

## HOW YOU CAN HELP

If divers at your resort see a large number of bleached corals (at the white stage before the alga grows on the coral) then let us know at Marine Research Section. **You should tell us the date the bleaching started, how severe you think it is and, if possible, note the water temperature around this period.** One good way of measuring the water temperature is at the intake to the desalination plant or in the pump room where the intake water is sampled. Somebody may already be taking these readings! In any case **let us know when, where, and at what depth, you recorded the water temperature.**

## STOP PRESS

As reported in the 'News from Resorts' the COT infestation on Ari Angaga appears to be over but has been followed by an infestation of Diadema sea-urchins. We asked John Benzie

of the Australian Institute of Marine Science to comment and provide advice on what to do.

- Q) *Is there any documentation to suggest that COT infestations are followed by an increase in Diadema?*
- A) *There have been several observations of Diadema increases following COT infestations. In Moorea, Mauritius (Terry Done, pers comm.), Japan, Great Barrier Reef (Peter Moran pers. comm.) and the Red Sea.*
- Q) *Is there any precedence to decide whether coral recruitment and reef recovery will be enhanced, or inhibited, by removal of the Urchin?*
- A) *There is evidence that high Diadema numbers depress coral recruitment rates (Sammarco 1980: J. Exp. Mar. Biol. Ecol. 45:245-272).*

In summary removing Diadema from Angaga house reef should assist the reef to recover from the COT infestation.

REG. No: 354

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## COT NEWS LETTER



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## EDITORIAL

### COT - ENVIRONMENTAL FLAG CARRIER

There is little doubt that we are trying to use COT plagues as a catalyst to create increased concern and awareness about the fragile nature of the marine environment. The coral devastation caused by a COT plague is all too evident at a resort like Ari Angaga, but of equal concern are what caused the plague in the first place, and whether the reef will recover. We pointed out, in the last newsletter, that Crown-Of-Thorns infestations have probably occurred on the Great Barrier Reef over the past several thousand years. Obviously these pre-historic infestations cannot have been due to human impacts. It follows from this that the fact that COT infestations occur today is not necessarily a sign of human interference and pollution. However, the rate, and extent, of recovery may be. Reefs have survived COT infestations in the past. The only way to ensure that they do so today is to protect the environment!

### PROTECTING THE ENVIRONMENT

How can we protect the environment? Well there are those who see no point in even trying to do something. They say that the Maldives will disappear under the sea in the next fifty years anyway. Some even suggest that the sea-temperature will rise by 2-3°C as a result of the greenhouse effect and corals will not be able to survive. Fortunately these people are in the minority in the Maldives!

For those who do have a concern for the future and for what they will be handing the next generation there are two fundamentally different philosophical approaches to coping with the consequences of human development. The two approaches are subject to very strong debate in the scientific community. The answer, as is so often the case, is a combination of both approaches.

### REACTIVE APPROACH

The first approach is to see what happens when you do something and then manage the situation accordingly. In other words 'react' to things once they occur. This approach is the one used for testing drugs and chemicals or setting the quality for drinking or bathing water. If the substance, or activity, is seen to be harmful then limit it to a level where it cannot cause harm.

### CAUTIONARY APPROACH

The second approach is to assume that any change is likely to do damage and so should not be allowed. This can be considered a 'cautionary' approach. This approach is, for example, used in nature reserves where you put a fence round the area and allow the 'natural' process to continue undisturbed.

### ACHIEVING THE RIGHT BALANCE

So where is this balance to be achieved in the Maldives? Well, each case has to be considered on its own merits. Not allowing coral collecting and spearfishing, except for research, is cautionary and appropriate. Throwing pollutants onto the reefs and seeing whether the reefs are affected is reactive and inappropriate. We simply do not know enough about the effects of human activities on coral reefs to allow them to be damaged.

### THE DEVELOPMENT DILEMMA

When development needs arise - for example using coral for building materials - there is a real dilemma and a need for compromise. All non-coral derived building materials have to be imported to Maldives so, at first sight, the choice would appear to be between destroying reefs or spending valuable foreign exchange revenues on imported aggregate. On second sight compromise is possible. The cautionary approach requires that coral be collected from the least sensitive areas well away from islands. Use of alternative sources of building materials like lagoon sand, quarried coral, and imported aggregate are encouraged. The reactive approach is to see

whether the mined reefs recover and, indeed, how that recovery can be enhanced.

Government of Maldives is following both approaches. There is a project underway to look at the feasibility of mining a single complete ring-reef (faro) in south Male' atoll to meet all building material needs for North and South Male' for the next twenty-five years. The idea is that only a small area of living coral will be destroyed using this method. In the existing method much of the coral is live and is stripped from the surface of the reef over much larger areas.

In addition a project will start shortly to look at how reefs recover following coral mining and how the rate of recovery can be enhanced.

## WHAT ARE COT

Some readers of the first COT newsletter have expressed an interest in learning a bit more about these starfish.

### THE ADULT

The Crown-Of-Thorns starfish, locally called "Kashi Boa" (thorn head) has 15-18 arms. The adult starfish normally ranges in size from 25-35 cm. The upper surface has hundreds of extremely sharp spines reaching a length of between 3 and 5 cm. These spines are sharp and are known to produce a severe toxic reaction in some humans. The underside of the starfish has hundreds of tube feet starting from the mouth in the centre and running in pairs to the tip of each arm. The tube feet are used for moving, feeding, holding, and sensing.

When feeding, the Crown-Of-Thorns starfish everts its stomach through its mouth. The everted stomach then spreads-out over the coral surface. Digestive enzymes are then secreted which break down the tissue of the coral so that it can be absorbed by the stomach.

### REPRODUCTION

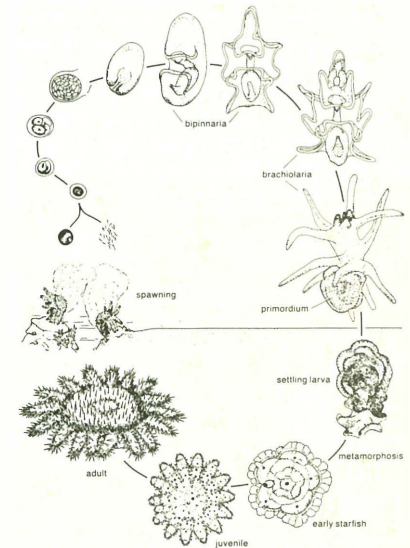
A Crown-Of-Thorns starfish is either male or female. The starfish reach maturity and

start to spawn at about the end of their second year of life. The eggs and sperm are released into the water column where fertilisation takes place. To synchronise the release of eggs and sperm the starfish secrete a chemical which induces nearby starfish to spawn. It is said that one adult starfish releases millions of eggs.

### TIME IN THE PLANKTON

The fertilised eggs do not immediately land on coral reefs but spend several weeks floating about in the plankton. They are only 0.2mm in diameter at this stage and hatch after about a day to produce a tiny transparent bag which gradually develops into a tiny bipinnaria larva (fig. 1) and looks nothing like an

Fig- 1 LIFE CYCLE OF COT



adult starfish. It consists of a simple gut and some bands of beating hairs called cilia which it uses for swimming and feeding. It takes the larva several weeks to develop to the next stage called the brachiolaria larval stage. At this point the embryonic starfish has two distinct parts. The front part resembles the bipinnaria stage and the back part starts to look like a starfish. The larva settles-out of the plankton onto the reef at this stage. The back 'starfish' part of the larva absorbs the

front 'bipinnaria' stage in a couple of days and a minute Crown-of-Thorns is left.

### GROWING UP

At this stage the Crown-Of-Thorns starfish is tiny, less than half a millimetre in diameter and only has five arms. It is too small to feed on coral and feeds on algae. By six months old it has many more arms and is about a centimetre across.

### FEEDING ON CORAL

A Crown-Of-Thorns starts feeding on coral when it is about six months old. However, it is not until it is about two years old, about twenty centimetres across, and starts rapidly increasing the amount of coral that it eats, that it comes out into the open and is seen by divers. This gives divers the impression that it has suddenly appeared from nowhere whilst in actual fact it was there all the time!

### NEWS ABOUT FILMING BY WIF

Filming for the first episode of the series is well underway. A trip was made to Baa Atoll in the north of the archipelago to get film illustrating how sand spits are formed and are colonised by plants. A considerable effort was made to get a good quality sunrise. The hope is to edit it into a sequence with an erupting volcano and associated larval flow to symbolise the dawning of the Maldives out of the fiery inferno of erupting volcanoes. We hope to finish the first episode by the end of Ramadan.

Staff also visited the WIF media centre in Colombo. The Centre has sophisticated editing facilities that are not available in Maldives. Forty seconds of material were edited and compiled to produce the standard introduction to all twenty programs.

### NEWS FROM LOCAL ISLANDS

It can be seen from table 1 that all atolls have COT. Only 17% of islands reported no COT. COT were reported to be abundant around a surprising 26% of all local islands. This is in marked contrast to the situation reported from Resorts where no COT were seen at 81% of dive sites and COT were abundant at only 4% of dive sites (see last months' COT Newsletter).

Table 1  
Returns on COT observations made by local islands.

Atoll	No COT seen	Few COT seen	COT common	COT abundant	Total
Haa Alif	4	3	2	5	14
Haa Dhaalu	1	1	3	2	7
Shaviyani	2	1	4	3	10
Noonu	3	3	0	0	6
Raa	5	3	5	1	14
Baa	1	4	2	0	7
Lhaviyani	1	1	0	0	2
Kaafu	0	0	2	1	3
Alifu	2	1	2	5	10
Vaavu	0	1	0	1	2
Meemu	0	3	2	0	5
Faafu	0	2	1	0	3
Dhaalu	0	0	1	2	3
Thaa	0	2	4	5	11
Laamu	0	3	2	1	6
Gaaf Alif	0	1	1	0	2
Gaaf Dhaalu	0	2	0	3	5
Gnaviyani	0	0	1	0	1
Seenu	1	2	0	1	4
<b>Total</b>	<b>20</b>	<b>33</b>	<b>32</b>	<b>30</b>	<b>115</b>

It is our opinion that the information from Resorts is likely to be more reliable. We gained the impression that a number of local islands did not distinguish COT from other spiny sea-creatures like the sea-urchin. Not many locals regularly view the underwater world. This is in marked contrast to the situation on Resorts where a diving instructor may do three or more dives a day nearly every day!

For these reasons we feel that it is better to concentrate on Resort islands for observations on COT. At the same time it is important to increase public awareness about COT on local islands.

### SAND LIMITS

Fortunately, unless the sand has been taken from the beach, the sand that has eroded from the beach has not been lost over the reef edge but has merely moved elsewhere on the reef flat. The amount of sand making up an island in the Maldives is actually relatively small. Most of the islands of the Maldives consist of a 1-5m thick veneer of sand and coral rubble on a more solid coral bedrock. There is a report (ICOD INFO Vol. 1, No. 2 1988) that 'Scientific evidence suggests that the regeneration of the sand deposit (in a similar environment in Mauritius) is part of a 4,000 year cycle, making it virtually a non-renewable resource'. This means that loss of sand from islands must be a cause for serious concern.

### RESORT CONCERN

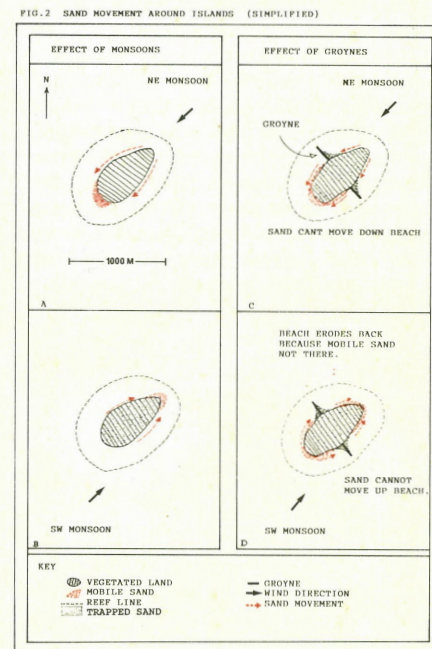
Most resort owners are well aware of the sensitive nature of their beaches. They know that the sand on the beaches is constantly moving in response to a variety of factors. These factors include wind, waves, and water currents, the state of the reef, and whether there are obstructions to sand movement on the beach. COTs obviously influence the state of the reef and the possible link between COT plagues and beach erosion will be discussed in next month's newsletter.

### THE MONSOONS

Two of the major factors determining the movement of beach sand are the north-west and south-east monsoons. In the north-west monsoon the sand moves to the south-eastern end of the island (fig. 2a) but, all being well, is brought back in the other monsoon (fig. 2b). However, periods of strong winds can increase this movement and perhaps to such a point that it will take years to move back. Fortunately hurricanes and typhoons are extremely rare in the Maldives. Hurricanes in parts of the Caribbean have caused damage to some beaches that may take centuries to recover.

### GROYNES - THE WRONG ANSWER

Faced with beach erosion the Maldivian resort owner may decide that the sand will never return and so, until recently, built



groynes to prevent further sand movement. Unfortunately whilst the groynes may have prevented more sand from moving away it also prevented it from moving back (fig. 2c,d)! Groynes also alter the wave regime on a beach so that, in some cases, sand may not be piled up to form a beach but wash back into the lagoon. Unfortunately, and to confuse the situation, the opposite sometimes happens.

However, on balance groynes are not a good idea and the Ministry of Tourism has recommended that solid groynes and jetties should not be built on tourist resorts.

### UNUSUAL WINDS

Is the erosion we have been observing due to a period of strong winds - to a natural phenomenon - or do we have to look further to find another reason? Well, this is where we need some feedback from you. Looking through the wind records collected and compiled by the Meteorology Department it is evident that December 1989 did have a period of relatively strong winds (table 2) and that

## NEWS FROM RESORTS

The COT team of Marine Research Section visited two resorts last month. They were Makunudu resort in North Male' Atoll and Angaga resort in Ari Atoll. We are extremely grateful for the hospitality shown us by both these resorts.

### MAKUNUDU

The visit to Makunudu was in response to Jean's report dated 4th February in last month's newsletter that *'the situation was very bad, crazy, with the starfish coming into the lagoon and even onto the beach....'* Representatives from MRS visited Makunudu on the 12th February. The situation was not as bad as expected but 28 COT were seen in an hour's snorkle which is much more than usual. MRS will continue to monitor the situation. The reef has been damaged by the COT plague but not devastated. Unfortunately this is not so on Ari Angaga.

### ANGAGA

Representatives from MRS visited Angaga Resort on 21st March. Marie, the diving instructor on Angaga, reports that the COT problem was bad when she arrived in October 1989. Since the resort had only just opened it seems unlikely that the COT plague would have been due to the construction of the resort. They have picked-up about a thousand COT from the reef. Numbers are now less and they pick-up about 5 a week. An hours snorkle around the reef showed that much of the reef flat is dead. The reef face had also been badly affected. However, no COT were seen. Instead the reef is infested with *Diadema* sea-urchin (see stop-press).

Fortunately Angaga resort can provide easy access to one of the most beautiful reefs to be found in the tourism atolls of the Maldives. The reef is around Hurusdhoo island which is uninhabited. Angaga management fully appreciate the value of this beautiful reef and island and have asked MRS to assist in making management recommendations to protect them.

## NAKATCHAFUSHI

We are sorry to report a deterioration of the COT situation around Nakatchafushi since the last newsletter was sent to press. We present a letter, dated 10th March, from Husain Rasheed, the manager.

*'In 1989 we collected lots of Crown-of-Thorns until the end of October and we observed a decrease in Crown-of-Thorns but again this year in January, we observed a large increase in Crown-Of-Thorns in the lagoon/reefs and near our diving spots.'*

*'In February, it became worse and early in the morning, we find many washed-up onto the beach.'*

*'From that day, we again started to collect these and to date we have collected a total amount of 5712 Crown-Of-Thorns and we are still trying to reduce the growing quantities.'*

*'We feel that all concerned should make efforts to reduce the growth of this reef-eating creature otherwise our underwater beauty will vanish leaving the reefs dead.'*

*'Since we are all concerned about our environment and especially the sea-level rise, our low lying islands will be affected. The only protection around our islands are the reefs.'*

*'We will keep you informed of the progress on the Crown-Of-Thorns and will do whatever possible to save our reefs from the Crown-of-Thorns.'*

Staff from MRS and WIF will visit Nakatchafushi in March and hope to report on the situation in the April newsletter.

## WINDS, WAVES AND BEACH EROSION

A large number of resort islands are reporting problems of beach erosion. This is not only a long-term problem if the island gets smaller but a short term one if the beach becomes undercut so there is nowhere to sunbathe.

these winds were particularly strong and sustained during the week of the 13th-19th (table 3).

TABLE - 2

Mean monthly wind-speed in knots (average all directions) and dominant wind direction from data for Hulule supplied by the Maldives Meteorology Department.

YEAR	DEC		JAN		FEB	
	DIRN	SPEED	DIRN	SPEED	DIRN	SPEED
1978-1979			ENE	12.0	ENE	7.9
1979-1980	E	7.9	ENE	9.8	NE	8.1
1980-1981	ENE	6.8	ENE	10.6	ENE	10.0
1981-1982	ENE	10.5	ENE	13.1	ENE	10.2
1982-1983	ENE	13.8	NE	14.1	NE	7.5
1983-1984	NE	11.1	NE	10.0	NE	10.3
1984-1985	NE	8.1	NE	11.9	NE	6.8
1985-1986	NE	10.9	ENE	8.6	NE	9.2
1986-1987	ENE	11.9	NE	11.8	ENE	10.0
1987-1988	W	8.6	NE	13.4	NE	8.5
1988-1989	ENE	11.3	ENE	11.3	ENE	9.6
1989-1990	ENE	13.6				

### HOW YOU CAN HELP

Did significant erosion occur on a resort you know during this period or not? In any case write and tell us whether you are having problems with beach erosion. It would be helpful to know:-

- 1 The length of your shoreline
- 2 The location and length of shoreline that is eroding and the direction it is facing.
- 3 The location and length of any shoreline that is building-up and the direction it is facing.

TABLE: 3

Daily and three hourly wind-speed in knots (average all directions) and dominant wind direction for December 13th-19th 1989 for Hulule supplied by the Maldives Meteorology Department.

DAY	WIND DIRECTION AND SPEED DAILY AND 3 HOURLY AVERAGE (UTC)									
	DAILY AVERAGE	3 HOURLY (DECEMBER 13-19 1989)								
		0000	0300	0600	0900	1200	1500	1800	2100	
13th	ENE 17	E 11	E 13	E 14	ENE 18	ENE 19	ENE 21	ENE 22	ENE 20	
14th	ENE 21	ENE 20	ENE 20	ENE 19	ENE 20	ENE 25	ENE 22	ENE 22	ENE 20	
15th	ENE 20	ENE 21	ENE 19	ENE 20	ENE 20	ENE 19	ENE 23	ENE 21	NE 17	
16th	ENE 18	NE 22	NE 27	ENE 20	E 13	ENE 07	ENE 15	E 15	E 27	
17th	E 15	E 20	ESE 20	ESE 15	NE 10	ENE 10	E 10	E 16	ENE 20	
18th	ENE 17	ENE 17	ENE 17	NE 19	NE 17	NE 18	ENE 18	ENE 15	ENE 15	
19th	ENE 16	ENE 13	ENE 17	ENE 15	E 11	ENE 18	ENE 20	ENE 20	NE 16	

## POST SCRIPT - CORAL BLEACHING

### REACTION TO STRESS

Hard and soft corals (and anemones) all bleach. The term 'bleaching' is used to describe the loss of coloured alga from the tissue of these animals leaving the flesh a white colour. Although the causes for this bleaching are not yet completely understood it is believed to be a reaction to stress. Extremes of temperature, and sudden changes in salinity, have been reported to cause bleaching.

### RECOVERY OR DEATH?

In some cases bleaching is followed by a gradual recovery of the normal green or brownish colour as the coral becomes repopulated with alga (zooxanthellae). This is essential to the survival of the coral because the alga provide a source of food. In cases of severe bleaching, however, the coral may die and then becomes overgrown by plants or invertebrates.

### SIGNIFICANCE OF THE PROBLEM

On any reef there will always be a few bleached corals at any given time. It is rare for lots of corals to bleach at one time and this should be reported. Mass bleaching events have been reported from the Caribbean and the Pacific and were observed in Maldives in May-June 1987.