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THE STATE OF THE NAITAUBA ISLAND FRINGING REEF

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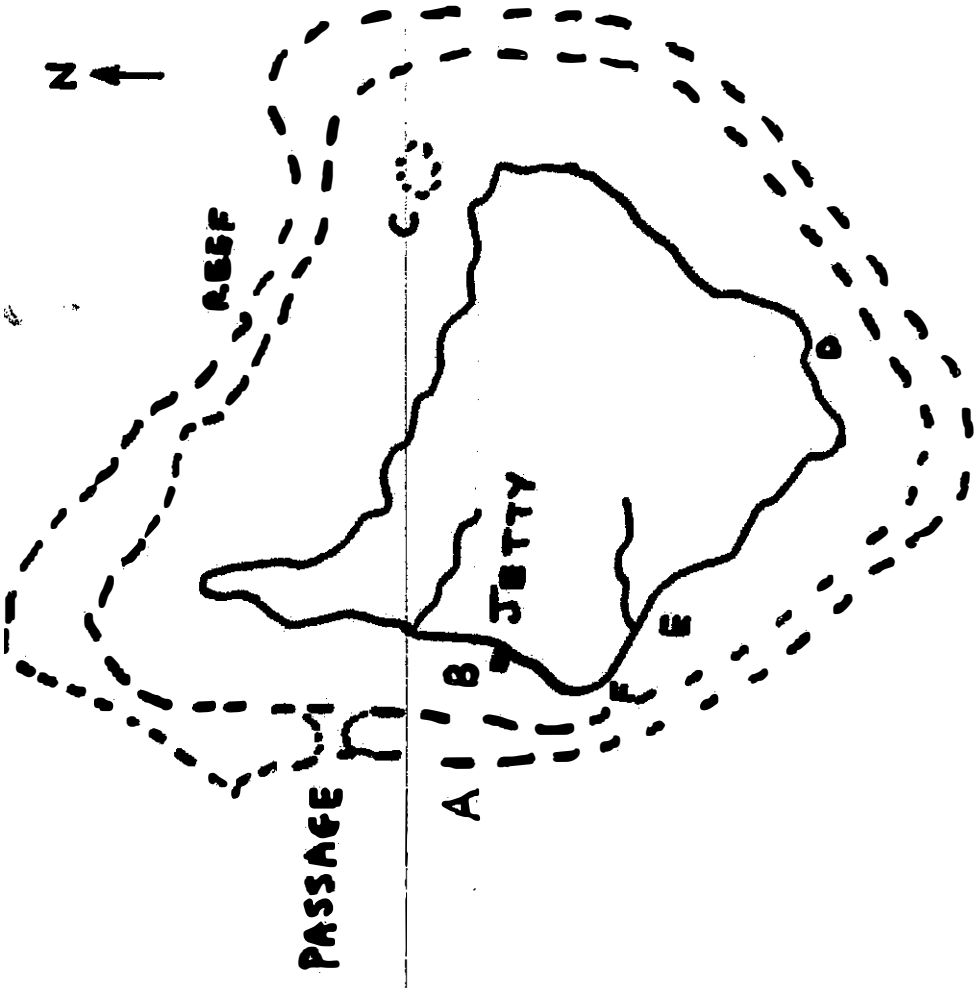
At the request of the Johannine Daist Communion (JDC, the owners of Naitauba Island, Lau Group, Fiji) a visit was made to Naitauba by Mr Jon Brodie and Ms G. Brodie from 3rd to 6th December, 1986. The purpose of the visit was to assess the state of the Naitauba fringing reef and lagoon, to advise the JDC on a number of reef related problems and to give informal talks to the school children and inhabitants on coral reef ecology and biology.

On the 4th and 5th of December dives were made in the areas marked on the map (Figure 1). A,B,C,D,E and the exposed reef at F was inspected while walking on it at low tide. The areas were examined for coral cover, evidence of dead coral, Acanthaster planci (Crown-of-Thorns starfish) numbers, algal abundance and general °reef health' such as numbers of chaetodontids (butterfly fish) using the methods developed by Dahl (South Pacific Commission) and the Great Barrier Reef Marine Park Authority. A brief description of each examined site is given below.

Carcharhinus melanopterus

Site A

At this outer reef site vertical walls dropped away the surface to 20m (70ft) and then gradually into deep water. Large fish and a number of shark species including Triaenodon obesus (White-tip reef shark) and Carcharhinus (Black-tip reef shark) were relatively common near the drop-off. Coral growth on the walls and overhangs of the drop-off luxuriant but large quantities of dead branching coral (Acro spp) at the base of the walls were noticed. This dead coral appeared to have died at least five years ago based on size estimates of new colony growths. The implications of this dead coral will be discussed later. One area of turbulent, turbid water was encountered in contrast to the normal 25 m (80 ft) visibilty along the drop-off. It is possible that this may be related to fresh water springs connected to the fresh water system of the island's interior cave complex but considerably further research would be needed to establish this connection.



NAITAUBA IS.

Site B

This site comprises the shallow reef system approximately 100m (300ft) off the jetty. The reef top is 0.5m (1-2ft) deep at low tide and the edges fall away to a depth of 5m (16ft) the lagoon floor. In the past this has been an extensive area of branching coral but much of it is now dead. However, once again, the damage seems to have been done more than 5 years ago. New growths of Acropora species, Pocillopora damicornis and branching and massive Porites species have now regrown in this area with colony diameters of up to one metre (3ft). Some large areas of the original growth are also still flourishing. Small reef-related fish abound on this reef and although visibility is low (10m or 30ft) it still provides a good area for beginner snorkelers to view. Two specimens of lagoon stingray Amphotistius (= Dasyatis kuhlii were observed on this dive. This stingray grows to 35 cm (14in) across the disc and is light brown with pale blue spots and a black and white marked tail. It is described as being very common in sandy patches among coral in the western Pacific (Carcasson,1977). A specimen was speared by one of the Naitauba staff during the visit. A much larger, darker stingray was also observed from a boat near the jetty. This may be Himantura uarnat or Dasyatis stephen both of which are found in the western Pacific. Both of these rays can grow to 150cm (5ft) and are considered particularly dangerous. Because of problems experienced by Naitauba residents with stingrays this topic will be expanded upon later in this report.

Site C

This site was a patch reef in the lagoon on the nortern side of Naitauba. The lagoon bottom was approximately 15m (50ft) deep in this area and this patch reef rises out of this depth to within 1 m (3 ft) of the surface. The water is relatively clear with visibilty of 15m (50ft). Once again large areas of old dead branching coral were observed with good regrowth of new colonies. A large number of Tridacna derasa (a large clam) were observed at this site.

Site D

At this site the school children were camping and after a short talk and discussion period with the children and teachers, the area in shallow water off the beach was used for informal field instruction. The reef has a small drop-off from the surface to the lagoon floor at 6m (20ft). A number of dangerous animals which may be encountered on the reef were identified for the children in this area. These included the stinging hydroid Millipora platyphylla, a soft feathery hydroid (similar to Aglaeophenia sp.), the floating Physalia physalis (Portuguese man-of-war) and a number of cone shells. An appendix (No. 1) is attached to this report giving further information on dangerous reef animals. Old dead branching coral was also noticed at this site.

Site E

This site consisted of the shallow reef stretching around the point near the area known as the Matrix. Water depths are only one metre (3 ft) around this reef. The reef consists primarily of dead branching coral with once again regrowth colonies of a few years of age common.

Site F

This site consists of a shallow reef with numerous boulders. The coral is in good condition with numerous shellfish (Trochus and turban shells) evident.

General Discussion

Reef Condition

In all areas inspected a large proportion of dead branching coral was observed but the event which caused this in every case appeared to have occurred at least several years ago. This was estimated by observation of the size of the new colonies growing in the destroyed areas. The cause of the coral death is difficult to uncover at this time but a likely cause may have been the Crown-of-Thorns starfish. The branching coral has not

been completely smashed as occurs in cyclone damage and death from fresh and/or silty water over such a large area would be most unlikely on an island like Naitauba.

Fish and invertebrate life is in good condition at Naitauba and the presence of species such as large clams and turtles, which are now becoming rare in Fiji testifies to this. Water clarity was 'normal' for the reefs visited and no excessive siltation due to land run-off noted. Control of silt run-off by good agricultural practice is necessary to maintain the reef in good condition.

Sting-rays

The presence of large numbers of sting-rays is likely to be a temporary population fluctuation but since the animals have a considerable life span the problem may last for a number of years. Although it may be possible to reduce numbers by spearing the surest method to provide protection for swimmers is to enclose an area with mesh, having first made sure all rays have been removed. The area close to the jetty would be suitable for this and a structure constructed of wooden posts and plastic mesh should be effective. The bottom edge of the mesh should be well buried to prevent rays from sliding underneath it.

I suggest a small aquarium be set up on Naitauba for both children and adults. In this way a far better first hand knowledge of the identity and behaviour of reef plants and animals can be gained. The instructions for setting up a low cost system are attached as Appendix 2. A useful book to identify many Fiji reef animals and plants is 'The Great Barrier Reef' published by the Readers Digest.

References

Dahl, A.L. 1981. Coral Reef Monitoring Handbook. Reference Methods for Marine Pollution Studies No. 25, UNEP, 1984.

Carcasson, R.H. 1977. A Field Guide to the Reef Fishes of Tropical Australia and the Indo-Pacific Region, Collins, Sydney, 1977.

Readers' Digest Book of the Great Barrier Reef, Readers Digest, Sydney, 1984.

APPENDIX I

DANGEROUS ANIMALS OF THE REEF : OFFENSIVE AND DEFENSIVE (reprinted from 'The Great Barrier Reef' Readers Digest)

Chemical Warfare

There is a constant warfare on the reef and some smart technical equipment has been developed for both offensive and defensive tactics by many organisms. Chemical warfare is the chosen defence of a host of animals, for if a poisonous or unpalatable substance can be accumulated in the skin or tissues it can prevent or reduce predation. Bacterial attack can also be countered by the development of bacteriocides. For example, 60% of a large number of sponges tested showed some anti-bacterial activity. This can be very important for an animal sitting on the bottom, straining the water for fine particles, and needing to feed on and not be infected by bacteria.

Offensive weapons are also abundant, and sometimes extremely sophisticated. They are often both mechanical and chemical. The coelenterates, including the corals, hydroids, sea anemones, sea wasps and the Portuguese man-of-war, have special toxin-loaded cells with needle-sharp barbs at the end of a coiled spring. These fearsome weapons are set off with a trigger that can be brushed by the touch of a prey animal, or a human finger. The stinging cells may be merely an irritant to humans, or may be like those of the sea wasps, where contact with the long tentacles results in many stings, and can cause death within minutes.

Sharp spines are the stock-in-trade of most fishes and sea urchins, but spines are often made more effective as weapons by a coating of venomous mucus or by associated glands. Sea snakes are also found on the reef. They nearly all have small fangs but deadly venom, although they will not strike unless provoked.

Surprisingly the venom is more dangerous than that of land snakes to humans.

Four Safety Rules

Even with these dangers, by observing simple precautions the reef is safer than any city. There are four primary warnings:

1. Don't wander in the shallow water among and between the reefs without wearing a pair of sandshoes with sturdy soles.
2. Swim in bright sunlight and in water where there is good visibility.
3. Don't eat fish until you have talked to the locals about it. An eating fish in one area may be known to cause ciguatera poisoning in others. You should also be aware of pufferfish.
4. Don't pick up cone shells; this harmless-looking and often beautiful shell can be dangerous.

Invertebrates to at a Distance

Most of the invertebrate animals of the Great Barrier Reef are not dangerous to humans, but it is worthwhile being aware of those that are potentially harmful, or that may cause irritation if touched or handled

The coelenterates capture their prey by using their stinging cells, and in some them these are powerful enough to cause pain or injury to humans as well. One of the most notorious is **Physalia** the Portuguese man-of-war, but it is not common in the waters of the reef. Swimmers and divers are more likely to encounter the stinging hydroids, **Aglaeophenia cupressina** and **Lytocarpus philippinus.** A with either of these can be searingly painful. **Aglaeophenia** is found in the tide pools of the reef flat. It looks like a clump of coarse, sturdy, yellow brown fern fronds. **Lytocarpus** occurs at greater depths and has a finer, more feathery appearance.

The hydrozoan corals are relatives of the hydroids that look superficially like the reef builders because they have hard limy skeletons. The stinging fire coral, Millepore **platyphylia,** lives towards the outer edge of the reef flat.

Among the jellyfish in reef waters, the lion's mane jellyfish, **Cyanea capillata,** is the largest. With its hundreds of long, highly elastic stinging tentacles, it can cause injury to humans. The most dangerous is the sea wast, Chironex fleckeri, but it usually occures only in summer in the northern part of the region near the coast.

Fire Anemones

The fire anemone, Actinodendron **plumosum,** has stinging cells in its tentacles containing an extremely strong poison that burns painfully if injected into the skin. When expanded, it looks like a tiny conical fir tree, and varies in colour between blue-grey and light brown and the disc around its mouth is speckled with dark spots.

Of the segmented worms, the fire worms ought not be handled. These polychaetes have long slender bristles that are as sharp as very fine needles. They can easily pierce the skin and when touched, they tend to snap off, becoming embedded and setting up a fierce local irritation. **Eurythoe complanata** is a common fire worm that lives on the reef flat among the coral rubble and under boulders.

The crustaceans of the reef pose little threat to humans, although the flesh of some ofthe crabs is known to be poisonous. If molested, the spiny mantis shrimps of the reef flat are capable of inflicting painful stab-wounds with their sharp claws, but they are so swift and wary that they are unlikely to be a hazard.

Among the molluscs, some of the cones are notorious for the toxicity of their venom. These reef carnivores inject poisonous saliva into their prey through sharp grooved teeth at the tip of a retractable proboscis. Harpooned victims quickly succumb. The poisons secreted by fish-eating cones are also toxic to other vertebrates, including humans. The beautiful reticulated and striped geographer cone, Conus **geographus,** has caused fatalities, and the tulip cone, Conus **tulipa,** the striated cone, Conus striatus, the magician cone, Conus **magus,** the textile cone, Conus

textile, the marble cone, Conus marmoreus, and the court cone, Conus aulicus, are all recorded as being dangerous.

A living cone must be approached with caution and, if handled, should be picked up by the broad, whorled end only. At the same time, a sharp eye must be kept on the slit of the shell, in case the flexible proboscis tube starts to protrude, with its threat of a quick shot of venom. The octopus is another mollusc with a very poisonous bite.

A few of the echinoderms are capable of injuring people. Of these, the crown-of-thorns starfish, Acanthaster planci, is widely known for its devastation of reef corals. The upper surface of this large starfish is a bristling mass of stout spines, each coated with a thin layer of skin that secretes an irritant poison. A puncture-wound from the crown-of-thorns' spines is fainful, and may become inflamed and swollen. The long, slender, needle-like spines of the sea urchins Diadema and Echinorthrix break off easily and lodge in the flesh. Because of their barbs, they are difficult to remove and the surrounding area may fester.

Another sea urchin that should not be touched is Toxopneustes pileolus. It has a spectacular array of densely packed, waving nippers that reach out in every direction. They look like three-petalled flowers, but they are equipped with poison glands and contact with them is dangerous. Holothurians, or sea cucumbers, contain toxins and if they are handled, care should be taken not to let them come in contact with the eyes.

Not to be Eaten

The pufferfish of the Tetraodontidae family have two unusual characteristics, one endearing and one unpleasant. They can puff themselves up, often into comical little balls and they produce a particularly strong poison, called tetrodotoxin. This poison is in the gonads, gut, liver and blood. The flesh is considered a delicacy in Japan (called fugu after the Japanese name of the fish), but it is eaten only after a specially trained cook has separated poison from flesh; even then there are fatalities.

These quaint and unaggresive fish are best left alone on the reef and thrown back if caught on a line.

It is easy to say the fishes containing the poison ciguatera should not be eaten, but the instruction is difficult to comply with, for the origin of this poison seems to be an alga which is eaten by grazers and passes up the food chain, making it difficult to know which fish has ingested it, or enough of it to affect a human. The concentrations of poison are greater the further up the food chain a fish is. A grazer may feed on ten such fishes and store their poison. When these fishes are eaten by the next predator it will be feeding on fishes they have already concentrated the poison. The older and larger the fish, the more poison it may contain.

So what fishes should be avoided? Luckily, local fishermen usually know which fishes have ciguatera, and their advice is invaluable. The chinaman-fish, Glabrilutianus and the red bass, Lutjanus bohar, have both been implicated on occasion, as have large individuals of the rock cod genus Epinephelus, and large moray eels.

Ciguatera symptoms often start with numbness in thelips, pain in the arms and legs, and nausea. There may be vomiting and diarrhoea, and hot things may feel cold, and vice versa. Recuperation takes a long time, but there is said to be a 90 per cent rate of recovery.

A number of stingrays, Dasyatidae, and eagle rays. Myliobatidae, are common on the reef and have one or more sharp serrated spines on the base of the tail. There are grooves running the length of each spine, filled with glandular tissue secreting venom. Don't stand on these rays, for they can strike rapidly. The wounds are intensely painful and have cuased death in rare cases. Some large stingrays come into shallow water to feed at night, so wading carelessly in the dark is not recommended.

Many of the scorpion fish, Scorpaenidae, have strong that can give a painful wound, but the aptly named fire fish or butterfly cod, Pterois, is more dangerous, and the long and

colourful fins have very venomous spines. Stabs from this fish are extremely painful, and can be fatal.

The stonefish, Synaciidae, belong to a family closely allied to the scorpion fish, but have a more elaborate and visious defensive mechanism. The 13 dorsal spines are sharp, sturdy and grooved on each side, and each spine has a pair of poison sacs containing a venom so strong that the pain can drive a victim insane. This is followed by numbness, and sometimes death. The stonefish is well camouglaged, looking very much like a weed-covered stone. The best defence is care when walking in the shallows and the wearing of shoes with strong soles.

Much less dangerous are rabbit fish, Siganus, catfish of the family Plotosidae, and surgeonfish, Acanthuridae. The rabbit fish have strong dorsal spines with a venomous coating and a sting can be painful. Ironically, the fish have been called 'happy mements'! The catfish also have poisonous pectoral spines and spines in the dorsal fins. Surgeonfish have a sharp scalpel on each side of the tail base, movable in some species, large and fixed in others. They should be handled with care.

A number of small blennies found on the reef have large canine teeth and will use them if handled. The sabre-toothed blenny, Plagiotremus, is only a few centimetres long, but has two very long canines in the lower jaw which have grooves that carry venom. A bite can be painful.

Rare or Reluctant Biters

Many fishes with normally peaceful dispositions, at least towards man, will bite when provoked, cornered or hurt. Moray eels and barracudas have large, razor-sharp teeth. Although they do not normally seem aggressive, they have both done severe damage to divers who have speared them. In other parts of the world there are a few records of attacks by the great barracuda, Sphyraena barracuda. These are not usually considered to be deliberate attacks on humans, but probably a swift rush at something flashing in the water such as a watch or a thrashing arm, or a swimmer carrying a bleeding fish. Occasionally a

barracuda will follow a swimmer.

Small and normally harmless reef sharks can sometimes be picked up by hand; but they, too, may object and bite, and some have sharp teeth.

Sea snakes are most commonly seen by divers, not by the tourist. Though dangerous, they do not seem to be aggresive and they have twined around many divers who have gently extricated themselves without being bitten. They are said to be merely curious, but the best approach is to keep clear and not put them to the test!

Sharks

Most visitors to the reef will not be lucky enough to see a large shark, and the chances of being bitten are negligible for the sensible tourist or diver. However, after dusk the behaviour of many sharks changes, and an angler hooking a good-sized turrum in the fading light can have it viciously attacked by a hungry hammerhead, absolutely determined to get the fish away, and unafraid of torches, yelling anglers, or boats. Some sharks may also feed during the day, and it is advisable to swim in full sun, and in water with good visibility. One is more prone to meet sharks off steep drop-offs on outer reefs, and more care is needed in such places. It is not wise to carry bleeding fishes.

The tiger sharks, Galeocerdo cuvier, hammerheads, and some of the whaler sharks, Carcharinus, are known to have attacked humans and are found on the reef. The sharks that the visitor is more likely to see, however, are the black-tipped reef shar, Carcharinus **melanopterus** - a timid shallow-water shark- and the white-tipped reef shark, Triaenodon **obesus,** a territorial shark that is usually only a little over a metre long, common around many of the island reefs. Both of these sharks avoid humans. In very shallow water about the corals, and active at night, is the slim little epaulette shark, Hemiscyllium ocellatum, which will bite only if picked up out of the water, and then not very fiercely. The tassellated wobegone, Orectolobus **ogilbyi** is a harmless shark sometimes seen in pools

on the reef. It rarely swims away, relying on its camouflage, and is tempting to touch. Don't - it has fierce, long sharp teeth.

APPENDIX II

Studying Reef Animals in the Marine Aquarium

Aim

To observe the behaviour of reef animals by housing them in a marine aquarium.

Materials

Aquarium tank - a large glass or clear plastic trough may be used if this is not available.
Subgravel filter - this may be bought or constructed (Construction details are described in the method section)
Plastic buckets
Fine mesh hand nets
Electric air pump
Two air stones

Method

Setting up the Aquarium

Locate your aquarium in a position which receives between one and two hours of direct sunlight per day. This helps keep alive algae and animals with symbiotic algae. Since the filled aquarium will have a considerable weight, place it on a level, sturdy support. A piece of styrofoam is desirable to serve as a cushion under the tank.

The best filtration system is the simple subgravel filter using the aeration pump to circulate the water. If the filter cannot be bought, one can easily be made from PVC water pipe and plastic insect screening. The filter should be made big enough to cover the bottom of the aquarium. After placing the filter on the bottom of the tank, fill the aquarium with clear oceanic water. Lagoon water may be used but it often tends to be polluted or to be of low salinity.

Collect coarse coral sand (just before it is needed) from below the water level at a beach and keep it with sea water.

until it is added to the aquarium. This keeps the microorganisms in the sand alive and these are useful in the aquarium. Two to four inches of sand are sufficient. Place the vibrator pumb above the water level to prevent water accidently entering the pump. Connect the two air stones to the pump with plastic tubing and put one down each vertical pipe in the filter. When the pump is operating the rising air bubbles lift water up the pipes from under the sand. Thus water is drawn down through the sand is filtered of suspended particles. The microorganisms which live in the sand (particularly bacteria) help to break down or absorb the soluble waste in the water. Run the pump for one or two days before adding live specimens and in this time the water should become very clear.

Stocking the Aquarium

Any organisms from the reef can be tried in the aquarium but the following notes give some advice on maintaining your aquarium.

1. Hard and soft corals and sponges are generally difficult to keep regularly. It is even better to add concentrated plankton collected in a plankton net. When corals die the water in the aquarium goes a milky colour and your fish begin to die.
2. Keep a cover over the aquariuj to cut down evaporation of the water. Too much evaporation raises the salinity of the water to levels not suitable for reef organisms. To maintain the level in the aquarium add tap water which has been allowed to stand for a few minutes.
3. Do not overcrowd your aquarium. There is only a limited amount of oxygen in the water available to the aquarium inhabitants. Overcrowding of fish also leads to territorial aggression with the fish continuously pecking and biting each other.
4. Provide shelter for fish and crustaceans by adding rocks and bleached, dead coral skeletons. These provide hiding and

sleeping places for the inhabitants.

5. Bottom scavengers are desirable to clean up uneaten food. Small crabs, shrimps and hermit crabs are useful for this purpose. A small sand dwelling holothurian is also useful as it ingests your bottom sand, removes anything edible and ejects clean sand.

7. Many types of food can be tried in your aquarium. The best general purpose food for fish and invertebrates is finely chopped fish, prawn or bivalve. One easy method of obtaining small enough pieces is to freeze the food and then grate it on a vegetable grater. Other welcome additions to the diet are plankton, an algae-covered rock or mosquito larvae caught in a net. A small piece of live hard coral is desirable if you are trying to keep butterflyfish (chaetodons). Commercial dried food can be used as an additional food when available. Don't overfeed your fish as too much uneaten food may overstrain the capacity of the scavengers and decomposers to remove it.