Coral reefs and bleaching phenomenon

Environment, Global Warming

Imagine yourself observing one of the most diverse ecosystems on earth. Thousands of species of plants and animals provide a dizzying array of color and motion. Massive structures provide a canopy that shelters hundreds of exotic species in a myriad of microclimates. As land-based observers, we almost automatically assume that this is a description of the rich ecosystem of a tropical rainforest. However, if we take ourselves off the safety of dry land and immerse ourselves in the ocean, we will find an equally dynamic environment in the depths of our world's coral reefs. As a Zoology major, I quickly decided to explore this biological component of the ocean environment. In the following paper, I will provide a general overview of coral reefs and examine the alarming depletion of coral and their ecological symbionts in a process known as coral bleaching. As mentioned earlier, coral reefs are among the most diverse and productive of all communities on Earth. They are also the largest biological structures on the planet. The Great Barrier Reef, along the eastern coast of Australia, covers over 2000 kilometers and is said to be visible from the moon (Goreau, 1987). While the size of coral reefs can be enormous, their real impact is on a much smaller scale. Reefs function as food and shelter for fish and marine invertebrates. While the coral itself is an animal, through a symbiotic relationship with the unicellular algae, coral becomes the primary producer in its ocean ecosystem (Richmond 1993). The reefs are formed by calcium carbonate deposits produced by the coral polyps. According to the legendary Cousteau, in his book The Ocean World, tube worms and mollusks also donate their hard skeletons to the architecture of the growing reef (174). Biologically active compounds are also produced by reef dwelling organisms and posses antimicrobial and antiviral properties (Van Alstyne 1988). In fact, coral produces a natural sunscreen that is currently marketed and also holds promise in generating chemicals for AIDS and cancer research. In 1995, researchers mimicked the structural components of coral and now use the patented super hard compound to repair shattered human bones (Alderage 1995). Further more, coral reefs are naturally extremely productive fishing grounds. In fact, healthy reefs produce up to 10-100 times more yield per unit area than deep-sea fishing (Goreau, 1987). These are just a sample of the multitude of resources coral provides their own ecosystem and the economic markets of humans. Sometimes growing from a single polyp, a colony of thousands of similar polyps is soon established through sexual and asexual reproduction. The sheer vastness of a coral reef provides many other benefits. Coral reefs are crucial land builders in tropical areas, forming islands and altering continental shorelines. Coastlines are also protected from erosion as the reefs dampen harsh incoming waves. This is vital to maintaining the white sandy beaches that drive the tourist motivated economies in tropical regions. An example of the value of coral reefs in this regard is illustrated by Jon Luoma in his article " Reef Madness". Luoma explains that after a land-reclamation project that destroyed a reef in the Maldives, the government had to spend more than $12 million to build an artificial seawall that served the same purpose(24). As with all diverse ecosystems, the coral reef must maintain a stable environment. Any changes in the physical ocean components can upset the balance of this ecosystem. Temperature, water depth, salinity, wave action, and turbidity all effect the growth of coral reefs. According to biologist Clive Wilkinson of the Australian

Institute of Marine Science, it is humans who have caused the death of 5-10% of the world's living coral reefs (Wilkinson 1987). One direct cause of coral depletion is overfishing. The overfishing of herbivores, which normally consume algae, can cause an explosion in algae and create what is caused and algal lawn (Luoma 1996). These " lawns" cover the coral and prevent the penetration of sunlight to the photosynthetic zooxanthellae. Similar to the familiar algal bloom of local ponds, toxic dumping and pollution can also cause either algal laws or the outright death of the coral reef. Recently, oceanographers began noticing another particularly disheartening phenomenon. When diving down to corral reefs and expecting a multitude of splendid colors, divers were struck by the brilliant white cast of entire sections of coral reef. The coral polyps themselves remained alive but were stimulated to expel their colorful symbiotic algae. With the algae gone, the transparent tissue of the animal polyp becomes invisible and only the white calcium carbonate skeleton of the reef is exposed. This phenomenon is known as coral bleaching. The progression below shows the transformation of a reef in the Maldive's as it undergoes coral bleaching: The transformation of the coral in this area is impossible to ignore. Initially, the coral reef is colorful and vibrant. Then the bleaching occurs and the area turns chalk white. Lastly, seaweed and decomposing organisms cause a dull brown hue on the entire reef surface. Coral naturally loses less than . 1% of their zooxanthellae algae during the normal processes of regulation and replacement (Brown 1993). Obviously, in cases of coral bleaching, there in an external stimulus that causes the discharge of the coral's zooanthellae. Scientists have established that coral bleaching is one of the first visible signs of stress on the coral reef ecosystem. One of the primary factors known to cause coral bleaching is thermal stress. Depending on location, coral can tolerate a narrow temperature change range between 25-29 degrees Celsius. In their article in Scientific American, Brown and Odgen conclude that coral begins to bleach when water reaches 32 degrees Celsius for a prolonged period of time (67). During the disastrous 1882-83 El Nino event, where unusually warm water flowed from the South American Pacific coast, up to 70-90% of corals off the coasts of Costa Rica, Panama, and Columbia died (Richmond 1993). The association between elevated ocean temperatures and increases in coral bleaching has caused concern in the light of predicted global temperature increases in the next century. According to Cohen and Lobel, there is a definite correlation between oceanic warming and increases in coral bleaching (276). Using satellite images, they established oceanic regions where an increase of 1-2 degrees Celsius in mean summer temperature was observed. In 1996, reported coral bleaching events in the western Caribbean, Gulf of Mexico, and Hawaiian Islands, all fell within the predicted satellite imagery region of warming ocean waters. There definitely appears to be a correlation between increasing mean temperatures and coral bleaching. On a more positive note, according to Jon Luoma in his Audubon article, it appears that coral polyps can often survive if the water temperature cools (24). Current research by Rob Rowan, who works for the Smithsonian Tropical Research Institute, is also optimistic (Discover 1997). Rowan extracted DNA from coral samples and found that several different species of alage actually exist in the same coral species. A few months after a bleaching episode it appears that new species symbiotic alga can move in and restore the reef. Unfortunately, the coral itself can die without the influx of nutrients during the period of months it is undergoing bleaching (10). Until the future gives us more supportive evidence of global warming, however, it seems as if our ocean paradises might be the first warning signs indicating a global warming trend. As the bleaching continues, the dead coral reefs who provided a host of invaluable purposes-from erosion prevention to medicine- will have a tremendous impact on the lives of humans and the unseen water environment. Unfortunately, as our tropical rainforests disappear at an alarming rate, it also appears that the earths other paradise is also succumbing to human devastation. As the coral continues to disappear, the fate of one of the world's most diverse ecosystem remains to be seen. Bibliography Alderage, Susan. April 1995. " Coral : Replacement for Human Bones." Focus Magazine. P45(46) Brown, B. E., Odgen, J. C. 1993. " Coral Bleaching." 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