CORAL REEFS

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Coral Diseases

An updated version of an article by James Cervino and Garriet Smith published in *Ocean Realm* in Spring 1997

By James M. Cervino,
Global Coral Reef Alliance

Last year it was reported that a new, devastating disease called Rapid Wasting Disease (RWD) killed corals at rates as high as 7.5 centimeters of tissue in 24 hours. Recent research has shown that this is the result of two different syndromes, we term parrotfish white spot biting (PWSB) and rapid wasting syndrome (RWS).These are now been identified across the greater Caribbean.

Massive reef-building corals such as *Montastraea annularis*, and *Colpophyllia natans*, appear to be stripped of living tissue from the coral head surface by the stoplight parrotfish, *Sparisoma virde*. Microscopic examinations of affected samples conducted by Drs. Ray Hayes of Howard University, and Garriet Smith of University of South Carolina reveal the presence of a filamentous fungus damaging the internal cell structure of the coral.

RWS was first seen in late 1996 by Kalli DeMeyer, the director of the Marine Park in Bonaire and by Dr. Rolf Bak, of the Netherlands Institute for Sea Research. In January 1997, Marine Biologist James Cervino, and Dr. Thomas Goreau of the Global Coral Reef Alliance, examined and identified this to be a new disease affecting two of the major reef builders in the Caribbean based on the microscopic examinations, along with this unusual physical damage. It is important to understand what is occurring on the microscopic level rather than relying only on visual as some scientists do. Humans are infected with HIV long before external visible symptoms appear. Recent research shows an extensive spread of fungal infected coral tissue. Parrotfish seem to be attracted to fungal infected tissue. The cause of the dramatic increase in fungal infection and PWSB is a subject of intensive investigation. Long term observations show a dramatic increase in PWSB which appears to have leveled off in many places.

RWS and PWSB looks as someone poured acid over the tops of the coral heads. The bright white skeleton remains completely intact, but with no living tissue surviving. On *Colpophyllia natans*, it occurs around the rim and on a few areas throughout the coral structure. During the beginning stages of RWS corals show signs of discoloration or loss of pigment in the polyp tissue, measurements show the repeated biting from the fish progresses up to one to two inches per day, and in some cases as high as 17 inchs.There is a sharp boundary between the eroded skeleton and live tissue. Algae quickly overgrow the skeleton. Therefore when one sees skeleton, it indicates the recent occurrence of RWS and PWSB. Sometimes the fungus resides on the coral that has just been bitten by S. Virde, which explains why the two syndromes were originally thought to be one disease. Our data show that RWS and PWSB occur at depths of less than 80 feet. The good news is, the corals if not completely damaged by the parrot fish can recover, however, some corals as old as 100 years have been wiped out by the combination of RWS and PWSB.

YELLOW BAND DISEASE

Another disease affecting the same species across the Caribbean is Yellow Band disease. First recognized in 1995 by Creig Quirolo of Reef Relief and Dr. Jim Porter. YB, RWS and PWSB can be seen on the same colony. Yellow Band is slow-acting according to measurements made by Ivan Nagelkerken in Curacao, and is characterized by round, yellow rings on the sides of the coral. In the early stages, the disease shows itself with clear rings (bands), which develop into yellow blotches (and rings) that are stationed around dead patches of coral covered by filamentous algae and sediment. Recent studies by Cervino, and Getajanc show the loss of pigmentation of symbiotic algae (zooxanthellae) that live in the yellow band affected tissue.

WHITE PLAGUE TYPE II

The only living reefs left in the United

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Coral Diseases

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States are also being wiped out by coral diseases, White Plague Type II being one of the most devastating. This disease was discovered in the Florida Keys by Dr. Laurie Richardson and Dr. Steven Miller in 1995, affecting 18 different species of corals and the fire coral *Millipora alcicornis*. It has also been seen on non-acroporid corals including *Dichocoenia, Dendrogyra, Stephanocoenia* and *Montastraea*. Bacteria of the genus *Sphingomonas* have been identified as the pathogen causing White Plague. Localized populations of *Dichocenia stokesi*, the species most affected, revealed up to 38% mortality. Many colonies exhibited complete tissue loss within days as the disease moved across colonies at rates of up to 2 cm per 24 hr. This initiated at the base of the colony and moved upward.

BLACK BAND DISEASE
Black Band Disease (BBD) effects hard corals, fire corals, gorgonians, and has also been seen on *acroporids* on the Great Barrier Reef. This disease is slow acting characterized by a black mat ring a few mm to cm wide on the surface of the coral tissue, moving across the surface of the skeleton, leaving the bare skeleton. The unaffected coral tissue appears normal in color, morphology, and behavior. Dr. Laurie Richardson and Debbie Santavy of the federal Environmental Protection Agency have found that BBD is caused by a consortia of bacteria. These bacteria include sulfur-reducers, a cyanobacte-rium, and other bacteria which resemble a microbial mat.

WHITE BAND DISEASE TYPES I AND II
White Band Disease (Type I) is also slow acting, only affecting *Acroporid* species of coral. First seen in the Caribbean, it has now been reported from reefs around the world. With Type I, coral tissue peels off slowly, with a white bands found at the base and middle of the coral. Dr. Esther Peters found bacterial aggregates present in Type I WBD. Type II White Band Disease often progresses very quickly, with greater speed than Type I. The disease moves up to 9 centimeters per day, according to descriptions by Kim Ritchie and Garriet Smith. A bacterium, similar to one previously the progression of Types I and II, the two types can sometimes appear very similar.

DARK SPOT DISEASE
Dark spot disease affects *Siderastrea siderea, Stephanocenia sp.* and *Montastraea sp*. and has been increasing in frequency in the past four years. First described by Dr. Jaime Garzon-Ferreira in Colombia, it is now found across the Caribbean. (Garzon-Ferreira, 1996; Cervino, Goreau field observations, 1997). The disease starts as a small dark depressed dark spot which expands with tissue dying in the center and turn into expanding rings and blotches. This disease is so widespread that many inexperienced observers think that this is a normal condition.

Black Band Disease Esther C. Peters photo

ASPERGILLOSIS
The New Sea Fan Disease - Diseases afflict other organisms under water, not solely corals. Extensive stands of sea fans have suffered mass mortalities due to Gorgonian diseases, for example. Ivan Nagelkerken of Curacao, Netherlands Antilles, recently reported that sea fan disease is widespread throughout the Caribbean. The cause is a species of the fungus *Aspergillus*, according to Kim Ritchie and Garriet Smith. The sea fans' response to infection is being studied by Dr. Drew Harvell and Dr. Kiho Kim, both of Cornell University. They suspect this pathogen affects other Gorgonians as well.

Conclusion: Many other diseases have been observed but not described, and the causes have not been identified. Corals may be stressed by disturbances such as increased sedimentation from deforestation, changes in climate cycles (such as El Niño) and other polluting activities. If the coral animal is more stressed, it is more susceptible to diseases. More research is needed to determine the cause of these diseases through observation, field experiments, and lab analysis of tissue. In the lab, researchers can attempt to culture and identify any possible disease-causing microorganisms. To determine the diseases' rates of spread, regular photographic and video monitoring of reefs is needed on select coral heads. This will also be helpful toward detecting changes in the abundance of diseases.

Divers can play an important part in helping scientists documenting reef diseases. A color underwater disease card is available from the association of Marine Labs of the Caribbean and the Global Coral Reef Alliance. More detailed information is also available in a special issue of the *Rivista Biologia Tropical of Coral Diseases*, the proceedings of a symposium held last year in Cosat Rica.

Over one hundred photos of coral diseases, maps of the distribution of coral diseases and bleaching, and a reporting form that allows divers to report to a global database is available through the Global Coral Reef Alliance website at http://www.fas.harvard.edu/~goreau

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Coral disease photographs from the Cervino database appear on page 13 of this issue in the online version only, which may be viewed at http://www.orf.org/CURRENTS/summer98.pdf.

Science Without A Conscience

Enewetak Atoll, Marshall Islands, 1952

"At a fraction of a second before 7:15 A.M. on the first of November, 1952, Mike was detonated. It exploded with a force nearly one thousand times greater than that of the atom bomb dropped on Hiroshima. The complex chain reaction begun inside of Mike resulted in a fireball that burned hotter than the sun.

It was dawn. Coral polyps, fat with zoox, would have been slowly withdrawing into their calcium dens after a nighttime spent capturing zooplankton. Parrotfish would have been emerging from their mucus cocoons to begin their daily hunt for algae. Crabs, shrimp and other crustaceans would have been crawling from their lairs. It was that magical moment of transition, with creatures of the sunlight replacing the many nocturnal feeders.

In nanoseconds they were all vaporized, transformed into a swirling, purplish cloud of unimaginably hot gases. This fiery mist shot twenty-seven miles up into the pale blue Pacific dawn, where it drifted with the cold winds blowing along the edge of the Earth's atmosphere.

Thousands of miles away, in a basement laboratory at the University of California in Berkeley, Edward Teller, the self-described 'father of the H-bomb,' saw the seismic evidence of the tremendous blast as sound waves that had crossed the Pacific Ocean in twenty minutes. He turned to a friend and commented, 'That's very nice.'

The holocaust left behind a crater over a mile wide and two hundred feet deep.

On the map of Enetewak Atoll, where the outline of the tiny island of Elugelab once existed, there is now only an unbroken expanse of blue indicating water."

I was only six years old when our government erased Enetewak Atoll from the face of the Earth, as the above excerpt from the new book *The Enchanted Braid*, by author Osha Gray Davidson, so poignantly describes. I had not yet learned to swim; learning to scuba dive and enjoy the undersea splendors of coral reefs would be some thirty-six years in my future. I have read this passage numerous times searching for an answer to my question, "How could an intelligent, reasonable and learned man of science (E. Teller) find the cataclysmic destruction of such a thing of beauty as the Enetewak Atoll, very nice?"

Certainly, scientists in 1952 were not ignorant of the beauty and complexity of coral reef systems. Coral reefs had been studied prior to the 1830's voyage of the *HMS Beagle*, and this five-year trip of discovery brought new knowledge of the world's oceans. The usually stoic scientists were giddy with astonishment over crystal-clear lagoons and coral formations. One hundred and ten years later, Jacques Cousteau made the first successful dive in the Mediterranean Sea with a 50-pound Aqua-Lung, and brought man face to face with coral reefs. I can only guess that Edward Teller was aware of the beauty of the Enetewak Atoll, if only on some superficial level, and perhaps only from second hand accounts from the workers who surveyed the Atoll in preparation for the bomb. I can only conclude that a scientist who toiled to create a bomb of such massive destruction, and subsequently vaporized a Pacific island, the reef system and inhabitants, had no conscience.

The legacy of Teller's research and the subsequent destruction of Enetewak Atoll lives on today. The International Atomic Energy Agency has been monitoring radioactive waste in the ocean for years and has documented the ocean dumping by a dozen countries. It is recognized that vast quantities of high level radioactive materials lie on the ocean floor unaccounted for, including entire reactors from Russian submarines. A recent IAEA report has confirmed that the Mururoa lagoons and Fangataufa atolls, France's South Pacific nuclear test sites, will be contaminated for centuries. France has permanently ended it's testing program and closed the government office responsible for conducting these tests. However, several kilograms of deadly plutonium are scattered in the sediment of the lagoons and atolls from atmospheric explosions, and radioactive tritium produced from underground tests will migrate from fissures into the surrounding ocean for a few thousand years.

We may have the wisdom to have ended the detonation of nuclear bombs on remote Pacific islands, but our attack on the world's reef systems remains aggressive and deadly. Nuclear bombs have been replaced by blast fishing with dynamite wielded by indigenous fishermen. Land-based pollutants, pesticides, fertilizers, sewage, and sediment, eutrophication, algae blooms, the destruction of coastal systems (wetlands, mangroves and sea grasses), coastal developments, El Niño, and overfishing are a few of the impacts on reef systems.

There has been much research on the condition of the ocean's reef systems, and it is generally agreed that, worldwide, reefs are suffering, yet there seems to be no clear consensus among researchers as to specific sources and specific cures. Coral research is presenting us with new discoveries at a rapid pace and this can often result in conflicting data describing cause and effect.

If we are to save our reef systems, we must become proactive, not just observers and record-keepers of a diminishing resource. An article on electrolytic reef restoration, by the researchers holding the patent, appears in the current issue of *Ocean Realm*. This large scale reef restoration is one of many proactive efforts showing promise for the future.

May the legacy of our research that we pass on to future generations be healthy reef systems, not vast volumes of data on extinct coral reef ecosystems. - GC

Coral Reef Bleaching in the Land Down Under - Australia's GBR

By Katharina Fabricius,
Australian Institute of Marine Science

A severe mass bleaching event has been reported from coral reefs of many parts of the southern hemisphere since early 1998. Not only hard and soft corals, but also sea anemones, zoanthids, giant clams, foraminifera, and many other zooxanthellate invertebrates have lost a great proportion of their symbiotic algae. Once stripped off the dull brown colour of healthy zooxanthellae populations, a beautiful pink, yellow, purple and blue pigmentation of coral tissue became prevalent in some species, while others turned spotless bone-white. Live corals in the field displayed a macabre resemblance to the pastel painted and glossed coral skeletons and shells for sale in some tourist souvenir shops. "The reefs have never looked more beautiful" was the comment of many divers, who found it hard to comprehend that this colourful display was a sign of extreme stress in the corals, which would soon kill a fair proportion of corals in the most impacted areas.

Three months since the onset of bleaching, we now have a clearer picture of its extent and severity. On the Great Barrier Reef, reefs close to the shore at shallow depths are most heavily impacted, with around 95% of hard and soft corals being partly or completely bleached. The rate of bleaching decreased with depth, but around 20% of hard and soft corals were affected even below 12 m depth. Many corals have "hung in" with reduced numbers of zooxanthellae for over three months. However, the rate of mortality increased continuously, with big differences among species and habitats. The process is not yet complete, but mortality rate of 30 to 50% of corals has already been observed on severely impacted regions on shallow near-shore reefs. Here, the loss of particularly sensitive taxa (such as hard corals of the common genus *Acropora* or from the family *Pocilloporidae*, or *Xeniid* soft corals) caused a shift in community composition towards dominance of the more resistant taxa. In contrast, bleaching on reefs further away from the coast, and on near-shore reefs below 10 m depth, was moderate to mild (< 10% of colonies), and although some colonies of sensitive species have died, first signs of recovery became evident after around 6 weeks. In other parts of the Pacific and Caribbean region, the process of severe bleaching is also being monitored carefully.

Mass bleaching of a fringing reef. Orpheus Island, NE Australia

The main cause of this bleaching event is seen in high sea water temperatures, which exceeded long-term averaged maximum summer temperatures by two to five degrees in many parts of the world. On the east Australian continental shelf, unusually calm and warm weather conditions increased temperatures from approximately 30 C, to 31 - 32 C, with occasional peaks of over 33 C. This hot spell lasted for about three weeks in February 1998. In this region, two additional factors may have contributed to cause bleaching. One being increased exposure to ultraviolet radiation and photosynthetically active irradiance. Mirror-calm seas prevailed during the hot spell, which reduced the back-scatter by waves, and may have contributed to stress some types of zooxanthellae and corals. Reduced salinity due to extensive runoff represented a third type of stress in particularly on near-shore reefs off the Northern and Central Queensland coast. Three weeks prior to the hot period, a cyclone had caused flooding, and the freshwater runoff decreased sea water salinity from 35 ppt to 30 ppt for several weeks, with some reefs experiencing brackish water with 20 ppt salinity for a few days. Although this exposure to low salinity did not result in bleaching and mortality per se, it may well have stressed the corals or zooxanthellae sufficiently to have increased their sensitivity to the subsequent high temperature and light levels.

Links have been drawn between the bleaching event and this year's severe El Niño Southern Oscillation (ENSO) event, as well as to global warming. ENSO has increased sea surface temperatures by up to 5 C in places such as the Galpagos and east Pacific areas. In these regions, it appears to be a direct cause of coral bleaching. In contrast, there is little evidence that the unusually high temperatures and irradiance on the east Australian continental shelf was a direct consequence of ENSO, although local climatic phenomena in Australia are obviously not isolated from global conditions. Concerns about the potential effect of global warming on future frequencies of severe bleaching events are based on the narrow upper margin of temperature tolerance in corals. A one to two degree warming of sea surface temperatures within the next 50 to hundred years, from maximum summer water temperatures which are tolerable to corals, to those which are harmful to present-day corals even in short spells, is well within the predictions of climate experts.

Of great concern is whether, or which proportion of, tropical zooxanthellate invertebrates are able to adapt or acclimatise to the global warming. Much work is still needed to understand how the three main types of stress (increased temperature and light, and reduced salinity) affect the physiology of various genotypes and phenotypes of algae and

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First Aid for Fragile Coral Reefs

Research, monitoring, and better management of coral reef resources in addition to improving the quality of reef environments promise recovery.

By Robin Bruckner, University of Puerto Rico and NOAA/NMFS Office of Habitat Conservation

Reefs Face Increasing Pressure

At the National Ocean Conference in Monterey, California, President Clinton recently pledged his support for coral reefs. The Executive Order for Coral Reef Protection, signed June 11, 1998, directs Federal agencies to expand research, monitoring, management and restoration efforts, and proposes an additional $6 million through 2002 to complete the restoration of 18 damaged reefs in the Atlantic, Caribbean and Pacific oceans. And less than two weeks after the President's address, the World Resources Institute released the results of a two-year study, "Reefs at Risk: A Map-Based Indicator of Threats to the World's Coral Reefs." The Report and Order follow the much publicized 1997 International Year of the Reef campaign, and come at a time of heightened public concern over the plight of corals reefs.

The Report evaluates the degree to which human activities threaten the vitality of reefs. It echoes the stark warning of scientists and policymakers - immediate action is needed to protect the world's reefs from the combination of pressures that are destroying them. The Report's carefully constructed map indicates areas where coral reef degradation is expected based on the effects of coastal development, over-exploitation and destructive fishing practices, inland pollution and erosion, and marine-based pollution. A lively Internet discussion among coral reef scientists addressing coral reef problems and potential solutions followed. The consensus reached was that reefs are in grave danger from a variety of factors which differ in proportion depending on a reef's location. If pressure from human activities is left unchecked, the irreparable degradation of reef resources will escalate out of control given the predicted expansion of the population and its focus along the coasts.

The Report indicates that almost two-thirds of the reefs in the Caribbean are in jeopardy, and most of Florida's reefs are threatened. This is cause for alarm, since the threats posed by global climate change, mortality from coral diseases and other factors considered largely natural in origin, and combined impact of natural and man-induced activities are not factored into the analysis. The fact is, there are no pristine reefs anymore; man has not left one single reef untouched, and even remote reefs are becoming increasingly affected. Steps to halt coral reef destruction and reverse the factors negatively impacting coastal ecosystems must be taken at once. These actions need to include everyone, even those people far removed from ocean environments, if we are to revive these fragile ecosystems.

Andrew Bruckner/NOAA

Terminal phase stoplight parrotfish (Sparisoma viride) biting live M. annularis coral tissue.

Restoration

Although seemingly insignificant on an individual basis, ship groundings have become one of the most destructive human impacts to coral reefs on a regional scale. Prior to 1990, attempts to alleviate physical destruction of reefs have focused almost exclusively on reducing boat anchor damage by establishing permanent moorings, and limited restoration of injured corals following ship groundings. Now ship grounding restoration efforts account for a substantial square footage of reef that may have been otherwise lost. Ship grounding restoration work includes accelerating the natural recovery of damaged areas by righting and reattaching broken corals, removing reef rubble or stabilizing unconsolidated reef material, and reinforcing the reef structure.

Fortunately, some actions are now being taken to deter the escalating number of ship groundings on coral reefs. For instance, within the Florida Keys National Marine Sanctuary, wayward owners are fined every day their boat is aground in addition to stiff damage and compensatory penalties. One settlement following a 1997 grounding of a 600' containership includes funding for a Florida Keys-wide Racon navigation system, which is predicted to reduce the risk of major groundings in the Keys by over 50%.

Research and Understanding

While remedial and punitive actions are being taken to deter ship groundings, more of the world's coral reef resources continue to deteriorate. Restoration can no longer be limited to repairing damages directly inflicted by ship groundings. Coral losses associated with hurricanes, disease outbreaks, chronic pollution and sedimentation are less obvious but potentially of greater significance, and pose greater challenges for restoration. Non-ship related impacts may encompass entire reef tracts, affecting large numbers of corals, including huge massive corals, which may be hundreds of years old and which provide a major source of new coral recruits. Degraded coral reefs will only exhibit natural recovery once the sources of stress have been significantly reduced,

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International Year of the Ocean - Loosing Ground

Laguna Ojo de Liebre, El Vizcaino Biosphere Reserve, Baja California, Mexico

The Environment Secretariat of Mexico has declared the salt company Exportadora de Sal , S.A. (ESSA) responsible for discharging hundreds of thousands of liters of toxic waste into Laguna Ojo de Liebre in December of 1997 and causing the death of 94 endangered sea turtles. “The event (the turtle deaths) was caused by a spillage of brine and other minerals into the lagoon from one of the evaporation beds in the Exportadora de Sal company” the secretariat said in a press statement.

Visit http://www.profepa.gob.mx for more information

PROFEPA photos

Complaints of the spill of toxic brine, which ESSA has repeatedly denied, were made by local fishermen in January of 1998. According to witnesses, ESSA personnel company removed sea turtle corpses from beaches near company’s installations, trying to erase evidence. Moreover, on May 1, 1998 a second spill of more than 16,000 cubic meters of highly toxic brine was discharged into Guerrero Negro. That spill caused mass mortality of fish and unicellular organisms critical to the health of the lagoon’s marine ecosystem.

PROFEPA has also retrieved nearly 300 automobile batteries, used by ESSA for their marine signal buoys, from the bottom of Laguna Ojo de Liebre. Lead-acid storage batteries are considered hazardous waste, because they release antimony, arsenic and lead, which are highly toxic environmental pollutants that can affect all marines species and can climb up the food chain reaching marine mammals like whales and dolphins. These heavy metals may also be found in fish caught for human consumption.

Since 1992, there has been strong opposition to ESSA’s proposed expansion project. Several international environmental organizations have requested the Mexican government to deny ESSA the environmental permits to extend their operations into Laguna San Ignacio, sanctuary of the gray whale. “It will be extremely irresponsible of the authorities to permit an expansion of the operations of ESSA into Laguna San Ignacio, which is much smaller than Ojo de Liebre, and where an enormous spill like the one of December would be catastrophic for the marine species, including the gray whales and their calves”, affirmed Juan Carlos Cantu, biodiversity campaigner with Greenpeace Mexico. The company is owned by the Mexican government and the Japanese company Mitsubishi. ESSA plans to use 52,157 hectares of sensitive wetlands for the production of salt in Laguna San Ignacio, located inside the Vizcaino Biosphere Reserve, declared a World Heritage site by the United Nations. Environmental organizations, fishermen and eco-tourist services, have protested against the project, considering that it represents a risk to the ecosystem, specially reproduction sites of the gray whales.

Saving X'cacel

Environmentalists unite as Hotel Sol Melia plans coastal destruction in Qunitana Roo

The Mexican state of Quintana Roo recently sold a 2 kilometer strip of X'cacel prime beach front property, and one of the most important sea turtle nesting beaches in the Caribbean, to the Spanish hotel developer Sol Melia. Now, Sol Melia has put up a sign at the entrance to the beach declaring it ''private property'' advertising a ''tourist development.'' Visitors can ask a guard to allow them onto the beach, and student volunteers still camp there at night, transplanting eggs to protected nesting areas, but the construction of a hotel on this site will result in the destruction of this critical sea turtle habitat.

"The loss of this habitat presents one of the most urgent conservation crises in the world today for sea turtles," reports Brian Bowen of the University of Florida. Bowen, a marine biologist who has studied X'cacel for some time, indicates that the nesting ground is the largest single reservoir of genetic diversity for Atlantic loggerhead and green sea turtles. X'cacel is estimated to contain more than 20 percent of the genetic diversity of both species. It is genetic diversity that allows a species to survive and adapt to environmental changes and increases in level of pollution. Coastal development of critical sea turtle nesting sites has become a global problem for turtle conservation specialists.

Sergio Perez Erales, environmental secretary of Quintana Roo, believes environmentalists are overly concerned with the development at X'cacel, as the project must be approved by and receive permits from the National Ecology Institute (INE). Mario Villanueva Madrid, governor of Quintana Roo, has declared portions of the state a turtle reserve. However, the protected area at X'cacel is only a narrow strip of beach that extends 100 meters above the waterline. Protection of the area is critical for other threatened species, besides sea turtles, and coastal mangroves.

In 1990, Mexico banned molestation of all sea turtles, and hosted the first two meetings for the establishment of the Inter-American Convention for the Protection and Conservation of Sea Turtles. Everyone always says, "Nothing will happen when hotels are built, but it's not true,'' said Daphne Gadar, a Mexico City biology student. "Tourists like to come to a place like this, swinging in a hammock, with clean water, and no big hotels. Mexico is still exotic in that way, but we're fast doing away with it.''

Mary Louise Whitlow

Greenpeace protest at Hotel Sol Melia.

The Oceanic Resource Foundation is urgently requesting concerned individuals to write letters to the following decision-makers. Please ask them to change X'cacel's standing from conservation to protection, which would prohibit construction. GET ACTIVE, WRITE TODAY!

C. Julia Carabias Lilo (SEMERNAP)
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Radio Tracking

A loggerhead sea turtle that was rehabilitated by researchers after she was found hypothermic on a Delaware beach has been released to the wild carrying a satellite transmitter.

The juvenile turtle, named Perdida was found cold stunned 10 months ago. She was rescued and nursed back to health at the National Aquarium in Baltimore. Perdida was returned to the wild off Assateague Island, just off of Delaware's coast, on August 14.

By studying the movements of this particular turtle, researchers with the Sea Turtle Survival League and the U.S. Army Corps of Engineers hope to learn more about the areas used by sea turtles to feed and forage along the East Coast. Perdida is hanging around Assateague Island, showing the researchers that sea turtles do indeed inhabit northern waters. The researchers don't know where Perdida will go, but it is likely she will head south, down the coast to Florida where there are known sea turtle feeding areas.

Perdida is one of more than 20 sea turtles being actively monitored by the Sea Turtle Survival League. The program is aimed at helping people around the world, especially school children, learn about the migration of turtles, the global range of the species and the importance of protecting all coastal waters and habitats.

Environmental News Network (ENN)

Bleaching in the Land Down Under

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animal hosts, and whether the frequencies and intensity of stressful extreme climate events are increasing. Susceptibility to high temperatures varies among zoogeographic regions and habitats, as well as among types of corals and zooxanthellae. Certain regions (such as the southern Red Sea and Persian Gulf) have had 2 to 3 degrees higher normal maximum surface temperatures than other regions for thousands of years, and several coral species are flourishing under these warmer conditions. Within cooler regions, a few species of coral (eg, some Faviids) are able to inhabit habitats (such as reef flats in sheltered bays) where frequencies of high light and temperature exposures are greater than in other environments, thus the tolerance range in taxa is wider than in others. It has to be noted though, that both the warm Persian Gulf and the reef flat environments have low species numbers compared with adjacent cooler environments. Similarly, certain types of zooxanthellae are less prone to degeneration or loss under high light and temperature regimes than others. A few Caribbean coral species host two to three clades of zooxanthellae within the same colonies, which differ in their tolerance to high temperature and light. As a result of high irradiance and temperature, a coral may loose the more sensitive clades, while the concentration of robust zooxanthella clades are maintained, protecting the colonies from complete bleaching. However, such mechanism of adaptive symbiosis has not yet been found in Pacific corals. Further, there is no evidence that bleached corals can get re-infected with new zooxanthellae later than in the early larval and post-settlement stages. Instead they appear dependent on a multiplication of those few zooxanthellae which survived in the bleached host tissue. The entirely asexual reproduction in zooxanthellae, and the slow generation time in corals, will hamper a genetic adaptation to a rapid change in the environment. Acclimatisation (the adjustment to new climatic conditions within the lifetime of an organism) is also discussed as a mechanism to adjust to new environmental regimes. Indeed, free-living dinoflagellates have been found to acclimatise within limits under laboratory conditions to a constantly higher light and temperature regime, however a successful acclimatisation to short-term high temperature peaks have not yet been demonstrated. Thus, to date there is no data available to support or reject the possibility of coral and zooxanthella acclimatisation.

This 70 cm Sarcophyton coral has lost most of its symbionic algae. Great Palm Island, NE Australia

Increased frequencies of temperature peaks two degrees above the present levels due to a combination of global warming and ENSO may result in one of the two following scenarios: (1) no change, as a result of successful acclimatisation of all taxa of hosts and zooxanthellae, or a recombination of all hosts with more robust zooxanthellae; or (2) shifts in species composition, and a set-back in successional stages of the coral reef community, if not all species adapt or acclimatise. This could take on the form of low coral cover, with a dominance of temperature-tolerant taxa, complemented by relatively young populations of the fastest-colonising bleaching-sensitive taxa. Under the second scenario, sensitive taxa with low rates of growth and reproduction will decline in abundance, and may be entirely lost from certain regions or habitat types. The question of whether, and to which extent, corals will be able to adapt, and whether global warming will impact on our present-day coral diversity, will continue to be a hot issue.

First Aid for Fragile Coral Reefs

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and this process may require decades. Natural recovery can be enhanced, however, by eliminating disease from affected corals, by transplanting living coral fragments into degraded areas, by forcing coral recruitment, by reintroducing herbivores to improve the substrate for corals to settle on, and by offering artificial substrates as a framework for natural coral colonization.

With support from the University of Puerto Sea Grant College Program and the National Oceanic and Atmospheric Administration, we have made underwater photo-identification cards available to aid researchers, reef survey groups and concerned sport divers to correctly identify signs of disease and predation on stony reef corals in the Caribbean. The bilingual cards come with a data sheet to generate reports to supplement data for mapping coral disease events in the western Atlantic. The cards have already been adopted by reef survey groups such as Caribbean Coastal Marine Productivity Program (CARICOMP), the Atlantic and Gulf Reef Assessment Program (AGRA), and the Nature Conservancy, Bahama Islands. Use of these underwater cards by coral reef survey and research groups will help standardize the type of coral disease data collected, and it is hoped that coral disease researchers will begin working on a concerted effort to collect, analyze and share such information.

There has been a great deal of confusion recently about coral diseases, and the causes of most diseases are still unknown today. Some biological agents have also been overlooked and mistakenly attributed to coral diseases. One such misidentification sent a small Caribbean island with some of the best coral reef management into panic after an article about the discovery of a “devastating new coral disease” appeared in a prominent U.S. newspaper last year. What researchers promoted as a fungal disease “dissolving” coral skeleton at unbelievably rapid rates was actually parrotfish

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First Aid for Fragile Coral Reefs *continued from previous page*

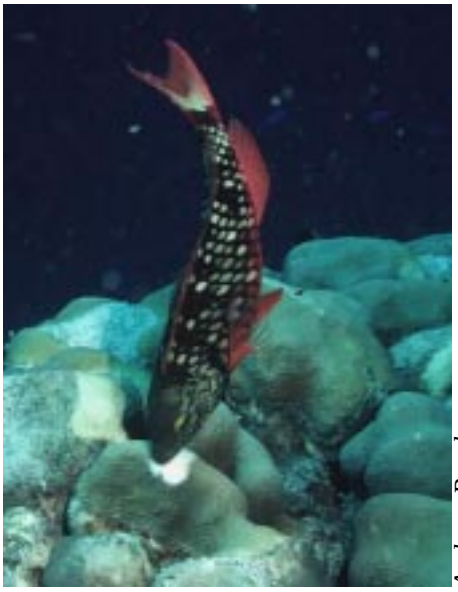
biting chunks out of the corals, a natural behavior described and photographed in Barbados over 20 years ago. Alarmist reports such as these provide little incentive for people to care for reefs once they are given the impression that even the healthiest reefs are doomed, and also reflect poorly on other coral reef scientists who present proof of their theories in the scientific arena.

Corrective Measures

Watching a coral perish over the course of months to years from coral disease has been likened to watching someone suffer with a terminal illness. Unless aggressive treatment is pursued, it will take a miracle for the coral to survive. Experiments we performed on reefs in Puerto Rico have focused on a variety of coral triage techniques which have proven extremely effective. Tremendous colonies of the major reef-building star corals infected with black-band disease (BBD) have been saved from certain death. By using a rapidly hardening underwater putty, the disease is suffocated, and the putty acts as a firewall to protect unaffected tissue. While this method is time consuming and practical only for treating the coral "dinosaurs", shading techniques we developed to eliminate BBD from infected corals can be modified to treat entire reefs. Shade screening available at nurseries was suspended over corals, cutting the amount of light available for the photo synthetic cyanobacteria which causes BBD. In less than two weeks, disease signs disappear from shaded corals and screening is removed. Further work to develop methods to effectively treat corals, which are facing a growing number of diseases, are urgently needed.

Natural Solutions

Scientists are also examining ways to restore systems to their previous condition using natural methods, such as the reintroduction of important herbivores which are significantly less abundant than they have been in the past. The long-spined black sea urchin *Diadema*, which experienced a mass-mortality around the Caribbean in the early 1980s, has been used by us to control coral disease; these urchins are now being cultured in the laboratory, with plans to reintroduce them onto reefs in an attempt to control the proliferation of fleshy algae. Scientists are also advocating the protection of parrotfish and other herbivores, which have become the target of many subsistence fishers now that preferred predatory species are few in number.



Andrew Bruckner

Initial phase stoplight parrotfish (Sparisoma viride) biting live M. annularis coral tissue.

Others are taking a different approach. We know that coral larvae recognize specific chemical signals from the environment that induce them to settle from the plankton and metamorphose to the adult coral form. Researchers from the University of California have developed an artificial substrate containing the purified compound extracted from a coralline algae that cue coral larvae to settle. These larval "flypapers" may prove useful for the reseeding of corals for environmental restoration in the near future. In the Florida Keys, another group has been collecting coral spawn from the most significant reef-building species during mass-spawning events, and seeding the larvae on the reef in protective cages until they can survive on their own.

Another technique introduces an advanced method for the rehabilitation of denuded reef areas which is easy to manipulate and can be applied on a large scale. German researchers working in the Red Sea have combined the underwater electrolytic deposition of a reef-like material with the simultaneous seeding of this "reef" with small coral transplants. Through the construction of a simple galvanic cell, limestone-like material is deposited on steel mesh using weak electric currents. By incorporating coral nubbins into the mesh, the time needed for natural colonization is shortened; after two months the electrodes are disconnected, and implanted fragments are well cemented and begin growing. Their presence is predicted to stimulate settlement of coral larvae, accelerating the rate of reef colonization.

A Brighter Future

While there is a growing consensus that coral reefs are declining at an alarming rate, there is no single factor which is responsible for all the changes. Rather, there is a complex web of interactions between biotic and abiotic stresses which may be exacerbated by man's activities, the effects of which are often unique to particular reefs. And though we can do little to reduce the impact of natural disturbances, to protect coral reef ecosystems for future generations we must begin to eliminate the stressors contributing to reef destruction, many which originate far inland from the reefs themselves. To accomplish this requires the involvement of local communities and governments, NGOs and volunteers. It means more research, more monitoring, and better management of coral reef resources in addition to improving the quality of reef environments. Once we have reduced the sources of negative impacts, we can begin implementing large-scale restoration approaches to facilitate the recovery of these priceless resources.

Underwater disease and predation photo-identification cards for Caribbean stony corals are available through the University of Puerto Rico, Sea Grant College Program, PO Box 9011, Mayaguez, Puerto Rico 00681-9011.

International Year of the Ocean - Loosing Ground

Ostional National Wildlife Refuge, Costa Rica

On September 12, 1997, the Government of Costa Rica's Ministry of the Environment and Energy (MINAE), executed a paramilitary eviction, closed down and confiscated the Douglas Robinson Marine Turtle Research Center in Ostional, Costa Rica. The research center was reinstated four days later and was again evicted on April 23, 1998.

Leslie du Toit, Director of the Center, alleges that the eviction is a result of accusations by the Center of illegal conduct by officials of the Tempisque Conservation Area. It has been alleged that within the Ostional National Wildlife Refuge, there has been illegal harvesting of turtle eggs, land sales, land occupation, building within the Maritime Zone, mangrove destruction, and removal of material from an ecologically delicate site.

On July 02, 1998, Leslie du Toit and other turtle researchers began a hunger strike in protest of what has been described as "the flagrant and repeated violations of our basic international human rights as set forth in the American Declaration." Du Toit vows the hunger strike will continue "until the Costa Rican government recognizes our rights, restores our private property and makes full restitution for costs and damages." The closure of the research center will jeopardized the investigation and protection of marine turtles in the Ostional Refuge.

On Saturday night, July 4, 1998 at 9.40 PM (Costa Rica), the Douglas Robinson Marine Turtle Research Center was destroyed by fire. The police investigation determined the fire was arson.

Leslie du Toit and Anny Chaves are seeking support for their efforts to reinstate the research center and to rebuild the facility. They may be contacted at 506-260-0377 or via email at turtles@gema.com.

If you wish to support this effort, please send letters to:
President Miguel Angel Rodriguez
Costa Rica Fax (506) 253-2064
Minister Carlos Manuel Rodriguez
Costa Rica FAX (506) 257-0697
Mr. Donald McConville
U.S. Dept. of State, Washington, D.C.
Fax: (202) 647-0377

US Tax-deductible contributions for the reconstruction of the facility are being accepted by ORF. Please send your check along with the form on page 12 of this newsletter. Contributions may also be made via secure server at www.orf.org.

Exporting Radiation

Radioactive technetium being discharged into the Irish Sea by the Sellafield nuclear plant in Cumbria is reaching Norway in significant quantities as reported by the Norwegian Radiation Protection Authority.

NRPA scientists have found levels of technetium-99 in the coastal waters of Norway have risen 16-fold since 1991. The radionuclide has a half-life of 213,000 years and will remain for thousands of generations. Discharges of technetium-99 from Sellafield into the Irish Sea have risen from 10 terabecquerels in 1993 to more than 180 terabecquerels in 1995.

New Scientist

Did you know...

The selling price of one kilo of shark fin in Japan is $450 US.

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A bowl of shark fin soup in Japan costs $150 US.

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An estimated 30-100 millions sharks will be killed this year for their meat, fins, skin, jaws, and internal body parts.

Baja Symposium

A Mini-Symposium is being planned for late January 1999 to be held in the town of Loreto. This meeting is expected to bring together non-government organizations such as the Asociación Sudcaliforniana de Protección al Medio Ambiente y la Tortuga Marina (ASUPMATOMA), community based groups, fishermen, marine researchers, and other individuals with a vested interest in the protection of Baja's marine resources.

Sponsors are expected to include ASUPMATOMA, Baja Life magazine, and Aero Calafia. Organizations interested in providing funding or individuals who wish to participate in the meeting are urged to contact "J" Nichols via email at *jnichols@ag.arizona.edu* or Greg Carter at *gcarter@orf.org*. Sr. Rene Pinal with ASUPMATOMA may be contacted in Cabo San Lucas via FAX at 011-52-114-3-01-34

Postcards from the Field

Graciela Tirbucio Pintos
Marine Biologist

Graciela Tiburcio Pintos is a marine biologist living in Veracruz, México. She received her degree from the Universidad Veracruzana in 1997 and has been involved in laboratory work at UV since 1993. Other studies include photography and HTML and website design, and Graciela is a PADI-certified diver. Graciela has also been involved in sea turtle studies at the Campamento Tortuguero Lechuguillas in Veracruz since 1994. Graciela has presented technical papers at international conferences in 1993, 1996 and 1997.

Graciela and friend at Lechuguillas

She has expressed much excitement this season as there has been a tremendous increase in number of turtles nesting at Lechuguillas. She will be joining Melania C. Lopez's team conducting a nesting behavior study of Olive ridley's from August through October this year. We are pleased to have Graciela joining ORF this season and we share her anticipation of a great nesting season in Cabo San Lucas.

Recommended Reading from the New ORF Online Bookstore

The number one book on the ORF reading list this quarter is *The Enchanted Braid: Coming to Terms With Nature on the Coral Reef* by author Osha Gray Davidson. Osha brings the coral reefs to life in a manner that is understandable for those with little technical knowledge of the oceans, and for the marine researcher as well. Osha relates the beauty of coral reefs and the challenges facing governments worldwide in protecting these valuable resources. This book is a call to celebration and a call to action; read it and dive into a reef!

Also recommended, *Sea Change* by Sylvia A. Earle, *The Universe Below* by William J. Broad and *Survey Manual for Tropical Marine Resources* from AIMS.

Originally published in 1995, *Sea Change* presents a moving plea for protection of the oceans that is as relevant today as is was three years ago. Dr. Sylvia Earle, past Chief Scientist of NOAA, brings the sea to life in a way that only an individual with over 6000 hours of dive experience can.

The Universe Below presents a chilling tale of sea life in the abyssal depths that reads much like a Tom Clancy mystery

The Enchanted Braid, Sea Change and *The Universe Below* are available from the ORF Bookstore at www.orf.org/bookstore.html as an Associate with Amazon.com. Your purchase through ORF will help support our reef protection projects.

The *Survey Manual for Tropical Marine Resources* is available through the Australian Institute of Marine Science via their website at http://www.aims.gov.au/pages/facilities/bookshop/bs-survey-manual01.html.

Thanks!

Our research and conservation efforts would not be possible without the support of our members and business partners. We encourage you to patronize these businesses that generously support our work:

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Boulder, CO 80301
(303) 442-1322

Planetary Solutions
Sarah Francis, Designer
Boulder, CO 80306
(303) 442-6228
email: sarah@planetearth.com

ORF needs your support. Become a member today!

The Oceanic Resource Foundation is restoring sea turtles and conducting coral reef research in the ocean waters off the Baja California peninsula. Patrolling remote beaches, collecting turtle eggs and releasing hatchlings, tagging and monitoring adult turtles, and conducting underwater coral reef surveys and fish population counts require the participation of volunteers and sustaining contributions from environmentally concerned supporters.

Join a once-in-a-lifetime expedition or become an ORF member. Help us protect Baja's Vizcaino Biosphere Reserve (a UN World Heritage Site), Scammon's Lagoon, Laguna San Ignacio and Bahia Magdalena (Pacific calving grounds for whales), Cabo Pulmo Reef Marine Park, Loreto National Marine Park, and over 100 kilometers of turtle nesting beaches at Los Cabos.

ORF is a 501(c)(3) tax-exempt organization.

It all begins with membership. Sign me up!

☐ $25 ORF Membership ☐ $50 Adopt-a-Reef ☐ $100 Loggerhead Sat-Tag

☐ **Save X'cacel $**_____ ☐ **Rebuild Ostional Turtle Center $**_____

Name (Please Print) _____

Address _____

City _____ State _____ Zip _____

☐ My check in US $ is enclosed. (Payable to the Oceanic Resource Foundation)

☐ Charge my credit card: ☐ VISA ☐ MC ☐ AMX ☐ DISCOVER

Card No. _____ Exp Date _____

Signature _____

FAX THIS PAGE TO 415-954-7199 OR MAIL WITH YOUR CHECK TO ORF, P.O. Box 280216, San Francisco, CA 94128-0216

KUDOS

ORF gratefully acknowledges contributions to this issue of *Currents* by Wallace J. Nichols, University of Arizona; Wendy Ellery, Australian Institute of Marine Science (masthead photos); Melania C. Lopez, Universidad Autonoma de Baja California Sur; James Cervino, Global Coral Reef Alliance; Robin and Andrew Bruckner, NOAA; Katharina Fabricius, AIMS; Mary Louise Whitlow, GEMA; Mark J. Spalding, UCSD; Anny Chaves, D. Robinson Turtle Research Center; Gary Weisler, Graphic Design. Thanks from the editor!

Oceanic Resource Foundation
P.O. Box 280216
San Francisco, CA 94128-0216
888-835-9478
www.orf.org

Address Correction Requested

CURRENTS SUMMER 1998 INSIDE THIS ISSUE

Coral Disease Photos from the James Cervino Database

White Band Type 1

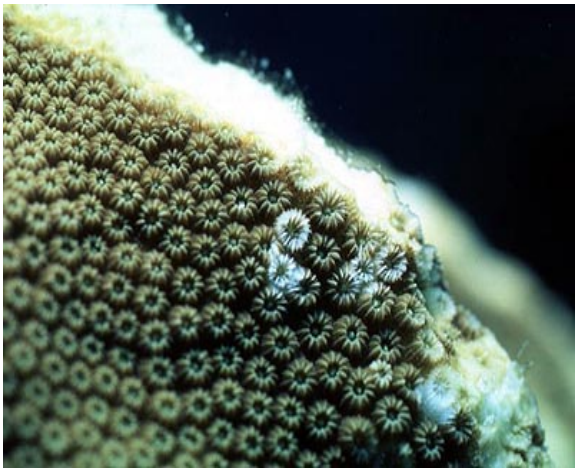
Classic white band has a bleached white rim next to dead coral which expands from the base up. The branch at left has only been affected at the base. The middle branch has only the tips remaining alive. The branch at right has had all the coral killed and overgrown by encrusting red algae, which are being killed in turn by Coralline Lethal Disease, which is in an actively growing phase with a white rim.

Yellow Band/Blotch

This picture clearly shows the spreading bands of yellow surrounding dead areas. Species usually affected: all morphs of Montastraea. Characterized by light yellowish tissue in irregularly shaped blotches or as bands (several cm wide). Pathogens unknown, high presence of bacterial colonies on tissue surface. Slow acting disease.

Yellow Band

Large round area on top has been affected, as well as the edges of the lower sheet growths.



Rapid Wasting Syndrome

M. faveolata observe the individual polyps, they show the early stages of the distruction, again no evidence of Parrotfish teeth

The Editor wishes to express thanks to James M. Cervino and the Global Coral Reef Alliance for permission to use these photographs. The complete coral disease database may be viewed at the GCRA website at www.fas.harvard.edu/~goreau.