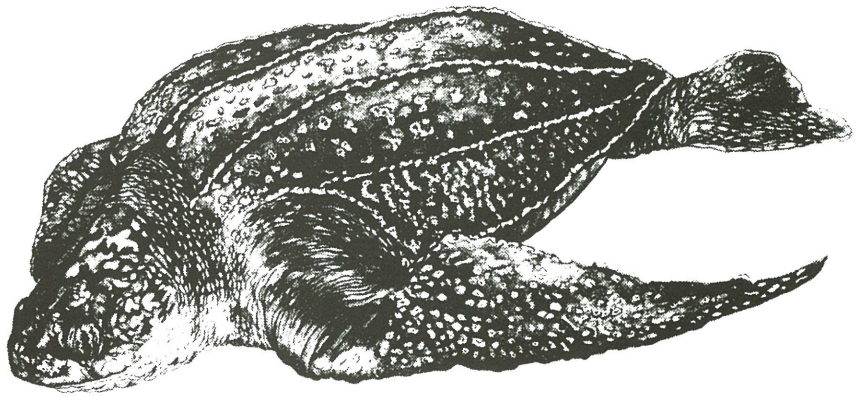
Flatback turtle
Natator depressus

FLATBACK TURTLE

Natator depressus

As its name suggests the flatback turtle has a distinctive low-domed carapace that is upturned at the edges. Flatbacks are the only species of sea turtle that is endemic (found only there) to Australia. They are found in shallow, coastal waters where they feed on a variety of crustaceans, molluscs, jellyfish and algae.

Leatherback turtle
Dermochelys coriacea

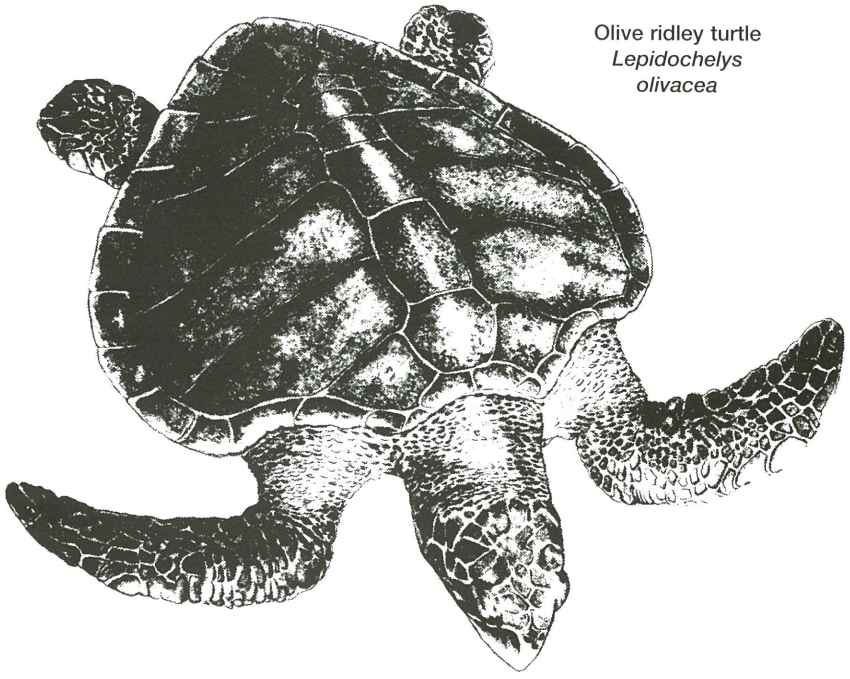


LEATHERBACK TURTLE

Dermochelys coriacea

The leatherback is the largest species of turtle in the world, reaching recorded lengths of over 2.5 metres and weighing almost a tonne. These sea turtles have an easily identifiable carapace with five distinct ridges running down the back to a very pointed posterior. Pale pink spots are present on the head. No major breeding aggregations occur within Australia, with only a few individuals coming ashore at Wreck Rock, Round Hill and Bundaberg. Leatherbacks are carnivorous, feeding on jellyfish, sea squirts and soft-bodied invertebrates.

Olive ridley turtle
Lepidochelys olivacea

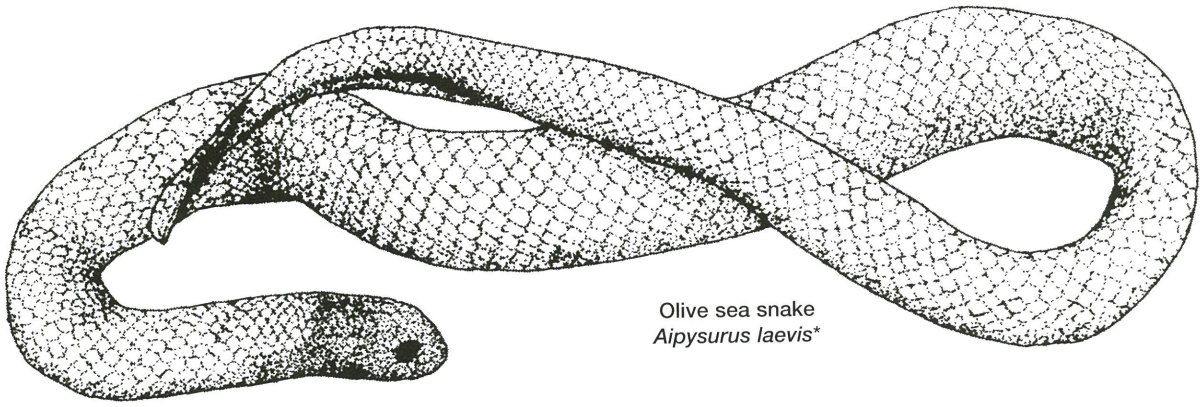


OLIVE RIDLEY TURTLE

Lepidochelys olivacea

The smallest species of sea turtle in the world, the olive ridley turtle reaches an average length of 71 centimetres. Adults are grey to olive colour with a white underside. The carapace is heart-shaped. There are no breeding populations in the Great Barrier Reef, however feeding populations are present. Olive ridley turtles are carnivorous, feeding mainly on small crabs.

Sea Snakes



Olive sea snake
*Aipysurus laevis**

Although similar to their land counterparts, sea snakes are well adapted to the marine environment. They have a paddle shaped tail that propels them through the water, and their belly scales are formed into a keel that helps stabilise them when they are swimming.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS REPTILIA
(Latin meaning 'to creep')
Pronounced rep-til'e-a

Characteristics

- elongated body
- paddle shaped tail
- keel shaped under-belly

Role on the reef

About 16 species of sea snakes are found in the waters of the Great Barrier Reef. The species most commonly encountered by divers is the olive sea snake *(Aipysurus laevis)*.

Feeding

Sea snakes are among the most venomous snakes in the world possessing some of the most potent toxins known. Most feed on a variety of fish, with one species, the turtle-headed sea snake *(Emydocephalus annulatus)*, being specialised in feeding on fish eggs.

Defence

Most sea snakes such as the olive sea snake *(Aipysurus laevis)* are extremely curious and will readily approach divers. Generally they are not aggressive except during mating season (late summer) when they are territorial. Fortunately the fangs of sea snakes are quite short with only the largest specimens able to penetrate a wetsuit. In addition sea snakes also have the ability to withhold venom during a strike.

Reproduction

Externally, female sea snakes are indistinguishable from males. Most sea snakes living in Australian waters produce between two and ten live young which are born at sea.

Great divers

Sea snakes are excellent divers, being able to dive for over an hour. They have only one lung which is over two-thirds of their body length. In addition to breathing air, sea snakes are able to take in about 30% of their oxygen requirement from the water through their anus and skin. By taking in the extra oxygen they are able to displace the amount of nitrogen in their blood, which prevents the bends.

Human use and impacts

In the Great Barrier Reef World Heritage Area, sea snakes are caught as by-catch in prawn trawling nets. In some countries, such as the Philippines and Japan, the skins of sea snakes have been used to make leather, especially belts, wallets, watch bands and handbags. In Australia, there is a small trade in skins, from snakes collected as by-catch.

History

Little is known about the history of sea snakes due to a lack of fossil evidence.

Seabirds

Life at sea occurs not just in the water, but above it too. Seabirds are animals of air, land and sea. They feed from the sea, travel through the air and reproduce on land. Seabirds are common and seen on all reef trips as well as from land. The Great Barrier Reef is a very important feeding and breeding area for seabirds. Forty species have been recorded in the area with 22 recorded as breeding.

Black Noddy
Anous minutus

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS AVES
(Latin meaning 'birds')
Pronounced ay'veez

Characteristics

- feeds and spends most of its time at sea
- has webbed feet
- has feathers that are usually oiled
- excretes excess salt from special glands
- has long thin wings designed for distance flying

Role on the reef

Seabirds are obvious components of the reef ecosystem. They consume considerable amounts of food particularly small species of fish close to the surface. Some scavenge and help keep the reef clean. Seabirds have a major influence on island ecosystems. On breeding islands where large numbers of seabirds congregate, their droppings (guano) fertilise plants and assist the introduction of plants on coral cays. Another way they assist plants is to carry seeds attached to their feathers and feet to new locations.

Feeding

Most seabirds feed on fish, squid and shrimps near the sea surface. The exact prey species eaten varies with the size of the seabirds and the feeding techniques used. Some seabirds dive from a height, others, like shearwaters, sit on the surface and dip underwater and some such as cormorants swim underwater. Prey is seized by the seabirds' beaks which are strong and often pointed to assist capturing prey. Other seabirds, such as gulls, also scavenge for food.

Defence

When faced with threats, the strategy of most seabirds is not fight, but flight. Few predators are a threat in the air. On or under the water large fish may be a problem so most seabirds don't linger for long on the water, taking to the air if frightened. Many seabirds are coloured grey above and white below. The grey colour helps them to blend in with the sea and makes them difficult to be seen by aerial predators such as sea-eagles.

The white underparts helps them to avoid predators from below because when they are sitting on the water white shapes are difficult to see against the bright sky.

Popular myth has it that many seagulls with one leg have had one bitten off by fish. That may be true in some cases but fishing line is also a leg lopper.

Seabirds are vulnerable on land, particularly when nesting. They nest on islands where they are safe from mainland predators such as goannas and dingos. Many seabirds lay eggs in nests on the ground. Eggs, and young chicks of these birds, often camouflaged to avoid detection from egg and chick robbers (especially other seabirds). Shearwaters have white eggs but they are hidden in and protected by burrows.

Reproduction

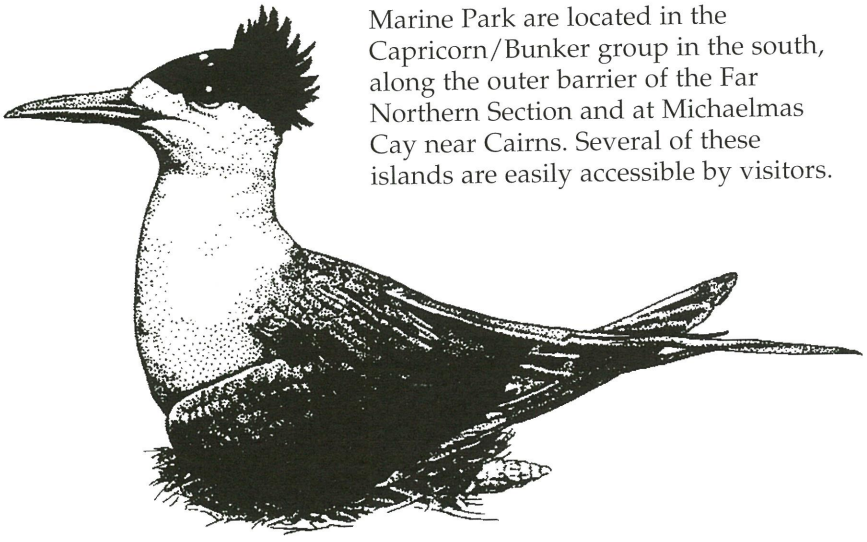
All seabirds must find land to nest on. Most are communal nesters and many form large breeding colonies. Some appear to require large numbers of

fellow breeders to stimulate their own breeding. Specific requirements for nesting sites vary. Many seabirds such as terns, brown boobies and silver gulls nest in shallow scrapes with little nesting material. Some prefer open areas, others under vegetation. Some seabirds such as frigatebirds nest in shrubs and black noddies nest in trees. Shearwaters dig nesting burrows amongst trees.

Parents take turns to incubate eggs for the first couple of weeks. Then chicks are usually left in nests or hiding in vegetation while both parents are out at sea finding food. Hungry chicks receive regurgitated food from their parents. Chicks soon lose their fluffy down as they grow and develop adult feathers. They teach themselves to fly, swim and feed.

Breeding times vary with location and species. Shearwaters breed in summer as do most seabirds in the southern part of the reef. In the northern part of the reef seasonality is not so rigid, and some tern species breed all year round. Some species are faithful to their own breeding sites returning time and time again, while other species move around, nesting on different islands regularly.

The most important seabird breeding islands in the Great Barrier Reef Marine Park are located in the Capricorn/Bunker group in the south, along the outer barrier of the Far Northern Section and at Michaelmas Cay near Cairns. Several of these islands are easily accessible by visitors.



Crested tern
Sterna bergii

Human uses and impacts

Cyclones and bad weather are natural problems for seabirds. Big waves and strong winds can kill adults and destroy nests. Bad weather also makes it difficult for seabirds to catch food, sometimes leading to parents not having enough food for chicks. If the poor weather persists chicks starve and adults may suffer.

Of more immediate impact is human disturbance to nesting sites. People walking about on seabird breeding islands can accidentally step on eggs and collapse shearwater burrows. Many visitors don't realise that walking or sitting on an island can kill eggs and chicks. Seabirds are easily frightened away from nests, eggs and chicks. Some species are more sensitive than others. Noddies and silver gulls are more tolerant of humans whilst roseate, little, crested and black-naped terns are particularly flighty and flee when humans are still a long way off. Often the seabirds leave eggs and chicks without visitors even being aware that they have scared them away.

If seabirds are disturbed too often they will desert the nest and eggs. For some seabirds such as pelicans, too often can be only once. When eggs and young chicks are left by disturbed parents they are vulnerable to cooking in the sun or to cooling in windy conditions.

Exposed eggs and chicks are also more vulnerable to predators, particularly silver gulls. Silver gulls have benefited from European presence. They have new abundant food supplies around rubbish dumps and towns. Gull numbers have increased in recent years. More gulls have meant more pressure on other seabirds. Terns in particular suffer from increased gull predation of eggs and small chicks.

People should take great care when visiting islands and in particular those islands known as seabird breeding islands particularly when seabirds are nesting. Some islands are closed to access during the nesting season.

History

The first bird-like animal in the fossil records is *Archeopteryx* which lived 150 million years ago. It was the size of a crow, had bony teeth set in beaklike jaws and was covered in feathers.

TERNS

Terns are the largest group of seabirds, and are commonly seen flying throughout the reef area. Breeding colonies are usually large and nesting birds are easily disturbed. Commonly seen species include the crested tern *(Sterna bergii)* with its black cap, pale yellow beak and habit of spectacular diving. Crested terns can hover above the sea

locating and targeting fish and then plunging beneath the surface to seize them. Lesser crested terns *(Sterna bengalensis)* are similar, with an orange beak. Black-naped terns *(Sterna sumatrana)* have a small crescent of black on the back of their heads rather than a black cap. Little terns *(Sterna albifrons)* are tiny and expert at hovering, keeping their heads perfectly still. Roseate terns *(Sterna dougallii)* have long tail plumes when breeding and their synchronised courtship flights are spectacular.

NODDIES

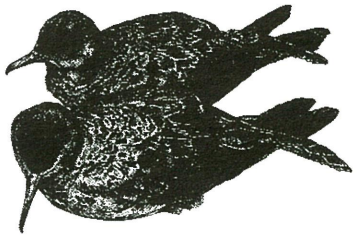
Noddies are really types of terns. Common noddies *(Anous stolidus)* prefer to nest on the ground while the very similar black noddy *(Anous minutus)* builds nests in trees, particularly Pisonia trees. The noddies are two of the few seabirds that tolerate humans close to the nest.

GULLS

As a group, gulls are a cold water group of seabirds with only one species venturing into tropical Australia. This is the ubiquitous silver gull *(Larus novaehollandiae)*. It is a great opportunist and is one of the few native Australian seabirds that has benefited from modern human developments and behaviour.

SHEARWATERS

Wedge-tailed shearwaters *(Puffinus pacificus)* breed in huge numbers on some islands particularly in the Capricorn/Bunker group. During the day they may be seen at sea feeding – often sitting on the surface and dipping under for food. At night they return to their burrows with raucous greetings to mates. They are clumsy on the ground and often crash land when returning to the nest. They require a runway to take off.



Wedge-tailed shearwaters
Puffinus pacificus

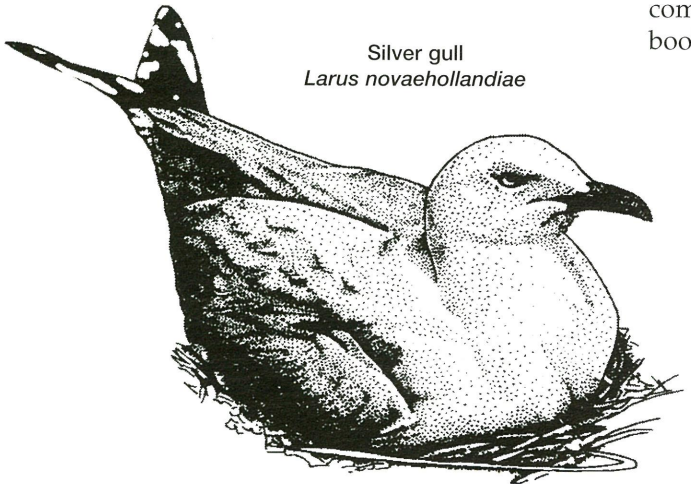
FRIGATEBIRDS

Frigatebirds are the pirates of the sea. They hassle other seabirds such as boobies and terns in mid-flight until those seabirds regurgitate recently collected food. The frigatebird then catches the falling food before it hits the sea. It is a cheat's way of obtaining a meal but it works well for the frigatebird. The very long thin wings and forked tail on these large black seabirds make them efficient and spectacular fliers.

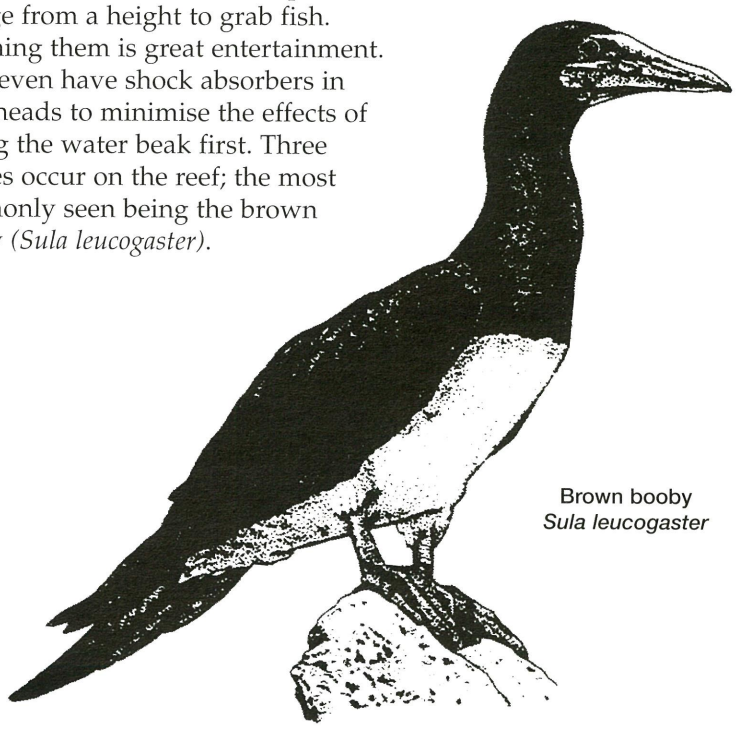
Great frigatebird
Fregata minor

BOOBIES

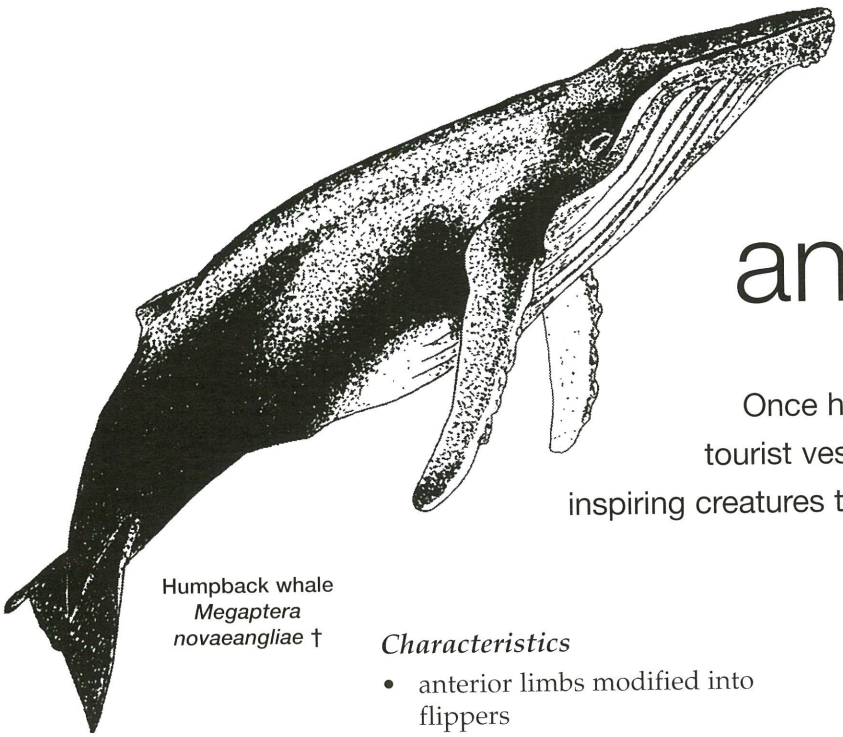
Boobies are large seabirds adapted to plunge from a height to grab fish. Watching them is great entertainment. They even have shock absorbers in their heads to minimise the effects of hitting the water beak first. Three species occur on the reef; the most commonly seen being the brown booby *(Sula leucogaster)*.



Silver gull
Larus novaehollandiae



Brown booby
Sula leucogaster



Humpback whale
Megaptera novaeangliae †

Whales and Dolphins

Once hunted for food, now keenly sought by tourist vessels, whales are one of the most awe inspiring creatures to be encountered in the waters of the Great Barrier Reef.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS MAMMALIA
(Latin meaning 'breast')
Pronounced mam-may'lee-a

ORDER CETACEA
(Latin meaning 'whale')
Pronounced see-tay'she-a

Characteristics

- anterior limbs modified into flippers
- posterior limbs absent (residual stubs on skeletons)
- nostrils modified into a single or double blowhole on top of head

Role on the reef

Large whales such as humpbacks and minkes are only seasonal visitors to the reef. They migrate from Antarctic waters during the winter months to mate and give birth in the warmer tropical seas. During their migration north they do not feed, and therefore have little direct impact on the reef's ecology.

Feeding

Cetaceans (whales and dolphins) are classified by their feeding mechanisms. Those with teeth such as dolphins and killer whales, feed upon prey such as fish and squid. Baleen whales do not have teeth; instead they have hundreds of thin plates known as baleen hanging from the two sides of the upper jaw. The inside edge of each plate ends in a coarse matrix of thick hair-like material and acts as an effective filter. Baleen whales feed by engulfing huge quantities of sea water and then squirting the water from their mouths. The small fish and small crustaceans (known as krill) are trapped by the baleen plates which are then licked clean by the whale. Baleen whales feed in the waters of the Antarctic where there are vast amounts of the krill which they feed upon.

Defence

Due to their large size whales have few predators, except humans. However, killer whales are known to prey on humpback whale calves.

Reproduction

Humpback whales travel into the water of the Great Barrier Reef to breed. In this nursery area, single calves are born after a gestation period of 12 months. At birth, calves are up to five metres in length. They gain weight rapidly feeding on milk squirted through the water from their mothers. They remain with their mothers during the return journey of 5000 kilometres to their feeding grounds in the Antarctic. After 12 months the calves have grown to half their maximum size and are independent.

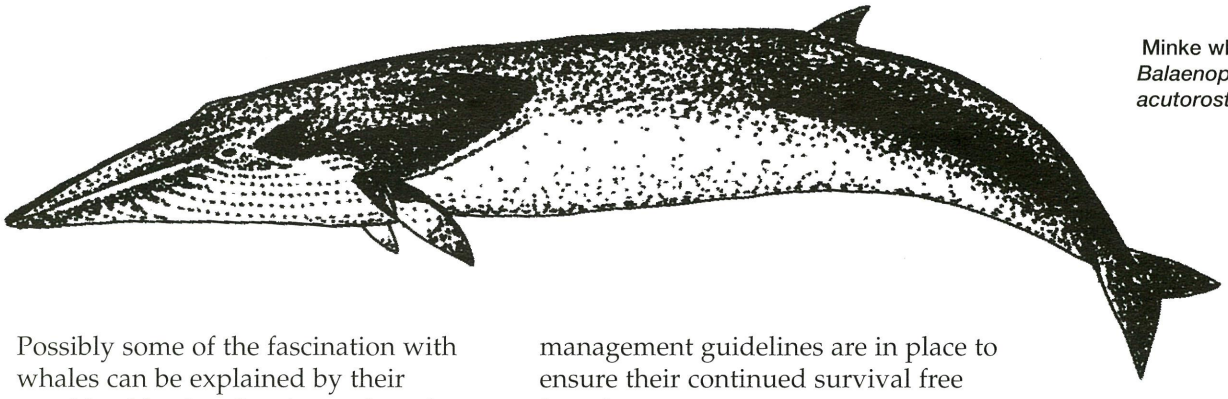
Mating is believed to take place in the waters of the Great Barrier Reef.

Human use and impacts

Whales, in particular humpbacks (due to their well-known close to shore migration routes), were subject to commercial harvesting. Between 1952 and 1962, 7423 humpback whales were killed at Tangalooma whaling station on Moreton Island and at a smaller sister station at Byron Bay in northern New South Wales.

By 1962 humpback whales were so scarce along the Queensland coast that whaling ceased. Today whales are protected, with many populations starting to increase.

Over the past two decades there has been a growing fascination around the world in observing marine mammals. In Australia this same trend has seen increasing interest in gaining access to a number of locations for the purposes of whale watching.



Minke whale
Balaenoptera acutorostrata

Possibly some of the fascination with whales can be explained by their considerable size. Species such as the humpback and right whales are so large that until a person has seen one, it is quite difficult to imagine what they are really like. A decade ago the opportunity to get close to whales was only available to a handful of dedicated researchers and a fortunate few of the general public. Today large numbers of tourists have the opportunity to be taken in safety and comfort into the natural habitat of these fascinating creatures. With this increase in whale watching comes the potential for harassment of what are still a protected species. Whale watching also presents an extremely powerful opportunity to explore a range of marine conservation issues. It seems everybody loves whales.

History

Ancestral whales evolved from land dwelling and walking mammals. They are thought to have entered shallow sea to take advantage of rich fish stocks. In doing so, their hind legs disappeared, with residual stumps remaining which can be seen on their skeletons. The oldest whale remains are over 50 million years old.

HUMPBACK WHALE

Megaptera novaeangliae

Humpback whales are the most acrobatic of the great baleen whales. Their spectacular displays, involving tail slapping and breaching, together with their annual migration path that brings humpback whales into close proximity to major coastal centres, provide a major focus for the booming industry of whale watching. Their stocks continue to slowly recover from the years of exploitation which nearly saw their total demise from the Great Barrier Reef. Fortunately, humpback whales today are regular reef visitors from May to October. Strict management guidelines are in place to ensure their continued survival free from harassment.

MINKE WHALE

Balaenoptera acutorostrata

Minke whales are regular reef visitors, but little is known of their migration path through the Great Barrier Reef. Recent research suggests the Ribbon Reefs, north of Cairns, are an important area for these creatures, particularly around May and June when individuals are regularly encountered by dive vessels in the area. While not exhibiting as spectacular displays as the humpback whales, minkes often exhibit a great deal of curiosity around boats and divers, making them a popular animal with the fortunate few who meet them in the wild.

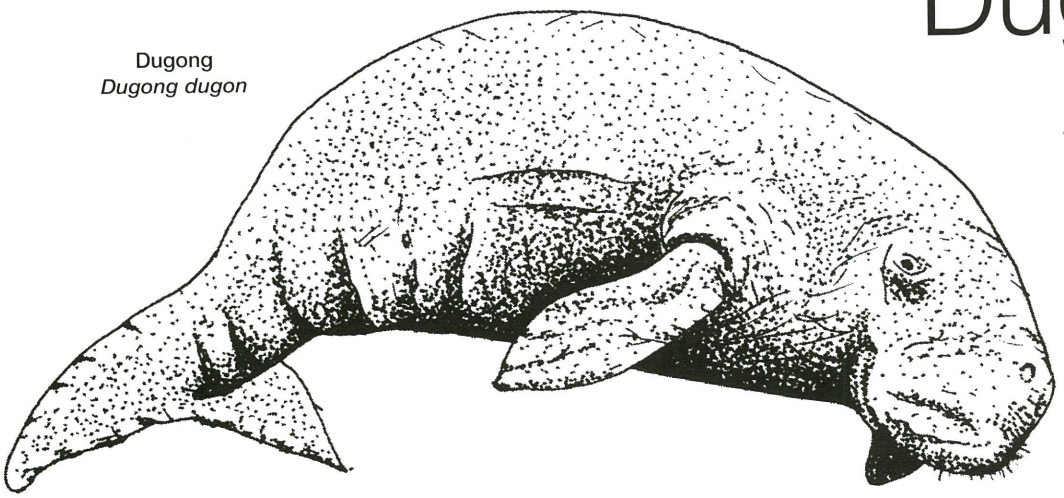
Bubble trap

Humpbacks help trap their food by swimming circles around schools of fish and blowing a curtain of bubbles. This serves to 'round up' the fish. The whale then swims up through the bubbles with its mouth open and gulps its prey down.

Big breath

The lung of an adult humpback is the size of a small car. The whale can empty and refill its lungs in under two seconds, exhaling 95% of the lungs contents in just one breath (we humans can only manage 15%). The air rushing out reaches speeds of over 500 kilometres per hour.

Dugongs



Dugong
Dugong dugon

The dugong was the inspiration for myths about mermaids created by early sailors who had been at sea for far too long.

PHYLUM CHORDATA
(Latin meaning 'characterised by cord')
Pronounced korda'ta

SUBPHYLUM VERTEBRATA
(Latin meaning 'backboned')
Pronounced ver'te-bra'ta

CLASS MAMMALIA
(Latin meaning 'breast')
Pronounced ma-may'lee-a

ORDER SIRENIA
(Greek meaning 'siren')
Pronounced si-ree'ni-a

Long intestines
The manatee, a close relative of the dugong, has an intestine over 45 metres long.

All in the tail
Dugongs are easily distinguished from their northern relative, the manatee, by the shape of the tail. Dugongs have a tail with a concave trailing edge, like that of a dolphin. Manatees have a rounded paddle-like tail.

Characteristics

- similar in appearance to a rotund dolphin
- no dorsal fin
- large mouth, with upper lip covered in bristles

Role on the reef

Dugongs are the only strictly herbivorous marine mammal on the GBR. They are found throughout the shallow, tropical waters of the Indo-Pacific region. However, many dugong populations are relict or extinct. Within Australia, dugongs range from Shark Bay in Western Australia around the north to Moreton Bay in Queensland. There are an estimated 100 000 dugongs in Australian waters, 12 000 of them within the Great Barrier Reef region.

Feeding

Dugongs feed upon seagrasses in warm, shallow inshore waters. They feed upon the whole plant by tearing seagrasses out by the roots. Over 40 kilograms of seagrass are consumed each day. Plumes of silt and feeding trails in seagrass beds, some over 10 metres long, are indicators of dugong feeding activity. Like their relative, the elephant, dugongs do not have a chambered stomach. Instead they rely on an extremely long intestine and bacteria living within it to digest the cellulose of seagrasses.

Reproduction

Dugongs spend their entire life in the sea. They live for about 70 years. Female dugongs first breed between the ages of six and 17 years. Single calves are born after a gestation period of about 13 months. The calves remain with and suckle from their mother for around 18 months. Most calves are born between September and October.

Human use and impacts

Dugongs have played an important role in the traditions and culture of Aboriginal and Torres Strait Islander peoples for thousands of years. Traditional hunting is still permitted within the Marine Park.

One of the greatest threats to dugongs is the loss of habitat. Seagrass beds are diminishing as a result of trawling and because of increased siltation and nutrients from human activities such as dumping of dredge wastes, urbanisation, industry and agriculture. Trawling and dredge dumping is now prohibited in a number of important seagrass areas.

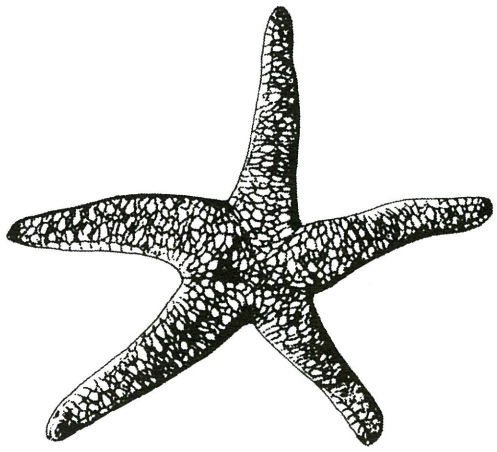
Nets are also a threat to dugongs. Dugongs can become entangled and drown in certain types of fishing mesh nets. A system of 16 Dugong Protection Areas have been established, where net fishing is restricted. Shark nets erected to protect beach users have also drowned over 800 dugongs in Queensland since the 1960s. Many of these nets have been replaced with drum lines in the Marine Park.

History

It is believed that the ancestral sea cow descended from a common ancestor of the elephant during the Eocene, 54 to 38 million years ago.

Part 3

reef**communication**



Introduction

Your first reaction when asked, or instructed, to present an interpretive activity will probably be the same as many people placed in the same situation. If the topic or activity is unfamiliar to you, or you aren't used to speaking in front of a group of people, where do you start?

Usually with a list of self doubts such as:

- I don't know enough about the subject.
- I can't hold the attention of a group for more than five minutes.
- I need a university degree in marine biology to do this type of work.
- I feel embarrassed standing in front of a crowd.
- I have a fear of public speaking.

Some facts:

The technical skills of being a good interpreter and building self-confidence can be learnt.

If you regularly work on the Reef then you know more than you think you know about the Reef environment and its ecology.

Personal qualities such as enthusiasm, a liking for people and the environment, and a sense of humour and perspective are far more significant than a science degree. With these qualities you can be an excellent interpreter.

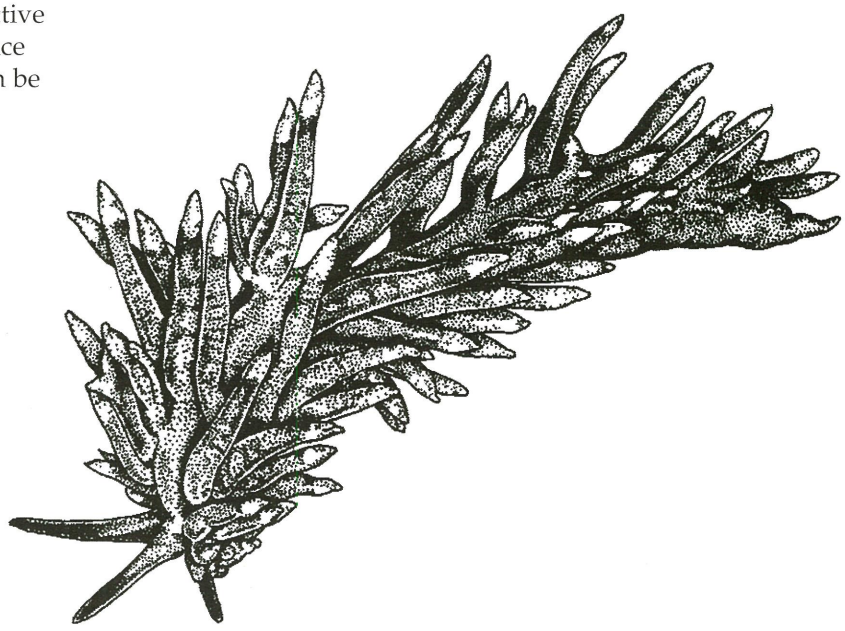
This manual leads you through a logical series of steps to help you prepare effective interpretive presentations.

Note:

While the word interpretation is used throughout this manual, you may know it by a different name e.g. guiding.

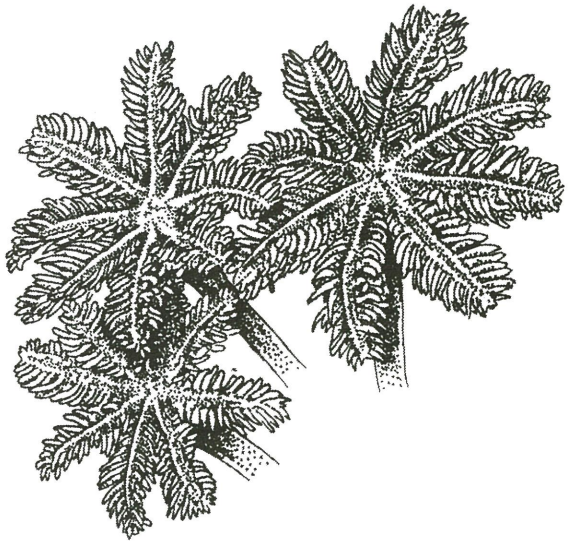
Similarly, the people who give interpretive presentations may be variously called:

- hostesses/hosts
- activities officers
- guides
- rangers
- marine biologists
- education officers.



Preparation

Objective of the Exercise



Why are you presenting this interpretive activity?

Presumably you have reasons for doing it and not just because you have to. You will find the activity a lot more productive if you are clear about what you are trying to achieve.

1. BROAD GOALS

Do you know how this exercise will tie in with the bigger picture of your employer's goals? For example, you may work for an ecotourism operator who is keen to promote the wilderness values of a particular area or a backpacker operator who basically promotes fun and good times on the Reef – both operations are equally valid but the types of activities you offer would vary greatly. Make sure you are clear about the kind of reef experience your company is marketing and who your target audience is.

2. OBJECTIVES

Objectives describe the results or outcomes of your activity rather than the processes you go through to present the activity.

What specific outcome do you want to achieve as a result of your activity?

For example do you want to:

- Motivate to take further action e.g. inspire someone to join an early morning bird walk or stay up late at night to watch turtle nesting.
- Inform e.g. let visitors know where and when certain activities are taking place, and what gear they should bring along.
- Educate e.g. explain to divers how to dive in an environmentally friendly manner and why it is important.
- Demonstrate e.g. show first-time snorkellers how to use a snorkel and face mask.

Sometimes the outcome of an exercise may not be what you thought. For example, a ranger was conducting guided birdwatching tours through the rainforest at Lamington National Park on the Gold Coast hinterland in south-east Queensland. During the hour-long walk the ranger carried a pair of field binoculars and was able to identify almost every rainforest bird species for his group of guests and at the end of the walk the visitors were asked for their impressions. They were very impressed by how much *the ranger* knew about rainforest birds.

Another ranger tried a different approach. At the beginning of the walk he handed field binoculars to everyone, together with a simplified guide for identifying the common rainforest bird species. It was a guide he had developed himself, and would certainly not stand up to any scientific validation – just the basics. The participants now had to identify bird species for themselves, with a bit of help from the ranger. At the end of the walk the group had only studied half a dozen different species and again they were asked their impressions. Now they were impressed by how much they had learnt about identifying rainforest bird species.

Think about what you are trying to achieve and your objectives. Do you want to show people how much you know, or, are you trying to engender a greater understanding amongst your audience? The Self Evaluation points on page 96 will help you establish if you achieved what you set out to achieve.

Knowing Your Subject

The success of your interpretive activity will partly depend on how well you know the subject material you intend to present.

Some interpretive activities can be successfully conducted by people with minimal knowledge, but obviously the greater your depth of understanding and appreciation of your topic, the more you will have to offer your audience.

This section looks at ways of developing and enhancing your subject knowledge.

1. GATHERING INFORMATION

In many instances the resource information you need to develop your interpretive activity won't be available and this can be very frustrating. You need to develop your own resources particularly if you are operating in isolated areas. Where do you start?

Books

- Readers Digest and National Geographic books are always good value.
- *Discover the Great Barrier Reef Marine Park* by GBRMPA.
- Collins Eyewitness Books by Collins Publishers.
- Steve Parish books – a variety of topics.
- *Fishes of the Great Barrier Reef and Coral Sea* by Randall, Allen & Steene.

Any book list will date fairly quickly as new books are published and come onto the market. Regularly browse through the major bookstores such as Angus & Robertson, the ABC Shop and the QBD for the latest publications.

Magazines

Australian and American dive magazines regularly have natural history notes and coral reef ecology articles. Other publications worth reading include: Nature, Australian Geographic, National Geographic, Geo, Australian Wildlife, Underwater Geographic.

These magazines are regularly available in newsagencies and libraries. Photocopy the articles and organise them into one area under subject headings e.g. corals, fish, sharks, seabirds, turtles.

Tropical Topics

This is an interpretive newsletter for tour operators produced by the Queensland Parks and Wildlife Service with funding from the Great Barrier Reef Marine Park Authority, the CRC Reef Research Centre and the Wet Tropics Management Authority. Each second newsletter focuses on a marine topic and provides lots of really useful, interesting and easy to read information.

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Videos

Some recommended viewing:

- *Nature of Australia*
- *Life on Earth*
- *Inside the Reef*
- *The Living Planet*
- *Trials of Life*
- *Ribbon of Life*

Similarly with books, new videos are continually being produced and these can provide excellent resource materials. Contact the Qld Dept of Education Film & Video library in Brisbane about joining their video library. The ABC Shops carry a good line of educational videos.

Other organisations

Major educational and interpretive institutions often employ specialist education officers to run programs and produce a range of educational materials. These materials come in the form of kits which are often freely available if you explain how you intend to use them. Contact the Education Officer at:

- Reef HQ, Townsville
- Regional offices of the Queensland Parks and Wildlife Services
- Underwater World, Mooloolaba, Sydney and Perth
- Queensland Museum, Brisbane and Townsville
- Other state museums in each capital city.

2. TURN YOURSELF INTO AN EXPERT

This idea might sound so far-fetched that you simply dismiss it out of hand. However, your own observations of the area where you work will help you to build up some excellent material for interpretive exercises. How?

Written observations

Keep a record or diary of:

- unusual events e.g. coral spawning
- aggregations or groupings of animals e.g. manta rays
- migratory species e.g. whales and turtles
- seasonal changes and variations
- breeding seasons for common species
- birds e.g. behaviours, nesting characteristics, what they eat, interactions with other species
- vegetation types e.g. times of flowering, 'bush tucker'
- types of fish and their behaviours.

Photography

There are two reasons you should begin to record your observations with photographs. Firstly, the images can be used in slide presentations and displays. Secondly, through photographing the particular creature, you begin to understand and learn more about its behaviour and how it fits in to the ecology of reef life. The photography becomes a learning experience in itself as you observe how the creature behaves and how it interacts with other creatures.

Try using slides – not colour prints. If you need colour prints for any reason these can be taken from the slides quite easily (but good slides cannot be made from prints). Store the photographs safely in an airconditioned room if possible. Use duplicates of your slides/photographs for your presentations and protect your originals.

Photographs and related notes then become the foundation for your reference material.

3. USING OUTSIDE HELP

Do you have access to researchers, rangers, interpreters, visiting lecturers, photographers, museum staff or scientists? Often you will find these people only too willing to help with information and guidance.

What about the person who did the job before you – they probably had their own notes and materials which they may be willing to share.

Organising the Material

Once you have gathered a fair amount of resource information you still need to focus your ideas before you are ready to start talking to a group of people. This focus will help you as well as your audience.

You become clear about what you want to say and your audience understands what to expect from the activity.

In this section we look at what to do with the information you have available.

1. CHOOSING A TOPIC

Is it a topic in which you have a personal interest? Your own enthusiasm and interest in a topic will be apparent to your audience. It's much easier to talk about something which excites you.

2. DEVELOPING A THEME

Rearrange the title of your talk or activity to demonstrate the focus of your ideas and the key points you want to discuss. For example, imagine you are giving a talk to a group of divers about 'reef fish'. There are over 1500 species of fish on the Great Barrier Reef. Some of the possible topics are:

- how fish feed and what they eat
- what eats them – predators and food webs
- why fish are so colourful
- life cycles
- protective coverings
- habitats
- how to catch fish
- fishy stories
- management of fisheries and so on.

You can't possibly include all of this information in one talk about fish and neither would you want to. It would be very long and no doubt very boring. So where to start?

Project yourself and your audience a little into the future to the point where you have just finished your activity. Now say to yourself "My audience now understands **something** about reef fish".

That **'something'** becomes your theme. For our example it could become 'How to identify reef fish using their colour and body shapes.'

This is a much better topic than just plain 'reef fish'. It is –

- better for you – you can organise your ideas and key points
- better for the audience – they have an idea of what to expect and they will remember more of a simple theme.

A topic is very broad. A theme is much more specific and focused.

Remember, 'reef fish' (topic) vs. 'how to identify reef fish using their colour and body shapes' (theme).

3. LINKING WITH OTHER CONCEPTS

Themes also give you the freedom to link with other subjects that may be totally unrelated to your subject (or so you thought). Using the 'fish' example you could refer to the advantages or shortcomings of using colour and body shape to identify other marine creatures such as corals.

Immediately, you've broadened your horizons and given yourself more to talk about, without having to know anything extra about reef fish (but you might know a lot about corals and how to identify them).

Be careful though not to ramble off on too many tangents and be certain you come back on track to your original topic.

4. FREQUENT QUESTIONS

What are the most frequently asked questions by visitors about the Reef?

The Great Barrier Reef Marine Park Authority conducted a survey of tourist industry staff to determine what questions visitors were most commonly asking during their trip to the Reef (see Most Commonly Asked Questions on pages 101 to 104 of this manual).

It should come as no surprise that the subject of 'sharks' came in at No. 1. Personal safety will always be foremost in people's minds – over and above the learning experience you wish to incorporate into their visit.

The questions people ask relate to the expectations that are built up in their minds. These expectations are based upon your company's advertising and marketing, other people's experiences, media, books they have read, movies they have seen etc.

These expectations are not always realistic. For example, how many times have you heard the question "Where's the colourful coral?"? Why? Because all of the beautiful underwater coral photographs used in advertising are taken using an artificial light source.

One of the most important tasks you can perform as an interpreter is to set realistic expectations amongst your clientele of their Reef experience.

By analysing people's questions you will gain a great insight into the types of talks and activities you can present. Or it might be enough to fine-tune your existing activities to incorporate answers to common questions.

For example, knowing from our survey that sharks are of concern to many people, you could include information in your orientation materials about the species of sharks that people may come across, how to identify them and what to do if they see one. This information could be made into a display or included in snorkel and dive briefings. It provides your clients with a degree of reassurance and sets realistic expectations about sharks. JAWS is not waiting to grab every person who sets foot in the ocean – but some people think this is so.

When you analyse your topic it soon becomes obvious some points are very important and others are much less significant. Common visitors' questions will probably fall into the 'should know' key points category and as such will need to be addressed by your presentation. Have you seen any previous presentations about this topic? For example, video, slide show etc. Watch the presentations again looking for key points and issues.

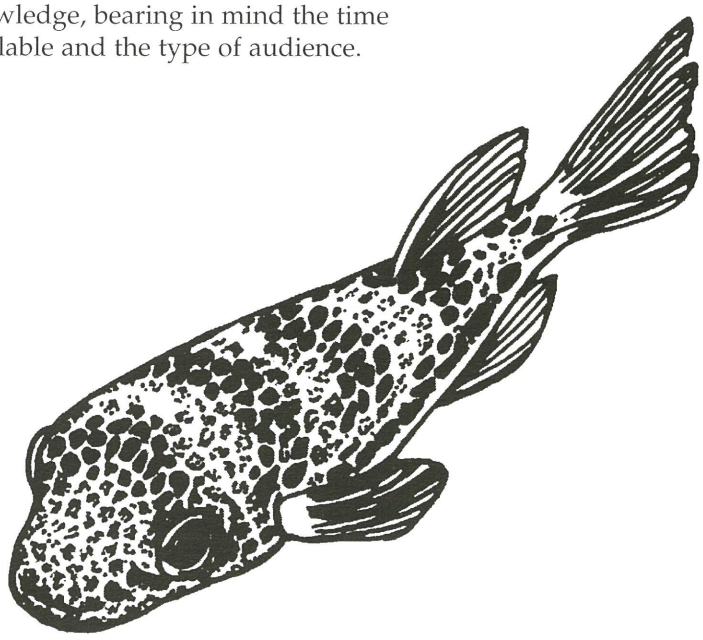
5. KEY POINTS

Can you list the key points which apply to your topic and rank them in order of importance?

For example, to develop a talk about the natural history of Lady Elliot Island in the Capricorn/Bunker Group of islands I could list the following:

- **The only reef** in the area where manta rays are regularly seen in large numbers and the rare red-tailed tropicbird nests.
- **One of only a few** coral cays where green turtles and loggerhead turtles can be found nesting.
- **One of many places** where seagulls can be found nesting.

These three points can now be ranked in order of importance from most important (primary value) to those of lesser importance (secondary and tertiary values). The primary and secondary values would be emphasised in my talk as points that people should know while the tertiary values may be introduced to add interest, understanding or background knowledge, bearing in mind the time available and the type of audience.



Understanding the Audience

If you are gathering people together with the intention of presenting new information and influencing their ideas and attitudes, it's important that you know something about the audience's perceptions, interests, likes, dislikes and motivations.

1. GETTING TO KNOW THE AUDIENCE

Not all of the above information is easily available, and most interpretive activities will be conducted without much knowledge of the audience at all – often just the number of people involved.

However, an informal chat with some of the participants in the few minutes prior to commencing an activity is a very good way of getting to know your audience. If your activity is planned for 10.00 a.m., get there at 9.50 a.m. Don't make it an interrogation or survey – just a friendly chat with a few questions to find out:

- Where are they from?
- Have they been to the reef before?
- Is it what they expected?

Why not come out and ask if there are any marine biologists in the audience? There is nothing wrong with being open and asking them if they would like to help you out with specialised information.

Who can help?

Is there someone who can help you better understand your audience? A previous employee, someone currently working in a similar position as yourself, department head etc.

What do you need to know?

Points to consider about the audience:

- Nationality – potential language barriers or difficulties understanding an Australian accent or Australian slang.
- Age composition – elderly people may have difficulties with hearing and keeping up with you on outdoor activities; children may require their own activities – young children need simple concepts andexplanations. Kids also tend to be less inhibited than adults. This can be a bonus if you are trying to be interactive with a group. Get the kids involved first, then the parents.
- Previous reef experience – this will give you an idea of what level to pitch your information. Too technical and it goes over everyone's head, too simple and they lose interest. Hint: look for anyone wearing diver's watches, they are possibly divers and likely to have a special interest in what you are saying.
- Number of people in your audience. For lectures and slide shows everyone has to be able to hear you and see the screen. It's preferable that your audience can still see you and your expressions and mannerisms. This may require specialised lighting such as a small spot light focused in your direction. For guided activities smaller group sizes are needed. It's up to you, but you may have difficulties once more than 15–20 people start tagging along behind you – mainly with keeping people together so they can hear and see what you are talking about.
- People with a disability – particularly for outdoor activities. Some activities will preclude certain people with a disability. Ensure the activity is appropriate to the physical capabilities of your group. However people with disabilities are often extremely innovative and very determined to do what they see their friends doing. Check with your supervisor if you have any doubts and use common sense.

Logistics

Once you know your objectives, have studied your audience, have researched and organised your material, it's time to consider what else you need to prepare to make your presentation run smoothly.

1. SAFETY AND COMFORT

Is your audience adequately prepared? The protection and safety of your audience is crucial – sun screen, hats, protective footwear, walking sticks etc. People will always be primarily concerned about their personal well-being and safety.

What is commonplace to you, may be high adventure and potentially threatening to them. You may feel comfortable snorkelling off the edge of a reef with a whitetip reef shark, but for many visitors this will be a first and perhaps once in a lifetime experience, and they may feel decidedly uncomfortable — even terrified.

On a guided snorkel tour, a weak swimmer with a leaking mask and in deep water is more than likely focused on drowning rather than on you espousing the delights of the Great Barrier Reef.

If conditions are such that you have totally lost audience interest (prevailing weather, seasickness etc.) don't doggedly persevere to the bitter end – just conclude the talk. Your audience's personal comfort and safety will always prevail over anything you have to say.

2. OTHER EVENTS

Time your presentation so it has the most impact or relevance for your audience.

- Should your presentation tie in with another event?
- What speakers/activities precede you?
- What speakers/activities follow you?
- How can you capitalise on these other speakers/activities?

In other words can these people support your session or can you support theirs?

3. VISUAL AIDS AND PROPS

Do you need other visual aids to support the activity? Props are something you can hand around to let people touch, feel, smell etc. They will also assist with audience involvement and understanding. They can also act to take the focus away from you as the presenter and give you a break while you collect your ideas.

An old Chinese proverb says:

I hear and I forget
I see and I remember
I do and I understand.

Think of ways to get your audience involved by doing something. This is far better than having a one-way flow of information from you, the presenter, to them, the audience. Refer to the bird watching example on page 83.

4. VENUE

Where is the activity to be held?

Is the venue suitable for the kind of activity you plan to present? Consider the following:

- noise levels
- climatic conditions
- lighting
- seating configuration
- suitability of A/V equipment
- displays.

5. TIMING

What time of day is the activity planned for? Be careful – do not stage it too close to lunchtime or at the end of the day (elderly people, children and divers are often tired by the end of the day). It might restrict interest, if audience members are anxious to leave. Choose a time when you think they will be most receptive. Will tide times affect your activity? e.g. snorkelling, reef walking, watching seabirds.

It's always best if your audience can see what you are referring to.

For example, on a walk around a vegetated coral cay I would delay talking about turtle nesting until we could see old nest sites. Giving a talk about turtles in the centre of the island would not be appropriate because turtles don't nest there. However, the centre of the island would be appropriate to look at the tree-nesting noddy terns and their relationship with the island's vegetation. This is common sense, but it is a point that is still frequently overlooked, possibly because you do the activities the same way as the person before you, and that is the way they were shown and so on.

On board a daytrip operation there are two points to consider with regards to timing of messages:

- Time is a limiting factor because of the busy daily schedule.
- Your clientele are receptive to different types of messages at different times of the day.

With regards to the first point, some interpretive information may be better incorporated into a static display on board the vessel or the pontoon. People can take their own time to digest the information.

To demonstrate the second point, have you noticed visitors act differently at the beginning of the day compared with the end of the day? This is important to recognise.

Divide the day into:

- Pre-contact phase – on the way to your destination
- Contact phase – on the Reef
- Post-contact phase – on the way home.

When analysing which activities are appropriate for your daytrip operation it soon becomes obvious that each phase has its own needs.

In the pre-contact phase set realistic expectations about the day, provide orientation to the vessel and the pontoon, explain timing of activities during the day etc. Don't overdo the information – people won't take it in.

The contact phase is often the busy period when people are engaged in a range of activities that put them in close contact with the reef environment e.g. snorkelling, diving, semi-sub tours.

Any interpretive activities need to be short because at this stage people are more interested in doing activities (looking, exploring for themselves etc.), rather than listening to you. This is where display material will be useful. Try developing a spot talk – a five-minute presentation with a couple of props on a topic you find interesting and that the guests will probably see during the day e.g. giant clams, parrot fish.

During the post-contact phase people are winding down – many go to sleep. But others are going over in their minds what they saw, what they did, and comparing it to other experiences. This is a great opportunity to provide information. Have a reference library available. Show a video and, if time permits, sit down with people and discuss their day.

The basic principles described for daytrip operations can apply to all types of operations. Your guests will be interested in different things at different stages of their visit. Try some simple observation of your guests and their reactions during the day. Maybe try a bit of brainstorming with work colleagues to work out what types of information guests are looking for, and receptive to, and at which stages of their visit.

6. LENGTH OF ACTIVITY

How long do you have for your presentation? No matter how interesting you are (or think you are) there are limits to anyone's span of attention. Interactive exercises like island walks, reef walks etc. can be longer but 30 minutes should be the maximum for slide shows and lectures while allowing additional time for questions from the audience.

7. EQUIPMENT

Make certain you are familiar with the operation of all technical equipment. Do you know how to use a video cassette player or slide projector? Where are the power points? Do you need extension leads or replacement bulbs for projectors?

Rehearsal

Will you make a faultless presentation the first time you present this activity?

A rehearsal gives you the chance to test all your thoughts and ideas, and further refine them before your activity begins.

1. PRACTISE BEFOREHAND

If possible have a 'dry run' in the venue or area where you will be presenting the activity.

2. PEER FEEDBACK

If any of your fellow employees are available during this rehearsal ask them to give you some feedback and suggestions for improvements. Accept their suggestions gracefully!

3. VIDEO FEEDBACK

If the resources are available try taping and/or video taping your presentation. You may be surprised at how you sound or look! We all have little mannerisms which we have incorporated into our body language. Self-assessment may be better for those who feel uncomfortable about peer evaluation.

4. SELF-CONFIDENCE

The best interpreters still experience nervousness – it's a healthy sign and prevents them from becoming lazy and set in their ways. Self-confidence often seems the hardest quality to achieve.

The best way to gain self-confidence in interpretive activities is to just do it. Nothing can replace practical experience and learning from your mistakes and successes. Remember that you probably appear a lot less nervous than you may feel.

Try tackling the activities you are uncomfortable about doing, as opposed to always choosing easy options. Make sure you are well prepared, with plenty of props to help you at first, and confidence will quickly increase.

5. BE YOURSELF

Finally, don't try to be something you're not. Be yourself, be natural and enjoy the experience. Analyse how other interpreters do their activities to give you ideas but don't copy their style. That must be yours alone.

Implementation

The Delivery

The previous six sections have concentrated on planning the activity.

Now comes the time when you stand up, take a deep breath and give the best presentation your audience has ever heard.

1. INTRODUCING THE ACTIVITY

Your introduction sets the tone for your talk. It should explain what you hope to accomplish and it should engage the interest of the group. If you deliver an introduction that covers the following points you'll very successfully introduce your activity.

The attention getter or grabber

Something startling, controversial or humorous to surprise the audience and capture their interest. It headlines your introduction.

Think about the very first thing you usually say to visitors at the beginning of your interpretive exercises. Now put yourself in your audience's situation. If you were them would you be dying to hear what this person had to say? Would the prospect of spending an hour with this person excite you? Would the sound of your snoring drown out the PA system?

Identify your theme

This need not be done awkwardly ("My name is Bill and my theme is ..."). You can subtly incorporate this information ("My name is Bill and today we're going to look at how the shape of corals relates to their reef habitat"). Think about the issues and points raised in your presentation and how they relate to your audience. How should these issues be introduced?

Why today?

Tell your audience why today is the perfect time to see or participate in your interpretive activity. Explain how it relates to recent, current or future events, trends or activities.

2. THE BODY OF YOUR TALK

Key points

What key points do you want to discuss during your activity? Remember that an audience retains little (approximately 10%) of what it hears, so focus on important points. Make sure the key points are remembered, even if the detail is not. If necessary ask yourself "Why am I including this information?" "Is it necessary?" "Am I including it because I have always included it, and for no other reason?"

Timing

Think about timing and when to include information. Should you talk about snorkel instruction just after leaving the dock? Do you identify dangerous cone shells at the conclusion of the reef walk? Should you describe the life cycle of a reef heron when visitors cannot see a reef heron? Try to tell and show at the same time.

The right sequence

Organise your information so it progresses in a logical sequence. You didn't learn multiplication tables before you could add, did you? It wouldn't have made much sense if you had. Likewise when developing and conducting your talk move from simple to more complex and then most complex issues. Useful principles of sequence are:

Simple to Complex

Known to Unknown

For example, imagine you were putting together a slide show on the life cycle of the green turtle. You have all the

photographs you need, you just need to decide in which order to show them. One possible sequence could be:

- turtles mating
- turtle coming ashore
- female digging a nest
- female laying eggs
- hatchlings emerging
- hatchlings swimming in the ocean.

This sequence is logical because that's how it actually happens. It makes sense to your audience.

Audience evaluation

We often make incorrect assumptions about the level of knowledge that visitors have about the resource. Before starting your talk, why not ask visitors whether they have been to the reef before. Even a simple show of hands will give you an idea of what visitors may already know about the reef.

Get your audience involved

A range of strategies can be used so people feel involved:

- questioning to highlight certain points and encourage self discovery
- use of props
- use of analogies and comparisons to familiar circumstances
- appropriate humour
- eye contact and body language.

3. CONCLUDING YOUR PRESENTATION

Develop a conclusion that gives a solid end to your activity. Firstly, you should summarise what you've said or what you've seen. Don't include new information, but relate it back to your introduction.

Secondly, leave your audience with a positive message. Make an impact by doing something inspirational like reading a quote, reciting a personal experience or make a solid statement to tie it all in with a bigger picture.

A general rule for the delivery of any activity is:

- EXPLAIN WHAT YOU INTEND TO DO – Introduction
- DO IT – Body of your presentation
- EXPLAIN WHAT YOU DID – Conclusion.

TEN WAYS TO KILL AN INTERPRETIVE ACTIVITY

1. Have a couple of beers before the activity – you'll feel relaxed and consequently give a much sharper presentation.
2. Avoid all planning and preparation – you're good enough to wing it.
3. Never get there early – you may have to interact with your audience.
4. Don't stop talking throughout the entire activity – your audience will be impressed by how much you know about the topic.
5. Assume your audience knows nothing about the subject – you're the only one who knows it all.
6. When you can't think of what to say, just make something up – your audience will never know.
7. Talk only to those people at the front of your group – they're the only ones who are keen.
8. Use only the bare facts – people never want to hear stories.
9. Pretend the turtle hatchlings (or manta ray swimming by or whatever) that so rudely interrupted you, don't exist – the group is here to see you perform.
10. Tell a few sexist or racist jokes – your audience will enjoy a good laugh.

An Example of an Interpretive Presentation

(courtesy Queensland Parks and Wildlife Service, Cairns)

This is a simple example of just one way of conducting an interpretive activity to demonstrate the application of some of the principles just discussed in this chapter. It is in no way intended as a prescription for a guided activity. If you already work in the field you will have your own experiences and style well developed.

[The scene is: audience has assembled in the semi-sub to do some reef viewing]

"Welcome aboard folks. My name's Bob and I'm here to ensure that you have a comfortable trip, introduce you to a few of the plants and animals of the reef and answer as many of your questions as I can."

"Please be sure to ask me if there's anything you want to know. I may not have the answer but in that case I'll endeavour to assist you with books and reference material back on board the catamaran."

"While we're motoring over this area of sandy bottom there's not much to see from the windows so I'll give you a quick idea of where we are at the moment."

Use the following props:

- Map – position on Great Barrier Reef and relevant zoning;
- Aerial photo – position on specific reef.

"You may notice that the colour of the coral is very different from that which you see on some postcards or in shop windows. Those corals have often been painted. The true life colour of corals is much more beautiful and subtle – like comparing a work of art with a postcard. Dead coral skeletons are nearly always white (SHOW EXAMPLE) when the living tissue is removed."

"As we explore the reef this afternoon take a good look at the variety of colours and shapes and think about why there are so many."

Bob has followed four simple principles here:

1. **Introduction. He's tried to establish a friendly and helpful relationship with his guests.**
2. **Orientation. He has oriented his visitors – fitted their present situation into their frame of reference. This has prevented that disconcerting feeling of not knowing where you are.**
3. **Allayed false expectations. He has headed off a common source of disappointment that the corals are not coloured like shop window exhibits.**
4. **Introduced a theme. He has focused the attention of his guests on the themes of shape and colour. This has prevented boredom and staved off bewilderment by giving them animals to focus on.**

"Something which always amazes me about the Reef is that absolutely everything you can see is either a living thing or made from a living thing. Even the rubble and sand are made from crunched up skeletons of plants and animals."

"Most of the corals need light to grow because they actually have gardens of tiny plants inside them. They are all in competition for light like the trees in a forest. Many of their shapes are formed to help them catch the maximum amount of light like those spread-out plate corals. The big round ones catch less light and therefore grow more slowly. In many ways corals are animals that behave like plants."

"A lot of things, especially down deeper, look a greeny blue colour. That's because sea water actually absorbs red and yellow light – like looking through a piece of blue cellophane."

"At night when there is no light the corals extend their tentacles and trap tiny floating animals for food. Some corals are better than others at trapping food at night. By looking at their shapes you can probably work out which ones they are."

"Most of the fish are brilliantly coloured. Can anyone guess why?"

"There's a familiar shape. That is a small giant clam. Those massive shells can weigh a quarter of a tonne and measure a metre across. They cultivate tiny plants inside them just like the corals do. It's the plants inside that give the clams their beautiful patterns and colours. These clams grow remarkably quickly and are farmed for food in some parts of the world."

"A lot of those plump looking things with wavy tops, there are plenty on both sides of the boat just here, those are soft corals. Very similar to the hard ones only they don't lay down a solid limestone skeleton. Most of them are poisonous for fish to eat and therefore they can survive without a skeleton. Some of their poisons are being analysed by drug companies to search for new drugs to fight against cancer and other diseases."

"Some of those branching corals have a convenient shape to shelter thousands of fish. You can see the fish darting in and out of the coral branches, snapping up plankton as it drifts by. Some of those fish spend their entire lives in that one piece of coral. Most of the fish live in one place and know their territory very well."

Four more principles followed by Bob:

1. **Bob has followed his theme but not too doggedly. As other interesting things come into view he has been discussing them.**
2. **He has made his presentation a little bit interactive by asking questions, but not overdone it like a school lesson.**
3. **He has left silent patches and let people think and explore for themselves.**
4. **He has kept it simple and used common everyday language and synonyms. The technical explanations are kept for those who specifically ask for them.**

"Well we're about to leave the back reef and head back to the boat. We've probably passed over hundreds of thousands of different types of living things and only really noticed a few of them. At night we would see a different set of animals. We have just seen the tiniest part of this huge reef. It's the best place on earth for fishing and diving but it's very complex and very delicate and it's ours to use wisely."

Bob has wound it up and left people with a little reminder that in the end it's up to us – ordinary people – to look after our own environment. It's the only one we have.

Evaluation

Evaluation and Follow-up

Once you have introduced the activity, carried it out and discussed all the points you wished to make...is the activity over?

In many cases, it is. No further action is required by you or the audience. However, in a situation where you are attempting to deliver information or change attitudes, some kind of follow-up may be necessary.

1. EVALUATION SHEET

Should you leave the audience with an evaluation sheet? This will help you to judge the effectiveness of the activity, evaluate the usefulness of your presentation and how adequately the points and messages were conveyed. Provide a simple rating scale (e.g. 1–5). Ask questions such as:

- Would you participate in the same activity again?
- What did you like ?
- What did you dislike?
- Any suggestions for improvements?

2. SELF EVALUATION

At the end of every presentation you should evaluate yourself. Here are some points worth considering:

- Did I prepare ahead of time?
- Did I explain what we would do and why?
- Did I give the group time to look and explore?
- Did I talk too much?
- Did I use ideas and words suited to the group?
- Did I speak clearly?
- Did I help people use as many senses as possible?
- Did I relate concepts to everyday experiences?
- Were my facts accurate?
- Did I cover the key points?
- Was I enthusiastic?
- Did I use a variety of teaching techniques?
- Did I use humour appropriately?
- Did I provide an introduction and conclusion?
- Are there areas about which I need to learn more?
- Did I enjoy myself?
- Did I stimulate and provoke the audience to extend themselves or to take further action?
- Did the group enjoy the presentation? How do I know?

3. OBJECTIVES

Are you satisfied your objectives have been met?

4. FOLLOW-UP

When you finish the presentation, what actions would you like the audience to take, either immediately, or perhaps when they return home? Do you need to arrange another activity before they go? Are there any follow-up activities your group can participate in?

- discussion groups
- practical demonstrations
- recap sessions
- written exercises.

Conclusion

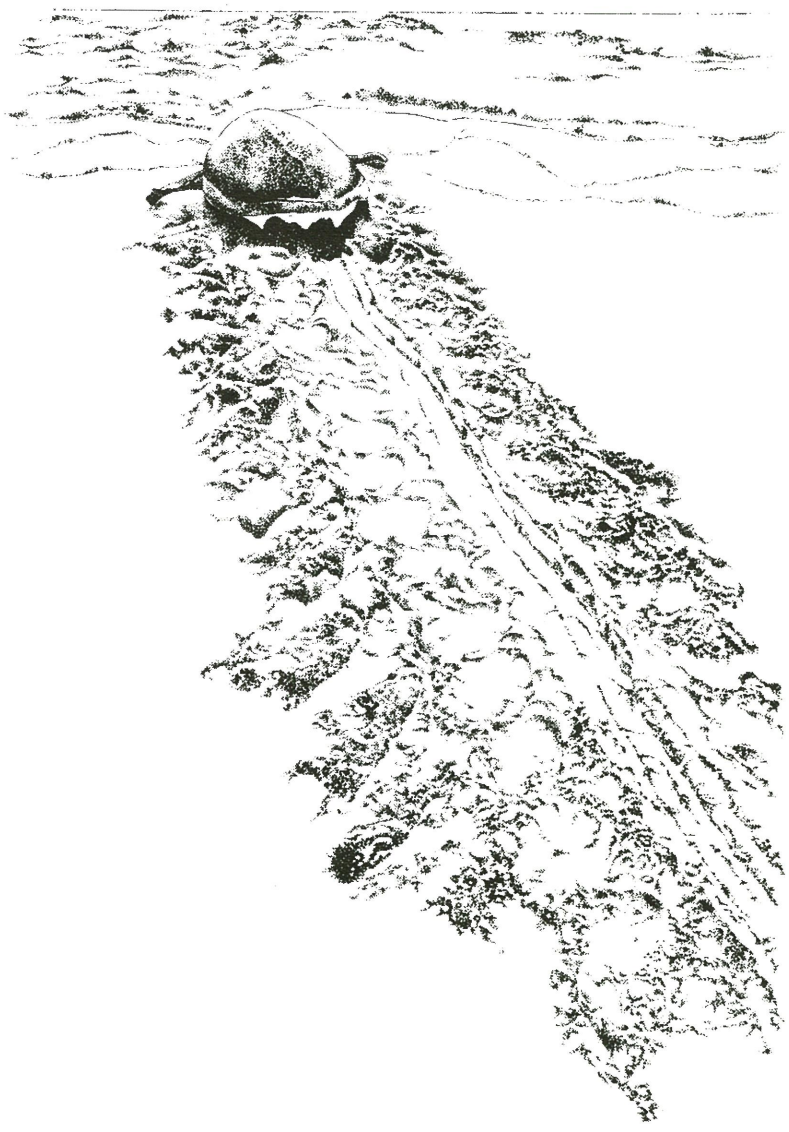
This part of the manual is designed to give you some ideas about how to get started in the field of interpretation.

Once you overcome the initial frustrations, confusion, and sometimes panic, of how to put it all together this type of work can be an extremely rewarding undertaking, both personally and professionally.

There are no right and wrong ways. With time you'll discover your own style, and then you are only limited by your own imagination.

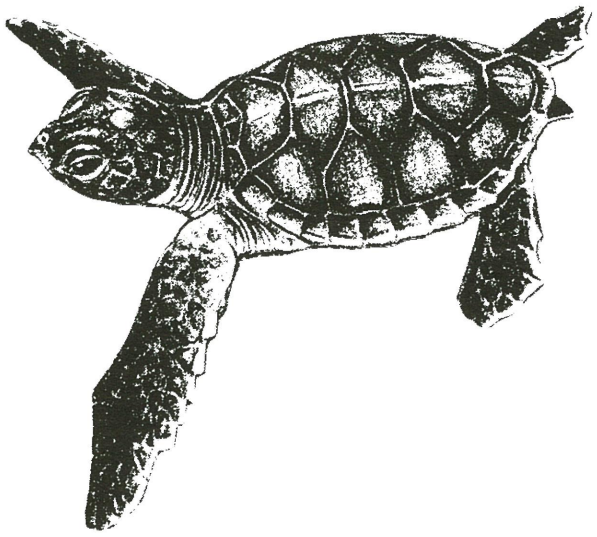
Remember the Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Service regional staff are able to help you plan your interpretive activities. Please contact us if you have any need of assistance.

Good luck!



Part 4

furtherinformation



Most Commonly Asked Questions

Reef facts and figures

The Great Barrier Reef World Heritage Area is approximately 348 700 square kilometres in area and approximately 2300 kilometres long, running from just north of Bundaberg to the tip of the Cape York Peninsula.

The reef is made up of over 2900 reefs. This includes 760 fringing reefs and 300 coral cays. There are also 618 continental islands.

As the world's largest coral reef ecosystem the Great Barrier Reef is home to approximately:

- **1500 species of fish**
- **400 species of corals**
- **4000 species of molluscs**
- **500 species of seaweed**
- **215 species of birds**
- **16 species of sea snakes**
- **6 species of sea turtles**

and some of the largest populations of dugongs in the world.

Are we going to see any sharks?

If you see a shark while visiting the reef, consider yourself very lucky as sharks are not frequently encountered by visitors. The sharks most commonly encountered by visitors are the whitetip reef shark and the blacktip reef shark. Both are easily identified by conspicuous markings on the tips of their fins. Whitetip reef sharks are often encountered resting upon the sea floor.

Most reef sharks are extremely timid and pose no threat to visitors as they feed on fish. However, all sharks should be treated with respect; never harass or corner a shark as they may attack out of fear.

Are there any stingers on the reef?

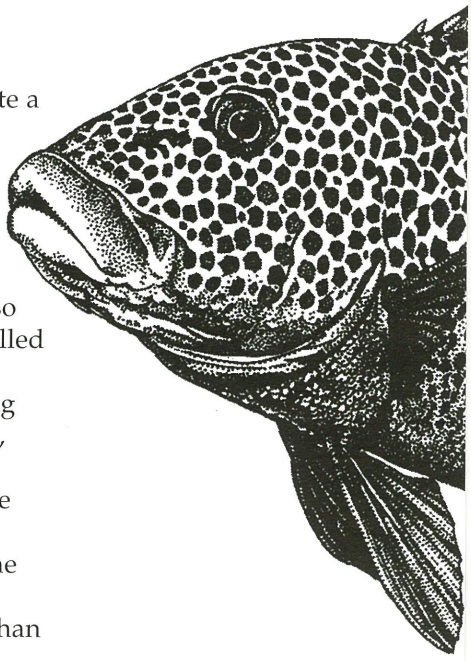
The box jellyfish is found in the coastal waters of north Queensland during summer months (October to March). Visitors wishing to swim in coastal waters during this period should only do so in protective swimming enclosures or wear protective clothing. The box jellyfish is a coastal species and is not found out on the reef, but they can sometimes be found around islands close to the mainland.

Other stingers that are sometimes encountered on the reef include the irukandji and blue bottle. Both can cause a nasty sting. Vinegar can be used on both box jellyfish and irukandji stings but not on blue bottle stings. For blue bottles use cold water and ice.

What fish is that?

With over 1500 species of fish on the reef the answer to this question is not an easy one. Books and underwater cards can be useful in identifying commonly encountered species. Body and mouth shape are often the best key features in identifying the type of fish. Aim to learn the name of just one fish every time you visit the reef, and you will quickly know the most commonly encountered species.

What are corals?



Coral colonies are colonies of coral animals called polyps, which secrete a chalky, limestone skeleton as they grow. Coral colonies grow as the polyps divide and multiply in a process known as budding.

In addition to catching planktonic prey with their tentacles, corals also derive nourishment from single-celled algae called zooxanthellae (pronounced zoo-zan-thel-ee) living within their tissues. Like all plants, zooxanthellae photosynthesise, producing carbohydrates which are used by the polyp for its own nutrition. Corals with zooxanthellae are able to lay down limestone skeletons up to three times faster than those corals without.

Why isn't coral very colourful?

Most visitors to the reef comment that the coral isn't as colourful as they are

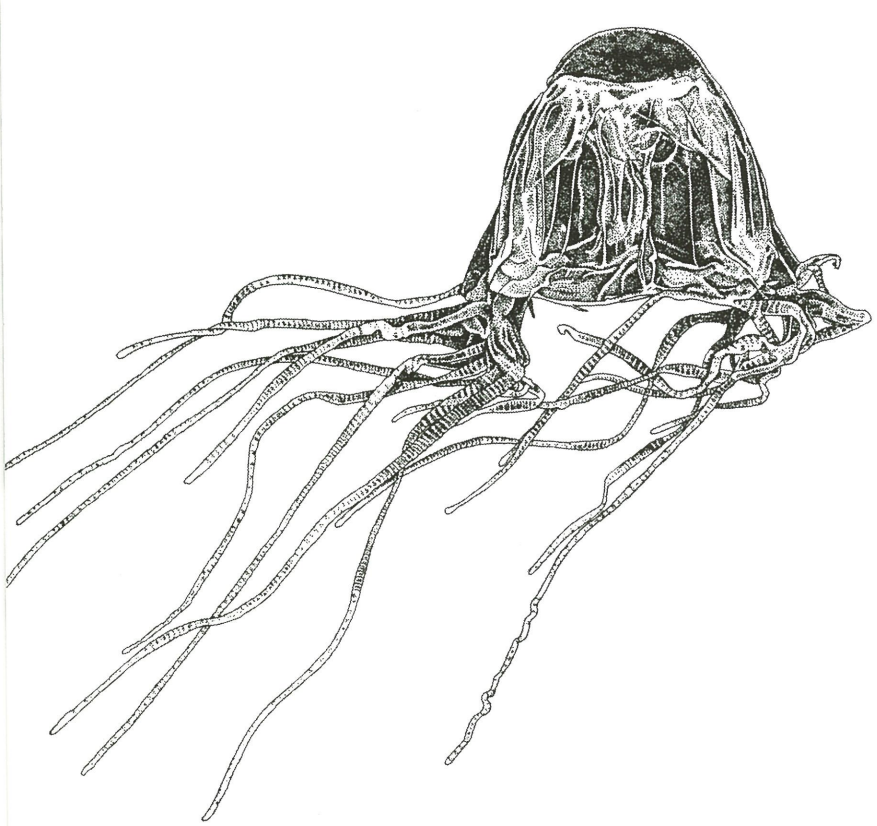
used to seeing in brightly coloured images in books and on television. Most corals are brown due to the presence of the brown zooxanthellae that live within their tissues. In addition, sunlight is filtered at different depths with red and yellow disappearing first. This gives the reef a predominantly blue-green appearance. Photographs and video footage are taken using lights to show the true colours of the reef. So the colours are there; it's just that you need white light to see them. This is why night diving using torches on the reef is so spectacular.

What type of coral is that?

Trying to identify particular species of coral is very difficult. What makes it so difficult is that one type of coral may appear as a branching form in calm water and look like a plate coral in another area. In many cases it is the environmental conditions, such as wave action, light levels and the amount of sediment in the water, that influence coral colony shape.

The easiest way to identify corals is by their appearance:

- boulder
- plate
- vase
- solitary
- branching
- table
- bushy



When do the corals spawn?

Every year over one-third of the reef's 350 species of coral reproduce sexually during a mass spawning event. Corals on the majority of inner reefs spawn around November with corals on the outer reefs spawning later in December. Spawning always takes place at night, and happens any time up to six days after the full moon. Eggs and sperm are released into the water where they eventually combine to form a free swimming planktonic larval stage.

Why is the reef so far offshore?

The Great Barrier Reef is located off the mainland of Queensland. Corals need clear water which are low in nutrients. They cannot tolerate fresh water or nutrients carried in the water run-off from the mainland. That is why the most diverse and abundant corals grow offshore where the environmental conditions are more suitable.

How clear is the water going to be?

The clarity of water on the reef is determined by a combination of the amount of sediment and phytoplankton in the water. Phytoplankton are microscopic plants that drift in the water. As the amount of nutrients in the water increases so does the amount of phytoplankton.

Those reefs found close to the mainland or large islands are frequently affected by both the nutrients and sediment carried by rivers and streams, particularly after storms. As a general rule, water clarity on reefs close to the coast will never be as good as those further from the coast. Periods of increased water motion during large tide changes and high winds also decrease visibility by keeping reef sediments suspended.

Are we going to see any whales?

Whales are normally encountered during the winter months when they migrate to the reef from Antarctic waters to mate and give birth. One of the most spectacular visitors during this period is the humpback. They are seen in the shallow coastal waters of the Great Barrier Reef from Hervey Bay to Port Douglas. Whale watching is

conducted by a number of tourist operators throughout these areas.

The minke is another species of whale seen during winter, particularly around the Ribbon Reef area.The smallest whales, the dolphins, can be seen all year round in most parts of the reef.

Is the crown-of-thorns starfish still a problem?

The cause of crown-of-thorn starfish outbreaks is still the focus of a lot of research and debate. Increased nutrients from the mainland and effects due to El Niño are being investigated as is the possibility that it is a naturally occurring event. Crown-of-thorns starfish may actually serve to maintain coral diversity on the reef by feeding on the fast growing species that, if left unchecked, could dominate the reef.

Where can we go fishing on the reef?

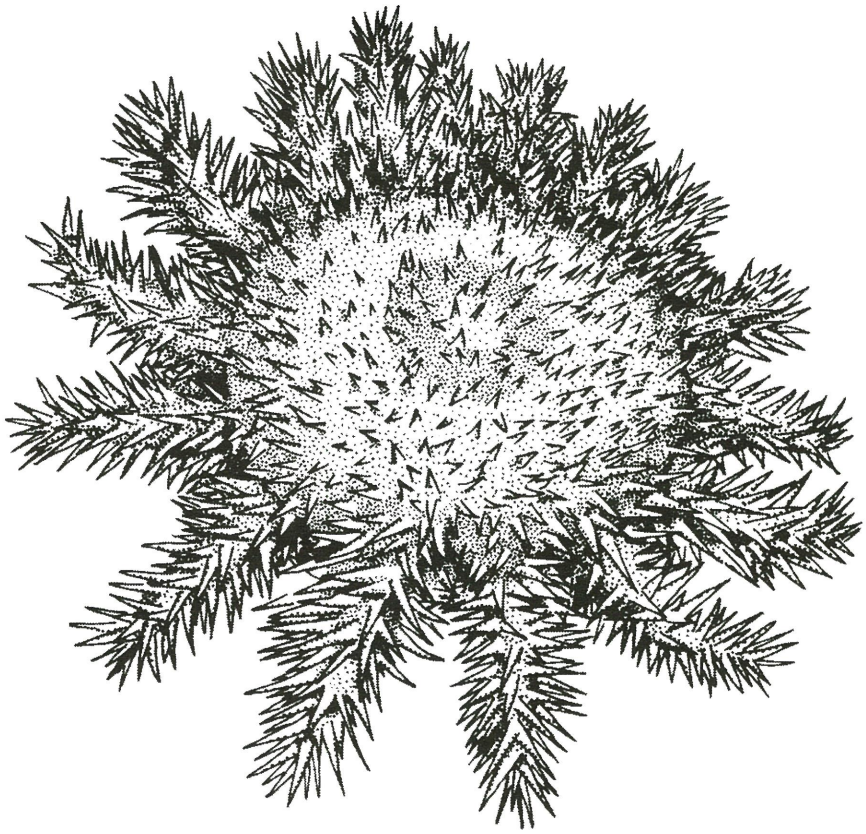
Fishing is not allowed in (green) marine national park zones, (pink) preservation zones and (orange) scientific research zones. In other zones fishing is allowed subject to Queensland fisheries restrictions. Legal sizes, closed seasons and catch quotas also apply to a variety of fish and shellfish.

Many animals such as whales, porpoises, dolphins, dugongs, turtles, clam, trumpet and helmet shells, female crabs, all grouper and cod over 1.2 metres may only be taken with a permit. Generally permits are restricted to users such as scientific research or traditional hunting and gathering.

How old is the reef?

The GBR started to form eighteen million years ago as the Australian continent was drifting north from cooler temperate waters into the tropics. Through the ages, the warming and cooling of the earth together with changes in the size and shape of sea basins, have caused numerous sea level changes, at times to as much as 100 metres below our present sea level.

During the last ice age the area that is now the Great Barrier Reef, was an area of grassy plains and limestone hills. It stayed like that for thousands of years until the earth started to warm and sea levels rose again. Sea levels



have fluctuated greatly over the last 20 000 years with water levels above and below our present level.

As the sea level rose, corals that survived in the deeper water off the continental shelf reproduced and started to recolonise the edge of Australia's continental shelf.

What is the weather going to be like?

In general the average passenger is not so much concerned with the weather as they are with how it will influence their day at the reef. Therefore an answer should be given in reference to their concerns e.g. sea sickness, water clarity, and/or the colour of the reef.

Why are clams so colourful?

The colourful mantle of clams may be due to light hitting the microscopic plants found lined up in rows just below the surface of the mantle. Clams which have lost their zooxanthellae are white.

What's that slick in the water?

When good growth conditions exist, blooms of a simple floating algae called *Trichodesmium* are often confused with oil and coral spawn slicks. Algal blooms can be easily identified by their rusty brown colour as they occur in windows along the surface of the water. Slicks of coral spawn generally

do not last for more than two days after coral spawning. Any oil spill should be immediately reported to the local maritime authority.

Why is the ocean salty?

The ocean generally has a salinity of about 35 parts per thousand or 3.5%. Besides containing sodium chloride (common salt), ocean salt contains 44 other elements including magnesium, calcium and even traces of arsenic and gold. Some salt comes from undersea volcanoes, but most comes from the land. As rain falls, salt contained in rocks is dissolved and rivers eventually carry it to the sea. There is enough salt contained in the world's oceans to cover the land with a layer over 150 metres thick.

Are there any sea snakes and are they dangerous?

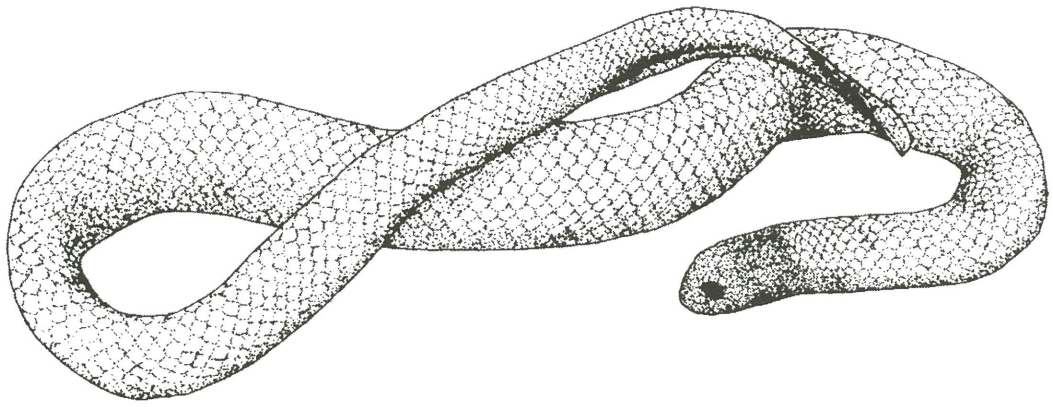
There are about 16 species of sea snakes in the waters of the Great Barrier Reef. Sea snakes are well adapted to the marine environment and use their paddle-shaped tail to propel themselves through the water. The belly scales are formed into a keel to help stabilise the snake whilst it is swimming. Sea snakes are among the most venomous snakes in the world as they possess some of the most potent toxins known. Most sea snakes such as the olive sea snake *(Aipysurus laevis)* are extremely curious and will readily approach divers. Generally they are not aggressive except during mating season (late summer) when they become more territorial. Fortunately the fangs of sea snakes are quite short with only the largest specimens being able to penetrate a wetsuit with their fangs. Although there have been no reports of deaths from sea snakes in the Great Barrier Reef region, all sea snakes should be treated with respect.

When and where do green turtles nest?

The female green turtle nests well above high-tide mark using her flippers to dig an egg chamber, into which 50-150 (average 120) ping-pong sized eggs are deposited. After laying, the nest is filled back in by the female and she returns to the sea. Female green turtles may lay up to eight clutches of eggs in one season (loggerheads up to six). The eggs take six to eight weeks to develop in warm sand and up to 12 weeks in shaded areas. Eggs tend to hatch simultaneously, with the young remaining buried until they erupt from the nest to make a mad dash to the sea. The two major nesting areas in the Great Barrier Reef are in the extreme north on Raine Island, and in the south at Mon Repos, near Bundaberg or on one of the islands of the Capricorn Bunker group.

Why is the ocean blue?

Ocean water is bluest where there is the least amount of sea life to reflect light. Water close to the coast is lighter in colour as it is shallower and also because plankton and sediment suspended in the water act like tiny mirrors, reflecting light.



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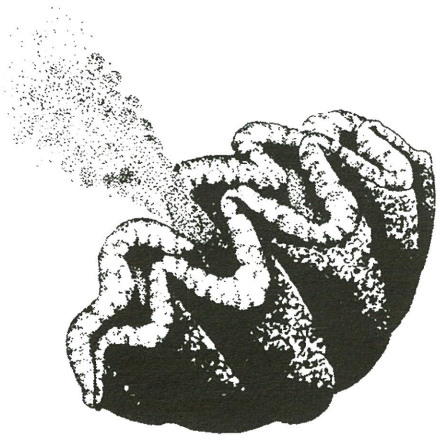

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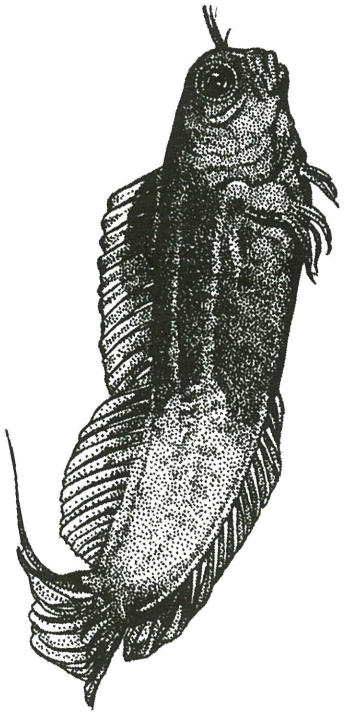

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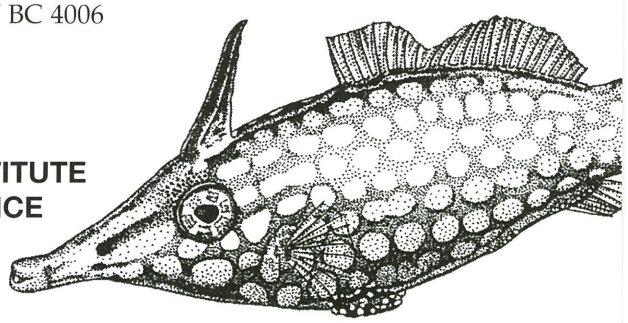

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Further Reading

General reef information

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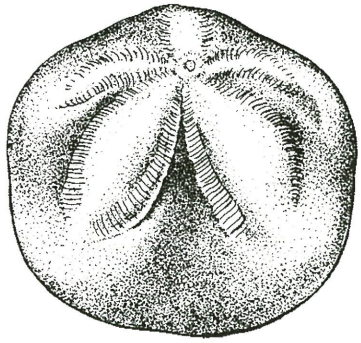

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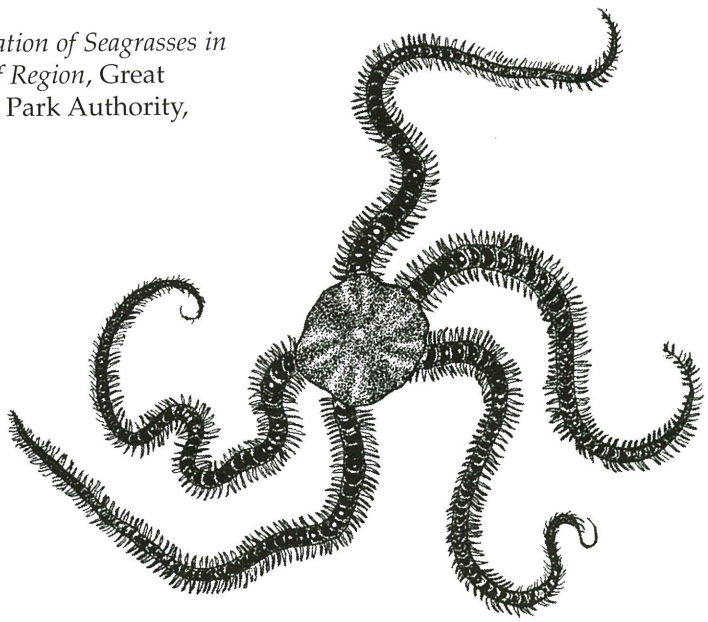

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