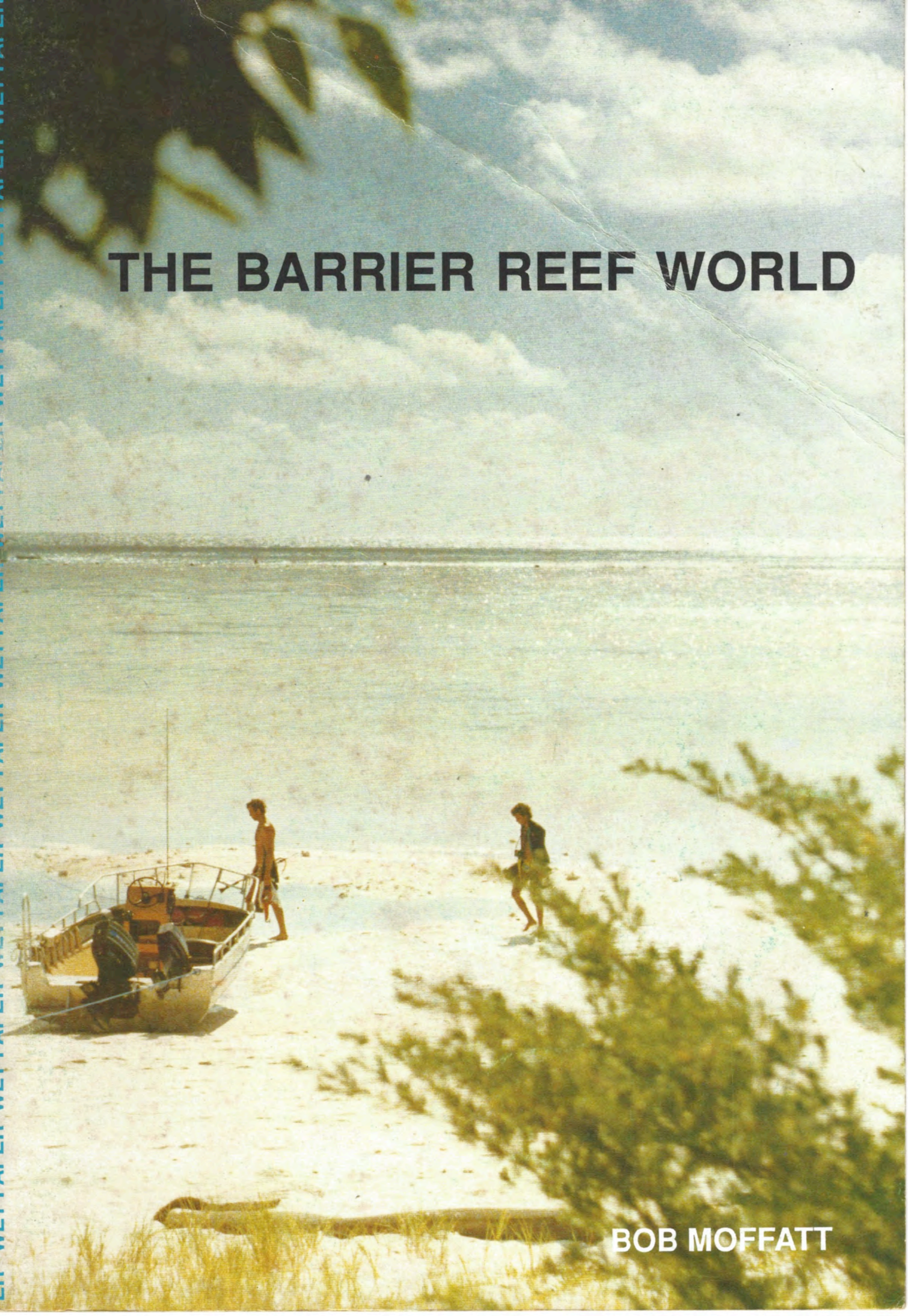

THE BARRIER REEF WORLD

BOB MOFFATT

WET PAPER WET PAPER WET PAPER WET PAPER WET PAPER

THIS BOOK BELONGS TO _____

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Special thanks

My sincere thanks to all those schools and individuals who bought the draft copies of this book. Without your finance this edition could not have been published as this is a private enterprise venture with no government grants, sponsorships and a shoe string budget. While every attempt has been made to contact individuals and organisations who have assisted to acknowledge copyright, the publishers tender their apologies for any accidental infringement where copyright has proven untraceable with this limited budget. They would be pleased to come to a suitable arangement with the rightful owner in each case.

Errata: Page 25. Substitute Calypso Kristae with Calypso Kristie.

Cover

North West Island that inspired me to write about the reef and the Gladstone Oceanographic Studies Programme Boat, "*CORIXA*" from which marine studies began in Queensland.

Errata
Insidecover, Acknowledgements: Add David Tulip
Tick socks should be thick socks P93

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THE BARRIER REEF WORLD

by

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Science Master
Benowa State High School
Gold Coast Australia

Copyright

Syllabus orientation

This booklet is written for the requirements of the new Senior Multistrand Science Syllabus topic, Ecology, Resource Management, Science for Recreation and the NSW and Vic topics:- *Ecology, Conservation and Management, Other Approved Studies.* It is also written for sections of Senior Geography, Junior Science, Geography or Social Studies, Physical Education or School Enrichment Subject programmes.

Computer illustrations and photography

R. Moffatt

Additional illustrations

R. Bedford, S. Byers, S. Oats, M. Moffatt, Project Neptune

Resources required

Teachers are advised to read each activity and project section with care as they require quite specific resources and videos to complete the activities.

A catalogue and price list for all resources is available from:-

Wet Paper Bookshop
14 Milbong Terrace
Ashmore Qld 4214
Australia

Phone 075 39 4187

CONTENTS

Resources

The following are recommendations only:-
VHS Video
Colouring in pencils
Cutting knives
Cardboard sheets
35 mm slide projector
Project sheets

Videos

Reef reporter 3/87 and 1/88
Encounters with the reef
Return of the Leviathan
Crown of thorns

Slides

Set of barrier reef slides
Encounters with the reef

Photographs and Maps

Select an island as your study and obtain the relevant Sun Maps
Reef posters for the room provide an easy access point for various sections of the unit.

Excursions

Permits are required to enter the reef and to camp on islands.

Write for two permits at the same time:

The Executive Officer
Great Barrier Reef Marine Park Authority
PO Box 1379 Townsville Qld 4810
Telephone: 077 81 8811

The Director
National Parks and Wildlife Service
PO Box 190 North Quay Qld 4000
Telephone: 07 224 0414

Camping fees are now imposed and a ballot system operates in some national parks so it is advisable to ring National Parks first.
Regional telephone numbers are:
Cairns 070 517811
Townsville 077 741411 (Office:41 The Esplanade)
Rockhampton 079 276070 (Office: Marlowe St)

Project Reef Ed

It's out and copies are available from Wet Paper Bookshop. It contains all the information necessary to go to the reef and things to do while you are there. An absolute must to accompany this book. Rec Retail $19.95 (Single copies) + P& P

CHAPTER 1

THE ARCHITECT OF THE REEF

Fig 1.1 : The coral polyp has been called the architect of reefs, because it is constantly shaping and changing its shape. Photograph courtesy of the Great Barrier Reef Marine Park Authority. (You are going to have to use the brochure on the Coral Polyp in this chapter).

Purpose

"The builders of reefs are the corals. The mortar is supplied by the algae. The architect is the coral polyp." Such analogies aptly describe how a coral reef is made.

This chapter introduces you to the bricks and mortar that make up a coral reef.

Prerequisite skills

Nil

Objectives

At the end of this chapter you should be able to

* distinguish between hard and soft corals
* draw a generalized figure of a coral polyp
* define the terms coelenteron, corallite, coral tissue, nematocysts, cnidoblast, venemon, planula, spawning
* list the six most common forms of coral
* describe how corals spawn and distinguish between the forms of spawning
* distinguish between the terms gonochoric and hermaphroditic
* describe how corals feed
* draw a diagram of how limestone is absorbed by the coral colony
* define the term symbiosis using zooxanthellae as an example
* suggest some hypothesis why corals spawn at night and at certain times
* read two pamphlets on hard and soft corals and make drawings from photographs
* suggest why hard corals only feed at night
* describe how soft corals use their chemical warfare as an adaptation to reef life

Equipment and resources required

Each group will require a copy of the pamphlets,
"The Coral Polyp" and "The Soft Touch."

Time required

1 week

CORALS

Corals are not plants.

They belong to a group of hollow gutted animals called *Coelenterates*.

The Coelenterates are a large group of over 9, 000 species, found on shores, reefs and oceans of the world. Well-known and easily recognized animals such as jelly fishes, anemones and corals, are included in this group.

Corals are very similar in shape and build to the common sea anemone but are generally smaller. The corals secrete a small cup-shaped structure of limestone (at its base) known as a *corallite*.

They have a mouth which also serves as an anus, and is surrounded by a crown of tentacles. Its hollow gut is called the *coelenteron* - which is the animal's stomach.

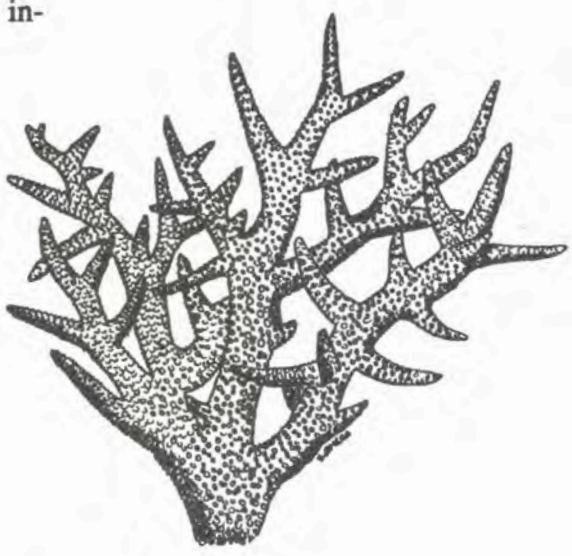


Fig 1.2: A coral clump

Activity 1.1 Corals

You will need per class

* 8 copies of each of the pamphlets "A Coral Polyp" and "The Soft Touch"
* A partner

What to do

* Half the class can work for 15 min, in pairs on one of the brochures and then swap.
* Use the information in the brochures to answer the questions on the next page
* Draw the corallite, which provides support and protection for the soft-bodied polyp which is able to retract when not feeding.

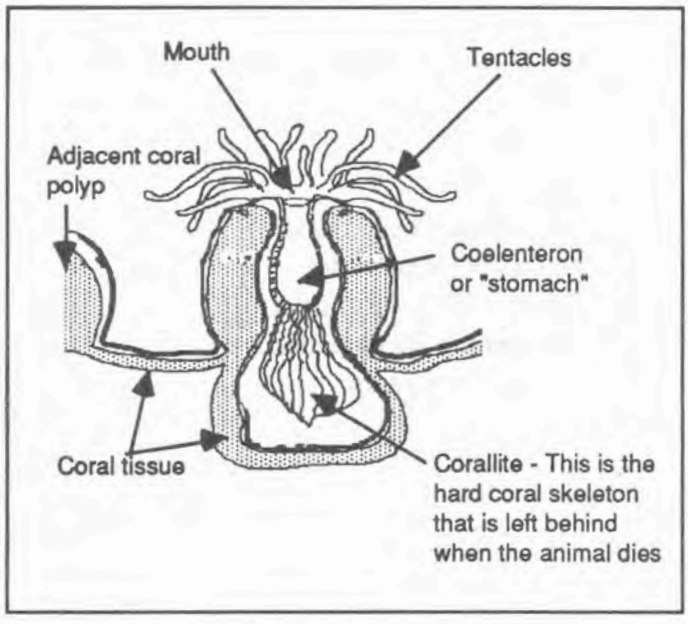


Fig 1.3: The coral polyp

Questions, sentences to complete and descriptions required

The Coral Polyp

1. Complete the sentence, Coral reefs are the only major.....
2. Describe a coral polyp in two sentences.
3. Explain what happens to hard corals during the day and why?
4. What are corals closest relatives?
5. What are septa?
6. Who are zooxanthellae and what do they do?
7. Describe how corals feed.
8. Make a coloured drawing of the coral colony on page 3 of the brochure.

The Soft Touch

1. Define soft corals.
2. What do they lack in their skeletons?
3. What role do small algae play that live inside the tissues of the coral ?
4. Write two sentences on the chemical defence mechanisms of soft corals.
5. What role do the thorn like spicules play in the protection of these corals?
6. How is the egg cowrie able to eat soft corals?
7. What scientific evidence has been obtained which explains why the egg cowrie doesn't die after eating soft corals.
8. Why is the Great Barrier Reef not a soft reef?

THE STINGING CELL

The stinging cells are found in the tentacles which surround the mouth of the coral polyp.

They are called *nematocysts* and contain coiled threads which enable the animal to paralyse its prey. Read the figure opposite to discover how they work.

The toxicity of these cells varies considerably, some being extremely potent.

Perhaps the species best known to man, from this point of view, is the Box Jellyfish which has killed a number of people in Queensland over the past twenty years.

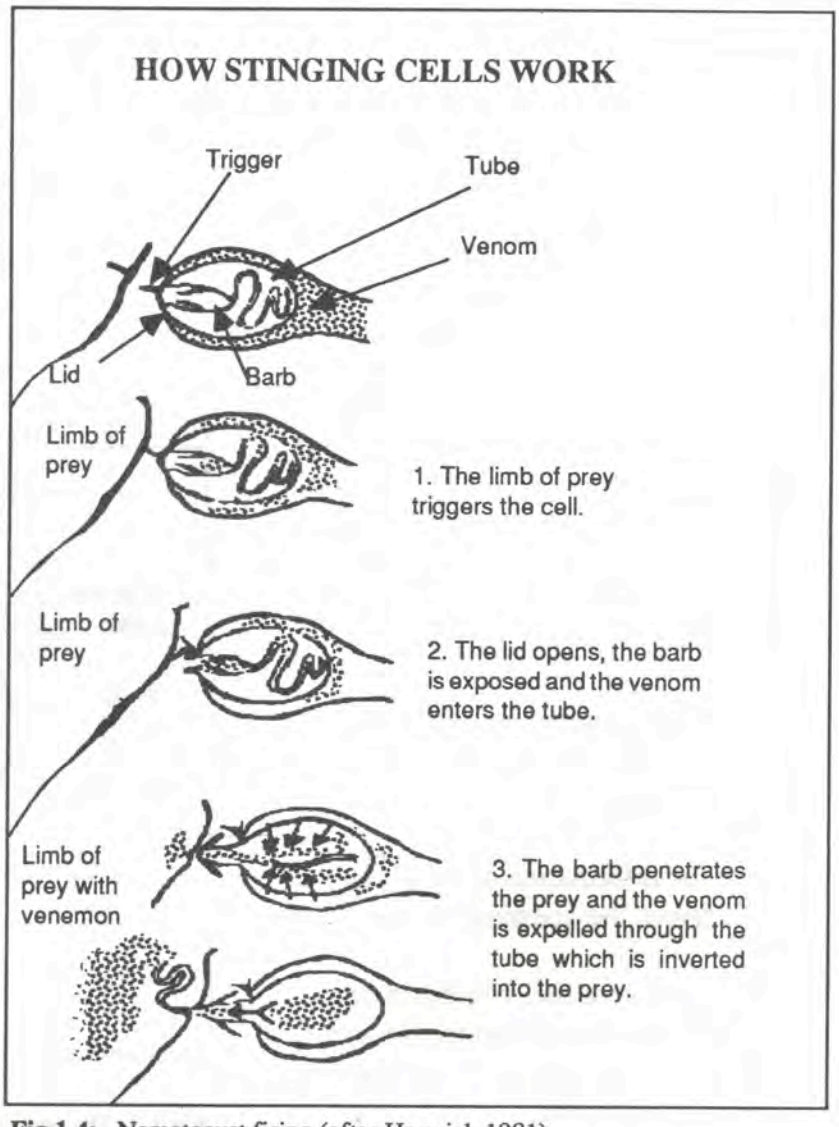


Fig 1.4: Nematocyst firing (after Harwick 1981)

CORALS FEEDING

Corals feed by extending their tentacles armed with nematocysts and catching microscopic plankton that pass by.

When the tentacle encounters an animal such as a shrimp, the barbed darts of the stinging cell are fired into the flesh of the prey, killing it instantly.

The prey is then stuffed into the animals mouth and into the *coelenteron* where it is digested.

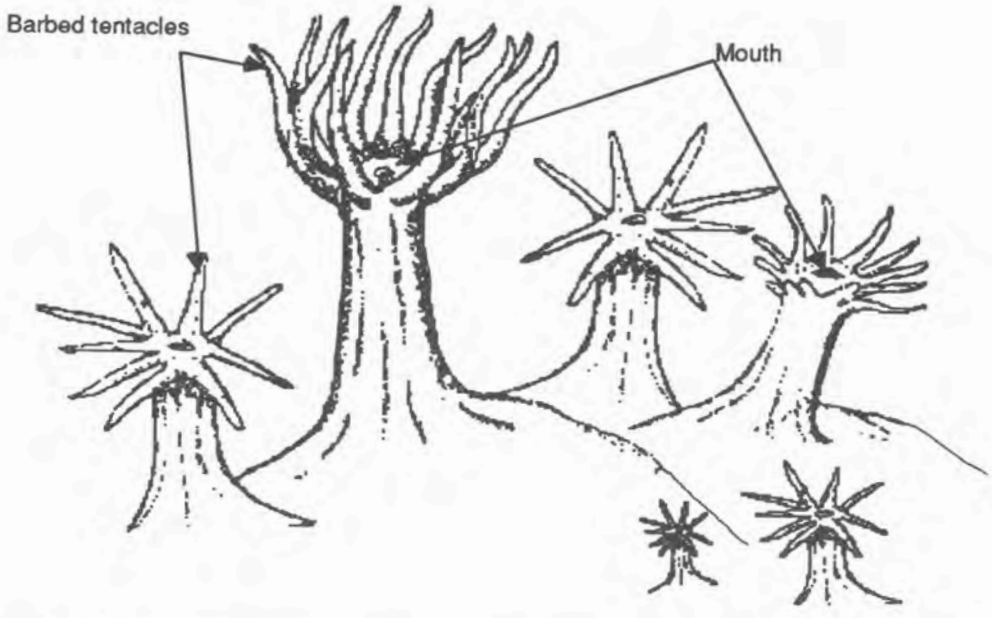


Fig 1.5: Corals feeding. Figure from Sea Worlds Project Neptune. Information about how students spend a day looking at Reef Fish and animals can be obtained by writing to the Education Officer, Sea World, PO Box 190, Surfers Paradise, 4217 Australia.

Once the food has been broken down and absorbed into the polyp's tissue, some of the nutrients are passed to other polyps by the interconnections that join with other polyps.

The limestone base is added slowly as a result of the polyp absorbing Calcium carbonate from the seawater.

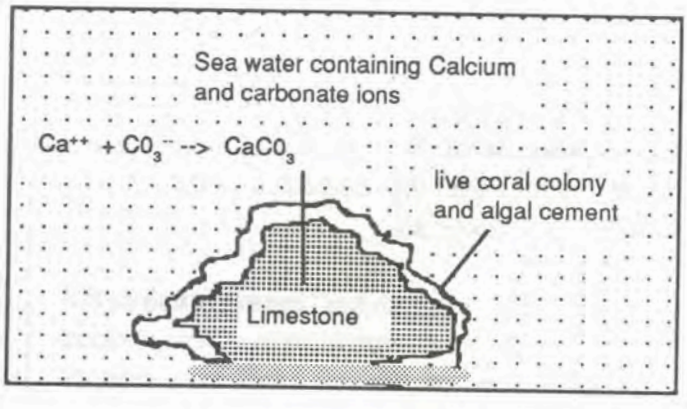


Fig 1.6: Coral colonies secrete a limestone skeleton as they grow by extracting calcium and carbonate ions from seawater.

ALGAE

The reef is not made entirely of coral. The algae play a very important role in the production of hard calcareous (calcium type)materials, which helps cement sand, coral pieces, living and dead material together to form the reef.

Corals are carnivorous animals, but they also obtain some nourishment from the plant cells embedded in their tissues. The success of corals as reef builders is due in part to the remarkable association with these tiny single-celled algae called *zooxanthellae*.

The relationship between the zooxanthellae and the coral is one of mutual benefit (symbiosis). The plant cells gain a suitable place to live. Like other plants they harness energy from sunlight to manufacture materials necessary for their own nutrition and reproduction. They also use the waste products of the coral polyp for nutrition and growth. The polyp gains oxygen, and probably food, made by the plant cells.

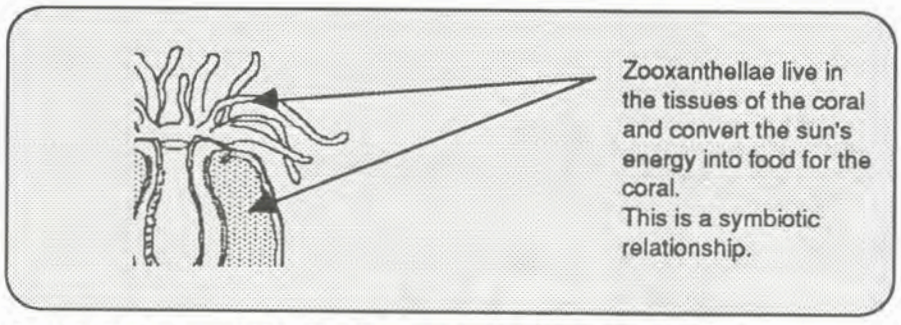


Fig 1.7: The zooxanthellae live in a symbiotic relationship with polyps.

During the day, reef-building corals usually have their polyps retracted, or pulled back , into their limy skeletons. This allows the microscopic plants to absorb as much light as possible.

Most corals feed at night, and at this time their polyps are fully extended in search of food. During the daytime they are retracted within their coral-lites. The night feeding pattern of corals probably occurs because zooplankton reefs are most active at night.

Reef-building corals flourish in shallow tropical waters, rarely being found below depths of 60 metres, and with water temperatures ranging be-tween 20°C and 30°C.

Since all plants require sunlight , it is considered that the presence of the zooxanthellae is a deter-mining factor, for the depths at which reef building corals flourish.

Recent scientific research has begun to explore the question of how much nutrition the coral obtains from zooplankton on the one hand, and from its zooxanthellae on the other.

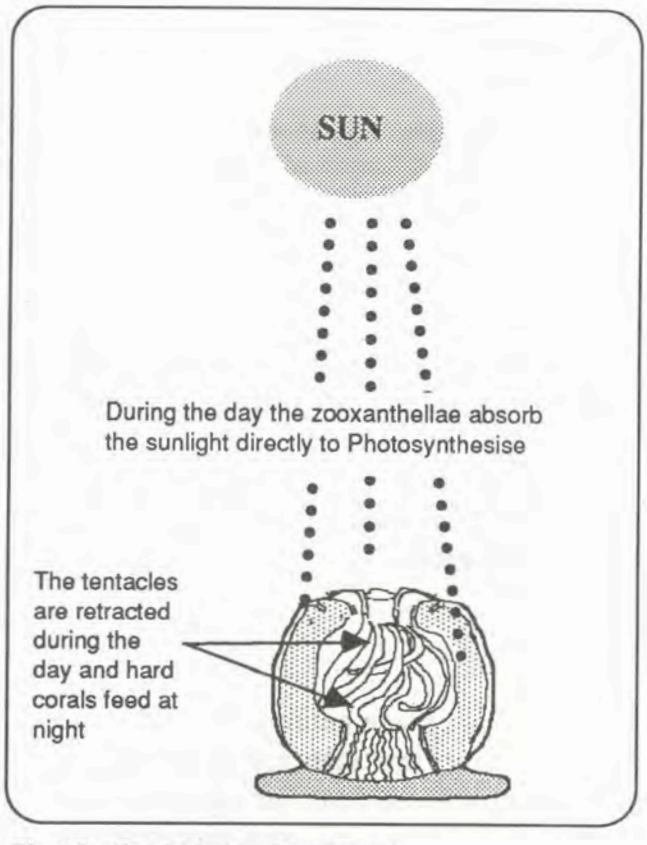


Fig 1.8: Corals during the day time

Some scientists believe that coral obtains most, if not all, of their nutrient from the zooxanthellae, while others seem to to think zooxanthellae play only a minor role in providing basic nutrition.

CORAL GROWTH FORMS

When a coral dies, the corallite remains as a hard skeleton giving the shape we most commonly recognise.

The branching coral shown in Fig 1.9 below, is one such example.

While coral colonies may form a great many shapes and sizes due to different skeletal patterns, the coral polyp, which is the fundamental unit, remains the same.

Corals as a group are difficult to define and generally includes three types of animals;

1. the hydrozoan corals,
2. the soft corals, and
3. the stony corals.

The most important members of the whole Barrier Reef are the reef builders themselves, the true or stony corals.

The builders are tiny animals called coral polyps, which by building a skeleton of limestone and by dividing to form new polyps, create the living structures known as colonies.

A coral colony is not a group of individuals living together for the common good, but rather the result of growth and division of an original founder polyp.

In corals which grow as sheets or layers, new polyps are added, around the edge of the colony.

Branching corals grow by adding new branches as well as extending existing branches.

In mound-like colonies, new polyps are added within the surface of the mound.

As the colony grows, polyps pull themselves upwards and lay down a new 'floor' of skeleton.

Fig 1.9: Branching coral

The thickness of the floor depends on weather conditions and other factors, so that accumulation of layers of floor over the years provides a calendar, somewhat like the rings in a tree trunk.

The layers of floor allow the age of the coral to be estimated, and unusual events in its history to be noted.

Colonies of stony corals occur in many different shapes and the intricate sculpturing of some coral skeletons is very beautiful, while others are so fragile it is difficult to understand how they survive.

These differences among species result in rather specific reef forms developing under the impact of the environment.

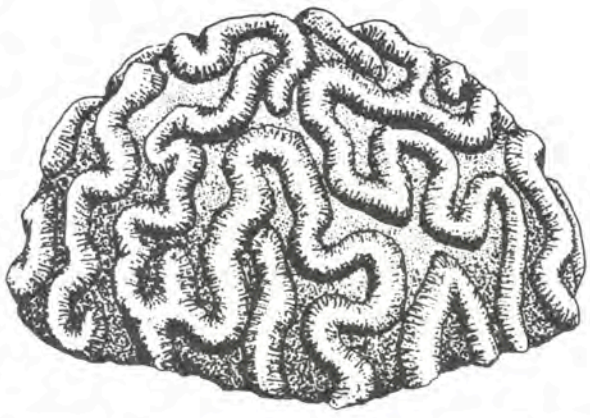


Fig 1.10: Round massive colonies (Brain Corals from Project Reef Ed)

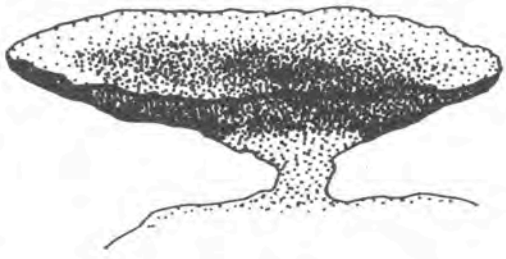


Fig 1.11: Plate or table colonies

The most common growth forms are the following:

1. Branching colonies that resemble trees or shrubs (see Figs 1.9, 1.12)

2. Round massive colonies that resemble boulders

3. Plate or 'table' coral which grow as broad circular upward-facing colonies usually supported by a central column

4. Corals that occur as sheets sometimes called 'leaf' coral. These are the soft corals you learned about in Activity 1.1

5. Free-living corals that occur unattached on the sea bottom

6. Solitary corals that consist of a single polyp, often relatively large.

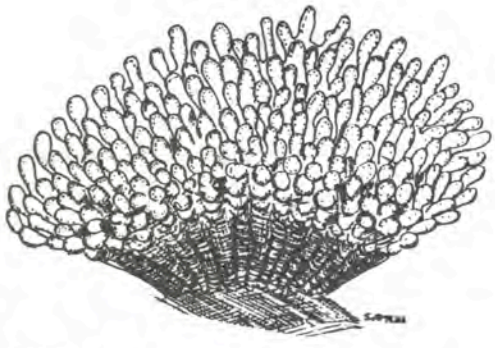


Fig 1.12: Branching colonies

Fig 1.13: Solitary forms of coral

Each of the above types has specific requirements for growth be it deep, shallow or quiet waters. Corals will die if covered by silt or exposed to air for long periods of time.

HOW CORALS REPRODUCE

Coral polyps owe their great success to their ability to reproduce.

They can do this sexually by producing male and female gametes (sperm and eggs) which unite to form tiny rounded larvae called planulae.

In some corals, separate colonies have either all male or all female polyps, while in others both sexes occur in the one colony.

ACTIVITY 1.2 Coral Spawning Event on the Great Barrier Reef

You will need

* A copy of the brochure,"The Annual Coral Spawning Event on the Great Barrier Reef".
* A copy of the Video, "Reef Report 3/87, segment on coral spawning".

What to do

Watch the video and answer the following questions on the brochure.

Questions

1. When do corals spawn?
2. Why do they spawn at night?
3. How long do eggs take to ripen?
4. What do you understand by the terms "hermaphroditism" and "gono - choric"?
5. Do sperm and eggs from the same colony fertilize each other? Give reasons for your answer.
6. What is the planula and how does it form?
7. Is the story the same for all corals or is there some variation in fertilization methods?

Fig 1.14: An egg and sperm bundle is ejected from a coral polyp. Photo Peter Harrison, James Cook University. Published undated Great Barrier Reef Marine Park Postcard.

Corals reproduce in late spring and early summer, at night and usually five or six days after the full moon. Remarkable as it may seem, this has now been documented by scientists working at the James Cook University who produced the remarkable video which you have just seen.

Sometimes each polyp is both male and female (Hermaphroditic), and releases a bundle of eggs and sperm into the seawater on only one or two nights each year. The egg and sperm package breaks open and fertilization takes place at the surface of the sea. They grow into a *Planula*. The millions of tiny planulae which are formed live freely in the water for up to 30 days as plankton, swimming slowly through the water using their hair-like projections for locomotion.

Sometimes the sperm and egg are fertilized inside the polyp. In this case the planulae are released from the polyp.

Sometimes the corals are different sexes (Gonochoric) and release separate sperm and egg packages which fertilize separately.

But why at night? Later in this book you will learn that most fish sleep at night. Do the corals know this and release their reproductive packages to avoid being eaten? And why all at once after the moon and in such great numbers? Is it the tides or is it the moon? In science it takes many years to answer these questions.

After a period of time, the planula will settle down and grow into a polyp. First it begins to secrete a base of limestone and then develops a crown of tentacles with a mouth that can injest food.

As scientists, we are only just beginning to unravel the facts about the reef. This coral story may only be true for our reef, and its takes years of research to uncover what really happens.

BUDDING

A second form of reproduction called *budding* can take place, where another polyp grows off one of the sides.

As this grows bigger, it too develops a mouth and tentacles and finally falls off and grows beside the "parent polyp".

Budding is useful for corals where there is a lack of solid substrate.

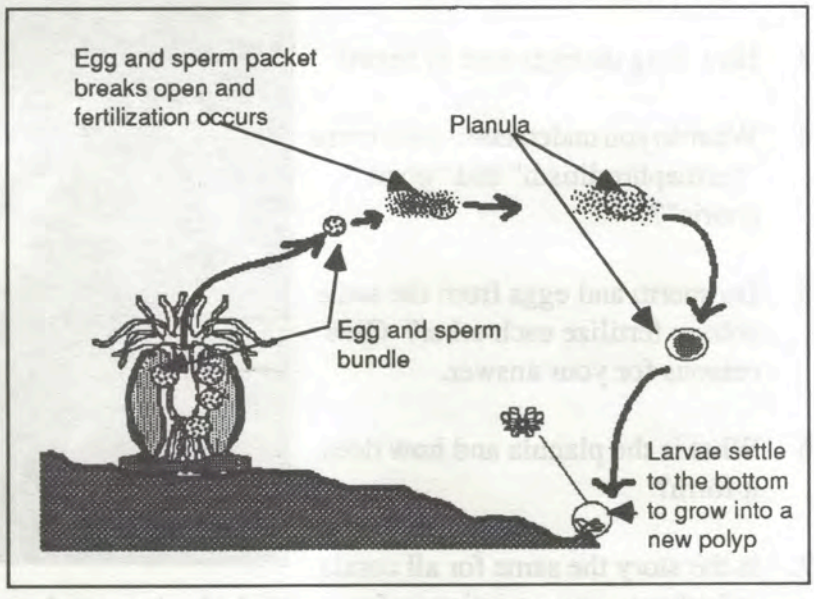
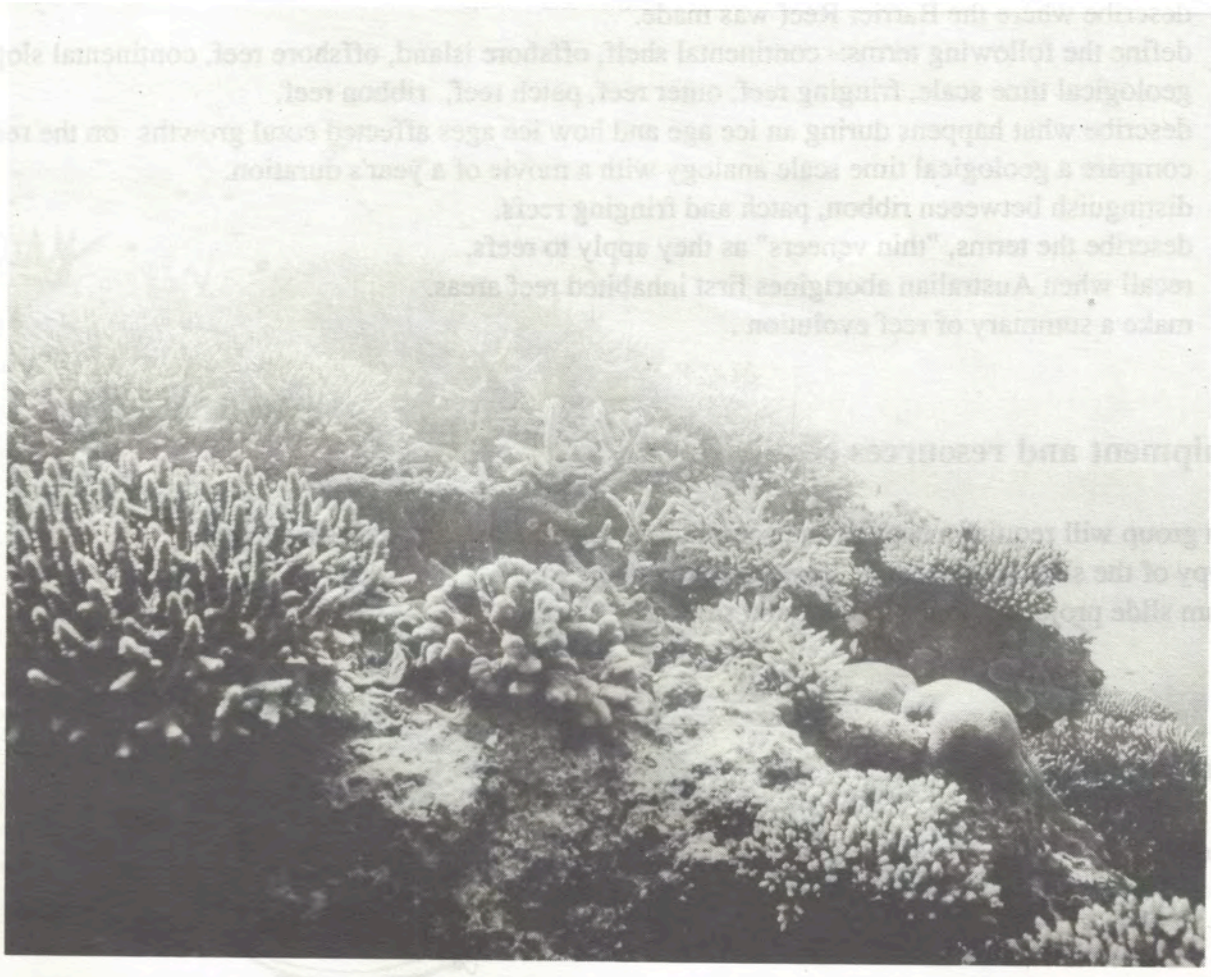


Fig 1.15: A coral sexual life cycle. Can you draw one for budding asexually.

CHAPTER 2

HOW OUR REEF FORMED



Corals grow up towards the light. Their upper limit is determined by water levels. This fact played an important part in the evolution of the reef. Illustration courtesy Great Barrier Reef Marine Park Authority.

Purpose

To introduce you to the concept that the reef is just a thin veneer over a fossilized reef that formed many thousands of years ago.

Prerequisite skills

Nil

Objectives

At the end of this chapter you should be able to

* place on a map the following towns, islands, areas and reefs: Cape Flattery, Torres Strait, Ashmore Reef, The Daintree Ranges, Lizard Island, Cairns, Townsville, Mackay, Rockhamp ton, Bundaberg, Gladstone, Green Island, John Brewer Reef, Hamilton Island, Heron Island, The Whitsundays, Thursday Island, Bamaga, Northern, Central and Mackay/Capricorn sec tions.
* describe where the Barrier Reef was made.
* define the following terms:- continental shelf, offshore island, offshore reef, continental slope, geological time scale, fringing reef, outer reef, patch reef, ribbon reef.
* describe what happens during an ice age and how ice ages affected coral growths on the reef.
* compare a geological time scale analogy with a movie of a year's duration.
* distinguish betweeen ribbon, patch and fringing reefs.
* describe the terms, "thin veneers" as they apply to reefs.
* recall when Australian aborigines first inhabited reef areas.
* make a summary of reef evolution .

Equipment and resources required

Each group will require a copy of the pamphlets:- *Coral Cays and Fringing Reefs*
A copy of the slide set or video, *"Encounters with the Reef"*
35 mm slide projector, tape recorder and screen.

Time required

2 weeks

Australia's Great Barrier Reef is found off the coast of Queensland.

It is made up of approximately 2,900 individual reefs and is approximately 2,000 kilometres long.

It can be seen from the moon and is the largest single living thing on earth.

Fig 2.2: Part of the Great Barrier Reef.

Activity 2.1 How much reef was made?

Purpose

To introduce the latitude, longitude, position, sections, depths and elementary geomorphology of the Great Barrier Reef Marine Park.

You will need

A copy of the Great Barrier Reef Marine Park Map (Appendix 1).

A ruler, dark and light blue, green and brown coloured pencils.

Note: Mackay/Capricorn Section is the amalgamation of the two previous southern sections: Capricorn and Capricornia. The renaming occurred on 24 September 1987.

Fig 2.2: Australia's Great Barrier Reef extends along most of Queensland's coastline.

What to do

Use a dark blue pencil to shade in between the ocean contour lines 2000 and 4000, a light blue between 2000 and 200 and light green between 200 and 0 metres. Colour in the islands in the reef brown.

Now answer the following questions:-

Navigation revision

Lines of latitude run down from the equator, lines of longitude extend eastwards from London. One nautical mile is one minute of latitude and 1 knot is one nautical mile per hour.

1. Using the scale in nautical miles at the bottom of the chart, how long is the Great Barrier Reef Marine Park?
2. If you sailed along the entire boundary of the Great Barrier Reef Marine Park at ten knots, starting just north of Bundaberg and finishing at Cape York, how long would it take?
3. At what Latitude and Longitude does the Far Northern Section begin?
4. What is the Latitude of Cape Flattery?
5. At what Latitude and Longitude does the Cairns Section the Marine Park finish?
6. At what Latitude and Longitude does the marine park finish?
7. What is the Longitude of the Daintree Ranges?

Geography and geomorphology revision
The continental shelf begins at 200m depth and extends down to 4000m

1. Are Torres Strait, Ashmore Reef, Boot Reef and Raine Island included in the Great Barrier Reef?
2. Is Lizard Island North or South of Cairns and at what Latitude and Longitude?
3. How many kilometres out from Cairns does the continental shelf extend?
4. Compare this with the distance out from Mackay and Gladstone?
5. What parts of the Marine Park are on the continental shelf?
6. What are the names of the sections of the Great Barrier Reef?
7. What is the area of each of the sections?
8. What is the total area of the Great Barrier Reef Marine Park?
9. What is the approximate Latitude and Longitude of Heron Island?
10. Where is ribbon reef #1? (Cormorant Pass)
11. Do the ribbon reefs off Cairns follow the 200m contour line?
12. Where do the ribbon reefs stop in the Cairns section?

Mark on the map the following towns, islands, areas and reefs:

Cape Flattery, Torres Strait, Ashmore Reef, The Daintree Ranges, Lizard Island, Cairns, Townsville, Mackay, Rockhampton, Bundaberg, Gladstone, Green Island, John Brewer Reef, Hamilton Island, Heron Island, The Whitsundays, Thursday Island, Bamaga, Northern, Central and Mackay/Capricorn sections.

WHERE WAS IT MADE?

You can read more about this in the Booklet called, "Oceanography" in this series which describes the theory of plate tectonics and how Australia moved north in time.

The Barrier Reef is only a relatively recent geological event but its history began many thousands of years ago as the Australian plate was moving northwards in its separation from Antartica.

The area described in Activity 2.1 is called the *continental shelf*, on which is growing the organisms that collectively are known as a Barrier Reef. A closer view of the continental shelf reveals a number of distinct areas.

These areas include the mainland, continental shelf, offshore islands and reefs, the continental slope and the deep sea floor. It was on this continental margin that the Great Barrier Reef started to grow some 20 million years ago.

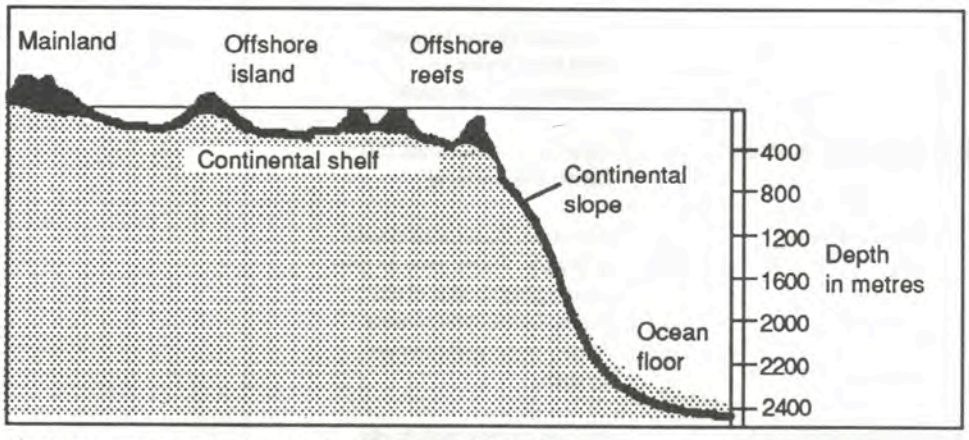


Fig 2.4 : A cross-section of the Continental Shelf

Geological time is difficult to comprehend. Ask your teacher to tell you the story* about how it can be explained in terms of a movie of life on earth that started on January 1st in one year and ended on 31st December of the same year. The reef and its varied life forms would appear at about 30 seconds before the New Year. The story should reveal just how recent our Barrier Reef is.

* This story has been reproduced in the appendix courtesy of "The Science Teachers Association of Queensland" Student memberships are available from The Secretary, Science Teachers Association of Queensland, PO Box Spring Hill Q 4001)

OPINION:- Do you agree?

If something is new, we always try to look after it. A new surfboard is put into a carry bag and carefully carried around. A new stero or compact disc system is looked after. A new record is carefully placed back into its case. Yet we humans have the incredible ability, not to look after the new things in Nature. It is hoped that by understanding that the reef is one of Natures new events, future generations, like yourselves, will look after it. Many Australians in the 1960's protested very strongly about the need not to drill the reef for oil or to mine it for minerals. Generations to come may not appreciate the significance of this, but should be encouraged to regard this recent geological event as something that is worthy of looking after very carefully.

GEOLOGICAL TIME

Perhaps the most important time for reef development was in the last 20 million years of the earth's development. If you look carefully at the table below, you can see that 18 million years is a rather recent event. In fact, if you studied the Geological time story from the appendix, you should now realise that we are talking about December 31 in the story.

Table 1: Abbreviated version of the Geological Time scale:

Approximate Time	Important events in the History of Life	Important events in the formation of the reef
6,000 years ago	Ancient human civilizations	**Present sea level** reached
12,000 years ago		Continental shelf fully submerged
18,000 years ago		**Ice caps began to melt Sea level starts to submerge coral reefs**
150,000 years ago	Aborigines came to Australia	Last ice age, sea level 150m below present level
3 million years ago	Appearance of Humans	Capricorn Basin subsidence complete. Reefs grew on pre-existing high points of old reefs. Distribution of reefs largely dependant on river systems
10 million years ago	Mammals fully established	Ice age causes reefs to die out
18 million years ago	Age of Apes	First corals grew on Barrier Reef
35 million years ago	Specialisation of mammals, sediments flowed from rivers onto the reef.	
55 million years ago	Australian plate still moving north and fracturing	
70 million years ago	Expansion of mammals, coral sea forms, cato trough forms, foundations for Bowen Basin laid down	
140 million years ago	Dinosaurs became extinct, Australia still joined to Antartica	
200 million years ago	First mammals and birds	
230 million years ago	First Dinosaurs	
285 million years ago	Expansion of primitive reptiles	
350 million years ago	Expansion of sharks and fish	
400 million years ago	First Insects	
430 million years ago	First land plants	
500 million years ago	First fish	
600 million years ago	First marine invertebrates	
4600 million years ago	The beginning of life in the Sea	

Homework exercise

When did.....

1. the first coral grow on the Barrier Reef?
2. the sea level begin to submerge coral reefs?
3. the ice ages cause the reefs to die out?
4. polar ice caps first form?
5. life begin in the sea?

As the coral polyp grows it secretes a limestone base called the corallite and is the white coral skeleton seen when coral colony dies. As the coral colony grows so does the size of the coral skeleton.

HOW WAS OUR REEF FORMED?

The sequence of events that started the reef's growth began almost 18 million year ago. Australia was at a latitude that promoted coral growth at a rapid rate.

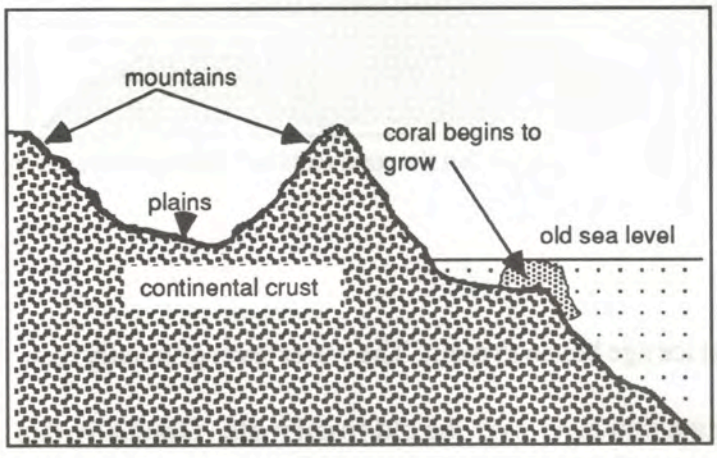


Fig 2.5: Australia's continental shelf 18 million years ago.

As the sea levels rose the corals began to grow in large numbers, forming a barrier reef on the outside of the continental shelf. The sea level gradually rose and with it grew the corals.

There were still mountains and plains on the continental crust as the age of the mammals increased and the Australian marsupials were coming into their own.

As the sea level rose, so did the reefs forming fringing reefs around the new islands and outer reefs on the edge of the continental shelf.

Life abounded in the seas and the islands became separated by large expanses of water. Populations of birds may have developed because of the absence of natural predators such as snakes or dingoes.

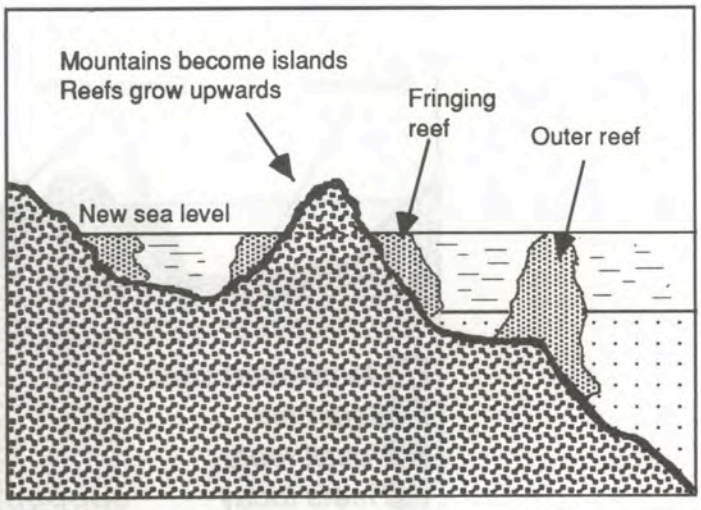


Fig 2.6: Between ice ages the sea levels rose and allowed coral colonies to grow upwards

This continued until a series of ice ages began. When ice formed at the poles it concentrated the water. This meant that the sea level fell. Although it is difficult to calculate, scientists believe this fall to be about 150 metres below the present sea levels.

Continental shelf areas were now subjected to river systems and erosion.

The limestone caves under and around old limestone cliffs were possibly the homes for our early aborigines. Trees and shrubs grew and kangaroos hopped around.

Figure 2.6 shows the build up of sediments from rivers.

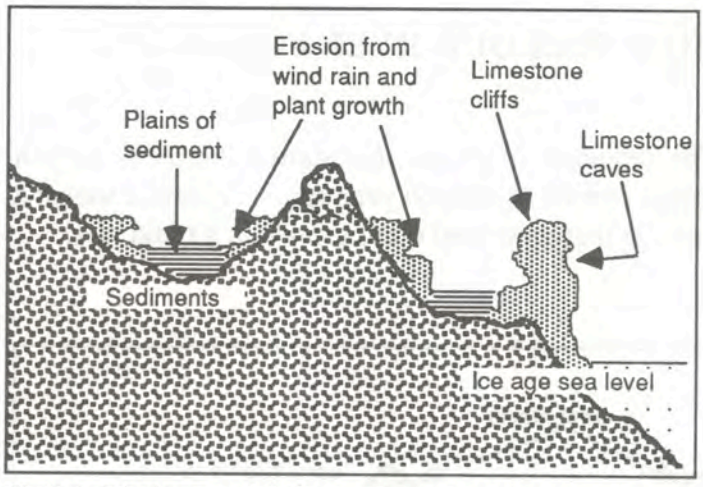


Fig 2.6 : The ice ages left the coral reefs bare and open to erosion.

TODAY'S REEFS

About 18,000 years ago the ice caps from the last ice age began to melt. The water level gradually rose.

With the rising waters grew more coral, forming a thin layer over the old fossil reefs. Gradually this layer increased and thickness of 15 metres new growth has been measured today.

The Great Barrier Reef as we now know it had formed. All that has changed is the gradual weathering and erosion that gives each reef its characteristic shape.

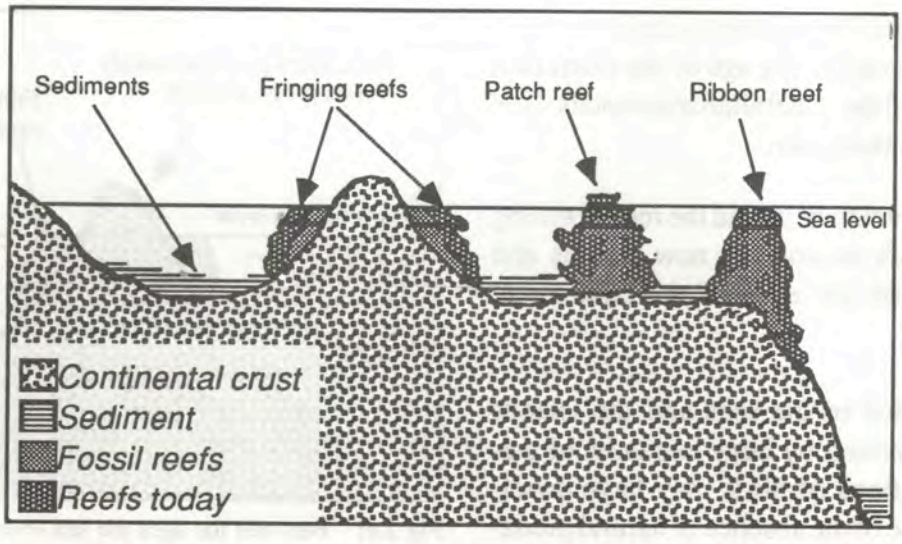


Fig 2.7: The reefs today are just a thin veneer on older fossil reefs.

Activity 2.2 An Encounter with the Reef

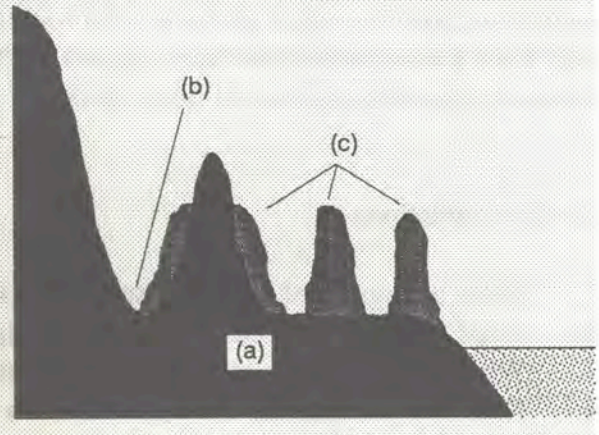
Purpose
To view a video in order to review the ideas so far presented.

You will need
The slide set or video "Encounters with the Reef", 35 mm slide projector, tape recorder and screen.

List of words:-
mountain, fringing reefs, round or oval, ribbon reefs, passages, drop away from northern, coralline, lizard, two hundred, limestone, ancient dead, 9000, Pleistocene, continental shelf, Bundaberg, 2000, 2400, dark night on the 11 June 1770, patch reefs, 18,000.

Questions

1. Under what circumstances did the Endeavour run aground on the reef?
2. Complete the sentence:- The Great Barrier Reef stretches along the.....from north of Cape York to ..... in the South, a distance of.....km.
3. How many reefs make up the total Barrier Reef System?
4. Complete the sentence:- Each reef is an accumulation of ..... built up by living creatures especially .....polyps and plants called .....algae.
5. Name three types of reef.
6. Reefs around islands are called..... such as .....Island.
7. Lizard Island is really an underwater ..... with its peak above the sea's surface.
8. The second type of reef is a ribbon reef. These are quite common in the .....part of the reef. They grow along the edge of the continental shelf just where it begins to..... .... to the ocean depths.
9. The third type of reef is called a patch reef. When seen from the air they are usually ..... or ..... in shape and may be several kilometres across.
10. The diagram below shows the continental shelf more than ..... years ago
    Label the parts (a) - (d).
11. The last ice age was the..... Ice age and exposed a coastal plain up to .....km across
12. As the ice melted about..... years ago, the seas again rose, flooding continental shelves all around the world. The new corals grew on top of the .... coral reef.
13. Is the Great Barrier Reef still growing today and why?



14. What roles do the following Abiotic and Biotic features play in the formation of the reef?
    (a) Waves (b) Coral rubble (c) Algae
15. What do you understand by a vegetated coral cay?
16. What is the name for live coral and to what animal Phylum does it belong?
17. Tiny plants live in the coral polyps. What are their names and what do they do?
18. Where does the limestone substrate grow and what chemical is the chemical name for limestone?

CHAPTER SUMMARY

A limestone mound is formed which represents the beginnings of a reef. Corals, molluscs, and algae flourish on the surface of the newly formed reef and, when they die, add to its bulk.

This process, over thousands of years, raises the reef towards the surface of the water, and it could be described as a 'growing' reef. When this reef finally reaches the surface, upward growth stops but sideways growth continues. The reef crumbles and breaks giving a jaggard form and sand fills in the spaces.

Special conditions favoured the growth and development of the Great Barrier Reef. The first of these conditions was the occurrence of a broad continental shelf off the coast of Queensland which provided a suitable base for coral colonization in shallow water. A second factor that initiated reef development in the past, was the fluctuation in the sea level that occurred many thousands of years ago. During this time the sea level was on several occasions much lower than its present level and parts of the continental shelf were exposed to air. When the sea level began to rise, taking thousands of years, benthic organisms colonizing suitable areas were able to keep pace with the rising sea level until the present reefs were formed.

The Great Barrier Reef, therefore, rests on the limestone remains of ancient reefs which were "born" about 20 million years ago when Australia's continental shelf was formed and covered by the sea. Then an ice age began which killed the coral reefs as it lowered the sea level until it reached its lowest point 150 metres below present sea level!

It took about 12 000 years for the ice to melt and bring the sea back to its present level. The dead reefs were once again covered by the sea and new corals began to grow on top of them. It is important to understand that the major part of a coral reef is nonliving limestone and the living plants and animals only form a veneer on its surface. On the reefs we see today are layers of new coral growth, about 15 metres deep, covering the old fossil reefs.

Review questions

1. Draw a diagram of a general section of a continental shelf.
2. What is an ice age and of what significance is it to the formation of the Great Barrier Reef.
3. When did the first Australian Aborigines inhabit the reef?
4. How is it possible for animals to live on the continental shelf?
5. What significance are sediments to the formation of the Reef?
6. Why is new reef growth often referred to as "a thin veneer"?
7. Where did reefs grow around continental islands?
8. What is the formula for the formation of calcium carbonate.

CHAPTER 3

TIDES AND THE REEF

Fig 3.1: A trip to the reef has to be planned so that arrival coincides with the right tide. Photo of the maiden voyage of the Calypso Kristae to North West Island Since then this vessel has become the major access for Barrier Reef user groups who must plan their trips around the tide, leaving day or night.

Purpose

To introduce to you the notion that tides control the rhythm of the reef and that the earth spins into a 'standing wave'. This wave has a period (time between waves) of 5 hours and 54 minutes and can vary in height according to the place it "breaks" on Queenslands Continental Shelf.

Prerequisite skills

A knowledge of tidal patterns, an ability to draw an x and y axis on a graph and a willingness to work with data for a length of time.

Objectives

You should be able to:-

* define a tide in terms of wavelength and period
* plot a graph of a daily and monthly tide for two Queensland towns
* describe the causes and effects of tides over time
* recall the difference in heights between tides
* recall the reasons for spring and neep tides
* construct a model of the tides and propose a hypothesis for spring and neep tides

Basic Equipment required

* materials from appendix
* graph paper
* paper clip, tape, colouring pencils

Time required

1 week

Fig 3.2: Illustration courtesy of the Department of Harbours and Marine. This organisation publishes the official tide tables for the Great Barrier Reef. Copies are available from all newsagents or Harbours and Marine Offices.

Perhaps the greatest single controlling event on the reef is the tides.

Tides influence when you can visit the reef, turtles mating, corals spawning, when some plants grow, when you can snorkel or fish. Can you think of any other controlling influences?

Tides can play some nasty tricks on humans if we do not understand them. Try going for a swim at Mackay at low tide and see how far you have to walk; or setting up camp on the beach of a coral cay just above the daytime high tide in winter, only to find water in your tent at high tide at night.

How about going fishing at high tide and forgetting your sandshoes when you return at low tide. There is nothing like a long walk back to the beach over coral to remind you that the study of tides is important. Finally, see what happens if you plan a trip to a coral island at neep tides when the boat you use to transport your gear draws more than the tidal range for this tide. Discover the joys of dinghy loading as you regret the fact that you did not take the tides into account when you planned your trip.

Tides are also important for the reef because they establish a cycle of water that flows over the reef cleansing it and supplying it with food for the next six hours. They provide the stimulus for animals to feed, for plants to grow and for every living thing to establish a rhythm of life.

Fig 3.3 Water rushing off this reef at low tide flushes some of the waste products of reef organisms into the ocean. The incoming tide will bring oxygen and food.

TIDES

Tides *are the periodic rise and fall of the water on the earth's surface.* But really does the water rise and fall?

Tides are actually one big wave caused primarily by the moon.

The earth spins into this wave and causes the water at the edge of continents to rise and fall on a regular basis. Australia is moving east into a large standing wave in the Pacific.

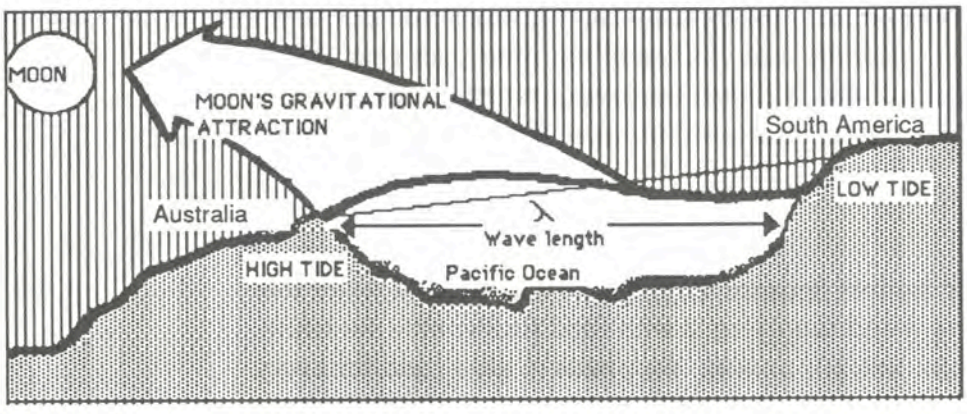


Fig 3.4: The moon's gravitational attraction causes daily tides.

This gravitational attraction causes the water in the Pacific to bulge up at one side. The nett result is a high tide in Australia and a low tide at California.

In the book Coastal Studies, you learned about waves. These had a number of characteristics that are described in Figure 3.4.

The tops of waves are called crests and between these are the troughs. The height of the wave is represented by (h) and the distance between crests is called the wavelength.

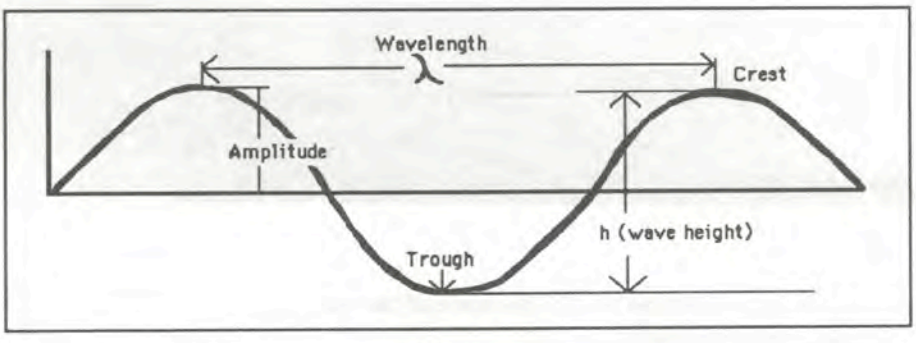


Fig 3.5: General features of a wave in the ocean

The wavelength is the distance between successive high tides. The crest is the high tide and the trough, the low tide.

But how fast does the earth spin? We know that one revolution is 24 hours and we know that the tides occur approximately every 6 hours. Therefore, there must be four tides a day and four standing waves that Australia moves through.

To gain some data on this we need to refer to the tide book and a model of the earth spinning. It was the French mathematician, Lapace, who first worked out the exact relationships between the moon, the sun and the tides. The activity below investigates this further.

Activity 3.1 Daily Tides

Based in part on an original idea by Roy Jenkins (FUSE Australia)

Each day there is a high and low tide.

Part A: Collecting data

You will need

1. A sheet of graph paper
2. Copy of tide book page from appendix

Fig 3.6: You can only walk out to the reef's edge at low tide. The lower the tide, the more coral is exposed.

Do you know how to plot graphs?

Ask your teacher now if you have forgotten.

What to do

1. Plot the tide for May 2, Cairns. Use half the sheet of graph paper to do this and make the *x axis time* and the *y axis height*. Make sure you work out the ranges for each scale and if you are unsure, ask your teacher to help you with the scales.

2. Now plot the tides for May 2, Mackay in another colour or style.

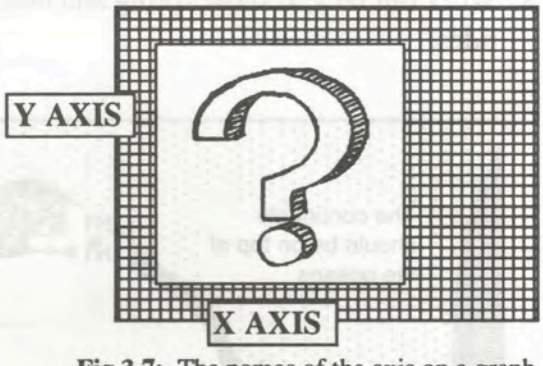


Fig 3.7: The names of the axis on a graph

Questions to answer

1. How many tides are there in a day?
2. Is the tide height the same for each?
3. Is one high tide higher than the other for the day?
4. Does the tidal range vary from Mackay to Cairns?
5. What are the dates for the full moon, new moon, first and last quarters?
6. What is the latitude and longitude for Mackay and Cairns?
7. Which is nearer the equator, Cairns or Mackay?

The distance between high and low water over a tide is called the tidal range. The figure over shows this difference.

But what causes this range and how can we show that the earth spins into a standing wave? Part B of this activity is an attempt to show you how.

Part B: Making a model

You will need

1. A copy of the model from the appendix.
2. Scissors, pencil, glue, a paper fastener
3. A coloured sheet of cardboard

What to do

1. Locate the ocean in the model in the appendix and colour it blue.
2. Cut out both models.
3. Take a paper clip and bend up the smaller point and push it through the centre of the coloured sheet of paper. On this paper draw the sun at the bottom. Your model will fit onto this sheet.
4. Now fit the models together so that the continents are on top, as shown in the figure below.
5. Line up H1 in continent A with H1 in the ocean. This is high tide.
6. Mark in sunrise, sunset, midday and midnight on the coloured sheet of paper.
7. Mark in the low and high tides on the shoreline of Continent A
8. Work out how to show spring and neep tides.

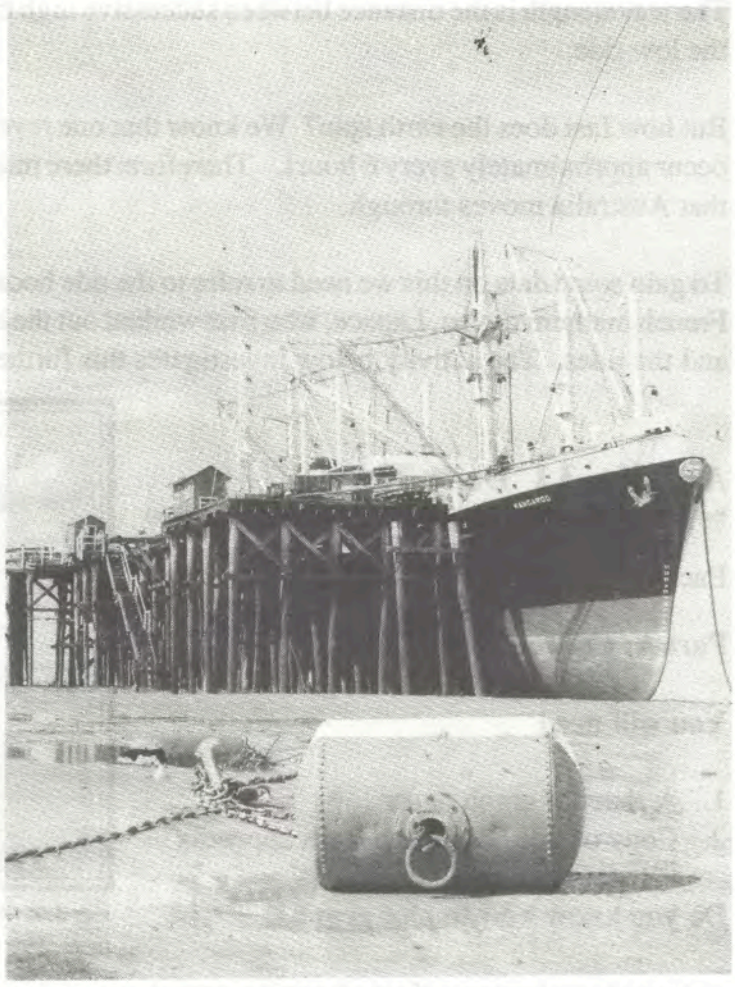


Fig 3.8: The rhymic rise and fall of the ocean's water is refered to as the tide. The tidal range in open water many vary from half a metre to up to eight metres as shown here at Broome. Photo courtesy CSIRO.

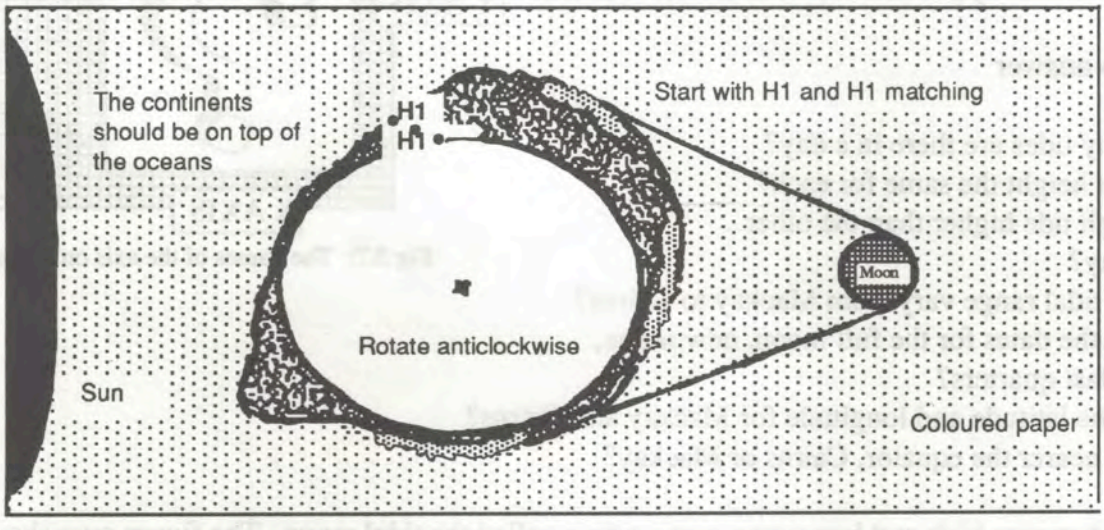


Fig 3.9: How to arrange your model

Questions

1.What times are the low tides and high tides?
2.Is the high tide at night lower than that of the day?
3.If 1cm = 1 metre, what is the tidal range at night?
4.Is it summer or winter?
5.Does your model show spring or neep tides and why?
6.Which port does the model best explain.
Cairns or Mackay? Give reasons for your answer.

Fig 3.10: At low tide you can walk out through the coral zone.

DAILY TIDES

These tides are caused by the position of the moon and the rotation of the earth. A careful study of the figure below reveals the subtle differences you have just made in your model.

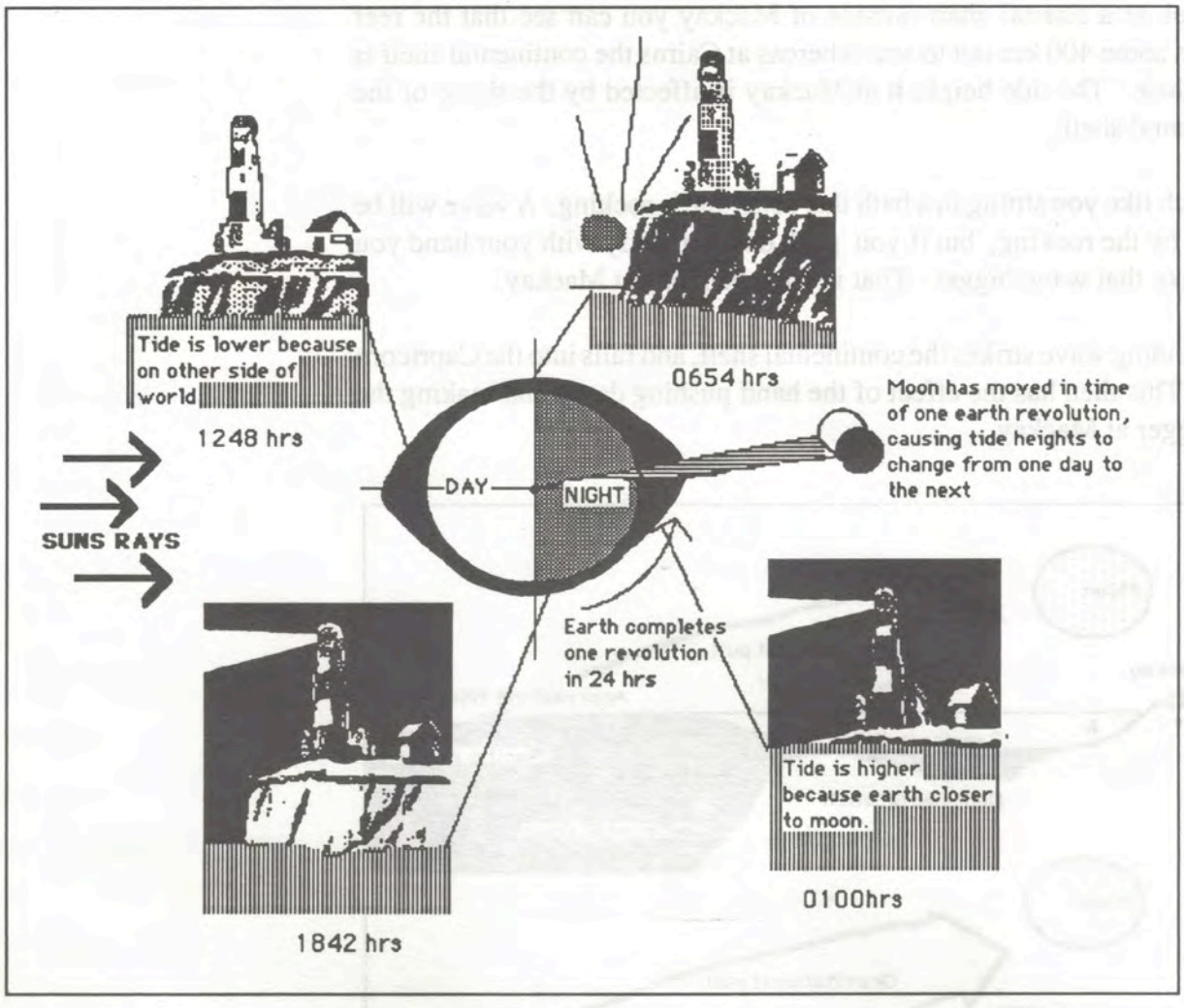


Fig 3.11 The causes of daily tides. Can you relate this diagram to the model you have just made?

There is 5 hours and 54 minutes between tides. Study the results you obtained in your graphing experiment. You should have concluded that each height was different.

This difference in height occurs because the earth spins through two different heights of tide. One height is higher because the point above the tide is directly below the moon. The other height is caused by the earth's centrifugal force and is slightly lower. Also tides in the summer are higher during the day due to the position of the earth in its orbit around the sun.

In fact there are over 52 variables that control the tides. It is beyond the scope of this book to discuss all, however we are going to consider three more. That is the relative positions of the sun, earth and moon.

MACKAY AND CAIRNS

Let us return to the question now why are the tides at Mackay so different from those at Cairns?

The answer lies in the shape of the ocean floor off the continental shelf. If you look at a coastal chart outside of Mackay you can see that the reef extends some 400 km out to sea, whereas at Cairns the continental shelf is quite close. The tide height **h** at Mackay is affected by the shape of the continental shelf.

It's much like you sitting in a bath that someone is rocking. A wave will be caused by the rocking, but if you push down quickly with your hand you can make that wave bigger. That is what happens at Mackay.

The standing wave strikes the continental shelf, and falls into the Capricorn basin. This then has the effect of the hand pushing down and making the tide bigger at Mackay.

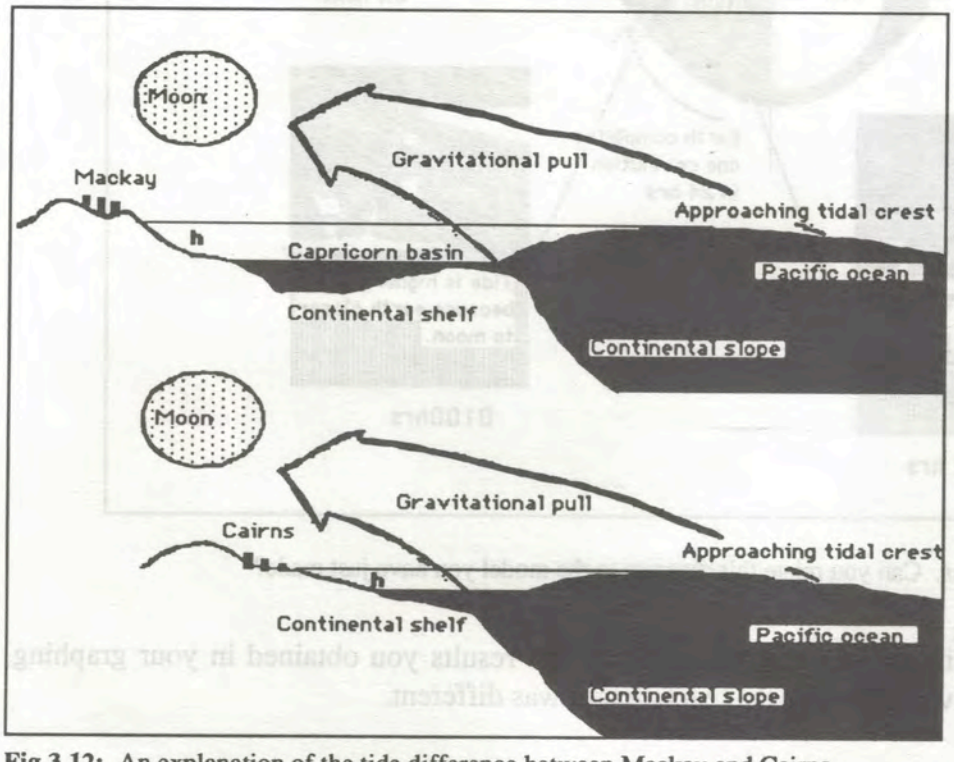


Fig 3.12: An explanation of the tide difference between Mackay and Cairns

SPRING AND NEEP TIDES

Tides also vary over the month. The next activity is designed to show you these changes.

Activity 3.2 Tides over the month

You will need

1. A sheet of graph paper
2. Appendix 3

What to do

1. Select a port from Appendix 3.
2. Study the tides for a month and plot these on a sheet of graph paper using appropriate scales.

Fig 3.13: At spring tides expose more coral than neep tides

Questions to answer

1. Which are the spring tides and which are the neep tides?
2. Read on and draw diagrams showing how spring and neep tides occur.
3. What are king tides?
4. See if you can find a tide book. Use it to see if you can answer this question; Do spring tides occur at night or during the day in summer?

You should have noticed a change in tide heights over the month.

The high points in the graph are the spring tides and the low points, the neep tides.

These can be explained by considering the relative positions of sun, moon and earth as outlined below.

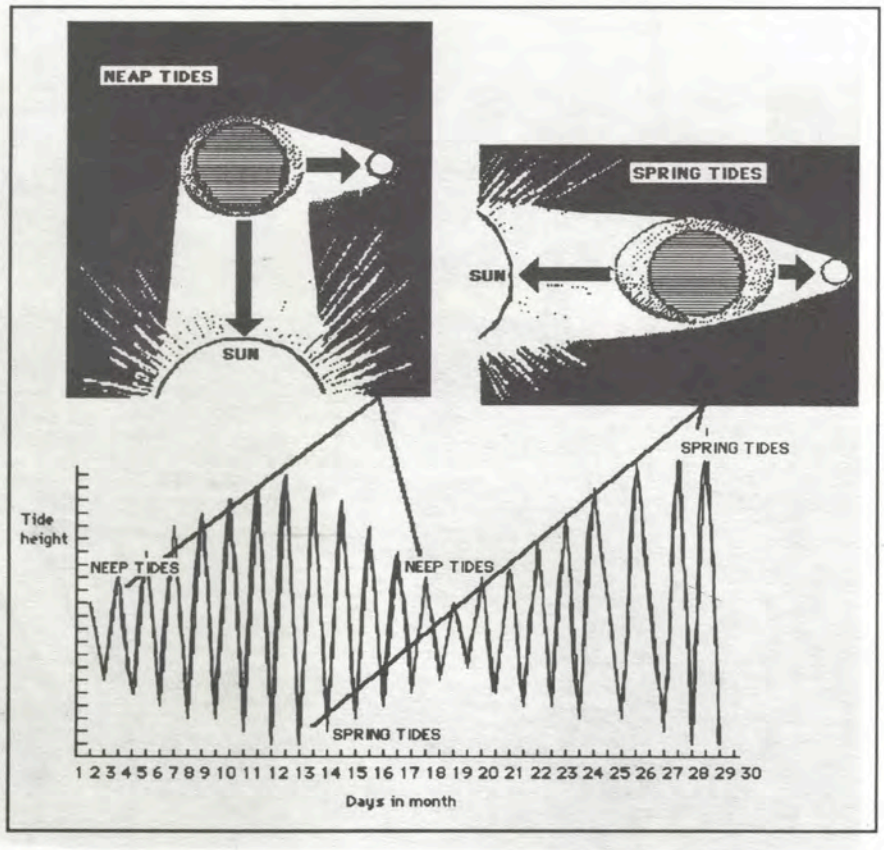


Fig 3.14: Spring tides are caused when the earth, moon and sun are in line, causing the greatest gravitational attraction. Neep tides are when the sun, moon and earth are at right angles, and the gravitational attraction tends to oppose each other.

King tides

These occur at various times of the year, when the sun, earth and moon are in positions where the greatest gravitational attraction can occur.

What you should have learned so far

1. Tides are the periodic rise and fall of the water on the earth's surface.
2. Tides are really one big wave. The wavelength is the distance between successive high tides. The crest is the high tide and the trough, the low tide.
3. Each day there is a high and low tide. The difference between the two is called the tidal range.
4. The heights of high and low tides vary because of the position of the moon, the earth and the centrifugal spin.
5. The side of the earth closest the moon has the higher high tide.
6. Tides vary over the month. The higher monthly tides are called the springs and the lower tides are called the neeps.
7. The moon takes about a month to move in an anticlockwise direction around the earth.
8. There are two springs and two neeps in each month caused by the positions of sun, moon and earth. Springs occur when the moon and the earth are in line, neeps when they are at right angles.
9. Tidal ranges vary along the length of the Barrier Reef because of the proximity of the continental slope. Mackay has a higher tidal range because of this.

Fig 3.15: Bath time as the tide comes in late in the day.

CHAPTER 4

TODAY'S REEFS

Purpose

To introduce some reef life to you and the types of reefs that are found today.

Prerequisite skills

Nil

Objectives

You should be able to:-

* describe the temperatures at which reefs grow
* list five conditions for reef growth
* recall the three main classifications for reefs
* appreciate that not all scientists adhere to the same classification system
* draw the position of a ribbon reef in relation to the ocean
* draw a cross section of a patch reef defining the following terms:- reef crest, lagoon, fossil reef, leeward and windward sides
* construct a model of a patch reef from a contour map showing the following:- high tide, low tide, reef front, reef crest, reef flat, bommies, inshore gutter, beach, coral cay, lagoon, high and low energy zones.

Basic Equipment required per group

* materials from appendix
* graph paper
* paper clip, tape, colouring pencils
* Reef Note on Fringing Reefs

Time required

2 weeks

REEFS TODAY

There are other Barrier Reefs in Australia.

The tropical region where warm waters are suitable for reef growth extends from south of the Abrolhos Islands in Western Australia, to central New South Wales. In fact the reefs off Western Australia are equal to if not surpassing those in Queensland. Look at Maxwell's map of the marine regions of Australia below. Can you predict where Barrier Reefs can form in Western Australia.

The Great Barrier Reef is not a single structure and should not really be called a "barrier reef".

In the north, on the edge of the shelf, chains of offshore reefs form a more or less continuous wall parallel to the Queensland coast. Elsewhere, inside these and to the south, reefs occur mainly as isolated offshore structures separated by large bodies of open water.

WHERE REEFS GROW

Australian coastal waters have been divided into a number of regions.

We are looking at life in the tropical waters of the Australian coast; a scene that is dominated by reef building organisms that flourish in clear, rapidly circulating water where the average sea temperature of the coolest month is not lower than 22°C.

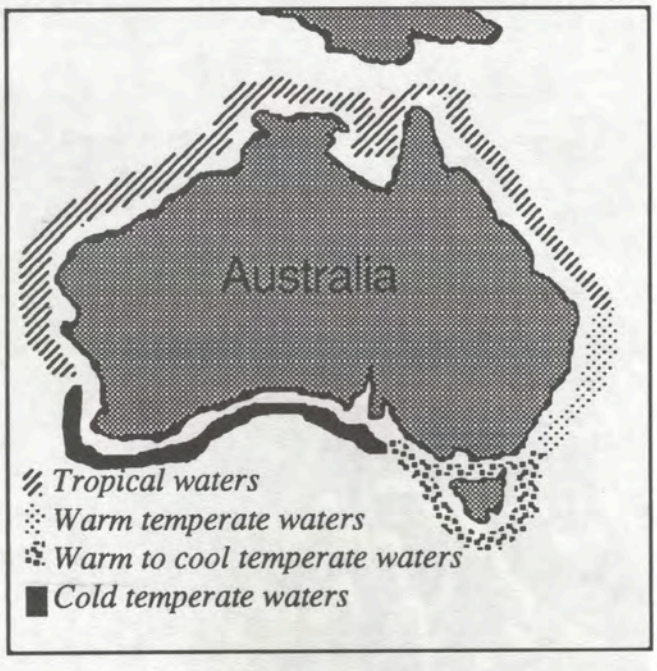


Fig: 4.1 The marine regions of the Australian coast (after Maxwell)

A reef begins to form when a shallow area of the sea floor can provide suitable conditions to encourage and support benthic plant and animal colonization. Such conditions include the presence of a solid surface that is free from excessive mud and sand. Sea water must be relatively clear, warm, and shallow, having sufficent movement to circulate oxygen and plankton amongst the colonizing organisms. These plants and animals grow upwards and outwards. They eventually die. Their skeletons and shells are cemented together by the calcareous algae.

There are many factors, such as tides, water clarity, waves, currents and salinity that affect marine organisms. Sea temperature is one of the most important factors that control where reef organisms are found.

On the Great Barrier Reef, coral extends from or near the surface of the water down to about 50 metres. Most of it is in the upper 30 metres. Some species are characteristic of shallow water and others of the deeper regions. The presence or absence of reefs may be influenced by mainland rivers. Such rivers alter the salinity of water adjacent to the coast and may affect corals locally that way. Also of importance is the load of silt that rivers carry.

Corals are sensitive to particles that are found in the water. These particles reduce the water clarity and deposit silt on the coral colonies. Other requirements of a reef include sufficient oxygen for sustaining life from the zooxanthellae (see chapter 1), and carbonates from which to construct the coral skeleton.

Supply of these carbonates depends in part on patterns of water circulation and aeration which is promoted by surf action.

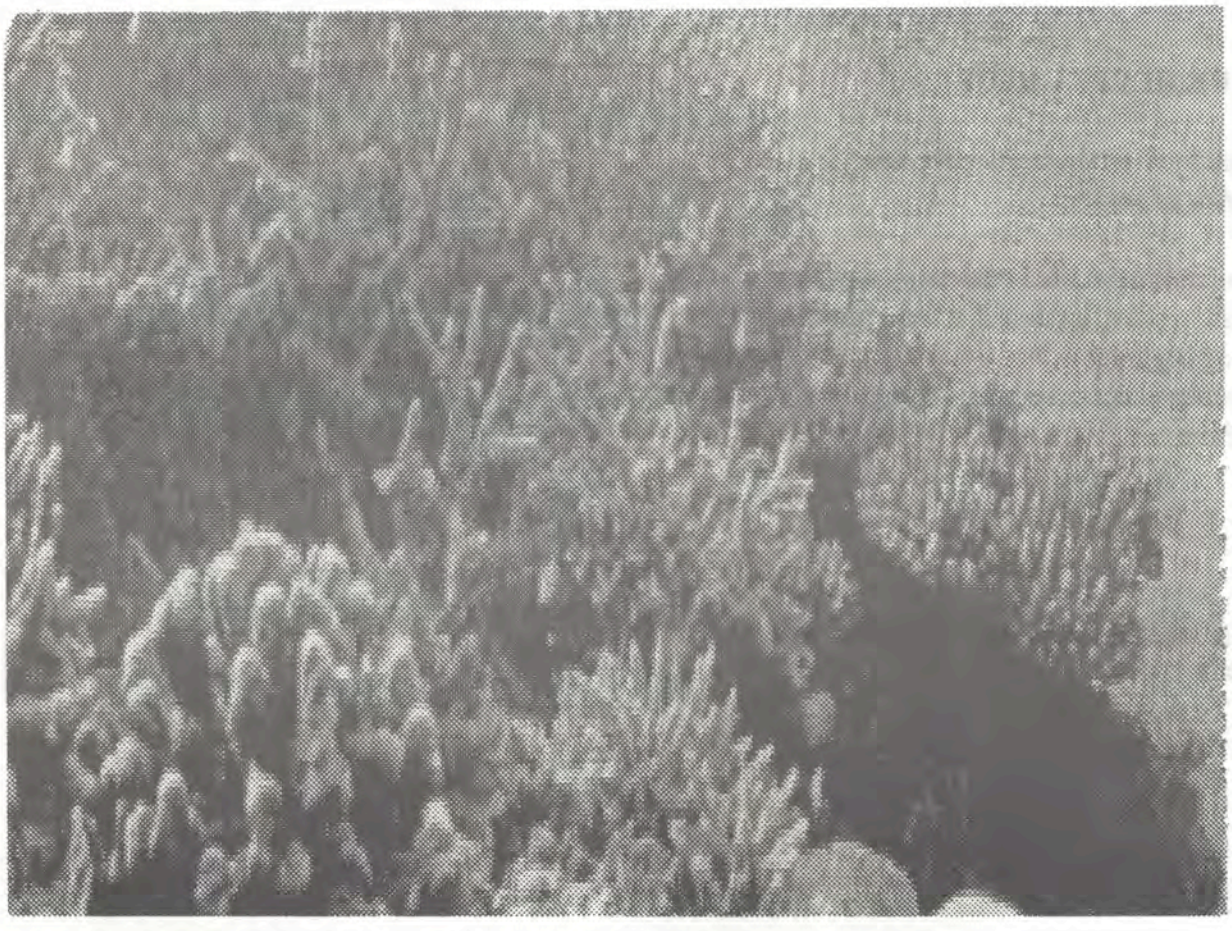


Fig 4.2 : The growth of a reef depends on many factors.

The figure below shows the distribution of coral reefs worldwide. What is an isotherm and between which isotherms do coral reefs grow?

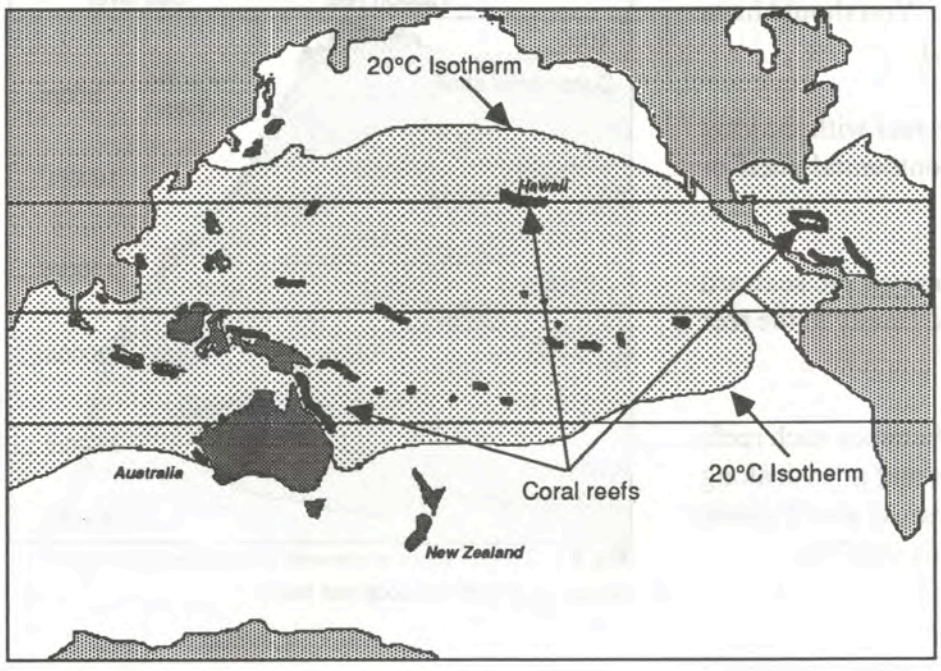


Fig 4.3: The coral reefs of the world are found within distinct isotherms

CORAL REEFS

Coral reefs have been divided into two major categories. The first comprise the oceanic reefs which are found in the open ocean in the shallow water on the top of old submerged mountain tops. The second includes the shelf reefs which occur in relatively shallow water on continental shelves. Since the Great Barrier Reef occurs on the Queensland shelf we will examine shelf reefs first. The separation of reefs into different types is based on shape, central structure (e.g. development of a lagoon), general zonation and their location on the continental shelf.

As you discovered last chapter the reefs of the Great Barrier Reef can be separated into three main types*:

1. Ribbon reefs occurring near the seaward margin of the shelf.
2. Patch reefs, which comprise the majority of reefs, have an oval shape and lie between the continental shelf and the mainland.
3. Fringing reefs that are found growing out from the shores of continental islands and the mainland.

* A lot of scientists disagree about the actual names of reefs. This is quite common among the scientific community. You may hear different names for these reefs, but for the purpose of this course the names. **Ribbon, patch and fringing will be used.**

Ribbon reefs

Ribbon reefs are found in the northern section of the Great Barrier Reef where the continental shelf is close to the mainland. You should have discovered this in Activity 2.1.

A ribbon reef is an elongated reef with the long axis along the edge of the continental shelf or coast line.

The reef front and algal rim are on the seaward side, grading into reef flat and finally to the reef back on the leeward side.

Water flowing through gaps between such reefs brings nutrients and promotes reef growth along the borders of such passages. It was Captain Cook who first discovered this in 1770.

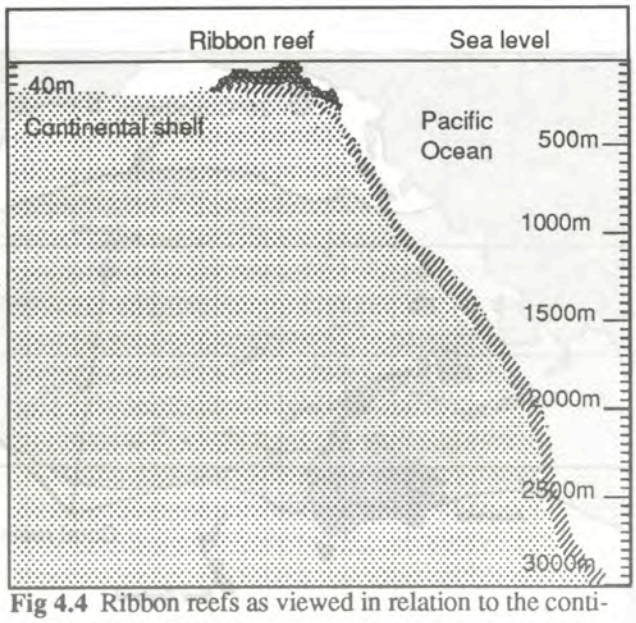


Fig 4.4 Ribbon reefs as viewed in relation to the continental shelf and the deep sea basin

These reefs form a wall-like structure which takes the full battering force of big waves of the Pacific Ocean.

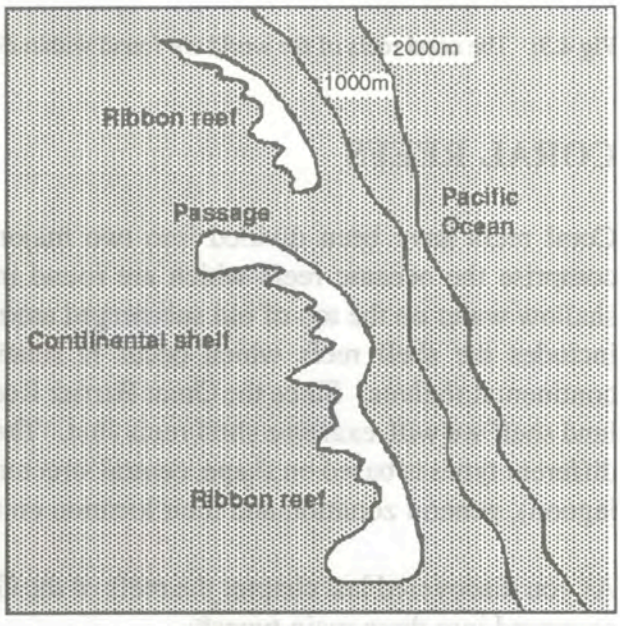


Fig 4.5 Ribbon reefs showing the shape and ocean contours

Fig 4.6 Ribbon reefs Nos 2 and 3 off Cairns. Photo courtesy Great Barrier Reef Marine Park Authority.

Patch reefs

Lady Musgrave Island off Bundaberg is an example of a patch reef.

These reefs form in mid shelf areas usually with distinct windward and leeward sides. Growth can occur equally in almost any direction (except up).

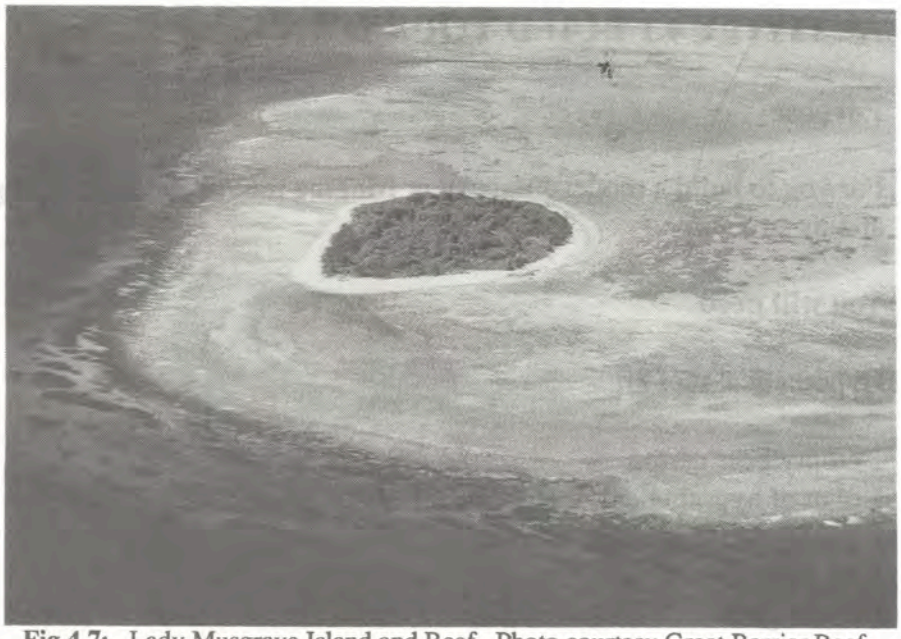


Fig 4.7: Lady Musgrave Island and Reef. Photo courtesy Great Barrier Reef Marine Park Authority

With continued enlargement, the central part of the reef becomes more sheltered from the surf and wave action which is essential for the aeration and nutrition of the corals and algae of the reef face and algal rim.

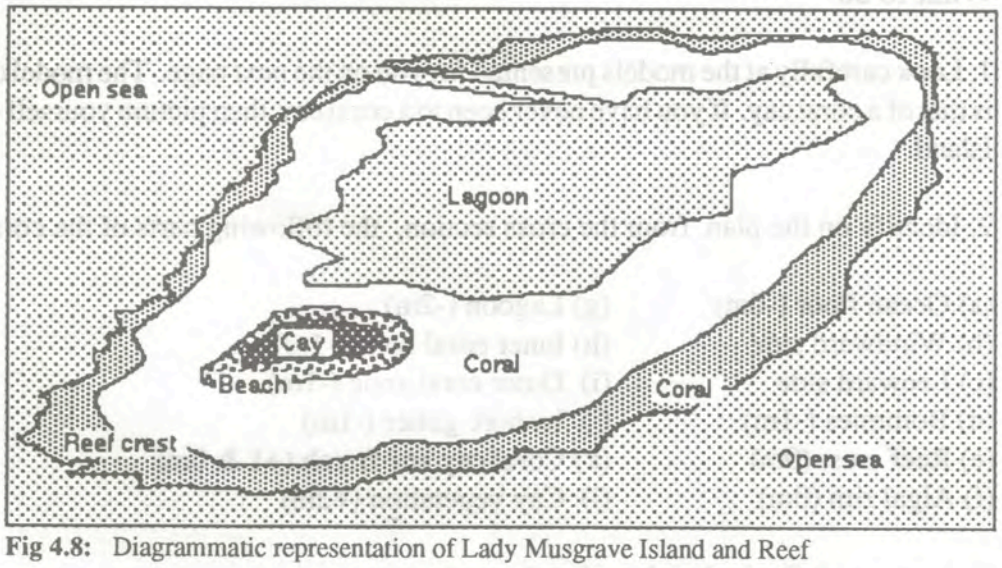


Fig 4.8: Diagrammatic representation of Lady Musgrave Island and Reef

Much coral dies and there is a general deterioration of the central area.

The formation of a lagoon can occur with the subsequent growth of patch reefs composed of corals which can tolerate the quieter lagoonal conditions.

Many patch reefs have shallow water lagoons in the centre and some support coral islands.

But what do these patch reefs really look like?

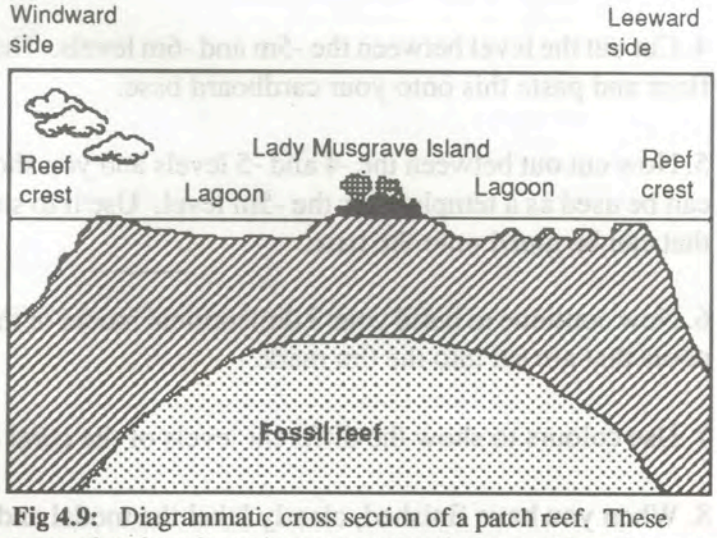


Fig 4.9: Diagrammatic cross section of a patch reef. These types of reef are found in more sheltered areas and have lagoons

ACTIVITY 4.1 BUILD YOUR OWN REEF

Purpose

For you to build a model coral cay or fringing reef to understand its geological history and its structure

You will need

Hypothetical reef kit:

1 empty beer carton
1 plan of hypothetical reef (appendix)
1 stanley knife or sharp scissors
1 tin paint
1 bottle glue

What to do

1. Look carefully at the models presented for you on the next page. The model described is that of a coral cay. If you have never been to a coral cay, then picture yourself on Heron Island.

2. Identify on the plan, from the cross section, the following parts of the coral cay

(a) Ocean floor (-6m)
(b) Windward side
(c) Leeward side
(d) Bommies (-1m)
(e) Reef crest (0m)
(f) Algal rim (0m)
(g) Lagoon (-2m)
(h) Inner coral zone (-1m)
(i) Outer coral zone (-1m)
(j) Inshore gutter (-1m)
(k) Coral cay and beach (+1 & 0m)
(l) Cay vegetation (+2m)

3. Note carefully the heights of each section.

4. Cut out the level between the -5m and -6m levels. The -6m level represents the ocean floor and paste this onto your cardboard base.

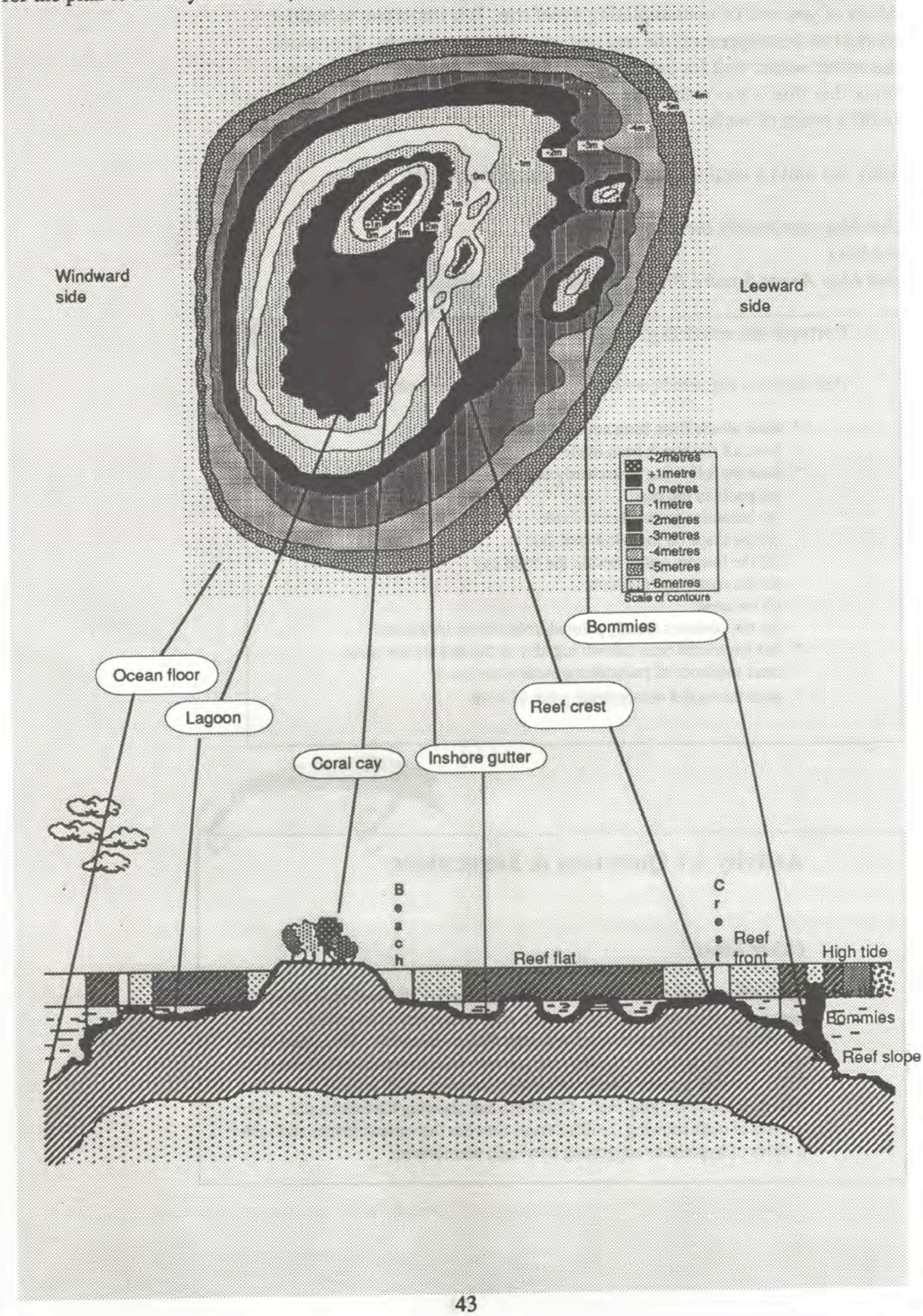
5. Now cut out between the -4 and -5 levels and you should be left with a thin strip that can be used as a template for the -5m level. Use it to shape another piece of cardboard that can be glued onto the base.

6. Now continue to build your 3 dimentional model of the coral cay. Note that there are pools that are set into the 0m mark.

7. Use colours to show the different levels of the coral cay.

8. When you have finished, clearly label the model and hand it in for marking.

SCALE MODEL OF HYPOTHETICAL REEF (Use the copyright free pages in the Appendix for the plan to make your model)

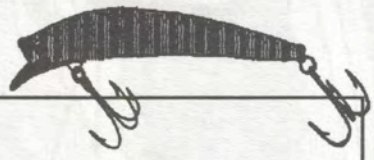


Note to teachers:

Many of you will be contemplating a reef trip. It is important to build a model that best represents the reef that you are going to study. The model described works well for patch reefs with coral cays on them. You may think that this is too restrictive so you could design a class activity to build a series of reefs.

Why not build a section of reef from aerial photographs.

Sun Map can supply these:
Address:
Sun Map Anzac Square Brisbane 4000



Criteria for marking:

Here are some suggested questions for you to discuss as a class.

* have all the lines been cut out precisely?
* have all the levels been made correctly?
* have the following been clearly and accurately presented in the model?
  (a) pools in the crest
  (b) bommies on the leeward side
  (c) the slope on the windward side
  (d) the inshore gutter beside the coral cay
  (e) the coral cays position
  (f) the crest
  (g) the contours clearly painted, coloured or identified
* has the model been thrown together at the last minute or is there evidence of painstaking meticulous work
* does the model demonstrate pride in work

Activity 4.1 Questions & Suggestions

Other Ideas:

Each class has its own ideas on standards, however the following should be discussed prior to or during the time used to construct the model. Some students may wish to construct or design their own models. This could be an alternative assignment. In this case you may wish to consider the following: Make a model atoll or a series of models showing atoll formation. Make a ribbon, patch or fringing reef. Cut one in half showing the fossil reefs. Make a series of reefs showing the differences between the various shapes and write a series of hypothesis suggesting how each was formed.

Questions to answer on model

1. Is this model a patch, ribbon or fringing reef?
2. At what depth is the reef crest and what do you think it would look like?
3. Where are the pools located and how do you think they got there?
4. Where is low tide and high tide on the model? Why?
5. What will grow on the coral cay?
6. Is any one side steeper than the other? Why?
7. Where will sand accumulate in the model and why?
8. Where is the windward side? Give reasons for your answer?
9. Where will the tallest trees grow on the coral cay. Why?
10. If the prevailing winds are south-east, which is north, south east and west on the model. Give reasons for your answer.

Your report should include the following:

1. The model itself with labels stuck on in the correct places (do not use pins)
2. The answers to the above questions.
3. A cross-sectional view of the model showing the depths.

Fringing reefs

These can be found growing around continental islands or along mainland shores. A continental island is really an underwater mountain with its peak above the sea's surface. Corals and marine plants (algae) may settle and grow in the shallow waters round the peak, forming a fringing reef.

Fig 4.10 Diagrammatic section of a fringing reef. Photo courtesy Great Barrier Reef Marine Park Authority.

Of the three main types of reef, the fringing reef is most susceptible to rainfall due to its close proximity to the continent.

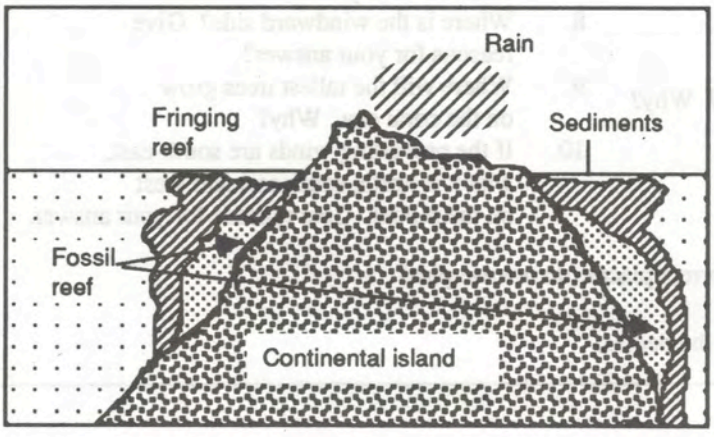


Fig 4.11 Diagrammatic section of a fringing reef

Activity 4.2 Analysis of Fringing reef photographs

You will need per group

A copy of the brochure "Fringing Reefs"

What to do

1. Make a careful outline copy of the island and reef on the first page.

2. Now use your coloured pencils to shade in the following reef zones
   * continental island
   * beach
   * inner lagoon
   * inner coral zone
   * reef crest (where the waves are breaking)
   * open sea

3. Read the first page and then make a list of three places where fringing reefs are found.

4. Now turn the page and look at the second photo of Nara Inlet. In which group of Islands is this? Can you see the fringing reef just beside the land in light blue? Do you think this is affected by tides?

5. Look at the photo top left page 3. Describe what you see.

6. Read the section on management and recall how reefs are affected by silt.

7. What are microattols and where are they found? What does a geomorphologist do?

Atolls

An atoll is a series of coral reefs which belong to the other category of coral reefs -the oceanic reefs. Atolls are roughly circular in shape often projecting above the sea's surface. Commonly they consist of a ring of islands on reefs surrounding a shallow lagoon.

Charles Darwin proposed the first acceptable theory of how atolls were formed. He said they started when corals grew around the edge of an island, forming a fringing reef. Then the land began to sink slowly, but the corals, growing upwards, were able to build up and maintain themselves in near-optimum conditions close to the surface. The land continued to submerge, the corals surviving but always doing best on the outer side.

Overcrowding and lack of sufficient food and sunlight gradually retarded the growth of corals inside the ring forming the lagoon. Eventually only a small part of the island remained, surrounded by a lagoon and an offshore, or barrier reef. In time the land sank beneath the sea, leaving only the ring of coral , an atoll. It has been suggested that all atolls were formed much in this matter, either by the sinking of the bottom or the rising of the sea level.

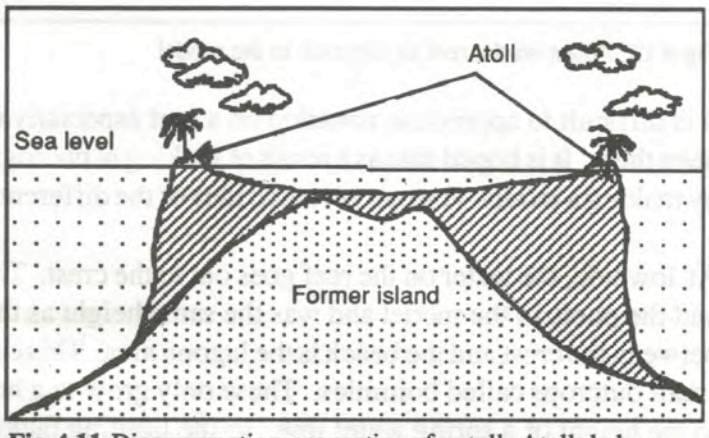
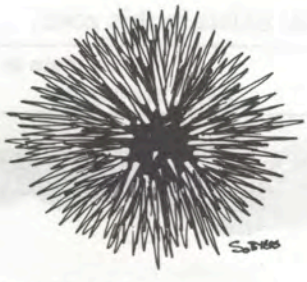


Fig 4.11 Diagrammatic cross section of a atoll. Atolls belong to the second group of coral reefs called oceanic reefs.

You have learnt so far that:-



1. Reef growth is affected by:
   * Temperature
   * Living organisms
   * Water clarity
   * Salinity.
2. There are over 2,900 individual reefs occuping approximately 2000 kilometres.
3. Corals grow between the 20°C isotherm.
4. Most coral growth occurs at depths of less than 30 metres.
5. The three main types of reef are ribbon, patch and fringing.
6. Fringing reefs are found growing out from the shores of continental islands and the mainland.
7. Patch reefs generally lie between the continental shelf and the mainland.

Zones in the reef

Let us return to the question of the model reef and cross-section you have made.

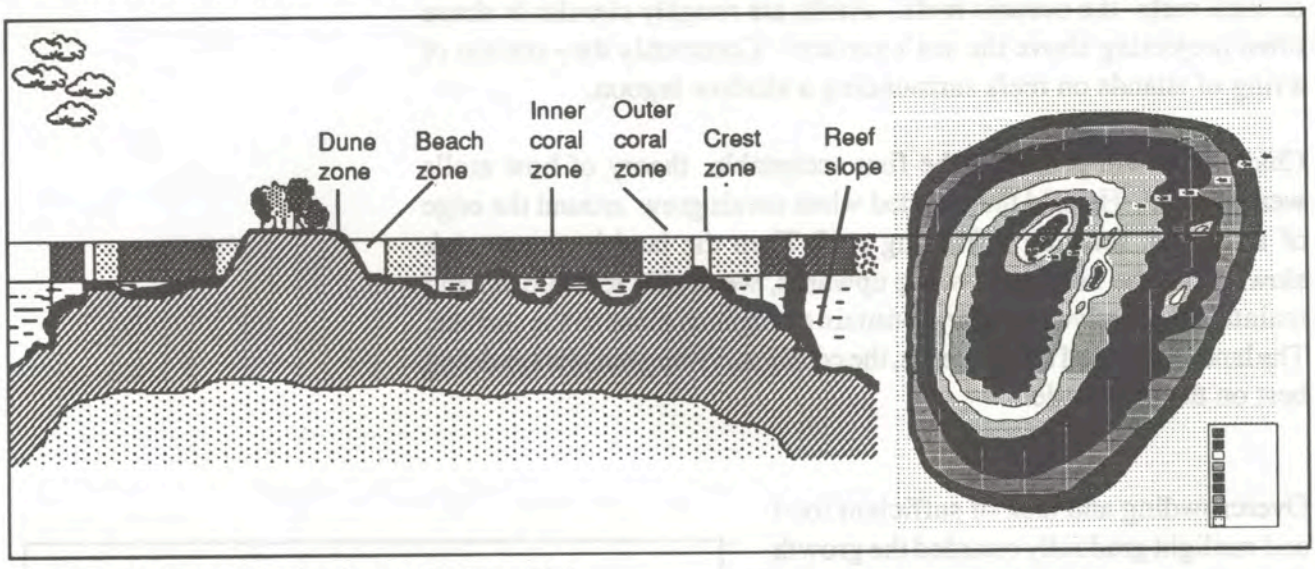


Fig 4.12 Zones on the reef as depicted in the model

It is difficult to appreciate zonation on a reef especially if you have never been there. It is hoped that as a result of looking at photographs, videos and by making a model, you can get some idea of the different areas on the reef.

At low tide, the water on the reef goes out to the crest. That is the area that had the pools in the model and was the same height as the beach. Now in between the crest and the beach is the lagoon area. This contains corals and small outcrops called bommies. These only grow to a height that is equal to the height of a spring water low, so the limiting factor in coral growth is water. An abundance of lifeforms exist and thanks to Sea World on Queensland's Gold Coast for permission to use their Project Neptune illustrations, the images below are but a small sample of the diversity of life that exists in this zone.

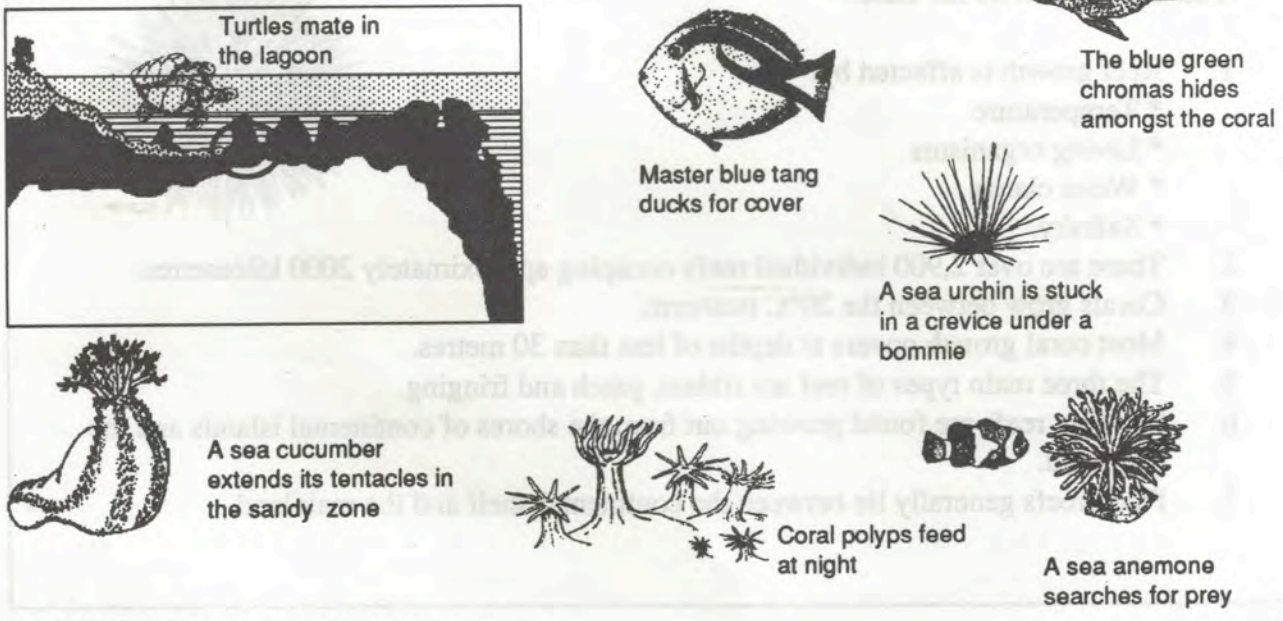


Fig 4.13 Some life forms on the inner coral zone
Illustrations from Sea Worlds Project Neptune

The crest is a different story. It is the same height as the beach and is exposed at low tide. A hard mat of algae covers it, cementing the small coral outgrowth into a pavement-like roadway. At low tide very little can be found apart from the odd starfish and crab, however with the rise of the tide, fish from all quarters come to feed.

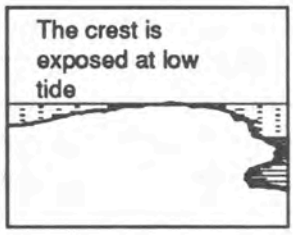


Fig 4.14 The crest

The most spectacular are the parrot fish which bite and gnaw at this algae.

Fig 4.15 The reef crest at low tide. This gets covered at high tide and is where the parrot fish feed.

The crest is a place of contrasts. At low tide almost bare, at high tide full of activity. With increased activity come the predators of the reef. Small sharks can feed here with the change in tide. It is a place where you can see a food chain in action viz; algae, parrot fish, shark, decomposers and cleaner fish.

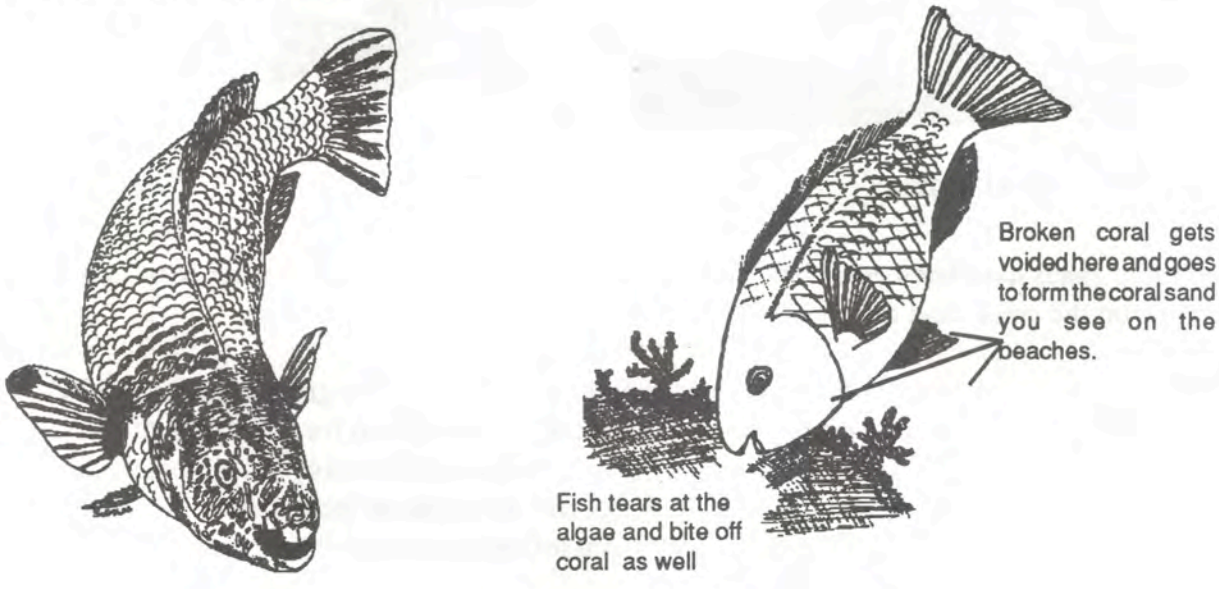


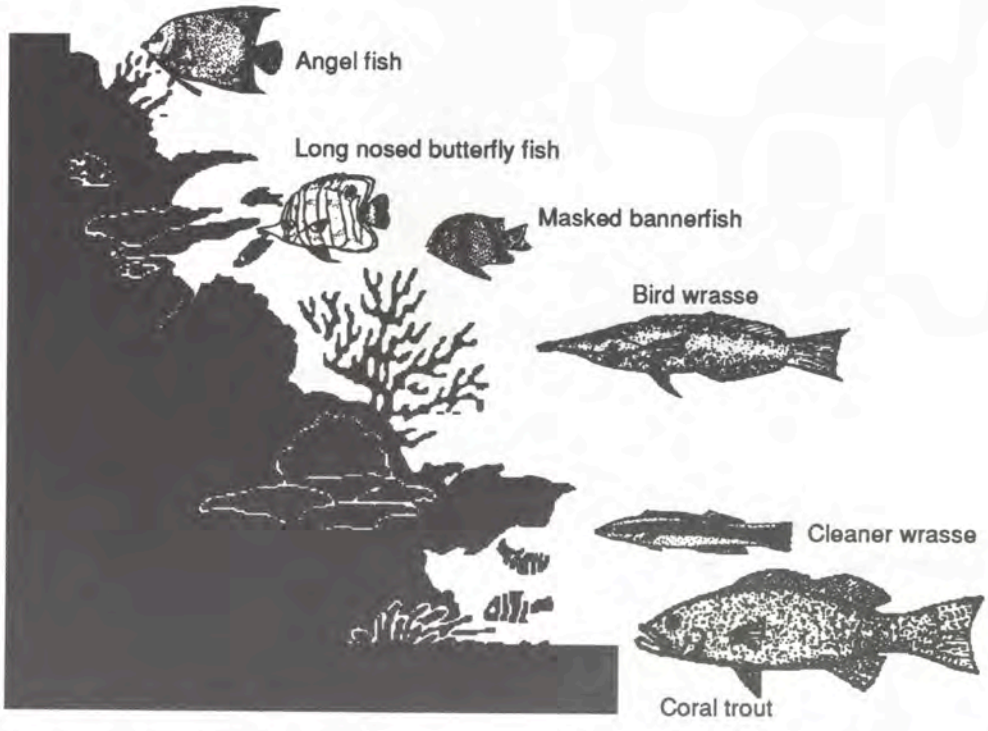
Fig 4.16 Parrot fish actively feed off the crest at high tide. Note how the mouth of the fish has been modified to bite at the algal turf on the crest.

Let 's go over the crest and onto the reef slope. Imagine yourself snorkelling down over and around those bommies you so carefully cut and pasted down. On your model that was between the 2 and 6 metre mark. The reef slope holds some of the most diverse forms of life imaginable. Basked in warm sunshine and protected by an incredible number of rocky outcrops, lies the world of just about everything.

Barramundi cod lurk under coral outgrowths, blue tangs gnaw at the algae, fish set up cleaner stations where the cleaner wrasse pick off parasites from the fish's flesh. Many fish set up territories and spend the day chasing others off.

Beaked coral fish pick at bits and pieces in the coral and a broadbarred pufferfish darts in and out of the coral overhangs.

Tucked into a crevice the moray eel waits for passing prey. The diversity of life is amazing.



Life in the coral zones

Four main zones have been established on the reef. These are the inner and outer coral zone, the zone on the crest, and the zone as the reef slopes away to the ocean floor.

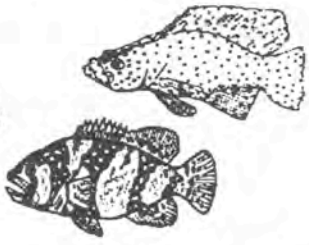
The main controlling factor is the tide, and the heights to which corals grow is controlled by the height of the water that covers the polyps. If the corals are exposed for any length of time, the animal will dry out. If waves crash down they will break, and if rivers push silt out to sea, they will be choked by mud, and if a flock of parrot fish descends on them they will be eaten to bits. So there is a series of secondary factors that influences where these corals grow and some of these are:-

(a) waves (c) silt
(b) predators (d) heat and light.

The living controlling factors are called biotic factors and the Non living forces are Abiotic factors. It is a combination of these two that controls life on the reef.

An organism's shape, size, reproduction, distribution and abundance are all controlled by the Biotic and Abiotic factors. How an organism changes in the light of these factors is called its adaptations.

This section looks at some abiotic and biotic factors on the reef, and discusses some of the adaptations animals and plants have made to cope with these changes. If you are lucky enough to visit the reef then you will be able to see at first-hand, these adaptations. One of the really nice things about the study of the reef, is to marvel at how these features have occurred. But first let's see if you can come up with some ideas.



Activity 4.2 Reef adaptations to limiting factors

You will need

Some colour slides of reef animals, or some books with photos of reef animals and plants, or a series of reef note pamphlets produced by the Great Barrier Reef Marine Park Authority.

What to do

Select a photograph of a reef organism in a reef scene under water. You are going to make a list of abiotic and biotic factors that you can think of, from the photograph, and then beside each, make a second list of adaptations.

Well, that is one way, but how about making some **flash** cards and getting the whole class involved. Divide into groups, have one group come up with the photo flash cards, one with biotic and abiotic flash cards, and the other with adaptation flash cards.

Now take turns to flash the cards at each other and see who is the quickest to match cards.

Begin with a walk out to the crest from the beach.

Most of the beach zone is covered with sand, pieces of broken shells, and the odd crab or two. Small pieces of coral outgrowth begin to appear and a long-slug like animal, called a sea cucumber is one of the first animals you will meet.

Fig 4.15 : A sea cucumber is like a long sea slug that lives in the inner coral zone.

The tentacles are used for feeding and contain a sticky mucous which traps sand and the dead remains of animals and plants. In some species, the tentacles are gently stuffed into the mouth one at a time and wiped clean. The sand and food pass into the digestive system and then clean sand is excreted as waste. In this way the sea cucumber literally vacuum cleans the reef. Some scientists have estimated that a individual sea cucumber can process 100 grams a day. The tentacles, hard leathery skin and uninviting appearance are some of the adaptations that help this animal survive in a hot shallow pool.

If you find a shallow pool and go for a snorkel on your stomach, and look carefully, you should find another two animals.

The goby and the schrimp

In this relationship is between two animals that share a burrow in the sand. A burrow provides a home to raise the young, protection from predators and a place to rest.

The shrimp digs the burrow because it has specialized hands called appendages which can dig the burrow.

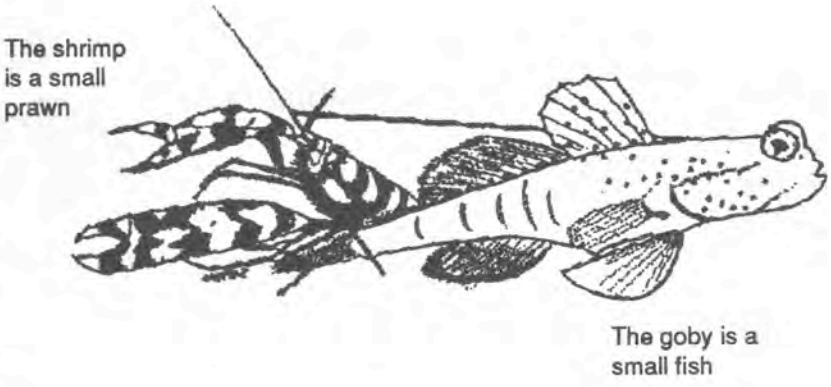


Fig 4.16 The goby and the shrimp both live together and benefit from the relationship.

If you look carefully you can see sand coming out of the burrow. The shrimp will appear and then go back in. Then the goby will occupy the mouth of the burrow, catch food and take it back in for the both to share. Literally they eat off the same table and share the same food. This relationship is called **symbiosis and is a behaviour adaptation.** Walk a bit further and see another.

The anemone and clownfish

You are now in the outer coral zone. It is now more difficult to walk and you have this guilty feeling you are breaking off coral that has taken hundreds of years to grow.

You find a coral clump and tucked away in one corner you see a number of small, brightly coloured fish.

A closer examination reveals that they are living in a big flower that you find is called an anemone, which is an animal and closely related to the coral you studied in chapter 1.

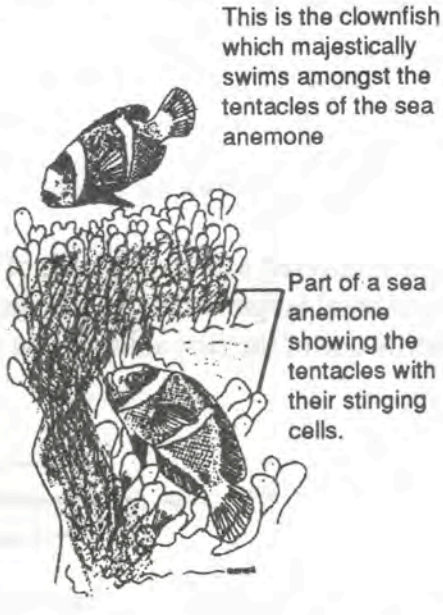


Fig 4.17 The anemone and the clownfish.

A sea anemone is a coelenterate which you studied in chapter one. This animal has a hollow stomach which acts as a mouth and anus, so it has to have a base to anchor itself to the reef.

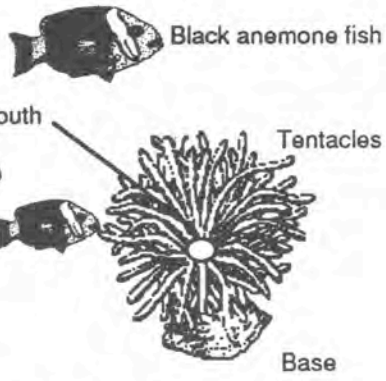


Fig 4.18 A sea anemone with its fish.

The tentacles are armed with rows of stinging cells which kill the prey on contact. The tentacles then stuff the food into their coelenteron where it is digested. These are structural adaptations.

What prevents the fish from dying? The answer lies in the skin which is covered with a mucous that in part protects the animal from being stung, but allows a controlled stinging to occur.

If you are lucky enough to go to Sea World or to any aquarium that has these fish, look carefully at the way the fish behave. You can see how they swim into the tentacles, get stung and then swim out. This process has been called acclimitization and is a behavioural adaptation developed by this species of fish. By becoming progressively stung the animal gains a certain amount of immunity to the stinging cells.

Now both will benefit from symbiosis as follows:-

(a) the fish attracts the food to the anemone who stings it to death or slows it down. The fish would do the rest if it survived.
(b) the fish then chews at the prey and some bits fall into the anemones mouth or are taken in by the tentacles. This way they are partly digested.

Both are again eating off the same table. At low tide there is a problem. The pool that the animals live in dries up or gets so shallow that it heats up. How do you think the animals will cope?

Discussion point

Copy the illustration below :-

(1) Colour it in and suggest reasons for the colours you have used.
(2) What would be the purpose of the spike at the top of the head?
(3) The tail is round and the fins are small. Does this fish swim fast or slow ?
(4) The fish is about 120mm long. Where do you think it would live?
(5) List one behavioural and one structural adaptation.
(6) List one biotic and one abiotic feature that would have contributed to the shape of this fish.

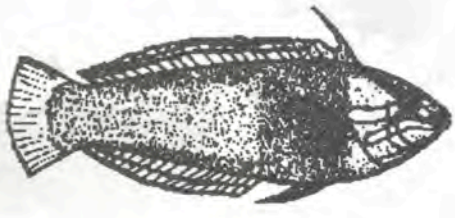


Fig 4.19 Gramards wrasse.

You have now reached the crest and discovered numerous other animals and plants too numerous to mention in this book. The tide is out and the algal turf is exposed to strong sunlight. Waves are breaking over the crest and a most important event is taking place.

Show the video Reef Report 3/87 with the section on purifying sea water.

Watch the video on algal turf scrubbing at the Great Barrier Reef Marine Park Authority Aquarium developed by the Smithsonian Institute.

The video is a good example of how a natural system has been recreated in a closed system. The reef aquarium is one of the first in the world to use such a process.

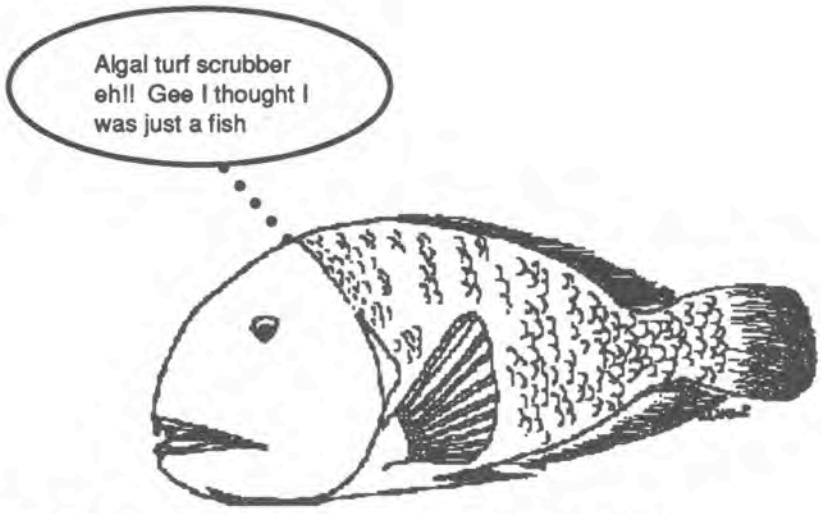


Fig 4.20 Tuskfish also remove the algae from the reef crest.

On the reef, the tuskfish and parrot fish were responsible for removing the algae, but how was it done in the video? But what is the role of this algae?

During high tide the activities of all reef animals produce waste products which dissolve in water. The same is true in an aquarium and there must be some means by which the water is cleaned. We learned that the vacuum cleaning was done by the sea cucumbers, we now learn that the sterilizing is done by the the algae. They purify the water by taking in the waste products and converting them into food so they can grow. The chemicals now are harmless to the fish that graze on them.

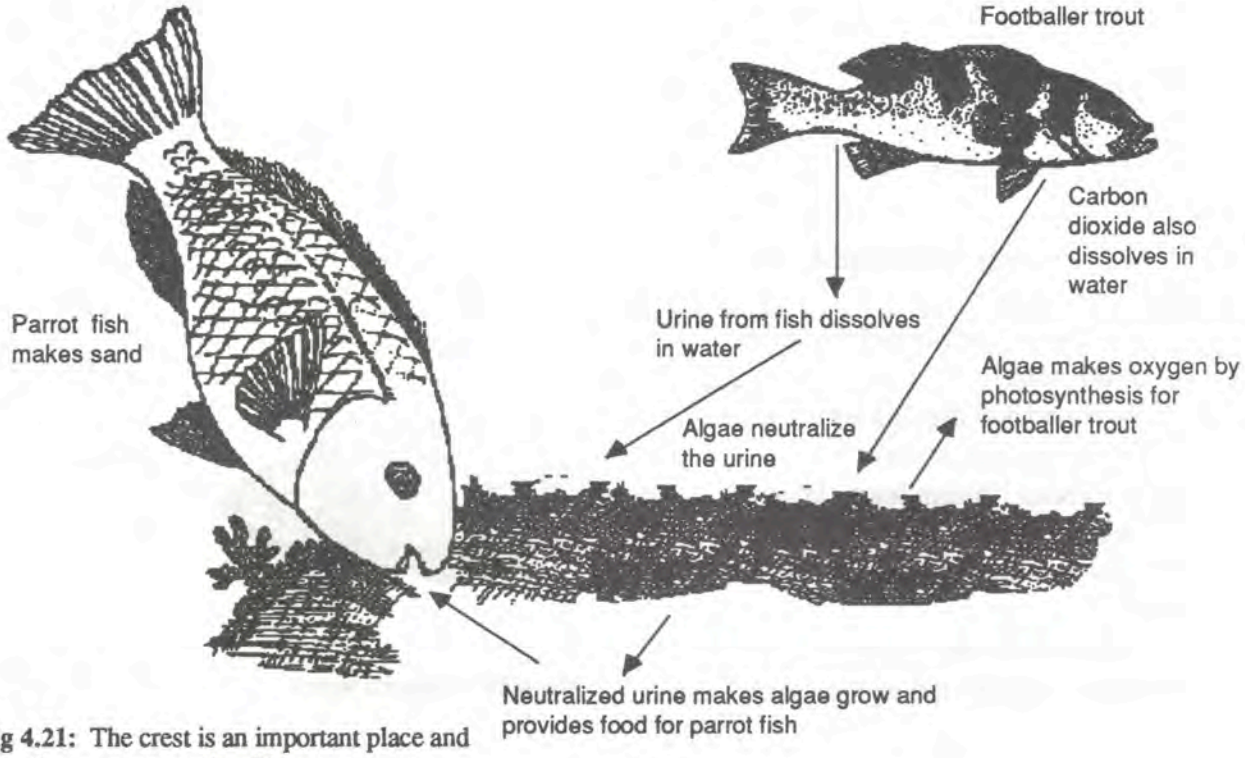


Fig 4.21: The crest is an important place and into history goes another idea.

The crest is an important place. Here some oxygen and coral sand are made, water purified and food chains established.

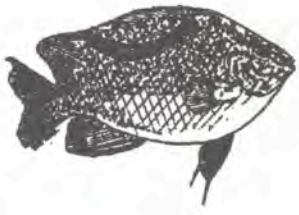
Put on some snorkelling gear and go diving down the reef slope.

It becomes obvious that the world is full of life and the diversity is immense. A close look at a piece of coral reveals a colony of tube worms. A touch and they retract into the coral. These clear the table by living off the dead remains of prey from above.

Fig 4.22: Christmas tree worms are filter feeders extracting food that floats down from above and gets caught in the spirals. They process the left-overs.

A group of fish wait around a coral bommie. These were the mounds you built rising from the floor on your model. A long blue striped fish is seen darting around, picking at the flesh of the fish.

You are looking at a cleaner station.



A fish waits to be cleaned by a cleaner wrasse.

Cleaner wrasse are fish that don't get eaten by others because the other fish have learned that these fish will clean parasites off their skin and gills

Fig 4.23: Cleaner wrasse and their fish.

A cod and cleaner wrasse. The cod comes to a cleaner station to have the parasites cleaned off by the cleaner fish

The diversity of life increses. Fish abound under crevices, in between coral and it seems like the Garden of Eden. One reason is the protection provided by the water. Temperature is constant and light abounds. Wave action is minimal and this area is a low energy area compared with the crest.

Responsible for all this life are the tiny plankton that float in the sea.

A division of reef organisms

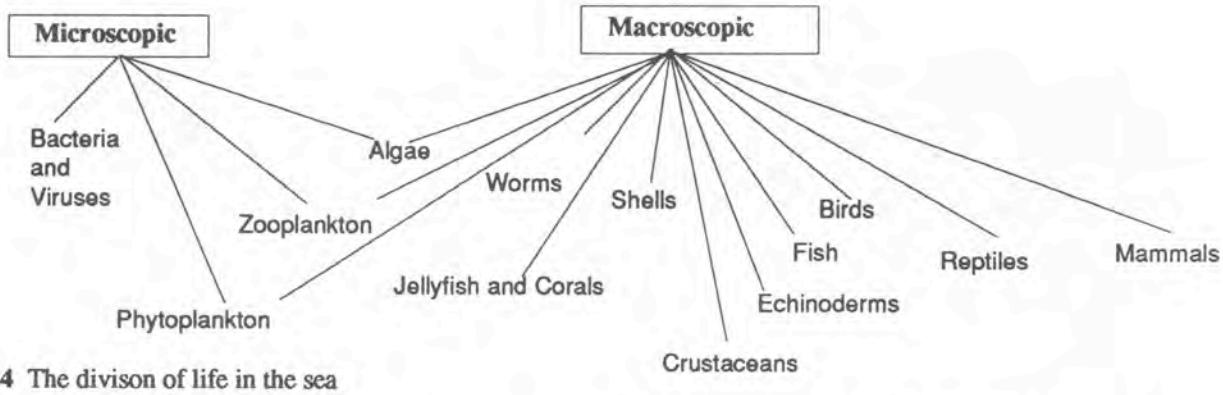


Fig 4.24 The divison of life in the sea

The diagrams below show some of the marine microscopic plankton that can be found around reefs. Plankton means floating life. Plankton forms part of food chains for everything in the sea and over ninety percent of people who use the sea never know it is there, let alone see it.

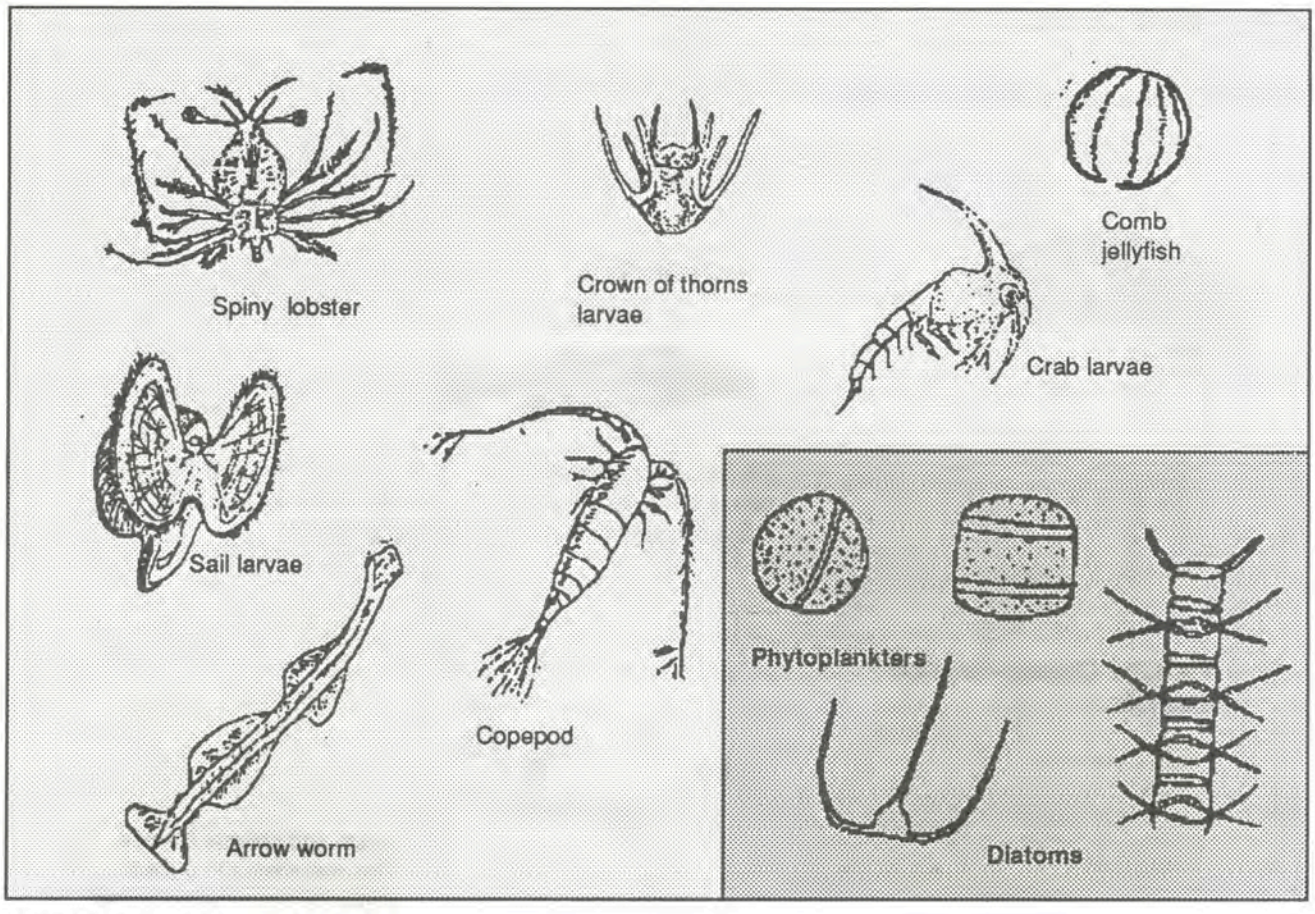


Fig 4.25: Some microscopic plankton

Activity 4.3 Reef Plankton

Purpose:

To prepare a wet microscope mount of some reef plankton, identify, draw and name a number of plankters.

You will need:

Student microsope
Reef Plankton sample
Microscope slides, cover slips and eye dropper.

What to do:

Prepare a wet mount of two drops of marine plankton, your teacher will show you how. Make line drawings of any six plankters you can see.

Some Plankton facts:

1. *Plankton* are the most abundant organisms in the oceans, the greatest proportion of which are the diatoms and dinoflagellates.

2. *Phytoplankton* are photosynthetic and provide a direct link with the sun's energy. They **are** the base of the food chain and provide much of the world's oxygen. If the phytoplankton of the sea are killed by pollution, then there is little hope for life in the sea.

3. *Zooplantkton* graze on the phytoplankton and in turn provide food for the other animals on the reef. Many of the larger reef animals' larval stages of development are in the plankton. Take the crayfish as an example.

Adults live in crevices on the reef slope and mate in spring. The male fertilizes the female and the eggs develop under the tail fan. When they have developed, the female releases them and the immature larval stages become part of the plankton for a time before maturing into the adult form and growing to maturity.

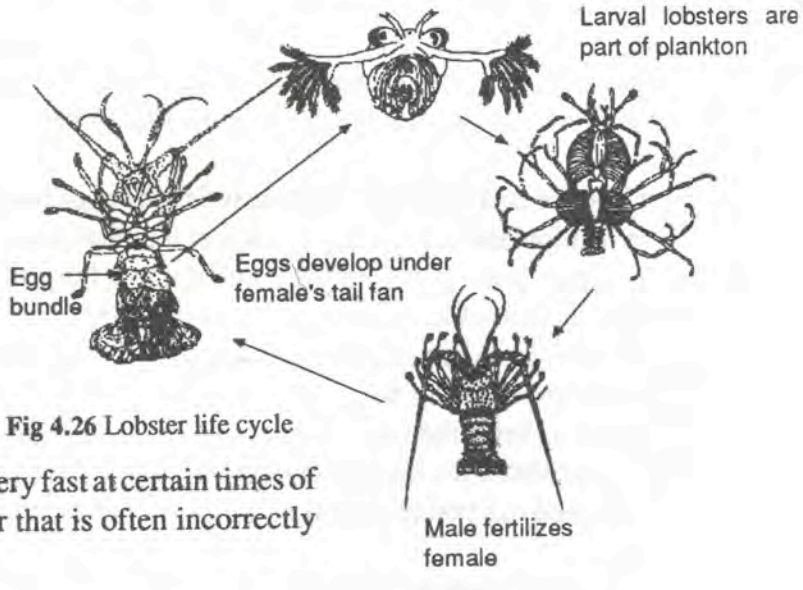


Fig 4.26 Lobster life cycle

4. Some dinoflagellates can reproduce very fast at certain times of the year to produce a scum on the water that is often incorrectly called *coral spawn*.

Summary

1. Barrier reefs today are complex structures that can grow in tropical waters in Queensland, the Northern Territory and Western Australia in areas above the 20C° isotherm.
2. The conditions necessary for reef growth are correct tides, salinity, ocean temperature and bottom substrate.
3. Three types of reefs are commonly recognised although some scientists disagree. These are patch, fringing and ribbon.
4. Ribbon reefs are found predominantly in the northern section of the Great Barrier Reef on the edge of the continental shelf, ribbon reefs around continental islands and patch reefs in the southern sections.
5. Some patch reefs contain coral cays which are built entirely of coral sand.
6. There are no atolls on the Great Barrier Reef.
7. Typical reef zones are, the beach, inner coral, outer coral, crest and reef slope zones.
8. The number and diversity of animals and plants increases as you progress through these zones towards the sea.
9. The crest is made of algae which sterilise and purify water as well as provide food and oxygen for many reef animals. It is exposed at low tide and higher than the other reef zones.
10. The reef slope is a low energy zone because of decreased wave action making the crest a high energy zone.
11. The coral zones are limited in height by the tide and are low energy zones. They can however become quite hot and salty at low tide and so have a group of animals and plants that are adapted to these conditions.
12. There are many reef associations that help animals co-exist. The goby and the shrimp, anemone and clownfish, fish and cleaner wrasse are examples.
13. Where animals eat off the same table, the association is called symbiosis by scientists.
14. There are animals which clean up dead and decaying matter and filter out the wastes of other animals. The sea cucumber and worms are good examples. This is one reason why the reef is so clean and nice to visit.
15. If humans destroy these small individuals, they are interfering with the natural cycle of things and will cause the reef to become polluted in its own waste.
16. Therefore the reef is not an inexhaustible source of food, nor is it a thing that can be manipulated. It is easy to look at it and say that there is no pollution and therefore become relaxed and lulled into a false sense of security.
17. The real danger is the organisms that disappear because of the activities of humans who have this increadible ability to ruin our world by manipulating the environment to suit their own needs and not those of the natural world.
18. Can you see that if the crest is damaged, the water will not be sterilized?
19. Can you see that if the sea cucumbers are removed the sand won't get vacuum cleaned? And can you see that if all the parrot fish are removed, the sand won't be made?
20. I hope you are beginning to understand some of the relationships that are involved here.

CHAPTER 5

REEF PROJECTS

REEF PROJECTS

The following projects are designed to be done using a variety of resource materials in your school library. No one source will ever be as useful as a combination and you are encouraged to use books, pamphlets, newspaper cuttings, videos and slide sets to enrich your answers.

1. Sea anemones and sponges
2. Clams and cone shells
3. Echinoderms and humans
4. Sharks and rays
5. Commercial fish
6. Turtles
7. Dolphins and dugongs
8. Humpback whales
9. Poisonous fish
10. Corals
11. Lobsters
12. Resorts and the Reef
13. Sea birds
14. Shells
15. Your choice
16. Reef Ed classroom projects

POSSIBLE CRITERIA SHEETS

To assist you in your studies the following information about marking and criteria for your success.

Possible marking scheme using descriptions

Written Projects

A good written project will have the following characteristics: Handed in on time, and be your own work; Clearly labelled and organised with sheets of paper stapled neatly together; Handwriting neat with answers in complete sentences where possible; All words that are mentioned in the project script to be spelt without error; Diagrams to be drawn in pencil and lines to be complete and join where possible; Illustrations to be copied and redrawn in black ink with appropriate shading; Data tables to be complete with accurate observations recorded; Questions to be answered correctly in sentences where possible; At least two adaptations to environmental conditions should be mentioned.

Project Talks

A good project talk will be: Well introduced and have everything for the talk organised. It will begin with a clear statement of what the talk is about and what had to be done in the project. Reference should be made about the references used and any assistance given. It would be interesting to hear about the problems encountered and the ways you overcome these difficulties. Finally you need to mention the questions you had to answer and the answers you gave to each. Don't forget to look at everyone as you speak and finish with a thank you and acknowledge any help that was given to you.

Possible marking scheme using numbers

Handed in on time, your own work, neatly organised ...	1 2 3
Introduction and organisation.	1 2 3 4 5
Statement of what the talk is about and what had to be done	1 2 3 4 5
Description of problems encountered and their solution ...	1 2 3 4 5
Handwriting, grammar and spelling	1 2 3
Diagrams, illustrations and graphics	1 2 3 4
Data tables and observations	1 2 3 4 5 6
Description of tank parts and ways fish were made ...	1 2 3 4 5 6
Answers to questions	1 2 3 4 5 6 7 8

TOTALS /9 Very limited Achievement , /27 Limited achievement, , /54 Sound Achievement, /82 High Achievement, >97 Very High Achievement

Reference Books

Here are some , your library may have others

Bennett, I. The Great Barrier Reef, , Lansdowne Press 1980
Carcasson, R. H., A field guide to Reef Fishes of the Tropical Australian and Indo Pacific Region. Collins, Sydney, 1977
Coleman, N. Australian SEA FISHES North of 30°, Doubleday Sydney 1981.
Endean, R. Australia's Great Barrier Reef, University of Queensland Press, 1982
Great Barrier Reef Marine Park Authority Reef Notes
Hargreaves, V.B. The Tropical Marine Aquarium, McGraw-Hill Book Company, New York, 1978
Mather and Bennett, (Eds), "A Coral Reef Handbook", Coral Reef Society, Brisbane, 1984
Moffatt, R.D. Snorkelling, Wet Paper Publications, Ashmore, 1988
Readers Digest, Book of the Great Barrier Reef, Readers Digest 1984
Saenger, P. A Divers Guide to the Great Barrier Reef, Scientific Commitee for the AUF 1977
Thresher, R.E. Reef Fish, Behaviour and Ecology on the Reef and in the Aquarium, John Bartholomew and Sons Limited, Edinburgh 1980

Magazines and projects

Neville Coleman's Underwater Box 702, Springood, Australia, 4127
Project Reef Ed, Great Barrier Reef Marine Park Authority. (op sit) 1988

Student Projects

Sea World's Project Neptune Series

No:	Name:	No:	Name:	No:	Name:
1.	Reef Dwellers	10.	The Mudcrab	19.	Anemones and their Fish
2.	Lobsters and Crayfish	11.	The Barramundi	20.	Behind the Scenes
3.	Life in an underwater cave	12.	Wobbegong Shark	21.	The Dolphin and Whale Show
4.	Reef Dwellers	13.	Reef Dwellers	22.	The Dolphin and Whale Show
5.	Tidal Pools	14.	The Coral Polyp	23.	Dolphins and Whales
6.	The Lungfish	15.	Reef Dwellers	24.	Dolphins and Whale Anatomy
7.	Poison Fish	16.	Mangroves and Mudskippers	26.	Bony fish
8.	Sharks and Pufferfish	17.	Reef Dwellers	27.	Sharks and Rays
9.	The Predators	18.	The Moray Eel	29.	Snr Dive Show

Great Barrier Reef Marine Park Authority Reef Notes/Videos

Reef Notes

1. Whales
2. Sea Birds
3. Crown of Thorns
4. Trochus Shells
5. Coral Cays
6. The Soft Touch
7. The Annual Coral Spawning Event
8. Turtles
9. Fringing Reefs
10. The Coral Polyp
11. Wrecks and the Reef
12. The Great Barrier Reef
13. World Heritage site
14. Marine Parks

Videos

1. The Crown of Thorns
2. Reef Reporter Series
3. Encounters with the Reef

Slides

Encounters with the Reef

Brochures and Pamphlets

National Parks and Wildlife Service

Ringtail December 1987
Camping on Reef Islands
Capricornia Section Zoning Strategies

Other Videos

The Return of the Leviathan,
Dreamtime Images, 90 Boundary St
Brisbane.

PROJECT 1: SEA ANEMONES AND SPONGES

Reference:

Sea World's Project Neptune Number 19.

Here are some questions and statements that will help you focus your ideas in this project:-

1. What is the difference between an anemone and a sponge?
2. What are spicules and where are they found?
3. What is a coelenteron, and what is its purpose?
4. Are sponges commercially harvested? If so where?
5. What is budding and how does it occur?
6. What are the names of the stinging cells in the tentacles of the sea anemone called?
7. Find out about the anemone and the clownfish. Look up Sea World's Project Neptune Project 19.
8. What is acclimatization and how does it affect the the clownfish?
9. List any five scientific names for the sea anemone. Now list three different species with the same generic name.
10. How is water circulated around the sponge?
11. How many cells thick is a sponge?
12. Are sponges important to humans? How?
13. Write a sponge poem.
14. Research how an anemone feeds.
15. Are any anemones poisonous to humans? If so, which?

Fig 5.1 A sponge. How is this different from a sea anemone?

PROJECT 2: CLAMS AND CONE SHELLS

These references may help you:

Wet Paper Snorkelling Book, Chapter 4
Reference books and newspaper cuttings

Here are some questions and statements that will help you focus your ideas in this project:-

1. To what phylum do cone shells belong?
2. Are clams in the same phylum as cone shells? If not, to what phylum do they belong? If so, to what class within the phylum do they belong?
3. Are some cone shells poisonous? If so, which?
4. Can a giant clam crush your hand?
5. Do clams have algae with symbiotic bacteria? What do they do?
6. What is a radula and what does it do?
7. Are cone shells collected? If so, why?
8. Do cone shells have eyes?
9. Is the term cone shell a good name for the animal? If so, why?
10. List three differnent cone shell species from the same genus.
11. Name two methods by which clams feed. (Are plants involved?)
12. Find out about the incurrent and out currents of clams?
13. What are the relatives of clams?
14. If stung by a cone shell, what is the emergency procedure?
15. Draw a diagram of the mechanism by which a cone shell inflicts its venon.

Fig 5.2: Giant clam

PROJECT 3: ECHINODERMS AND HUMANS

Reference:

GBRMPA pamphlet and video on Crown of Thorns. Science Mag article as well. Wet Paper Book, on Snorkelling. Sea World's Tidal Pool Project.

Here are some questions and statements that will help you focus your ideas in this project:-

1. What does the word echinoderm mean?
2. Is a sea cucumber an echinoderm? Does it have another name?
3. Are Sea Cucumbers harvested and exported for their meat?
4. If so where and by whom? Is there any money to be made from the export trade?
5. Are permits required to collect them on the Great Barrier Reef?
6. Why is the Crown of Thorns such a topical newspaper animal?
7. How does it eat its prey?
8. What is its natural predator?
9. Are the thorns dangerous? What happens if you stand on one?
10. Do sea cucumbers play chemical warfare and why and with whom?
11. What are sea eggs and where are they found?

Fig 5.3: Sea Cucumber

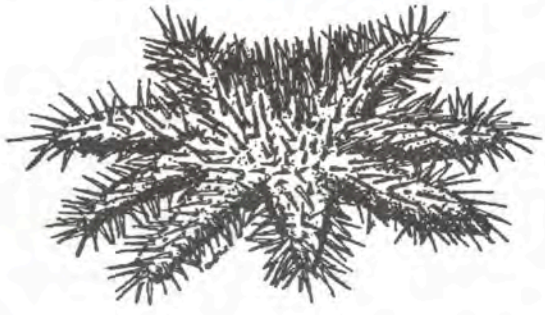


Fig 5.4: Crown of Thorns Starfish

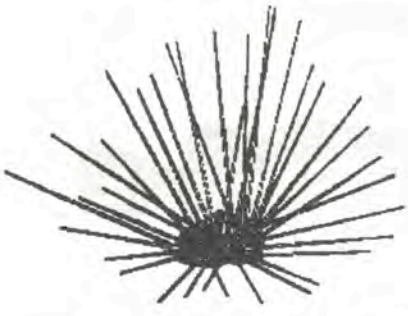


Fig 5.5: Long spined sea urchin

Fig 5.6 A sea egg. What's the relationship between this and the sea urchin?

PROJECT 4 SHARKS AND RAYS

Reference: Sea World's Project 25 & 26, GBRMPAS Sharks Brochure

Here are some questions and statements that will help you focus your ideas in this project:-

1. What is the difference between a shark and a ray?
2. How do sharks breathe?
3. What is the lateral line used for in sharks?
4. How do sharks swim? Research the fins that are used for turning up and down, sideways, propelling. Make outline drawings of the shark, explaining your answer.
5. Draw a shark's tooth.
6. What is cartilage? Which fish are cartilagenous?
7. Is the silvertip shark dangerous to scuba divers?
8. Are all sharks dangerous? How many shark attacks have there been in Queenslandover the past 10 years?
9. When do black tip reef sharks breed and what foods do they eat?
10. Are white tip reef sharks dangerous to divers and snorkellers and where are they found on coral reefs?

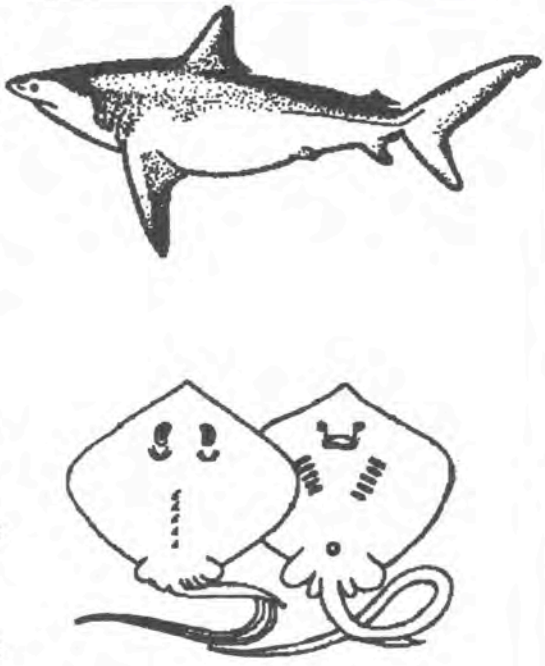


Fig 5.7 External features of shark and stingray. From Sea World's Project Neptune.

PROJECT 5 COMMERCIAL FISH

GBRMPA Reef Note: Reef Region Fisheries.
DPI Brochure on Ciguiteria
Sea World's Project on Barramundi.

Here are some questions and statements that will help you focus your ideas in this project:-

1. How big do these barramundi grow and do they change sex?
2. Why is this fish so famous?
3. Does the prawn fishery extend into the Great Barrier Reef Region?
4. What is ciguateria and in which fish is it found? What is the treatment for it?
5. What is a lure?
6. Where is the cod end of the trawl net found? How are scallops prepared for sale?
7. Is recreational fishing more dangerous than commercial fishing?
8. Write a paragraph on the impact of commercial fishing operations in our reef region.
9. What is the value of fishing to the tourism industry?
10. Make a list of any six fish that are sold in a local fish shop.

Fig 5.8: Barramundi and fish lure Diagrams from Sea World's Project Neptune.

PROJECT 6 TURTLES

Reference: GBRMPAS Turtle Brochure. Hints on turtle watching by NP&WLS.

Here are some questions and statements that will help you focus your ideas in this project:-

1. What types of turtles are found in the Barrier Reef Region?
2. What types of food do turtles eat?
3. It has been said that turtles eat the box jelly fish. Find out if this is true and if so what effect does it have on jellyfish population densities.
4. Were turtles commercially harvested in the past? If so where and by whom?
5. Fig 5.9 shows turtles mating. Find out when they mate and how the young are born.
6. To what class do turtles belong? What are the features that place turtles this class?
7. Are sea snakes related to turtles? How dangerous are they and what safety precautions need to be taken when diving with them.
8. How old do turtles grow? Where do they go when not on the reef?
9. How many baby turtles hatch from a clutch? How many survive to maturity. Who is the animal's greatest predator?
10. What happens to female turtles if you shine a torch light at them as they come up the beach?
11. Do buildings have the same effect and how has this affected the development of beach resorts at Mon Repos, near Bundaberg in Queensland?

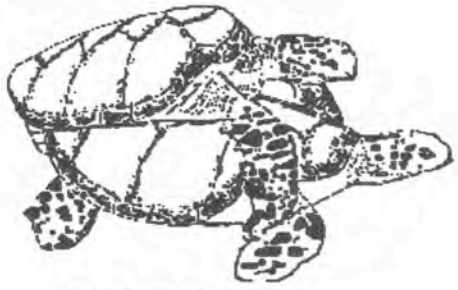


Fig 5.9: Turtles mating.

PROJECT 7 DOLPHINS AND DUGONGS

Reference: Sea World's Project Neptune Project 24.GBRMPAS Dugong Brochure

Here are some questions and statements that will help you focus your ideas in this project:-

1. To what class and order of animals do dugongs and dolphins belong?
2. How do dolphins breathe?
3. Do dolphins have hair?
4. How do dolphins locate their food and what do they eat?
5. How does a baby dolphin get its milk?
6. Where do dolphins live? Do they migrate or stay in the one place all the time?
7. What do dugongs eat? Where are they found? Are they hunted? If so, who hunts them, and for what reasons?
8. Are dolphins as intelligent as humans? Give reasons for your answer.
9. How long do dugongs live?
10. Write a paragraph on how Aboriginal communities are allowed to hunt dugong.
11. Make a visit to Sea World and complete the project on dolphins.

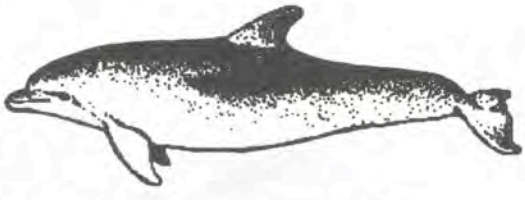


Fig 5.10: Dolphin from Sea World's Project Neptune, Number 24.

PROJECT 8 HUMPBACK WHALES

References:
Video Return of the Leviathan, Dreamtime Images, 90 Boundry St, Brisbane. GBRMPAS Whale Reef Note.

Here are some questions and statements that will help you focus your ideas in this project:-

1. Where are humpback whales found?
2. Once they were hunted in Queensland in the past. Where was the last whaling station, how many people did it employ and why did it have to close down?
3. Where do humpbacks migrate to? Draw a map.
4. Why do they migrate?
5. How are whales classified? To what class of animal does the humpback belong? Why?
6. How big do humpbacks grow?
7. What other whales are found in Qld?
8. How do whales reproduce?
9. How long is their gestation period and why is it so?
10. How helpless are baby whales?
11. What is a whale pod?

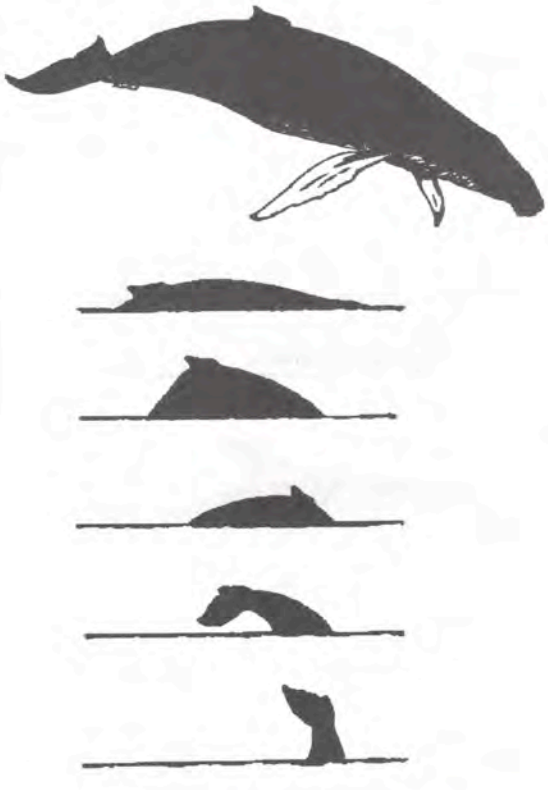


Fig 5.11 The Humpback Whale. Side view, mating and diving sequence. Can you also find out about the fingerprint on the tail?

PROJECT 9 POISONOUS FISH

References:

Sea World's Project 7 on Poisonous Fish. Reef Reporter 1/88 Segment on Look but don't touch. Reference books. Ciguiteria pamphlet from DPI. Wet Paper Snorkelling book.

Here are some questions and statements that will help you focus your ideas in this project:-

1. Make a careful line drawing of the two fish and mark carefully where the animals inflict their poison.
2. Where do both fish live in the sea?
3. Write a paragraph on what you should do if you step on a stone fish.
4. Find a reference book on fish and colour in your diagrams.
5. What is ciguiteria? How is it treated and how is it transmitted in a marine food chain?
6. Which species of fish are likely carriers of ciguiteria ?
7. How should you handle a fish you had just caught with which you were familar?
8. How does hot water help stop the pain from a fish puncture wound?

Fig 5.12: The Stone Fish

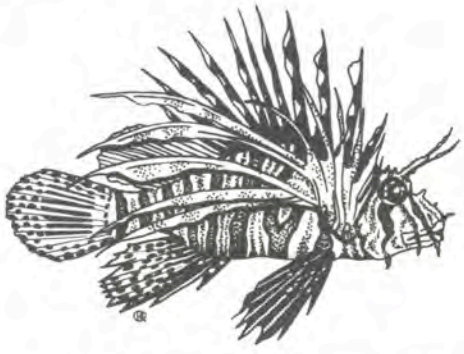


Fig 4.38 The Butterfly Scorpian Fish.

PROJECT 10 CORALS

References:

GBRMPA Reef Note on Soft Corals and the Coral Polyp
Reference Books

Here are some questions and statements that will help you focus your ideas in this project:-

1. What is the difference in feeding patterns between soft and hard corals.
2. Make a coloured poster of the coral polyp as depicted in Reef Note page 3. Use it to show how food is transmitted from one polyp to another and food is caught.
3. Write a paragraph on coral reproduction and the great spawning event on the Great Barrier Reef.
4. What is chemical warfare as it relates to soft corals.
5. How do soft corals kill hard corals?
6. Can soft corals move? If so, how?
7. What is the natural predator of the soft coral and how does it avoid being stung.
8. Make a drawing of an animal that builds a tube into a coral colony.

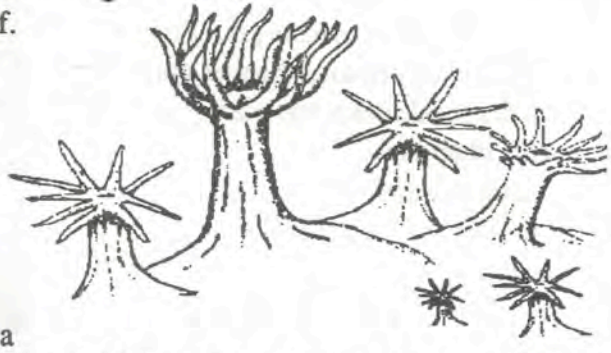


Fig 4.39.. Coral polyps feeding. But day or night? Soft or hard?

PROJECT 11 LOBSTERS

References:
Sea World's Project Neptune No 2

Here are some questions and statements that will help you focus your ideas in this project:-

1. How is lobster cooked?
2. Where are they caught and how are they brought to market?
3. How much is lobster thermadoir in your local restaurant?
4. Write a paragraph on how lobsters mate and reproduce.
5. Use a diagram to illustrate your answer. You can find one in this book.
6. What is a fishery?
7. How many eggs does a female lobster produce?
8. What is an adaptation, and list any five that you can see in the drawing opposite.
9. Copy the drawing opposite and write in the names of the following appendages:
   (a) walking legs (c) tail fan
   (b) swimming legs (d) reproductive legs
10. Have you ever eaten lobster? If so, where? Did you enjoy it?

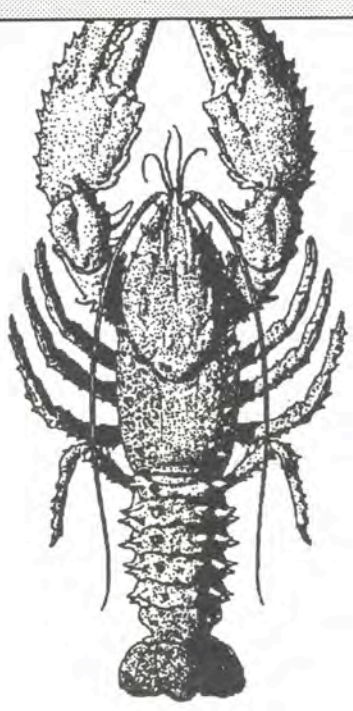


Fig 5.15: Lobster?

PROJECT 12: RESORTS AND THE REEF

References: Travel brochure on a Great Barrier reef holiday desternation. GBRMPA also has a discussion paper on the Reef Link Hotel.

Here are some questions and statements that will help you focus your ideas in this project:-

1. Copy a map of Queensland(you can copy the one from chapter 2) and mark where your resort is located.
2. How much is the holiday there and what does it include?
3. Where was Australia's first floating hotel moored?
4. Does your island have a fringing reef?
5. Cut out the photo of the reef and mark in the coral zones you learned about in this chapter.
6. Does the reef have a management plan for the conservation of the plants and animals?
7. Review the articles prepared by GBRMPA on the Reef link hotel.

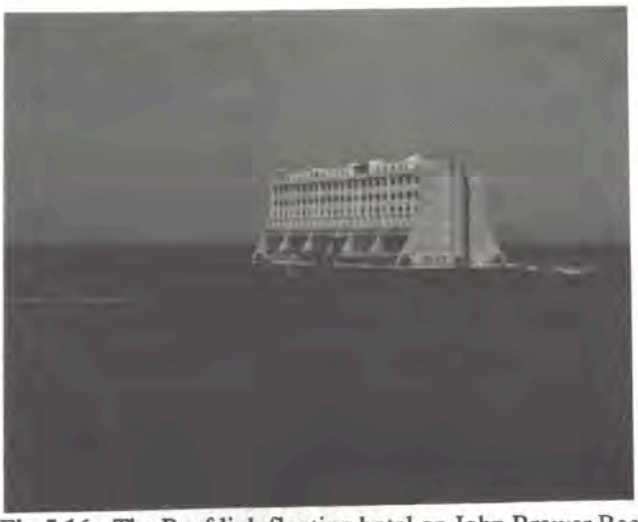


Fig 5.16: The Reef link floating hotel on John Brewer Reef off Townsville.

PROJECT 13 SEA BIRDS

References:
GBRMPA Reef Note on Sea Birds
Reference books

Here are some questions and statements that will help you focus your ideas in this project:-

1. Copy the diagram of thė noddy tern below and use the Reef Note to match the colours.
2. Now take a copy and turn your diagram into a lesser crested tern by careful examination of the bottom right photo in the Reef Note.
3. Why have bird populations been able to reach such high numbers on the reef islands?
4. Why have sea birds been attracted to the Barrier Reef?
5. What problem arises if you cause the sea birds to fly off their nests?
6. Is the sea gull friend or foe to other sea birds? Give reasons for your answer.
7. Is there a need for management of sea bird populations and why?
8. The mutton bird has quite a remarkable migration. Draw a map of the Pacific Ocean marking in the migration route.
9. Write a paragraph on what would be good advice to people who visited a coral island where there were large numbers of birds.
10. What was guano and how was it mined?

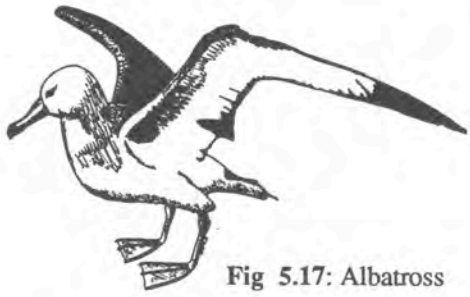


Fig 5.17: Albatross

Fig 5.18: Noddy tern

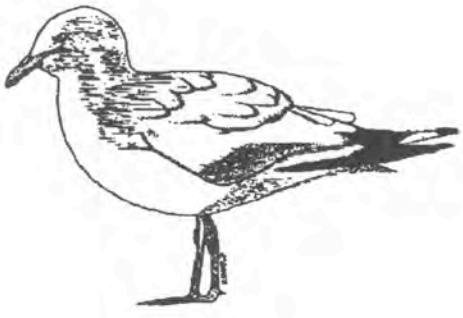


Fig 5.19: Sea Gull

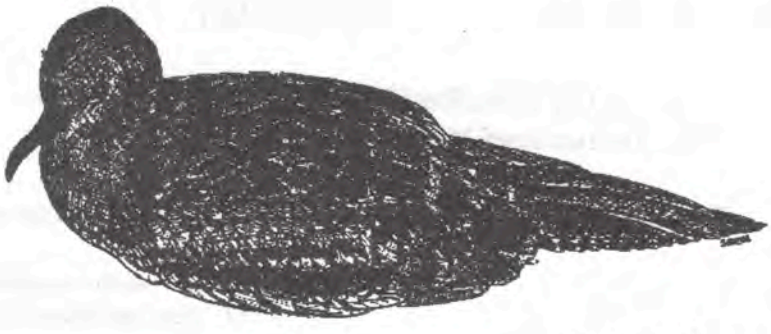


Fig 5.20: Mutton Bird

PROJECT 14 SHELLS

Referehces:

GBRMPA Reef Notes on Trochus shells and Shells

Here are some questions and statements that will help you focus your ideas in this project:-

1. Use the shell brochure to find out where a Chiton lives. How does this shelled animal feed?
2. How were buttons made before 1950 in Australia?
3. Draw a diagram of how button blanks were made from Trochus shells. How were these shells harvested in Queensland?
4. Write two paragraphs about the reproductive biology of the Trochus shell.
5. What are the trochus shells natural enemy?
6. To what group of animals do shells belong?
7. What are the principal shell bearing classes?
8. What is the Queensland shell collectors club code?
10. What are two ways in which clams feed?
11. What is your attitude about collecting shells on the reef?

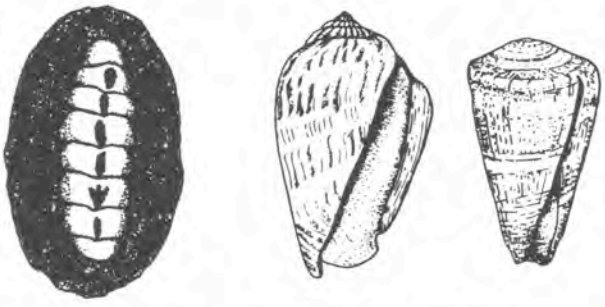


Fig 5.21 Chiton, stromb shell and cone shell.

PROJECT 15 YOUR CHOICE

References:

Your own Imagination

Here are some questions and statements that will help you focus your ideas in this project:-

1. Read all the other projects and design your own.
2. Illustrate it yourself using a computer, and publish your project.
3. Write to us here at Wet Paper to see if it could be published.

PROJECT 16 PROJECT REEF ED

References:

GBRMPA Reef Materials

1. Obtain a copy of the Reef Ed materials published by the Great Barrier Reef Marine Park Authority.

2. Focus on one of the following classroom projects (Numbers refer to Reef Ed numbers):-

(1) On location
(11) Tidal changes
(12) Endeavour, reef and tides
(15) It's tropical
(17) Wind and waves
(18) Air photo interpretation
(19) Reef and Island Cross-sections
(20) Formation and development of a cay
(48) Coral tree comparison
(67) Fish bird comparison

CHAPTER 6

CORAL ISLANDS

Fig 6.1: Approaching a coral cay after a long voyage creates special images in your mind. The island is North West, the vessel the Calypso Kristae.

Purpose

To introduce to you the nature of a coral island, how it formed and of what it is made.

Prerequisite skills

A knowledge of camping would be an advantage.

Objectives

You should be able to:-

* recall how refraction plays a role in the movement of sand around a cay
* recall the stages of coral cay development
* draw a vegetation map of a coral cay
* recall the role of the casuarina tree in the protection of inner cay vegetation
* describe some dune vegetation
* debate camping effects on coral cays
* describe the symbiotic relationship between pisonia trees and birds
* make judgements on the value of seagulls
* debate the value of resorts on coral cays
* recall who manages a coral cay and how permits are obtainable

Resources

* materials from appendix
* graph paper
* paper clip, tape, colouring pencils

Time required

1 week

Fig 6.2: All islands in the Geat Barrier Reef are now national parks.

Coral cays are just drops in the ocean. Heron Island, Green Island or the deserted islands off the coast of central Queensland are really special.

They represent one of the most recent formations on the reef and support some of the world's last remaining turtle and bird populations.

This chapter discusses how coral cays form, and provides some of the insights into how they function.

Coral cays are formed by a process called ecological succession. This involves the gradual change from simple ecology such as a sandy beach with a few plants, to a complex ecology such as a forest with birds, insects and plants all interrelated in a complex web.

Get out the model you built of the reef in the last chapter and imagine 10,000 parrot fish, 60,000 tons of waves and the heat of a million lamps eating, crashing and eroding at the crest you so carefully cut out.

The end result of all these pressures is the cracking off of the living coral and the subsequent formation of coral sand.

A study of the currents around a reef reveals that the currents move in the direction of the waves. The waves set up a longshore drift current and bend as a result of the shape of the cay. This current carries with it the sand that was formed by erosion and dumps it at one end in the lagoon. Gradually the sand builds up and a sand spit forms. This is the start of the coral cay. From here succession takes place and the main sequence is summarized below.

Stage 1: Formation of a sand spit.

Remember that sand was formed in many ways. Here are four:-

1. Large ocean waves can break off fragments of coral.
2. Fish can chew at the coral and algal crest and void sand in the process. This can be seen in Reef Report 1/88.
3. Wind can erode the reef at low tide causing sand particles to form.
4. Activities by people who fish or use the reef can cause coral fragments to break off.

This sand is then moved around the reef by wind, water currents, or possibly by the activities of organisms.

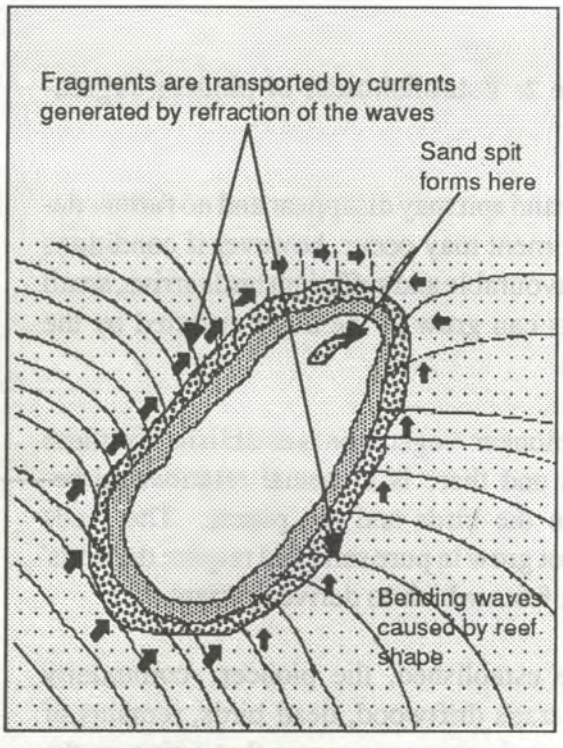


Fig 6.3: Refraction around a cay causes sand to be transported to one point and dumped. The bending effect is called refraction and the arrows above show the direction in which the sand moves

Stage 1 involves

(a) sand being made and transported from areas of high energy to areas of low energy - see figure 6.3.
(b) sand being dumped into a sand spit at the low energy end of the reef to form a sand spit.

Stage 1 is complete when the sand spit forms.

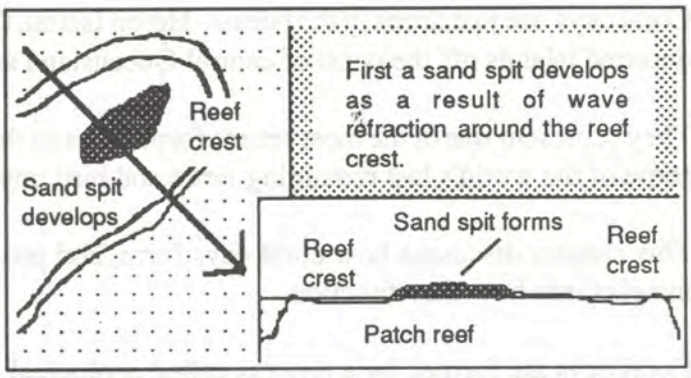


Fig 6.4: Stage 1. A sand spit forms at the end of the reef as a result of wave refraction.

CLASS ACTIVITIES

Poster:
If you can obtain a copy of the Great Barrier Reef Marine Park Authorities colour poster on Fairfax Island and Reef, you can see this refraction process.

Videos:
Alternatively classroom video, see appendix, produce a video on waves and refraction which explains the process in some detail.

Booklet:
Another booklet, "Coastal Studies" by the same author, explains this concept as well and it is worth revising the concept of refraction as a class activity. The experiments involving the wave tanks are applicable and it would be interesting to see if they could be applied to coral cays.

Slide set:
Now is the time to show the second half of the Great Barrier Reef Marine Park Authorities, *"Encounters with the Reef", Slides 28 -37.*

Stage 2: Establishment of pioneer vegetation

The sand spit may disappear and no further development may occur, however if conditions are favourable and sufficient birds arrive, small plants can grow in the dung excreted by the birds.

The pioneer vegetation is established by these birds and there is a special relationship between the birds and the plants. The seeds cannot grow in pure sand and require the birds' dung from which to derive nutrient.

Once established, the pioneer community then traps driftwood, dead birds, remains of crabs and other scavengers that arrive on the cay. Figure 6.5 , shows the arrival of birds and the growth of pioneer grasses and shrubs.

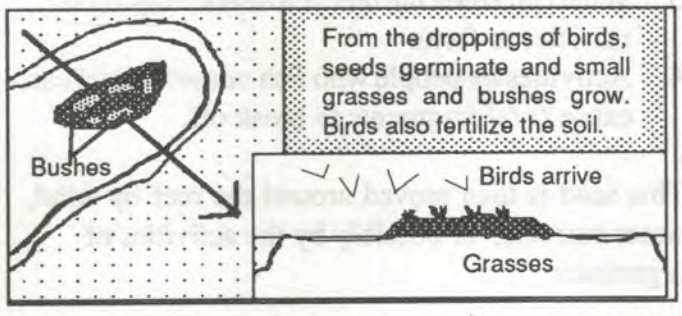


Fig 6.5: Stage 2 and small plants grow out of seeds dropped by birds. Bird droppings also fertilize the sand.

Stage 3: Establishment of vegetation

As the shrubs grow and die and as more humus develops in the newly established soil, larger trees can start growing. Insects, spiders, centipedes now arrive on the wings of birds or on driftwood. As these die, more is added to the humus.

Stage 3 is characterised by the growth of She oaks on the foreshore, larger trees inland which provide homes for the birds that characteristically inhabit the cays of the southern Barrier Reef. As more birds form nests, more dung accumulates on the ground.

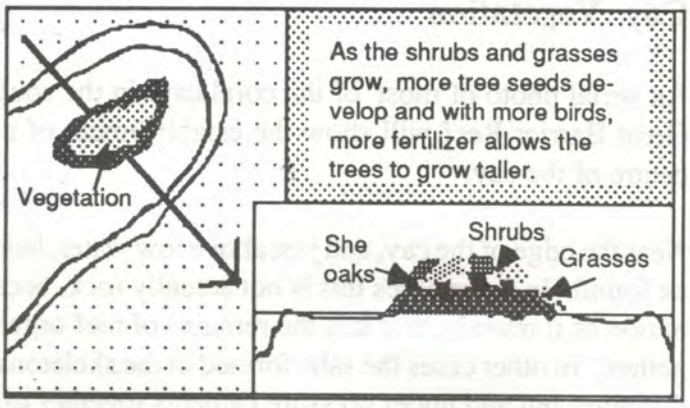


Fig 6.6: Stage 3. Vegetation almost complete

Stage 4: Establishment of a climax community

A cyclone or fire may interrupt the process, calling a temporary halt to the continued growth. However the cay can now consolidate the vegetation and regrowth is quick.

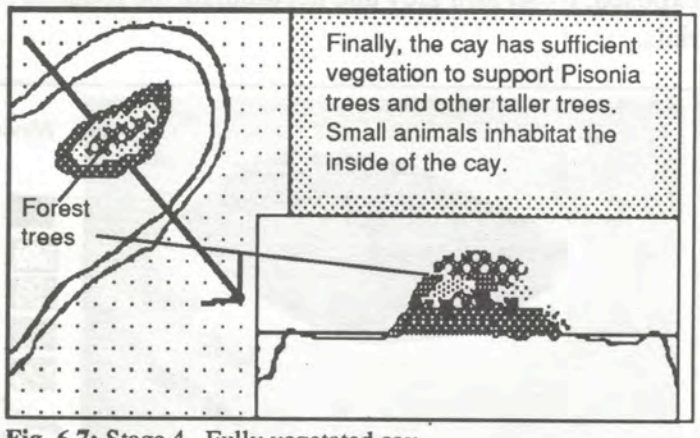


Fig 6.7: Stage 4. Fully vegetated cay

Fig 6.8: These stages can be seen recreated on the beach of a coral cay. The grasses in the foreground give rise to the shrubs behind and finally the trees in the background of the photo.

Cay Vegetation

An aerial photo of most of the coral cays in the southern section of the Great Barrier Reef will show the establishment of a thick forest in the centre of the cay.

Near the edge of the cay, and just above low water, beach rock can usually be found. In some cases this is not actually rock, because a close examination of it reveals that it is the remains of reef organisms cemented together. In other cases the salts formed in the skeletons of living organism dissolves out and under pressure cements together to form limestone. If exposed, it can turn grey and accumulate the remains of other dead materials.

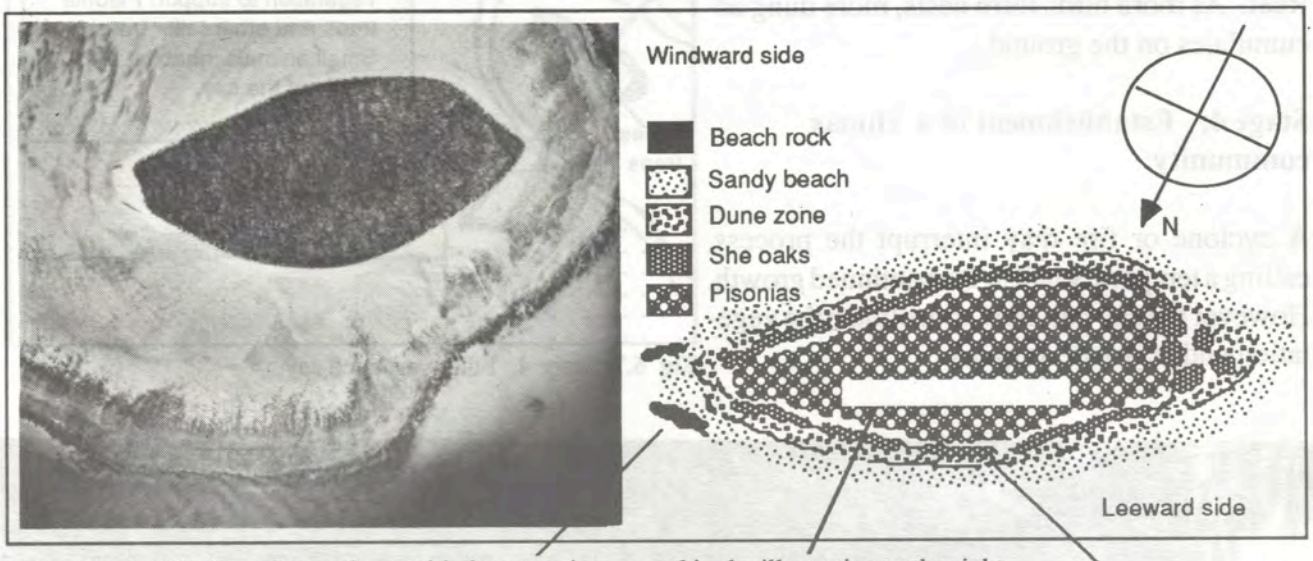


Fig 6.9 Aerial view of a coral cay with the zones interpreted in the illustration to the right

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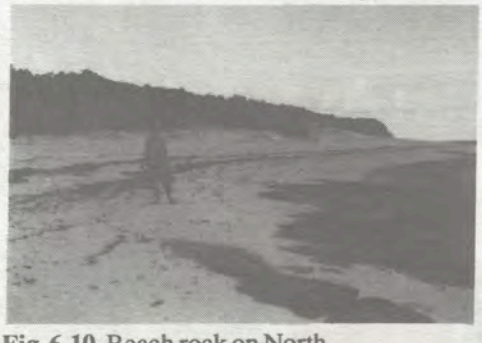

Fig 6.10 Beach rock on North West Island. This photo was taken at the end of the cay.

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Fig 6.11 A photo from inside of the cay showing the Pisonia trees. Don't climb these as they break easily.

This photo was taken here.

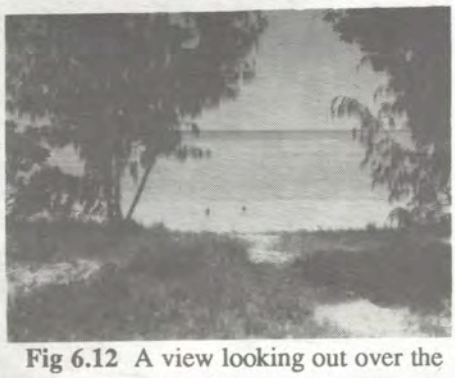


Fig 6.12 A view looking out over the dune vegetation. Campers should avoid this as it is fragile and can be destroyed, causing beach ersoion.

Some cay plants

Cays often have only a few plant species; these are usually ones that are tolerant of beach or sand conditions (salt tolerant, resistant to dessication and are especially adapted to dispersal over water).

Some cays can also have up to 60 different types of plants including rainforests.

Pisonia trees

Perhaps the best known in the southern region are the Pisonia trees. If you visit these cays, don't climb them as the branches are weak and will break.

Pisonia trees provide homes for many species of sea bird. The bird dung accumulates at the base of the tree, and dissolves when it rains to provide a fertilizer for the trees growth.

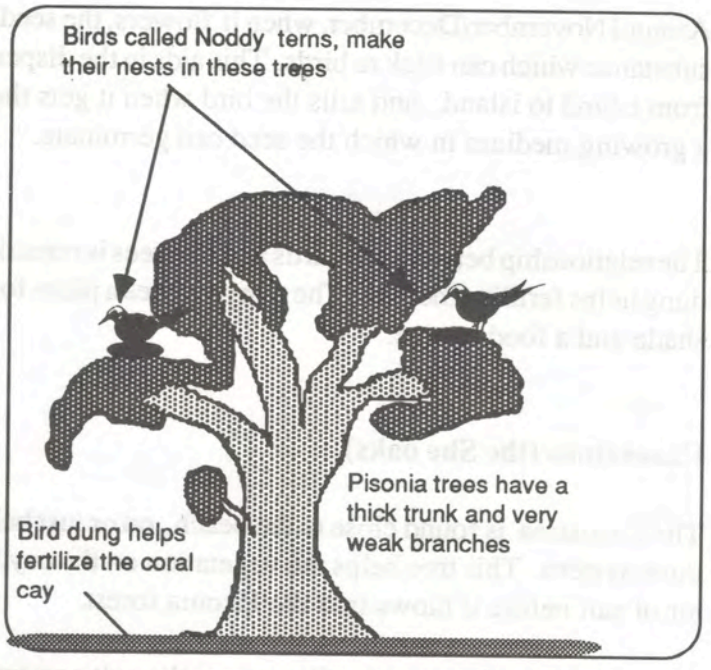


Fig 6.13: Pisonia tree, common to the central part of coral cays on the southern Great Barrier Reef.

Fig 6.14 : A Noddy tern and tree

The Pisonia tree, has very big leaves which are easily blown off. These fall to the ground and make instant cover for the many small insects that live on the cay. In some cays, large cockroaches make exclusive use of this small habitat called a microhabitat. The Pisonia tree is remarkably well adapted to the life on the cay.

The branches are thick and stubby which makes them break quickly. The leaves are large and fall easily. This aids in the humus growth beneath the tree. However the tree has one added feature to assist its growth.

Around November/December, when it flowers, the seeds form a sticky substance which can stick to birds. This aids in the dispersal of the trees from island to island, and kills the bird when it gets there, providing a growing medium in which the seed can germinate.

The relationship between the birds and the trees is remarkable. The bird dung helps fertilize the tree. The tree provides a place for nest building, shade and a food source.

Casuarinas (the She oaks)

The Casuarina is found close to the beach, on or just behind the frontal dune system. This tree helps the vegetation on the cay by cleaning the air of salt before it blows into the Pisonia forest.

As the salt air blows at the Casuarina, the salt accumumlates on the branches. Therefore the air that blows into the Pisonia forest is less salty and less able to burn and dry out the leaves of the Pisonia tree.

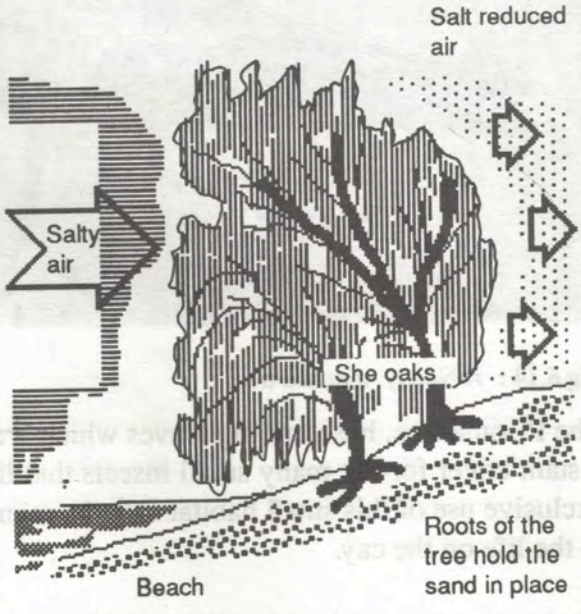


Fig 6.13: Casuarina trees sieve the salt air and protect the cay from dehydration as well as holding the sand together to prevent erosion. The salt water couch grasses and other smaller dune plants also help keep the dune stable that is why you should only have one walking track to the beach if you camp on these islands.

The *Casuarina* has a second function. Its roots penetrate deep into the frontal dune. Out from each root is a root hair system which further helps to anchor the tree and bind together the sand.

When big storms such as cyclones strike the island, large waves break on the beaches causing beach erosion. The roots of the *Casuarina* help to hold the soil together. The branches also provide roosts for the many sea birds that come to the cay to live.

Finally, the *Casuarina* is able to convert the nitrogen in the atmosphere to a solid form inside the tree. This is done by micro-organisms, called nitrogen fixing bacteria, that live in root nodules at the base of the tree. The bacteria absorb the atmospheric nitrogen and convert to a bound or "fixed" chemical form that can be released as a fertilizer to help the tree to grow. This may be one reason why the tree grows so quickly. This process is called nitrogen fixation and is part of the nitrogen cycle that is so important to the survival of the coral cay.

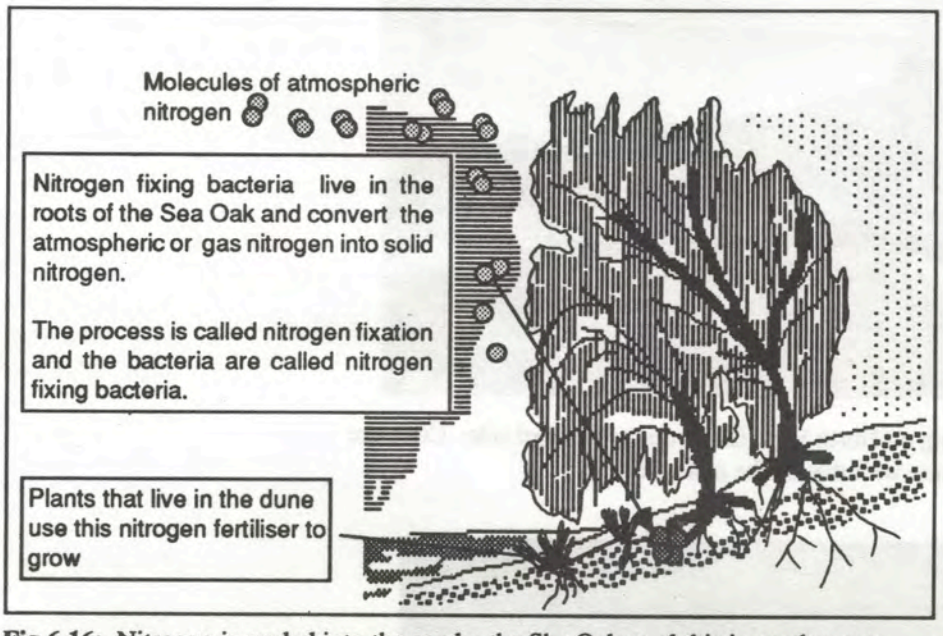


Fig 6.16: Nitrogen is cycled into the cay by the She Oaks and this is another new idea which needs to be taught.

So the humble She Oak is more important than you thought. You should look after it and not use the timber for firewood when you camp.

Really the dune system is the most fragile on the cay and we humans are not the only ones to damage it. A turtle in summer can completely excavate a She Oak causing it to fall down, and many turtles do this each summer right in the heart of the cyclone season where big waves erode the cay. How does the cay react to these erosive forces? Does it shift from place to place?

The answer to the second question is yes but to the first, scientists don't know. Much more research into the shape and movement of cays will reveal answers.

Would it be wise to construct a resort on a coral cay?

The effects of wind on plant size

Cays can have up to sixty different plant forms of different shapes and sizes.

The fig tree shown below is over 25 years old and has been growing on the dunes. It has been allowed to grow to this height because it is on the leeward side of the cay, i.e. the side protected from the wind. Compare the height of the vegetation in this photograph with that of the next photo from the same island, but this time on the windward side. What do you notice?

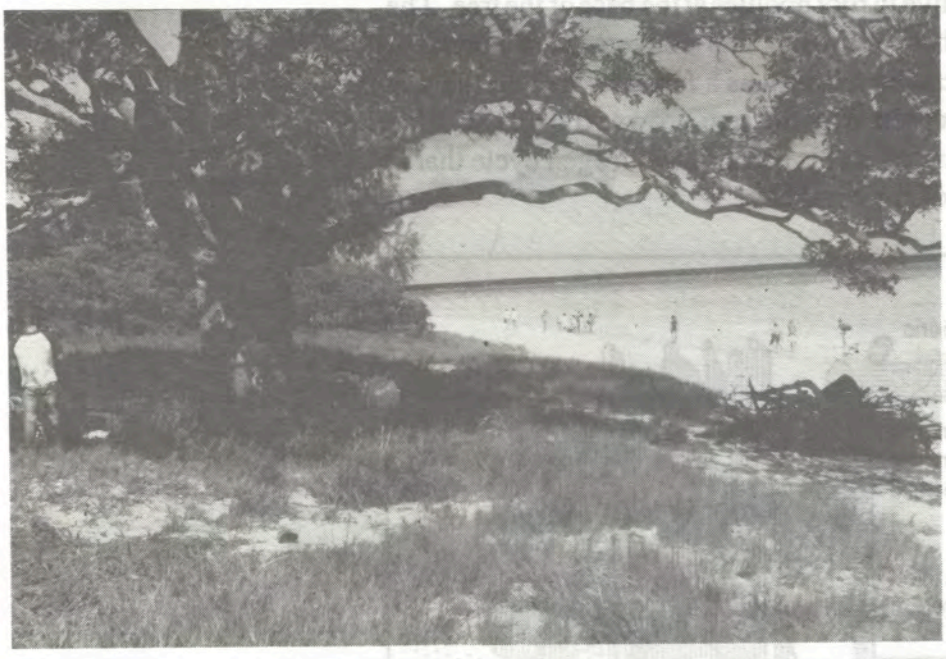


Fig 6.17 : A large fig tree growing on North West Island on the leeward side. Compare the size of the vegetation on this side with that on the other side.

Fig 5.18 : Vegetation from the same island, but this time on the windward side. Note the size of the plants on this side.

The effect is called wind shearing and accounts for the fact that the vegetation is different in height and shape from one side to the other.

Other plants that can be found are the screw palm (figure 6.19) and the octopus bush (figure 6.20)

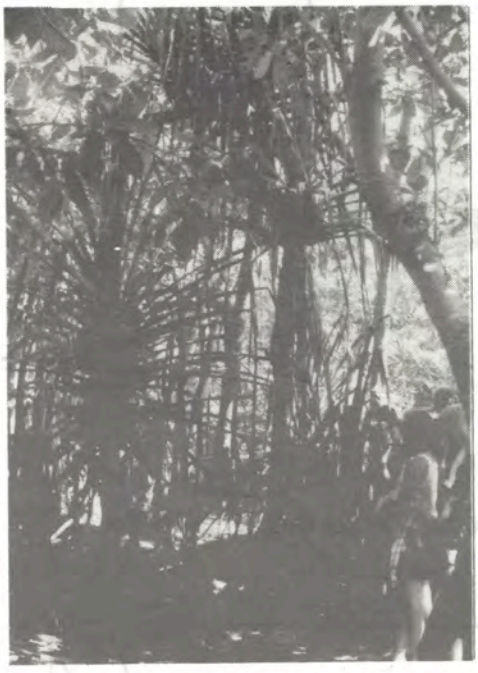


Fig 6.19: A screw palm or breadfruit tree

Fig 6.20: An octopus bush growing on the sand dune

Not everything always goes the plants way. There are other plants that parasitize this vegetation. The devils guts is an example of this which has completly smothered the octopus bush on the windward side of the coral cay.

Fig 6.21: An octopus bush smothered by a parasitic devils guts weed.

Reading activity

Read the pamphlet "Coral cays", produced by the Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville, Qld, 4810.

Bird life

The Barrier Reef is famous for the bird rookeries that have been established over thousands of years. Many birds that visit the islands of the Barrier reef are migratory and have flown a long way to breed or stop over for resting. This is why you should never chase birds that are resting on the water's edge on coral cays.

If you visit a Barrier Reef island or coral cay it is important to look after the birds that you see. Humans can learn a lot about how their behaviour can interfere with a natural habitat and this section describes some of our insignificant habits that can seriously affect bird populations. The common sea gull is a good example.

Before Australia was colonised by white people, the sea gull population was small. As the white people created more garbage than the aborigines, the sea gull had more available food. Numbers increased and now the seagull is in much larger numbers than before.

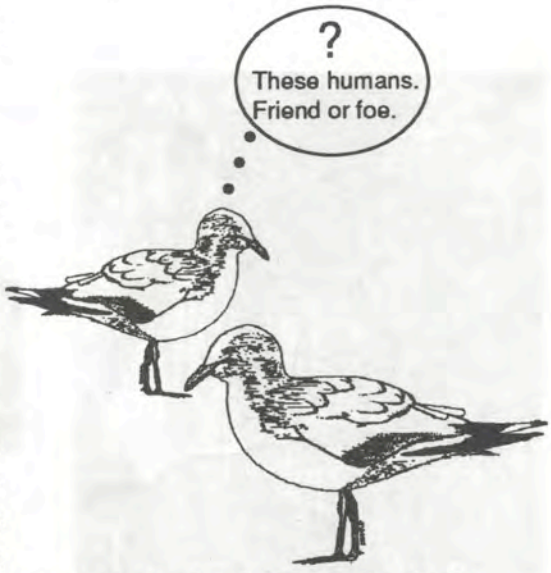


Fig 6.22: The Sea Gull. Friend or Foe?

A similar series of events has occurred on the barrier reef islands but the effect is more pronounced.

Competition for space and food on the cays is greater and so an increase in gull population causes problems because:-

(a) they compete for more available space and food
(b) they eat baby turtles as they hatch and
(c) they prey upon the eggs and chicks of the noddy terns and mutton birds that inhabit the islands.

Fig 6.23 The Human. Friend or Foe? Illustration from QNP&WLS camping guidelines brochure, Rockhampton.

Human presence increases the problem. As helicopters or planes land on these islands, nesting birds leave their nests and fly up into the air and the gulls can then prey upon the chicks and eggs.

This also happens when visitors play loud music, run generators, operate speed boats at excessive speeds or generally move about the island.

Usually once a bird is forced to leave its nest it may not return, leaving the chicks to die.

These birds leave the cay and fish for the best part of a day. Each night they return in very large numbers to rest, build a nest, court, mate, or feed their young.

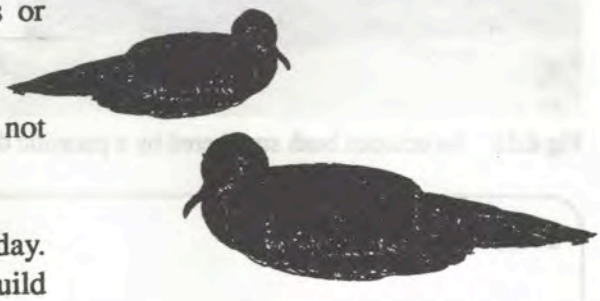


Fig 6.24: The Mutton bird is a ground nesting bird.

Some birds, like the mutton bird, live on the ground in burrows. Here they reproduce and raise their young. Humans walking around can collapse these burrows, killing the chicks in the process.

If you have the chance to visit a coral cay and are there when the mutton birds are, you will have a chance to witness a most amazing event each morning. Thousands of mutton birds wake up early and line up on specially created "runways" prior to taking off for the days fishing. If you are unlucky and pitch your tent in the runway, then you will get a rude awakening in the morning.

Fig 6.25 During the day mutton bird runways look just like walking tracks

Fig 6.26: During the morning these tracks turn into mutton bird runways and become a hive of activity. Be careful not to camp in these runways if you visit a coral cay. Photo thanks to Len Zell who was one of Australia's first Great Barrier Reef Marine Park Managers.

Study Assignment

Purpose

To have each member in the class research a question about a coral cay and give a short talk on the topic.

You will need

Reference books, Great Barrier Reef Marine Park Authority Pamphlets, National Parks Pamphlets, OR Tourist Maps.

What to do

Form a group of five, and discuss the following questions or discussion points. You may have to use reference books from the library to answer some of them.

Then decide who will give a talk on which question. Each group has a theme. The first person introduces the theme and then the other members of the group expand on the theme. You must use the model you made in Chapter 1 to illustrate your answers. At the conclusion of the talk each member of the group must hand in all the answers to the group's questions (in your own handwriting)

GROUP 1: HOW CAYS AND ISLANDS FORM

1. Find a diagram of a cross section of a coral cay. Make a list of the things that would need to happen in order for it to become a fully vegetated coral cay.
2. What is meant by refraction and how does it contribute to the formation of a coral cay?
3. What is the reef crest and what forces break it down? You must mention Biotic and Abiotic factors. (You will also have to define Biotic and Abiotic)
4. How are fringing reefs formed? How does their cross-section compare with a coral cay? Make a drawing or an overhead transparency to illustrate your answer.
5. In Northern Queensland, mangrove cays occur. Use the Great Barrier Reef Pamphlet on Coral Cays to explain the difference between the coral cay and the mangrove cay.

GROUP 2: CAY VEGETATION

6. Use a reference book to find an aerial photograph of two coral cays. Prepare a vegetation map for each from it, naming the zones you can see.
7. From the vegetation maps prepared in Q6, make a cross-section like the diagram in Figure(check), showing the distribution of the vegetation.
8. Take another island from one in Q6 and prepare a vegetation map naming the zones.
9. Prepare a cross-section of the cay your friend is describing in Question 8.
10. Prepare a vegetation map from aerial photograph of a continental island.What type of vegetation is found there and how is it different from a coral cay?

GROUP 3 CAY PLANTS

11. Find a photograph of a Pisonia tree. How big does it grow? How big are the leaves and give two reasons why it is important to cay life.
12. Find a photograph of a sandpaper fig tree. How big does it grow? How big are the leaves and give two reasons why it is important to cay life.
13. Here is an illustration of a mangrove. Find out where mangroves occur in coral cays. In what parts of Queensland are they found and how important are they to the coral cay?
14. Find a photograph of an Argusia and make an outline sketch of it. Where is it found on the cay?
15. Find a photograph of a Pandanas or Screw palm. Make a drawing of it and find out where it lives.

GROUP 4: CAY BIRD LIFE

16. Find a photograph of a Noddy tern and make a colour drawing of it. Where does it build its nests and why? What food does it eat and when does it return back to the nest to feed its young?
17. Find a photograph of a reef heron. Where does it build its nest and what does it eat. Make a colour drawing of it.
18. Find a photograph of a sea gull. What happens to the colours of their legs as they get older? What do they eat and why are they a nuisance to other birds on the reef?
19. Find a photograph of another bird. Make a colour drawing of it and list two interesting points about its behaviour.
20. Find out which bird the person is answering in question 19. Select another bird and make a colour drawing. List any three things that you find interesting about this bird's life style.

GROUP 5: OTHER CAY LIFE

21. Use the index of a book to make a list of the invertebrates that are found on a coral cay.
22. Where are spiders found on coral cays? What are their predators and their prey?
23. Are ants found on coral cays? How did they get there and what effects do they have?
24. Are bacteria found in the air around a cay? What effects would a virus have on Pisonia trees? How could the virus be introduced to an island where campers wanted to burn wood?
25. Do kangaroos, wallabies or other marsupials live on cays? Give reasons for your answer.

GROUP 6: HUMAN INFLUENCES ON THE CAY

26. Make a list of the types of resorts that are found on coral cays. Who goes there and why?
27. Make a list of the effects humans would have on a cay where there was a tourist resort.
28. Make a list of the effects humans would have if camping on a deserted cay.
29. Talk to the persons who are researching questions 27 and 28 and say which humans have the greatest effect.
30. What effects do helicopters have on the bird life on cays? Use the model you made in Chapter 4 to explain where you would land a helicopter on a coral cay and why.

CHAPTER 7

REEF MANAGEMENT

Who will mange who? Why? Are we masters of our planet or servants to it? Will we drill the reef for oil in 2035?

In November 1970, Isobel Bennett wrote,

"There are two extremes among the alternatives for the development of the Great Barrier Reef.

The preservation of a unique national heritage - the conservation of its living resources in a manner which ensures their continued survival - the selection of sites and the planning of tourist facilities to enable the greatest number of visitors to enjoy the reefs without detracting from or destroying their natural beauty

or

The utilization of all natural resources to their fullest extent in a short term interest of the national economy of the country - regardless of whether or not this exploitation results in the despoilation of the reefs and possible death of the living communities of animals or plants which created them.

The responsibility for the Great Barrier Reef's future development within these extremes lies with all Australians. The overall plan for the administration of the development of the Great Barrier Reef province as an entity is an objective for which we must all strive..."

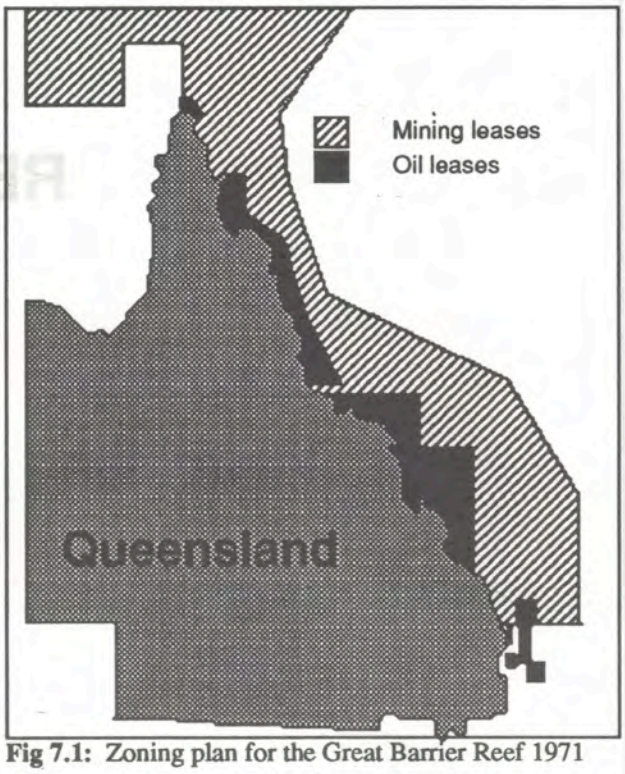


Fig 7.1: Zoning plan for the Great Barrier Reef 1971

That year, a government in Australia, had allowed mining companies from within Australia and overseas to have permits to search, drill and mine for oil and gas off Queensland's coastline.

In California, in the same year, similar leases had been granted. Figure 7.3 shows some small dots in the background. These are oil rigs near Los Angeles, one kilometre apart. Figure 7.2 shows oil pumps, ten metres apart on shore, which run along a road between Los Angeles and San Franscisco. These pumps are used to pump the oil to storage containers located inland.

That year in summer, the local press in California, reported problems again with empty blood vials and used syringes.

Fig 7.2: Californian beach 1970.

Fig 7.3: Oil rigs near Malibu, California.

Eight years later, The Great Barrier Reef Marine Park, Capricorn Section, was declared. The Government of the day then decided not to allow mining or drilling for oil on the Barrier Reef.

Discussions between the State and Federal Governments set up a plan for joint management which lead to an act of Parliament.

The Great Barrier Reef Marine Park Act of 1979 provides for the management of the Great Barrier Reef. So the Reef has its own act of Parliament. The Reef is a world heritage listing which makes it special.

Any elected government from now on will have to convince world authorities of the need to drill for oil and mine the reef. But can they?

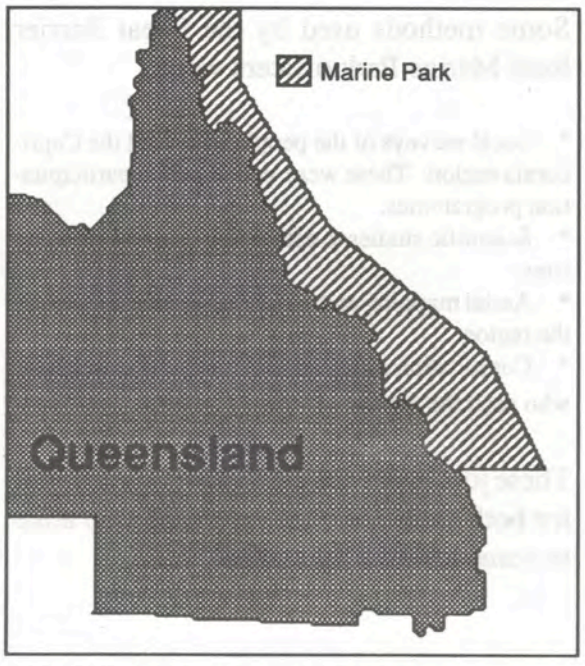


Fig 7.4: Zoning plan for the Great Barrier Reef today

The Great Barrier Reef Marine Park Act, set up a Government Authority, The Great Barrier Reef Marine Park Authority who was responsible for the safe management of the reef. Officers were appointed, a building established at Townsville, and staff employed as public servants to manage the reef.

One of their jobs was to prepare a zoning plan for the Capricorn Section of the Reef. Figure 7.5, shows the original zoning plan which was used to develop the concept of a multiuser park. The reef zoning plans are now constantly being updated.

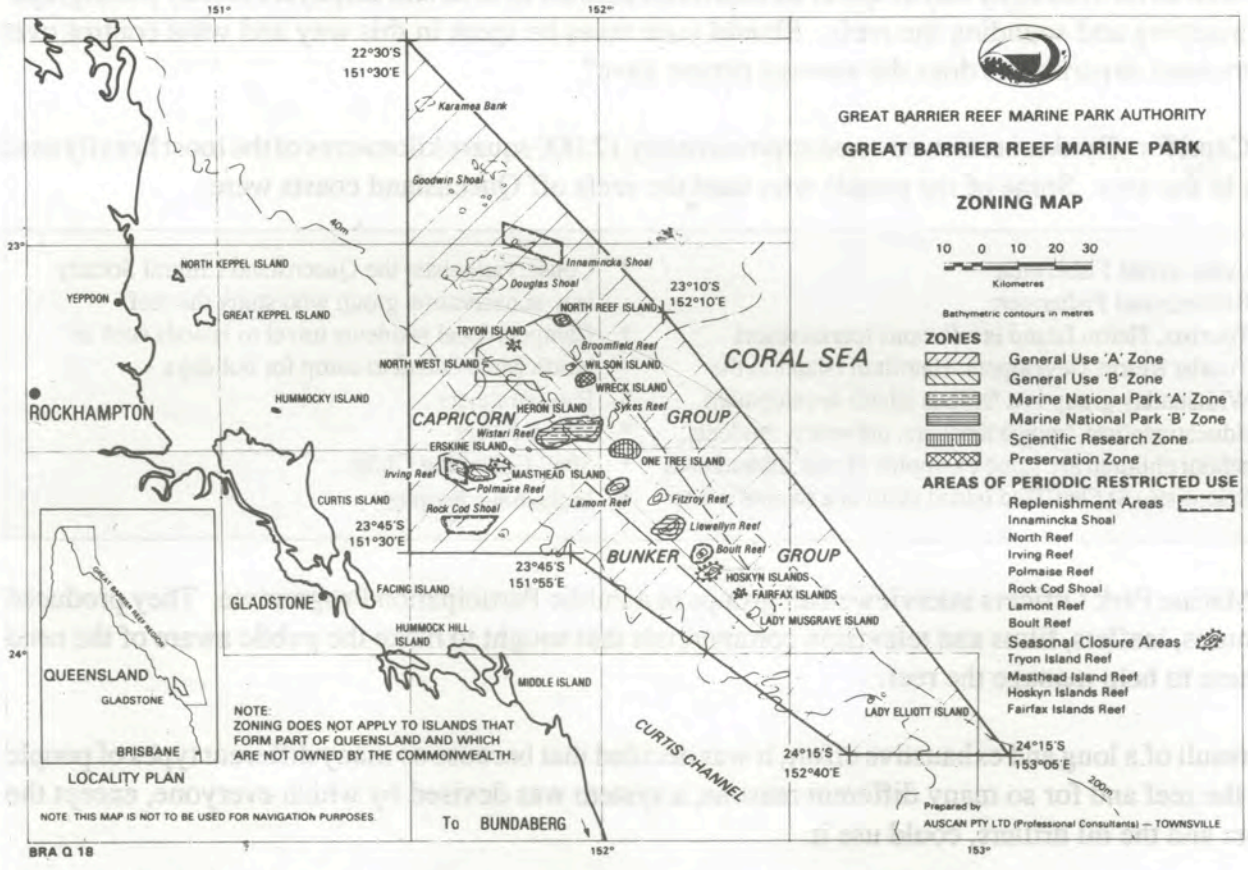


Fig: 7.5: Historically, the Capricorn Section was zoned first. This section is now the Mackay Capricorn section.

Some methods used by the Great Barrier Reef Marine Park officers were:

* Local surveys of the people who used the Capricornia region. These were called public participitation programmes.
* Scientific studies to establish important breeding sites
* Aerial mapping and surveying to map accurately the region
* Consultation with other Government Departments who used the region.

These jobs were not easy and it was difficult for both public servant and user group alike to come to some agreement.

Fig 7.6 : When the first plans were released, there was a public participitation programme called, "Help zone the reef". From GBRMPA annual report, 1986.

Look at the big spanner in the centre of figure 7.5. A group of professional fishermen traditionally used this area for trawling and it has been specifically zoned to allow trawling to continue so that families can make a living. Should the park officers and parliament deny people their rights to make a living?

Nothing had been attempted like this ever before in the world on such a large scale. There were marine parks overseas, but none of the size of the Great Barrier Reef.

What made their task even more difficult was the fact that many of the charts of the reef were not readily available so the Authority had to spend an enormous amount of time and taxpayers money photographing, mapping and sounding the reefs. Should your taxes be spent in this way and what control over government departments does the average person have?

The Capricorn Bunker section covered approximately 12,000 square kilometres of the most heavily used reefs in the area. Some of the people who used the reefs off Queensland coasts were:

* Commercial Fishermen
* Recreational Fishermen
* Tourists, Heron Island is a famous tourist resort
* Tourist Resort Developers, Hamilton Island in the Whitsunday group is a famous island development
* Educationalists, trainee teachers, university students, school children are some examples of educational uses
* Scientists, At One Tree Island there is a scientific site
* Conservationists- the Queensland Littoral Society is a conservation group who study the reef
* Campers-local residents travel to islands such as North Mole Island to camp for holidays
* Photographers
* Scuba divers
* Shell Collecting Clubs
* Indigenous Peoples

The Marine Park Officers interviewed all groups in a Public Participation Programme. They produced brochures, leaflets, films and television commercials that sought to make the public aware of the need for them to help manage the reef.

As a result of a long and exhaustive effort, it was decided that because so many different types of people used the reef and for so many different reasons, a system was devised by which everyone, except the miners and the oil drillers, could use it.

This, the Park Officers called, **MULTI-USER ZONING.**

Some of the stages of multi-use zoning are:

(1) An area of reef is zoned as Marine Park; clear maps are drawn showing the boundaries. The public is surveyed so as to identify the uses of that area.
(2) The Authority then draws up a proposed zoning plan and then gives it back to the public to prepare a submission for park use. Each of the interest groups is asked to prepare a submission for a public meeting which will be used as a forum for discussion about the zoning plan.
(3) The Authority then makes recommendations to Parliament about the proposed zoning plans. The Parliament then debates the zones.
(4) The zones then pass from the House of Representatives to the Senate to be debated further. After all this is done, the zones become law.
(5) After a period of time, the zones are reviewed and the cycle is then repeated.

Also the demand by development companies was great. Applications for tourist developments came in thick and fast. There were no environmental impact statements done on tourism, and funds had to be set aside for research. But results had to be fast and great changes were taking place. Tourism was on the increase. Cairns and Townsville now had international airports and jumbo jet loads of overseas visitors were flooding to see the reef. The entire reef has now been zoned.

But what can you do and how do you use these zones? The best way is to go to the reef and observe these zones in action.

Activity 7.1 Practical reef management

You will need

GBRMPA map Capricornia BRA Q123 July 1988.
OR the colour zoning map for your particular area.
Appendix 6:

What to do

1. Decide which area of the reef you wish to go to and obtain the relevant zoning plan.

2. Decide what you want to do and then consult the zoning plan. (e.g Figure 7.7, shows a typical activities guide, indicating which activities are permitted in a particular zone.

Use the colour map now to look at the islands zoned.

3. Write for permits to enter and use the park. If you camp, then you need a second permit.

MACKAY/CAPRICORN SECTION
ACTIVITIES GUIDE
(see Zoning Plan for details)

	Bait netting and gathering	Camping	Collecting (recreational – not coral)	Collecting (commercial)	Commercial netting (see also bait netting)	Crabbing and oyster gathering	Diving, boating, photography	Line fishing (bottom fishing, trolling etc)	Research (non-manipulative)	Research (manipulative)	Spear fishing	Tourist and Education facilities and programs	Traditional hunting, fishing and gathering	Trawling
General Use 'A' Zone	Yes	Permit	Limited	Permit	Yes	Yes	Yes	Yes	Yes	Permit	Yes	Permit	Permit	Yes
General Use 'B' Zone	Yes	Permit	Limited	Permit	Yes	Yes	Yes	Yes	Yes	Permit	Yes	Permit	Permit	No
Marine National Park 'A' Zone	Yes	Permit	No	No	No	Limited	Yes	Limited	Yes	Permit	No	Permit	Permit	No
Marine National Park 'B' Zone	No	Permit	No	No	No	No	Yes	No	Yes	Permit	No	Permit	No	No
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Preservation Zone	No	No	No	No	No	No	No	No	Permit	Permit	No	No	No	No
Seasonal Closure Areas*	No	No	No	No	No	No	No	No	Permit	Permit	No	No	No	No

Fig 7.7: Activities guide from the zoning plan, Mackay/Capricorn section, courtesy Great Barrier Reef Marine Park Authority.

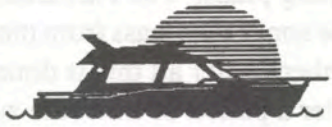
4. Each group discusses each of the following topics using the map of Capricornia supplied. If you prefer you could use the map of your local area. Maps are available from the Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville.

The Capricornia map

Q1. Use a copy of the map in appendix six along with the real map, to colour in the seven zones indicated and mark in the following islands and reefs: Masthead, Irving, Pomolaise, Erskin, North West, Heron, Wreck, Wistari, North Reef, Tryon, One Tree, Lady Musgrave Is, Boult, Lyewellyn Reef.

Q2. Complete the table in the bottom right hand corner to match the colours with the following permitted activities:-

(a) Bait netting and gathering
(b) Camping
(c) Collecting (recreational, not coral)
(d) Collecting commercial
(e) Commercial netting
(f) Crabbing and oyster gathering
(g) Diving, boating and photography
(h) Line fishing (bottom fishing, trolling etc)
(i) Research (non manipulative)
(j) Research (manipulative)
(k) Spearfishing
(l) Tourist and educational facilities
(m) Traditional hunting, fishing and gathering
(n) Trawling.



Q3. Mark in the colour zones of North West and Lady Musgrave in the second box. Now copy those for the other islands and mark in their colours as well.

Q4. Which reef has been declared:-

(a) A preservation zone
(b) A scientific research zone
(c) A replenishment area
(d) Marine park B.

Q5. How far is Lady Musgrave from Heron Is?

Q6. What do the terms Seasonal Closure, Replenishment and Reef Appreciation Areas mean?

Q7. Which islands are classified:

(a) Marine National Park "A" Zone (b) Marine National Park "B" Zone
(c) Scientific Research Zone (d) Preservation Zone

Q8. Which areas are declared General Use "A" Zones, General Use "B" Zones?

Q9. You are planning a trip to Tryon Island. You want to obey the laws of the Park.

(a) Who should you write to and for what purpose?
(b) What limitations would be imposed on you?

Q10. Where is spearfishing allowed??

Q11. Is spearfishing allowed with SCUBA?

Q12. Where is a permit required for netting of fish?

Q13. On what reefs is diving not allowed? Why?

Q14. Where is commercial spearfishing allowed?

Q15. Who is responsible for the day to day management?

Q16. Define each of the following terms and draw a diagram to illustrate your answer where applicable:-

(a) Bait netting and gathering
(b) Camping
(c) Collecting (recreational, not coral)
(d) Collecting commercial
(e) Commercial netting
(f) Crabbing and oyster gathering
(g) Diving, boating and photography
(h) Line fishing (bottom fishing, trolling etc)
(i) Research (non manipulative)
(j) Research (manipulative)
(k) Spearfishing
(l) Tourist and educational facilities
(m) Traditional hunting, fishing and gathering
(n) Trawling.

Once you have figured out what you can do and where you can go, write for your permits. Here are some sample letters to copy.

Anglefish High School
Reef Slope Drive
Capricornia Qld 4680

The Director
Great Barrier Reef Marine Park Authority
PO Box 1379
Townsville Qld 4810

Dear Sir,

Our school wishes to conduct an educational excursion to North West Island from the 23 September to 29 September this year. We will be entering the park by ferry departing Gladstone.

The party will comprise 45 students and 5 staff. Students will be undertaking a range of Project Reef Ed activities and be camping in tents.

Please may we have a permit to enter and use the park for educational purposes?

Yours sincerely

Anglefish High School
Reef Slope Drive
Capricornia Qld 4680

The Regional Superintendent
Queensland National Parks and Wildlife Service
212 Quay St
Rockhampton Qld 4700

Dear Sir,

Our school wishes to conduct an educational excursion to North West Island from the 23 September to 29 Septemeber this year.

The party will comprise 45 students and 5 staff who will set up camp in tents. Students will be spearfishing, scuba diving, using boats and undertaking a range of Project Reef Ed activities. We will be bringing our own food, water and a radio. The group will be entering the park by ferry departing Gladstone.

Please may we have a permit to camp in the park?

Yours sincerely

Once you have decided what you can do, it is time to apply to your superiors for permission to go. Also a letter communicationg your intention to the group is important. Here are two samples:-

Anglefish High School
Reef Slope Drive
Capricornia Qld 4680

The Director
Coral Cay Regional Office
Beach St
Capricornia

Dear Sir,

Our school wishes to conduct an educational excursion to North West Island from the 23 September to 29 September this year.

The aims of the trip are
(1) to provide practical examples of conservation that students can apply later in life
(2) to teach leadership skills and increase self-esteem and group co-operation while camping
(3) to complete a series of reef activities to supplement this semester Barrirer Reef World Unit

Please find attached the requirements as set out by your office and looking forward to your approval.

Yours sincerely

Anglefish High School
Reef Slope Drive
Capricornia Qld 4680

Dear Student,

Welcome to this year's reef trips organised by the Marine Studies section of our department. As you know, a selection process occurred and your participitation in this trip is evidence of the exemplary standard of behaviour that you have shown so far this year.

The islands are a long way off; communication is limited to a marine radio and the closest medical help is available by helicopter during daylight hours.

There is no water, electricity or sewage system on the island and students will be rationed to 4 litres of water a day. Washing wil be in the sea and cooking will be on gas burners to conserve the island's timber which is the home for lizards and other creatures we will be visiting.

Please set aside the night of Wednesday 7 September, at the Marine Studies building, at 5.30pm for an information night.

The aim of the trip is to write into the minds of those who go, the need for practical conservation methods so that as earth inhabitants, we can learn to live with nature wisely.

The trip is conditional on the allocation of permits and sufficient numbers to make it viable. Present cost for the 6 day's camping, travel and all other expenses is $.....

Yours sincerely

It is not a bad idea to then produce an information book that would contain the following sections:-

* Activities guide
* Student programme
* Equipment required per group
* Cooking gear required
* Sleeping gear required
* Personal equipment list
* How the bus and boat are to be packed
* Information on travel by boat
* How to set up camp
* Some basic safety rules
* A list of conservation ethics and rules
* A first aid list
* An equipment list
* Information on accident management
* Travel information.

Here are some suggestions for camping with a party of about 50 on a deserted reef island as described in the letters.

Activities guide

It is important that all who participitate experience the joys of travelling and the organisational hassles involved. Once on the island, all should walk around the cay during the day and at night. They should walk out to the crest through the coral zones and snorkel over these at high tide. They should also snorkel in the crest or over the slope at low tide.

The opportunity to catch a fish and have a fish meal should be provided and all should prepare, cook and clean up a meal either as a group or individually. All should walk for some distance along the reef crest in quiet solitude so that as individuals, they can relate to and reflect on the natural beauty of nature.

All these things should then be communicated to others both orally and in writing.

Fig 7.8 Students should be given time to reflect and ponder over the need for conservation of the reef. Simple activities like going for a boat ride along the reef crest at low tidecreate images in the minds of future Australians that will last long after school has finished. Attitudes to zoning are not made, they are created by experience and are one of the most important skills to learn.

Student programme outline

Saturday
Getting there and setting up, hygiene, noise curfew and safety rules

Sunday
Core activites, walking around the island, island conservation and camping, introductory snorkelling, beach fishing. High tide and low tide activities.

Monday
Core activities, low tide walk, high tide activities, night island walk

Tuesday
Student projects begin. Safety rules.

Wednesday
Student projects finish, afternoon free to explore and snorkel.

Thursday
Pack up and travel home.

There are other programmes in Project Reef Ed

Equipment required

Camping creates an attitude problem with many people. The more you take the greater the organisation. The simplest organisation with the least effort will beto adopt an attitude of roughing it, cooking on small gas stoves, drinking water, sitting on the ground and eating simple food. The following suggestions are made with this attitude in mind.

Cooking and sleeping equipment required
(per group of 8 for 5 day's camping)

* Lightweight tents and fly
* Sand pegs or pieces of wood with one sharp end
* Piece of plastic for over tents
* two burner gas stove and 4.5kg bottle
* 44 gallons of water in drum and small bottle and hose to fill from
* 1 esky with dry ice and all food frozen prior to trip
* 3 pieces of marine ply to act as table tops
* 1 rubbish bin for dried food storage
* 2 milk crates for canned food storage
* 1 sharp knife, teapot or billy, matches, egg flip, wooden spoon, can opener, potato peeler, wash-up brush, tin to put cutlery in , sugar container, tea container, toilet rolls, frying pan, washup bucket, salt/pepper, saucepan with lid, cutting board, detergent, mixing bowl, scourer, dish wipes.

Fig: 7.9: The right attitude to equipment can save the organiser a lot of time. Durable crates, food organised into groups a number of small eskies, light weight tents and a radio will cut down the organisational time.

* **Personal equipment list,** (to be packed as follows)

torch with batteries
toiletries
sunglasses
mosquito repellant
sunburn cream
camera
shampoo
raincoat
3 pencils
rubber and pocket knife
aspirin and medications
coloured pencils and ruler
+ tent fly and plastic cover
+ Wet suit
+ Tent and pegs
+ facemask and fins
* tick pair of socks
* pair of shorts
* plate, dessert bowl and cup
* knife, fork and spoon
* Towel, tea towel
* 5m of clothes line cord
* clothes pegs
* long sleeved shirt
* old woollen jumper
* sleeping bag
* 5 plastic bags
* swimmers
* long pair of jeans
* pair of sandshoes and thongs

* rubbish bin, to be packed into the bus trailer see figure 7.11)
# carry bag, to be taken onto the bus and contain your valuables and raincoat
+ snorkelling bag, to be taken onto the bus and contain gear that can get wet.

Fig 7.10. The packed bus and boats

Fig 7.11: The rubbish bins are packed into the bus's trailer and can be unpacked in pouring rain which should be planned for. The trailer should have racks if boats are to be taken.

Travel by bus

As outlined earlier, packing should be quite specific. The diagram below shows how to pack a bus economically for 50 people for seven days. Students should be made responsible for all items they take onto the bus and reminded to take all items of personal luggage with them when they leave.

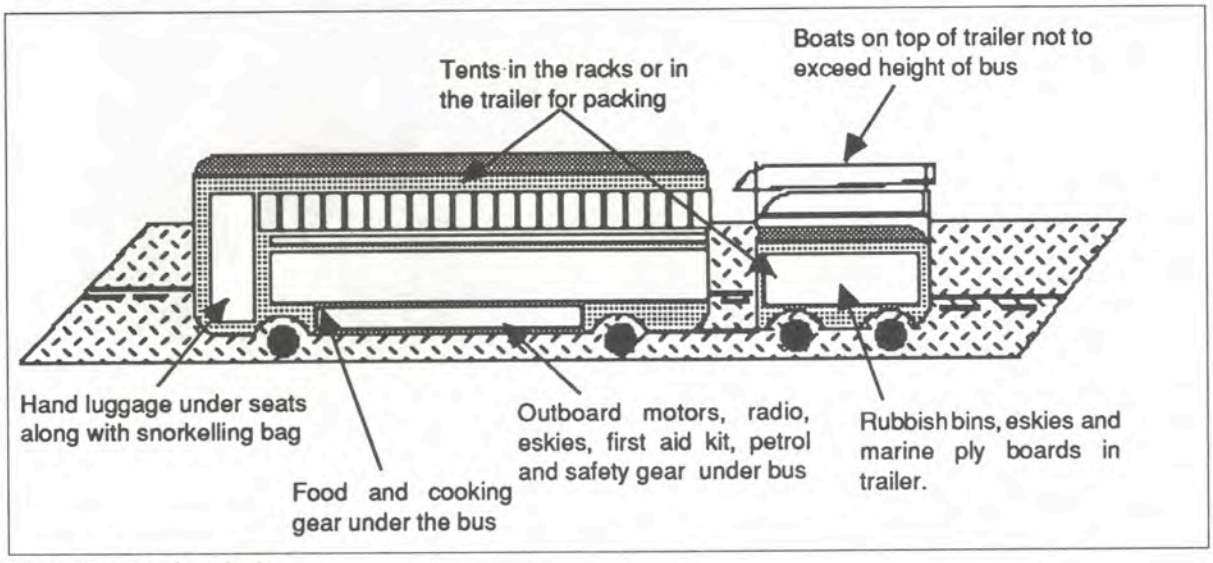


Fig 7.12: Packing the bus

The party should prepare to unpack the bus after an exhausting 8 hour trip in cramped conditions and pack the boat , at night, in pouring rain with torches and bad tempered organisers who have had many holdups with flat tyres and poor service en route.

Fig 7.13: Boat travel

Travel by boat

Now that you are refreshed after a 60 minute frantic packing job, you can settle back to an 8 hour boat trip at night in rough weather at 4 knots jammed together with people who are seasick. The best advice is to go to sleep and if you suffer from seasickness, take some tablets and lie down somewhere in the middle of the boat.

If you pack the boat so that the food and rubbish bins are out of water's way and leave the tinned food, water, boats, eskies, boards and snorkelling gear on deck, then there should be just enough room to sleep on the tents. Boats get very cold at night and jeans, thick socks and a jumper should be worn.

Fig 7.14: To unload quickly, form a chain.

Unloading the boat.

Have students collect all their personal gear and unload it first then form a chain and unload the rest. Many boats have to make a tide, so be quick and work well as a team.

Setting up camp.

Select a suitable site that will give privacy to the group but allow easy communication. Do not camp on the beach or on the dune vegetation. It is much cooler inside the island and better for nature. Tents should be light weight, contain a fly and be able to be stored easily. When pitched, the fly should not touch the inside of the tent to prevent water penetrating.

Here are some other ideas of practical campsite management:-

* Rubbish bins containing food can be placed be tween the fly and the inside tent to assist.
* You are camping in sand so pegs are different. If you tie your tent to a tree, be careful not to mark it with nylon ropes. Sand pegs can be made from pieces of wood about 500mm long with a point at one end.
* Tents should be arranged for privacy in mixed groups and a rule of no visiting of tents is quite good to ensure this as knocking is difficult on tent flys.
* Cooking gear should be simple and dependable. Two burner stoves with a 4.5kg bottle are by far the most commonly available and if placed on a milk crate, provide a safe place to cook.
* A rubbish bin close by can contain cooking utensils or food that needs to be stored away from rain.
* Above all do not burn any timber on the island. It provides humus and places for lizards to live. It allows for fertiliser to build up from the drop pings of the birds and is an essential part of the island's ecology.
* Set up a kitchen area with a tarp and arrange your marine ply for tables.
* A common walking path to the beach, a sink where all cooking wastes are rinsed through a gause mat.
* Freeze drinks and all food for esky. These act as ice blocks.

Fig 7.12: Tents should be lightweight. Use the wood you clear to make paths to avoid trampling damage.

Fig 7.13: Fuel stoves should be used when cooking.

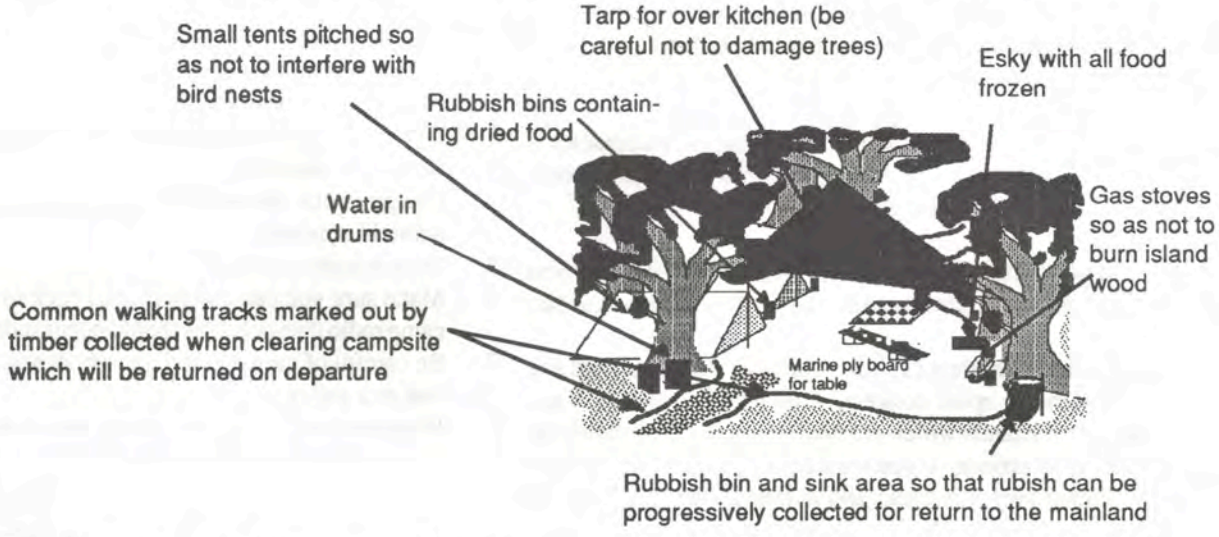


Fig 7.14: Some practical hints for camp conservation

TWENTY HINTS FOR CONSERVING ISLANDS AND REEFS

GENERAL

1. Leave plants, animals and natural features undisturbed so that they can be enjoyed by people who come after you.

2. Encourage others to develop a caring attitude for the Reef.

3. Some islands have been damaged by people in the past. Help them to rehabilitate now. Your contribution is important.

4. Observe any regulations established by park management authorities for wise use of the Reef and its islands.

ISLANDS AND REEFS

5. If visiting cays in the summer bird breeding season, take paricular care not to disturb nesting birds and chicks. Some types of ground nesting birds are easily disturbed by human approach and will leave the nesting site. Unprotected eggs and chicks are rapidly killed by heat, cold or sea gulls. Chicks may also become exhausted or lost if frightened away. Remember, if birds are flying above your head and calling they may be distressed having left the nest in an effort to protect it. (It's worth keeping in mind that at Heron Island, several species of ground nesting bird formerly found at the island, no longer nest there, because of human interference.)

6. Avoid going to the parts of an island where burrowing Wedge-tailed Shearwaters nest in the summer. It is difficult to avoid collapsing their burrows thereby crushing or suffocating the adults, chicks or eggs. If you fall into a burrow during the nesting season, dig it open in case it is occupied.

7. Do not disturb nesting turtles during the summer. Wait until the turtle begins to lay her eggs before approaching closely and switching on torches. Newly hatched turtles are attracted to lights so ensure your tent lights don't draw them inland where they will perish.

8. Do not feed food scraps to seagulls as this attracts them to the islandwhere they prey on the eggs and chicks of other birds as well as hatching turtles.

9. Do not burn or bury rubbish. Place litter in receptacles if provided. If rubbish receptacles are not provided, take rubbish back to mainland in strong plastic bags.

10. Do not bring animals or plants to the island because you may inadvertently introduce intestinal parasites or fungus etc.

11. Use fire with great caution. Ideally campers should use gas, kerosene or spirit cookers. Collecting firewood is not permitted on islands which are National Parks and should be avoided on all islands. If you must have a fire, bring your own fuel, making sure it is clean and is free of insects. Take all precautions to ensure that fire does not spread.

12. If staff smoke, collect all their butts and take them back to mainland.

13. Do not use island timber to make camp furniture. Site your camp carefully to avoid interference to plants or animals.

14. Keep to already-formed pathways. Do not trample plants or damage branches. For camp organisers to deserted days or islands, it may be to your advantage to mark out a pathway with fallen branches.

15. When reef walking, try to walk on sand or gravel between stands of living coral. Avoid trampling of coral.

16. When exploring the reef, only pick up unattached, robust organisms for examination and replace them quickly where you've found them. Do not collect specimens, dead or alive, unless you have a permit.

17. When looking for interesting life under reef boulders, select only a few boulders to search under, and turn them back quickly.

18. Avoid carrying out studies which involve manipulation of the environment.

19. If boating, avoid using damaging methods of boat launching and mooring. Don't throw rubbbish out of boats.

20. Make sure you understand fishing regulations which apply. Catch only what you can eat.

Ten basic safety rules

1. Do not swim in the sea at night.
2. Never wander over the reef by yourself. Always use a buddy system.
3. Always wear sandshoes when walking away from the campsite.
4. Use gloves or chopsticks to handle unfamilar animals or plants.
5. Do not harass animals.
6. Make sure you can communicate back to the camp radio if an accident should occur suddenly.
7. Be careful of currents and use a boat and float line as a safety precaution.
8. Wear a hat and burn cream all the time in the sun.

Students sample menu

Saturday	
Dinner :	Brought from home beforehand or purchased en route
Supper:	*enroute*
Sunday	
Breakfast:	Purchased *enroute*
Lunch:	Sandwiches on board the boat.
Dinner:	Chicken, vegetables (carrots, boiled potatoes, pumpkin, peas, tinned fruit, cordial, tea)
Supper:	Tea, Coffee, Milo, Biscuits, fruit cake.
Monday	
Breakfast:	Cereals or eggs (Cornflakes/Vita brits/Bioled eggs/Toast with jam/honey/vegemite/honey/ scrambled eggs/fried eggs/long life milk/ tea/coffee/milo
Lunch:	Sandwiches or crackers with cold meats, spreads, carrots, lettuce, celery, coleslaw, tea/coffee/...
Dinner:	Beef Casserole (Diced beaf, peas, pumkin, potatoes, carrots, celery, onions etc), Dried stewed apples, custard with powdered milk) tea/coffee/milo/cordial.
Supper:	Tea, Coffee, Milo with long life milk, Biscuits, fruit cake.
Tuesday	
Breakfast:	Similar to Monday
Lunch:	Similar to Monday
Dinner:	Hamburgers , hot dogs or fresh fish, with vegetables or left over salad. Creamed rice and peaches or whipped long life cream
Supper:	Tea, Coffee, Milo with long life milk, Biscuits, fruit cake, pancakes and jam.
Wednesday	
Breakfast:	Similar to Monday
Lunch:	Similar to Monday
Dinner:	Tinned ham steaks or fresh fish vegetables, Stewed apples, custard and more pancakes
Supper:	Tea, Coffee, Milo with long life milk, Biscuits, fruit cake.
Thursday	
Breakfast:	Similar to Monday
Lunch:	Similar to Monday
Dinner:	Sausages and Eggs or fresh fish with vegetables. Tinned two fruits and whipped long life cream, rice patties and cream or more pancakes
Supper:	Tea, Coffee, Milo with long life milk, Biscuits, fruit cake.
Friday	
Breakfast:	*enroute*
Lunch:	*enroute*

Sample programme (Another is in Project Reef ed)

Saturday		***Tuesday***	
1.00 pm	Depart school	all day	Work on projects and write up
11.00pm	Arrive Gladstone and pack boat		
12.00am	Depart Gladstone for Island	***Wednesday***	
Sunday		all day	Finish projects
7.00	Arrive island and unload	***Thursday***	
8.00	Set up tents and kitchen areas		
9.00	Collect food and 3water ration	8.00	Practical conservation and management session
10.00	Morning tea, site inspection and rest	4.30 pm	Pack boat.
1.00	Core activity 1. Reef walk and snorkel	5.30	Depart Island for Gladstone
3.30	Campcraft lesson on cooking and hygene		
7.00	Core activity 2: Walk around the cay	***Friday***	
Monday		8.00am	Arrive school
8.00	Core activity 3 Manta tow and snorkel at high tide		
11.00	Core activity 4 Cay vegetation and conservation		
1.00	Core activity 5 Reef top walk		
4.00	Core activity 6 Daytime walk around cay		
7.00	Explanation of projects		

FIRST AID KIT
(My sincere thanks to Dr. Victor O'Keefe from the Nerang Medical Centre for the advice on this section)

General Use Kit

TABLETS	USE
andrumin	prevent sea sickness
kwells	prevent sea sickness
disprin	pain
aspirin	pain
codral	cough lozenges
polaramine	allergy
avil	allergy
laxettes	constipation

MIXTURES	
mylanta	for indigestion
dexal	indigestion
ipecacuanha	to induce vomiting (replace each year)
bricanyl	cough
koamagma with pectin	diarrhoea

CREAMS	
aristocort	for itch, rash, sunburn
hibitane	for itch etc.
metsal	for muscular soreness
dencorub	for muscular soreness

DROPS	
visine	eye irritation

POWDER	
medipulv	for cuts to be dried
boracic acid	powder drying

PREPARATIONS	
sunblock	sunburn
adaptic	a non stick dressing
stingose	stings
vinegar	stings
calomine lotion	sunburn - rash
metaphen	coral cuts
betadine	coral cuts
rid	insect repellent
sunburn cream	

EQUIPMENT	
small sterile packets	sterile swabs
crepe bandage	constricting bandage -stings
paper adhesive tape	non-stretch adhesive
elasto plast	stretch adhesive
cotton buds	-
butterfly closures	constricting adhesive - small cuts
splinter forceps	remove splinters
disposable tongue depressors	depress tongue
steri strips	repair lacerations
cotton wool	-
clinical thermometer	body temperature
centigrade 100°C	to check water for 50°C
small hand towel	-
soap	-
safety pins	-
bandages	(6) 1", (6) 2", (6) 3".
kidney dishes (2)	use with dressings etc.
bowls (2)	use with dressings etc.
scissors	use with dressings etc.
scalpel blades	use with dressings etc.
scalpel handles	-
tampons and pads	-
triangular bandages (disp)	arm slings, folded compression bands, dressings
combine dressing rolls 3"	non-sterile dressings large areas / arms
labels, rubber bands, pencil	label patients
writing paper	letters to hospital or medics
clinical record charts	record pulse, temps, clinical condition
1 arm inflatable splint	broken arms
1 leg inflatable splint	broken legs
1 hot water bottle	trauma
1 tent	first -aid station -
thermos flask	water
marine radio	communications

Sample campsite

MANAGING ACCIDENTS WITH REEF CREATURES

Most animals seek only to defend themselves or their offspring. It is therefore important to understand not only the dangers associated with these animals and plants, but also their behaviour and reproductive cycles. As a general rule, most animals that are territorial will actively defend this territory. A moray eel, for example, is not an aggressive animal by any means and only seeks to protect its own private space.

The story is often told of a group of foolhardy people who went on a snorkelling trip to a barrier reef island. *"An over enthusiastic and uncaring snorkeller speared a moray eel. This was wrong in itself, for in the Great Barrier Reef Marine Park, moray eels are a protected species. However, the young lad thinking the animal was dead, threw it at one of the girls in the party. The moray, half dead and clinging to whatever it had in its dying nervous system, lashed out at her legs and inflicted a wound requiring 60 stitches. The reports in the press portrayed the moray eel as the villain, hiding in the pool where the girl was snorkelling and darting out and gnashing at her anatomy."* It is so easy to take the human side and so easy to portray animals as dangerous beasts of prey.

The first rule in reef management is do not disturb or pick up any creature until you are familiar with its Biology.

Most injuries from marine creatures occur as a result of carelessness on the part of the victim. You should have people in the reef party who are proficient in first-aid, especially resuscitation and are capable of identifying the marine creatures mentioned on the following pages.

Fig 7.12: Moray eel

CUTS

Coral is covered in a slime which can easily cause infection in a wound. Even apparently minor grazes and abrasions must be treated promptly and carefully, or else they will become infected.

First-Aid for cuts

Thoroughly clean the wound as soon as possible after the injury. Remove all foreign material with a cotton bud, tweezers or tooth brush and use an antiseptic lotion. Apply a local antibiotic powder or ointment. If necessary, apply a dressing and keep the affected area dry once the dressing has been applied. It should be noted that there are many marine bacteria that are very resistant to some antibiotic creams. If the wound becomes infected, make sure you seek medical advice so that the marine bacterium can be identified by a pathological test and the correct antibiotic prescribed.

Coral cuts need special attention. If cleaned and treated with a drying agent, (hydrogen peroxide, metaphin or betadine), the wound will dry up thus depriving the bacteria of a moist place to grow.

VIDEOS
REEF REPORT 3/87
Show the segment on " look but don't touch".
MARINE FIRST AID
Mackay Air Sea Rescue Association. Show the segment on Marine Cuts.

PUNCTURE WOUNDS

Fish Spines

These wounds can vary depending on the nature of the venom. All fish spine wounds are associated with the rapid onset of pain. Fish which inject venom from their spines include the stone fish and the butterfly cod. Injuries from this family can occur if protective footwear is not worn or if the fish is handled underwater.

Safety precautions

Always wear protective footwear. Fins with a shoe while snorkelling or sandshoes while walking to and from your favourite snorkelling site. The most economical form is a pair of sandshoes. The most effective are snorkellers' booties, however these require a fin that has a strap attachment so fin and booties can be an expensive investment.

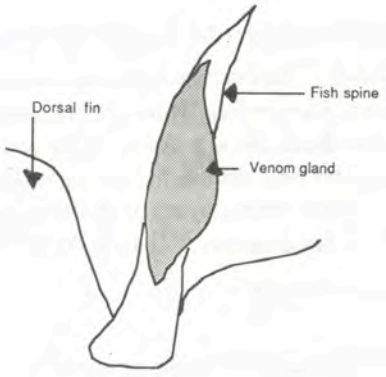


Fig 7.13: Butterfly cod and spine

First-Aid for fish puncture wounds

Remove the patient quickly from the water. People vary greatly in their reaction to fish puncture wounds. In the case of a puncture wound from a fish with venom on its spines medical aid will be needed as soon as possible. There is an antivenom available for stone fish injuries.

First-aid for all fish spine injuries includes immersing the affected area in hot water (up to 50°C) as soon as possible to immobilise the venom. If a local anaesthetic is available it should be administered to relieve the pain and calm the victim. Seek medical assistance. This should be followed by the application of a pressure bandage to stop the spread of the venom. Application should be similar to that of a snake bite. In the case of an injury involving venom, the patient should be carefully monitored for respiratory failure and cardiac arrest. The person administering first-aid should be prepared for External Cardiac Compression (ECC) and Expired Air Resuscitation (EAR).

First Aid for Stone Fish

Immerse the puncture wound in hot water. Apply a pressure bandage and transport the patient immediately to medical aid.
The doctor will carry out the following steps:
1. Inject a local anaesthetic solution around the wound - thus providing immediate relief from the pain.
2. Inject specific stonefish antivenom, once identification of the sting is confirmed.
3. Carefully incise down the puncture line and wash out the venom with sterile hot water.
4. Dress and bandage the wound appropriately and give a tetanus toxoid booster injection.
5. Arrange bed rest and supervise until further pain relief.

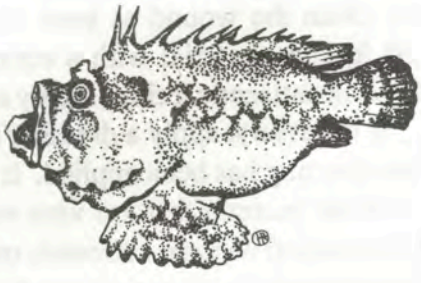


Fig 7.14: Stonefish

All stonefish envenomations require medical assistance.

Stingrays

A stingray is definitely not an aggressive creature and if left undisturbed presents no problem to reef walkers and snorkellers. If stepped upon or provoked stingrays can inflict a nasty wound from a serrated barb on its tail. (Some rays have venom associated with their barbs).

Safety precautions

Always shuffle your feet in the water as you enter a sandy still water beach. This makes the rays aware of your presence. Stingrays like to cruise close inshore and feed off the molluscs just below the waterline.

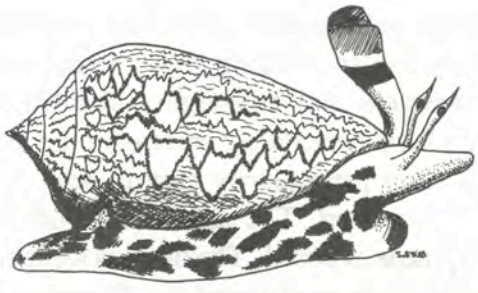
Fig 7.15: Stingray

First-Aid for Stingray

These injuries are always painful and a rescuer must be prepared for ECC and EAR if the patient's reaction is particularly bad. As with fish spines the affected area should be immersed in hot water (up to 50°C) and a general anaesthetic should be applied after the wound has been thoroughly cleaned. Seek medical assistance. The doctor will inject a local anaesthetic so as to remove all traces of the barb, its sheath and venom.

Cone shells

It is difficult for a newcomer to distinguish between poisonous cone shells and harmless molluscs which look somewhat like them.



Therefore, under no circumstances should any shell resembling the drawing opposite, be picked up by a person who knows the poisonous species from the harmless. It has been claimed that the venom apparatus can penetrate clothing so do not put cone shells in your pocket!

First-Aid for Cone Shells

Muscular paralysis and respiratory failure can result as quickly as 10 minutes after the injury. Seek medical assistance as soon as possible. A rescuer must be prepared for ECC and EAR.

The affected limb should be immobilised and a pressure bandage should be applied as for a snake bite. No antivenom has been developed for the cone shell.

Fig 7.16: A cone shell and how to get stung if you picked one up.

How to tell the difference between a cone shell and a stromb shell

A stromb has a wider mouth than a cone shell. However if you are in doubt, don't touch either as the poison from the proboscus of the cone shell can kill you very quickly. The barb is located near the narrow end of the shell and is shot out at prey. The barb contains the toxin, which can immobilise the prey very quickly.

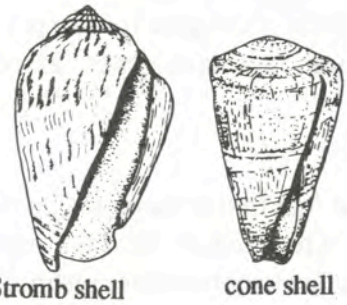


Fig 7.17: Stromb shells and cone shells.

Sea Urchins

The spines of the sea urchins are long, sharp and brittle. Their spines tend to break off and remain in the tissues when they are stepped on or touched. Injuries from sea urchins most often occur when reef walking, or when slipping down a crevice.

Safety precautions and first aid for sea urchins

Always wear sandshoes or booties when walking to and from the snorkelling site. Remove the spine with tweezers and thoroughly clean the wound. Apply a local anaesthetic cream to relieve the pain. If spines are particularily hard to remove, a razor blade can be used. The skin is sliced off till the top of the spine is exposed. The blade is wedged into the side of the spine and levered out. Cover the area with a clean dressing and seek medical advice if the patient shows any adverse reactions.

Fig 7.18: Sea urchin

Bristle Worms

Bristle worms are found on the underside of coral boulders. They are segmented worms with bristles protruding from each segment. The injury occurs when the animal is touched and the fine bristles penetrate the skin. Contact with bristle worms rapidly produces an intense itching or burning sensation lasting up to a week.

Safety precautions and first-aid for bristle worms

Always be careful when touching anything. If you later rub your eye, you can rub in the stinging cells which can be very painful. Remove the bristles by applying an adhesive tape over the affected area. As the adhesive tape is peeled off, the bristles are pulled from the tissues. Apply an anaesthetic ointment to the affected area. Seek medical advice if the problem persists.

Fig 7.19: Bristle worm

STINGS

Some animals responsible for stings are

* *stinging hydroids*
* *jellyfish*

Stings result from the stinging (nematocysts) cells along the tentacles. Corals rarely present a problem, however some hydroids and jellyfish can deliver painful stings.

Fire coral in particular can cause great pain and possible respiratory and cardiac failure in some. It should be avoided at all times.

Fig 7.20: Stinging hydroid

The Box Jellyfish or Sea Wasp

The animal lives in calm warm water on a sandy bottom near the coastline. The jellyfish are rarely seen on offshore reefs and tend to concentrate in the summer months off Queensland beaches north of Gladstone. It is so named because of its box like shape with four fleshy protrusions called *pedalia,* which hang from each corner of the jelly.

The tentacles are ribbon-like if undisturbed and can stream out behind the animal or be contracted when swimming. It has been estimated that an adult box jelly can have over five thousand million nematocysts on its tentacles. In the natural movement of the water, the box jellyfish is very difficult to see.

First-Aid for Sea Wasp/Box Jellyfish

Quickly remove the patient from the water and apply vinegar as soon as possible. This will inactivate any undischarged nematocysts. (Don't waste time removing the tentacles as the vinegar renders them harmless)

Next stop the venom from being absorbed into the blood by applying a constrictive bandage. Apply the bandages directly over the tentacles which have been treated by vinegar **but** not over untreated tentacles.

Note the following points:

* In the case of the Sea Wasp the patient will be in excruciating pain and a rescuer must be prepared to perform ECC & EAR.
* Picking off untreated tentacles will cause nematocysts to fire
* There is an antivenom available and medical assistance should be obtained as soon as possible.
* Never use sand to remove the tentacles
* Do not leave the victim
* Do not move seriously stung patients

Fig 7.21: The box jellyfish, *Chironex fleckeri.*

The Townsville "Stinger suit"

This suit has been developed for sailors, lifesavers, divers and snorkellers who use tropical waters in the summertime. The suit is made of specially prepared materials through which nematocysts cannot penetrate. The suit also prevents sunburn.

The box jellyfish deliver fatal stings (51 in Australia since 1884). One third of victims died within 3 minutes of being stung. This number can be reduced with modern resuscitation methods coupled with quick action, correct application of vinegar and bandages.

BITES

These are inflicted from the mouth of the animal. In most cases the mouth is located in the front.

Blue Ringed Octopus

This animal will display iridescent blue rings on its body and tentacles when agitated. The octopus should never be picked up as it can inflict a severe bite.

Fig 7.22: Blue ringed octopus

Safety Precautions and first aid.

Do not handle blue ringed octopi. A rescuer must be prepared for ECC and EAR. Apply a broad pressure bandage as high up the limb as possible. Immobilise the limb with a splint and seek medical aid as quickly as possible.

Moray Eels

Moray eels are generally retiring creatures and students should be warned not to feed them or provoke them as this is the only time they could become dangerous.

Fig 7.23: Moray eel

First-Aid and safety precautions for moray eels

Direct pressure must be applied to stem blood flow with a pad or bandage. Medical help should be sought as soon as possible because stitches may be required. Do not provoke moray eels into attacking you. Handle gently with confidence and care.

Shark

The risk of shark attack is extremely low. Tourist resorts would never be able to function if the danger was nearly as great as that sometimes told in the newspapers. There has never been a reported shark attack on a snorkeller in Queensland waters.

Safety precautions

Areas to be avoided are remote locations not used by regular visitors. Places where fish are regularly cleaned or trawlers work should be avoided. An area soon gets a reputation amongst regular users if there is any danger from sharks, so seek local knowledge about snorkelling if you are unsure.

There are some simple rules to follow to avoid shark attacks:

* don't swim in the sea at night
* avoid areas where sharks frequent eg: trawler bases, meatworks, garbage tips
* avoid swimming at dawn or dusk
* if spearfishing throw dead fish into a boat or tie them to a marker buoy
* do not provoke sharks by poking, spearing, grabbing or riding on their backs

First-Aid for shark bite

Quick and efficient first-aid in the event of an attack is vital. The victim will be suffering blood loss and shock and the actions of those first on the scene will largely influence the victim's chances of survival. Remove the patient from the water as quickly as possible. However, don't move the patient again once first-aid is being given. Send for medical help immediately, rushing a victim to hospital in a boat or car can cause further loss of blood. Try to get help to the victim. If possible, pressure should be applied to the wound while in the water to prevent as much blood loss as possible. Lay the victim down on the beach, head lowermost and apply direct pressure to the wound. Transportation of the victim must be left to the medical experts.

Sea Snakes

Sea snakes are generally quiet creatures, however at certain times they can become inquisitive.

Under no circumstance should a sea snake be hit or poked as this will naturally create aggression with the animal. If a sea snake does become inquisitive, you should move casually back to the boat or shore trying to hide your incredible fear that most of us have to sea snakes.

If you are bitten, then treat the wound like that of a stone fish.

Fig 7.24: An olive sea snake

SAFETY

Overall safety while on the reef is important because the group will be some distance from immediate medical help and require boat or helicopter rescue. It is important for all who go to increase their own personal level of safety awareness in all activities be it boarding a boat, cooking on the islands, snorkelling or reef walking. It is equally important for tour leaders or group organisers to make the members of the party aware of this.

ACTIVITIES TO DO WHILE ON THE REEF (Project Reef Ed)

The manual called Project Reef Ed, contains 159 student activities designed primarily for reef project work. The activities are divided into into two categories:

(a) The natural world
(b) The human dimension

A number of suggested programmes have been given as well as a a sample programme to Heron Island. An appendix justifying reef education is given which is particularly useful to schools who require a detailed justification for a reef field trip. A discussion on values education, choosing content for a reef education programme, the reef and environmental education and how syllabus are matched as well as a resource list on books. If your were going to the reef, this book is a must.

One fact remains. The very fact you go to the reef is an education in itself. What attitudes and values are gained rests completly with the organiser. Make sure you teach the right attitudes and values.

BACK TO THE CLASSROOM

It is an unfortunate fact that not every one can participitate on a reef trip. A video will shortly be available on a reef trip, however the "Reef Report 2/88 Video, "a day on the reef", is a useful supplement for those who are unable to go on a reef trip.

This book is designed to be the culmination of a course of marine studies. Other booklets in the Wet Paper series gradually lead students towards a study of the Reef. For those of you who have studied the full set, this is the opportunity for you to put it all together.

Many marine educators see a study of the reef as a separate entity, however nothing could be further removed from the truth. The reef is one of the most complex systems known. It is an interaction of a study of social and political science, human and Australian geography, physical, chemical, biological and geological science and to fully understand its complexities, requires a lifetime of study by thousands of people.

ACTIVITY 7.1 SUMMARY

A reef trip should have enabled students to:-

* appreciate that there is a great deal of effort involved in travelling and that travelling requires a degree of organisational skill in the following areas:-
  (a) documentation and finance
  (b) packing and selection of personal equipment
  (c) safety and first aid management
  (d) knowledge of the area to be visited with special reference to (c) above
  (e) recreational activities including snorkelling
  (f) cooking and food preparation
  (g) interpersonal relationships

* gain a knowledge from the following reef experiences (This and other books in the series)

  (a) walking on or around an island and reef (Chapters 2, 3 and 4 of this book)
  (b) swimming in and below reef waters (Snorkelling book)
  (c) observing reef animals and plants macroscopic and microscopic (Fisheries Biology book)
  (d) travelling, navigating and position finding (Navigation book)
  (e) observation of beaches and dune systems and the importance of each (Coastal studies book)
  (f) conducted an abiotic reef project involving the determination of salinity (Seawater book)
  (g) experienced diving underwater, methods of ocean study,
  the weather at sea and ocean currents (Oceanography book)

* aquired values and attitudes consistent with sound management and conservation practice.

* demostrated skills in survival and recreational outdoor pursuits.

Finally, you should be now in a position to make some decisions about reef management and conservation so that you can put into practice, those values and skills you have learned. Activity 7.2 is designed to do just that. It takes about two weeks in class to get ready and assemble materials and should not be examined formally, rather assessed by group opinion and peer influence.

It is the conclusion of the course and it is hoped that you now have some attitudes that you can defend with some scientific knowledge. For example:

(a) a development which cuts down the She Oaks, will pay more in glass cleaning bills. So is it not better to leave the She Oaks and make a nature path between them to the beach?
(b) pollution which prevents the crest algae from photosynthesising will stop the water being cleaned and purified
(c) removing sea cucumbers will cause the sand to become dirty because there will be no animals left to vacuum clean the reef
(d) burning the wood on the island will stop the leaves from creating humus and so stop the natural process of soil fertilization and deprive lizards of homes
(e) leaving litter will clog up sand crabs holes and not allow for the turning over of sediments so the sea cucumbers will have nothing to vacuum clean.

How many more can you think of? These days when there is increased pressure to develop our reef and coastline it is just not good enough to come up with unsubstantiated cases to halt progress. In fact, if we want jobs in the future and to hold on to our standard of living, we need development. What are other people's values and how influential are they? This activity will flush them out.

Activity 7.2 : Zone the Reef - A classroom role play

(Based on an original idea by Dennis Bridger and Len Zell and later developed by Brian Armour for the Project Materials Encounters with the reef. Finally published in Project Reef Ed, 1988.)

Purpose

To split the class into different user groups so as to conduct a meeting in which a hypothetical reef area will be zoned by the Marine Park Authority.

Optional extra

The Authority could then prepare a zoning plan and the class could select from an opposition and an elected government to role play a debate in the House of Representatives.

This takes about two weeks to prepare and organise fully.

Time Required

Two weeks for collection of information, group discussions, library research, preparation of report.
One full period for the group to role play the Authority, to present their zoning plan and their activities guide pamphlet.
One Eighty Minute Double Lesson for meeting for the interest groups to present their cases and reports.
One full period for the whole class to reach a decision that can be submitted to Parliament.
One week completion of reports, summaries and handing in of Assignment.

Materials required

Copy of Hypothetical Reef Park Proposed Zones and No Zones
Each group will require a copy of the briefing sheets from Project Reef Ed, Activity 143

What to do

In class: Now that you have a knowledge of some of the activities that one or two user groups would have and some of the restrictions that apply in a park such as Capricornia, you are to use a hypothetical reef park to come up with your own zoning plan.

To work in a user group. Select one of the following and collect a plan of Hypothetical Reef Park. Your teacher will help you organise the groups and may have a draw for the groups. You may come with groups of your own and use as little or as much of the following information as you desire.

The user groups:- Note * Core groups

The Half Moon Island Development Corporation *
The Newtown Shell Collectors group
The Hypothetical Tourist and Development Corporation
The Scientists from the Newtown University*
The Hypothetical Park Authority**
A Newtown ports fisherman's group
The Newtown Society for the preservation of the reef*
The local aboriginal population who have a burial site on Deadman's Island*
The local camping adventurers club
The Newtown commercial fisherman's association*
The Newtown waterside workers club.

The Hypothetical Park Authority plans are appendixed as are blank plans of the Park. Make sufficient copies of these to assist your group discussion. You must each submit a separate report based on the combined discussions of the group.

Make clear in your report the following:-

1. What areas you object to and at least two reasons why you object to them.
2. What areas have been completely neglected and why you think they should be zoned.
3. What areas your interest group wants and five good reasons why.
4. What your interest in the park is and why.
5. What association your group has had with the proposed park and for how long.
6. How you wish the park zoned. Use the blank map in Appendix 7.

The group who play the authority's role: You must obtain a copy of the zoned map in the appendix, and each person in the group prepare a report as follows:-

1. Clearly make a colour map of the park indicating the zones (use the one in Appendix 6)
2. Make up an *Activities Guide* like the one for Capricornia. Type or neatly write this up and circulate it to members at the meeting for consideration.
3. Prepare an overhead transparency or big wall chart for the meeting.

Teachers Note: It is your responsibility to let groups come up with their own ideas, however it may be necessary to seed some ideas into the discussions. Brochures and pamphlets are useful and a model report prepared.

STOP PRESS: *Future editions of this booklet will have one such simulation.* ***Benmar mining****, would be a good example to present because it would seek to mine the reef when in fact we know that mining is impossible at this stage in our reefs. However students who are not used to preparing reports or playing simulation games need some guidance and this example could help.*

The first lesson.

Devoted to the Authority, which explains to the assembled group, its proposed plans. It hands out a pamphlet describing the various uses and restrictions that may apply.

The next lesson.

You need a double period and about 15 minutes per group. User groups, why not make signs and placards for your presentation. Better still, dress up and really role play the user group as you have seen them depicted in the media.

You may like to discuss this with you teacher first and the class next door. You could invite the local press to make it more realistic or a representative from the National Parks and Wildlife Service or Great Barrier Reef Marine Park Authority to act as an observer and then comment on the role play and the accuracy of the roles played.

During the lesson give the people who role play the chance to get their point across. Then try to strike up a debate trying to pick flaws in their arguments.

Try at all times to base your arguments on the knowledge that you have gained in this book and reference books, television programmes and newspapers you have read. Make sure you acknowledge these references so that others may judge you on your factual knowledge.

Show the video segment:-

Reef Report 1/88 on the Floating Hotel to stimulate discussion as well as commercial fishing from the same video.

The final lesson

As a class come to some consensus. This must be done because someone has to make a decision sometime.

Use the chart that the authority has to draw in the following zones:-
General Use A
General Use B
Marine National Park A Zone
Marine National Park B Zone
Scientific Research Zone
Preservation Zone

Concluding remarks.

To the students and teachers who use this booklet:

The management of the Reef is up to you. We hope the knowledge and skills you have aquired will assist you to make responsible, and more importantly, informed decisions. In 200 years the Reef could be mined and there could be oil rigs or some underground mining. Governments across the world change and so do the attitudes of people from one generation to the next.

Make sure your generation makes informed decisions and judges the reef for what it really is - one of the world's greatest living things to be loved, admired and used by all wisely for all times.

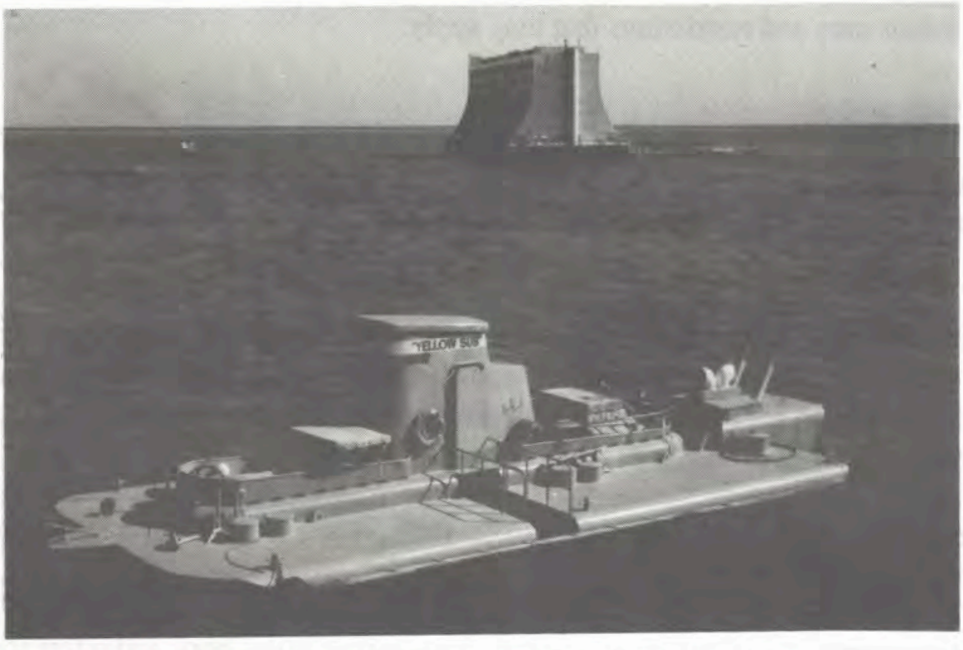
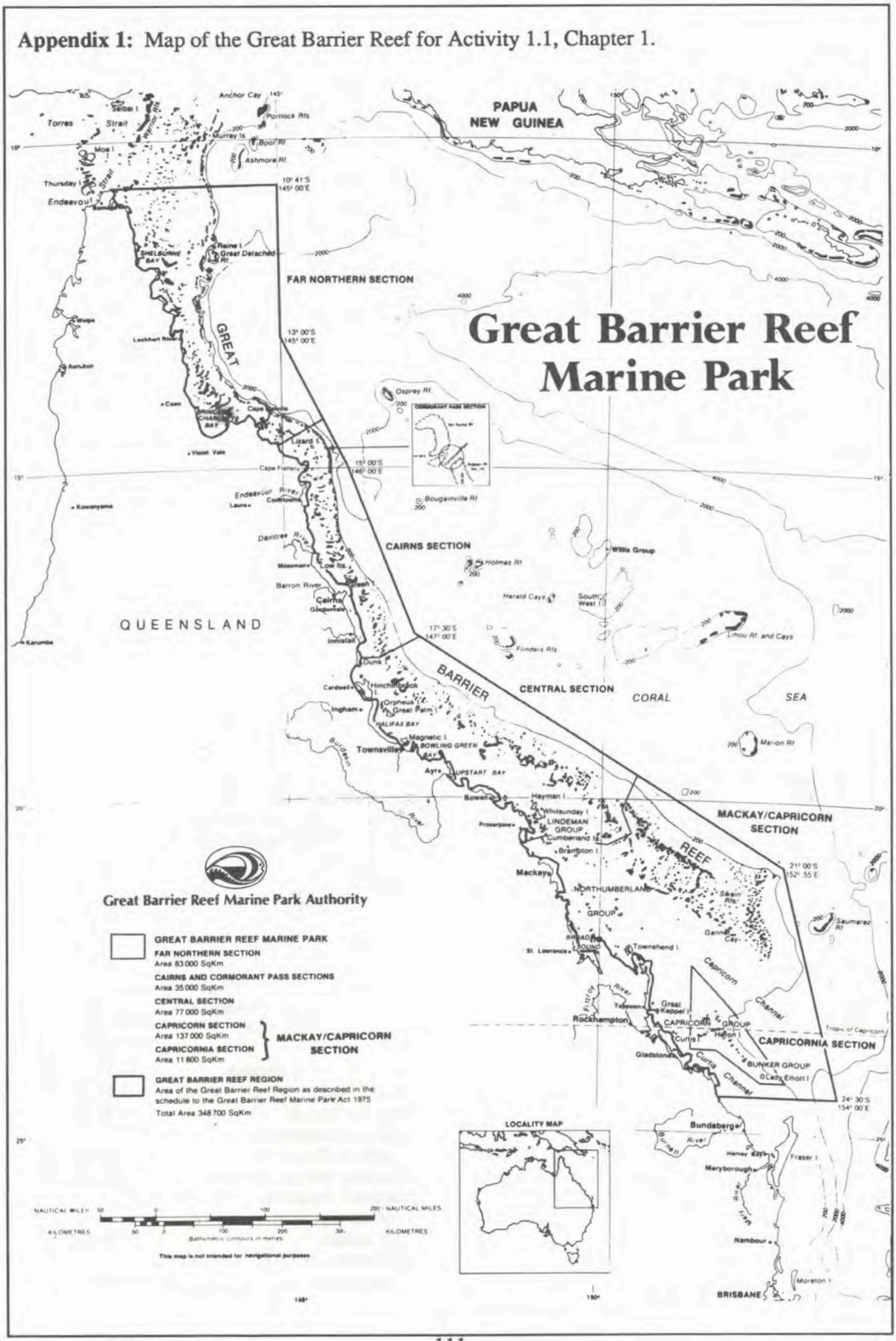


Fig 7.25: Different user groups make different demands on the reef.

Appendix 1: Map of the Great Barrier Reef for Activity 1.1, Chapter 1.



Appendix 2: The Geological Time Scale Story. Reproduced with permission, from the Australian Science Teachers Journal, *August 1987, Vol 33, No2, pages 77-78.*

GEOLOGICAL AND ASTRONOMICAL TIME

Roger Scott
Pine Rivers High School, Qld. 4500

Time is one of the key concepts in earth science. Almost all geological processes require immense spans of time. Evolution, deposition of thick sedimentary sequences, mountain building and continental drift are just a few. In order to understand those processes, a new concept of time is necessary.

Yet this is not an easy concept with which to come to terms. Students must make a large adjustment, and they have to be helped in this. There is little in their common everyday experience to help them with this radically new time frame.

One of the best methods I have seen is that of Carl Sagan, the American astronomer and popularizer of science (Sagan, 1977).

He has produced a "Cosmic Calendar", which compresses the history of the universe into one year. The Big Bang is taken as occurring 15 billion years ago, and by definition occurred in the first second of January 1 in the Cosmic Calendar. The present time is midnight on December 31. Various important events are allotted dates in the calendar by proportion.

This compression of natural history produces interesting results. A thousand years becomes roughly two seconds, and a hundred million years a couple of days. It gives a new perspective.

Some of the dates from Carl Sagan's calendar have been reproduced below, with a few extras.

EVENT	DATE
Big Bang	Jan 1
Origin of the Milky Way Galaxy	May 1
Origin of the Solar System	Sep 1
Origin of life on Earth	~ Sep 25
Date of oldest fossils	Oct 9
Formation of Mount Isa ore bodies	Nov 24
Significant atmospheric oxygen develops	Dec 1
First worms	Dec 16
Precambrian ends, invertebrates flourish	Dec 17
First fish	Dec 18
Plants begin to colonize land	Dec 20
First insects	Dec 21
First amphibians	Dec 22
First reptiles, large coal deposits in Northern Hemisphere	Dec 23
First dinosaurs, large coal deposits in Australia	Dec 24
Palaeozoic Era ends, Mesozoic begins	Dec 25
First mammals	Dec 26
First birds	Dec 27
Mesozoic Era ends, dinosaurs extinct, first primates	Dec 29
Giant mammals flourish, Himalayan mountains developing	Dec 30

Our knowledge of December 31 is so good that hours, minutes and seconds are necessary to properly see the sequence of events.

EVENT (December 31)	TIME pm
First humans	~ 10.30
Widespread use of stone tools	11.00
Beginning of most recent glaciation	11.56
Aborigines arrive in Australia	11.58
Invention of agriculture	11.59.20
First cities	11.59.35
Invention of the alphabet	11.59.51
Bronze Age	11.59.53
Iron Age begins	11.59.54
Ptolemaic astronomy, birth of Christ	11.59.56
Crusades, Mongol invasion	11.59.58
European Renaissance, emergence of the experimental method in science	11.59.59
Widespread development of science and technology	NOW !!!

REFERENCE

Sagan, C.. (1977). *The dragons of Eden,* London: Hodder and Stoughton, (pp 14-16).

Appendix 3: Tide tables for Activity 3.1 and 3.2. Reproduced with permission from the Department of Harbours and Marine

AUSTRALIA, EAST COAST - CAIRNS

LAT 16°55′ S LONG 145°47′ E

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

MAY

	Time	m		Time	m
1 SU	0221	0.99	**16** MO	0311	1.02
	0815	2.32		0850	2.12
	1424	0.51		1508	0.36
	2101	2.55	●	2201	2.75
2 MO	0252	1.06	**17** TU	0355	1.15
	0836	2.22		0923	1.91
	1452	0.49		1544	0.49
○	2133	2.58		2243	2.64
3 TU	0328	1.16	**18** WE	0446	1.29
	0900	2.08		1001	1.70
	1523	0.52		1623	0.67
	2208	2.56		2335	2.47
4 WE	0409	1.28	**19** TH	0559	1.41
	0930	1.92		0650	1.42
	1559	0.60		0804	1.40
	2252	2.48		1040	1.49
				1704	0.86
5 TH	0502	1.41	**20** FR	0044	2.30
	1008	1.73		0945	1.31
	1642	0.72		1145	1.32
	2352	2.37		1752	1.04
6 FR	0837	1.48	**21** SA	0224	2.20
	1059	1.54		1126	1.19
	1735	0.87		1602	1.29
				1910	1.18
7 SA	0145	2.30	**22** SU	0340	2.17
	0949	1.31		1154	1.10
	1338	1.41		1654	1.41
	1917	0.99		2117	1.22
8 SU	0322	2.40	**23** MO	0427	2.17
	1024	1.12		1200	1.04
	1535	1.57		1726	1.55
	2107	0.95		2223	1.20
9 MO	0415	2.52	**24** TU	0505	2.18
	1056	0.91		1150	0.96
	1635	1.79		1757	1.70
☾	2219	0.86	☽	2313	1.17
10 TU	0505	2.62	**25** WE	0538	2.18
	1133	0.70		1204	0.86
	1731	2.03		1828	1.86
	2320	0.78		2355	1.16
11 WE	0552	2.68	**26** TH	0608	2.17
	1211	0.50		1224	0.76
	1826	2.28		1857	2.02
12 TH	0013	0.73	**27** FR	0032	1.15
	0637	2.67		0632	2.16
	1250	0.35		1245	0.66
	1918	2.50		1924	2.18
13 FR	0102	0.74	**28** SA	0104	1.14
	0717	2.60		0654	2.14
	1327	0.27		1307	0.55
	2004	2.67		1951	2.36
14 SA	0147	0.80	**29** SU	0135	1.12
	0751	2.47		0721	2.12
	1401	0.24		1331	0.45
	2045	2.77		2021	2.52
15 SU	0229	0.90	**30** MO	0208	1.09
	0820	2.30		0750	2.09
	1434	0.27		1401	0.36
	2123	2.80		2055	2.64
			31 TU	0247	1.09
				0822	2.02
				1435	0.32
			○	2133	2.70

Symbols for Moon Phases ● new moon ☽ 1st quarter ○ full moon ☾ 3rd quarter

★Extra Tides—See Page 62

AUSTRALIA, EAST COAST - MACKAY OUTER HARBOUR

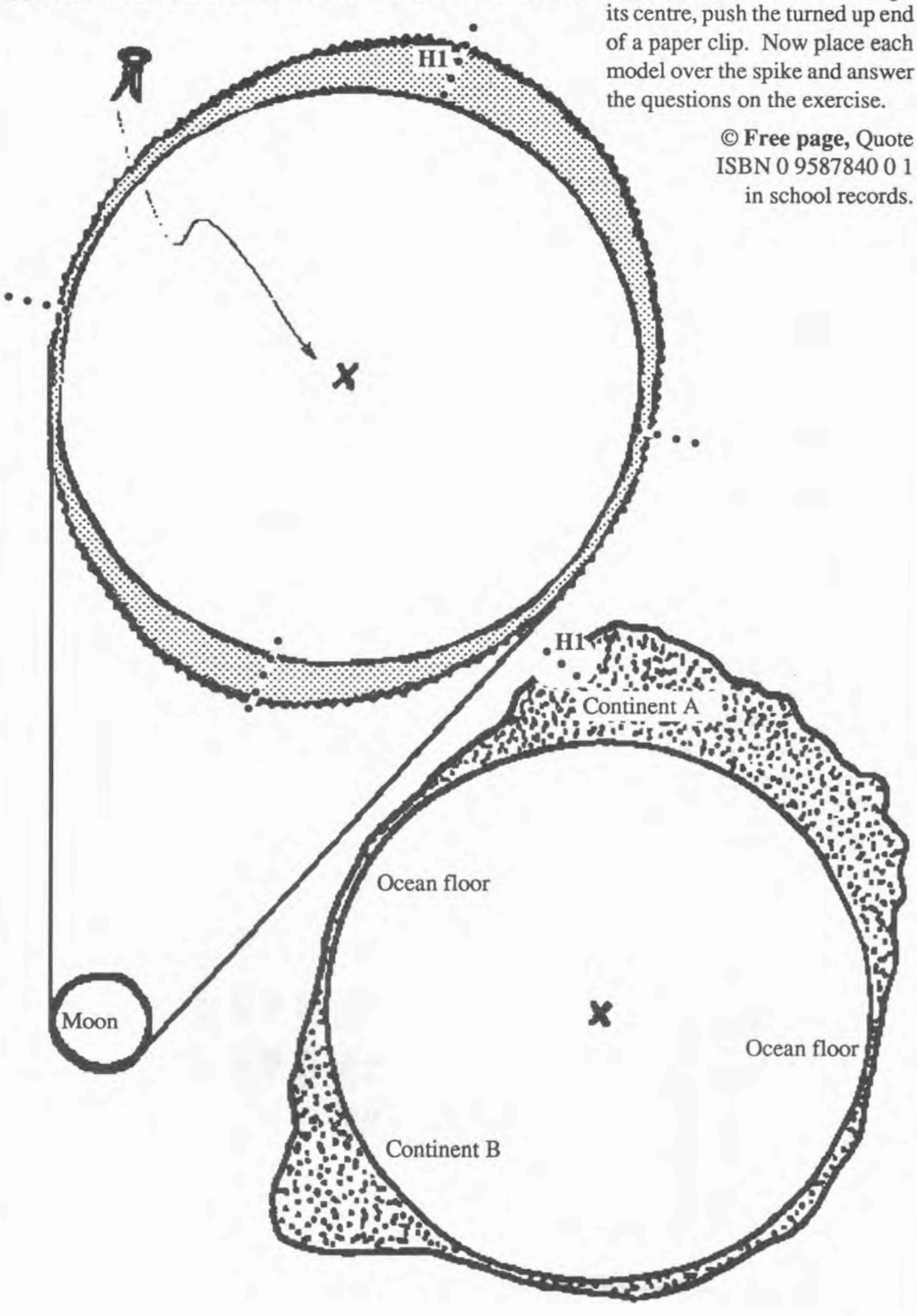
LAT 21°07′ S LONG 149°14′ E

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

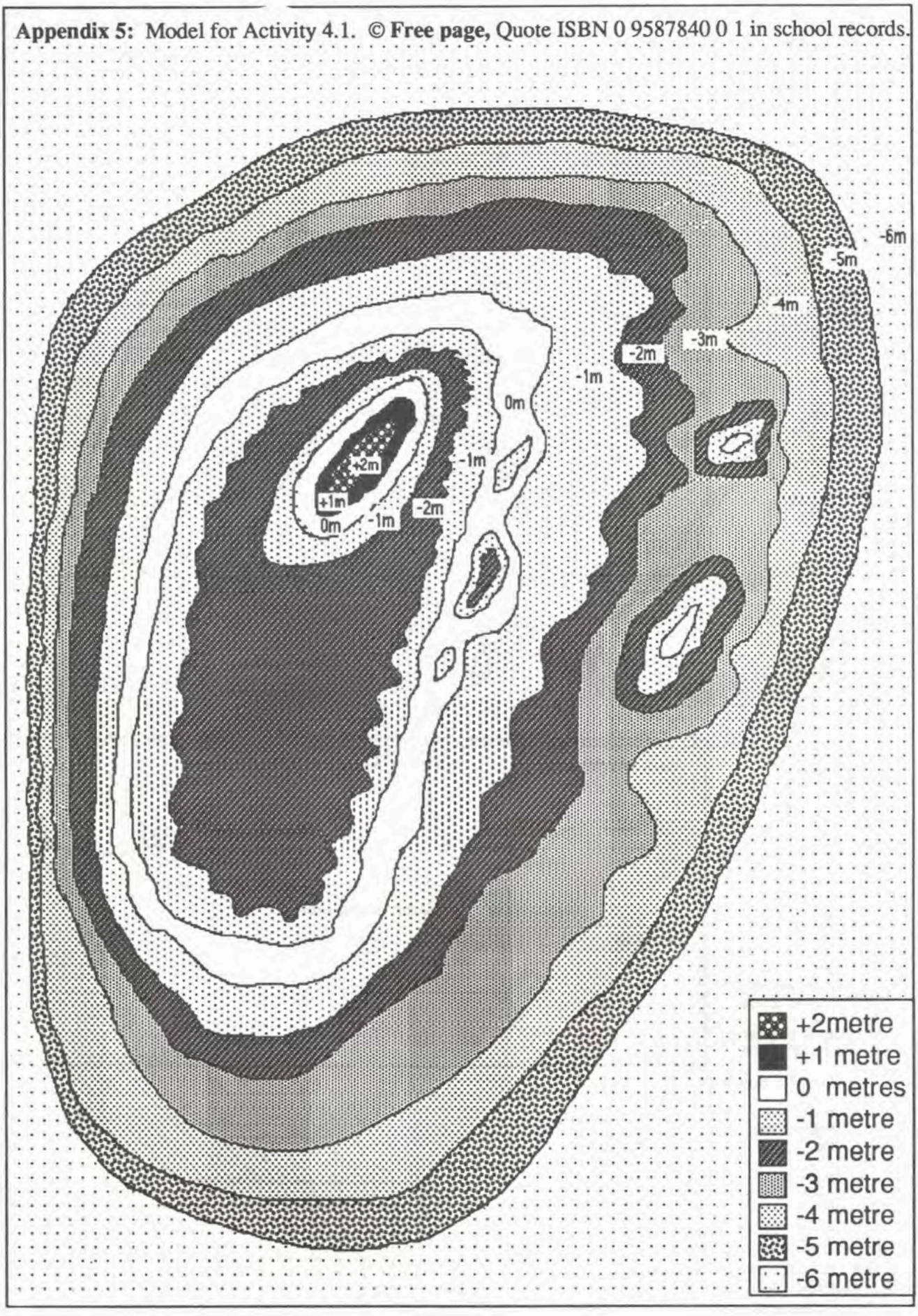
MAY

	Time	m		Time	m
1 SU	0438	1.15	**16** MO	0451	0.98
	1025	4.89		1035	4.82
	1641	0.75		1647	0.42
	2253	5.44	●	2308	5.94
2 MO	0515	1.28	**17** TU	0536	1.04
	1059	4.62		1121	4.60
	1712	0.91		1726	0.58
○	2327	5.39		2353	5.86
3 TU	0554	1.46	**18** WE	0623	1.16
	1135	4.30		1209	4.36
	1744	1.13		1808	0.84
4 WE	0002	5.26	**19** TH	0040	5.66
	0636	1.69		0712	1.32
	1211	3.97		1302	4.13
	1815	1.40		1851	1.16
5 TH	0038	5.08	**20** FR	0129	5.39
	0721	1.91		0807	1.49
	1253	3.67		1358	3.94
	1849	1.66		1942	1.50
6 FR	0122	4.87	**21** SA	0223	5.09
	0818	2.10		0907	1.62
	1346	3.43		1502	3.80
	1935	1.92		2048	1.80
7 SA	0219	4.68	**22** SU	0323	4.81
	0933	2.16		1015	1.66
	1504	3.32		1621	3.78
	2045	2.11		2208	1.98
8 SU	0333	4.58	**23** MO	0437	4.65
	1056	2.03		1127	1.56
	1639	3.42		1745	3.94
	2213	2.13		2332	1.96
9 MO	0456	4.63	**24** TU	0551	4.64
	1209	1.72		1230	1.35
	1806	3.76		1849	4.24
☾	2340	1.95	☽		
10 TU	0609	4.83	**25** WE	0045	1.78
	1302	1.36		0650	4.72
	1904	4.21		1318	1.13
				1936	4.55
11 WE	0055	1.65	**26** TH	0138	1.59
	0705	5.03		0735	4.77
	1345	1.02		1356	0.96
	1949	4.66		2013	4.82
12 TH	0152	1.36	**27** FR	0223	1.45
	0750	5.15		0813	4.75
	1423	0.76		1431	0.85
	2028	5.06		2047	5.04
13 FR	0239	1.16	**28** SA	0302	1.37
	0831	5.18		0848	4.67
	1458	0.56		1504	0.81
	2107	5.41		2120	5.22
14 SA	0323	1.03	**29** SU	0340	1.34
	0910	5.13		0923	4.55
	1533	0.43		1537	0.80
	2145	5.69		2154	5.37
15 SU	0407	0.98	**30** MO	0420	1.32
	0952	5.01		1000	4.43
	1608	0.37		1610	0.82
	2225	5.88		2230	5.49
			31 TU	0501	1.32
				1040	4.30
				1647	0.87
			○	2308	5.55

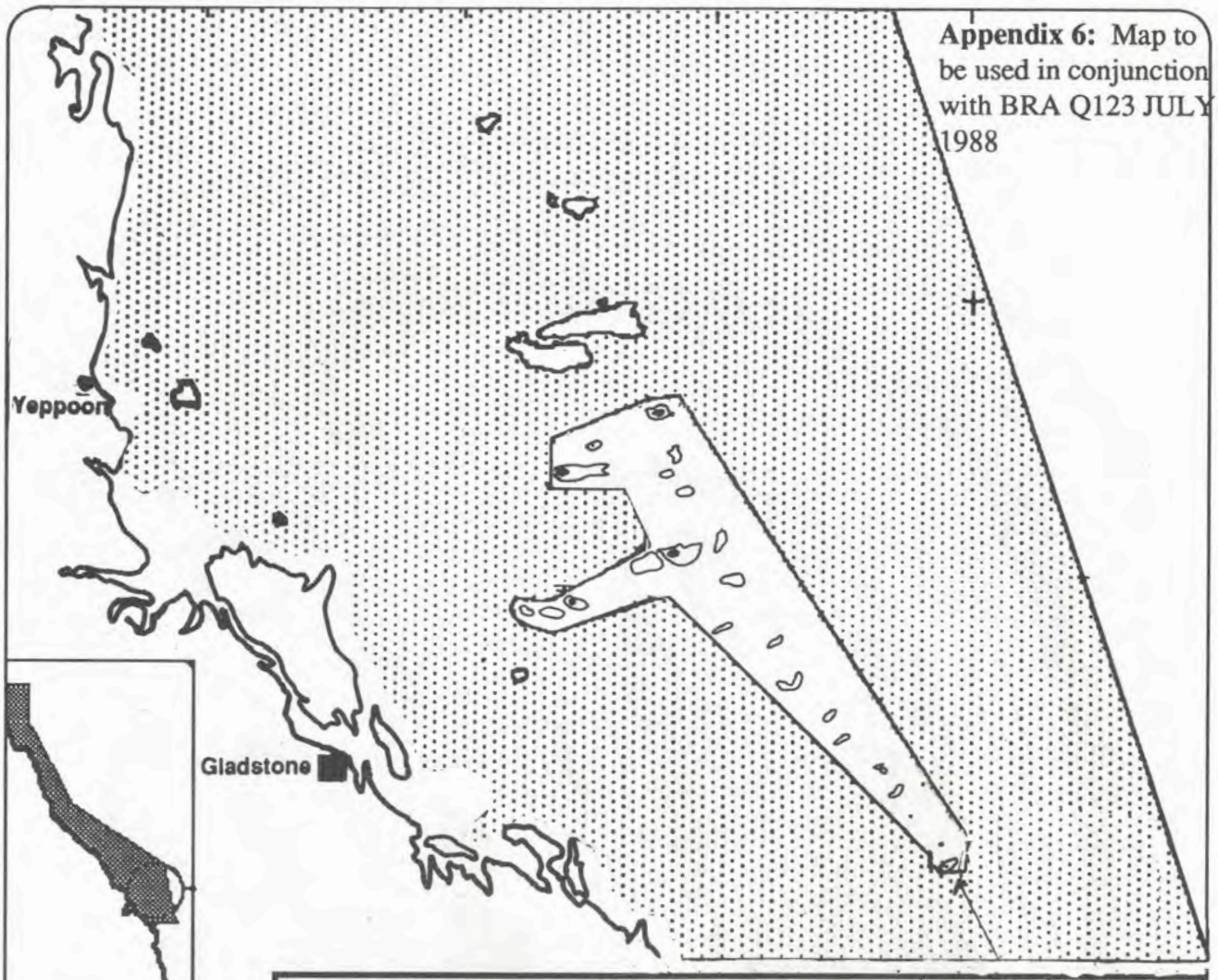
Appendix 4: Cut out both the models. Make a hole in coloured sheet of cardboard, and through its centre, push the turned up end of a paper clip. Now place each model over the spike and answer the questions on the exercise.



Appendix 5: Model for Activity 4.1. © **Free page,** Quote ISBN 0 9587840 0 1 in school records.



Appendix 6: Map to be used in conjunction with BRA Q123 JULY 1988



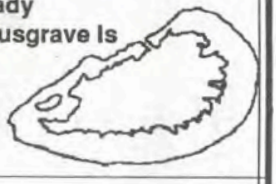
Your island maps

North West

Wreck Is

One tree Is

Lady Musgrave Is

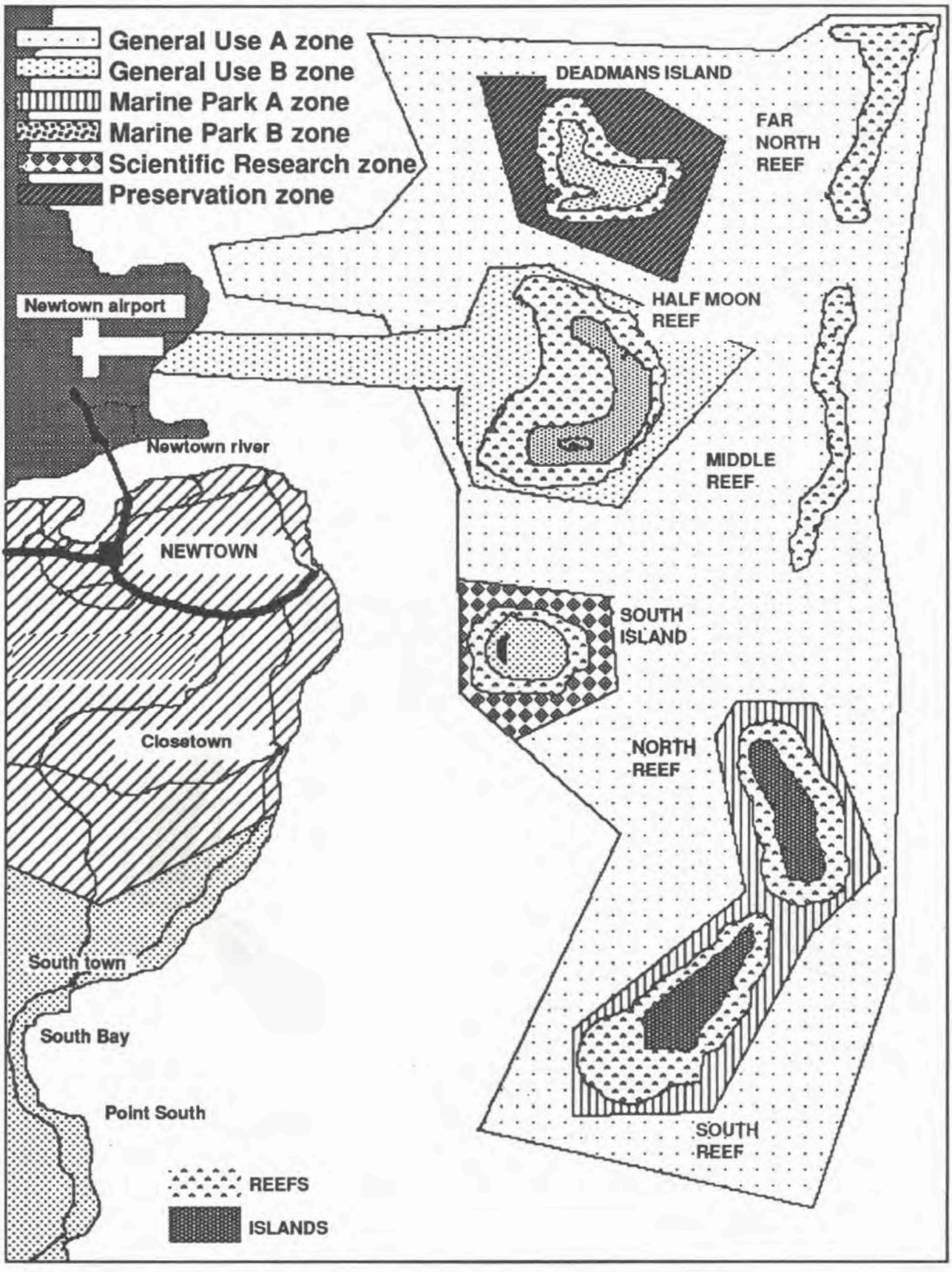


Heron Is and reef

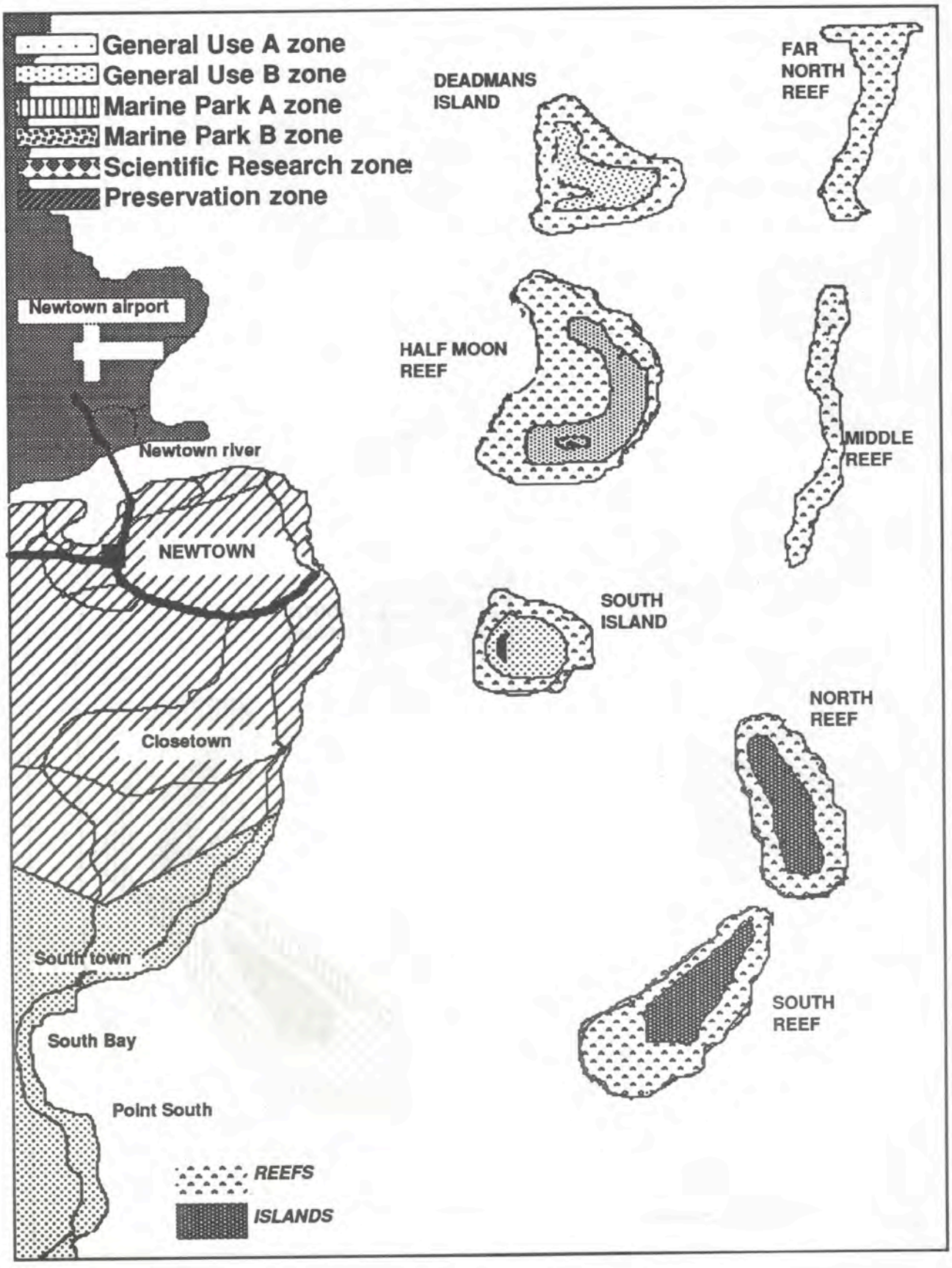
- General Use "A" Zone
- General Use "B" Zone
- Marine National Park "A" Zone
- Marine National Park "B" Zone.
- Scientific Research Zone
- Preservation Zone
- Seasonal Closure Area

This map is to be used with activity 7.1 page 89 and is to be handed in with the questions from page 90.

Appendix 7: HYPOTHETICAL REEF PARK WITH ZONES This is the proposed plan as presented by the group who role plays the authority. No reasons are given and it up to the authority to explain its reasons at the first meeting. Use the Reef Ed briefing cards to get some ideas but you will score more if you come up with your own.



Appendix 8: HYPOTHETICAL REEF PARK WITH NO ZONES. You are to use this plan to show how your interest group wants to set up thezones for your use. Use the briefing cards in project Reef Ed to get ideas on the type of attitudes and values that this group would take. You should not be constrained by these and you will get more marks if you come up with more and use newspaper references to substantiate your claims.



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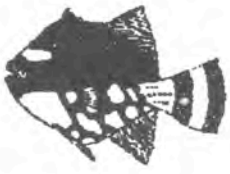
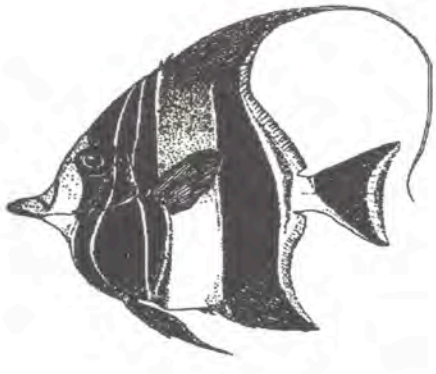




THE AUTHOR

Bob Moffatt is a Science graduate of the Queensland University majoring in Marine Zoology and has completed a Graduate Diploma in School Administration from the Brisbane College of Advanced Education specialising in Marine Management Systems.

He began teaching marine studies programmes 16 years ago in the Wide Bay Region where he developed a programme for Senior Zoology students. In 1976 he received a grant from the Commonwealth Schools Commission to begin the Gladstone Oceanographic Studies Program in Queensland's Central Region. In 1983 he founded the Brisbane South Region Marine Studies Program on Queensland's Gold Coast from which many curriculum materials have been developed.

Bob has been a pioneer in the design and implementation of curriculum materials. He built a prototype Marine Studies building in 1985 and actively promoted marine education throughout Australia largely from the sales of his earlier books. He has had much to do with the purchase of marine resources in Queensland schools and is presently assisting with the Marine Studies Board of Secondary School Studies Syllabus. He was a foundation member of the Marine Studies Education Society of Australasia of which he is now immediate past president.

In 1986 he undertook, at his own expense, a world tour to 14 overseas countries to gather ideas to further marine studies school based curriculum development in Queensland schools. In addition, he represented the Queensland Education Department at the Pacific Area Conference of Marine Technology in Hawaii on an honorary basis.

Bob was a recipient of the Science Teachers Association teacher of the year award in 1985, he won the Inaugural Australian Castrol Sea Safety Award for excellence in the design of a marine safety programme in 1987 and was nominated for the Shell Achiever's Award in the same year. Bob enjoys surfing and snorkelling as often as possible with his three sons. He has worked with private enterprise as a consultant in his own time and has written part of the Reef Ed curriculum materials for the Great Barrier Reef Marine Park Authority on an honorary basis. He developed the Sea World Project Neptune Activity Projects in 1987 and was asked to develop a syllabus and curriculum materials for UNESCO where he participitated in the first marine science curriculum workshop in Fiji in 1988.

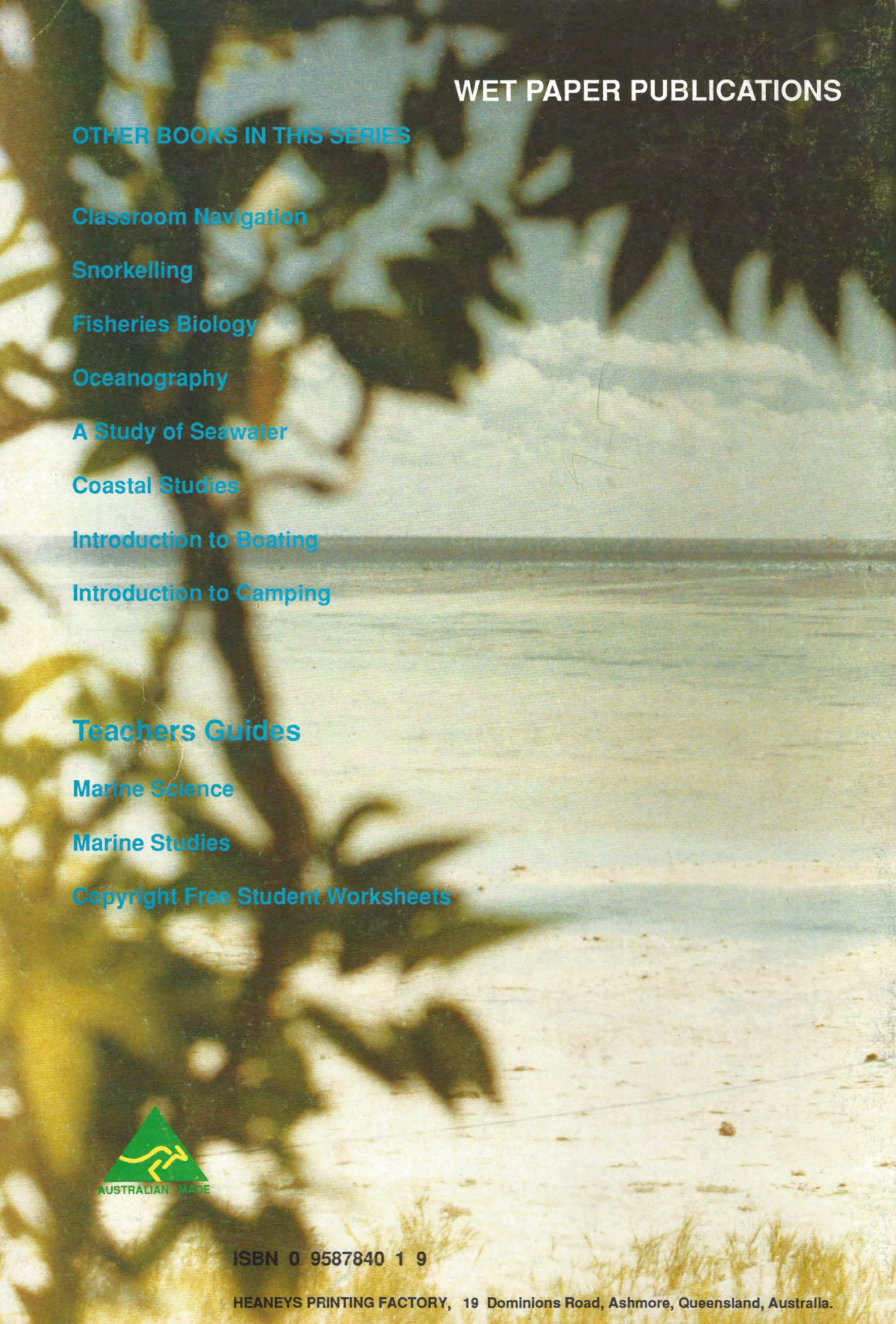
He is at present Science Subject Master at Benowa State High School and co-director of Wet Paper Publications a small family business specilizing in marine education curriculum materials.

THE HISTORY BEHIND THE BOOK

In 1976 Bob first taught about the Barrier Reef to students at Gladstone State High School. With the assistance of David Kopelke from the Boyne Island Field Study Centre, he was successful in obtaining a Schools Commission grant to purchase a boat that was used to stage reef programmes.

A series of reef activities were started in 1979 and the first excursion to Nort West Island was in 1981 by students of Gladstone State High School. Since then, the need for a complete book suitable for students at schools became evident. There was a need for a complete package where all students learned about the reef before they went, and to give the students who were unable to go, something to do while the others are away. There was a need to then present an organised programme when all students returned. The book is the culmination of a two year course of study where students can apply their knowledge into a practical situation. Also there is a real need for a book for adults who wish to visit the reef and to give some basic information. In 1981 Bob became involved in Project Reef Ed and with Ann Byrnes, Tony O'Neill, Jan Oliver, Phil King and Jack Marsh, developed over 150 activities that could be done on an excursion. Later in 1987, he worked with representitives from the University of Hawaii and UNESCO to develop further Reef Activities for South Pacific countries.

Working with a dedicated team of teachers and administrators at Benowa State HighSchool as well as a co-operative Regional Education Department Office and groups of Year 12 students for six years, this volume represents the end result. The book is not like others because it is not recycled information. All the illustrations had to be drawn from scratch with the ideas trialled year after year from first principles. It is no minor task to publish a book from a family budget. It is in its first edition and there will be errors, but it will be the yardstick for reef education in Australia for years to come because it will be taught daily in classrooms and not stay on library shelves to gather dust.



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