Coral Recovery From Bleaching in Seychelles
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A study carried out on behalf of the Seychelles Marine Park Authority
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INTRODUCTION

Digital video transects were filmed at nine coral reef locations around Mahe in March 1997, and at 14 locations including additional sites in Curieuse, Coco, La Digue, and Cousin in May1998 as part of at he Seychelles Marine Park Authority Monitoring program. This report describes preliminary observations made at 16 locations, including most of the previous sites and some new ones during early December1998. The first series of videos recorded the condition of the coral reef prior to the impact of coral bleaching, the second recorded conditions during the intense coral bleaching event of early 1998, and the current observations record conditions in the aftermath of the event, allowing the first accurate estimates of overall mortality and survivorship and of the differences in them between habitats. Due to lack of time and bad weather it was unfortunately not possible to re-film the sites around Curieuse, Cousin, and La Digue, however some new sites were examined near Mahe, and additional sites in the Amirantes will be covered in a separate report. This report contains preliminary field notes, and much more detailed quantitative information on coral species abundance, survival, and mortality will be available after the digital videos are analyzed. All three series of observations will be contrasted in more detail in a longer study to be published in a forthcoming IUCN volume of bleaching studies from around the world to be edited by T. Goreau, T.McClanahan, andR. Ormond.

OBSERVATIONS BY SITE

These observations are preliminary field notes. All estimates of percentages and proportions given should be understood to be approximate, but in general they are probably accurate to within 10%.Much more accurate numbers will be forthcoming from detailed analysis of the video images recorded at each site. These images will also allow more complete and accurate listing of the corals present, their relative abundances, and their mortality and survival rates. Species lists will be greatly expanded from this preliminary report once these images are studied, but it is likely that the overall estimates and conclusions stated in this preliminary report will change only in a minor way.

1) BAIE TERNAY

Since May around three fourths of the corals which were bleached but still alive have died, and only roughly 5%of the corals survived, giving a mortality of around 95%. The many Acropora species which dominated the reef were entirely killed following the bleaching event: not a single live specimen was seen during the dive. The second most common branching genus, Pocillopora was also completely eliminated. The third most common species, large rounded heads of Porites up to 4 meters or more across, largely survived the bleaching event, although most of them lost major portions of their living tissue. The fourth most common genus, Lobophyllia, which formed exceptionally large colonies up to 10 meters or more across and perhaps up to a thousand years old, was entirely killed. The fifth most common genus, Diploastrea, which formed large colonies up to 4metres across, was killed over most of their surfaces, but small patches of tissue survived on most colonies. Of the less common coral genera at this location, only Goniopora showed high levels of survival. Smallresidual surviving fragments of three or four other genera were found, including Plerogyra, Pachyseris, and Montipora.

The green water conditions and high-level of filamentous algae overgrowth of dead coral seen in May had abated considerably in December, and it is likely that it was a temporary response to nutrients released from rotting coral tissue as this site is the most pristine reef near Mahe and free from land-derived pollution. While filamentous algae were still present in large amounts, they had sharply declined appeared to be dying back. Their decline is marked by an expansion of pink coralline encrusting red algae, which are now beginning to overgrow dead coral surfaces, in particular the dead Pocillopora skeletons. These limestone producing algae are the preferred substrate for settlement of young coral larvae, and so their expansion is creating suitable conditions for new coral settlement in the future. The problem is that the bleaching event has eliminated most of the rapidly colonizing and growing branching corals throughout the Indian Ocean, and so new recruits may be very scarce for some years to come. A further problem is the presence of two diseases attacking the calcareous red algae, Coralline Lethal Orange Disease (CLOD)and Coralline Algae Lethal Disease (CLD). However both of these seemed less abundant at this site in December than they had been in May. A further threat to the reef at Baie Ternay in 1997andearly 1998, an infestation of the Crown of Thorns starfish, has largely disappeared. While around 25-30 starfish were seen on each of the first two surveys, only one was seen in December. It appears that the death of their favored food species has caused the hungry starfish to migrate in search of more corals. It is to be hoped that the entire population will starve to death before they can do further damage to corals which might survive the event.

2) STE. ANNE SOUTH

Mortality of corals in the fringing reef along the southeast of Ste. Anne appears to have been around 90%. The large areas of Acropora which dominated the reef were almost totally eliminated, and only a single small (roughly 20 cm diameter)

living colony was found, apparently in perfect health. All the rest had died. The second most common genus, Pocillopora, was also almost entirely eliminated. Nolive Pocillopora were seen on the reef, but a handful of colonies survived on the vertical wall of the boat jetty, including one Pocillopora verrucosa and a few Pocillopora damicornis, along with a small Acropora, several small Stylophora, Goniastrea, and Porites.Large Stylophora mordax patches on the reef had been killed. Almost all the Porites and Goniopora massive colonies on the reef survived, although many suffered partial mortality. Survivor ship was very high in the rapidly growing branching species Porites rus, which is abundant at St. Annes but not found at Baie Ternay. However in contrast to the situation at Baie Ternay, many of the less common species showed partial survival. At least 10 genera which suffered considerable mortality showed either whole colonies which were fully recovered, or small fractions of colonies which survived. For example some colonies of Favia were fully recovered, some Echinopora survived unscathed although most died completely, a few polyps (roughly one in fifty to a hundred) of Lobophyllia survived in colonies which were largely killed, Diploastrea had much higher survival than at BaieTernay. As at Baie Ternay the coralline red algae, although more strongly affected by CLD (no CLOD was seen) are replacing filamentous algae on dead coral skeletons. Sargassum over growth of the reef was less abundant than on the previous two observations, but this might be a seasonal response due to the recent drought. Overall the conditions for recovery are improving in that new space is becoming available for coral settlement and a large quantity and variety of corals survived at this location than at Baie Ternary. However bleached corals do not reproduce because they lack energy for forming reproductive tissue, and many of them will not do so for a while because many species have a minimum size before reproducing, so small residual fragments of surviving colonies are unlikely to reproduce for a few years. In the experimental artificial reef project near the jetty, almost all the corals survived, in fact only one appeared to have died and around dozen were alive, with one colony having grown sufficiently to incorporate part of the structure within its skeleton.

3) YELLOW BUOY REEF, NORTH OF VICTORIA HARBOUR ENTRANCE

This reef was not filmed during the previous two surveys, so changes cannot be documented with the same level of confidence. This reef is important because it is north of the main harbor entrance, and lies near Victoria, and so is subjected to land based sources of turbidity and pollution. In addition it lies in an area that is due to be destroyed by dredging for land reclamation in the coming year.

This reef was absolutely remarkable for several reasons:

A) It had the highest live coral cover seen in Seychelles, around50% even though most of the branching corals were recently dead from bleaching. While almost all the Acropora and Pocillopora colonies in shallow water were dead, several live and healthy Acropora and Pocillopora colonies were seen. While some pale

residual bleached patches were seen on Porites, most colonies of other genera had recovered fully from bleaching. Although some totally dead colonies of head corals were seen, the majority were healthy and lacked even partial mortality. The exceptionally high survival from bleaching maybe due to the fact that this stressed habitat was primarily dominated by more stress resistant species (although the reef flat was dominated by sensitive Acropora species) or due to the high turbidity which may have protected the corals from the additional stress caused by highlight levels, so that muddy conditions may have allowed better survival from high temperature. Dead corals are largely covered with sediment and fine large filaments, and little Porolithon was seen, making the prospects for new coral settlement low.

B) This reef had an astonishingly high coral species diversity, with large colonies of genera which were rare at other sites (such as Plerogyra and Favia) and many genera which were not seen at any other site in Seychelles (such as Caulastrea, Cynarina, and Scolymia).

C) This reef had the highest diversity of invertebrates seen at any reef in the Seychelles, including lobsters, crinoids, and nudibranchs and high levels of gorgonians and clams. Fish abundance and diversity were also high.

This reef is of critical national conservation importance given its exceptionally high diversity, recovery from bleaching, and large number of intact large colonies. It needs to be fully protected so that it can serve to repopulate the damaged reefs around Mahe and the Ste. Anne Marine Park. If dredging takes place nearby this area should be thoroughly protected by multiple silt curtains around the dredged areas. It is already subjected to high sedimentation stress, and increases in turbidity caused by dredging would kill the deeper high diversity portions of the reef and prevent recovery of the damaged shallow areas. High turbidity and mud covering dead corals is likely to prevent new coral settlement, but may help corals because low light suppresses weedy algae growth. If the shallow reef areas which were dominated by Acropora do not recover, the new landfill will be unprotected against coastal erosion and the effects of rising sea level. Reef restoration projects in the Marine Park should attempt to transplant colonies of as many of the rare species found in this reef as possible as insurance that these species are not lost due direct or indirect impacts of dredging.

4) WEST STE. ANNE REEF

This reef was dominated by large colonies of Acropora growing between very large Porites heads. The Acropora were entirely killed with the exception of a single small colony, as were all Pocillopora.In contrast almost all the Porites survived, and because of their high abundance the overall survivorship of this reef approaches one half. Three species of Porites are abundant on this reef: large heads of Porites lutea up to 5 metres or more across, patches of the rapidly growing finely branching species Porites rus, and large clumps of the branching

speciesPorites cylindrica. All three species showed very high survivorship. However a major fraction of the large Porites lute heads are being attacked by Porites Line Disease. Most corals of this species are affected, although nearly half do not show signs of this disease. Corals affected range from having only small dead patches covering only a percent or less of their surface, through those which are half dead, up to huge colonies which have only very small patches, as little as 1%, surviving. This syndrome shows a characteristic dying discolored fringe of decaying tissue about a millimeter or two wide between normal tissue and dead areas which is not seen in corals which have had partial mortality from bleaching. The band can range in color from pink, white, grey, blue, or brown. The pathogens have not yet been identified, and it is not known if these different colors are responses of differently colored corals to the same disease or if they represent different pathogens. The coral probably dies back at around a centimeter a month, but more detailed estimates of its advance at this site will be made from comparison of video images of corals taken at different times. Observations by T. Goreau have found this disease occurring throughout the Indian and Pacific Oceans, but in most sites the disease is fairly rare. Colleagues from Sri Lanka and India are also reporting high levels of line disease attacking the large Porites heads which were the major survivors of the bleaching events there this year. However the West Ste. Anne reef has some of the highest incidence of this disease yet seen. While some huge colonies had been nearly completely killed by this disease, many more colonies showed signs that it was just starting since they were covered with up to hundreds of very small dead patches. Much more research needs to be done before the pathogen causing this disease can be identified, and only then can be see it can be stopped or slowed. No other species was seen to be affected by the line disease, including the Porites rus and Porites cylindrica colonies, which are likely to become the dominant species in this reef within a few years as the Porties lute dies back. While most corals of other genera had died from bleaching, over half a dozen genera were found with live specimens. These included one large Diploastrea which had completely recovered (it was fully bleached in May), but all the rest were small. They included Leptoria, Platygyra, Favia, Montipora, Herpolitha, Fungia, and othergenera.

Dead coral surfaces were entirely covered by a white layer of resuspended sediments trapped by a fine layer of filamentous algae about a millimeter high. Almost no encrusting red calcareous algae were seen. The fine algal layer was extensively grazed by large schools of parrotfish, surgeonfish, and rabbit fish, but intensive cropping seemed to have little impact on its abundance. Because algal turf covers all dead coral surfaces, there is little chance of new coral settlement at this site even if there were sufficient coral larvae present, unlike some other sites seen. This high level of fine algae may be due to the fact that this side of Ste. Anne faces Victoria, and may be affected by nutrient pollution from Mahe. An additional stress factor unique to this site is its proximity to the oil storage depot tanks on Ste. Anne. A large spill of oil recently took place during transshipment of oil to or from a ship.

5) NORTH MOYENNE

This site was almost entirely dominated by large colonies of Acropora, and colonies of other species were relatively rare and small. Mortality of Acropora was almost complete, and only three very small live colonies were found at the bottom of the reef, of species which were not among the dominant large species previously found. Overall coral mortality at this site was at least99%. A few Poriteslutea colonies survived, but many had partial mortality and most showed signs of line disease. A handful of small live Favites, Favia,and Montipora colonies were seen. A large clump of living Goniporawere found at one site at the bottomof the reef where it gives out into a sand plain and sea grass. The overall impression was of virtually total devastation from bleaching. Reef areas less than five feet deep were covered with dense mats of Trubinaria and Sargassum algae. Some recently dead coral was still covered with the fine brown filamentous algae mats seen in May, but most of it had become replaced by encrusting pink calcareous red algae, mostly Porolithon, but including at least three other genera. The encrusting red algae appear to be rapidly covering most of the dead coral, and so are providing the optimal substrate for new coral settlement. This is indicative of clean low nutrient waters, as these encrusting hard algae are quickly overgrown by filamentous algae or by large fleshy algae if nutrients are only slightly elevated. The abundance of these crusts at this site is probably due to its exposure to open ocean waters and the fact that this site is the most remote monitoring site in the Ste Anne Marine Park from Mahe. Two factors appear to limit Porolithon's complete spread over dead coral. The first is the exceptionally high abundance of territorial damsel fish on this reef, which defend patches of dead coral from herbivorous fish, allowing large patches, up to 3 metres or more across, of algae to develop. These areas of dense algae overgrowth on dead coral prevents the red encrusting algae from developing, and were far more common at this site than most others. One possible reason for the exceptional abundance of damsel fish at this site may be over fishing of their predators. The other factor limiting the spread of the encrusting red algae was the extremely high level of Coralline Lethal Disease, which was abundant everywhere, and had killed between a fifth and a third of the Porolithon crusts. Coralline Lethal Orange Disease was also seen, but was hundreds of times less common.

6) WEST CERF

This reef was nearly 100 percent dominated by large colonies of various Acropora species, except for mixed coral populations dominated by large Porites lutea heads on the deepest parts on the south and southwest sides. The Acropora were entirely killed, and not a single live colony was seen. Because of its dominance, overall mortality of corals on this reef was over 90%. The only live branching corals seen on the upper reef were three small colonies of Pocillopora damicorn is, the largest of which was 10 centimeters across and the other two about 5centimetres across. This species, which is highly stress tolerant, was not common in Seychelles, and the dominant Pocillopora species,

Pocilloporaverrucosa and the subdominant Pocilloporaeydouxi, were almost totally eliminated. In the mixed coral communities on the south and southwest of the reef survival was fairly high. Most of the Porites heads survived with all or most of their tissue intact, but less than a quarter of them show signs of disease.Of the less common coral species, few reach a large size except for some Diploastreas, and among these mortality was probably over half. However at least ten genera were found alive in these areas, either wholly intact or with only partial colony survival. These included Diploastrea, Montipora, Favia, Favites, other Favids, Leptoria, Platygyra, Leptoseris, Hydnophora, and other genera.

Dead corals at this site are almost entirely overgrown with dense algal turfs. There are large numbers of damsel fish, but algae turfs dominate most areas outside damsel fish territories. Only around 10 to20 percent of the dead coral was covered with Porolithon, and this was largely areas which had already been dead coral rubble prior to bleaching. Porolithon was extensively attacked by Coralline Lethal Disease, but no Coralline Lethal Orange Disease was seen. The high levels of algae cover will act to prevent new coral settlement, and is probably due to this reefs location in the Cerf Channel, through which much of the effluents from Victoria harbor are carried by tidal currents.

7) PROVIDENCE

This reef lies on the opposite side of Cerf Channel from the previous site, and is near to the dredged and reclaimed land sites along the coast of Mahe near the airport. The top of the this reef was largely covered by large Acropora colonies, with a significant amount of Pocillopora verrucosa. All were dead, and not a single live colony of either genus was seen. As a result overall mortality on this reef is probably above 90%. Along the western (Mahe facing side) of the reef other coral genera predominated including Porites lobata heads-up to 2 metres across mixed in with corals of many other genera. These largely survived, and signs of line disease were not common. Although probably around half of then on branching corals died, survival was quite high, and whole or partially surviving colonies of around dozen genera were seen, dominated by Goniastrea, but also including Poritesrus (small patches only), Diploastrea, Goniopora, Favia,Favites,Echinopora, Oxypora, Montipora, Fungia, and other genera. While around a third of the dead coral was covered by algal turfs which were heavily grazed by Parrotfish, Surgeonfish, and Rabbitfish, most of the dead coral was covered with encrusting coral line algae, although around a fifth of this had been killed by Coralline Lethal Disease. Coralline Lethal Orange Disease was not seen. The much lower algae cover and higher Coralline algae cover on the Mahe side of the Channel than on the Cerf side was very surprising. Presumably higher currents are reducing the amount of sediment settling on the reef and preventing build up of nutrients. Detailed studies of current and circulation patterns need to be done to understand the distribution of sediments and nutrients in the area.

Interviews with fishermen and boatmen should be also conducted to document average and anomalous circulation patterns.

8) TREE POINT

This reef lies north of the previous site, and is much closer to Victoria Harbor and to the dredged landfill areas. The shallow portions of the reef were composed of a mixture of Acropora colonies and Porites lutea heads up to 3 metres across, with smaller mixtures of Goniastrea, Pocillopora, and other species. All Acropora and Pocillopora appear to have been killed, and none were found alive. Most of the Porites survived intact, as did many of the Goniastrea. However many large completely dead Porites heads were also seen, possibly the victims of line disease. The steeply sloping eastern reef face is dominated by large Porites heads, up to 4 or 5metres across, mixed with large amounts of Galaxea, and a very diverse community of other coral genera. Most of the large Porites heads survived, although many show partial mortality. Disease was not common. Mortality varied greatly among different coral types. High survival was seen in Goniastrea, Favia, Favites, Montastrea, Montipora, Hydnophora, and other genera, while equivalent proportions of Diploastreas, Fungias, Echinopora, Oxypora, and other genera were found to be alive or dead. Most of the Galaxea were killed, especially the large colonies, but a few small ones were found alive. Some corals suffered very high mortalities, but had a few small patches of tissue surviving, including Lobophyllia and Leptoseris. In contrast all colonies of Pachyseris, Pocillopora, and Acropora seen had been killed. Overall mortality was probably around 60%.

Dead coral surfaces at this site are not recovering to a condition which would allow new coral settlement. Shallow dead coral is entirely covered by algal turf, and the deeper dead corals are entirely covered by sediment. Almost no encrusting red algae were seen. The cause of the extremely high sediment damage to corals and the larger amounts of algal turf are probably related to this site’s proximity to the Harbour and to the dredging areas.

9) POINT CONAN

This reef is located off the radio towers north of Victoria in a location which is due to be affected by dredging. The shallow areas of this reef had been dominated by large thickets of Acropora mixed with much lower amounts of Pocillopora verrucosa and a few small head corals, mostly Goniastrea, favids, Astreopora, and Leptoria, occupying less than 5% of the area. The Acropora and Pocillopora were entirely killed, but a bit more than half of the head corals seem to have survived. The slope areas of the reef were different from the sites to the south in having only a few Porites heads, and having a much more evenly mixed coral community, distinguished by large patches of the very finely branching coral Seriatopora hystrix along the mid slope and large sheet colonies of Echinopora and Pachyseris at the base of the slope, mixed with large Diploastrea and

Lobophyllia colonies, and many other less common species. Seriatopora and Pachyseris appeared to have been completely eliminated, only a hand full of polyps survived in a few of the large Lobophyllias, Diploastreaslargely survived but many suffered extensive mortality over part or almost all of their surfaces and some were still pale and partly bleached. Other corals showed strong or partial recovery and at least a dozen genera were found alive, including those reported previously at other sites such as Favia, Favites, Hydnophora,Porites,Montipora, Herpolitha, Fungia, Goniastrea, etc.

Dead coral surfaces in deeper water were entirely covered with a layer of white sediment, and it appeared that many bleached corals had succumbed to sedimentation stress. Areas shallower than around 15 feet were in the zone of breaking waves coming from the North, and these areas appear to be swept clean of sediments (which are dumped on the deep reef). These areas on the seaward fringe were largely covered by Porolithon calcareous crusts, setting the stage of potential coral settlement. However it was being attacked by Coralline Lethal Disease which had killed perhaps a fifth of the Porolithon. Coralline Lethal Orange Disease was not present. The Porolithon dominated dead coral and rubble area contains large patches of algae turf, much of which is in damselfish territories. On the reef top the dead Acropora is almost entirely covered by algal turf with calcareous algae confined to deeper crevices and areas of old rubble. In water less than 5feetthe reef crest is covered by the tough brown alga Turbinaria. Overall probably between 90 and 95% of the corals died after bleaching and only small parts of it have clean substrate on which new settlement could take place, with algae or mud covering most portions.

10) STE. ANNE PIPELINE

The pipeline at Ste. Anne was used as a transect line by filming from the floating offshore terminal pumping site to inshore areas. This reef is dominated by small Porites heads typically around a metre across, with minor amounts of Acropora and Pocillopora. While the Acropora and Pocillopora on the reef crest were all seen to be dead, most of the Porites survived, and because of its dominance overall mortality was probably only around 40%. Porites disease was not very abundant. Dead coral was mostly covered with algal turf. Along the pipeline itself at least three quarters or more of the corals had died. These were corals no larger than around 30-40 centimetres across which had settled on portions of the pipe overgrown by calcareous encrusting red algae. The dead coral community had been dominated by Pocillopora verrucosa and small Acroporas. Along the entire length of the pipe a few colonies were found alive, mostly small colonies on the underside. These included one small Acropora colony, two small Pocillopora damicornis colonies, about 8 small Stylophoramordax colonies, and a similar number of encrusting colonies of Montipora and Goniastrea.

11) SNORKEL TRAIL, ILE RONDE

Reefs around the snorkel trail were largely composed of Acropora with much smaller amounts of Pocillopora. Both were entirely dead. The reef was also distinguished by huge colonies of Pavona varians and of Favia stelligera, up to 5 metres across. These were also entirely killed. Porites heads of modest size largely survived, as did a few of the rarer corals including Favids. Overall mortality on this reef was between 95 and 99%, probably closer to the high end. Portions of the reef more shallow than 5 feet are overgrown with dense growth of the brown alga Sargassum. Dead coral in deeper portions are largely overgrown by algae turf. Coralline red encrusting algae are overgrowing some parts of the dead corals, but they are being affected by Coralline Algae Lethal Disease.

This reef is now almost totally dead except for a few small Porites heads, and offers no significant attractions to tourists at this time. It might be worth removing snorkeling activities from this area and moving them to the areas on the north and west of Cerf, which are dominated by large Porites heads, most of which are alive. Tourists expecting to see a live vibrant reef on the current snorkel trail will be very disappointed unless they are too inexperienced to know what to expect. More knowledgeable snorkelers will demand better conditions, and the reputation of the Seychelles and Marine Park ecotourism experience would be best served by moving the snorkel trail to an area with more live coral.

12) EAST STE. ANNE

These areas are steeply plunging granite rock surfaces which have only very sparse coral growth. The overwhelming majority of the corals on the rock were composed of Pocillopora verrucosa, but not one of these was found alive. A few live corals were seen, which were all small, flat, and low encrusting forms of Goniopora, Montipora, and Porites. Although coral cover was never above a few percent, from 95to 99% of these were dead. The virtual lack of coral colonization on granite rock surfaces in contrast to limestone rock is extremely dramatic. Encrusting coralline red calcareous algae also appear to avoid colonizing granite, which may be why coral settlement is so poor. The extremely small amount of coral growth on rocks which have been submerged for over five thousand years is not due to its igneous rock nature. Basalt lava flows in Indonesia are completely covered over with corals within a few years. The barren nature of the granite rock surfaces may be due to their relatively acidic nature and lack of base, in contrast to basalt. Even concrete, which is an inferior substrate to limestone, is far more favorable than granite. Concrete is also basic, and the concrete structures at the jetty are overgrown with calcareous encrusting red algae (although strongly affected by Coralline Algae Lethal Disease) and the density of corals which have settled on concrete is greater in a few years than on granite in a few thousand years. When one swims past the end of the island towards the southwest a fringing reef appears in the first bay. The corals on this reef were virtually entirely killed, with mortality perhaps close to 99%, and the dead coral is overgrown by Sargassum. Neither area appears likely to be able to recover a reef community soon.

13) EAST MOYENNE

The open ocean facing side of Moyenne was regarded as having the highest coral cover in the Marine Park, full of brightly coloured Acropora colonies covering the entire bottom, except for a few Pocillopora colonies. All of them were found to be dead. During 17minutes of filming only two live corals were found, a small Porites head less than 50 centimeters across, and a patch ofPorites rus about2 metres across. Overall mortality is therefore in excess of 99%. Dead coral surfaces are largely overgrown by encrusting calcareous red algae, but these are heavily affected by Coralline Algae Lethal Disease. No Coralline Lethal Orange Disease was seen. Parts of the dead coral are covered by algae turf, largely in damsel fish territories. An exception is that the large dead table Acroporas and Elkhorn Acroporas are still largely algae turf covered, while the staghorn Acroporas, corymbose Acroporas, and Pocilloporas are largely covered with pink Porolithon crusts. This may reflect the nature of the surface of these species, and perhaps following death the initial fuzzy algae overgrowth seen on all dead corals in May is slower to be replaced by Porolithon on these corals. Hopefully they will eventually also make the same transition. The East Moyenne reef has been totally devastated by bleaching, but the dead coral surface is recovering to a status suitable for coral settlement, if any larvae of the dead species were available.

14) VICTORIA CHANNEL LIGHTHOUSE REEF

This reef lies directly in front of the lighthouse marking the ship channel to the Port of Victoria, and is therefore perhaps subjected to the worst pollution and turbidity of any reef in Seychelles. Despiteits severely stressed condition, this reef proved to be one of the healthiest remaining reefs seen with overall mortality probably around50%. The slopes of this reef are dominated by very large Porites heads, up to 5 metres or more across, and most survived bleaching. Many however suffered partial mortality, and a large fraction of the surviving corals are being attacked by Porites line disease, which appears to have completely or nearly completely killed many large heads. Another characteristic feature of this reef was the extremely high amount of Galaxea, forming colonies up to 4 metres across, and found in all areas from deep slopes to the top of the crest. Most of the Galaxea on the slopes were killed, but a higher proportion of those in shallow water survived. Shallow reef areas were dominated by Acropora, mixed with Galaxea, Pocillopora, Porites, and other species, primarily Goniastrea. No live Pocillopora were seen, and only one very small live Acropora was found on the deep part of the slope, but this was not of a species which had been common in shallow water, which were entirely killed. Along theslope many live and healthy coloured corals were found, including Goniastrea, Favia, Favites, Hydnophora, Psammocora, Montipora, Goniopora,and other species. Mixed populations of colonies individually showing both high and low tissue survival were found in Diploastrea, Astreopora, and Montipora. Low levels of survival were found in

Fungia, Plerogyra, Echinopora and other species. Large Pachyseris colonies were all killed.

Dead corals in deeper water were entirely covered in sediment, and in shallow water algal turf covered them. Pink encrusting coralline algae crusts were almost entirely absent. Therefore despite the high survival and diversity of this reef, the prospects of new coral settlement are not good.

15) AVE MARIA

Ave Maria is a granite rock between Praslin and La Digue. The granite rock surface was sparsely covered with corals, which covered only around 10% or less of the rock, and was almost entirely made up of Pocillopora verrucosa. Some Acropora colonies were found in shallow water, and Porites heads in deeper water. No live Pocillopora were seen. Only one small live Acropora was found. A bit more than half of the Porites had survived, but many were dead, and many of those alive had lost part of their tissue and the majority of the surviving corals were affected by Porites line disease. A few live colonies of Favia, Favites, Echinopora, and other genera were found. Overall mortality was in excess of 90%. While some dead Pocillopora were largely overgrown by Porolithon, this was scarce on the granite or on other dead corals, and most of the dead coral were covered by algal turf, much of it in damselfish territories. Consequently the prospects for recovery at this site do not seem to be very good. Two Acanthaster planci, the coral-eating crown of thorns starfish, were seen, more than at any other site in the Seychelles during this period.

16) COCO

The reefs at Coco were regarded as the finest reefs in the Seychelles. While waters deeper than 5 metres had only sparse cover by Pocillopora and a few small Porites heads, shallower areas were covered with extremely dense and large colonies of many different Acropora species, with a few Pocilloporaverrucosa on deeper fringes. No live Acropora or Pocillopora were seen. While around half of the Porites in deeper water had survived, many were affected by Poritesline disease, and several were being eaten by dense swarms of the coral eating snail Drupella. This normally feeds on Acropora, but as none remained it appears to be transferring it’s attention to the few remaining Porites. Overall mortality at this site was well over99%, perhaps even closer to 99.9% due to the total mortality of all of the Acropora and Pocillopora which dominated shallow and deeper portions respectively. The only live corals seen in the shallow reef were a few partly alive small Porites heads, a half dead Goniastrea, and a large colony of the plate coral Echinopora lamellosa, up to 8to10 metres across. While this had suffered considerably mortality, most of it was alive and healthy. Dead coral was almost entirely algae overgrown, by dense fine filamentous algae turfs, by large green tufts of Bryposis around 10 cm long in shallow water, by branching red fleshy algae and the calcareous red branching alga Jania in

crevices and holes where herbivorous fish could not easily reach them, and by a brownish red algae similar in appearance to Centroceras clavulatum, but lacking its characteristic tips. Only small areas of Porolithon covered dead coral were found, and this was almost entirely on old dead coral rubble which had been killed by storms or anchor damage before the bleaching event. The Porolithon was being extensively attacked by both Coralline Lethal Orange Disease and by Coralline Algae Lethal Disease. The very high amounts of fleshy algae makes the prospects for recovery very poor. Almost all of the recently dead coral is still standing and intact, and it still provides shelter for abundant populations of herbivorous surgeonfish, parrotfish, damselfish, and planktonic fish like Anthias and fusiliers. The herbivorous fish did not eat the abundant Bryopsis, and appear to focus on the fine filamentous algal turf, much of which lays in territories protected by abundant damselfish. The excessive number of damselfish may be related to the low amounts of piscivorous fish such as jacks and groupers, and will act to retard reef recovery. As the dead coral gradually breaks up, the shelter for most reef fish will disappear, but if the algae dominance remains, the herbivorous fish may be able to survive. Although this site still has spectacular fish populations, this will undoubtedly change since virtually all the corals are dead. The fact that what was the most spectacular coral reef in Seychelles is now a grave yard makes this site a priority for reef restoration efforts, but the predominant coral species in the past may now be extinct or nearly so throughout the Indian Ocean, so it is not clear where they can be transplanted from. The Red Sea maybe the near extinction.

CONCLUSIONS AND RECOMMENDATIONS

Overall coral mortality from the bleaching event was found to be considerably higher than estimated in May, since most of the corals which were still alive and bleached at that time subsequently died. Mortality was almost complete in the dominant Acroporas and the subdominant Pocilloporas. Survival was highest in the Porites species, and intermediate in the other less common genera. Overall mortality rates were probably close to 90%. The major surviving species, the large Porites head corals which dominate muddy habitats, are being attacked by diseases which are slowly killing many of them, and which appear to be spreading rapidly. As a result there will be dramatic changes not only in live coral cover, but also in species composition of Seychelles reefs. The fastest growing species, which also provide the best habitat for reef fishes, are the first to normally colonize new empty space, and which are the most important for absorbing wave energy in shallow reefs, have been almost entirely eliminated. This will eventually but inevitably have dramatic, but not immediate, impacts on fisheries, shore protection, and biodiversity. If such corals die as the result of cyclones, ship groundings, or dredging, they are usually rapidly recruited from surround undamaged areas, but this is not a likely consequence of this year’s bleaching event. Since these corals were also virtually eliminated through almost all of the Indian Ocean, these species will not be able to come back for many years. Corals which did survive will probably not be able to reproduce for at least

a year, as they recover from the effects of bleaching. Even if new coral larvae were available, they will not be able to colonize areas which have excessive algae, such as many of the reefs affected by currents transporting land-based sources of sediment and pollution from Mahe. These are unlikely to recover unless water quality is improved by reducing inputs of nutrients, sediments, oil, and organic pollutants such as sewage and cannery wastes. Because the cleanest water sites which were most dominated by the branching corals have had the highest mortalities, the conservation priorities of Seychelles reefs have entirely reversed. The highest diversity and highest coral cover reefs are now found in the areas which are closest to human impact, and which are likely to further damaged by proposed dredging and land filling activities. These reefs now critically need to be protected from such stresses if they are to help reseed the damaged areas further away, and they should be placed under much stronger protection as they lie outside of the current marine park boundaries. A further concern is the diseases which are attacking the encrusting red calcareous algae on which young corals prefer to settle. And of course, unless global warming is controlled, bleaching events will eventually recur with increasing intensity and frequency.

The most important steps which need to be made at this time are:

a) to strengthen the capacity of the Seychelles Marine Park Authority to continue the ongoing video monitoring program and to extend it to more sites,

b) to document growth rates and species composition of surviving corals and any new coral recruits,

c) to document changes in water quality, especially temperature, salinity, oxygen, chlorophyll, and nutrients,

d) to develop a large scale reef restoration programme and establish coral nurseries using new technology to speed up the growth of corals, especially species which have become rare following the bleaching event,

e) to halt all practices in the water and in adjacent water sheds which adversely impact corals, including treating sewage, reforesting watersheds, preventing negative impacts of dredging, banning sale of corals and reef organisms, and controlling pollution,

f) to support strong international measures to halt global climate change.

Proposals to implement all of these steps are being prepared by the Seychelles Marine Park Authority.

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