



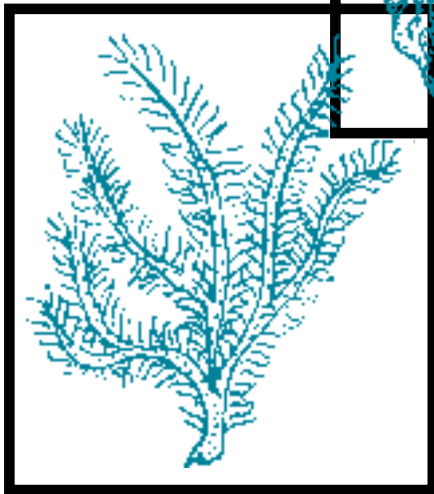
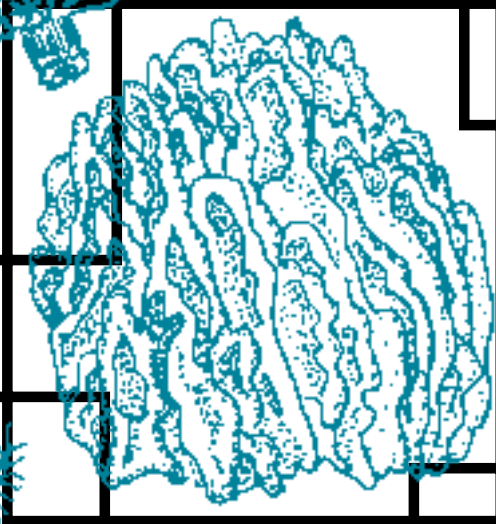
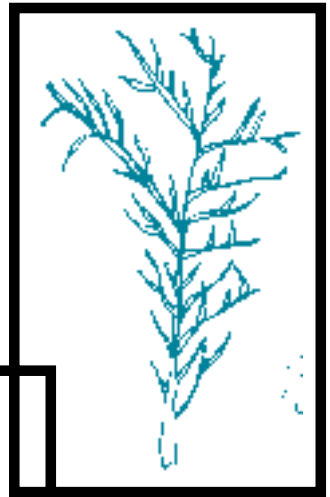
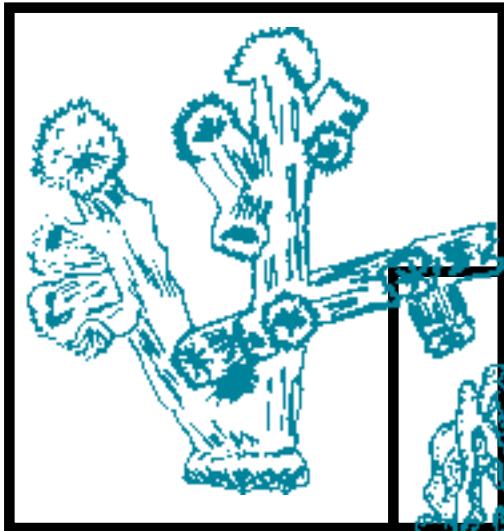
**101 questions on corals:
Towards awareness**

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101 questions on corals: Towards awareness

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2001



About corals

1. When I first saw a coral, I thought that it was a plant. Is that right ?

I am not surprised. Most first-time visitors to a reef tend to think of the corals as plants because they remain fixed to rocks, are colourful to look at, and many of the branched ones resemble small trees.



In reality, a coral is a simple animal like the sea anemone we find on rocky beaches. Unlike the anemone, the coral animal is generally small and constructs a skeleton around its body for protection. A coral animal is also called a polyp.

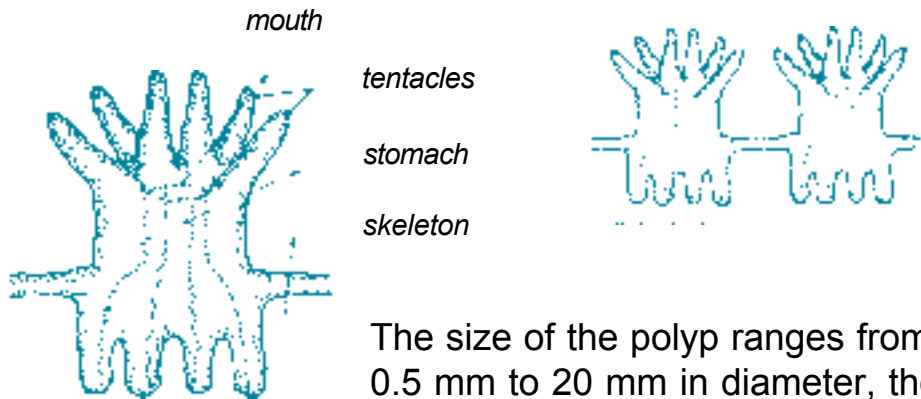
2. Are polyp and coral the same?

No. The term coral usually denotes the skeleton though at times the polyp is also called coral animal.

3. What does a polyp look like?

Each polyp is a hollow cylinder of tissues with tentacles and a central mouth opening at the top. In a coral colony, a thin layer of tissue joins the adjacent polyps to each other.

The central part of the cylinder has filaments called mesenteries. They serve like the stomach to absorb the food and also have gonads that produce male and female gametes (reproductive cells).

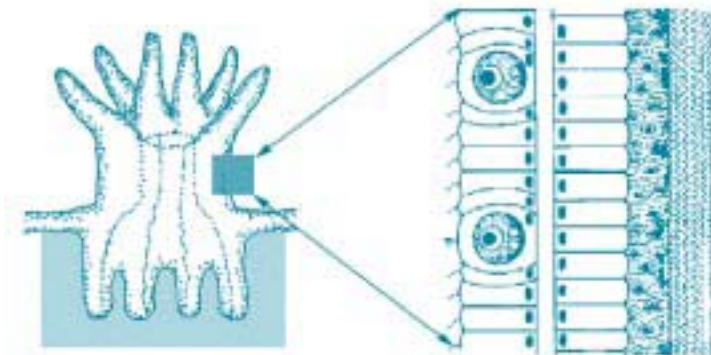


The size of the polyp ranges from about 0.5 mm to 20 mm in diameter, though there are exceptions.



4. How does the polyp make its skeleton?

The external surface of the polyp has some special cells called calciblasts that can take dissolved calcium from seawater and construct a solid skeleton. The skeleton thus looks like a cup with side walls, a bottom and open at the top.



5. If the polyp is so small, then how come some corals look so big?

What you look at and think is a coral is not one coral but a number of them growing together. If you look at a coral piece closely you will find a lot of pores on it. Each one was the place where one individual polyp lived. Every coral colony begins as a minute skeleton of one single polyp and then keeps on growing by adding more and more individuals.



6. If all coral colonies start from a single polyp, then how come there are so many varieties?

Genetic diversity comes to play its role here. You know the tiger, the cat and the lion all belong to the same genus, yet are so different. Similarly, the shape and size of a coral colony is genetically determined.

The forms that we commonly see are:-

- *massive (stone-like)
- *foliaceous (leaf-like)
- *branching (tree-like or like) and
- *encrusting (coating-like).

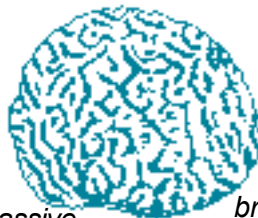


massive



encrusting

flower



massive

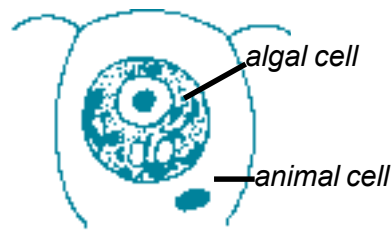


branching

At times, water depth and light may also control the shape. At greater depths, the pressure is high and the coral skeleton tends to grow more flatter. The growth forms also change because the corals are continuously on the look-out for light.

7. How does sunlight affect the growth of a coral?

Here we come to an interesting aspect of coral life. All corals that we see on a reef have microscopic plants (called Zooxanthellae) living inside their cells. These algae have chlorophyll pigments and produce organic matter by photosynthesis. For this, they need light. So the coral has to remain near the surface where the sunlight is abundant.



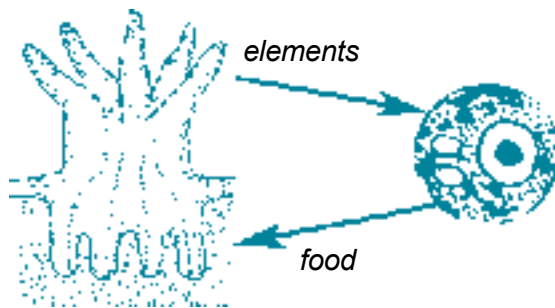
The colour of the corals, in fact, comes from the algal pigments. If the algae were not there, then the coral tissue would be a transparent layer through which we could even see the skeleton.

8. How has the coral acquired the algae and why should it tolerate them?

Nobody knows how the algae came to live inside the animal cells. In fact, these algae are also found in some clams and worms. When the algae live with the animals, both are benefited.

The algae produce organic matter by photosynthesis but

do not use all of it. Some portion of this is passed on to corals for their nourishment. The corals, like all animals, excrete nitrogen and phosphorous salts and carbon di-oxide. All these are needed for photosynthesis by algae and are readily taken up by them.



The presence of zooxanthellae also enhances coral growth. When they photosynthesize, they remove carbon di-oxide. This reduces the acidic conditions at the sites where calcium is deposited by the corals. This in turn retards calcium dissolution, thus enhancing precipitation of calcium and coral skeletal growth. The mode of living together by two organisms with mutual benefit like this is called symbiosis.

9. Interesting. Then corals do not need any other food, is that right?

No, not totally. What they can get from their algae cannot satisfy all their needs. In fact, corals are basically carnivorous. They catch tiny animals from seawater and swallow them. That is their main food. What they get from the algae is only supplementary.

Some corals can also feed on detritus (dead organic matter) and some others can take up dissolved organic matter directly from seawater.

Corals are thus versatile in their feeding habits. This is what helps them to survive and thrive in oceanic deserts.

10. So corals will have to move in search of food?

No. As their skeleton remains fixed to the rocky bases in the reef or the lagoon, the corals cannot move. Instead the food comes to them, along with the water currents.

Corals feed on tiny microscopic animals called plankton. These animals drift along with currents and when they pass close by, the corals catch them with their tentacles, sting them with their stinging cells, paralyze them by injecting venom and swallow them.

All corals are nocturnal; they become active feeders at night, when the plankton animals come to the surface layer from deep waters to where they go during daytime. If you dive in a reef at night, you'll be surprised to see how active the corals are - a totally contrasting picture from the daytime when they are withdrawn into their skeletal cavities.



11. What are these stinging cells?

All corals have cells called nematocysts in their tentacles and near the mouth.

These nematocysts have a central space filled with a venomous substance, a long coil through which the venom can flow and barbs on the coil to hold the prey tight. The stinging cells come in at least 20 varieties - small, big, long, short but all have only one function.



12. Don't the corals move even for short distances?

Not the ones that are colonial and remain cemented to the bottom. Only one coral, the mushroom coral, can move for short distances. Incidentally, mushroom corals are single polyps that can grow up to 30 or 40 cm and lead a solitary life. In colonial corals, the polyps rarely exceed a cm in diameter.



13. Are there other solitary corals?

Yes, some deep-water corals are solitary. If you recall, we said that corals need light and hence they remain near the surface of the sea. These corals, having zooxanthellae, are also called hermatypic corals. They can be seen only in tropical and subtropical seas. These are the ones that form the coral reefs.

Some other corals, called ahermatypes, do not have zooxanthellae. Therefore they do not need light and can live in deep waters upto depths of 1000 or 2000 meters. These corals generally lead a solitary life and if they happen to form colonies, they are usually small with only a few individuals. The ahermatypic corals also occur in all latitudes.

14. Does temperature promote the development of coral reefs?

Yes. The reef building corals require warm temperatures for their survival. They grow well at



temperatures greater than 20°C and can thrive even at 35°C as in the Red Sea, Persian Gulf or our Gulf of Kachchh. Some of them occur sometimes at low temperatures, even down to 10°C, but they do not form reefs. It is because of this preference for warm waters, that the greatest number of corals is found in the tropical belt, with a decrease towards the subtropical seas.

15. Are there other conditions that effect coral growth?

Yes. Several but at least 3 of them are important:

(a) Firm substratum to settle

Corals need natural surfaces like rocks, coral stones or even molluscan shells to settle and grow. We rarely find profuse coral settlement on man-made structures like jetties or tetrapods though metallic structures like hulls of sunken boats and ships favour coral settlements.

(b) Salinity:-

Seawater contains 35 g of dissolved salts per liter whereas freshwater has only a few mg of dissolved salts. This saltiness is called salinity. Corals need this salinity to grow well. At times, corals can withstand some decrease in salinity (perhaps down to 30 g of salts per liter) for sometime (a few weeks to one or two months) but not more than that.

(c) Water clarity

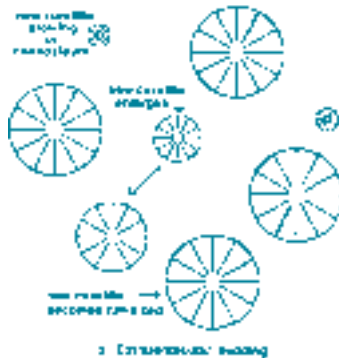
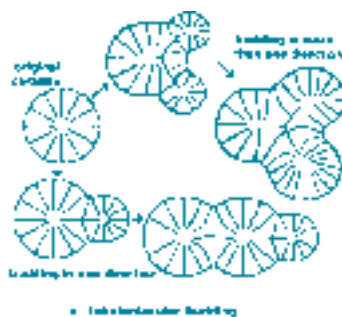
When the waters are turbid, inorganic particles keep on

falling on corals, but the corals cannot escape from this particle rain by moving away or by closing the skeleton. If the particle rain is less intense, corals can still clean themselves by ciliary movements but at high turbid conditions, the cleaning mechanism cannot cope and the corals eventually die of smothering.

The sedimentation also has an indirect effect - it reduces light penetration in the sea, thus reducing photosynthesis by zooxanthellae and the coral growth. This does not, however, kill the corals.

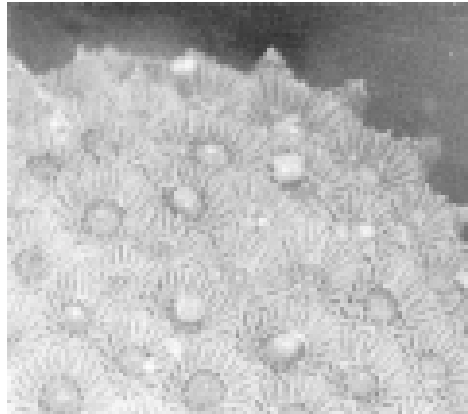
16. You said that a polyp grows into a colony by adding individuals. How does this happen?

This happens by budding, which is an asexual method of reproduction. In this case, the first polyp buds off a second one, which buds off another one and so on. The colony thus keeps growing. Budding can be either intratentacular or extratentacular, depending on the coral species: in the former, the offspring is first produced by division of a polyp within its own skeleton and then separated from the mother polyp by a skeletal wall. In the latter, the mother polyp produces a bud outside its skeleton. This bud later secretes its own skeleton.



17. Do the corals reproduce sexually also, like other animals? Are there mating rituals?

Yes, they do. Each polyp is a hermaphrodite and can produce both male and female gametes. At certain phases of the moon, the corals release synchronously the male and female gametes into the surrounding seawater. Though there are no sexual



manifestations beforehand, this comes as close to as being called a mating ritual. The gametes unite and produce a larva called planula. This swims around for a few days, looking for a hard substratum to settle. Once settled, this starts reproduction by budding to form a new coral colony.

18. How long corals live?

It is a difficult question to answer. When the polyps reproduce by asexual means, the growth can be endless. Some large coral colonies have been known to be as old as 100-200 years.

19. How fast the corals grow?

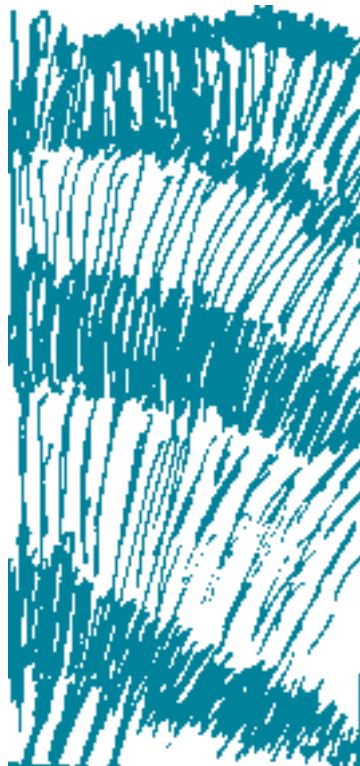
Very slowly! The massive ones like the brain corals (the ones that resemble in form the human brain) grow no more than a cm per year. This is because the calcium carbonate deposition is a slow process and the

growth occurs in all directions. The branching corals are relatively fast-growing. Some of them can grow as much as 18 to 20 cm per year but their skeletons are less dense than those of the massive ones.



20. You mentioned that some coral colonies could be more than 100 years old. If the growth of corals is so slow then how can you make out their age?

The growth of a coral is not uniform throughout the year. At certain times, when warm conditions with abundant sunlight prevail, coral grows fast. At other times, when there is heavy rain during monsoon, its growth slows down. When a coral grows fast, it deposits more calcium into the skeleton, which becomes dense. When the growth is slow, calcium deposition becomes lighter. If we x-ray a coral skeleton, these regions would appear as dark and light bands. Since seasonal changes, such as those between warm and rainy months occur generally once in a year, a dark



and light band together would correspond to one year's growth. If we take a portion of a coral colony and count the number of dark or light bands, then we will know its age.

21. What else can the bands tell us, apart from age?

While the corals deposit calcium, they also include with it a variety of materials, like metals, humic acids and some natural elements like carbon and oxygen. Among these, humic acids come from land sources and are brought into the coastal waters by river flow. So, the more the rainfall, the more humic acids come with the river flow, the more their abundance in the coral skeleton. When we look at a coral skeleton under ultra-violet light, we can see the presence of humic acids as fluorescent bands. The intensity of fluorescence thus is an index of rainfall. Knowing the age from the growth band at the location of the fluorescent band, we can deduce whether the monsoon was strong or weak - at that time.

22. Interesting. Do these bands tell us anything more?

Yes. You know, most elements have isotopes i.e. atoms that are slightly different from the most common ones. Oxygen has two isotopes: a lighter one (O_{16}) which is common and a heavier one (O_{18}). At higher temperatures the lighter isotopes escape from the seawater leaving the heavier ones behind. So if we find more heavier isotopes of oxygen in a coral skeleton at a particular growth band, then we can conclude that the sea temperature was higher in that year. If we know how much more of heavier isotopes were there, then we can even deduce how much higher

the temperature was.

Corals can thus act as indicators of past climate changes.

23. Are there natural enemies to corals?

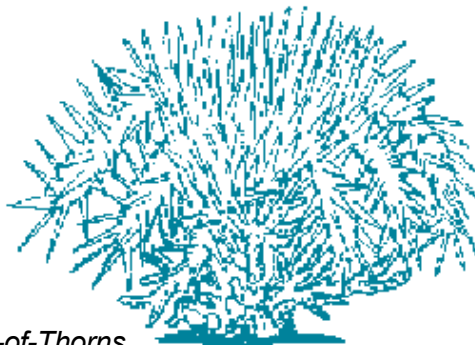
Yes, some fish, in particular the parrotfish, feed on corals. These have powerful teeth with which they can snip off pieces of coral skeleton along with the polyp tissues and ingest them. The butterfly fish also feed on corals but since their teeth are not as strong, they just nibble the corals.



Parrot fish



Butterfly fish



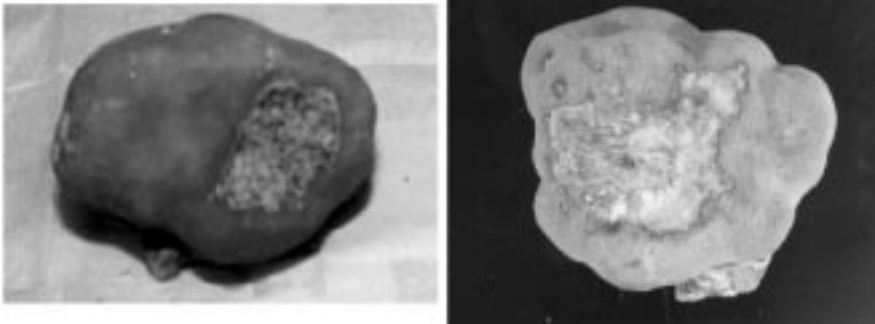
Crown-of-Thorns

There is one more predator that is more dangerous to corals. It is the crown-of-thorns starfish. It exclusively feeds on corals. Unlike the fish which bite or nibble parts of the corals, this starfish envelops the whole coral with its arms and sucks out all of the coral tissue, leaving only the

bare skeleton.

24. Do corals suffer from diseases?

Yes. At least two diseases are known so far to affect corals. The first is the black band disease, which is widely prevalent. The cause for this is infection with a bacterium. Coral tissues affected by this disease become blackish and look like a dark band among healthy tissues. The less prevalent white band disease causes the affected tissues to look like a white band around the lesion. The organism responsible for this disease is not known at present.



Recently NIO scientists recorded another disease, the pink line disease, from some corals in Lakshadweep. Though the cause for this is also not known, it is suspected that the mortality associated with the 1998 El Nino event has a role in this.

25. How many species of corals are found in the world?

At a best count, somewhere between 800 to 1000 species. Nobody knows exactly how many because we don't know all of them. We may not know yet those corals that live in deeper waters or remote reef areas. Sometimes the same coral species is called by different names in different countries. However, we can safely say that at least 800 species are known so far.

26. How many coral species occur in India? Are there any corals unique to India?

206 species of corals are known from Indian reefs, with a majority of them occurring in the Andaman and Nicobar Islands. Some coral species such as *Porites mannarensis* are unique to India. This is natural because we can't expect all species to be cosmopolitan in distribution.

27. Is the precious red coral one among them?

We are so much used to the idea of red coral in jewelry, we tend to think it should be unique to India! The red coral, called *Corallum rubrum*, is not a reef coral at all. It is a stony coral without zooxanthellae. The red colour comes from natural pigmentation of the skeleton that remains even after the death of the polyp. Again, unlike the reef corals that are porous (with cavities in the skeleton), the red coral is dense and compact. So, it can be shaped or machined without breakage. That is how coral beads

are cut for jewelry. The red coral occurs only in the Mediterranean Sea and off Japan from shallow depths up to 1000 meters. They are collected by dragging wooden frames over seabed and breaking off the branches. Some fishermen from Mediterranean coasts are also known to collect them by skin diving. Like the red corals, the black corals and blue corals also retain the colour after death.

28. Are there other corals that are different from the ones we see on a reef?

Yes, there are several of them. They resemble the true corals but do not have zooxanthellae. They occur sometimes in profusion in deeper parts of the reefs. The fire coral, tree coral, wire coral, sea fan and sea fern are some such corals.



Wire Coral



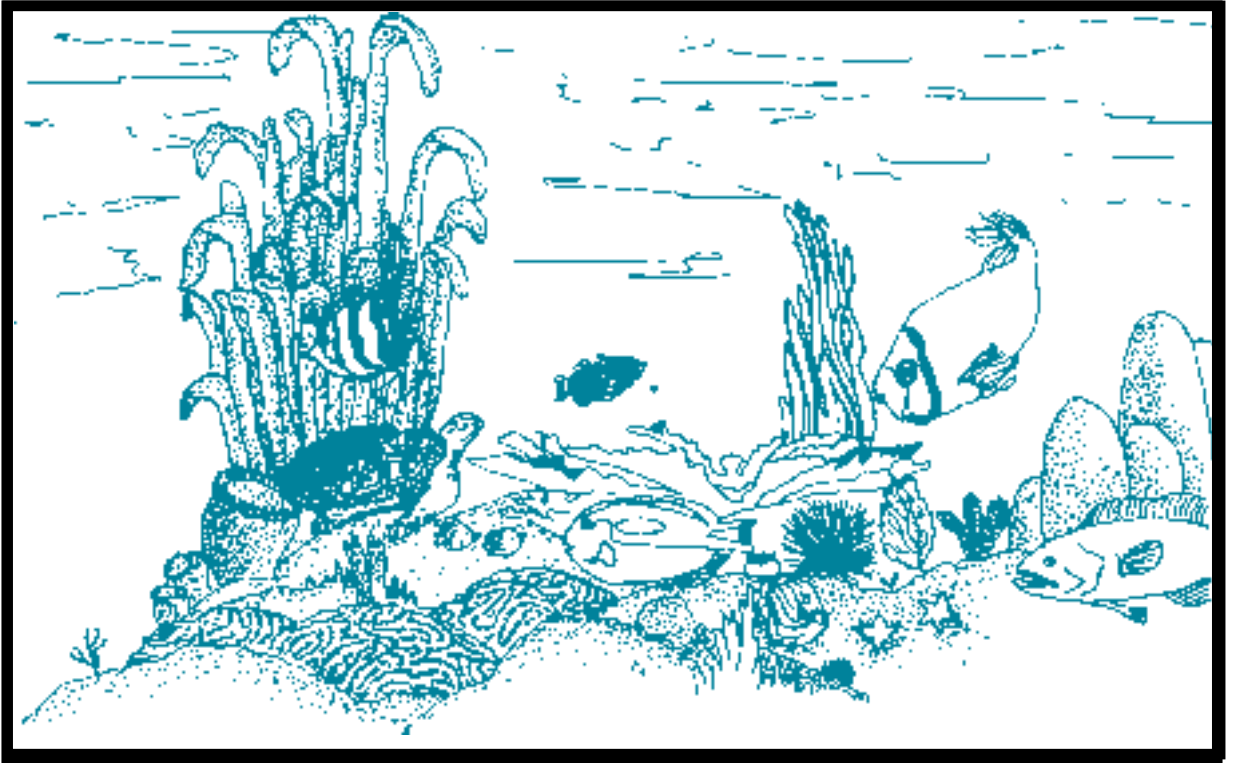
Sea Fan



Sea Pen

Some cousins of the stony corals are called soft corals. These are large ones, several cm in diameter: they

lack a true skeleton but have spicules (spiny material) in their tissues which give them a leathery and tough consistency. Soft corals also occur profusely in most coral reefs. They are an interesting group of animals because several of them are sources of bioactive compounds.

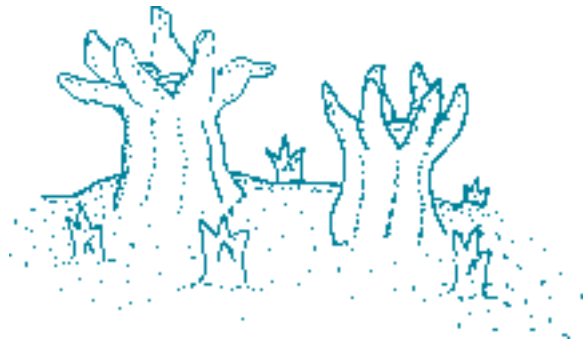


About reefs

29. Corals are minute invertebrates, yet they can build vast reefs such as the Great Barrier Reef in Australia, which is the largest natural structure in the ocean.

How is a coral reef formed?

Reef building begins in a very simple way. The coral larva settling on a hard substratum begins to grow into one colony by repeated budding. This colony continues to grow vertically towards the sea surface and laterally as far as they can.



Besides corals, several other organisms in the reef, notably the mollusks and some algae, called calcareous algae, also construct calcium skeletons. When these organisms die, the calcium first dissolves and then re-solidifies to form a rock, on which new corals come and settle. Thus between every birth and death scenario, the reef continues to grow. On an average a reef grows by 1 mm per year.

30. I thought coral growth and reef growth were the same. Is there a difference?

Yes, there is a difference. A coral may grow 1 cm or even 10 cm in a year but that does not fill up the space between the corals or even the space between the

branches of a coral. A reef, on the other hand, is a solid wall with all spaces totally filled up with calcareous material. It is the cementing process that takes time - that is why the reef grows much slower than the corals.

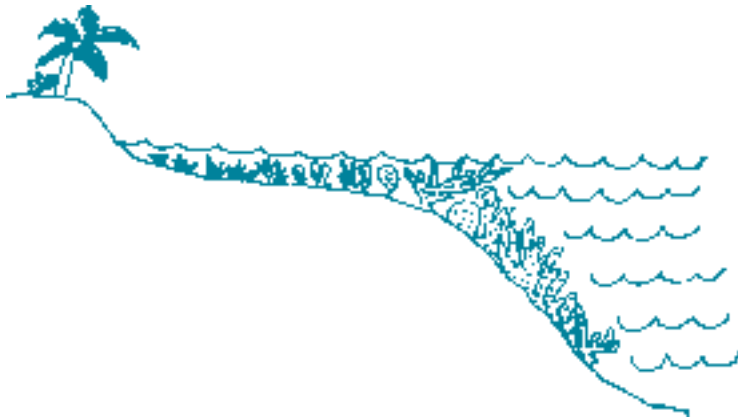
The reefs we see today like the Great Barrier Reef must have begun to grow thousands of years ago.

31. Are all reefs the same?

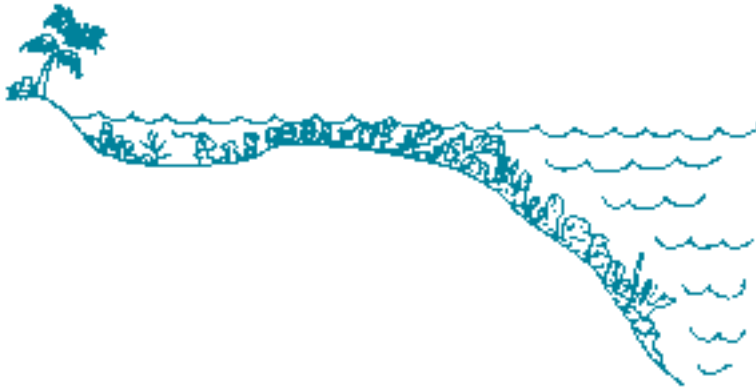
No. To answer this question we should first see how the reefs are formed: at the beginning, the corals settle and grow near the coastline, often growing almost up to the edge of the shore (high water level). At this stage they are called *fringing reefs* because they border on the land.

As the corals can now grow only seaward, they start propagating in that direction. In the process, they create a gap between the shoreline and reef. This space, generally with less number of coral colonies, becomes the lagoon. At this stage of its evolution, the reef is called a *barrier reef*.

If the corals happen to be growing around an island and if the island happened to sink below the sea surface, then the reef structure would resemble a ring around the non-existing island. The place once occupied by the island becomes the lagoon and the reef is then called an *atoll*.



*Fringing
Reef*



*Barrier
Reef*



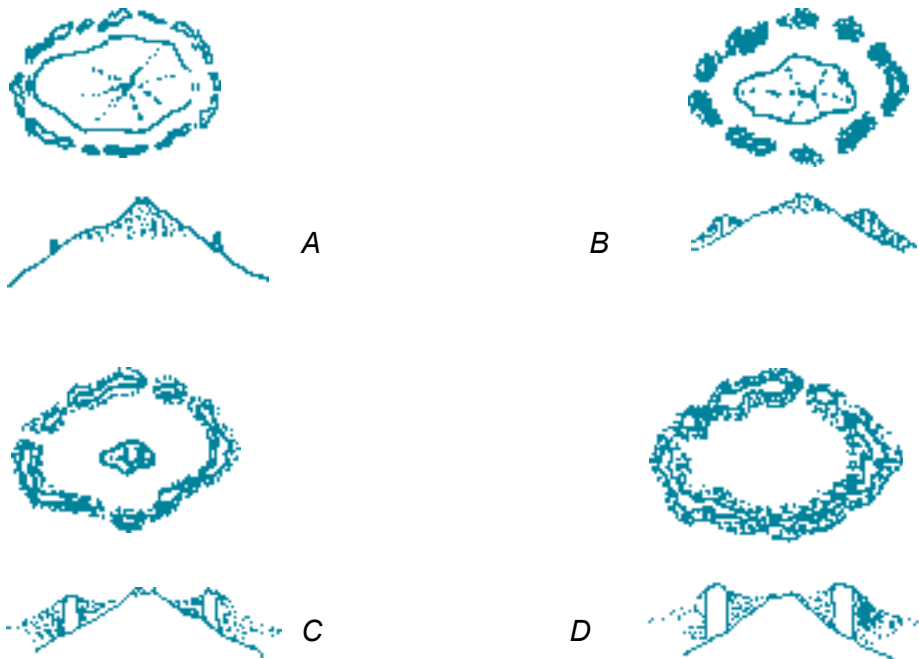
Atoll

32. So, all these types occur near the continents?

Yes, except atolls. They occur in mid-oceans, as in Lakshadweep, or on continental shelves at several hundred meters depth. Quite often, these atolls grow on top of extinct volcanoes.

33. Then how do islands form on atolls?

When corals die or break, their skeleton is broken down gradually to fine sand particles. The winds and wave action then move them to one side of the atoll where they accumulate. When the top of this sand bank is at level with the sea surface, vegetation like coconut settles there and grows. The vegetation binds more sand and this gradually leads to the formation of islands.



34. Are there other types of reefs?

Yes, but they are less important and not widespread in distribution. A *patch reef* refers to a small patch of colonies, smaller in size than a *fringing reef*. A *table reef* looks like a table of coral colonies placed on the sea floor. A *ridge reef*, as the name implies, is a long ridge of corals. A *micro-atoll* is an atoll-like reef structure within a major atoll.

35. What are the reef types found in India?

There are two major types:

Fringing reefs are common. They occur around the islands in the Gulf of Mannar, Gulf of Kachchh, Andaman and Nicobar Islands.

The reefs in the Lakshadweep group of islands are oceanic atolls.

Barrier reefs are not known from Indian seas though there was a record of such a reef off Andamans in the 1920s. This has never been reconfirmed.

36. Are there coral reefs on the central east and west coasts of India?

No. The conditions here, especially salinity and high sediment load, are not ideal for coral growth.

Most major rivers of India, like the Ganges, flow into

the sea on the east coast, bringing in lots of sediments that would not allow the corals to grow. On the west coast, the monsoon is intense from June to August. The fresh water flow into the sea at this time reduces salinity to less than half of the normal and the sea water becomes murky brownish with the sediments.

37. Was it always like this?

No. There were coral reefs along the west coast some 18,000 years ago. These reefs got drowned (sank below the lighted layers) when the sea level started rising fast during the last glacial ice melt.

Some reefs later started growing near the coast but the change of climate to monsoon style some 6000 years ago killed them also.

Not all of them are lost, however. Some die-hard stragglers have managed to reach the shore and grow there. We can see them as isolated patches on the coast. They do not, however, form reef structures and will not be able to do so in the near future.

38. Are there other ways in which reefs can get killed?

In the course of natural geological events, a reef may sometimes get lifted above the sea surface.

The earth's surface is not one single plate but is made up of number of plates that fit together. These plates

constantly push against each other and if one plate near the coast overrides another, then the reef on it gets raised above sea surface and dies.

There are two such raised reefs in India - one in Ramanathapuram in Tamil Nadu and another in Okhamandal in Gujarat. Both these reefs were raised and died some 5000 years ago.

39. Is there anything special about present day Indian reefs?

Yes, specifically with those of the Gulf of Kachchh. The reefs here are the most northern in India.

The temperature variations here are high, from 15 to 30 °C. The salinity goes above normal seawater salinity for several months. The area experiences high tidal amplitude, which leave corals exposed for several hours at times. The strong tidal currents also stir up inorganic sediments.

In spite of these adverse conditions, corals still thrive in the Kachchh region. The biodiversity of the corals, and that of the reefs as a whole, however, is much less than in other reefs.

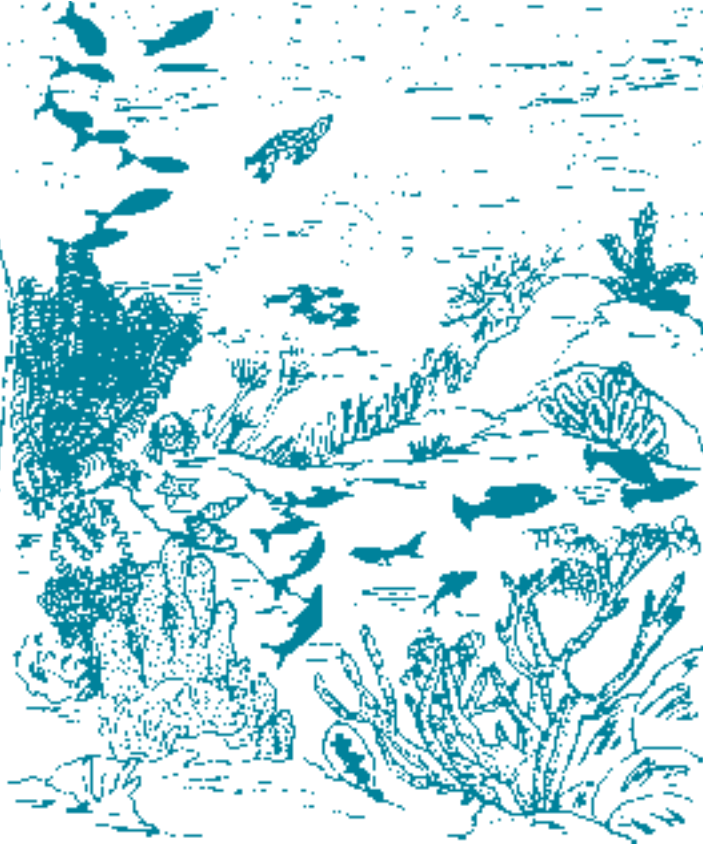
40. What has this biodiversity got to do with coral reefs?

You know that diversity means variety. Biodiversity means the variety of animals and plants that live together at one place or in an ecosystem. The higher the biodiversity,

the more mature and stable an ecosystem is and higher its biological productivity is.

Coral reefs have the greatest biodiversity of all marine ecosystems. In a typical reef you'll find corals, snails, clams, sponges, anemones, crabs, worms, starfish, shrimps, lobsters, sea

cucumbers, sea lilies, fish such as groupers, snappers, breams, surgeonfish, damselfish, butterflyfish, parrotfish, clownfish and a number of other highly coloured ornamental fish, sharks, turtles, dolphins, green algae,



brown algae, red algae, sea grasses and dozens of other animal and plant groups that you've not even heard of. And all of them represented by dozens of species!

41. Sounds great! So I can see all of them when I go to the reef.

No, you won't. Not in one visit, not even in several. You need to go to a reef many times before you can see even half of them. Still better if you can dive, since some animals like soft corals live only below 5 m depth. You also need some experience in recognizing them for what they are.



42. Well, you can at least tell me what can I expect to see in the reef the first time.

Let us begin with corals. If you are on the shore, of course, you will see only sand. But if you swim out into the lagoon or take a small boat you'll begin to see clumps and bushes of staghorn corals. Between them you may find some massive corals.

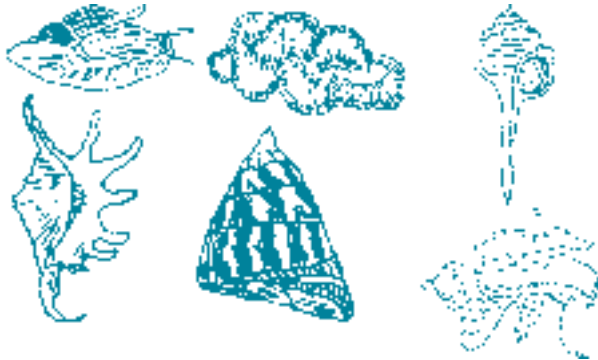


The closer you go near the reef, the corals will become abundant and more varied. You may also see the mushroom corals at times. On the reef flat, you may not find much except few flower corals and creeping ones; outside the reef, on the seaward slope, the coral abundance will again become high. If you are a good snorkeler or a scuba diver you could go further down and experience the wonder of corals even more.

43. What else would I see?

Snails and clams.

Have you seen the cowrie shells sold as souvenirs in many curio shops? Well, down there you can see them live, glossy and brightly coloured. You can also see large ones like strombus or trochus shells often.



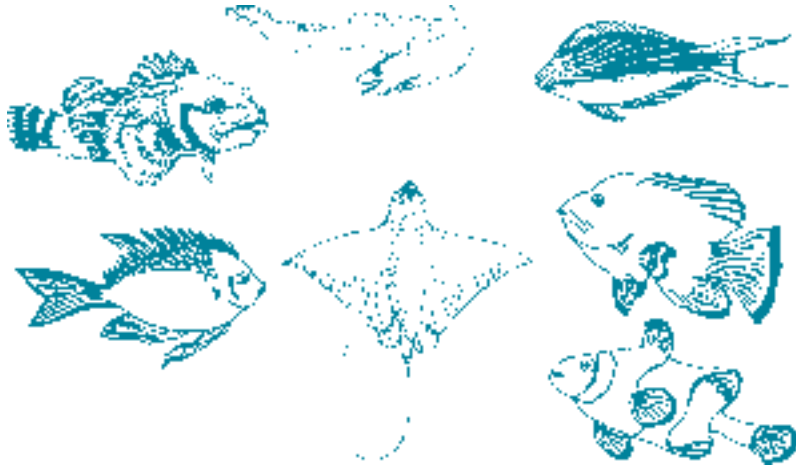
There is one clam that is particularly interesting. It is the giant clam *Tridacna*. This clam does not move but gets embedded between rocks, cements itself there and grows. It is the largest clam known and individuals of half a meter length are common in our reefs. The biggest ones, such as those from Pacific atolls, can even weigh up to half a ton. This clam, like the corals, also harbours zooxanthellae.

Be careful when you go near them, don't put your finger or toe between their valves. The muscles that close the shells are so powerful that your fingers can be snapped off like matchsticks.

Some snails like limpets have no shells. These are brightly coloured and look attractive on the coral rocks. You can also see octopus darting in between the corals.

44. Can I see lots of fish also?

Yes, that is what attracts most people to the reefs. The variety in number, size and shape is almost endless. Not all of them are so common. The butterfly fish are the most abundant, you are almost certain to see them in the first dip in the water.



If you float silently near large coral blocks,

you'll also see a number of other brightly coloured fish. And if you see an anemone you are certain to see the yellow and red clown fish darting between its tentacles.

The polka-dotted moray eel is also a common sight. It hides in crevices and only its head comes out in search of food. Be careful with your fingers - the teeth of the moray eels are razor-sharp.

If you are wading in shallow water or reef-walking, then it would be a sensible idea to wear thick canvas shoes. You may step on a sting ray, a scorpion fish or a stone fish and end up with pain and swelling for several days.

45. Are there sharks too?

Not in the lagoons. They are so shallow that sharks do not venture in. Outside the reef, on the slope, you may encounter small sharks, like the dog-shark variety. This is a harmless species. Rarely you see bigger ones and still rarely they attack human beings. No need to worry about them.



46. How about shrimps and crabs?

There are no large shrimps, like the ones we eat, but there are plenty of small, colourful ones. One among them, the snapper shrimp, is worth mentioning. This is a small shrimp, only a few cm in size, and lives in crevices in the corals. But it can make a snapping sound, like a pistol shot, with its claws. Perhaps it is a mating call, but on a calm day in the reef, you can hear dozens of them snapping off continuously.



Crabs are many and, like all reef animals, are brightly coloured. Sometimes you may see a lobster hiding in the crevices in coral rocks.

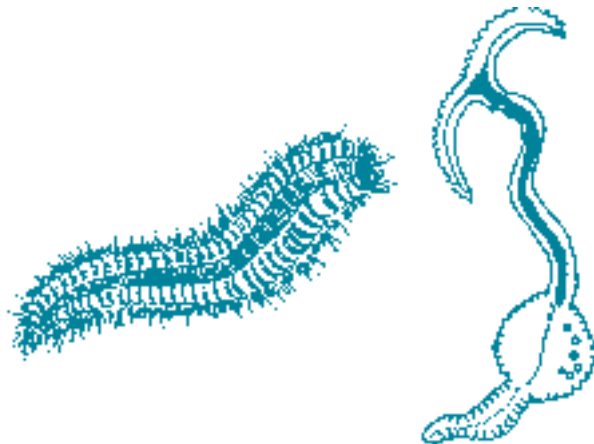
47. What else can I hope to see easily?

Some stars: the sea stars and brittle stars. They all belong to the starfish family, with 5 arms that are either rigid or soft (hence the name brittle star, sometimes sea lily). You may also see sometimes the bluish crown-of-thorns starfish, which we spoke about earlier.



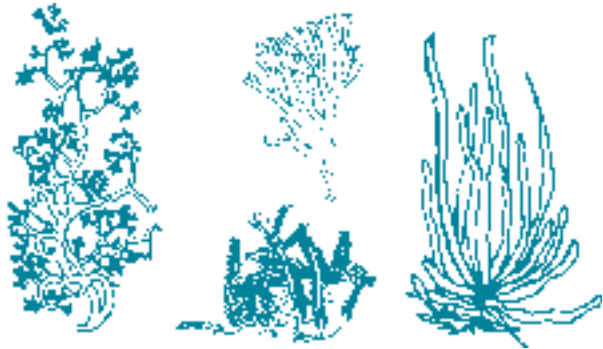
48. Wow, there is much to see in one trip, isn't there?

Yes, and the list is not over yet. If you wear goggles and are a patient observer, you can see small worms protruding out of coral colonies. These worms have colourful whorls of fine tentacles that help them in catching food. These whorls are one of the most beautiful sights in a reef.



49. How about sea plants?

You'll find them everywhere on a reef - red, brown, green, even white - the calcareous algae. Often you may find the lagoon covered profusely with sea

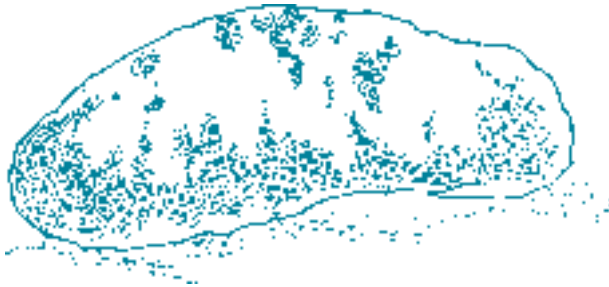


grasses - dense mats of several hundreds of square meters.

Did you know that the sea grasses are the only flowering plants that live in water?

50. What do sea grasses do in a coral reef?

They enjoy the protection of the lagoon and proliferate. They are not totally selfish, either. They support a food chain in



their own way. Many fishes and small crustaceans feed on these grasses. You may find the sea cucumber, the cousin of the starfish, in abundance in the sea grass beds.

There is also another role for them. They bind the sands and prevent erosion, like most sand dune plants do.

51. Is the turtle grass the same?

Yes, it is one species of sea grass. But as the name says, sometimes you can see turtles coming to feed on them. Quite often you see the turtles swimming outside the reef, and if you dive, you can even see them resting between coral rocks.



52. Is there any other animal I might enjoy looking at?

The dolphins. You can see them quite often frolicking near the reefs.



53. Are all these animals and plants the same in all our reefs?

unique species. If you go to Andamans you'll see the salt-water crocodile near the reefs. You can also see the giant sea anemone here, which is at least half a meter across. You don't see them in atolls.



54. One more question. Are there any dangerous animals in a reef?

No, not the ones that cause fatal harm. Contact with some corals can cause skin allergies and irritation. Sting by some fish can be painful for some days. Even scratching your unprotected legs or arms against corals can cause cuts and sores but not death.



There is one animal you should be vigilant against. It is the box jellyfish.

Its sting is fatal. Fortunately we don't see it near our reefs. It is more common in Pacific reefs but who knows, you may one day go to see those reefs also. You should, because each reef you visit can be a new wonderful experience.

About resources



55. Let us talk about what coral reefs can give us. Tell me something about that.

I guess after listening to me about fish, shrimp, crab and lobster brings fish food to mind!

The reefs abound with food fish. Most of them live in the lagoon. Some fish like tuna and sharks live outside the reef but come closer to the reef to feed on the small fish. The biological productivity of the reefs is very high. We can get from a unit reef area as much fish as from rich fishing grounds like the Peruvian upwelling known for record anchovy catches.



56. But I don't see any major fishing units near the reef.

Fortunately, it is not easy to catch all reef fish as we do elsewhere with trawlers and seiners. The nature of the rocky bottom, presence of corals that can tear away the nets and the abrupt variations in depth, guarantee that no fishing net of mass catches can be used in a reef. Most of the fish can be caught only with lines or traps. Often what can be caught this way is more than enough for local needs.



57. What about the small colourful fish? We can't eat them, of course.

No, but we can sell them to aquarium hobbyists. The ornamental fish from reefs are far more colourful and diverse than those from freshwaters. The demand for these fish worldwide is so great that it is a lucrative industry in several third world countries. The Philippines is known to export every year aquarium fish worth several million dollars from her reefs.



58. What else is edible?

The sea weeds, if you have a liking for them! In India, we don't eat them but some of these weeds are used for producing jellies, agar and cosmetics. There is a good potential for collecting seaweeds from the reef or even cultivating them in the lagoon. In some reef areas the local people relish the Octopus and the giant Clam.



59. What other useful things has the reef to offer us?

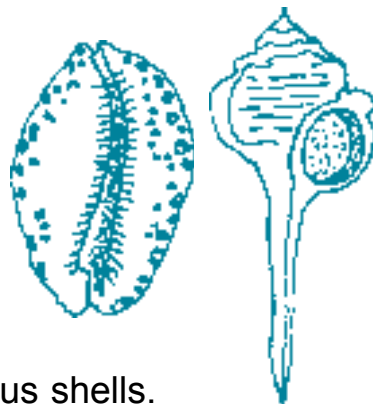
The corals themselves, of course. In most of the villages bordering coral reefs, houses are built only with coral stones and mortar from coral debris. Even whitewashing is done with coral lime paste. At an industrial level, the coral sand rich in calcium is a potential raw material for the cement industry.



Most often corals, particularly the branching ones, are also collected and sold as souvenirs. Curio shops near the reefs have stocks of them though it is forbidden.

60. I have also seen shells being sold.

Yes. The cowrie shells are the most popular though a large variety of other shells are also sold. Some shells are collected for industrial purposes also.



Do you know that, before the advent of plastics, even shirt buttons were made from the trochus shells.

Some large shells are cut and polished and sold as ornaments and bangles, ear-rings, studs, necklaces, pendants, finger-rings etc. This is again a large industry in the Indo-Pacific reefs, generating several million dollars worth of business every year.

61. I read sometime back that corals can also be used as transplants. Is that correct?

Yes. A substance for use as bone transplant should have nearly the same chemical composition as the bone, should be tough to give mechanical strength and at the same time porous enough to allow fine blood vessels to pass through. Among the several bio-materials, corals like the massive *Goniopora* are the best choice. Either we can cut a bone-shaped structure from the coral and use it as a transplant or better still, convert the skeletal material to hydroxyapatite, which is the mineral component of the bone. This forms a bond directly with the bone and hence can be used as a bone-replacing material; on implantation, this promotes new bone growth.

Coral skeletons also find use in dental applications, as materials to fill in cavities.

62. Can we get medicines from corals?

Not from hard corals, though some Ayurvedic preparations may include them. Most other organisms like soft corals, sponges, bryozoans, sea slugs, pufferfish secrete compounds that are bio-active.

It is like this. In a coral reef space is at a premium. Every organism tends to protect its space and when others encroach, it secretes some compounds to repulse them. These are basically antibiotics but may prove useful drugs for some human ailments.



The possibility of discovering novel products from these organisms has generated considerable interest worldwide. In India, NIO is doing research in this area for the last two decades. Some products extracted from sponges and soft corals have shown anti-viral properties.

63. What else can we get from reefs?

Protection to our coasts. The reefs are natural walls that stop the strong waves and storm surges from reaching the shores. That is how the lagoon is calm even when the sea outside the reef is rough. This prevents shore erosion.



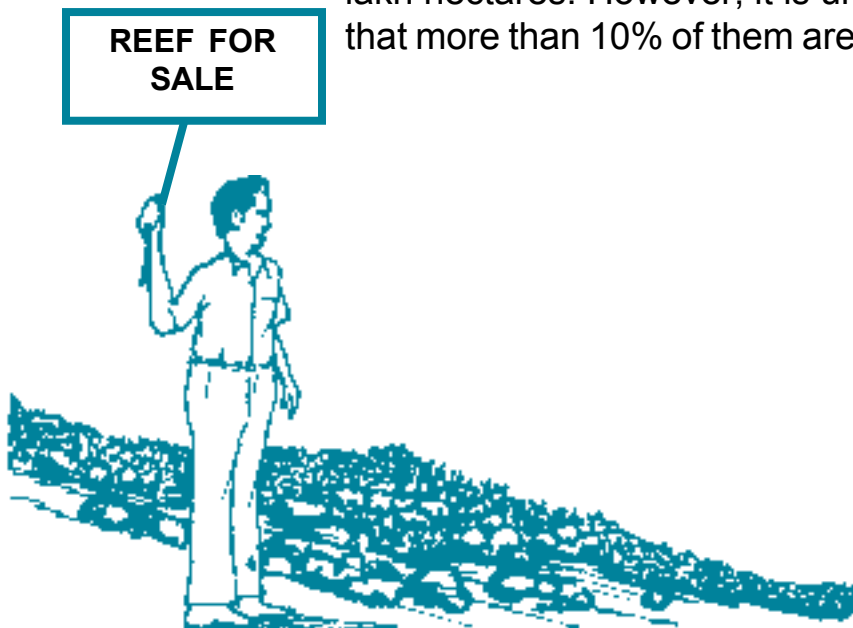
This type of protection is critical to the islands. Most of our

coral islands are small and low-lying. Even little erosion can affect them dramatically.

64. Impressive! Can you put all these together and tell me what is the worth of a reef in hard currency?

Difficult, because the extent of uses varies from reef to reef. Again the economic value of an activity is modified from region to region by cultural beliefs and traditions. On an average, the total economic value, in terms of extractive uses, is about 2750 US \$ per hectare reef area per year. Globally, all the reefs together (62 million hectares) have therefore a resource use value of about 170 billion US \$ per year. This is only a potential estimate since not all reefs are accessible at present.

Indian reefs cover an estimated area of about one lakh hectares. However, it is unlikely that more than 10% of them are used



them are used at present. Even at this level, the economic value of our reefs could be about 30 million US \$ (about 120 crore Indian rupees). But this is only half the story.

65. This is very interesting. Tell me what is the other half?

Tourism. What the reefs can offer you by way of aesthetics, recreation, and adventure cannot be matched by any other ecosystem, except perhaps tropical rain forests.

Tourism to coral reefs is a massive industry worldwide involving transporters, hoteliers, boat crew, diving gear operators, guides and a host of other auxiliary services. The current estimate of the economic value of coral reefs from this source alone is as much as that from other uses, and together can take the total economic value of coral reefs to more than 350 billion US \$ a year. If the present trend is any indication, it is ever- increasing.



About



threats to corals

66. The coral reefs must pay for being so rich, do they?

Yes they do. But not all damages are man-made. Some are natural and at least one cause was natural in the beginning but got aggravated by human activities later.

67. What is the natural threat that has been aggravated by human activities?

Predation by the crown-of-thorns starfish. This is an interesting story.



The starfish is normally present in the reefs in very low numbers. The triton snail feeds on the young ones of the starfish and thus keeps the population of the starfish in check. But when we started harvesting triton shells in commercial quantities, there were not enough snails left to feed on the young starfish. The latter started growing in proliferation and their feeding on corals increased dramatically.



That was how many reefs got totally devastated by the starfish outbreak.

This is an example of how unregulated human activities can aggravate natural damages, even indirectly.

68. Was there any other natural event that caused as much damage?

Yes, the unusual summer warming of the year 1998. Even in tropical seas, temperature changes follow a seasonal cycle, with increase in summer. Sometimes corals react to this increase in temperature by expelling their zooxanthellae. As a consequence the corals lose their colour and look white. This is called bleaching.



As a consequence the corals lose their colour and look white. This is called bleaching.

Bleaching is a common phenomenon in most coral reefs in summer but never reaches a severe degree. The bleached corals usually recover their colour once the temperature comes back to normal. The temperature increase in these instances is generally less than 1 degree and lasts for only a few days or may be a week or two.



During the 1998 summer, however, a vast layer of warm surface waters spread over the whole tropical region. As a result, the temperature increased by 2 degrees higher than the seasonal maximum and persisted for several weeks. This was too much for corals. Most of them, in particular the branching corals which are more sensitive, got bleached and died, eventually leaving vast stretches of the reefs barren.

More than 40 countries reported impacts varying from moderate to severe. In India, Andaman and Nicobar reefs were the most severely affected (upto 80% death of corals) followed by Lakshadweep (40%-80%) and Gulf of Mannar (60%) reefs.

69. What other natural causes affect corals?

Exposure. Corals living in the intertidal zones get periodically exposed to atmosphere. This lasts generally 1-2 hours and all the coral species can withstand this exposure. But in regions of high tidal amplitude, as in the Gulf of Kachchh, this exposure can last several hours. If this also happens to coincide with sunny weather, then it can kill corals. Fortunately, this does not happen often.

70. Do corals also must breakdown at one time or other?

Yes, they do. A coral colony is home to many animals and plants but some of them are not that grateful! The mollusks, worms and sponges are notorious - they bore into the coral skeleton to make their homes there. In the process they weaken the skeleton and make it susceptible to mechanical breakdown by wave action.



71. So, waves also affect corals.

Yes, continuous pounding by waves on the forereef and reef flat kills many corals there. That is why you find lots of rubble and less of live corals there. But if the



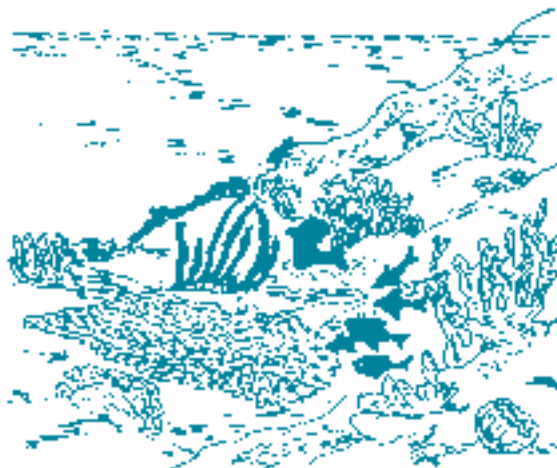
wave action is very strong, as during hurricanes, corals even several meters below can also be broken to pieces or uprooted by the waves. Hurricane damages are common with Pacific reefs but rare in Indian reefs.

72. Well, these are known threats. Are there potential threats?

Yes, one such is the sea level rise. You may remember that we said entire reefs got drowned in the past because of sea level rise. But this happened over many centuries.



In the present century, it happens in decades.



We are burning

so much of coal and oil that the carbon di-oxide concentration in the atmosphere is increasing rapidly. This causes the earth to warm up which in turn causes polar ice caps to melt. This makes the sea level to rise at a rate higher than the reef growth. If this continues then the coral reefs will drown.



73. But I read that the sea level is not rising as much as we thought earlier, is that right?

Nobody knows for certain. It is possible that the rate of sea level rise is reduced now but it does not seem to have reversed.

There are different possible scenarios, from low to high rates of rise.

The atolls will be the most affected; even if they grow faster, they may not be able to cope up with projected sea level rise in the next century. The fringing and barrier reefs may fare better, keeping up with the sea level rise upto mid-range projection.



In any case, the threat is real but its magnitude is difficult to gauge now.

74. Will this have serious fall-outs?

In the case of mainland, the protection offered to the coasts by the reefs would be lost. There will be increased erosion and land loss. In the case of islands like those of the Lakshadweep, the situation will be still worse. These low-lying islands, hardly a meter or two above sea surface now, can get drowned totally.

75. But are there man-made effects that have immediate impacts?

Yes, the most important among them is coral mining. We said that corals are taken to build houses and produce lime. For most of the coastal villagers, this comes free from the sea and they have no qualms in taking away as much as possible. And they make no distinction between dead and live corals.

As a result, several large patches of low-lying reefs are totally lost.



This impact is most serious in the Gulf of Mannar reefs, especially near the coastal villages and towns like Mandapam and Tuticorin.

76. But these are only local impacts and people do need some coral stones, don't they?

Well, if the removal is only moderate and restricted only to dead corals, like coral debris, then perhaps the impacts could be minimized. But most often, people do not make any distinction between dead and live corals, nor do they respect any limit for extraction. And if the extraction is on an industrial scale, then it could be catastrophic.

Did you know that the extraction of coral sands in Gulf of Kachchh was leased out to a cement company in the eighties? Every year about a million tonnes of coralline material, including live corals, were dredged out, killing a large portion of the reefs in the process. Fortunately better sense prevailed and this lease was not renewed. But then the damage was already done the loss of coral cover was in excess of 50% at most of the reefs in the leased area.

77. But can't we allow some corals to be collected as souvenirs? I'd like to take a coral home.

That is precisely the problem. If each one of us want a coral like that, we would then need one billion corals. Not even all the world reefs put together can satisfy this need!



And again, we all want the beautiful branching corals.

That means the removal is selective, affecting the biodiversity. Some fish which live only with the branching corals will also disappear and the very beauty of the reef will be lessened. What do you prefer - looking at the colourful corals in all their splendour in the reefs or their bleached skeletons in the showcases?

Is there a choice?

78. Okay, I get your point. But don't tell me I can't even catch some fish to eat!

You can, as long as you use a line or a trap or a harpoon. If you resort to other methods, then it is a different story.



79. How?

Some methods used for fishing in reefs are highly destructive.

In one such method the fishermen dive to the reef floor and release a poison. The fish in the surrounding area get narcotized and float to the surface where they are collected. What is not seen is the death of all other organisms near the site where the poison is released.

In a similar way, some fishermen use dynamites underwater. The fish get stunned with the shock waves and float to the surface. The damage in this case is much

more intensive. All corals in the vicinity of the blast are smashed to bits.

In both these methods of destructive fishing, damages are not visible to the casual observer and often the impact goes unnoticed until it is too late.

80. Are such methods practiced in India?

Fortunately, no. The fish poison (generally called Rotenone) or the dynamite material are not easily available to ordinary fishermen. Some fishermen, however, use poisons extracted from locally available plants and animals.

81. But I am sure some forms of fishing practiced in India that is more destructive than productive, is it not?



Yes, it is the practice of collection of live baits and the ornamental fish. The live-bait fish are used in

pole and line tuna fishing. The ornamental fish are collected for sales. Both these groups of fish usually live between the coral branches or around the coral colonies.

The fishermen encircle large patches of corals with

fine mesh cloth or net and hit on the corals to chase the fish out. In the process of collecting these fish worth a few hundred rupees, colonies of corals growing for several years are killed.

82. Are there unintentional damages associated with fishing?

Yes, the most common and the most serious one is that made by anchors.

Most of the fishermen, when they go for reef fishing, anchor their boats in the shallow parts of the reefs. Quite often the anchor falls on the corals and if the boat drifts, then the anchor and the chain get dragged over the corals, breaking the branches or even uprooting



entire colonies. In the case of large ships that anchor near the reefs for passenger and cargo traffic, the damage can be enormous. Imagine what would happen if a 20 to 30 ton giant broom sweeps the reef?

83. What other human activities affect corals?

Pollution. Corals are very sensitive to oil and metal pollution. If a reef happens to be near the effluent discharge point of any industry or near a harbour, then the reef is practically doomed.



Even seemingly unrelated onshore activities can kill corals. For example:

- (1) Logging is a major land-based industry in Andaman and Nicobar Islands. As a result, huge quantities of mud and silt are washed off every monsoon on to the coastal zones. These settle on corals and kill them by smothering.

(2) In the Gulf of Kachchh lots of mangroves have been cut. The mangroves have a mud-binding capacity. When the mangroves are cut, the mud-binding capacity is lost and the mud gets washed on to corals. This is a major cause of death of nearshore corals in this region.



(3) Thermal pollution, like hot water discharge from the cooling towers of industries or power plants near the reefs, can also kill them.



84. Does atomic radiation affect corals?

I remember that some reefs in the Pacific were used as nuclear bomb test sites by USA and France.

We don't know for certain about radiation effects because these sites are not accessible to civilian scientists. Undoubtedly, the shock waves of nuclear explosion must have killed corals. How much? Nobody would tell us that or let us find out.

85. The corals must be living a miserable life, aren't they?

From every angle, yes.

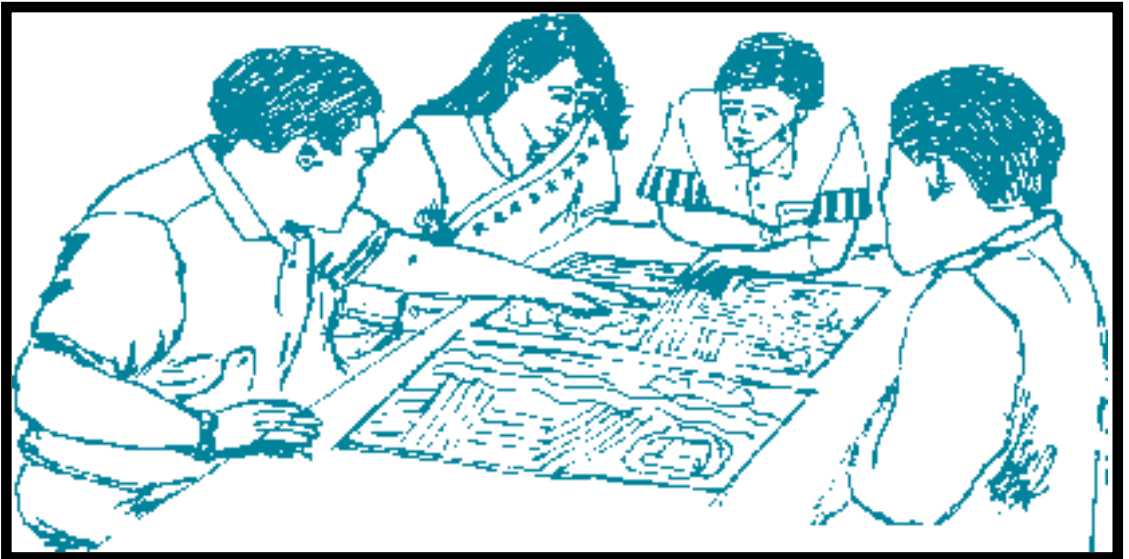
Even when you pay a visit to them you make their life miserable! The hotels meant to provide lodging for you may be built of coral stones, or may *even be built on the reefs* so that you don't have to go too far



to see them! With the tourism industry, comes the pollution - sewage, oil, plastics and other solid wastes.

Even your reef walking can be harmful to corals; you may inadvertently step on them and break off their branches.

ABOUT



**PROTECTING THE
CORALS**

86. You discourage me from going to the reefs!

Not at all. I am telling you only to observe some precautions like minimizing sewage pollution, not littering the lagoon or reef with solid wastes and not anchoring your boat anywhere but tying it to moored buoys. Exercise caution while reef-walking or snorkeling and do not take away corals or shells as souvenirs. Leave them where they are so that others also have a chance to see them in their natural splendour.

87. That is alright as advice to a tourist. But how can I play a more useful role in protecting our reefs?

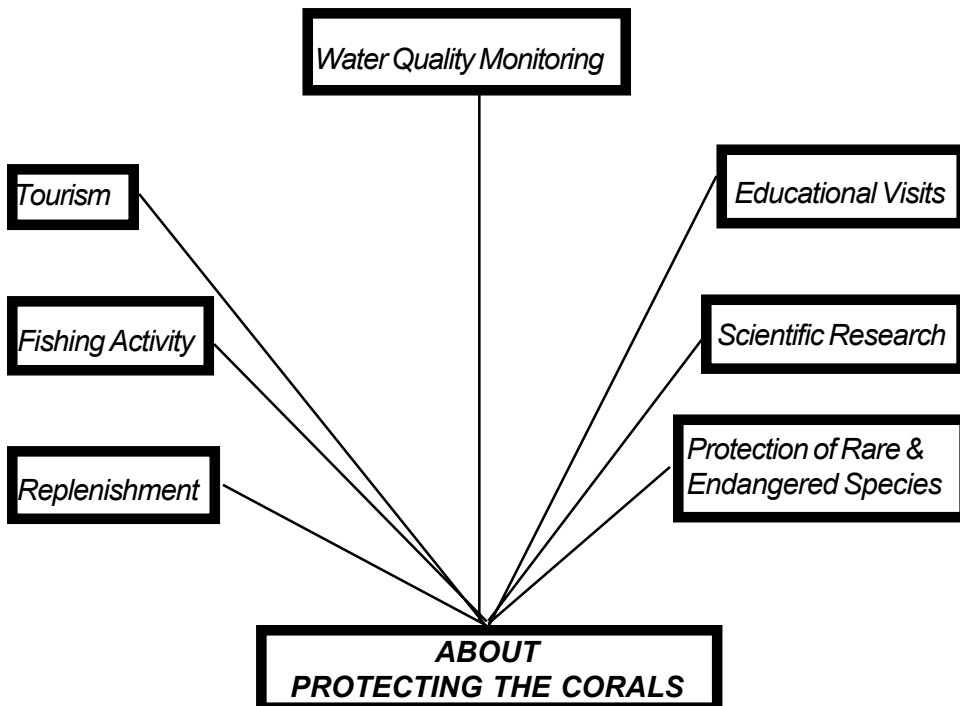
I am glad that you are a concerned citizen attempting to strike a balance between protection and sustainable use of the coral reef resources.

88. But can it be done?

Yes, with some co-operation from all concerned. Let us start with a basic issue. It is setting aside some reef areas for some specific purposes so that there is no conflict of interest between users. This is called a zoning plan.

89. What possible zones are there?

There are several zones: for fishing, tourist activities, water quality monitoring, educational visits, scientific research, protection of rare or endangered species, replenishment (closed for all activities) and even simple aesthetics. As it is obvious, each zone should ideally be used for only one activity.



90. How can you define such zones?

With some experience, logistic considerations and scientific knowledge.

For example, to define a tourist zone we should know how high is the biodiversity of the area and how safe it is for recreational activities like snorkeling and diving. Water quality monitoring zones should be nearer to effluent discharge points, if any. Scientific research zones should be in relatively undisturbed areas. Of course, activities in the zones can also be rotated periodically so that the impacts from any one activity do not become excessive.



91. Still we need to keep track of what is happening?

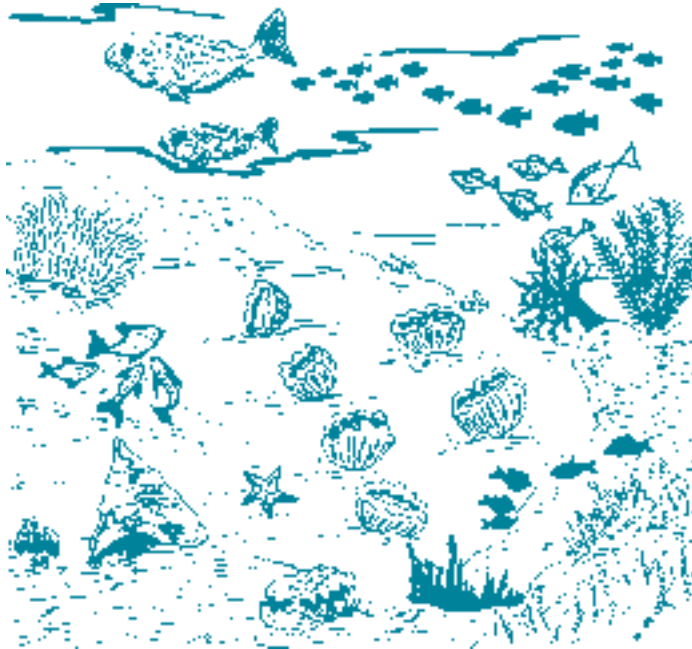
Yes, for that we need to have a reef management plan.

92. How will you manage a fishing zone?

We go in sequence. First, we list all fish in that area and study how fast they grow. Based on this data we can calculate how much can be fished. This is called setting the quota.

We can also study the biology of the fish. From this, we can come to know when they are going to reproduce (r e l e a s e

eggs). We can then declare that period as the closed season to protect egg-laying fish. Similarly, from biological studies we can also know when the fish become adult. We can then set size limits for the fish to be caught so that young ones are not caught.



93. And a tourist zone?

By setting limits to the number of tourists coming to the reef and the sites they can visit at any given time so that the pressure on the reef is thin and uniform. By educating

them on the possible damages their recreational activities can cause, and ensuring that they understand their responsibilities.



94. And the biodiversity protection zones?

Some species, by nature, occur in low numbers and only in certain parts of a reef. An example is the *Balanoglossus*, the first animal to acquire a backbone in evolutionary history. This occurs only in some reefs in Gulf of Mannar and is much sought-after by student parties! The only way such species can be protected is by having these zones declared inaccessible to all except scientists.



95. What can we do with the scientific research zones?

These zones serve normally as control zones against which other zones can be evaluated for impacts. These are generally left undisturbed. If there are no large industries present, then the water quality management zones can also be integrated with the scientific research zones.



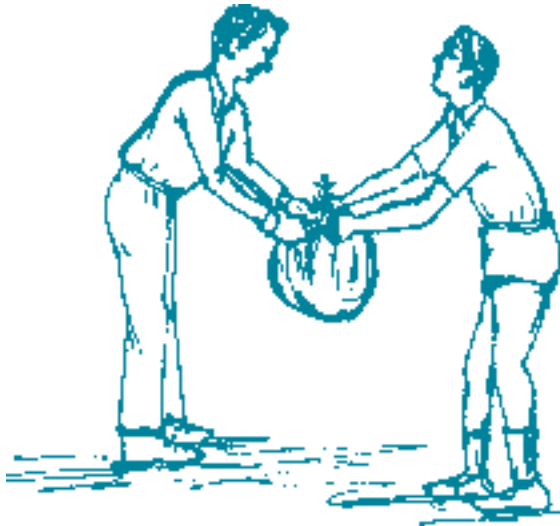
96. What can we do with the education zones?

Use them to teach students, public and managers alike of the value of the reefs and the need to use their resources meaningfully. These would serve as natural demonstration laboratories where impacts on small scales can be created and their damaging effects can be shown to them. Like what happens if you overturn a stone and leave it like that, or how poisoning fish can affect all other organisms in the vicinity.



97. Still we will need some sort of enforcement for compliance, is it not?

Unfortunately, yes. That is why surveillance against infringements and enforcement of the regulations form part of the management action plans. However, compliance can best be achieved by creating awareness among the users. It is the basis for the joint management approach.



98. What is it?

A system of management where every stakeholder has a say on how to use the reef resources and how to protect them. The stakeholders are the government, the local communities, the NGOs, the tourists, the scientists, the industries, and above all the Mother Nature. In such a plan, where everyone's needs are taken care of, compliance is almost automatic. Another advantage here is that the traditional knowledge finds its right place. You know, the local communities have been living with the reefs for centuries and they probably know better than us how to manage their precious reefs.

99. Do we have such management plans for all our reef regions?

They are being drafted. You know, such plans also keep on evolving based on new scientific inputs. That is why the Government of India has initiated a national framework of data collection called 'Indian Coral Reef Monitoring Network'. The aim of this project is to bring uniformity and relevancy to data collection on the status and impacts on coral reefs and promote exchange of information between all concerned with coral reef management.

100. Will all these measures be successful?

We have no other choice than to make them successful. Otherwise you'll be seeing a coral reef only in picture post cards or video clippings. As simple as that.

101. Thanks a lot for all this information. In what way can I be a part of your efforts to protect corals?

You can help in four ways: by practicing what you learnt through this book; by leaving the reefs in a better shape for the future generations; by spreading the message among your friends, classmates, colleagues, family members and your children; and also by telling us what else can we do for a sustainable management of our coral reefs.

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The living splendour of coral reefs can only bring pleasure to millions in the future as they did to millions in the past, if we make it possible for them to survive.

