ecology: the sea

by r. behan

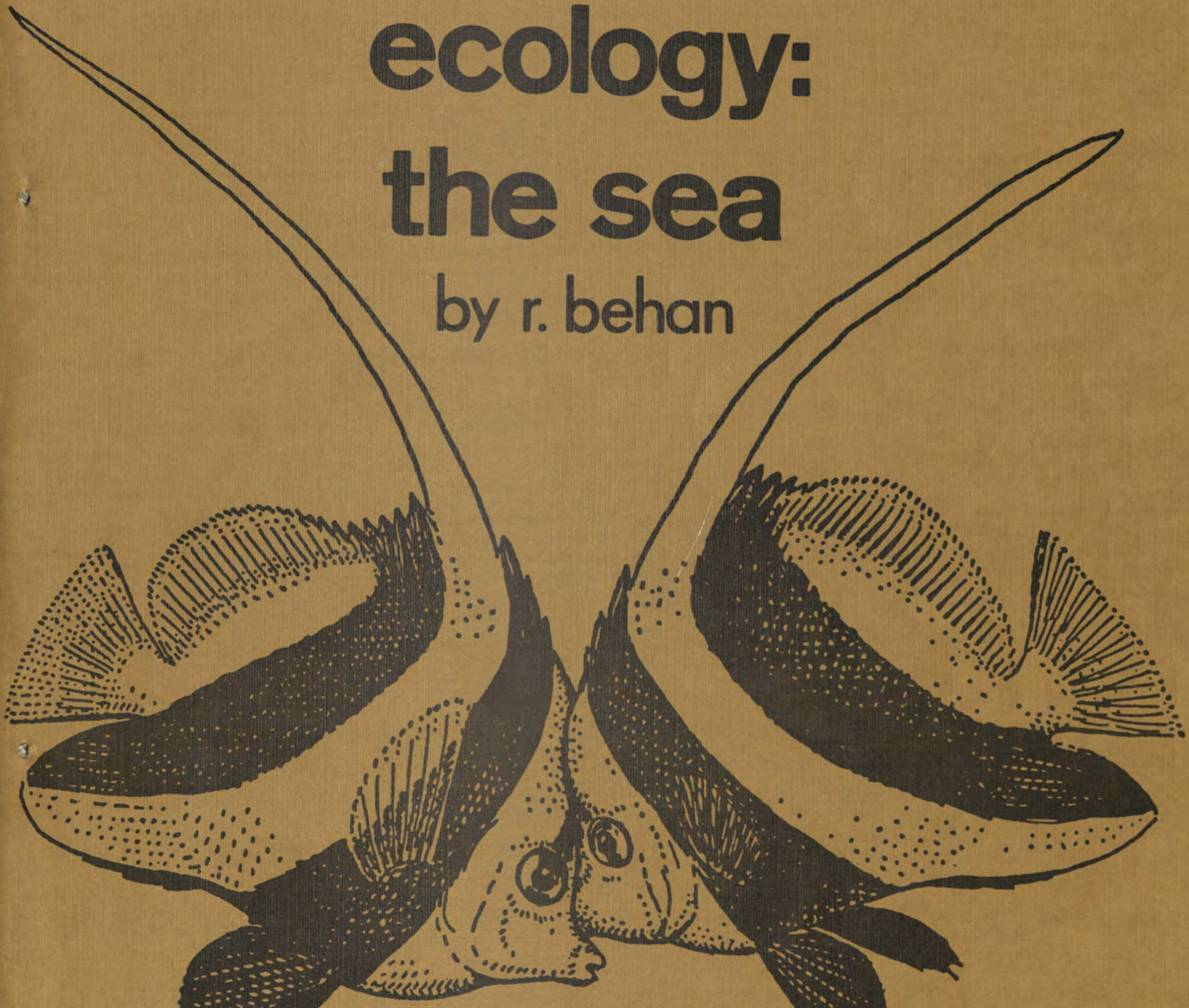

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TABLE OF CONTENTS

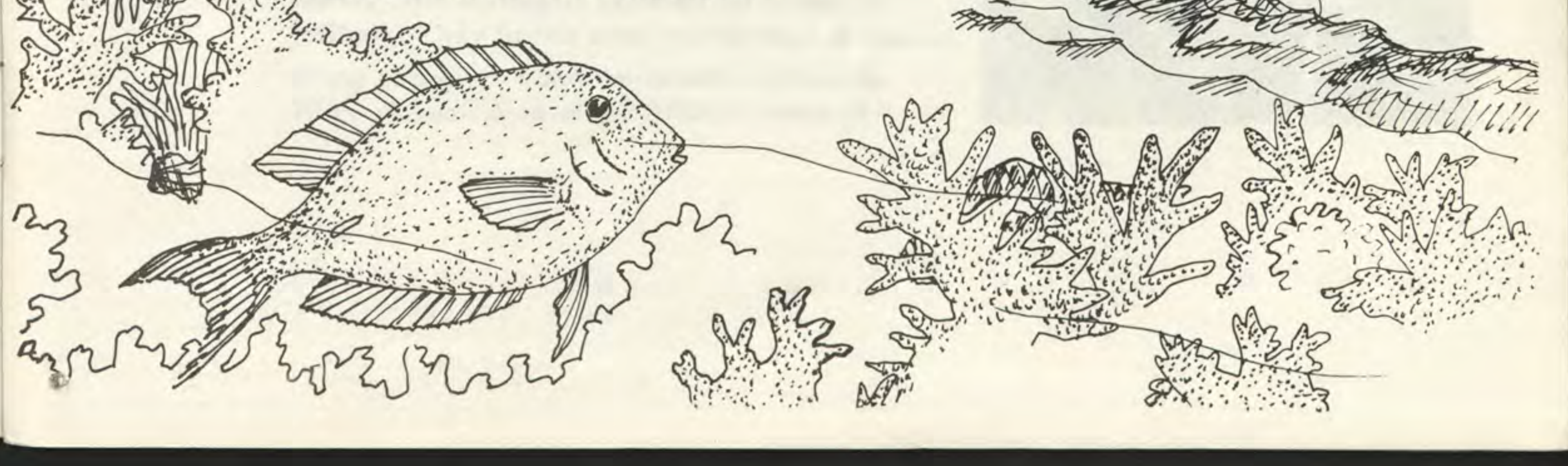
INTRODUCTION

The islands of Samoa are small with many steep mountains. The sides of these mountains are covered with a rich layer of green plants. A boy named Tama is working on one of the steep hillsides. He is cutting away a part of the thick plant covering. His bush knife moves quickly back and forth. Soon he will pull the roots of the plants from the ground and replace them with taro. Tama works very hard to clear the land and plant taro. The taro that Tama plants will help to feed his family. Tama has a very large family and he will have to plant many taro patches on the hillside to feed them all.

Living coral reefs surround the islands of Samoa. The water over the reef is blue and clear. Ume is a large fish that lives on the reef. He swims in and out of coral openings, looking for food and watching the rest of the reef-life. Waves move gently above Ume and break in shallow water. There are many different types of coral around Ume. This layer of living coral keeps the reef alive.

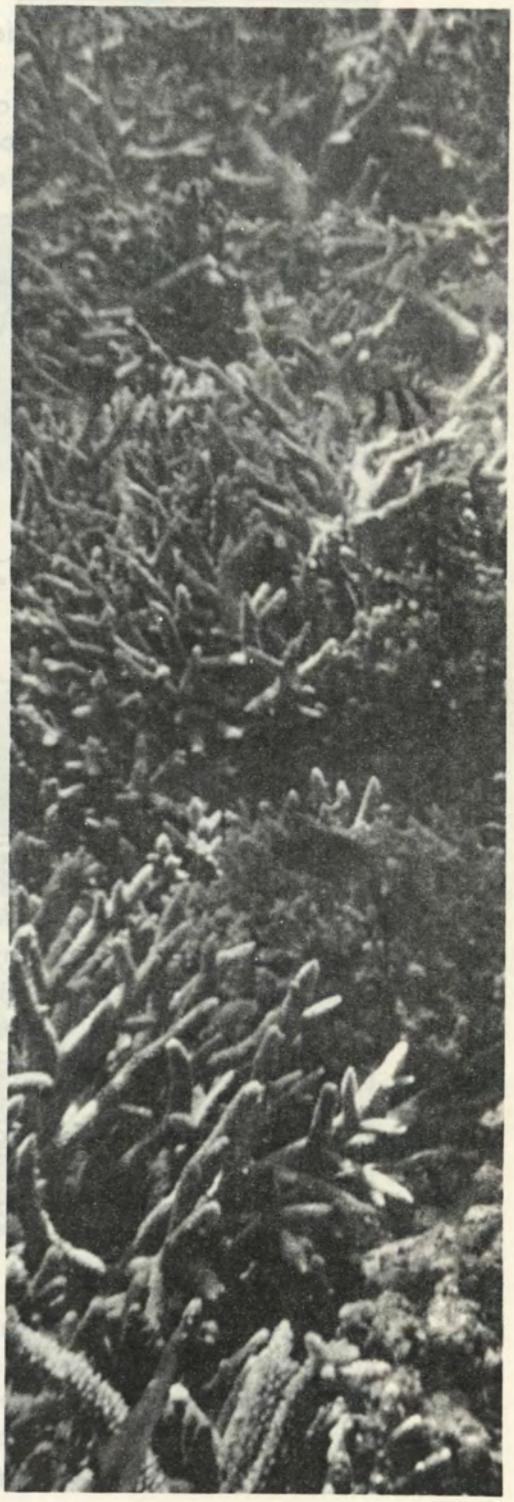
Tama and Ume are only a mile apart. But the worlds they live in seem to be a million miles apart. Tama lives and works on the solid land. He breathes the air from the atmosphere. Ume lives in the liquid sea. He cannot come out into the air. Perhaps Tama and Ume might meet if Tama went for a swim in the sea.

The story of ecology is the story of Tama and Ume. They seem to be in different worlds but they are not. Their lives meet and they are affected by each other in many different ways. As you study ecology, think of Tama and Ume.



Chapter I CORAL

A strange animal grows in the shallow parts of the warm oceans of the world. It is a prisoner inside its own house. The animal imprisons (traps) itself inside walls that it makes. Once the animal starts growing in one place it never changes places until death. Even after death the walls it created remain in the same spot. A tiny plant lives in the same house with the animal.

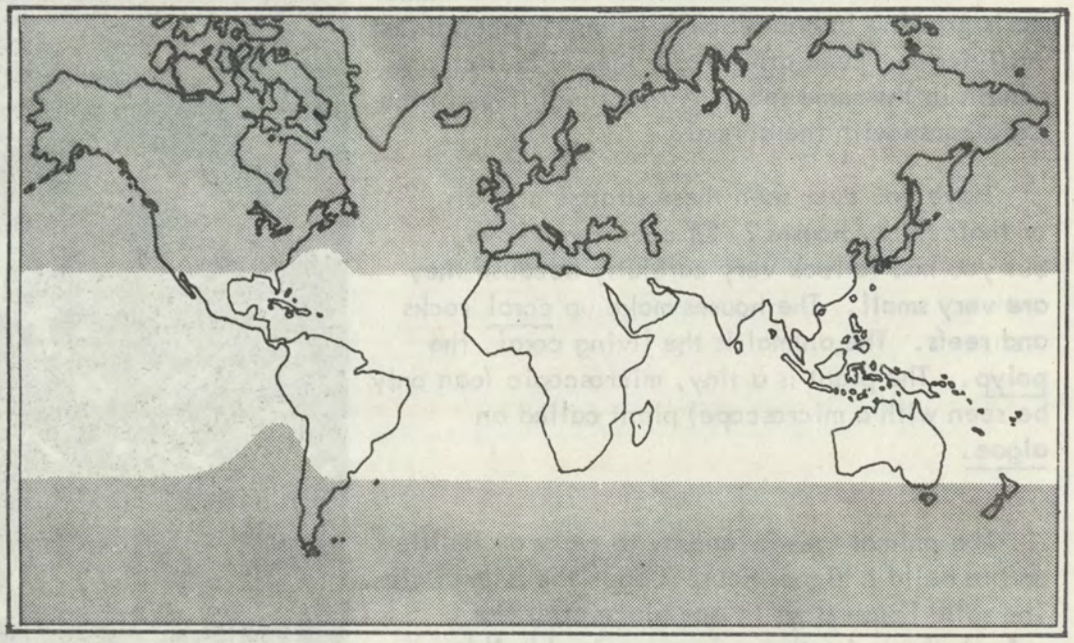


Have you ever seen these strange animals or their sturdy houses? Of course you have, but you had to look very carefully because they are very small. The houses make up coral rocks and reefs. The animal is the living coral, the polyp. The plant is a tiny, microscopic (can only be seen with a microscope) plant called an algae.

The animal uses its energy to carry on its life and to build a higher house. Soon the animal dies. The solid house stays in one place after the animal dies. Another prisoner animal builds a house on top of the first. After his imprisoned (trap) life, this animal, too, dies. Another and another build houses above the first. This may go on until the column of houses is many thousands of feet thick and miles wide.

The coral animal can only live in water that is warmer than 70°F. The greatest variety of coral occurs in water whose temperature is 77° to 84°F. If the temperature falls below 70°F by more than a couple of degrees the coral die. Coral does not have a way of keeping warm as you and I can. Coral lives in the tropical zones of the world. This is roughly between 30°N and 30°S latitude. Only in this zone are the rays of the sun strong enough to warm the ocean's surface to 70°F. A small area of the Atlantic north of

30°N latitude may be added because the Gulf Stream carries warm water into that region. Areas off the west coasts of South America and Africa are too cold for coral due to the cold ocean currents that lower the temperatures.



The plants inside the coral polyp are not used for food. Coral cannot digest plant matter. Coral polyps use their tiny arms to catch small animals that pass by. Why are the plants inside the polyp (even in its stomach) if they are not used for food? Scientists believe that the tiny algae cells produce oxygen for the coral polyp, remove carbon dioxide from the polyp and help to build the walls around the polyp. For these reasons the coral seems to grow better when it contains algae.

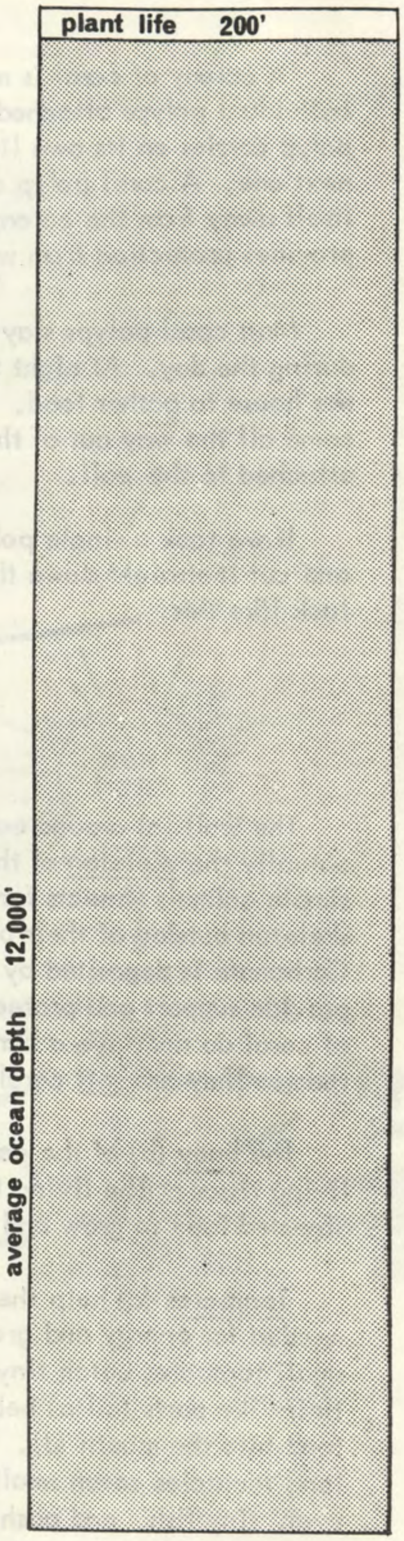
The plants need light from the sun in order to make their own food. Sunlight that enters the sea is absorbed (taken in) by particles in the water and by the water itself. Below 600 feet the world of the sea is very dark and black. Most plants need more than just this dim light. For this reason plants only grow to a depth of 200 feet. Below 200 feet there is not enough sunlight to support the food-making process (photosynthesis). Coral needs the plants of the sea so it does not usually grow below 200 feet.

Most coral is limited in its growth to areas of the ocean that have a temperature above 70°F. It is also limited to the upper sunlit 200 feet of the ocean. When we understand that the average depth of the open sea is 12,000 feet, we see that coral grows in a very small part of the world's oceans.

Each coral polyp builds a wall around itself. It uses Calcium Carbonate ($CaCO_3$) from the sea to build the wall. The shape of the wall depends on the type of coral.

Some corals make houses that are star-shaped. Others look like wheels or spokes. Each coral polyp is attached to the next one producing a general shape of all the polyps together.

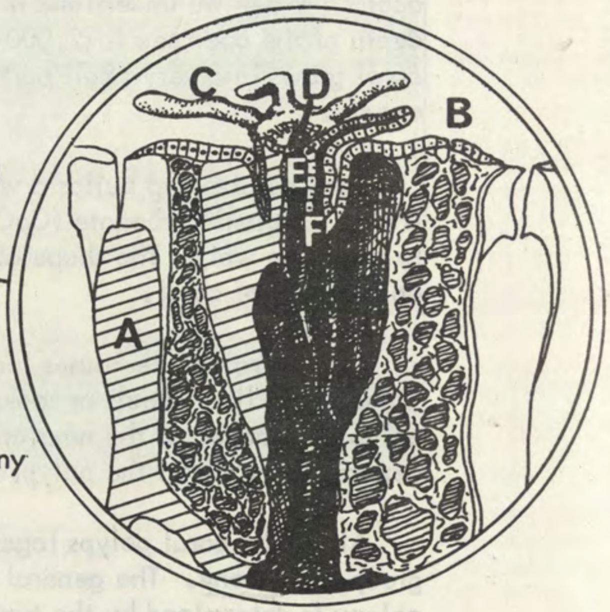
All of the coral polyps together form a group, or colony. The general shape of any colony is determined by the type of coral. Colonies grow in many forms, round, branching, flat and many other shapes. One type of coral grows in the shape of an animal's brain - "brain coral."



A colony of coral is made of many individual polyps attached to each other. Each polyp carries on its own life independent of the next one. A coral polyp could live all by itself away from the colony, but the colony provides protection from waves and currents.

Most coral polyps stay inside their house during the day. At night they come out of the house to gather food. The polyp can not come all the way out of the house for it is attached to the wall.

If we took a single polyp, magnified it and cut it straight down the middle, it would look like this:



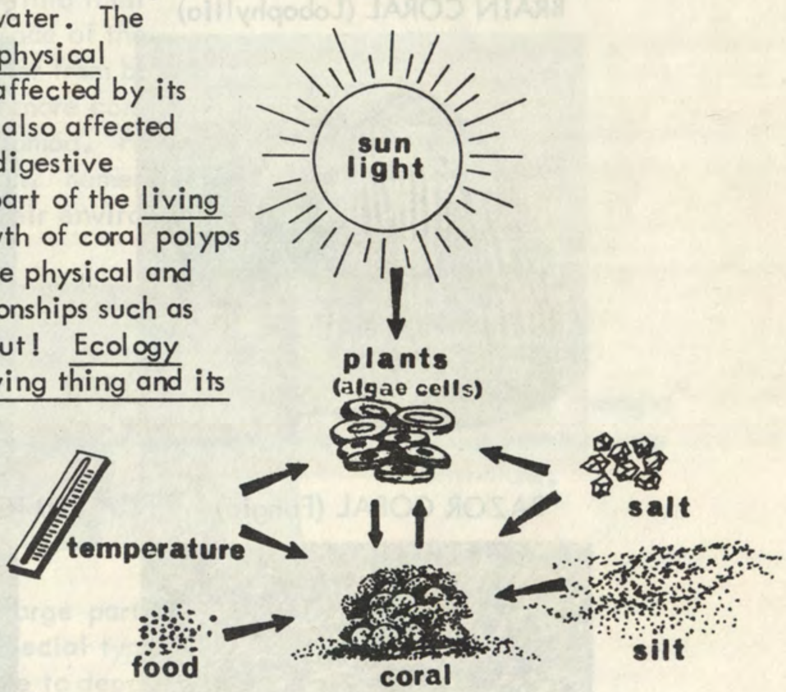
The wall (a) around each coral polyp is actually the skeleton of the tiny animal. Many simple animals (insects for instance) have a skeleton outside of their body. The Calcium Carbonate is deposited by the coral polyp to provide support and protection. Some types of coral do not have a hard skeleton around them. They are soft corals.

The body (b) of the coral polyp is made of living tissue. The living tissue uses energy from digested food to grow and reproduce.

Tentacles (c) help the coral polyps obtain food needed for energy and growth. Corals with very small tentacles catch tiny animals in sticky strands. Hair-like parts (cilia) help to push the trapped food into the mouth (d). The larger polyps with long tentacles catch small animals, sometimes even tiny fish, and push the food into the mouth.

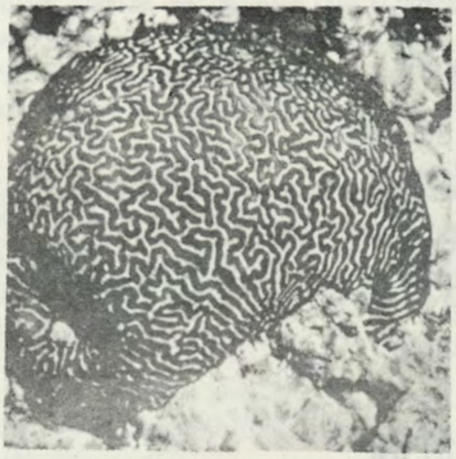
Food that enters the mouth passes down to the stomach cavity (e) to be digested. In the lining of the stomach cavity are the tiny plant cells (f) - dinoflagellates. Coral is not able to digest plant cells so the dinoflagellates are not used for food by the coral. The coral polyp and the plant cells work together. Scientists believe that the plant cells help the coral polyp and the coral polyp helps the plant cells. The plant cells provide oxygen and remove carbon dioxide for the coral polyp. The polyp builds a safe home for the plant cell. Each may live without the other, but they seem to live better when they are together.

You have found that coral is affected by the temperature of the surrounding water. The surrounding water makes up the physical environment. Coral growth is affected by its physical environment. Coral is also affected by the living plant cells in the digestive lining. The plant cells are a part of the living biological, environment. Growth of coral polyps and colonies is controlled by the physical and biological environment. Relationships such as these is what ecology is all about! Ecology is the relationship between a living thing and its environment.



Every living thing is affected by many, many things in its environment. Coral is affected by many factors (fish, wave-force, worms, etc.) other than those listed. To understand ecology, we must find all the factors that are interacting.

The reef corals of Samoa have many other animals interacting with them. Each special type of coral may have a special group of interacting animals. Here are some of the common reef corals of Samoa:



BRAIN CORAL (Lobophyllia)

STAGHORN (Madrepora) 'AMU

RAZOR CORAL (Fungia)

STINGING CORAL (Millepora) PUGAŪ

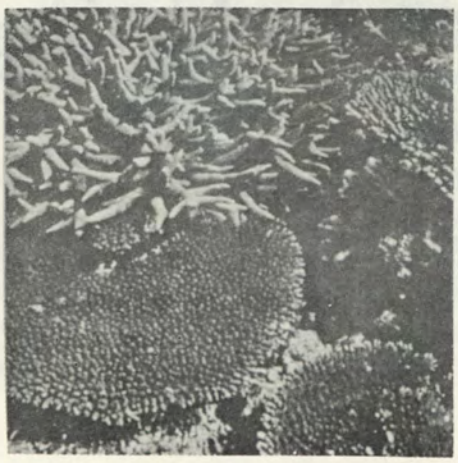
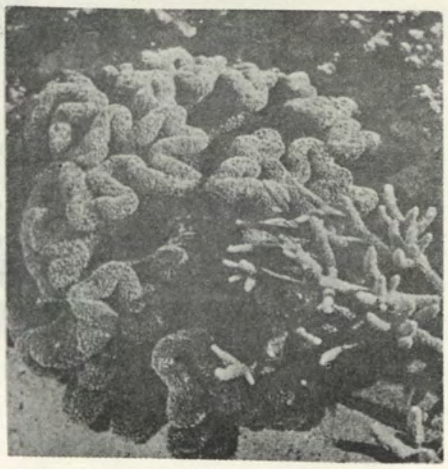


PLATE-LIKE CORAL (Madrepora) LAPA

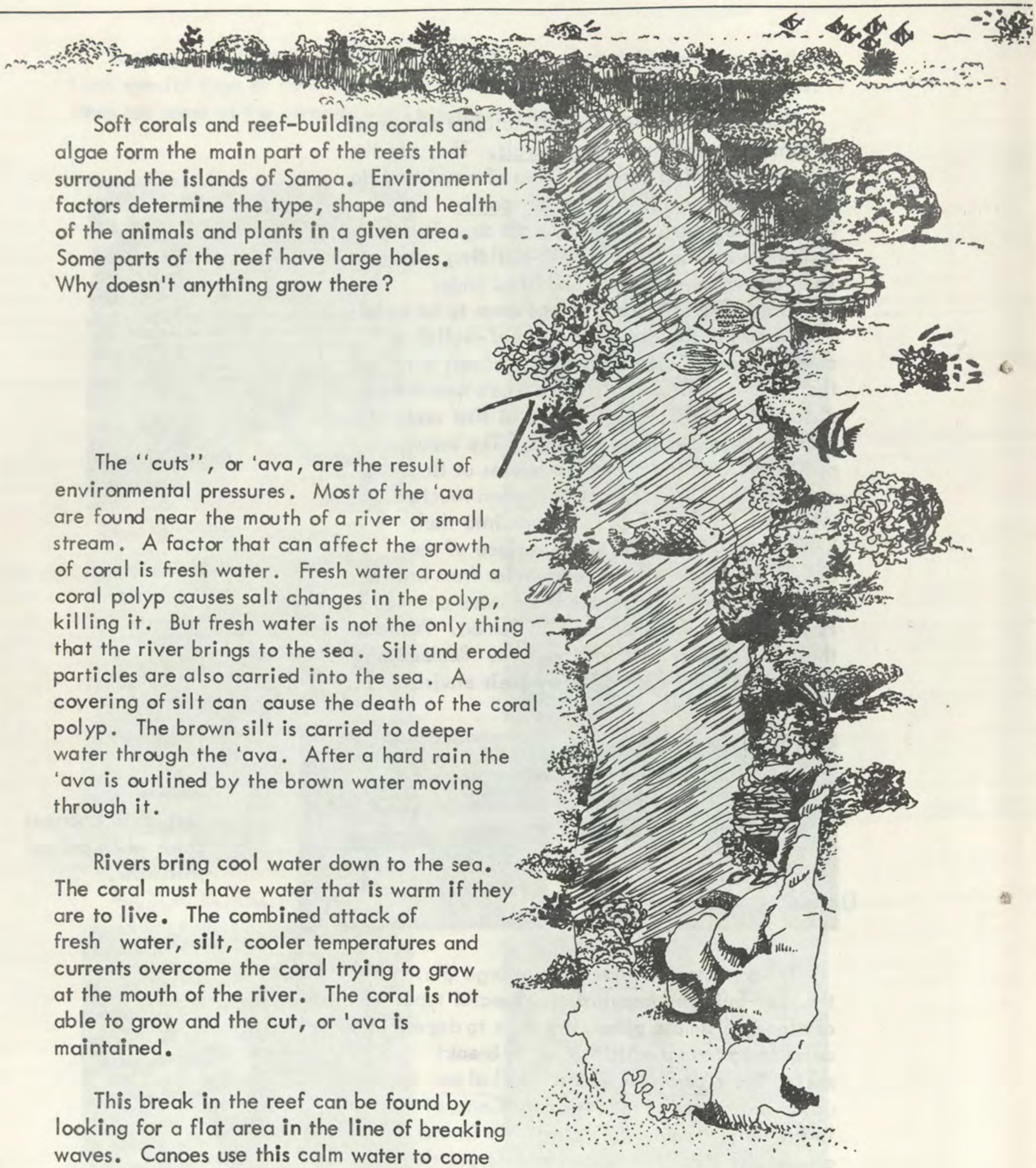


SOFT CORAL (Alcyonaria) 'ANA

Coral colonies that deposit calcium carbonate to form hard walls are stony corals. They are the true reef-building corals. Types of coral that do not build hard walls are the soft corals. Soft Corals (Alcyonaria - 'Ana) do not deposit calcium carbonate and so, are not reef-building corals. They are smooth to touch and bend under pressure. The soft coral polyps seem to be more active during the day than the reef-building coral polyps. One common type of soft coral on the Samoan reef changes color when touched or disturbed. The colony is brown at first and changes to white when touched. The brown polyps are partly out of their houses at first and they pull in for protection when touched. When the brown polyps pull back into their houses, they leave the white surface of the colony exposed - a change in color from brown to white. Soft corals seem to be more common in Pago harbor than other areas of Samoa. Perhaps there is a reason for their location. Remember, living things are controlled by their environment.

Soft coral changes color when polyps withdraw.

In some places algae form a large part of the reef-building population. Special types of algae, a simple plant, are able to deposit calcium to form a brittle (easy to break) reef. These coralline (coral-like) algae make up a large part of the reef near Coconut Point in Nu'uuli. Would the animal life in and around the coralline algae be different than the animal life around stony corals? Why?



Soft corals and reef-building corals and algae form the main part of the reefs that surround the islands of Samoa. Environmental factors determine the type, shape and health of the animals and plants in a given area. Some parts of the reef have large holes. Why doesn't anything grow there?

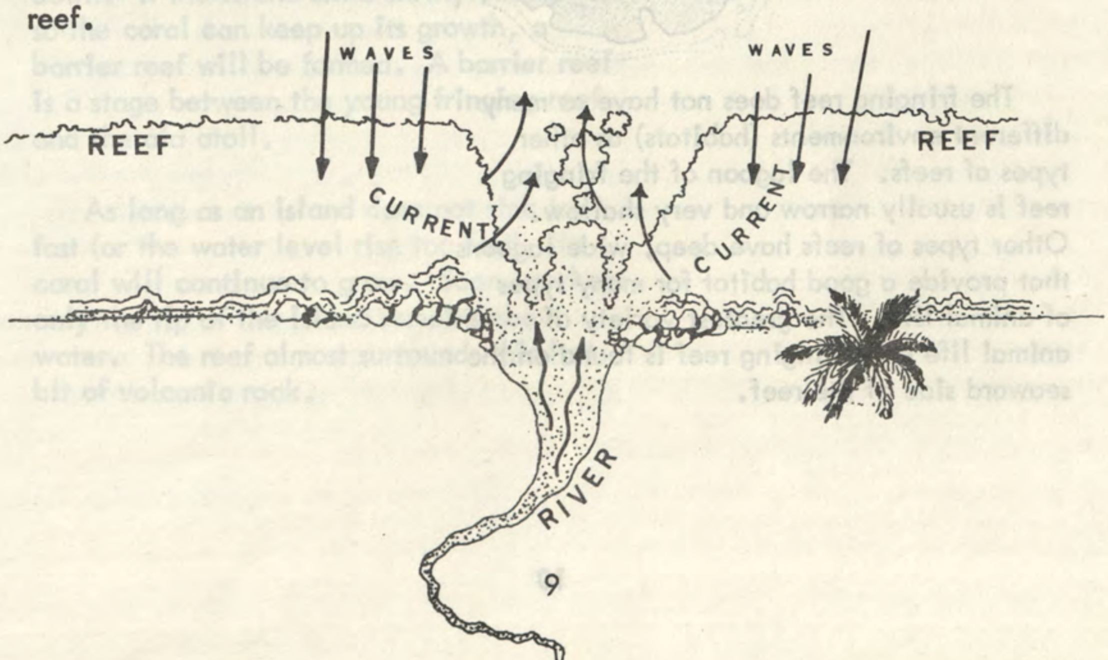
The "cuts", or 'ava, are the result of environmental pressures. Most of the 'ava are found near the mouth of a river or small stream. A factor that can affect the growth of coral is fresh water. Fresh water around a coral polyp causes salt changes in the polyp, killing it. But fresh water is not the only thing that the river brings to the sea. Silt and eroded particles are also carried into the sea. A covering of silt can cause the death of the coral polyp. The brown silt is carried to deeper water through the 'ava. After a hard rain the 'ava is outlined by the brown water moving through it.

Rivers bring cool water down to the sea. The coral must have water that is warm if they are to live. The combined attack of fresh water, silt, cooler temperatures and currents overcome the coral trying to grow at the mouth of the river. The coral is not able to grow and the cut, or 'ava is maintained.

This break in the reef can be found by looking for a flat area in the line of breaking waves. Canoes use this calm water to come through the breaking waves. The waves do not break in the 'ava because the water is deeper.

The waves break on both sides of the 'ava and throw water up onto the reef. Most of this water runs back to sea through the 'ava because it is lower than the surrounding reef. This returning water creates very strong currents that run directly out to sea. Large waves throw more water onto the reef and create stronger currents. A person that is carried out by an 'ava current should swim to one side of the 'ava or ride the current all the way out. The current is weaker at the sides of the 'ava and a swimmer reaching the side may be able to return to shore. Riding the current out allows the swimmer time to rest and find a way back through the waves. When the 'ava becomes wider and deeper the current slows down and stops. Swimming against a strong current in an 'ava is not the easiest way to return to shore!

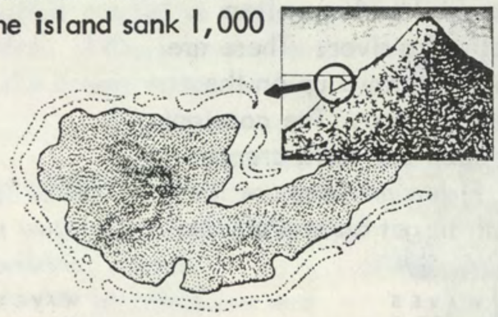
Small, shallow cuts (or 'ava) are often found far from the mouth of a river. These are created when water that is thrown up on the reef rushes back to the open sea. The constant flow of water currents back and forth create these <u>surge channels</u>. Fish sometimes use the surge channels as a path to get on and off the reef.



Coral reefs border the islands of Samoa in most areas. The edge of the reef is never very far from shore. The coral acts as a close colorful "fringe" (edge) for the dark volcanic rock. The reefs around Samoa are <u>fringing reefs</u>.

A fringing reef is a reef that is closely attached to the island. It usually forms a flat shelf from the shore.

The water on top of the flat shelf makes a shallow lagoon. The edge of the reef drops off quickly to the depths. The edge and top of the reef receive the full force of the waves that sweep in from the ocean. A narrow fringing reef usually indicates a young reef, one that has not had time to grow into either of the next two stages. Tutuila's reef is a young fringing reef because a great change took place many years ago. A large reef used to surround the island of Tutuila but it was killed when the island sank 1,000 feet into the sea.

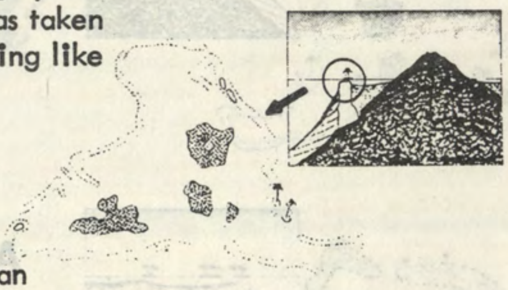


The fringing reef does not have as many different environments (habitats) as other types of reefs. The lagoon of the fringing reef is usually narrow and very shallow. Other types of reefs have deep, wide lagoons that provide a good habitat for many types of animal life. The greatest variety of animal life on a fringing reef is found on the seaward side of the reef.

At one time there was another type of reef around Tutuila. This reef was far from the volcanic shore and acted as a barrier to the force of the waves. It was a barrier reef. The island sank rapidly and the coral was not able to live far below the surface.

Many other islands have a barrier reef around them. The edge of the barrier reef is usually quite far from the shore. A barrier reef usually has a wide and deep lagoon between the reef edge and the shore.

The deepest part of the lagoon may be 60-300 feet down. The edge of the reef is found from one-half mile, to many miles off-shore. The barrier reef on the northeast shore of Australia is the largest reef in the world. This barrier is 1100 miles long by 50 miles wide. Think of how long is has taken those tiny polyps to construct something like that!

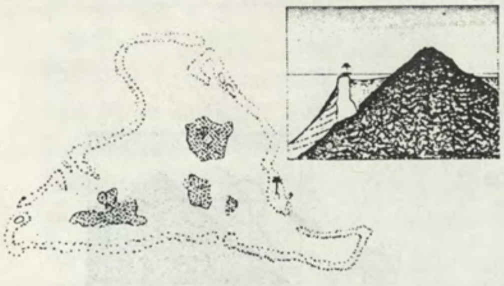


A barrier reef may be formed if an island slowly begins to sink. The edge of the fringing reef grows upward as the island sinks down. If the island sinks slowly enough so the coral can keep up its growth, a barrier reef will be formed. A barrier reef is a stage between the young fringing reef and the old atoll.

As long as an island does not sink too fast (or the water level rise too fast), the coral will continue to grow. Soon, perhaps, only the tip of the island remains above water. The reef almost surrounds this last bit of volcanic rock.

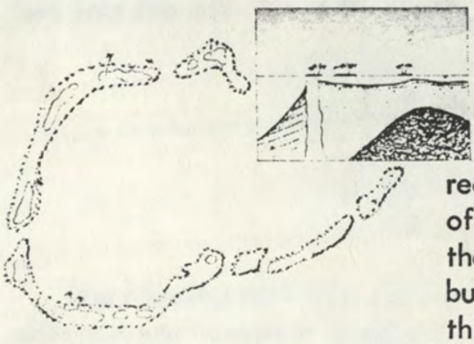
Continued change in the water level completely covers the last volcanic peak. The coral continues to grow and grow. Soon the coral is all that is near the surface. Small islands of coral are formed at the old reef edge. An atoll is formed!

Fringing Reef



Barrier Reef

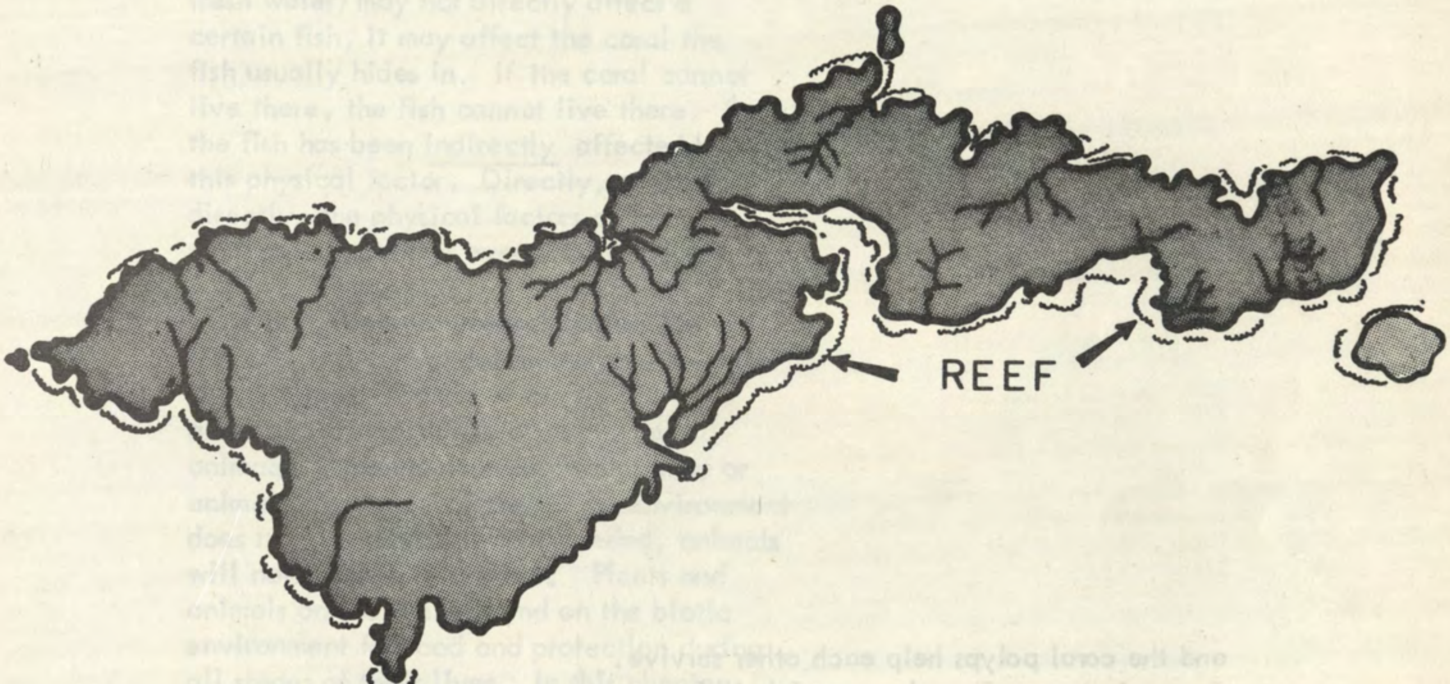
Sometimes the coral grows to a great thickness on the old volcanic rock. Holes drilled into the coral of Eniwetok Atoll went down 4222 feet before volcanic rock was reached!



Atoll

The change from a fringing reef to a barrier reef to an atoll seems to be part of the life cycle of a mountain. The mountain is worn down by the forces of weathering while the coral is building up. The Hawaiian Island chain shows this life cycle change very well. The youngest island (Hawaii) has a small fringing reef. Other islands have barrier reefs, a small volcanic rock in the middle of encircling reefs and the oldest volcanic mountains are atolls. In the Samoan Islands, Rose Island and Swain's Island are atolls. What does that tell you about the age and coral growth of those two islands?

The island of Tutuila is surrounded by a fringing reef. Compare the location of the rivers with the location of the 'ava.



SUMMARY

Environmental factors are able to control the growth of all animals and plants. Coral is controlled by the presence of silt, sunlight, warm water and fresh water. Any one of these factors can control the growth of coral. The controlling force of the environment affects all plants and animals everywhere in the world. Coral does not grow in the Arctic Ocean, nor do polar bears live in Samoa.

Each piece of coral is a group, or colony, of individual coral polyps. Tiny one-celled algae live with the coral polyps. The algae and the coral polyps help each other survive. Two main types of coral are reef-building coral and soft coral. Staghorn coral (Madrepora - 'amy and lapa) is a very common reef-building coral in American Samoa.

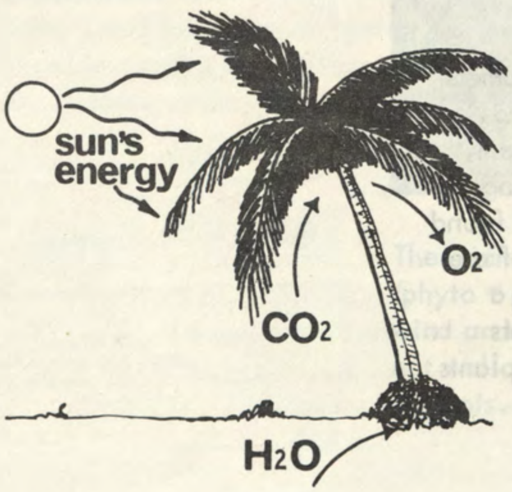
Large coral "cuts" or 'ava have been formed near the mouths of our rivers. The coral cannot live in the environment the river creates. Smaller 'surge channels' are formed by water movements when large waves break on the reef.

Coral forms three general types of reef: fringing, barrier and atoll. The different types of reef seem to be stages in an island life cycle. The islands of American Samoa are surrounded by fringing reefs.

Chapter 2 CYCLES, CHAINS AND WEBS

Physical factors of silt, temperature, etc. determine the type of coral that will form a reef. Each type of coral has a special group of animals associated with it. While a physical factor (such as fresh water) may not directly affect a certain fish, it may affect the coral the fish usually hides in. If the coral cannot live there, the fish cannot live there. So the fish has been indirectly affected by this physical factor. Directly, or indirectly, the physical factors of the environment control every living thing.

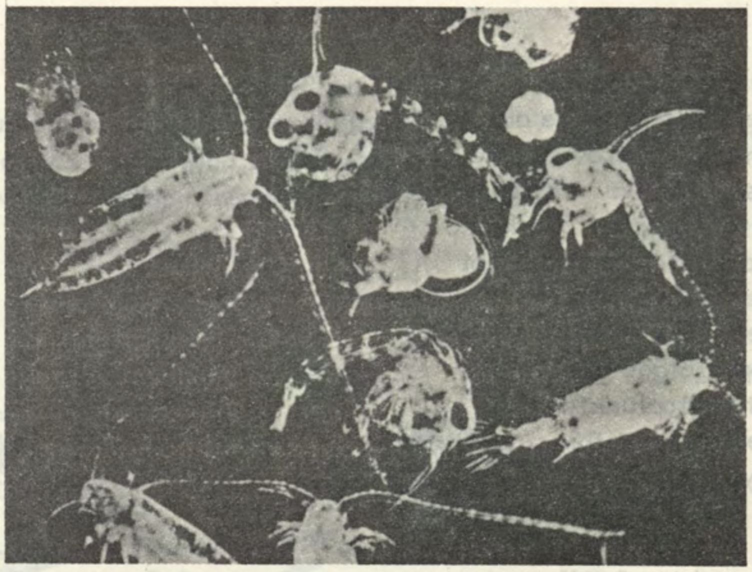
Physical environmental factors are not the only things that determine growth. The living (biotic) factors of the environment also control the growth of plants and animals. Animals need certain plants, or animals, for food. If the biotic environment does not contain their food needed, animals will not be able to survive. Plants and animals on the reef depend on the biotic environment for food and protection during all stages of their lives. In this chapter you will learn how many biotic factors interact with each other.



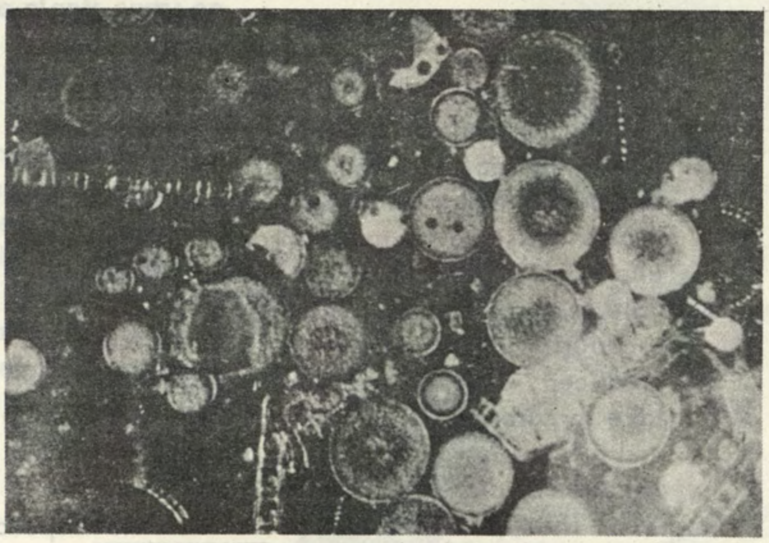
All animals life depends upon green plants. Green plants are the only living things able to make their own food. Plants are able to take carbon dioxide from the air and water from the soil and change them into a simple sugar - a food. Energy from sunlight is used in the chemical reaction. This process is known as photosynthesis.

The food made by plants is used for growth by those plants. Since the plants produce the food, they are called the producers. The rest of the living world depends on this production. Animals that depend on the producers are called consumers - the "eaters". A consumer that eats only plants may be a first-order consumer. A rhinoceros beetle that eats coconut leaves is a first-order consumer. Moths that drink nectar from flowers are also first-order consumers. Birds that eat insects like the rhinoceros beetle and moths are second-order consumers. Lice that live in the feathers of a bird are third-order consumers.

The examples of producers and consumers mentioned so far have been from the land. The producers in the sea present a problem. Have you ever seen a green plant growing on the coral reef? Large plants are not found on the coral reef. The plants of the reef are very small; too small to be seen without a microscope. There are a few small plants that can be seen, but the most common plants on the reef are very tiny.



The tiny living things that drift through the sea are called plankton. The tiny animals of the sea are the zooplankton (zoo = animal).

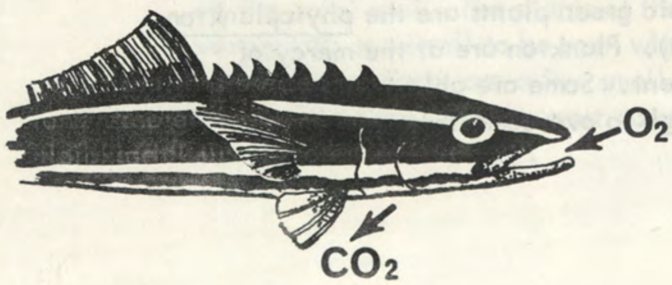


The microscopic green plants are the phytoplankton (phyto = plant). Plankton are at the mercy of wind and current. Some are able to swim but not well enough to overcome the movement of currents.

All life in the sea depends on the phytoplankton. These tiny plants are able to carry on photosynthesis and provide food for the consumers of the sea. These producers are limited to the upper 200 feet of the sea. They need sunlight and are not able to live below the sunlight level of approximately 200 feet. The chief producers are diatoms, microscopic algae and dinoflagellates. Most phytoplankton are only as big as a single cell, but this single cell may exist in many beautiful shapes and forms.

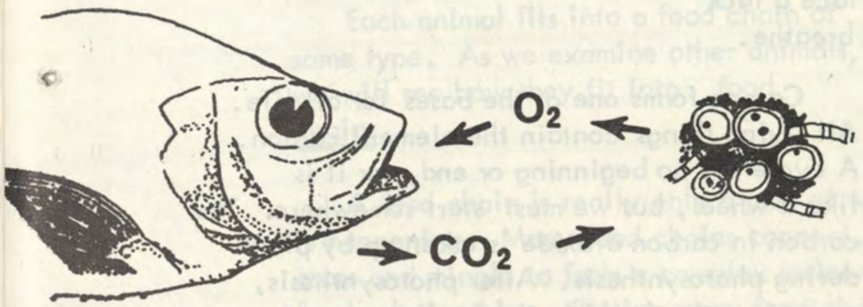
There are a great number of different types of zooplankton. Small single-celled animals, multiple-celled animals and many-celled fish larvae are all a part of the zooplankton. Zooplankton are first-order consumers, second-order consumers and third-order consumers. The tiny plankton far outnumber any other living thing in the sea.

The drifting plankton form the base for all life in the sea. The sea depends upon zooplankton-phytoplankton relationships for a food basis and for use and re-use of the chemicals needed for life. Phytoplankton are able to carry on photosynthesis for food production. At the same time the food is produced, oxygen is released. Phytoplankton take in carbon dioxide and water to make food and release oxygen. Most of the oxygen in our atmosphere comes from these tiny plants of the sea. The animals of the sea and the land depend upon oxygen produced by the phytoplankton.



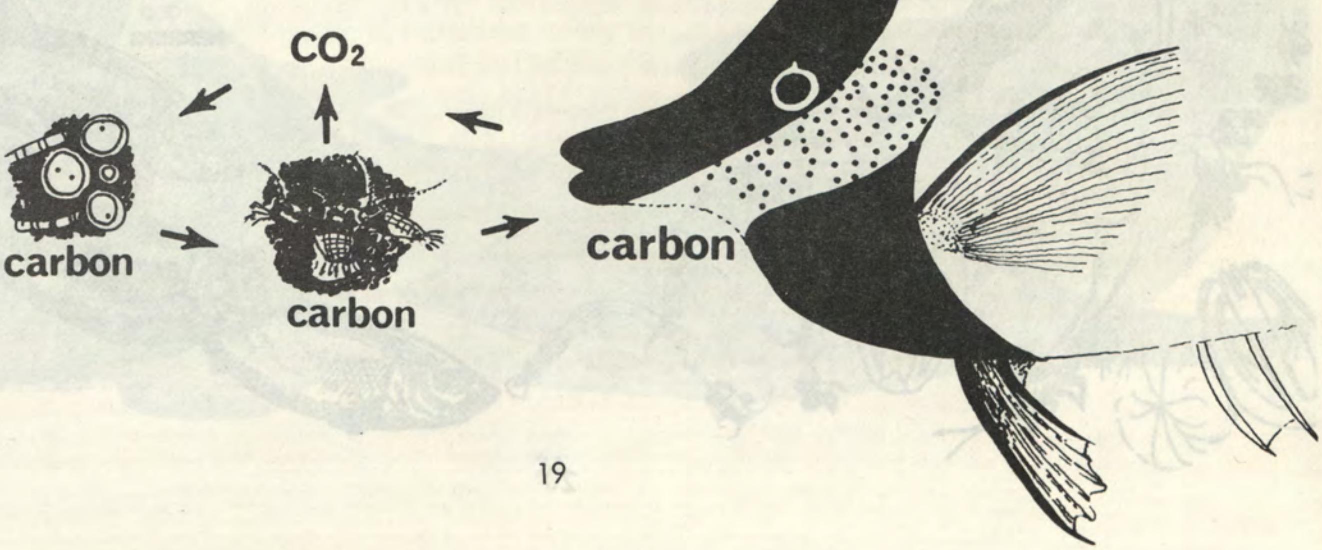
The oxygen taken in by the animals of the sea (and land) is used to "burn" their food to release energy. As the food is "burned" carbon dioxide (CO_2) is released.

This carbon dioxide can be taken up by the plants, along with water to make more food and oxygen. The whole process is repeated over and over.



This is a cycle. The carbon dioxide and oxygen are used and re-used in a constant cycle. Trees and other large plants carry on this vital cycle on land. In the sea tiny plants take the place of the large plants.

Life has been going on in the seas for many millions of years. If minerals and gases were not constantly used and re-used in a cycle, they would have been used up a long, long time ago. The use and re-use of materials is a lesson that man should learn. The sea provides many good examples of cycles, the carbon dioxide-oxygen cycle is one, the <u>carbon cycle</u> is another.



Cycles are one reason why man must be very careful when he disturbs any life system. A cycle is like a chain; it is only as strong as its weakest part. If a cycle is broken at any point, the whole cycle is destroyed. The ocean's carbon dioxide-oxygen cycle provides most of the oxygen for the earth's atmosphere. If this cycle were upset through ocean pollution, we might face a lack of life-giving oxygen in the air we breathe.

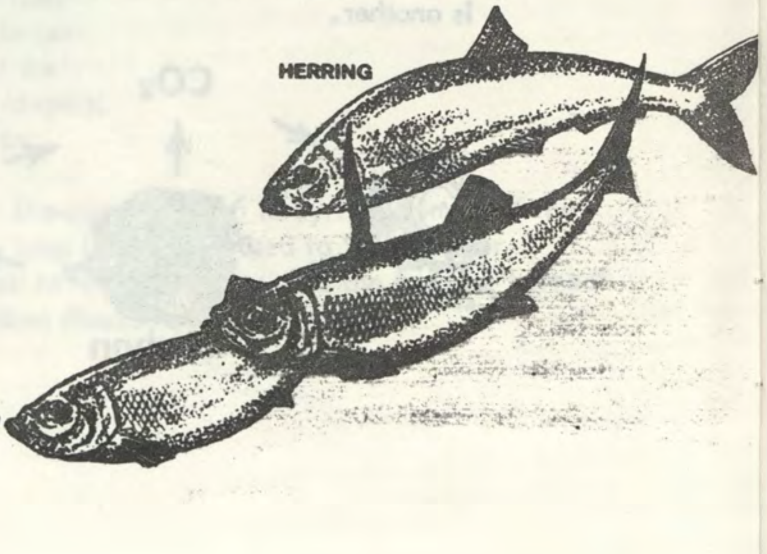
Carbon forms one of the bases for all life. All living things contain the element carbon. A cycle has no beginning or end, for it is like a wheel, but we must start somewhere. The carbon in carbon dioxide is taken up by plants during photosynthesis. After photosynthesis, carbon can be found in the food that was formed. This carbon helps to form the living plant. If an animal eats the plant the carbon is passed to the animal, to help form living tissue. If another animal eats that one, it is passed on again. Finally the carbon will be combined with oxygen to release energy from the animal creating carbon dioxide. This carbon dioxide can once again be used by the plant to form food. You can see that the carbon dioxide-oxygen cycle is a part of the carbon cycle.

The basis for a food cycle is the phytoplankton in the sea. The phytoplankton produce food that is used by <u>all</u> levels of life

PLANT PLANKTON

ANIMAL PLANKTON

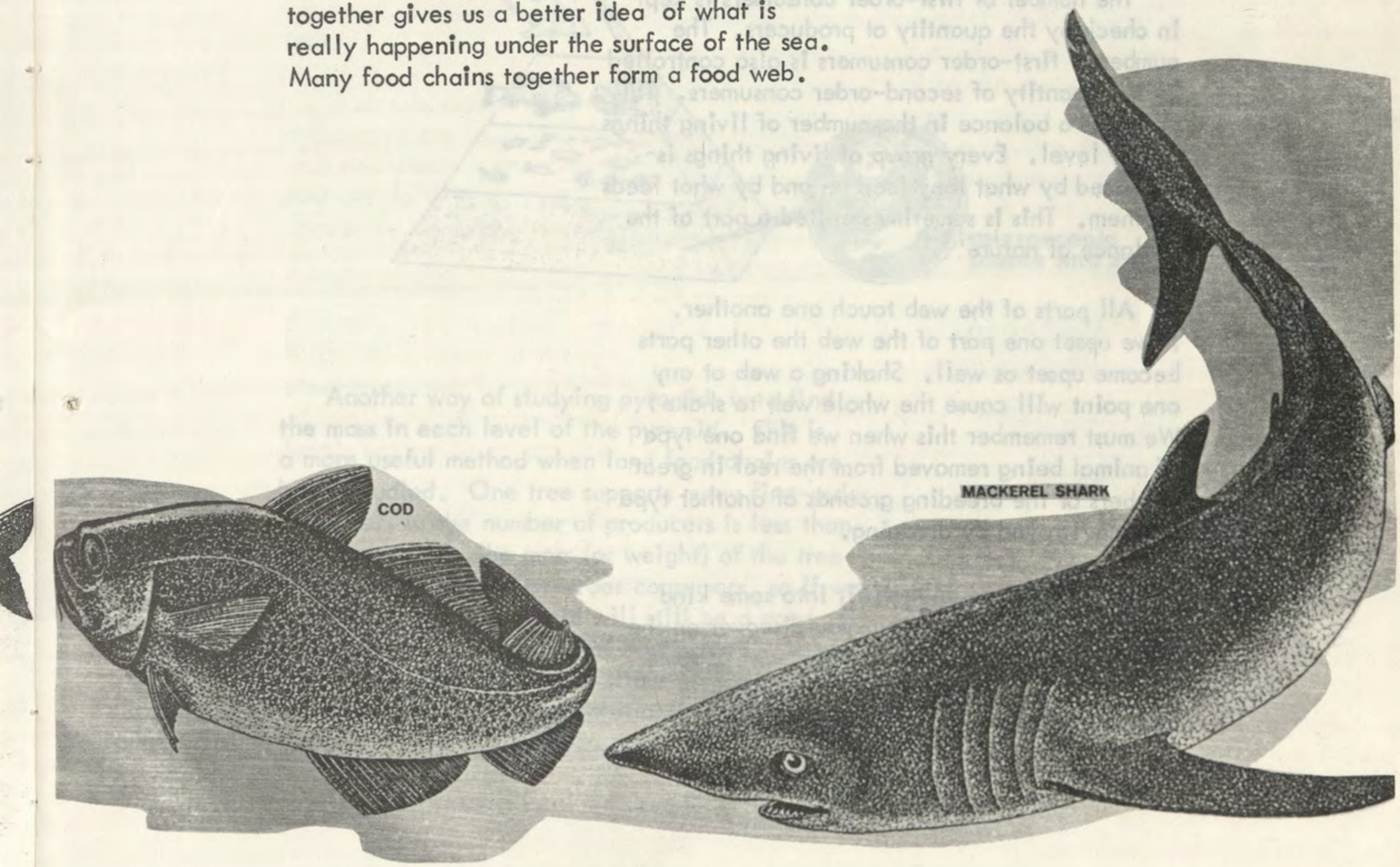
HERRING

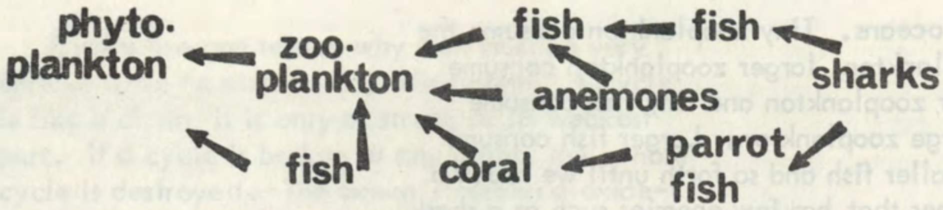


in the oceans. Tiny zooplankton consume the phytoplankton, larger zooplankton consume smaller zooplankton and tiny fish consume the large zooplankton. Larger fish consume the smaller fish and so forth until we reach a consumer that has few enemies such as a shark. This is called a food chain.

Each animal fits into a food chain of some type. As we examine other animals, we will see how they fit into food chains.

A food chain is really only a part of what is happening. Many food chains connect, cross and mingle to form a complex series of food relationships. Putting many food chains together gives us a better idea of what is really happening under the surface of the sea. Many food chains together form a food web.





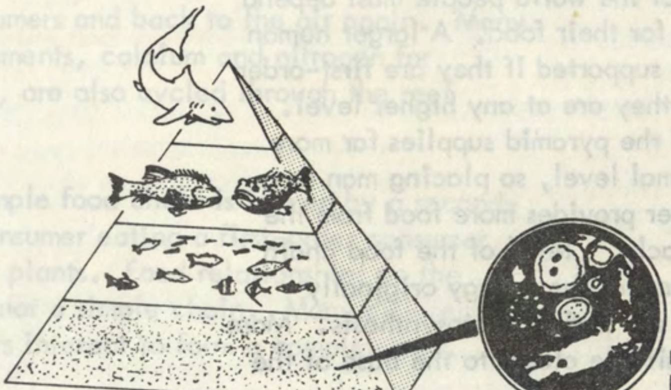
The most numerous producers in the sea are diatoms. These producers are eaten by many different kinds of first-order consumers. Zooplankton, fish and shellfish may all feed on the phytoplankton. There are more producers eaten by zooplankton than by any other consumer. The phytoplankton feed the zooplankton and the zooplankton feed the rest of the ocean in one way or another.

The number of first-order consumers is kept in check by the quantity ot producers. The number of first-order consumers is also controlled by the quantity of second-order consumers. This produces a balance in the number of living things at any level. Every group of living things is balanced by what they feed on and by what feeds on them. This is sometimes called a part of the 'balance of nature'

All parts of the web touch one another. If we upset one part of the web the other parts become upset as well. Shaking a web at any one point will cause the whole web to shake! We must remember this when we find one type of animal being removed from the reef in great numbers or the breeding grounds of another type being destroyed by dredging.

All plants and animals fit into some kind of web. Every animal that you discover on the reef fits into the food web of the reef at some point. No animal can stand apart from its living and non-living environment.

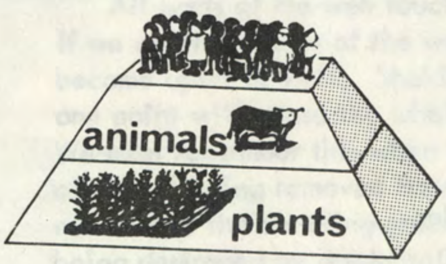
Food chains and webs in a system are often represented as a pyramid, with the food producers at the base and the highest consumer at the top. A food pyramid can be made to represent an actual food chain by counting the numbers of individuals involved at each step of the chain. A count of the living things in one cubic meter of reef might result in a pyramid such as this: 5,842, 424,000 producers (plants), to 7,762,400 first order consumers (zooplankton), to 500,000 second-order consumers (fish, coral and anemones), to 45 third-order consumers (fish), and one end consumer (shark).



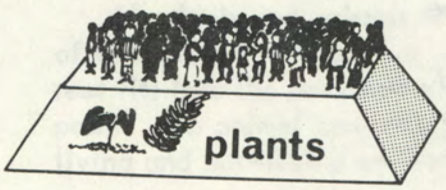
Another way of studying pyramids is to find the mass in each level of the pyramid. This is a more useful method when land food chains are being studied. One tree supports many first-order consumers so the number of producers is less than the consumers. The mass (or weight) of the tree is greater than the first-order consumers, so if we use the mass, our pyramid will still be a good model. An understanding of how a food pyramid fits into any environmental situation can help us to understand the energy relationships and even to predict future changes.

Pyramids based on numbers of individuals, or on mass, show what is happening in an environment at any one moment. Conditions do not stay the same, they are always changing. The amount of food at any one time is not as important as the speed of replacement of that food. The high temperatures and strong sunlight of our reef systems allow a rapid replacement of food.

A knowledge of food pyramids may help us solve a human social problem. The human population of the world is increasing at a temendous rate. Can this population continue to increase without causing a serious food shortage? In crowded areas of the world people must depend directly on plants for their food. A larger human population can be supported if they are first-order consumers than if they are at any higher level. The plant level of the pyramid supplies far more food than any animal level, so placing man as a first-order consumer provides more food from the available soil. Each level of the food chain uses (and loses) some of the energy originally obtained from the sun during photosynthesis. More food energy is available closer to the base of the pyramid.



By finding more ways to get nearer to the base of the pyramid, it may be possible to allow larger human populations.



In Samoa man is already near the base of the pyramid. Most of the available soil is being used. Do you think Samoa can allow a larger human population?

SUMMARY

All green plants are able to produce their own food and oxygen by combining carbon dioxide and water in the photosynthetic reaction. The plants are the producers of the world while the animals are the consumers.

Diatoms, dinoflagellates and algae make up the producers of the reef. Zooplankton, fish and all the rest of the animals are the reef's consumers. The producers and consumers constantly exchange oxygen and carbon dioxide in a never-ending cycle. Carbon itself is transferred from the air, to the producers, to the consumers and back to the air again. Many other elements, calcium and nitrogen for instance, are also cycled through the reef system.

A simple food chain is formed by a second-order consumer eating a first-order consumer who eats plants. Food relationships on the reef are not a simple chain. Many different consumers interact to form a complex web.

Food relationships can also be seen as a pyramid. The greatest number (or mass) of living things exist at the producer level. The greatest number (or mass) of consumers exist at the first-order consumer level with higher levels having fewer and fewer members.

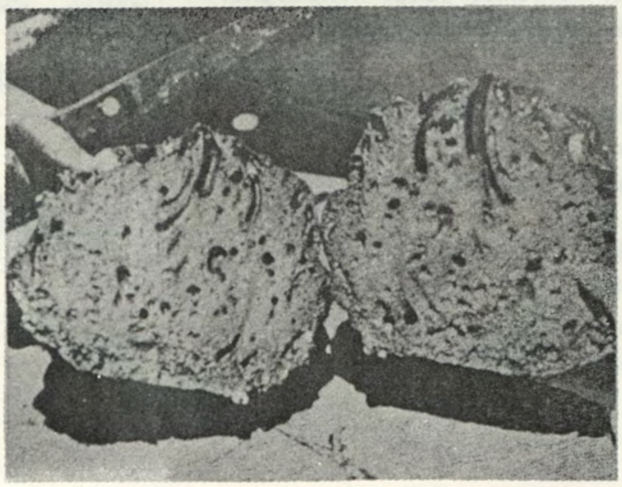
Chapter 3 ANIMALS OF THE REEF

A coral reef contains many, many different types of animals. Some of the most beautiful animals in the world live on the coral reef. Some of the ugliest animals also live there. Animals that are good to eat and animals that contain deadly poisons live side by side on the coral reef. Large and small, soft and sharp, all live together in the strange world of coral.

Here is a list, with descriptions, of the major groups of animals found on our Coral reefs. The interrelationships and homes of these animals will be studied in later chapters.

I. PORIFERA - SPONGES - OMOMI

Many different types of sponges inhabit the reefs of Samoa. Round, gray sponges with yellow interiors contrast with the flat, bright orange sponges. All sponges grow attached to some type of solid object. They must draw their food to themselves. Tiny hair-like whips in the walls of the sponge wave rapidly to create a current. The water moved by the current is drawn through tiny holes, or pores, in the sponge. The sponge acts as a filter removing the plankton from the water for food.



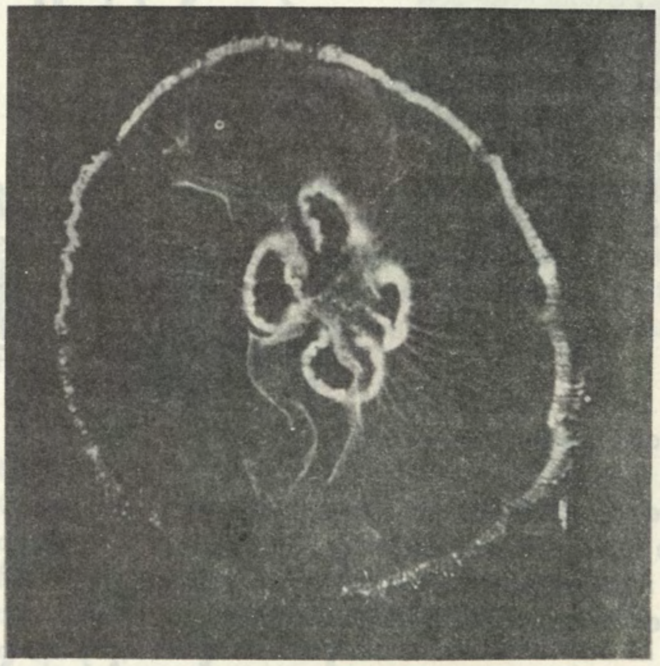
Sponge - Omomi

The dried bodies of some types of sponges are used to wash floors, walls and dishes. Sponges are harvested as a crop to be taken to market in areas of Greece and Florida. Most of the sponges sold in the stores today are made man-made fibers, not the real sponge animals.

2. COELENTERATES

a. Jellyfish - 'alu'alu, sesama

The first group of coelenterates consists of jellyfish. Jellyfish are not fish but get their name from their soft, jelly-like body and the fact that they live in the water. Many animals have 'fish' for part of their name when they really are not fish at all (shellfish, cuttlefish jellyfish). Most jellyfish are able to swim by a beautiful slow-motion flapping action.



Jellyfish (Rhizostoma - 'Alu'alu)

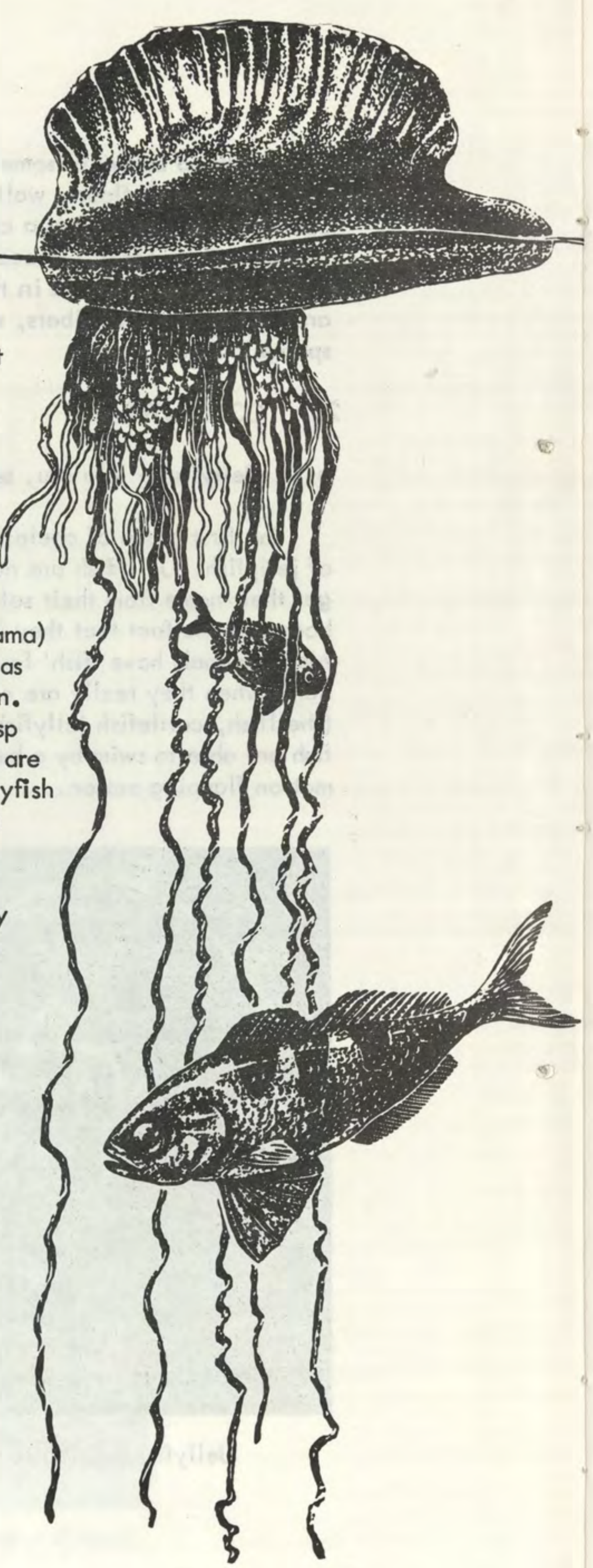
Jellyfish have long arms (tentacles) that hang down from the "umbrella" part of their body. If a small fish swims into tentacles to hide from a larger fish, he becomes a meal for the jellyfish. Each tentacle contains many stinging cells that inject a poison through a tiny spear. Many tiny spears are shot into the fish at once, and the fish is killed by the poison. The jellyfish digests the fish after pulling it close to its body.

Almost all coelenterates have stinging cells that help them capture their food. Some of these cells are not harmful to man, and some will cause great discomfort and pain. The stinging cells of the Portugese man-of-war (sesama) are able to inflict a very painful wound, whereas the 'alu'alu are not able to seriously poison man. Some of the most poisonus jellyfish, the sea wasp or lightning, are very hard to see because they are small and clear-colored. Stings from these jellyfish have been fatal. If you are not familiar with a jellyfish you see, stay away!

The Portugese man-of-war and the Sailor-by the-sea are two large jellyfish unable to swim. A large inflated air bladder acts as a sail for the wind to push them about. Long tentacles hang down to trap unsuspecting fish below.

b. Anemones - Lumane and Corals - 'Amu

Anemones and corals are often called the "flower animals" due to the flower-like appearance of the polyps. Most anemones, like the corals, live attached to one spot all their lives.



Portugese-Man-O-War (Physalia-Sesama)

Anemones

Anemones have tentacles similar to a jellyfish. Stinging cells are able to capture and kill small fish. Food for an anemone ranges from tiny plankton to small fish. The small animals that are caught by the tentacles are pulled down into the mouth opening to be digested.

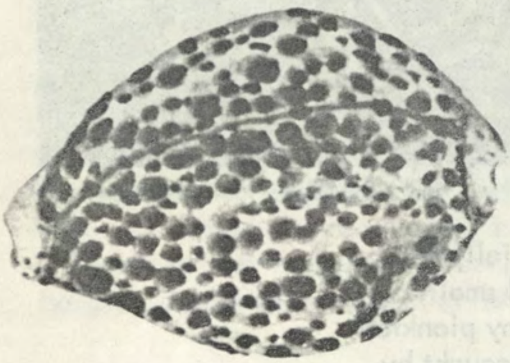
Coral is one of the most important animals on the reef. Its closest relative is the sea anemone. Coral, like the sea anemones, has tiny stinging cells on tentacles that can be used to capture food. Many coral polyps look like tiny sea anemones. The story of coral is outlined in chapter I.

3. MOLLUSKS

a. Shells - Pule, 'Asi'asi, etc.

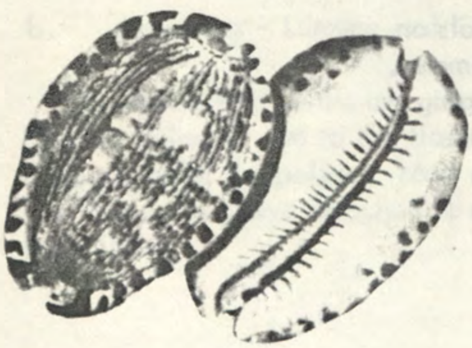
Mollusks and their products have been used for food, money, eating utensils, jewelry, buttons, dyes, tools and weapons since earliest times. The animals of this group are called "shellfish", though they certainly are not fish, and some do not even have a shell. Shellfish form a large and important part of the animal life of the reef. They can be divided into two main groups: animals with one shell (gastropods) and animals with two shell parts (pelecypods).

Animals with one shell form a large part of the shellfish population in Samoa. Gastropods are particularly common on the coral reef itself. Cowries (cypraea - pule) with beautiful patterns on the back of the shells once served as money.

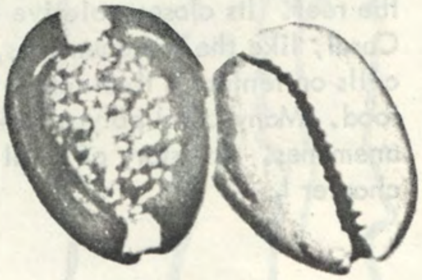


Tiger Cowry (Cypraea - Puleta'ife'e)

Goldringer (Cypraea - Pule)

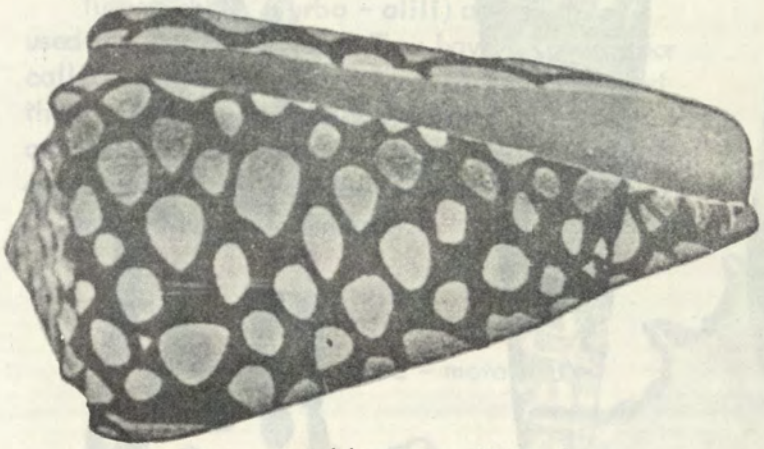


Arabian (Cypraea - Pule)



Serpents' - Head (Cypraea - Pule)

Today cowries can be exchanged for money because their beautiful shells are purchased by collectors. Cowries move about and feed mainly at night. During the day they hide under rocks and coral. A first-order consumer, the cowry moves along the reef scraping algae away with its rasping tongue. This rasping tongue can be seen in an aquarium when the cowry feeds on the algae attached to the glass. The tiger cowry (c. tigris - puleta'ife'e) has been used in Tonga and Samoa as a lure for catching octopus. Other common cowries are used for ulas, pocketbooks and decoration.

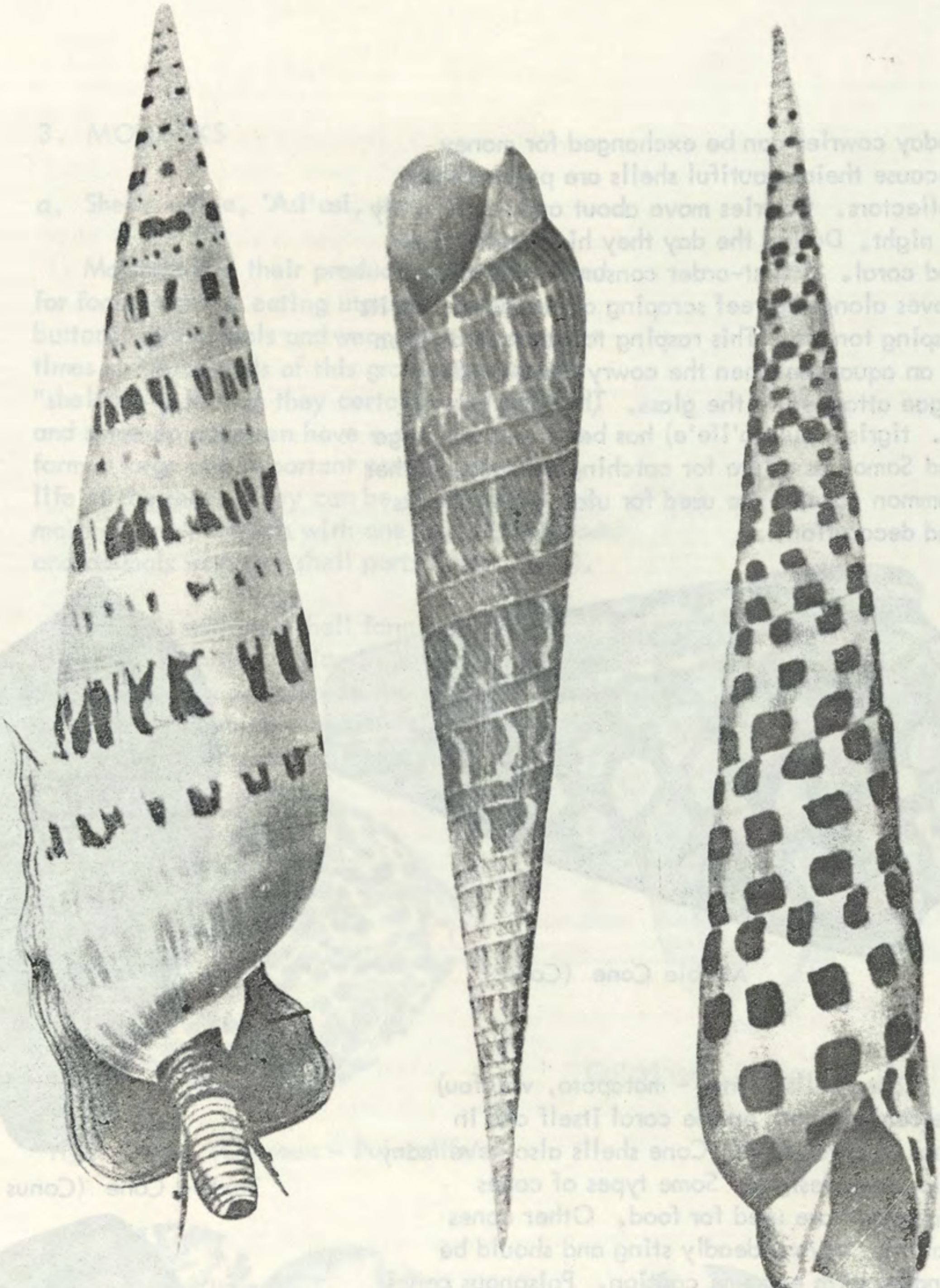


Marble Cone (Conus)

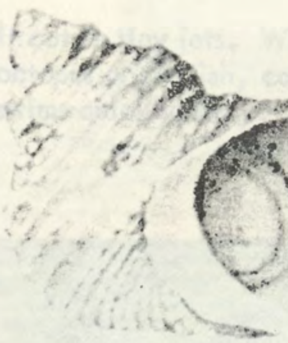
Textile Cone (Conus - Valufau)

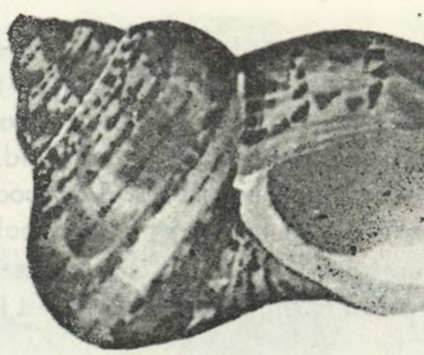
Cone shells (conus - matapoto, valufau) are common both on the coral itself and in areas of coral sand. Cone shells also have many colors and designs. Some types of cones (matapoto) are used for food. Other cones (valufau) have a deadly sting and should be handled with extreme caution. Poisonous cones have a small spear with a barb that they shoot into other animals. Poison from a poison sac is pumped through the spear into the animal. In this way cones are able to hunt and kill fish and other shells.

Hebrew Cone (Conus)



Other hunters in the single shell group are the augers (Terebratui, fao). Commonly found in areas of coral sand, the augers hunt for other shells. When they find another shell, they bore through the hard covering to get at the meat of the animal inside.

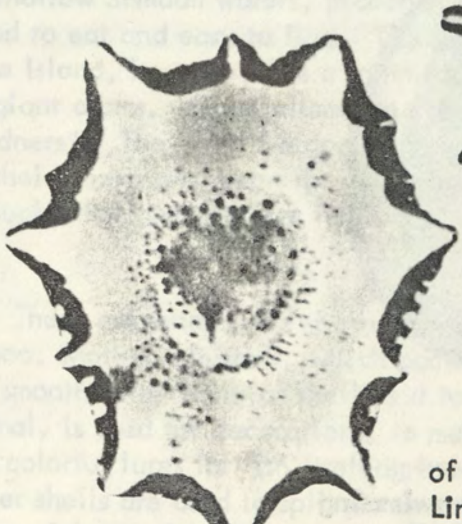


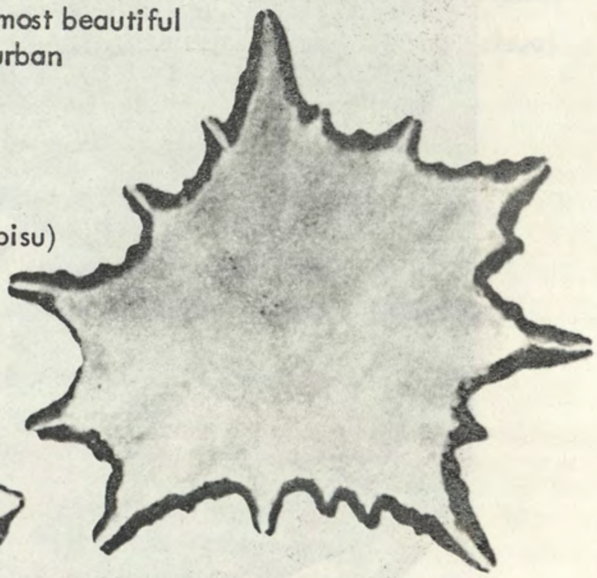


A. Turban Shell (Turbo - Alili) B. Tapestry Turban (Turbo - Alilimoana)

Turban shells (Turbo - alili) are commonly used for food in Samoa. They have a round door called an operculum that they can close behind them when they pull back into the shell. This operculum is used for jewelry. The most beautiful operculum comes from the tapestry turban (T. petholatus - alilimoana).

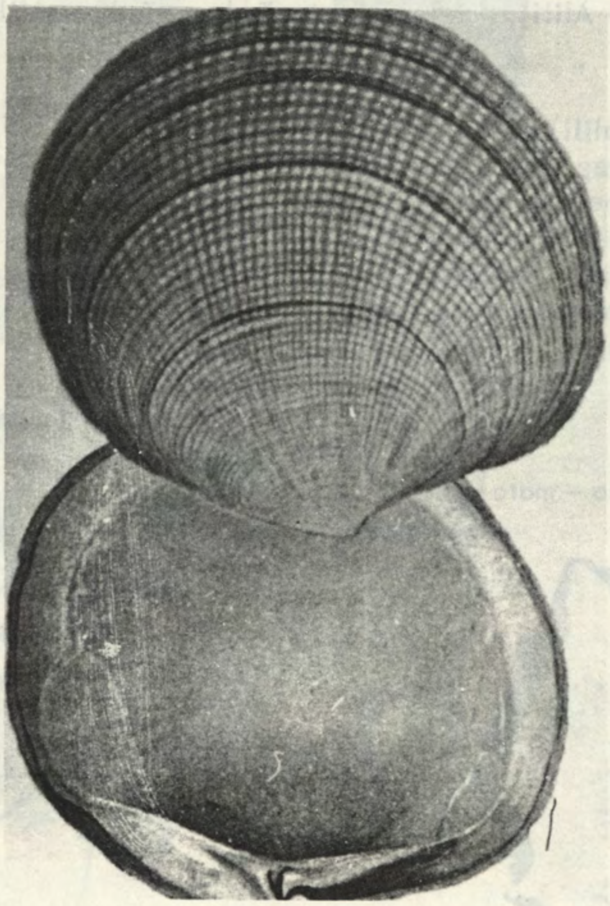
Limpet (Acmaea - matapisu)





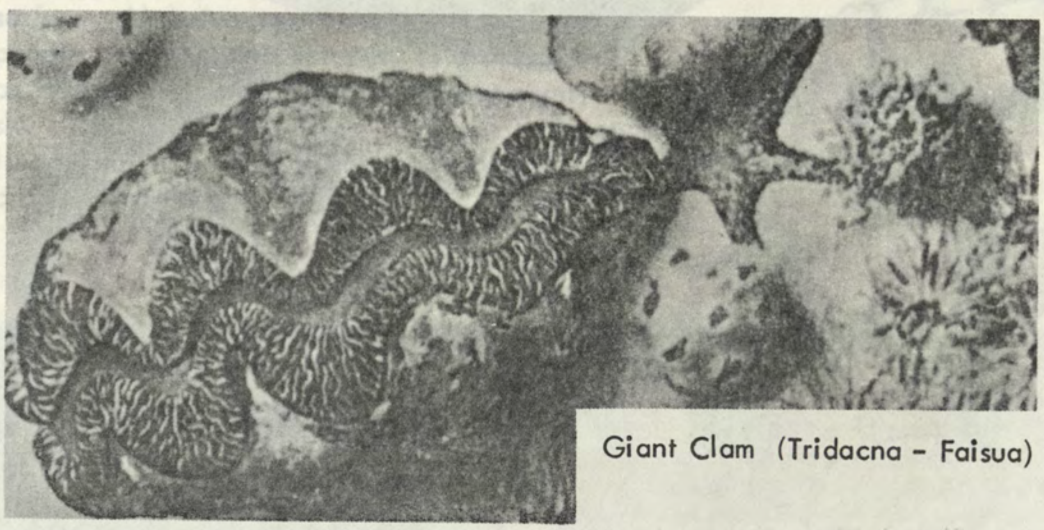
One type of shell appears to be one-half of a clam. This is a limpet (Aemaea - matapisu). Limpets hold themselves very firmly to rocks at the edge of the water. When pried away they become a source of food.

Animals with 2 parts to their shell (pelecypods-'asi'asi, faisua) make up a smaller part of the shellfish of Samoa. Most of the members of this group are found buried in sand or attached to rocks. Almost all the shellfish sold as food in Samoa are members of this group. The shellfish sold in Nu'uuli are a type of clam (Venus-Tugane) that are obtained from the sand-bottomed Pala lagoon.



Clam (Venus - Tugane)

Scallops (Pecten -'asi'asi) are free-swimming shellfish that inhabit Samoa's reefs. Scallops are able to swim by drawing water in and pumping it out in tiny jets. When an enemy, such as octopus or starfish, comes near a scallop, it swims quickly away.

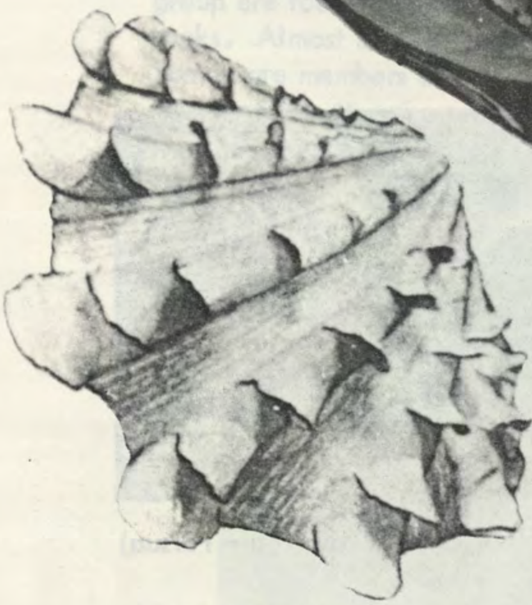


Giant Clam (Tridacna - Faisua)

The "giant clam" (Tridacna - faisua), which in Samoan waters seldom get larger than one foot long, lives buried in the reef. There are few left in shallow Samoan waters, probably because it is good to eat and easy to find. The lagoon on Rose Island, however, has a tremendous number of giant clams. Giant clams are "underwater gardners". They allow algae to grow in a part of their body, and when the algae become large enough, they are used for food.

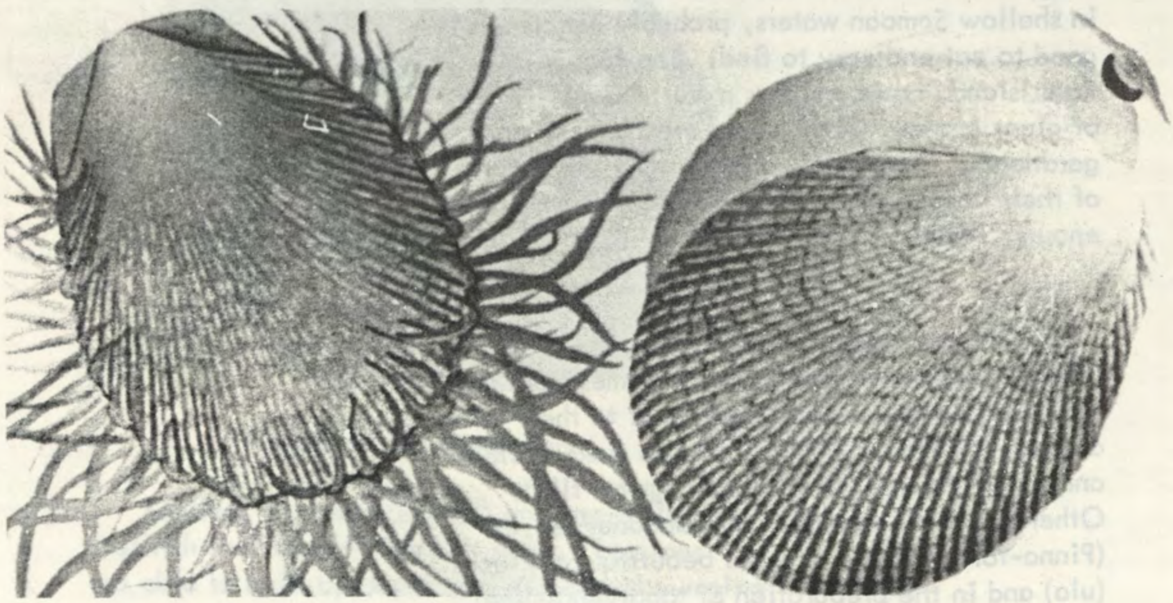
There are many special uses for shells in Samoa. Mother-of-pearl, which comes from the smooth shiny layer of shell next to the animal, is used for decorations, to make buttons and colorful lures for fish (meleagrina-tifa). Other shells are used to split pandanus leaves (Pinna-fole., tofe), to make beautiful necklaces (ula) and in the preparation of tapa(venus-pae).

Mussel



Fluted Giant Clam

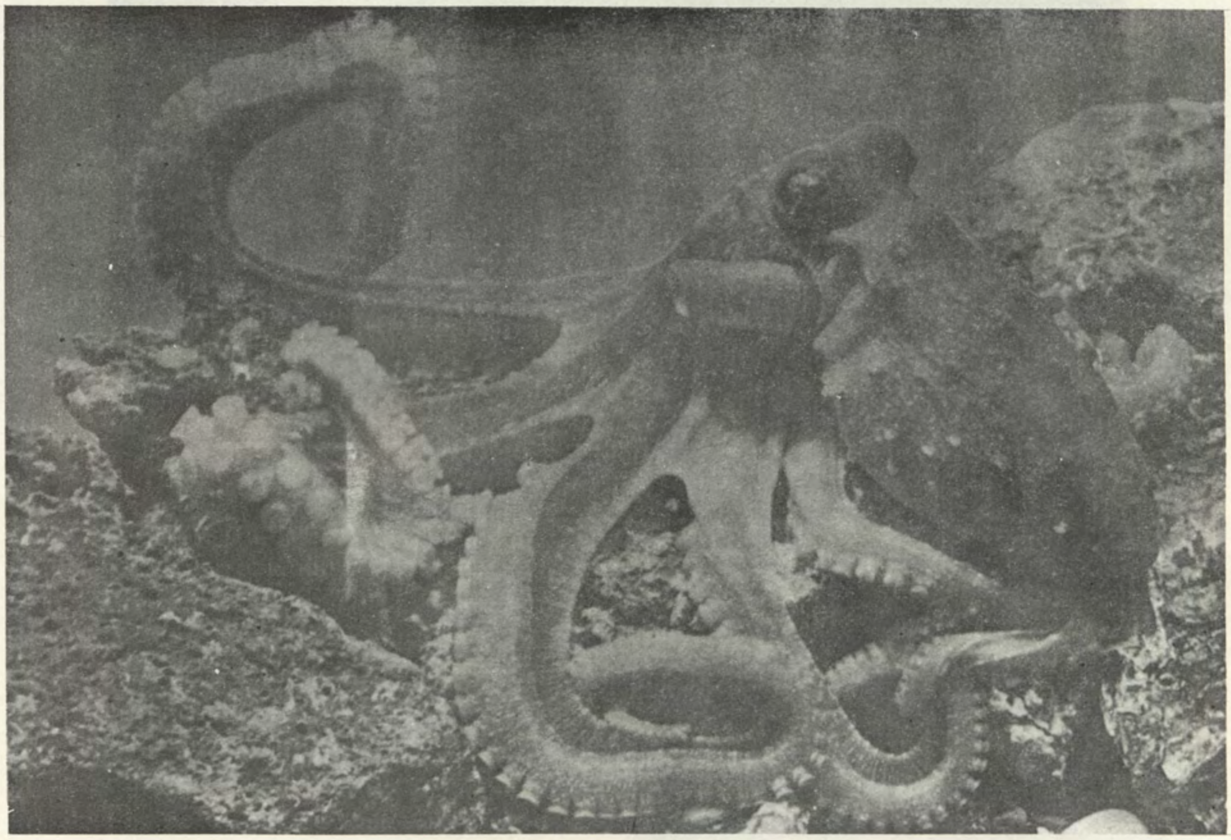
Oyster



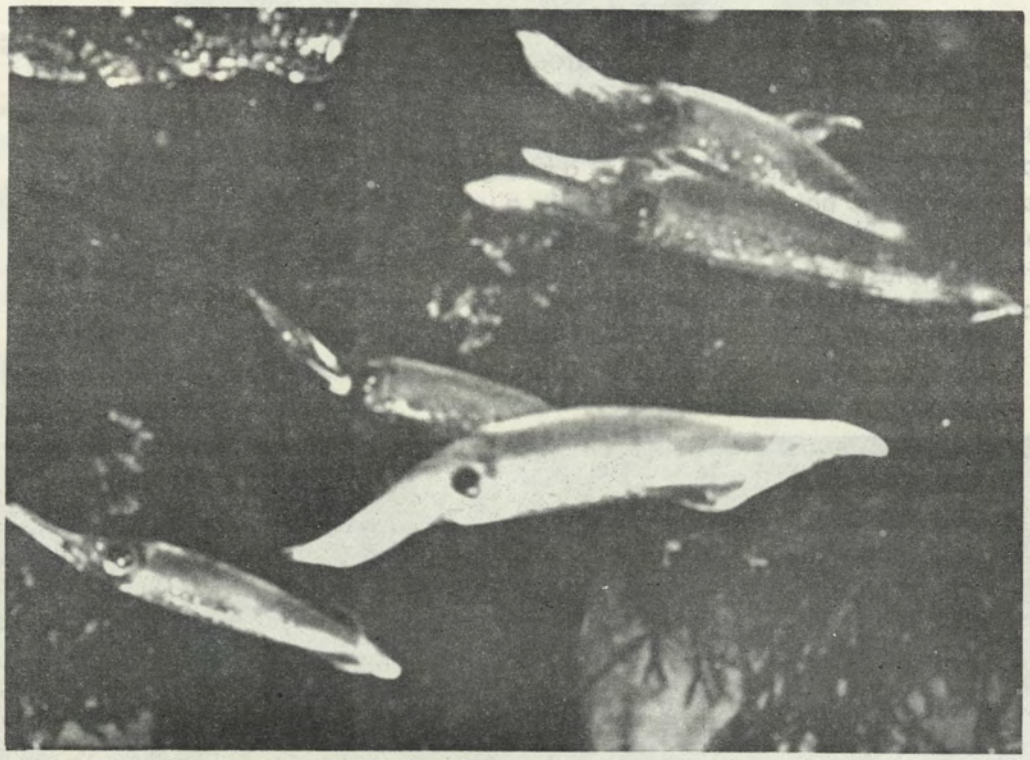
File Clam

b. Octopus and Squid

Long arms reach out to grasp the unsuspecting deep sea diver. The diver fights free from the deadly menace (threat) and rises safely to the surface. Unfortunately this is the way most people have seen the octopus, as a bad guy in a movie. The octopus (fe'e) is really a very shy animal who wants to be left alone. Octopus live in holes in the reef quietly feeding on crabs and shellfish.



Octopus (Fe'e)



Squid (Sepioteuthus, Gufe'e)

The squid (sepioteuthis-gufe'e) is a free-living animal that swims rapidly on jets of water. Squid capture their food (small fish and other animals) by catching the animal tightly with their arms. Squid have ten arms, two more than the octopus.

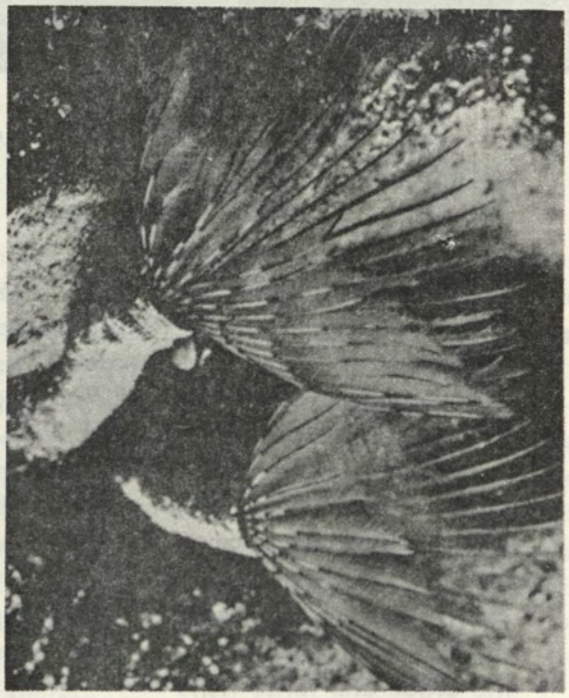
Both squid and octopus are able to change colors easily. Color patterns can be changed to fit the background. This is a form of protection, protective coloration. Both squid and octopus contain an ink sac that is used for protection. If an enemy gets too close, a cloud of ink is released hiding the quick escape of the squid or octopus. This ink was at one time used in pens (old-style India ink).

4. ANNELIDS

The annelids (segmented worms) make up a small group of animals that usually remain out of sight. The body is divided into small "rooms" (segments) that are almost all the same. The rings on the outside of the body point out walls that separate the rooms. Some segmented worms burrow into the sand for protection while others build walls around themselves.

The best-known annelid in Samoa is the palolo (Eunice viridis). Burrowing into the coral for most of its life, the adult animal usually remains unseen. At one certain time of the year the palolo release eggs and sperm cases that float to the surface. These reproductive cells are used as food by many Pacific people

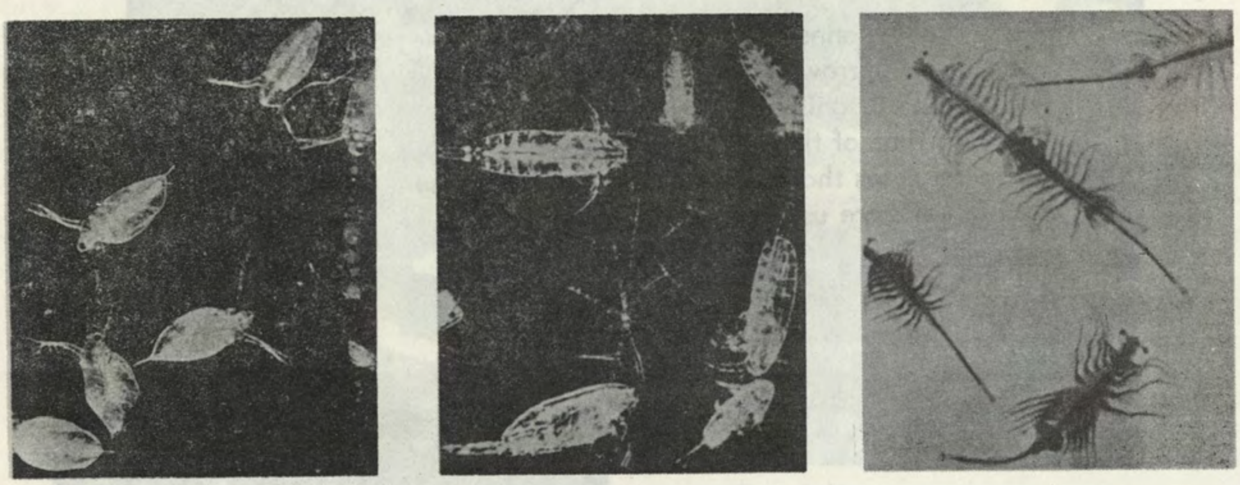
Some annelids have long feather-like ends. These feather-duster worms are beautifully colored with bright bands. The feather ends are used to trap food and oxygen. Any motion or disturbance will cause the feather end to snap instantly back into the tube.



Feather - Duster Worms (Annelid)

5. ARTHROPODS - CRUSTACEANS (pa'a, ulatai, papata, etc.)

The crustaceans have a segmented body similar to the annelids. Their legs are jointed and they have a hard outside skeleton. The crustaceans that exist in the greatest number are not usually even seen for they are very small.

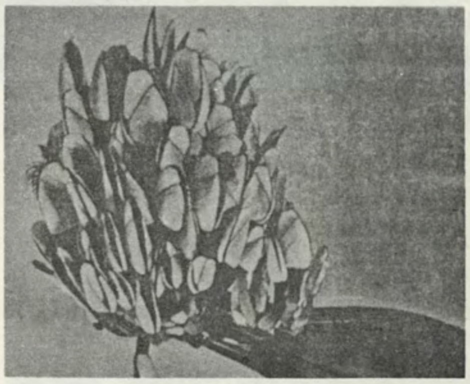


Microscopic Crustaceans

Small crustaceans are part of the zooplankton. Tiny brine shrimp, water fleas and copepods are the main food for many types of fish. In the deep waters around Samoa, millions upon millions of tiny crustaceans move up and down in a daily cycle. During the day the Crustaceans stay in deep water, but at night they rise to feed on plankton near the surface. Sometimes these tiny animals rise 1000 to 1500 feet and then swim back down at dawn! Fantastic numbers of tiny crustaceans provide an extremely important link in the food chain between the algae and large fish.

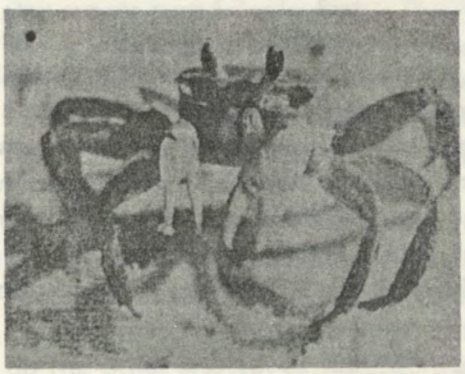
A small group of crustaceans can be found attached to rocks near the shore. They are barnacles. Barnacles can be found attached to parts of the dock in Pago harbor or the underside of boats. Tiny legs wave plankton and oxygen into the mouth of the barnacle.

Barnacles (Motō)



Goose-Neck Barnacles (U'U)

The crustaceans that people are most familiar with are crabs, shrimp and lobsters. The reef provides a home for many different types of crabs. Each type of crab finds a special place to live, some inside the branches of coral, others in sand, and still others on rocks at the water's edge. Some crabs feed on dead matter on the bottom while others gather live animals or plants. Crabs (pa'a) are an important link in the food chains around Samoa. Along with the lobsters (ulatai) they also take part in food chains that include man. Many types of crabs are used as food in most parts on the world, including Samoa.

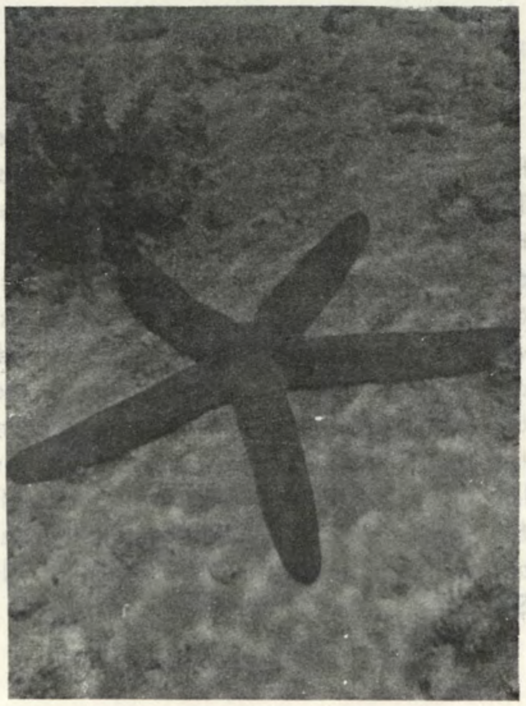


Crab (Pa'a)

One common type of crab is the hermit crab (coenobita, Pagurus-Uga, Ugatai). Hermit crabs, unlike other crabs, have a soft (instead of hard) tail section. To protect the soft tail, they choose a shell and back into it. Now the shell becomes a home. When the hermit gets too big for the shell, he finds a larger shell and trades in his old one for the new model!! Perhaps hermit crabs had the first "mobile home".

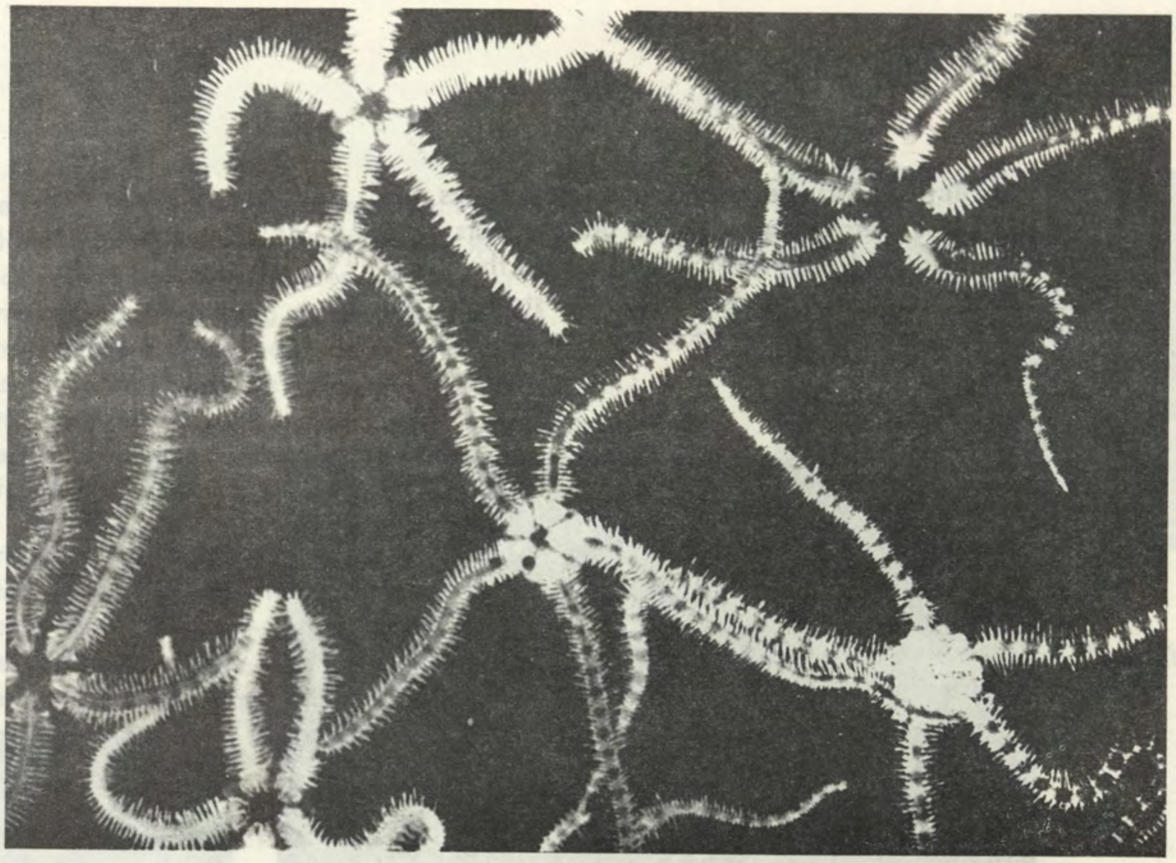
6. ECHINODERMS

The echinoderms are called the "spiny-skinned" animals. Some echinoderms live up to this name with long sharp spines, while others are almost smooth to the touch. Starfish, sea cucumbers and sea urchins are all echinoderms. Most echinoderms have many tube feet that they use for movement and for obtaining food. The tube feet are able to grasp an object by using the force of water pressure. Of all the echinoderms, starfish seem to depend most on the tube feet.



Starfish (Linckia, Aveau Moana)

One of the most beautiful starfish in the world is commonly found on Samoa's reefs. This is the blue starfish (Linckia - aveau moana). Unlike other starfish, the blue starfish lies on the open reef during the day. The members of this group are the only ones able to grow a whole new starfish from a piece of one arm.



Brittle Stars (Ophiocoma, Aveau, Fa'aatualoa)

Turning over a rock on the coral reef will usually uncover one or more brittle stars (ophiocoma - aveau fa'aatualoa). The brittle stars are the racehorses of the starfish family. While other starfish move more slowly than a snail, the brittle star moves surprisingly fast. The name 'brittle' star comes from a defensive action of these echinoderms. When trapped by man, or another enemy, they have the ability to drop off one of their arms so their arms appear to be brittle.

The largest starfish in Samoa are found in Pala lagoon. These are 'sea pumpkins' that may be one foot across and four to five inches thick. The sea pumpkin does not have definite arms as do the other starfish of Samoa, they have a rounded shape.

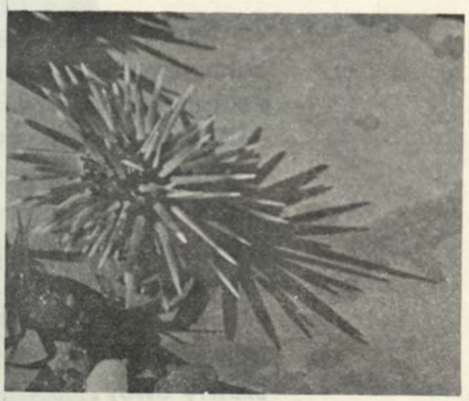
Feather stars are often found under rocks on the coral reefs of Samoa. The feather stars have branched arms with short side branches that look like feathers. In opposition to most starfish, the feather stars lie on the rocks with mouth and arms turned upward.

Crown - of - Thorns Starfish
(Acanthaster - Alamea)

The starfish with the largest spines is the crown-of-thorns (Acanthaster - alamea). Fortunately, this starfish is still rare in Samoa. It has long sharp spines that contain a poison. The starfish moves over coral, digesting it as it moves along. In this manner whole coral reefs have been destroyed on other islands.

Most starfish take mollusks as their favorite food, but some eat sea urchins, sea cucumbers and other starfish. A few are able to catch small fish and shrimp. Most will consume dead organic matter found on the bottom.

Sea urchins are the real spiny-skinned group of echinoderms. Most urchins prefer to spend their days hidden in, and under, rocks. At night they may be found moving around and feeding. Sea urchins are able to move on the short tips of their spines in a "walking" motion. When disturbed, urchins point many spines at the site of disturbance for defense. Some types of urchins serve as a source of food for the people of Samoa.



Sea Urchin (Echinometra, Ina, Tuitui)

Probably the most common urchin on the reefs of Samoa is a small urchin that can burrow into the rocks (Echinometra - Ina, tuitui). It is an edible urchin that can easily be found on the inside of the reef near the shore.

Hatpin Urchin (Diadema, Vana)

The hatpin urchin (Diadema - Vana) has the longest spines. The black spines may be 12 inches long and break easily after penetrating (entering) human skin. A mild poison causes pain the wound and the spines break apart when the person tries to remove them. Hatpin urchins can be used for food but must be carefully handled.

Sometimes thick banded spines are found on the beach. These spines are from the slate-pencil urchin (Heterocentiotus - Vatu'e) which lives in the rough waves at the edge of the reef. This type of urchin can also be used for food, and the beautiful spines are sometimes used for jewelry.

Slate-pencil Urchin (Heterocentiotus, Vatu'e)

Sea cucumbers are a very common sight in calm water inside the reef. This slow-moving echinoderm gathers food as it creeps over the bottom by rubbing its tentacles across the rocks and sand. Because they are so slow, they have had to develop a strange method of defense. When disturbed, most cucumbers send out long thin strands that are very sticky. The animal that was bothering the cucumber becomes entangled in the strands, and the cucumber moves slowly away. Some cucumbers have a poison in their skin that can kill fish which come near them. A cut-up cucumber is used as a fish poison by some people of the Pacific.

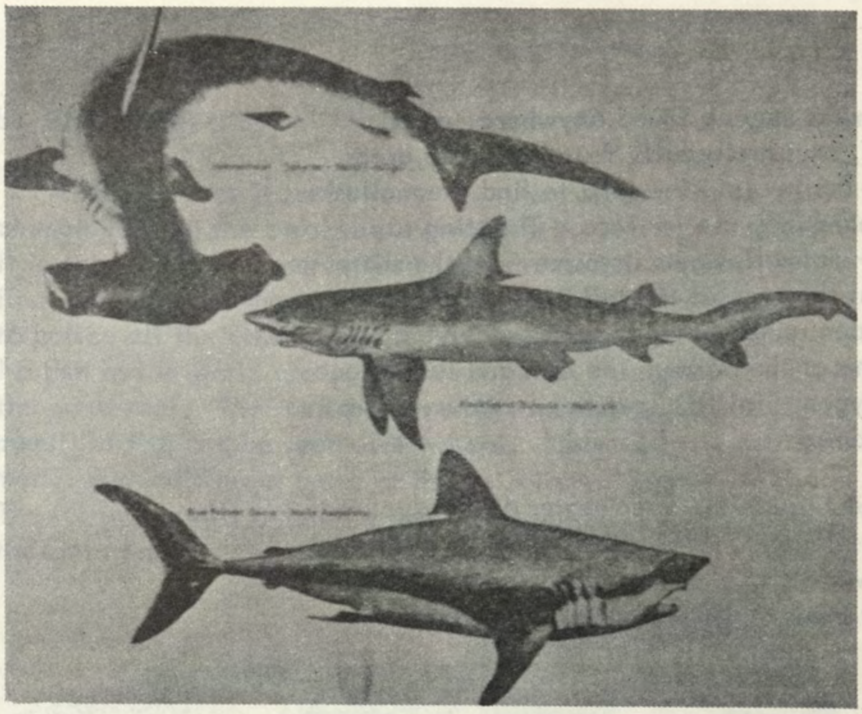
Some cucumbers are used for food in many parts of the world. Called ''trepang'' or ''beach-de-mer'', they once formed a large part of South Pacific trade. The edible cucumbers of the Samoa reefs (Holothuria-Fugafuga, Loli) are collected during low tide and used for food.

7. CHORDATES

The chordates are the animals with backbones. All of the other animals mentioned before do not have a backbone, they are invertebrates. On land the chordates are represented by many types of animals (lizards, birds, rats, etc.), but normally fish are the only reef chordates. The reef supports a wide variety of fish, only the major groups will be mentioned here.

a. Sharks and Rays (Malie and Fai)

The sharks and rays are different from other fish in the composition of their skeleton. Sharks and rays have skeletons made of cartilage which is what your nose and ears are made of. All other fishes have skeletons made of bone.



Sharks are the most feared animal of the sea, not only in Samoa, but throughout the world. Sharks can easily attack, and kill, a man in the sea. The combination of sharp rows of teeth, a powerful body and primitive attack instinct (reaction) make the shark a fearsome enemy. Most sharks in Samoa do not usually attack man. They have plenty of other food and, if approached aggressively (as if to attack), usually move away to find an easier meal. They should always be treated with respect and never underestimated.

The most common type of shark around the reef is the blacktipped shark (Eulamia-Malie alo). Sometimes a hammer head shark (Sphyrna-Mata-I-Taliga) will wander onto the reef, but they are not common in Samoan waters. Larger sharks usually live in the deep waters offshore (Carcharias-Malie asopolata).

While sharks may be found anywhere, on or off the reef, rays are usually found in sandy areas. Rays usually burrow into the sand to find the mollusks and crustaceans they use for food. The sting ray (Rhinobatis - Faimalie) gets its name from the sharp barb found at the base of the tail. A person stepping on a ray hidden under the sand might receive a painful sting from one of the barbs. The skin and tail of one sting ray (Trygon - fai ili) have been used as a rasp, or file, in Samoa.

The largest ray is the deep-water devil ray (Myliobatis - faeme). While this ray is very large (15-20 feet wide), it is not as dangerous as its name sounds for it feeds by straining tiny plankton from the sea.

Rays are very beautiful to watch when they are swimming. They swim by graceful flapping movements of their wide fins and appear to be gently "flying" through the water.

b. True Fishes (I'a)

At first glance it seems only two types of animals live on the coral reef, coral and fish. It is only after the observer has gotten over the first impression of the reef's beauty that he begins to notice all the other animals that live there. No fish in the world are as beautiful as the fish of the coral reef. The reefs of Samoa are no exception; beautiful fish can be seen everywhere. There are many, many different types of fish in Samoan waters. The following will only be a brief introduction to the main types.

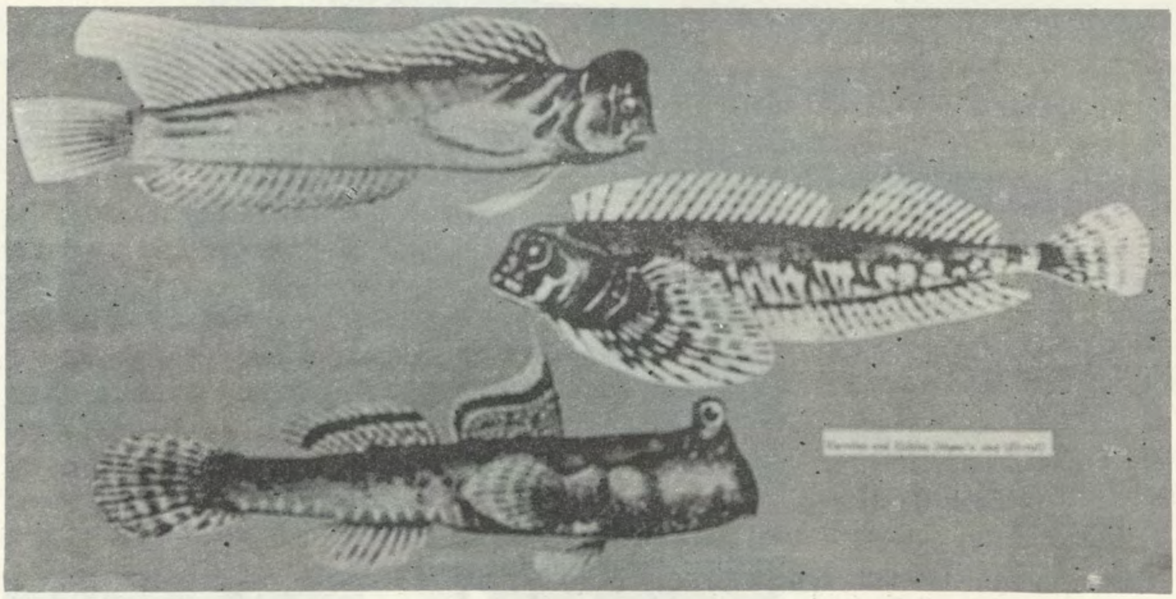
Eels (Pusi)

The eels appear to belong to a group of animals that might include the snakes, but they are true bony fish. Eels spend the daylight hours in hiding, coming out to hunt for food at night. Moray eels (Muraena - pusi a'aiuga, pusiga tala) have large sharp teeth that can cause a severe wound in human flesh. Normally very shy, the moray will bite viciously when cornered or caught. Moray eels come in a variety of colors and patterns and are commonly seen peeking out from a hole, or from under a rock.

Samoa also has fresh-water eels (Anguilla - tuna) who live in the streams and rivers that flow from the mountains. These eels are more common in Western Samoa where the rivers are larger and deeper.

Flying Fish (Malolo)

Fish are supposed to swim and leave the flying to the birds, but this group of fish try both means of travel! The flying fish (Exocoetus - Malolo) take to the air when being chased by larger fish below. They are able to "fly" by pushing themselves from the water with a powerful swimming stroke and spreading their wide fins. Their enlarged fins act as "wings" and the fish are able to glide for long distances (up to 500 feet). Flying fish inhabit the deep water offshore and seldom come near the reef.



Blennies and Gobies (Mano'o ma Uli-tui)

The first fish that will be found as you approach the water are the blennies (Salarias, etc. - Mano'o). Skipping from rock to rock, blennies obtain their food from the living material washed up by the waves. Gobies (Serranus - Uli - tui) appear very simiiar to blennies and usually live in the shallow water near the shore. Clothed in drab colors, the gobies and blennies do not represent the beautiful fish of the reef, but they are an important link in the shoreline food chain.