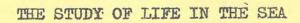


GRADE 11 MULTISTRAND SCIENCE UNIT 2 LIFE IN THE SEA

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GLADSTONE OCEANOGRAPHIC STUDIES PROGRAM

MARINE BIOLOGY





R. D. MOFFATT

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UNIT 2.

MARINE BIOLOGY - LIFE IN THE SEA

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PLEASE ACKNOWLEDGE WHEN COPYING MATERIAL FROM THESE PAGES.

OCEANOGRAPHY

YEAR 11 MULTISTRAND SCIENCE

"LIFE IN THE SEA"

UNIT II

Compiled by R. Moffatt

OBJECTIVES:

At the end of this section you should be able to:

- 1. Describe the variation in life forms to be found in different regions of the sea;
- 2. Describe the complex food web; of the sea.
- 3. Understand the changes in colour and intensity of light under water and its effect on temperature of the sea:
- 4. Discover some of the animals and plants which live on
- rocky shores; and coral reefs.

 5. Understand some of the problems of living on the sea's edge;
 6. Describe some of the ways plants and animals are adapted to
- living in this hostile environment;
- 7. Describe ways coasts are formed and change.

You are making good progress towards these objectives if you can -

- 1. (a) Describe some of the life forms from the surface of the sea, the middle region of the sea (Nekton) and the bottom of the ocean (Benthos).
 - (b) Name life forms found from the three regions of the sea.
 - (c) Describe adaptations exhibited by different life forms from the three regions.
- 2. (a) Construct a number of food chains and a food web to illustrate the relationship between members of the three abovenamed regions of the seas.
 - (b) Identify the components of a food chain.
 - (c) Construct a food pyramid from a food chain.
 - (d) Describe the energy flow through a food chain.
 - (e) Explain the effect of removing a member of a food chain (i) over fishing (ii) pollution due to pollution
 - (iii) natural population decline
- 3. (a) Explain the reasons for changes in colour and light intensity and some of the effects this has on ocean life.
 - (b) Describe unique life forms found at extreme depths in the sea.

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- 3. (c) Explain briefly the changing amount of available oxygen in water at different depths and different temperatures.
- 4. Name six animals and plants of the rocky shore and state where on the shore you would find them.
- 5. Explain the terms:
 - a. Salinity
 - c. Zonation
 - e. Niche

- b. Dehydration
- d. Competition
- e. Food Chain
- 6. Name six animals and plants and explain how they are adapted to living between tides.
- 7. (a) Describe the actions of different wave formations on coasts.
 - (b) List devices man has employed to combat coastal erosion.
 - (c) Describe how you would demonstrate the effectiveness of these devices.

....

MARINE BIOLOGY - LIFE IN THE SEA

WHY STUDY THE UNIT?

Plants and animals, whether on land or in the sea live together. Why? Because living things depend upon each other for their food, their reproduction, their communication and in fact for their very life.

Living things also depend on their surroundings or environment. All factors of their environment: food, water, oxygen, minerals, pressure, and temperature all affect living things.

A very important branch of science is ecology - the study of the togetherness of life.

In this unit, we shall study those living things whose environment is in or near the ocean. This subject is MARINE BIOLOGY. We shall first talk about the ecological factors that affect life in the sea. Then we shall survey some animals that live in the sea. You will find it a fascinating story - a story that may solve some of man's greatest problems.

NOTE TO STUDENTS:

This set of notes is only a "kick-off". Your learning in this unit will revolve around many Activities - films, television programmes, practical activities, slides, charts, excursions.

Your notebook will need to be well-kept in a neat and organized manner if you are able to attain fully the objectives which we the teaching staff require.

Good luck with your studies!

FOREWARD

- by Len Zell of the Great Barrier Reef Marine Park Authority

THE MARINE ENVIRONMENT

The immense size of oceans - their seabed mountains dwarfing the Himalayas, ocean trenches more than 10km deep, undersea volcanoes spewing hot lava into the cold deep waters, sulphurous underwater hot springs, deserts of sand, clay and oozes, submarine meadows and forests of plants, a boundless variety of swimming, walking, crawling and sedentary animals - dwarf our terrestrial world.

The oceans cover 71% of the Earth's surface to an average depth of 4km. Saltiness is the most dominant feature of the oceans, a feature which remains very constant with only local river runoffs, rainstorms and dehydration periods causing changes.

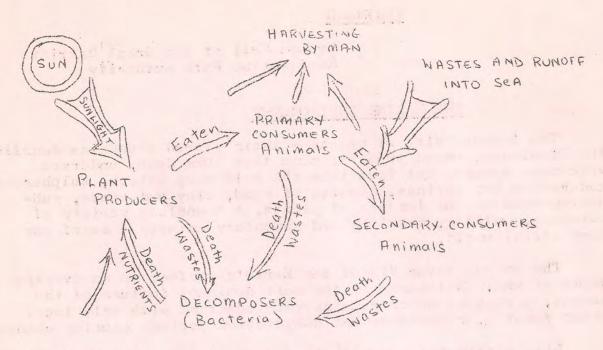
Life within the ocean is dependent upon the all important input of energy from the sun, nutrients from the land and seas themselves with the physical ocean features determining distribution and types of species. These physical features are light, temperature, salinity, turbulence, turbidity, currents, waves, gases, nutrients and substrates.

The cceans are a vast cradle of life extending from the high tide mark to the bottoms of the abyssal trenches. Mangroves, wetlands, sandy and rocky beaches are the fringe areas which are subjected to a combination of terrestrial and marine effects. These fringe areas are generally the most accessible and offer an excellent opportunity for interpretation activities. Queensland also has the vast Great Barrier Reef region adjacent to the coast; an area demanding its own description.

Oceanic influences are often extended much further inland than the high tide line. This is due to the climatic effects of large areas of water adjacent to the coast.

Life Within the Sea:

Plants are the producers in all food webs, the producers are eaten by consumers who may or may not be eaten by other consumers. All these organisms die and are broken down by decomposers and supply nutrients for the plants. The life cycle diagram below is to be used as a guide only, as it is very simplified for purposes of clarity.



Light from the sun is the source of all the world's energy. It is captured by plants and converted to starches and sugars to be eaten by the consumers. In the marine environment light is often very limiting due to water quality and depth. Coral reefs are totally dependent on access to warm shallow well lit clean waters.

Man can have a dramatic effect on the marine life cycle by overharvesting or by the use of the ocean as a dumping ground for wastes.

Physical Features of the Marine Environment: (A review of some ideas in Unit I, and how they affect life ... R.M.)

Ocean temperatures vary with depth, seasons, etc.

Different temperatures of large water masses combined with winds and the Earth's rotation, cause large oceanic currents.

Colder water in the polar regions tend to sink, drawing in the warm water from the tropics. Cold water is more dense than warm water and thus will sink. Large oceanic water masses of different temperatures will remain quite discrete and will slide over or past one another with very little mixing.

Temperature has a profound effect on the distribution of most marine species. Corals can only exist in warm waters, kelps only in cold waters.

Seasonal temperature changes in the oceans tend to lag about two months behind the land. So the coldest Australian sea temperatures tend to be in August, not June when we would expect. These seasonal changes determine the breeding seasons for many species.

Estuarine and coastal waters tend to have temperatures more closely linked with the land.

Salinity.

Saltiness is the ocean's most obvious physical feature. It can be generally stated that the sea is a 3.5% solution of salts, i.e. 35 gms of salts per litre of water. The most common salt is sodium chloride (table salt) but magnesium, calcium, potassium and many other salts, metals and elements make up a very standard mixture which exists the world over. The ratio of these salts to one another remains constant with only the total concentration varying.

Salinities generally only vary in localised areas, e.g. in estuaries where freshwater flows in or wetlands where evaporation causes concentration. Even heavy rain periods at sea can cause freshwater layers on the surface which soon become mixed.

It is almost impossible to create an artificial sea water because of the many micro concentrations of things like gold, strontium and all the other elements present in normal sea water.

Sea State.

Currents and waves are incredibly varied in all oceans.
They can be caused by winds, storms, earthquakes and temperature changes. These features create localised effects such as areas of high turbidity where silt or organic material is kept in suspension reducing light penetration or smothering some organisms.

Oceanic currents can also cause large areas of upwelling where deep waters flow to the surface, downwelling where surface waters are sinking and masses are moving past one another. All these ocean features can create concentrations of many nutrients, plants and animals. Waves on shore can place intertidal organisms under immense stress by constant washing, pushing and pulling. These effects cause many organisms to change their life style and growth form to be able to survive in these extreme areas. Currents are also very important for the transport of nutrients and most importantly, larvae.

Gas Content.

Oxygen and carbon dioxide are the most important gases and their presence or absence in oceanic waters determine which organisms can survive. Surface waters are the areas of greatest change due to turbulence giving good aeration, and with normal diffusion this increases both 02 and CO2 levels. Plants and animals in the sea also produce and consume these gases, as do terrestial organisms.

Nutrients.

Probably the most important factors for plant production in the water is the presence of phosphates and sulphates. These are often limiting and even small inputs from man's agricultural activities can have incredible effects causing great blooms of marine plants.

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Substrate.

A suitable settling, hiding and breeding site is essential for the survival of many species - the muddy mangroves aren't suitable for coral settlement and so on. We must therefore find each substrate type has a specific fauna and flora present, with local physical features determining the overall community structure.

Tides:

The pull of the sun and more importantly, the moon cause changes in the tide every 24 hours 50 minutes, two high and two low tides. These tides are often confused due to the effects of ocean currents and land masses. On the Australian coast tidal ranges vary from 1m to 10m. The extreme of these tidal ranges occur at tidal node points, e.g., the Mackay Shoalwater Bay area is a node point where a tide range of 8m is recorded whereas at Fremantle in W.A. a range of less than 1m exists. Broome in W.A. is another node with a 10m range.

The largest tidal range occurs at each place when the sun and moon pull together causing spring tides. When the sun and moon pull in opposition we get neap tides when there is little or no change in tide height. It is essential to consult your tide tables for each part of the coastline because every place is different in tide times and distance from node points.

If you are planning a visit to an intertidal area consult your tide tables and plan to be there an hour or so before low tide. This allows you to follow the tide out and then work back in with it.

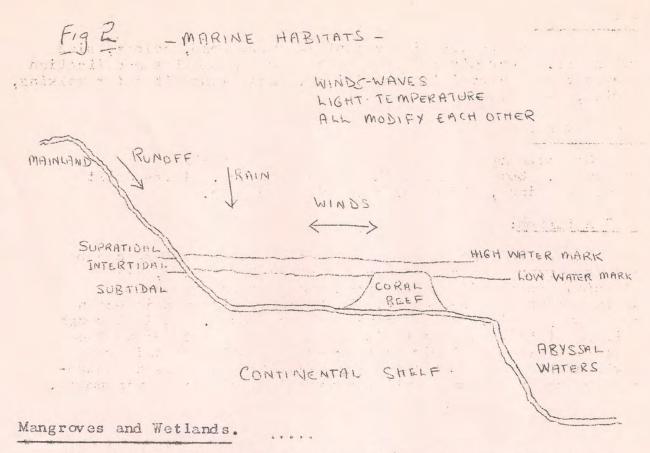
Shape of the shoreline will determine the area exposed with each tide. A vertical cliff will expose only a small area, the vertical tide change distance, whereas a mudflat may be several kilometres across all exposed each low tide. Coral reefs with their large flat tops often expose large eas of reef flat at low tide.

Marine Habitats:

To show the diversity of marine habitats a brief listing of each of the main types is made below with some of the predominant features of each. If you are intending to visit any one of these areas it is best to refer to some of the texts listed below or contact your head office for advice on where to get information.

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Place to St. I'm this William Con-



These large expanses of hypersaline mudflats and rich areas of mangrove forests provide dramatic examples of intermediate habitats, the transition from terrestrial to marine. Trees with roots in salt water and others that have 'breathing' roots to survive in the mud. Animals with adaptations to allow exposure for long periods, e.g. mudskippers, a fish that can walk and breathe out of water. Birds, fishes, crabs, mulluscs all abound.

Sandy Beaches.

These are more popular places for visitors, who seldom realise the fantastic array of life forms which exists under their feet. Long worms crawl about under the sand, bivalves lie buried waiting for the next tide, crabs lurk in burrows, sand lice scuttle about in the seaweed, all to be seen by the careful observer.

Rocky Shores:

These provide a good hard substrate with many nooks and crannies for hiding and generally are subjected to waves breaking. The animals and plants here must be able to withstand periods of immersion and then the scorching sun. A paradise for those highly adapted limpets, periwinkles and oysters.

Subtidal Sandy and Muddy Bottoms.

A great variety of detrital feeders, crabs, starfish, prawns, worms and fish utilize these areas.

Subtidal Rocky Bottom.

Excellent substrates for animals and plants to attach to so we find corals, anemones, weed, kelp, sponges, sea squirts, oysters and all the animals that live in, under and around these.

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CHAPTER 6MARINE ECOLOGY

6 - 1 THE CROWN OF THORNS PROBLEM

Moving slowly along the Barrier reefs, a crown-of-thorns starfish slowly begins to eat away at the coral - destroying the reef in its path. If nothing is done to stop it, the lovely coral reefs of the Pacific will be destroyed forever.

What can be done to stop this destruction? Shall we dump chemicals into the water to kill the starfish? Shall we try electric shock? Shall we simply collect all the starfish we can? (At Green Island, people are employed to do this day by day.)

Living things have a relationship with the factors of their environment. But don't they also relate to other living things around them? Couldn't we find some natural enemy of the crown-of-thorns starfish?

We shall get back to this question after we explore the subject of this chapter: MARINE ECOLOGY.

6 - 2 SURVIVAL OF THE FITTEST

How are living things affected by other living things?

Have you ever heard the phrase 'struggle for existence'?

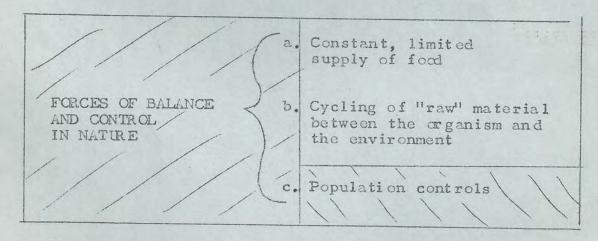
This phrase was used by the biologist Charles Darwin to describe the competition among living things. What do they compete for? For food, for space, for oxygen, for mates!

According to biologists, those organisms that are better adapted to their environment win out. Darwin called this the 'survival of the fittest'.

6 - 3 BALANCE AND CONTROL

The organisms of the sea stay 'in balance' so that one population in the environment does not outstrip another. How? The chart below gives you this answer.

Figure 3:



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If the population becomes too large, the food supply will tend to run out. This will result in fighting, and only the strong and able organisms will be able to capture food. Over-crowding is then a limiting factor.

Every animal group has its enemies. The animal that attacks is known as the PREDATOR (PRED-uh-tor). The one that is eaten is called the PREY (PRAY). The predator-prey relationship is nature's way of controlling animal populations so that overcrowding does not take place.

Think back to the crown-of-thorns problem. Who is the predator? Who is the prey? Do you now see a possible solution? It was soon discovered that the crown-of-thorns did have a natural enemy - the beautiful shellfish TRITON (TRY-tun). Perhaps tritons were dying for some special reason; perhaps they were being collected for their beautiful shells. As they decreased in numbers, the crown-of-thorns increased and the reefs were attacked. Now, by bringing in tritons and protecting them, the crown-of-thorns will be kept in check. The reef may be saved after all! But this will be a costly and time-consuming affair and will involve considerable expense. Who will pay? Is it worth it?

LEARNED SO FAR....

Marine ecology is the branch of oceanography that studies the relationships of living to nonliving and living to living things.

Those organisms that are better adapted to their environment survive.

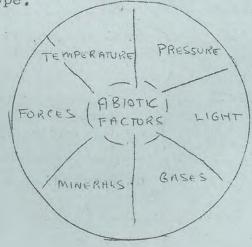
Organisms stay in balance; therefore, populations in the environment do not outstrip one another.

6 - 4 NONLIVING FACTORS IN THE ENVIRONMENT

We have already seen that the survival of all living things depends on all other living things in the environment. These are the BIOTIC (by-OT-ik) factors (bio = life). In addition, all organisms depend on the raw materials and other factors of the environment. These are the ABIOTIC (AY-by-ot-ik) (a = without) factors.

The chart below shows some of the abiotic factors with which organisms must cope.

Figure 4:



6 - 5 THE INFLUENCE OF LIGHT

Plants and animals that live in the sea are influenced by the amount of light reaching them. Green plants need light to make their own food. We would then find plants in areas where light can reach them.

light; they are found near the surface where they can absorb the longer waves, such as red and orange. Red seaweeds absorb the green wavelengths and the blue wavelengths, and hence are found at greater depths.

Are animals affected by light? Indirectly, their food supply depends on green plants. But light also affects the appearance of marine animals. Did you know that the colour of fish depends on the level of the ocean at which they live?

Light also affects the movements of certain marine animals. Many animals travel between the surface and the depths below when light changes occur. Finally, light affects the behaviour of marine animals.

When the weather turns colder, birds prepare for their journey to warmer climates. This is called MIGRATION. Ocean temperatures have the same effect on many marine creatures. Try to think of some Queensland fish that migrate in winter or summer. You may like to look up the Australian Fisheries Journals in the school library. (MUTTON BIKOS)

6 - 6 THE INFLUENCE OF TEMPERATURE

Visit a mangrove swamp in winter and you will find that a lot of things have changed since the summer. The grasses that grew so well have died. Many of the crabs that were 'all over' are deep in burrows. Many of the small animals are hibernating. Since they are cold-blooded, their body temperatures get lower. This causes them to slow down and go into an extended period of sleep. When warmer weather returns, the swamp will come to life again.

6 - 7 THE INFLUENCE OF SALINITY

We have already seen that the most plentiful mineral in the sea is sodium chloride. How does salt affect life? Chemists have found that the concentration of salt in ocean water is about the same as that in living matter. Do sea animals have to adapt to salt?

The life story of the salmon is fascinating and illustrates this problem. The young fish are born in freshwater streams. When old enough they migrate to the sea. Here they will spend a number of years until they are mature adults. They then return to the rivers of their birth to reproduce and die.

Salmon must adapt to both fresh and salt water. But there are many creatures that cannot live in salinities lower than 35%. Others may be able to survive at very high salinities. Consider what happens to the little animals left behind in the small pools created by the outgoing tide. When these pools are exposed to sunlight, they heat up rapidly. This causes a high rate of evaporation and a high salinity. Any creatures living here must be able to adapt to this change.

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6 - 8 INFLUENCE OF MINERALS AND GASES

One cycle in the ocean includes the dissolved gases, carbon dioxide, and oxygen. We shall zero in on this cycle when we study food making in green plants.

Of course, you realize that living things in the ocean die sconer or later. What happens to them? Well they they decay. The CRGANIC (or-GAN-ik) or living compounds are broken down. This releases carbon, phosphorus, and nitrogen. These are used by green plants in food making. They are also needed by all creatures to build new living matter.

So you see, cycling is an important process in ocean life.

6 - 9 THE INFLUENCE OF THE OCEAN'S FORCES

Reviewing quickly, the ocean's forces include currents, waves, and water pressure.

We learned in Chapter 5 that tides cover and uncover our shores twice a day. Marine organisms that live along the coasts must be able to survive this sudden exposure. One thing is certain: they cannot dry out or they will die quickly. They must either dig into the bottom for moisture, hide in wet areas, or move with the outgoing tide. Shore animals have special ways in which they can adapt to this condition. Some have hard shells which they can close up and keep closed until the next tide comes. Others can release a slimy covering which prevents them from drying out.

In the ocean, pressure gets greater with depth. At 10 mts, below the surface, the pressure is TWICE that of air. In some deep trenches, pressure is 1,000 times that at sea level. Deep-sea fish have internal pressure to equalize the outer pressure so that they are not crushed. Most sea animals stay at their own level. Deep-sea fish are often flat and streamlined to resist water pressure.

LEARNED SO FAR

Abiotic factors are the nonliving factors in the environment that influence marine life.

Marine plants and animals have many ways to adapt to the abiotic factors.

6 - 10 LIVING THINGS ARE LIMITED

All living things are limited to certain kinds of environment. This is their home, or HABITAT (HAB-uh-tat).

Marine animals and plants are confined to certain environments. For example, some forms of fish are found only in very deep water. Others can be found only in shallow bays. Factors of the environment that determine how and where an organism lives are called LIMITING FACTORS. To meet its everyday needs, the organism must develop ADAPTATIONS (ad-ap-TAY-shuns), or changes in structure or function. If the organism can adapt, it survives, otherwise it dies.

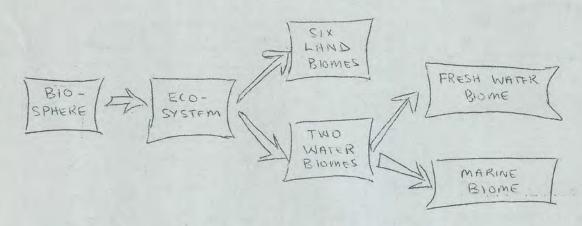
What are the limiting factors in a habitat? How do they control and influence life?

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6 - 11 PHYSICAL AND CHEMICAL ENVIRONMENT

All plants and animals of our land and water live together. They live in a narrow sphere called the BIOSPHERE (BY-uh-sfeer). The biosphere is made up of living things and their non-living environment. We call this the ecological system or ECOSYSTEM.

Figure 5: An Ecosystem is controlled by its living and nonliving factors



A large area ecosystem is called a BICME (BY-ome). Ecologists have divided the world into six land biomes (terrestrial; terre = land) and two water biomes (aquatic; aqua = water).

As you can guess, the two water biomes are the FRESHWATER BIOME of rivers and lakes and the MARINE BIOME of oceans, bays and seas.

6 - 12 WHERE DO THEY LIVE?

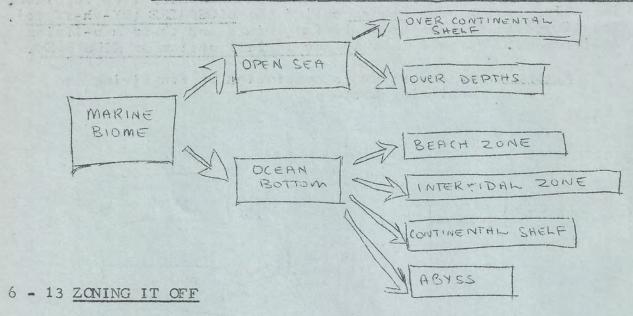
The first thing we can ask about a living organism is: Where does it live? Is it found in sand or mud? High up on the beach or low in the water? The surface on which the marine organism lives is called the SUBSTRATE (SUB-strate). If we examine a rocky shore at low tide, we may find many animals hiding under the rocks. This hard substrate provides attachment and hiding places for many different creatures. These animals would have difficulty living on a sandy beach. Clearly, the sandy substrate would be a limiting factor.

Let us remember that the marine biome is both at the EDGE of the sea and INSIDE THE WATERS of the sea. The limiting factors would be different in each case.

Most marine life is found close to the shore, where conditions change rapidly from hour to hour as the tides rise and fall. Farther out on the continental shelf and in the shallower waters, conditions are again different. The presence of green plants provides large amounts of food.

Out in the deep cold ocean, the food supply drops sharply. The general marine population is small. There are two exceptions to this. Many fish are found in or near the currents. Below the ocean there are some regions called BANKS, which are high-level ground. Because the water is more shallow, these areas are the home of many fish. One example of this is the Grand Banks of Newfoundland, which are visited by many commercial fishermen.

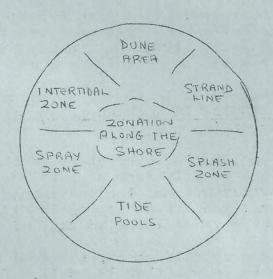
Figure 6: The marine biome is made up of many different areas



Try walking along a sandy beach at low tide. Look for some evidence of life. Search under the sand or look into the water. The same type of walk along a rocky shore would be a lot easier, for you would find many examples of living things attached to the rocks. Many of these organisms would probably be living in groups. We call such a group a POPULATION. This is what the ecologist calls an example of ZONATION - of organisms clustered in a particular zone. Why do we find populations living in one zone and not another?

When we study zonation, we must also look at the area under water. This means we must wait for low tide to uncover the ground below. This is the INTERTIDAL zone. Twice a day the bottom is covered and uncovered. The animals living here must adapt to periods of wetness and dryness.

Figure 7: Marine Organisms can be found in many different zones of life.



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LEARNED SO FAR

All living things are confined to certain environments called habitats.

Factors in the environment that determine how and where an organism lives are called limiting factors.

Living things are found in zones of life.

6 - 14 ZONATION ALONG A SANDY BEACH

What kinds of zones shall we find along a sandy beach?
Due to the shifting nature of the beach sands, zonation along a sandy beach cannot be seen so easily as it can in other areas. But if we look hard, we can still find some definite signs of life. What shall we find?

Beyond the high-tide mark, high up on the beach, we can find the DUNE AREA. What are the important limiting factors affecting life here? If you said wind and salt spray, you were correct.

The first group of dune plants facing the ocean must be able to adapt to salt spray and lack of fresh water. As a result, a very hardy type of beach grass is present; as we approach the side facing the land, grasses, shrubs, and trees take hold. Some of the trees look as if they have been twisted. This is caused by the salt spray.

Below the dune area, there is the STRAND LINE. It consists of dead seaweed, driftwood, and other articles washed up by the sea. High tide or unusually rough water can cause these materials to reach a high level. The strand line provides homes for many living things, such as insects, crabs, and worms.

The zones that lie between the tides are not too easy to find. If a certain animal is present in large numbers, we may call it a zone for this species. Clams and worms, for example, may be found in a moist-sand zone. To seek protection from the rough surf and to gain moisture when the tide is out, animals on sandy beaches must dig into the moist sand.

6 - 15 WHAT ARE THE FEATURES OF A ROCKY BEACH?

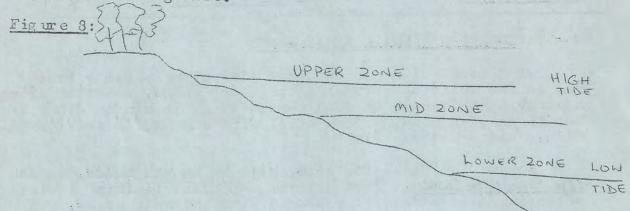
Because of the hard surface of the rocks, animals in this zone cannot dig into the ground for protection. They must find a place to attach themselves. Otherwise, they would be carried away by the surf. They must also have special parts to attach themselves to the rocks. Starfish have sucking feet and mussels have tough threads to 'glue' themselves to the rocks.

Because they cannot dig below the sands for meisture, these animals are left exposed to the air at low tide. How do you think they can survive the drying effects of the air?

Another feature of the rocky beach is the TIDE POOLS. They are found wherever spaces in the rocks trap pockets of water. These pools provide living places for small creatures at low tide. Typical organisms living in the pools are crabs, small fish and algae. Animals living here at low tide must be able to withstand high temperatures and salinities. Can you think of reasons why?

6 - 16 ZONATION ALONG A ROCKY BEACH

Rocky shores are the best places to look for zonation: When the surf hits the rocks, it creates droplets of water which bounce off to the higher areas. This forms a zone of life called the SPLASH ZONE. We can find blue-green algae and many snails living here.



6 - 17 MUD BEACHES AND MANGROVES

What zones of life do you think you can find along a mud beach? The mud beach is found in calm and protected waters; the upper section of this community has a mangrove area. Since the manghyenvironment is very important to the life of the sea, we shall give it special treatment.

LEARNED SO FAR

Animals living along a sandy beach dig into the sands for protection.

To avoid being swept out to sea, organisms on rocky beaches attach themselves to the hard surfaces of the rocks. One feature of the rocky beach is the tide pool. Rocky shores are the best places to look for zonation.

STUDY GUIDE

- TASK 1: Find the explanation. In which section of the chapter is the answer to each of the following questions? Write the question and the answer in your notebook.
 - a. What is meant by 'natural enemy'?
 - b. Why is the predator-prey relationship important to balance?
 - c. Why is it important to the salmon to be able to live in both fresh and salt water?
- TASK 2: Knowing and understanding. Find the answer.
 - 1. "Survival of the fittest" among living organisms means that
 - a. the weaker organisms get more food
 - b. the better adapted organisms win out over the weaker
 - c. both strong and weak organisms survive
 - d. no weak organisms survive

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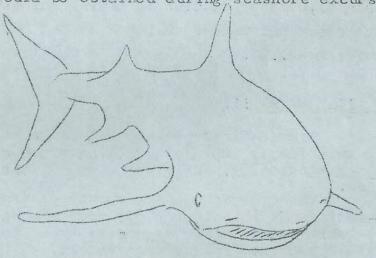
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AUDIO VISUAL

- 1. Slide Set on Rocky Shore.
- 2. Film: 'Life between the Tides' (Media Centre, Brisbane)
- 3. V.C.R: 'Life on Earth No. 3'

PRACTICAL WORK

- 1. Laboratory Exercise 21 Analysis of Rocky Shore results
- 2. Laboratory Exercise 22 Analysis of Boyne River results
- 3. Set up a marine aquarium. Use 'Marine Aquaria' by John Smith, or refer to 'A Source Book for the Biological Sciences' by Morholt et al page 600.
- 4. ASEP 'Seashore', page 93, Activity 9 A Miniature Ocean
- 5. 'The Web of Life', Students Manual Part I, Exercise 9.1 Exploring Marine Communities.
- 6. Measurements of temperature and light intensities at various depths in water, for example reservoir, or in open sea
- 7. Read 'The Web of Life' pages 149-157 Marine Habitats: The Sea than answer Guide Question 8 on page 157.
- 8. Fish no. 46, page 138 of Discoveries in Science! Prac. Bk. I Specimens could be obtained during seashore excursion.



STUDY ASSIGNMENTS

- 1. Use audio visual resources to prepare a paper on some aspect of 'Life at the Sea's Edge'.
- 2. ASEP 'Seashores' Option 2, Vanishing Beaches
- 3. 'In Search of Science' Book 2 page 283, Question 5.
- 4. Prepare a model of a typical rocky seashore and indicate the distribution of plants and animals to be found there.
- 5. Prepare various models of coastal land forms.
- 6. 'Science for Secondary Schools' Bk 2 Questions 1 and 2.

DIRECTED TOPICS (TEACHER INFORMATION)

The use of film or slides to illustrate 'Life in the Seas' would be useful. Films could be used in conjunction with Practical Work Activities 3-6 as an aid to answering Activities 7-8.

Films and slides are listed in the Teachers Resource Section.

Key concepts are: Food chains, variation in light intensity and temperature with depth, photosynthesis, adaptations and all of these will need careful explanations and integration.

References;

There is a large collection of books on the rocky shores in the 500.92 series in the town libary and in the school library. Here are a few of the many:

Dakin. Australian Seashores.

Bennett I., Fringe of the Sea. ****

Stephenson W., Outdoor studies in Living Animals.

Check out other meferences on Pages 49 and 50.

Other references....

PRAWN LIFE CYCLE EXTRA :::

Prawns are Crustaceans that are capable to both walk and swim fairly rapidly. They have a hard external shell and moult periodically, the young ones do this more often than the oldies.

There are two major groups of prawns, the Penaeids (Pen-a-idz) which shed there eggs into the sea and the Carids (Kar-id) which carry their eggs under their tails. All of Australian commercial Prawns are Panaeid.

Prawns bury themselves under the sediment at the bottom of the sda and are commercially caught when they emerge to feed or to school for breeding or migration. Females are larger than males. There are 3 main stages in the prawn life cycle: larval, Juvenile and adult. The Prawns spawn in the open sea and the larvae move or are moved towards rivers and inshore waters. Here juverniles grow rapidly before returning to the sea to mature into adults. There life span appears to be about 1 year.

For more information, consult the photocopied articles on "Tigers and Bannanas - a harvest from the sea" Division of Fisheries and Oceanography P.O.120 Cleveland Q 4163

CHAPTER 7 CRAB AND PRAWN ECOLOGY

You are making good progress if you can -

- 1. Describe the following features of interest about the Gladstone mud crab
 - a. how it grows
 - b. how it reproduces
 - c. the crab burrow
 - d, mud crab enemies
 - e, catching mud crabs
 - f. farming mud crabs
 - g. mud crab recipes
- 2. Describe the following features of the Australian Prawn fisheries in relation to the Banana Prawn ...
 - a, how the Banana Prawn grows
 - b. the life cycle
 - c. behaviour
 - d. populations
- 3. Describe the nature of the Gladstone Fishing industry in relation to ...
 - a. species fished and fishing grounds
 - b. fishing seasons
 - c. fishing units
 - d. gear
 - e, fishing operations
 - f. catch
 - g. economics
 - h. legis lation

STUDY GUIDE

- TASK 1: Read "The Mud Crab" Queensland Booklet No. II, and make a summary of the following:
 - a. Growth and development:
 - b. reproduction;
 - c. crab burrows;
 - d. catching crabs; e. the crabs' predators;
 - f. farming mud crabs.
- TASK 2: Arrange a trip to Appo's Fish Market to see how crabs and prawns are processed.
- TASK 3: Discuss the crabs ecological relationships with the environment in which it lives. (Refer to pages 11-14 this booklet)
- TASK 4: Read the articles on the Prawn Industry and identify the main points under the following headings:
 - a. Growth and development;
 - b. life cycle;
 - c. behaviour;
 - d. populations.

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ASK 5: Relate the articles on the Prawn Industry to Gladstone and find out: -

- a. The species of prawn caught;
- b. the fishing season;c. the type of fishing boats used;
- d. the fishing gear typically used on a prawn trawler;
- e. fishing operations;
- f. economics of the prawning industry in Gladstone; g. legislation affecting the industry.

AUDIO VISUAL

. Slide set on "The Prawn Trawler".

PRACTICAL ACTIVITIES

- 1. Set up a Prawnery or Crabbery in a marine aquarium.
- 2. Analyse a plankton sample and identify Crab Zoe and Megalopa; - Prawn Protozoe and Mysis:
 - . Make a chart of the Prawn and Crab life cycles.
 - . Dissect out a prawn's appendages and make a chart.

STUDY ASSIGNMENTS

. Read the articles on the Australian Prawn Seminars.

Tiger, Bannana, and King Prawn Life Cycles.

NURSERY AREAS FISHING AREAS AND SPAWNING GROUNDS Rivers and Mangroves Muddy rivers PLANKTON Low salinity Tigers and Low Turbidity Kings IFFERENT SPECIES Sea grass and Sea Weed f Prawn have different Beds. Full sea salinity High Light Unionsity. ehaviour patterns and ifferent life histories. nese differences mean that < Bannana Prawns the techniques of fisherman & active by day. Day FISHERY. the Marine Biologist have to be varied accordingly. Tiger and King active at night NIGHT FISHERY SPAWNING

GROUNDS

CHAPTER 8 FISHERIES BIOLOGY

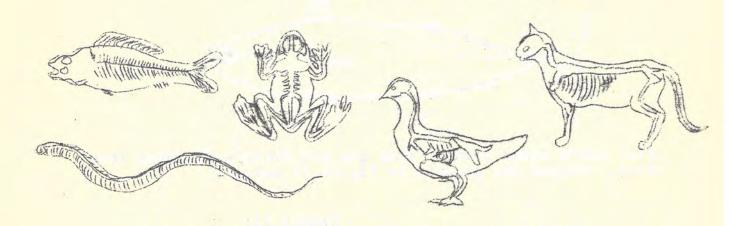
The following material has been copied for the purpose of private study of each student enrolled in this course - Reference pages 137-149 "Oceanography and Our Future" by Oxenhorn and Goldfeld

How are Fish adapted to their life in the sea?

8 - 1 LOOKING BACK

with some sort of backbons. Actually, some of these animals have simple rods made of CARTILEGE (KAR-tuh-lij) in their backs. Flip your outer ear, which is made of cartilage, and notice that it is flexible but returns to its shape and position. Other chordates that are more developed have spinal columns made of small bones called VERTEBRAE (VUR-tuh-bray). Run your hand across your own spine. The vertebrae are connected by cartilage. Your spine is flexible, but it keeps your body shape;

Figure 9: Five classes of vertebrate skeletons. All are alike in one respect. What is it?



8 - 2 ALL KINDS OF FISH

To many people, "a fish is a fish". To the marine biologist, fish are of many kinds. There are the primitive fish without jaws called hagfish and lampreys. There are fish whose bodies are mostly made of cartilage. These include the sharks, rays, and skates. Finally, there are the true bony fish.

Rays are interesting members of the shark family. They are flattened and have winglike fins. In the tropics, stingrays are the most feared creatures in the sea. The stingray has a sharp spine near the bottom of its tail. Special openings in the spine contain poison sacs. If a person steps on the spine, a powerful poison is released.

Rays live in waters close to shore, usually buried in the sand. Skates are harmless cousins of the rays. When you walk along the beach, you may find the skates' empty egg cases. They are sometimes called mermaid's purses. These leathery sacs enclose the embryo during its early development.

There are some bony fish that stay most of the time along the bottom and some that stay at middle depth. Others live near the surface and even come out of the water at time. One unusual fish is the common flying fish. These little fish glide out of the water on their winglike fins. Sometimes they can reach speeds up to 35 miles per hour.

8 - 3 BUILT FOR LIVING

To cope with the marine environment, fish have developed special adaptations.

Examine the picture of the fish in Figure 10. How is it able to adapt to the problem of moving through the water? For one thing, it has a beautiful and streamlined shape. Since it is narrow at the head and tapers off toward the tail, the water can flow smoothly along its body.

The fins help the fish to move and steer. In some fish, like the sea robin, the fins have become adapted for crawling on the bottom. One fish can even crawl right out of the water! The flying fish uses its fins to glide over the water.

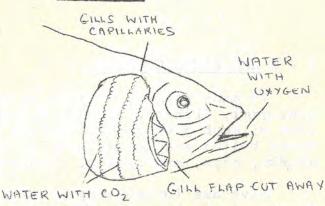
Figure 10: How is the body of a fish modified for living in the water?



Fish don't drown because they can get dissolved oxygen from the water. Follow the process in Figure 11 below:-

Figure 11:

Water is taken in through the mouth. It passes over the gills which are lined with many blood capillaries. Oxygen passes into the blood; carbon dioxide passes out of the blood. The water leaves through the gill slits under the gill flap.



LEARNED SO FAR

Fish are classified as vertebrates.
Some fish have skeletons made up of cartilage; others have skeletons made of true bones.
Fish have many adaptations that enable them to live in the watery world.

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8 - 4 MEET THE SHARKS

Sharks are a very ancient group of vertebrates. They have changed little in 350 million years. The shark's body is very streamlined and fishlike.

The sharks have a reputation as killers of the sea. Any blood in the water can drive them into a feeding frenzy. Because of their fantastic powers of smell, sharks can detect wounded animals for miles around. Of the 250 shark species, only about 12 are believed to be really dangerous to humans.

The white shark is one of the most dangerous to humans. It can measure 30 feet or more. This shark is a very fast swimmer and has been known to attack humans. Another dangerous shark is the hammerhead. It has a very unusual head, shaped in the form of a T. The whale shark can reach a length of 50 feet but is really harmless. It feeds only on plankton,

8 - 5 LIFE CYCLE OF FISH

Reproduction is the most important process for continuing the species. Male and female members of most fish species shed their reproductive cells directly into the water. The male releases sperm or milt. The female sheds eggs or roe. Sperm and eggs join in the process known as fertilization.

The young fish develop in the egg for a certain number of days. After hatching, they are called FRY. Not all the fertilized eggs will survive. Many are eaten by other fish. It has been estimated that a female codfish can lay 6 million eggs, but only 50,000 will ever become fry.

The eel, a slippery snakelike fish, is a good example of use in illustrating the fish's life cycle. When the eels are between 5 and 8 years old, they make a journey to the Sargasso Sea. European eels also migrate to this area. The female then deposits her eggs; the male covers them with sperm. This is known as the SPAWNING process. Both parents then die. The fertilized eggs develop into the larva stage.

What happens to the larvae after hatching is a fascinating story. They begin a journey of thousands of miles that will take them back to the same rivers that were the homes of their parents. Both European and North American eels enter the Gulf Stream. In one to three years, they become adults.

8 - 6 NATURE'S NAVIGATORS

Eel and salmon migrate, or change location, for spawning.
How do they know where to go? How do they know where to return?
Let's look at the salmon.

Adult salmon live in the Pacific Ocean. In the spring, they leave the ocean and enter the bays along the West Coast. They enter the Columbian River in Oregon. They fight their way upstream against the current and waterfalls. They spawn and the young fry hatch. They feed on plankton and develop. The parents die after spawning.

Some scientists believe the odors of the stream may guide the young fish back to the ocean. Some feel they follow currents. Can you think of some reasons why the migration takes place at all?

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LEARNED SO FAR

Sharks are primitive fish with skeletons of cartilage. The life cycle of fish includes external development. Many fish migrate for their spawning process.

STUDY GUIDE

- TASK 1: Knowing and understanding. Find the answer. Write it in your notebook.
 - 1. Fish are able to remove oxygen from the water because they have
 - a. streamlined bodies
 - b. gills
 - c. good eyesight
 - d. fins
 - 2. Man and fish are placed in the same phylum because
 - a. they both have vertebrae
 - b. they do not resemble one another
 - c. : they lack backbones
 - d. they both have lungs
 - 3. The process following hatching is
 - a. spawning
 - b. migration
 - c. fertilization
 - d. egg-laying
- TASK 2: Which is the outsider? Choose the one word in each list that does not be long with the others. Write the word.
 - a. Vertebrate, amphibian, fish, clam, bird.
 - b. Larvae, migration, eel, invertebrate.
 - c. Shark, cartilage, ray, bone.
 - d. Oxygen, gills, carbon dioxide, lung, fins.
 - e. Salmon, eel, bony fish, shark.
- TASK 3: Explanations, please....
 - 1. How are fish adapted to life in the water?
 - 2. What is the advantage of a fish producing so many eggs?
 - 3. How is the Gulf Stream important in the life of the eel?

8 - 7 MORE VERTEBRATES IN THE SEA

The first class of vertebrates is that of the fish, just studied. A second class, the AMPHIBIANS (am-FIB-ee-unz), includes the frogs, toads, and salamanders. Amphibians spend part of their lives in water, but they are truly land animals. They breathe air through lungs.

The next class is the REPTILES, including snakes, turtles, lizards, and alligators. There are a number of sea snakes. They capture fish -often by poisoning them - and breathe air by raising their nostrils out of the sea.

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The sea is also the home of many huge turdes. They are protected by shells, swim with giant flippers, and breathe air through lungs. Green turtles and loggerheads grow to weigh over 400 pounds. Turtles return to land to bury their eggs. They then abandon the nests. The young, soon after hatching, return to the sea.

8 - 8 MEET THE MAMMALS

Mammals are vertebrates whose females produce milk to feed their young. Most are covered by hair or fur. They have four-chambered hearts. This serves to keep them 'warm blooded'. In other words, they maintain a regular body temperature regardless of the temperature of the water or air.

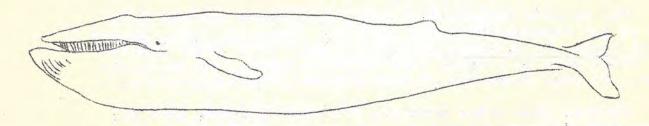
Marine mammals include the whales, porpoises, dolphins, and seals. Other lesser-known creatures are the sea otter and manatee (MAN-uh-tee). These animals are amazing in their adaptability. They are fascinating for their size. Some show remarkable intelligence. All are economically useful to man.

8 - 9 MOBY DICK - THE STORY OF THE WHALES

The story of Moby Dick describes the adventures of Captain Ahab and his search to kill the famous white whale Moby Dick. In the end, the whale destroyed the ship and most of the men on board. This book was written in 1851, when whaling was a big industry in this country. Men would leave their homes for many months to hunt whales for food and oil.

When the lookout on board ship sighted a whale, he would shout, 'thar she blows'. What he saw was the whales SPOUT (SPOWT), caused by blasts of air exhaled or blown out by the animal. A whale's spout sometimes reaches 20 feet into the air. Whalers could tell the type of whale by its spout. For example, some whales have a tall, thick spout; other spouts are divided in two at the top.

Figure 12: Why do we classify the blue whale as a baleen?



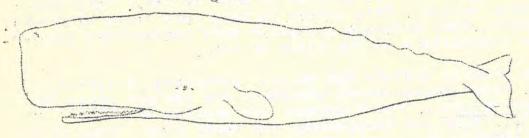
Whales can be divided into two groups: toothless and toothed. BALEEN (bay-LEEN) are toothless whales.

Instead of teeth, the baleen whales have large mouths, lined with a material called whalebone (baleen) that hangs from the upper jaw. The baleen acts as a strainer to capture tiny organisms from the sea. These whales feed mainly on tiny fish and a type of shrimplike plankton known as KRILL. Some of the largest whales belong to this group. The blue whale, for example, is one of the largest creatures that ever lived. It can grow to be 100 feet long and to weigh about 150 tons.

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The toothed whales (Figure 13) have teeth, which they use for capturing fish. One of the best-known of the toothed whales is the SPERM WHALE. It is the largest of these whales and grows to a length of about 60 feet. The sperm whale was hunted almost to extinction because its forehead contained wax which was used as oil for lamps. It can dive to 3,000 feet and hunt for its favourite food, the giant squid.

Figure 13: Sperm whales dive to great depths in search of giant squid. What group of whales does it belong to?



8 - 10: ADAPTATIONS FOR SUCCESS

What adaptations do whales have for life in the sea?
To understand this, let's trace the whale back to its ancestors. Whales evolved to the watery world from extinct land mammals millions of years ago. One theory states that about 100 million years ago, small four-footed animals from the land entered the water. Over the course of time they developed torpedo-shaped bodies. The front legs developed into paddlike fins. The hind legs developed into a structure called a FLUKE. The whale lost its covering of hair, and its nostrils moved to the top of its head to form the blowhole.

Examine the whale's skeleton in Figure 14. Does it resemble your own? The whales's fingers are covered by muscles which form a short fin. These fins help the whale in balance and movement. The bones in the fluke are the hind legs. To get movement, whales fan this fluke up and down.

The whale's torpedo-like shape and smooth surface help him to get through the water quickly. Under his skin, he has thick layers of oil-rich BLUBBER or fat. This layer protects the whale when he travels into the cold Arctic and Antarctic seas. It also helps him to maintain his body temperature.

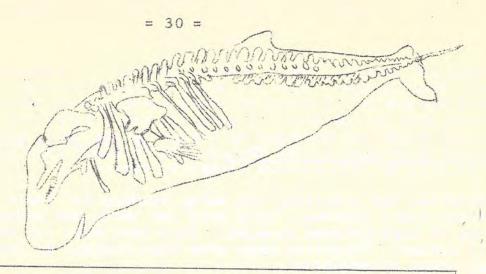
Whales, like other mammals, are warm blooded; that is, their body temperature remains even. They maintain the same temperature because of their powerful four-chambered hearts. We learned before that whales have lungs. Air is taken in through the blowhole.

Whales are being studied by scientists to learn how they can hold their breath for long periods of time. How can they dive so deep and rise to the surface so quickly? Sperm whales, for example, can stay under water for more than an hour.

Figure 14: The whale's skeleton is similar to your own.

How is the whale adapted to life in the water?

-- OVER -- /30



LEARNED SO FAR

Whales, dolphins, porpoises, and seals belong to the mammal group.
Whales are warm-blooded, air-breathing creatures beautifully adapted to the water.
Whales evolved from creatures that once lived on land.

8 - 11 VANISHING WHALES: A CALL FOR CONSERVATION

We learned in Section 8 - 9 that years ago men hunted whales for their oil and meat. Whaling continued into this century, but the methods used were different. Instead of going after the whales in small boats, men began to use radar and helicopters. Once a whale is located, a special gun shoots a harpoon containing an explosive charge at it. As a result of these methods, whales have continued to decline in numbers. For example, in the first part of this century, there were 100,000 blue whales in Antarctica. Scientists estimate that today there may be only a few hundred left.

Despite the fact that many whales are on the road to extinction, some countries still continue to hunt them. These countries use the oil for soap, fertilizers, and ink, and the meat for pet foods.

Conservationists are urging the adoption of laws and international controls to save the whales from extinction.

8 - 12 DOLPHINS AND PORPOISES: BRAIN AND BRAWN

From early Roman times comes the story of a dolphin that made friends with a young boy. The dolphin would carry the boy on its back wherever he went. Throughout history there have been reports of how dolphins have saved swimmers from sharks. Are these stories real or just legend? Scientists have made many studies of these creatures. They will admit that the dolphin is quite intelligent. Perhaps even intelligent enough to carry a boy on its back.

Just what is a dolphin? What is a porpoise? Many times these words are used to describe the same animal. Both dolphins and porpoises belong to the toothed-whale family. An easy way to tell the difference between a porpoise and a dolphin is by the fact that the porpoise does not have the "grin" on its face. The dolphin has a snout which is shaped into a beak.

The bottle-nosed porpoise is the one most of ten seen in captivity. When full-size it may reach a length of 8 feet and

may weigh 800 pounds. These animals also have a wonderful communication system. They can signal each other with sounds and body movements. Because of their intelligence, bottle-noses have been used by the Navy. A porpoise named Tuffy was trained to deliver tools and messages to divers living under water in a special project called SEALAB. It is hoped that someday delphins will be able to work alongside divers.

Dolphins and porpoises are being studied for their remarkable sonar systems. They send out their own sound in the form of high-pitched squeaks. They then wait for the echo to return. Porpoises have even been trained to jump through hoops blindfolded!

8 - 13 MORE MARINE MAMMALS

The seals, walruses, sea otters, and sea cows are also important to life. Sea cows belong to the order of mammals known as "Carnivora". All carnivores have special teeth adapted to eating meat. Seals and walruses are excellent swimmers that feed on fish. Their legs, like the whale's, are adapted for life in the water.

Sea ofters are amusing little creatures that like to swim on their backs. They are found along the Pacific Coast from Alaska to California. They hunt for ABALONE (ab-uh-LOH-nee) a mollusk, in kelp beds of f Southern California. Their fur is very fine, and they were once hunted for it. Since they were almost wiped out, they are now protected by many governments.

LEARNED SO FAR

Conservation is needed to protect the vanishing whales and otters. Dolphins and porpoises are intelligent sea mammals belonging to the toothed-whale family.

Other sea mammals include seals, walruses, sea otters, and sea cows.

STUDY GUIDE

- TASK 1: Knowing and Understanding. Find the answer. Write it in your notebook.
 - 1. Sea mammals belong to the higher group of animals known as
 - a. mollusks
 - b. invertebrates
 - c. vertebrates
 - d. crustaceans
 - 2. One adaptation that all whales have for life in the water is
 - a. gills
 - b. hind legs in the form of a fluke
 - c. thin skin
 - d. scales
 - 3. Baleen whales are adapted to feed on -

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- TASK 1: 3. a. fish
 - b. plankton
 - c. other whales
 - d. seals
 - 4. One adaptation of whales for living in cold Arctic seas is ther
 - a. thick, oil-rich blubber
 - b. blowholes
 - c. small eyes
 - d. flukes
- TASK 2: What's the difference? State the difference clearly in your own words:-
 - 1. What is the difference between a whale's spout and it's lungs?
 - 2. What is the difference between a dolphin and a porpoise?
 - 3. What is the difference between a baleen and a toothed whale?
 - 4. What is the difference between a mammal and a fish?

PRACTICAL ACTIVITIES

- 1. Discretion of Fish, Ray, Shark. See someone who is goig fishing this weekend and get him to take some shark gear. Small sized fish are required for this work, so dont's get a 6 metre white pointer to work with and don't get anything undersize. Collect a dissecting board and a disection guide and open the organism to display the following systems: Respiratory (Breathing), Feeding (alimentary), circulatory(Blood), muscular, Have a look for the swim bladder and the bobes, cartilage (kar til -age)
- 2. Arrange a visit to Appos fish shop and see how his fish are processed and sold. At the same time arrange to visit the Gladstone Fish Board and look at the processing rooms. Prepare a class report and or a display for next years class on the operations of the fish board and the main catch handled.
- 3. Read the G.O.S.P. unit on fishing and snorkeling.

FIND OUT about GREENPEARE

CHAPTER 9 SOME IMPORTANT INVERTEBRATES

PHYLUM ARTHROPODA - ANIMALS WITH JOINTED LEGS

Think of animals with hard outer skeletons whose jointed legs can bend. This is the jointed leg PHYLUM. Their bodies are in SECTIONS. The legs and sections are moved by muscles. Members of this group can creep, crawl, or hop. Some of them can swim, but only slightly.

Do these animals remind you of any land animals you know? You are right. The insects and spiders are their cousins on land.

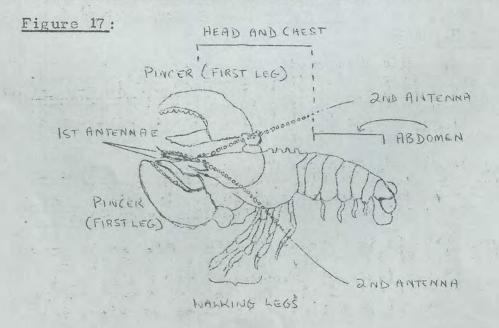
This is the PHYLUM called ARTHROPODS (AR-thruh-podz). Most marine arthropods belong to a sub-group called CRUSTACEANS (krus-TAY-shuns). These include barnacles, lobsters, shrimps and crabs.

So often when we think of a fine sea food dinner, we think of lobster. No other marine animal is prized so highly for its meat. Some of the great lobster fishing areas are just off the coast of Gladstone, Western Australia, and Tasmania. Fishermen set special baited traps; when the lobster enters, the trap closes.

The lobster has five pairs of legs (ten legs in all) attached to its chest region. Anyone who has ever foolishly put his finger near the first pair never forgets them. These are the PINCERS (pinchers), which grab other animals for the lobsters dinner.

Lobsters use gills to remove oxygen from the water. They have well-developed eyes and feelers, or ANTENAE, (an-TEN-ee), for receiving sensations from the environment.

The female lobster lays between 8,000 and 10,000 eggs. As they leave her body, they are fertilized by the male. The eggs stick to special structures on the female. Young lobsters hatch from eggs into a larval stage. They quickly undergo many changes before they reach the adult stage.



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The lobster lives in the sea. However, a totally new idea arises on land -

- 1. The animal must be able to support itself;
- 2. it must be able to breathe air;
- 3. it must be able to withstand the change in climate.

Some very amusing creatures of the sea are the crabs.

Che fellow that is most easily observed is the ever-present
HERMIT CRAB. This small CRUSTACE/AN seeks out empty shells
of snails. Running across the sea bottom, hermit crabs
look very amusing as they carry their homes on their backs.

As the hermit crab grows, it has to keep looking for larger shells.

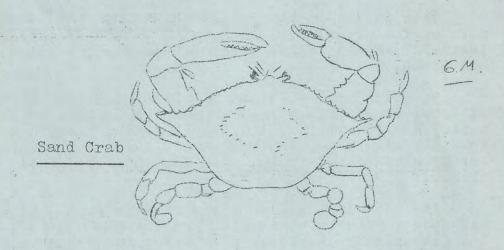
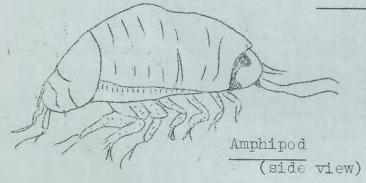


Fig. 18. Some Crustaceans



Amphipod
(Front
View)

Why do you think Amphipods are so thin?

THE UNUSUAL CRUSTACEAN

Ask any boat owner what marine animal is most annoying. He will probably tell you that it is the BARNACLE (Bar-nuh-kul). These crustaceans attach themselves to boat bottoms and can slow them down. How do you think they do this? Boat owners have to scrape their boats each year.

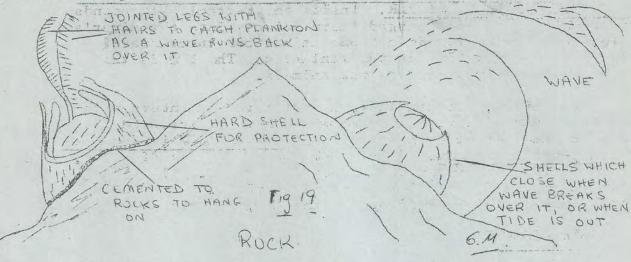
At first glance the barnacle does not seem to resemble any other crustacean. Most of ten you will find them firmly attached to rocks, boats, and pier pilings. In spite of their strange appearance, scientists recognise them as crustaceans.

The young barnacle is a free-swimming form. As it grows older, it fixes itself to a rock, and secretes a shell around itself. The barnacle feeds by extending feather like feet through the opening of the shell. One scientist has described a barnacle as an animal that lies on its back and kicks its

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food into its mouth with its feet.

Barnacles produce a very strong cement that helps them to stick to rocks even though there are powerful waves. For this reason dentists are testing barnacle cement for possible use as a filling for teeth.



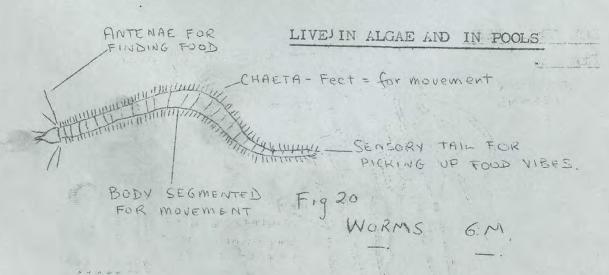
So successful is the barnacle that it is the dominant life form at Tannum. Over 10,000 can exist on one rock.

PHYLUM ANNELIDA - ALL KINDS OF WORMS

All worms, to an untrained eye seem to be alike - but they are not. There are roundworms, flatworms, and segmented worms. Members of all three groups are found in the sea.

Marine worms swim free, creep, crawl, and burrow under rocks or sand. Some are vegetarian; others eat smaller worms.

When you visit the shore at low tide, turn over some rocks and see if you can see some worms. You may come across a large worm that looks as if it were divided into compartments, closer inspection will reveal a short head with two claws. This is a clam worm, or NEREIS (NEE-ree-us). Members of this family all have bodies that are divided into sections resembling rings. A well known example is the common earthworm. Others are the feather worms and fan worms. Worms are the food of many larger and more powerful marine animals.

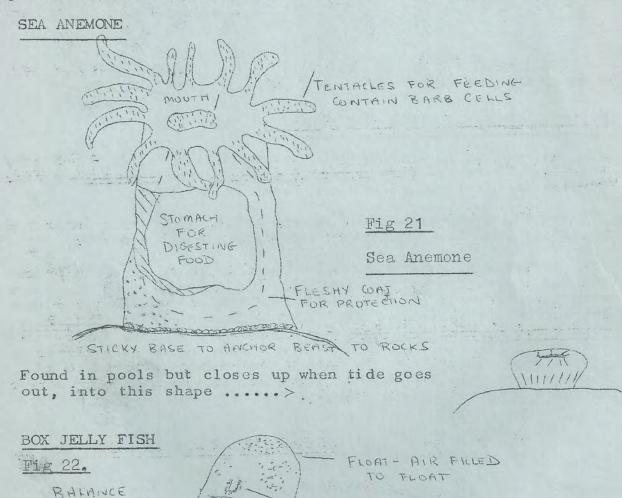


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PHYLUM COELENTERATA - ANIMALS WITH STING ING CELLS

A skin diver exploring tropical waters noticed a large bag-shaped object on the surface. Moments later he felt a sharp pain in his leg; red angry welts appeared over his skin. The diver had become entangled in the TENTACLES of a large PORTUGESE MAN OF WAR. Inside the tentacles thousands of stinging cells discharged their poisons into the diver's skin. The Man of War is not one animal but thousands of tiny animals that live in the tentacles. The bag is the result of a gas released by the animals.

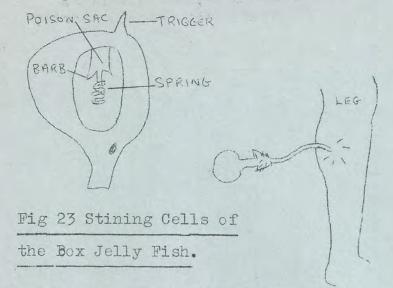
Most of us, fortunately, do not have encounters with Portugese Men of War. But many of us have experienced the sting of the more common jellyfish. This PHYLUM is known as the cup-shaped phylum. It consists of two layers of cells, with a jelly like material between the layers. All have stinging cells filled with a powerful poison. Members of the group include the jellyfish, sea anemone, and corals.



FOR FEEDING

ORGANS

Let us have a look at the BARB CELLS



- 1) LEG FIRES TRIGGER
- 2) BARB SHOUTS INTO LEG
- 3) POISON SEEPS INTO LEG

Never rub sand into a sting. WHY?

Always use VINEGAR. WHY?

The beast is found in SUMMER at Tannum AFTER A NORTH EASTERLY BREEZE, and only on a CALM DAY.

****SEE NOTE BELOW. ******

CORALS AND CORAL REEFS ..

Distant places with strange-sounding names! Bikini Atoll, Christmas Island, Cnaton, Eniwetok, the Great Barrier Reef, Cozume 1......Where are they? What are they? Are they the homes of castaway sailors like Robinson Crusoe? These are all Coral Formations.

Coral reefs are found in three basic forms. A FRINGING REEF develops to shore, with a shallow channel between the reef and shore. The coral is built outward toward the sun and the open sea. A BARRIER REEF is usually far from land. The channel between the reef and shore is deep enough for ships to pass through. The Great Barrier Reef in Australia is almost 1,250 miles long and is separated from the land by a 10 mile passage. ATOLLS are reefs that are horseshoe-shaped and form little islands. In the centre of the ATOLL is a LAGOON, or small bay.

******BOX JELLY FISH EXTRA :::::

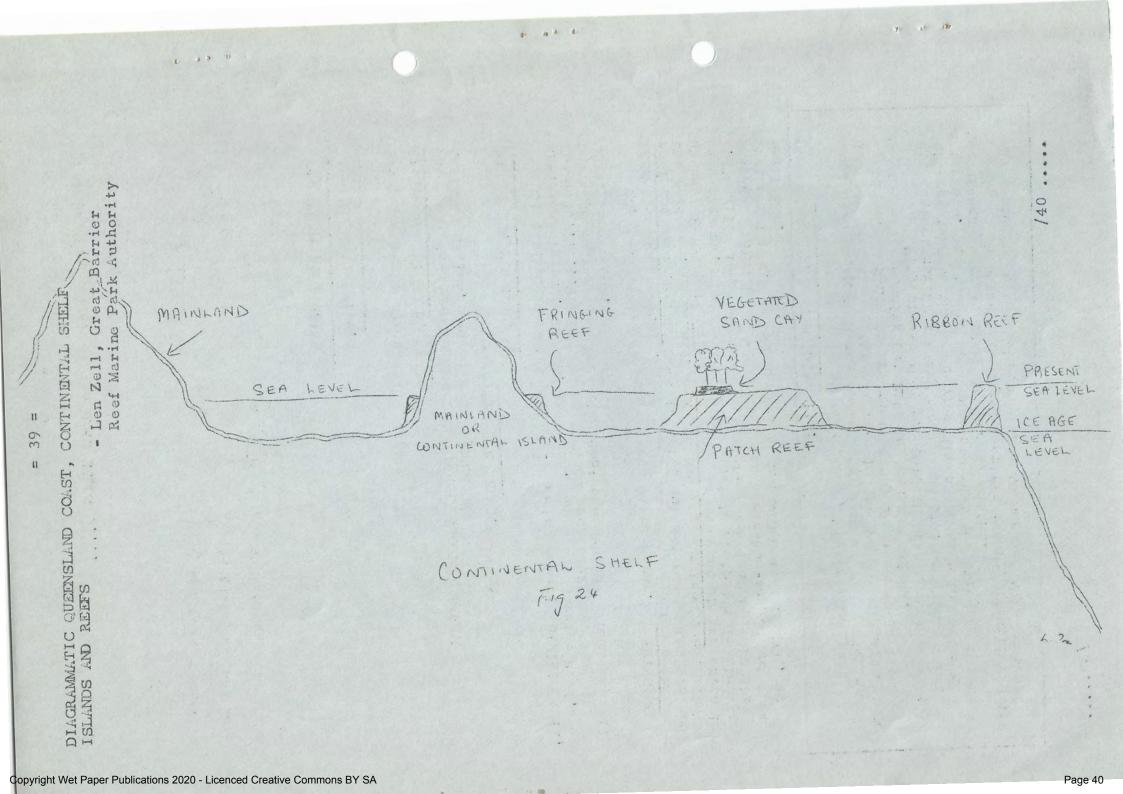
Tests done on the Box Jelly fish over the past 3 years have shown that the old theory that the jelly fish was blown in from the northern waters in the summer months may not be unique. A new theory that it may be breeding in local creeks before heading out into the sea has arisin.

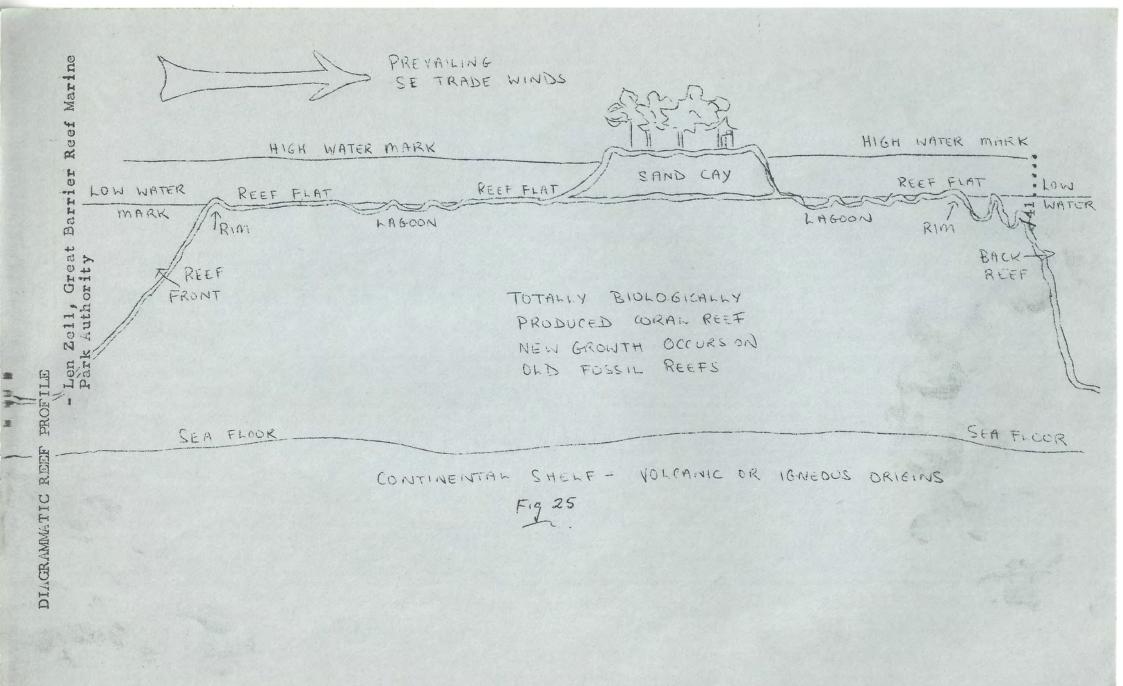
Many creeks that run into the sea have a very high salt content during the dry months and it is possible that the stingers take to the ocean when the seasonal rains enter the waterways. The theory also suggests that the stingers return to the creeks to spawn after the summer months.

the creeks to spawn after the summer months.

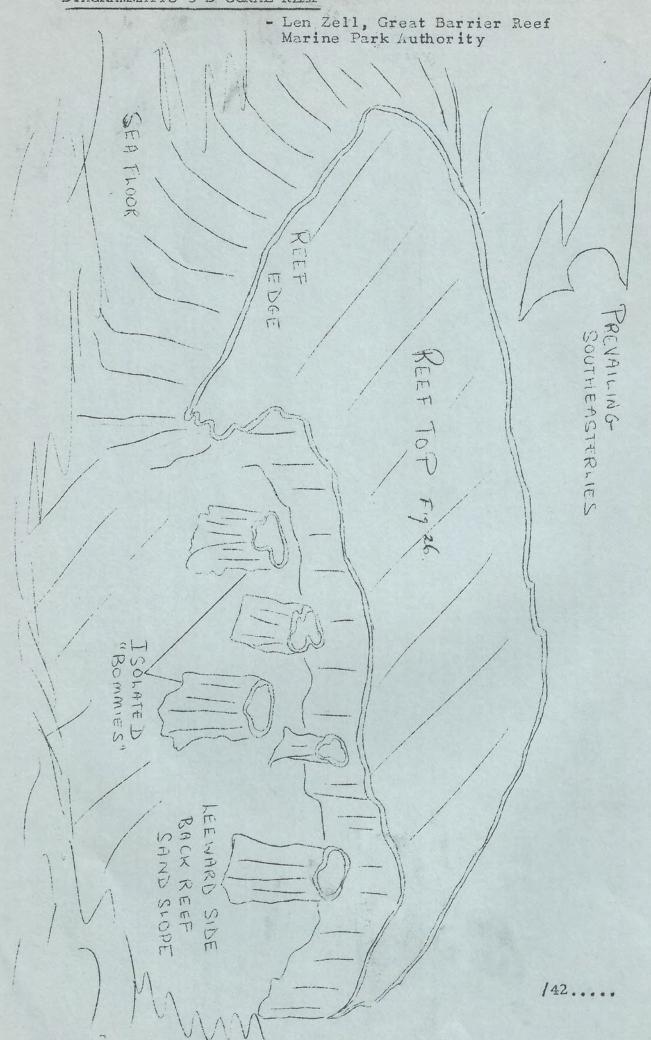
However like any Scientific theory, it will require many months of painstaking research to unravel this mystery.

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PHYLUM PORIFERA - ANIMALS WITH PORES ...

Imagine a piece of beef liver shaped a little like a basketball with holes in it. This will give you some idea of the body design of a typical sponge. Most sponges grow attached and of ten look like plants.

Some are so tiny that they live in snail shells. Others grow to 2 or 3 feet. They are found in many colours.

The sponges are simple in structure; they have bodies made out of many cells in two layers. Sponges take in water through their pores to strain out the microscopic animals and plants. Some of the sponge's cells create currents of water; others grasp food from the incoming water and digest it.

The sponge body is supported by a skeleton made up of hundreds of tiny structures called SPICULES. Spicules are made of either lime or a glasslike substance called SILICA.

How does water move through its body?

Fig 27. The body of a sponge.

Arrows indicate water movement.

When the sponge dies, the spicules are left behind to form beautiful and interesting designs. A few kinds of sponge build their skeletons out of a material called SPONGIN. These are the sponges that we use in our homes. They are collected by divers on Florida's Gulf Coast. Most sponges are marine. A few are freshwater.

PHYLUM CTENOPHORA .

The se can be distinguished from Jelly fish in that there are no Barb Cells.

Fig 28. The Comb Jelly Sequence to Keep animal afloat

The area of the comb Jelly Sequence to Keep animal afloat

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LEARNED SO FAR

- * Marine animals without backbones are called invertebrates.
- * Animals are classed together in a phylum when they resemble one another closely.
- * Members of the sponge group all have pores.
- * Animals of the cup-shaped phylum all have stinging cells.
- * Animals with jointed legs and outside skeletons belong to the arthropod phylum.
- * Most marine arthropods belong to the sub-group Crustacea. Crustacea includes lobsters, crabs, and barnacles.
- * The horseshoe crab is related to the spider family on land.
- * Marine worms may belong to the flatworm, roundworm or segmented worm group.
- * Feather worms and clam worms are segmented.
- * Starfish, sea urchins and sea cucumbers belong to spiny skinned group.
- * Animals belonging to the Mollusc PHYLUM have shells and soft bodies.
- * Examples of Molluscs are clams, oysters and snails, octopus and squid.
- * Molluscs are an important source of man's food.

STUDY GUIDE

Review of Chapter. Find the answer. Write it in your notebook.

- TASK 1: 1. Members of the arthropod phylum can remain upright when removed from the water because
 - a. they have eyes
 - b. they have outside skeletons
 - c. they have legs that may bend
 - d. they are advanced
 - 2. Jelly fish collapse when they are removed from the water because
 - a. they lack backbone's
 - b. air pushes on them
 - c. they have outside skeletons
 - d. of the sunlight
 - 3. Lobsters and crabs do not collapse when removed from the water because
 - a. they are strong
 - b. they have outside support
 - c. they have backbones
 - d. they live on land

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TASK 1: 4. In order to feed, a sponge -

- a. must take in water through its pores b. must move around and capture its food
- c. must swim
- d. must sting its food
- 5. Animals are placed in a phylum because
 - a. they differ from one another
 - b. they resemble one another closely in structure
 - c. they live in the same place
 - d. they eat the same foods.
- TASK 2: In what way is the barrier reef different from a fringing reef?
- TASK 3: Explain how a stinging-celled animal differs from a sponge.
- TASK 4: Find the outsider. Which word does not be long with the others?
 - 1. Red-beard sponge, sulfur sponge, jellyfish, bath sponge
 - 2. Jellyfish, Portuguese man-of-war, coral animal, starfish
 - 3. Fringing reef, barrier reef, atoll, lagoon
 - 4. Feather worm, nereis, clam worm, sea anemone
 - 5. Starfish, sea urchin, sea anemone

TASK 5: Answer the following: -

- 1. How are chordates like vertebrates? How are they different?
- 2. Can you make bath sponges from sponges that have spicules?
- 3. Can sea anemones move away from enemies? Why not? How do they protect themselves explain please.
- 4. What is adaption? List 10 animals you have studied in this unit and give 2 adaptions of each.

AUDIO VISUAL

- 1. Slide Sets on Rocky Shore.
- 2. V.C.R. Unit: The Coral Reef
- 3. Life on Earth: The Oceans No. 3

CHAPTER 10 ... THE SEA - A VALUABLE RESOURCE

OBJECTIVES:

At the end of this section you should be able to: -

- 1. Appreciate the abundance of mineral, food and water to be found in the sea.
- 2. Be able to describe some of the ways man has utilized this resource.

You are making good progress towards these objectives if you can:

- 1. (a) List some of the more common minerals found in the sea
 - (b) Relate approximate concentrations
 - importance to man
 - ease of recovery
 - (c) Identify important food resources
 - fish types
 - crustaceans
 - molluscs
 - plankton
 - (d) Describe how sea water can be used to provide 'fresh water'
- (a) Describe particular methods of fishing and scientific apparatus used to aid fishing
 - (b) Describe methods of mineral extraction and their economic importance
 - (c) Describe the process of desalination

Read the following summary - "The Sea - A Valuable Resource"

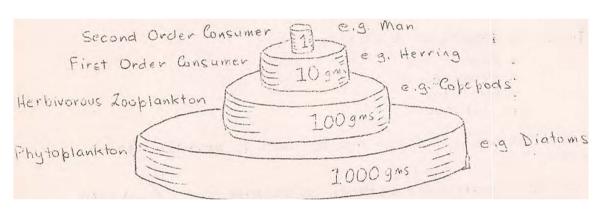
Since the formation of the seas thousands of millions of years ago, the solid rocks have been eroded by the action of water and minerals have been leached from the rocks. The seas contain all the mineral sources of the world, some in low concentrations, but many are present in sufficient quantities to render them economically extractable. Magnesium and its salts, sodium chloride and bromine are extracted. With improved techniques other minerals may well be extracted in the future. Already deep sea drilling rigs, suction dredges and other versatile machines are being employed to recover manganese, tin and diamonds from the sea floor. Many animals and plants of the sea contain minerals within their bodies. Iodine can be extracted from seaweeds and vanadium from the sea slug. In future times such animals and plants may prove to be important sources of minerals.

Water is a resource no living thing can be without for very long. With man's increasing demand for more water, the provision of this valuable resource can be a problem. The removal of /46....

the dissolved salts from sea water or desalination has proved to be a useful and economic way of obtaining fresh water. Useful, in that the extracted salts can be used commercially, and economic because the salts can be extracted by using free solar energy. A cubic mile of sea water contains 166 million tons of salt. Sea water is let into fields and left to evaporate naturally under the sun's heat. The evaporated water condenses on a catchment roof and is guided into storage tanks.

The base of all food chains is occu ied b reen plants and the complex ood chains of the sea are no exception. Minute phytoplankton absorb minerals from the sea and through the process of photosynthesis, complex organic substances are synthesized. Upon these phytoplankton feed the microscopic cooplankton that in turn provide food for many of the fish in the sea. It has been estimated that I kilogram of phytoplankton provides about 100 grams of herbivorous zooplankton which provides 10 grams of first order consumer and 1 gram of second order consumer.

Figure 29 The Pyramid of Biomass



A fish contains valuable rich protein, edible oils and vitamins A and D and on average provides 328 kilojoules of energy. Harvesting the seas has been part of man's life-style for many thousands of years. With increasing efficiency and improved technical and scientific skill and understanding, man could in the future obtain great quantities of food from the sea. Over fishing can be a problem and with the use of various sound scanning devices such as echo-sounders and side scan sonar this means more efficient fishing. In some parts of the world limits have been placed on the total permitted annual catch, the size of the mesh on fish nets, the length of the fishing season and limits to the actual fishing grounds in order to conserve our stocks of fish.

.Flounders were found to increase in size very rapidly when provided with certain conditions. Some s =1

locks in Scotland were enclosed using a dam. Fertilizers were used to enrich the water. Problems were encountered in preventing loss of nutrients to the sea and many species of fish, with the exception of flounder, did not take kindly to being enclosed for long periods of time. However, the experiments did point a way to future developments and with the use of genetic selection experiments the future looks promising. Some countries, for example, France, India, Hong Kong, Formosa and the Phillipines stock salt water ponds with grey mullet with success. Also with improved culture of marine fish and the transplanting of them to suitable feeding grounds could lead to increased stocks of fish.

However, perhaps at this point it would be a good idea to point out that man should be cautious before interfering with the sea's environment. Our knowledge of the sea is insufficient for us to make precise predictions as to what the consequences of our actions could be. In fishing, as in most human affairs, progress improvement depends upon intelligent control of human behaviour.

1 "Elements of Marine Ecology" by R.V. Tait, page 250.

PRACTICAL ACTIVITIES

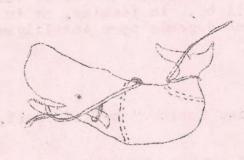
- 1. Refer to Activity 3, "Activities in Science 29"
- 2. Refer to 'Further Activities' page 15 of "Activities in Science 29", 'Iodine from the Sea'
- 3. Refer to Activities 1 and 2, "Activities in Science 29"

STUDY ASSIGNMENTS

- 1. Find out about the migration of marine species. How were these migrations discovered? How do fish navigate?
- 2. Find out and give an account of food webs in the sea.
- 3. Write an account of the life-cycle of a named food fish of commercial value and importance. How can a knowledge of this fish be valuable to the fishing industry?
- 4. Find out and describe ways man could obtain more food from the sea.
- 5. Describe various methods employed by deep sea fishermen to locate fish.
- 6. Outline the various methods of commercial fishing. How are these methods related to the habits of the fish sought?
- 7. Describe methods employed to extract minerals from the sea. Outline one method in detail.
- 8. What are the problems involved, in terms of pollution and conservation, when considering the sea as a resource for:/48....

- 8. (a) minerals (b) food

 - (c) water
- 9. Outline methods used to desalinate sea water.
- 10. What relationship is there between the phytoplankton of the sea and the mineral constituents of the sea? How could you increase the production of phytoplankton and what would be the effects of this action?
- 11. "Instead of catching fish, why not directly harvest the plankton itself and process it to extract the food material?" Discuss this statement.



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Carcass of a drowned sperm whale raised from a depth of 3,302 feet off Ecuador by a cable-laying ship with the telegraphic cable in which it had be come entangled. Other sperm whales have died the same way when becoming fouled in cables lying in depths of 3,850 feet.

DIRECTED TOPICS - TEACHER INFORMATION

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- 1. The study assignments could be allotted to various individuals or groups of individuals. These could be instructed to present their study assignments to the other members of the group using whatever supplementary aids they can to illustrate various aspects of this section. It would be hoped that an understanding of and use will be made of information gleaned from previous sections. Where this is not obvious the teacher could play an important role in drawing together the various sections to form a uniform body of knowledge and understanding.
- 2. A discussion of the problems associated with conservation and resources with particular reference to the sea could be rewarding and a valuable exercise.

SOME POPULAR AND READILY AVAILABLE BOOKS ON THE GREAT BARRIER REEF

- ALLEN, Jim and CORRIS, Peter. 1977. The Journal of John Sweatman. University of Queensland Fress. 280 pp \$24
- Australian Conservation Foundation 1969. The Future of the Great Barrier Reef. Papers of an Australian Conservation Foundation Symposium. Special Publication No. 3. 69 pp
- Australian Conservation Foundation. 1975. The Great Barrier Reef. Habitat. 3 (4) 24 pp
- BAGLIN, Douglas and MULLINS, Barbara. 1969. Australia's Great Barrier Reef. A.H. & A.W. Reed Pty. Ltd. Sydney. 14 pp \$2
- BENNETT, Isobel. 1971. The Great Barrier Reef. Lansdowne Press.
 Melbourne. 183 pp \$25
- BENNETT, Isobel. 1966. The Fringe of the Sea. Rigby Ltd.
 Sydney. 261 pp \$4
- BOLTON, G. K. 1977. The Great Barrier Reef. G. K. Bolton Cairns 50 pp \$2.50
- BROWN, Theo W. and WILLEY, keith. 1972. Crown of Thorns. The Death of the Great Barrier Reef? Angus and Robertson (Publishers) Pty. Ltd. 128 pp
- BURGESS, Warren E. and AXELROD, Herbert R. 1976. Fishes of the Great Barrier Reef. Pacific Marine Fishes Book 7. T.F.H. Publications U.S.A. 275 pp
- CAMPBELL, Andrew C. 1976. The Coral Seas. Orbis Publishing. London 128 pp \$12
- COATES, George. 1974. Fishing on the Barrier Reef and Inshore. T. Willmett and Sons (Pty) Ltd., Townsville. 132 pp \$2
- COLEMAN, Neville. 1974. What Shell is That? Paul Hamlyn Pty. Ltd. 308 pp
- COLEMAN, Neville. 1975. Australian Marine Fishes. A.H. & A.W. Reed, Sydney. 108 pp \$4.95
- COLEMAN, Nevelle. 1976. Shell-collecting in Australia.
 A.H. & A.W. Reed. Sydney. 176 pp \$15
- DAKIN, W. J. 1963. The Great Barrier Reef. Walkabout Pocketbooks, Sydney, 176 pp \$1.50
- DEAS, Walter. 1977. Australian Fishes in Colour. Rigby Ltd. 31 pp
- DEAS, Walter and Jean. 1972. Natural Life of the Barrier Reef. Rigby Ltd. Sydney. 32 pp \$4
- DEAS, Walter, and DOMM, Steve. 1976. Corals of the Great Barrier Reef. Ure Smith. Sydney. 112 pp \$10
- EDMONDS, Carl. 1974. Dangerous Marine Animals of the Indo-Pacific Region. Wedneil Publications, Newport. 235 pp. \$4

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- GILLETT, Keith. 1968. The Australian Great Barrier Reef in Colour A.H. & A.W. Reed, Sydney 112 pp \$4.95
- GILLETT, Keith, and MCNEILL, Frank. 1959. The Great Barrier Reef and Adjacent Isles. The Coral Press Pty. Ltd. Sydney. 209 pp
- GREAT BARRIER REEF COMMITTEE. 1978. A Coral Reef Handbook G.B.R.C. Handbook Series No. 1 Brisbane 92 pp \$2.50
- HOLTHOUSE, Hector. 1976. Ships in the Coral. Macmillan Co. of Australia Pty. Ltd. 146 pp \$13.90
- JAMES, PEter. 1976. Requiem for the Reef. Foundation Press. Brisbane. 84 pp
- LAVERY, H. J. 1978. Exploration North. Richmond Hill Press. Pty. Ltd. 251 pp \$15
- LUCAS, Alan. 1968. Cruising the Coral Coast. Horwitz Publications. 336 pp \$10
- McGREGOR, Craig. 1978. The Great Barrier Reef. Time-Life Books. 184 pp \$14
- PC/NELL, Peter (Ed.). 1975. The Great Barrier Reef. Australian Fisheries Reprint No. 39 28 pp \$1.24
- ACCKMAN, Irvin. 1974. Underwater Australia. Lansdowne Press.
 Melbourne. 112 pp \$7
- SAENGER, P. (ed). 1977. The Great Barrier Reef. A Diver's Guide. Scientific Committee, Australian Underwater Federation. 206 pp \$7
- SAVILLE-KENT, W. 1893. The Great Barrier Reef. Its Products and Potentialities. 387 pp \$50
- WRIGHT, Judith. 1977. The Coral Battleground. Thomas Nelson (Aust.) Ltd. Melbourne 203 pp \$8

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