First Reports of Coral Disease in the Hawaiian Islands

Dr. Cindy Hunter, Curator, Waikiki Aquarium

Dr. Cindy Hunter, coral ecologist and curator of the Waikiki Aquarium, has been monitoring the reefs of Hawaii for the last seven years. Reefnet recently interviewed Dr. Hunter to find out the current status of Hawaiian reefs and the prognosis for their future health. Read on to find out what her keen observations and experience on various reefs of the world can tell us about coral disease.

When was coral disease first described?

Black band disease was first formally described from the Caribbean in 1982 by Klaus Rutzler and Deb Santavy. In 1983, Deb came to Hawaii to look for evidence of this kind of coral disease but did not observe any. I have not yet seen it here in Hawaii.

It is important to note that awareness of coral disease is relatively recent. Researchers are consciously looking for disease now that they know what to look for. So the question arises: is it that we did not see disease before because it wasn't there or because we did not know how to recognize it? Most researchers, myself included, do not recall if the level of disease we are now observing was present in earlier studies. I suspect that disease was present but that we were not seeing it because to a certain extent we only see what we are looking for.

What kind of coral diseases have been identified?

White band disease has been implicated in the death of many corals in the Caribbean and Florida. Black band disease is also present and is responsible for coral mortality in Florida but probably not to the extent of white band disease. At this point in time, these are the only two diseases that have been positively identified as pathogens in corals. The field is virtually new. We know very little about the nature of these diseases: whether they are bacterial or fungal in origin and what threat they represent for corals. We are just beginning to undertake these essential studies.

Band diseases appear to be rare in Hawaii. I have observed only four or five incidences of a brown band disease on reefs here.

How do disease levels in Hawaiian reefs compare to those of reefs in the
Caribbean?

It appears that there is very little disease in the Pacific compared to the Caribbean and Florida. I recently returned from a trip to Key Largo where I was working at the National Undersea Research Center, a facility run by NOAA. NURC supports Aquarius, the only underwater research habitat in the world, positioned at 55 foot depth on Conch Reef near Key Largo. I have been working there since 1994 with a team of scientists studying a seaweed called *Halimeda*. *Halimeda* is a sand-producing seaweed, a beautiful organism, that is one of the algae that Ken Clifton observed spawning for the first time a few years ago. (Note: See Ken Clifton's interview in Reefnet Issue 3.)

Although we were studying *Halimeda*, I could not help noticing how much the coral in this area has declined over recent years. Other researchers on the project corroborated this observation. A significant coral bleaching event occurred there last year and they are expecting another one this summer. Besides coral bleaching, many areas in Florida and the Caribbean have experienced epidemics of white band disease as well as a half a dozen other unidentified diseases that have taken their toll on the major reef-building species. These reefs look very different than they did just a few years ago.

It is difficult to find reefs in the Caribbean that have not been affected by disease and yet, in Hawaii and the Pacific, we have not seen coral diseases to nearly the same extent. Of course, we do have disease here in Hawaii and there is also evidence of coral disease in places like Palau and American Samoa. I believe that a certain background level of disease is natural in corals. As all animal species, corals undergo a constant process of senescence and regeneration. If not buried in sand, toppled by a storm, or eaten by fish, a coral will eventually succumb to senescence and such senescence may appear as a disease.

For the Reefnet readers that are not familiar with the coral animal describe it and explain what happens when corals are touched, bumped or walked on.

The coral animal has two thin layers of living tissue, the ectoderm and endoderm. They are simple organisms with few organs, primarily tentacles surrounding a mouth that leads into a blind sac or coelenteron. This coelenteron is partitioned by membranes that increase surface area for digestion. The ectoderm layer secretes a calcium carbonate skeleton. Corals deposit calcium carbonate underneath the layers of tissue in species-specific patterns.

Because coral tissue is only a few millimeters thick, any contact can abrade this tissue from the surface. A certain amount of abrasion is not catastrophic for corals because they are very plastic and can regenerate quickly. They are similar to humans in this sense: if we get scraped, the wound will heal quickly in normal conditions, but if the affected area is continually scraped, the healing process is
interrupted and the wound becomes infected. In the case of corals, bacteria and fungus can invade the abraded areas. In fact, I believe that diseases are often initiated by injury and that tumors can be triggered by an injury in which the healing process goes awry. If the injury is chronic, bacteria, fungi and algae may move in and begin to invade and weaken the coral.

**Your research started in 1991 as a result of a report of problems with corals at Hanauma Bay. Prior to your research on coral disease had there been any papers published on Hawaiian coral disease?**

In the 1960's, "tumors" were described in deep-water Hawaiian corals. These tumor-like growths turned out to be galls produced by animals living inside the corals. There were also some published works on a trematode parasite that lives in individual coral polyps and gives these polyps a pink, swollen appearance. There may be many of these swollen polyps on a colony. Once the trematode larvae hatches, it leaves the coral or it is eaten by a butterfly fish and the polyp heals over. Apart from this work on trematodes, there have not been any papers on diseases intrinsic to coral themselves.

Diseases of Hawaiian coral have not been formally described. The process of describing diseases is very laborious in that you must satisfy what are called Koch’s postulates:

1. Are they communicable?
2. Can you isolate the pathogen?
3. Can you re-infect another coral with that pathogen and see if you get the disease again?

Only black band and white band diseases have been described within this context, although many more types of disease have been observed on reefs. I have seen diseased coral in many locations, deep and shallow, close to shore and far from human influences. For example, there is some level of disease at Molokini, although very rare, and a great deal on the south shore of Maui. We do not know why disease occurs more in some areas and not in others. Some reefs close to human settlements are unaffected and others that are far away may be heavily diseased. The same pattern has been documented in Florida and the Caribbean.

**Can you see residual disease on the skeleton?**

I do not think so, but we do think that we may be able to see a record of abnormal growths in tumors that have been replaced by normal tissue over time. We have plans this summer to take sections from corals that have tumors now and examine their skeletons for evidence of the initiation of the tumors.
What are the parameters for choosing the three research sites of your study at Hanauma Bay, Oahu, Honolua, Maui and Puako, Big Island?

Because my attention was drawn first to Hanauma Bay, I looked for sites that were similar so that the results of our observations could be more easily compared. My criteria were to identify protected areas with an abundance and diversity of coral and minimal influence from other elements such as heavy fishing pressure or runoff.

What is the length of time you considered as ample for the study?

One does not know a priori what to expect in terms of patterns. We started our monitoring as soon as we were aware of the issue in 1991 and have gone back annually since that time to continue our observations. There is no reason to stop. One is never sure if the whole pattern has been seen and, in fact, we can be pretty certain that all the manifestations of disease have not yet been seen.

I am trying to understand the natural background levels of disease in Hawaiian coral. I think that it is appropriate to expect some level of disease: corals do die and are injured. Some of the questions that I would like to answer are: how long does it take for the process to occur, how long does it take for recovery to occur, does healthy tissue regrow in a diseased area or does it become colonized by new coral recruits or algae? Coral reefs are present due to accretion and growth of coral. Where disease is present and coral tissue is lost, one expects a net replacement of new corals or growth. We are looking at rates of tissue loss compared with the rates of re-growth or regeneration. We are trying to relate these rates to other factors, such as natural disturbance or proximity to anthropogenic influences.

Can you talk about the contagious aspect of the disease?

I really can not at this point. We still know so little about these diseases. At Waikiki Aquarium, we have used chloramphenicol, an antibiotic, to treat disease in some of our captive corals. It is an effective treatment for some cases but not for others, emphasizing that these are complex issues. We have new funding to study the distribution and abundance of coral disease and to investigate how these might be influenced by nutrients, grazing or predatory fishes, and whether or not disease and tumors can be initiated by fish bites or abrasion.

Talk about the mutualist and opportunistic aspects of algae and what that means.

This idea was first brought to my attention by Dr. Les Kaufman, who has also been observing changes on coral reefs in Jamaica and elsewhere for more than 20 years. He noted that when coral tissues die, algae can often be seen growing
underneath. This algae may have existed in the coral all along, benignly living inside the coral skeleton. But when the coral dies suddenly, and this is just postulating, it may have more light or a different environment that permits it to grow very rapidly. Bacteria and algae are noted for being able to grow rapidly in the right circumstances. Higher nutrients around the areas where tissues are dying combined with increased light would provide optimal growing conditions for some of these species. Perhaps these algae are living benignly, or mutualistically, in reef areas, but when the coral is weakened due to disease or stress, the algae actually becomes more aggressive.

There may be 50 different algal species on a dying patch of coral, not all of them known. One of the objectives of the study funded by a new grant through the Hawaii Coral Reef Initiative is to identify and characterize these turf algae communities. Turfs are difficult to study because they are small and have to be examined closely under a microscope to tell them apart. We are excited about this study and plan to use molecular methods to look at their DNA in order to determine which kinds of seaweeds, algae or bacteria are present on the corals.

**How do algae affect re-colonization of the corals?**

Algal turfs appear to be persistent in some reef areas, although it would be a more normal succession that they be replaced by coralline algae and then eventually by new coral recruits. Turf and other algae preclude settlement of new corals. We are not seeing this succession in a number of places on Maui and in Hanauma Bay. Why the turf remains persistent at these sites is an area of active research.

**You are using both video and macrophotography in your research. Have you found any inadequacies with either system?**

One always would like to see what is going on at the level of coral and algal interaction more closely. We would like a finer scale of resolution to identify all the players. I really want to know what species occur and if they differ from place to place, or if some tend to be more persistent than others.

We use a Yashica TR-81 Hi-8 video camera with an auto exposure feature. We have learned that using white or black transect lines caused either over or under exposure of the film, so we switched to using a rainbow colored line to correct the problem. We’ve learned a lot of good tricks to getting good video footage over the years!

**On the three sites you have been monitoring, do you have any real concerns?**

The reefs of Puako and Honolua have maintained their state over time but the areas that we have been monitoring in Hanauma Bay have undergone significant
changes. There has been a decline in coral and an increase in algae. But, in
general, the reefs are in reasonably good shape given the population on the
islands. There are hot spots that have suffered and continue to suffer from the
effects of sedimentation and dredging. Also, over-fishing has dramatically
reduced the normal fish abundance and diversity that once existed on the reefs.

**Overall, are you particularly concerned about Hawaiian reefs at this time?**

I think the level of disease that we are seeing now is probably a natural pattern on
reefs. We know so little about the kinds and rates of change that disease brings to
reefs. If we see a degradation of reefs in the future, we need to be able accurately
calculate the amount that is due to influences other than natural mortality and
disease.

**How did you land this coveted job at the Waikiki Aquarium?**

I have long admired the people at Waikiki Aquarium and had taught many
courses here over the years. Although I’m not an aquarist in the traditional sense,
I felt that my research background and interests in many aspects of marine
ecosystems might fit in with the dynamic programs here at the aquarium.

**Describe your position as curator.**

As curator, I am in charge of the Live Exhibits department, consisting of eight
full-time aquarists, seven students, and 40 volunteers. The staff here are very
skilled people who know an enormous amount about what it takes to keep marine
animals alive, healthy, and exhibiting well in a public aquarium. It is a great
privilege for me to work with them and it is also a wonderful challenge. I could
not have imagined a job as fun, interesting and fulfilling as this one is.

**Will you be doing any collecting for the aquarium?**

Yes, as expeditions come up, or as the needs for new programs emerge. We have
a long list of future projects.

**Citation:**

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