CORAL REEFS AS A LIFE SUPPORTING SYSTEM

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Summary

Coral reefs are among the most productive and biologically diversified ecosystems of the world. Long time accumulation of calcium carbonate deposited by many living organisms is the basis of reef formation. Thousands of species use the complicated 3-dimensional topography as their habitats. Oddly, most coral reefs exist in waters with very little nutrient input, and cycling of nutrients within the system is fast. Coral reefs have been part of many cultures for thousands of years. At present, they are the foundations of tropical tourism, nursery grounds of hundreds of commercially important species, buffer zone between land and sea. On the other hand, coral reefs are heavily affected by human activities, including those on land. Excessive nutrient input, poor soil conservation, over- and destructive fishing, ship grounding, coastal constructions, mining and pollution all threaten the health and the very existence of coral reefs. Natural disturbances, e.g., storms and El Niño, also cause damages of different magnitudes and scales. Although less than 0.5% of the surface area of the sea is categorized as coral reefs, their importance has been receiving greater and greater appreciation.

1. Introduction

Coral reef is one of the crucial life supporting systems on earth. Its importance has been compared and known to be no less than that of rainforests on lands, and thus coral reefs are often referred to as the rainforests of tropical waters (see also Coral Reef Ecosystems: An Overview Of Their Structure And Function). They share common features in the ecological sense. Both of them have high biological productivity with

tremendously high biodiversity (see also Coral Reef Biodiversity). They do differ in certain aspects. For example, the biomass of a rain forest is mostly plants, or rather, the trunks and leaves. Coral reefs, on the other hand, are mostly comprised of animals which feed on other organisms. Plants, e.g., macro-algae and phytoplankton do occur in coral reefs, but they do not dominate. The animal diversity in rain forests is mostly represented by three phyla while coral reefs are well represented by about thirty phyla. However, rain forests and coral reefs are both suffering from heavy anthropogenic impacts, and deserve protection and conservation (see also Coral Reef Regeneration). In the 21st century, we are enjoying the benefits derived from scientific achievements, but we are also suffering from the side effects of development, e.g., global warming, air and water pollution, acid rain etc. Coral reefs suffer from human activities in both large and small scales. For example, mass bleaching and mass mortality around the world in 1998 affected 70% of the reefs (see also Efects of Climate Change on Coral Reefs). Therefore, the aim of this section is to introduce basic knowledge of the coral reefs and tip some ideas of protection and restoration of this irreplaceable ecosystem.

2. The natural history of coral reefs

2.1. Distribution of corals and coral reefs

Corals are a group of animals in the phylum Cnidaria (Coelenterata). A coral reef, on the other hand, is a kind of tropical (and sub-tropic) marine environment, with calcium carbonate substrate which is deposited by plants and animals. While corals have a wide distribution from shallow to deep waters, coral reefs are limited in horizontal and vertical distributions. Most coral reefs are found between 30N and 30S). The suitable water temperature for coral reef development is between 20-30^{o}C; almost no coral reef exists where annual mean temperature is below 18 ^{o}C. It has also been suggested that the carbonate saturation level, which varies according to latitudes (and depths), limits the horizontal distribution of reefs.

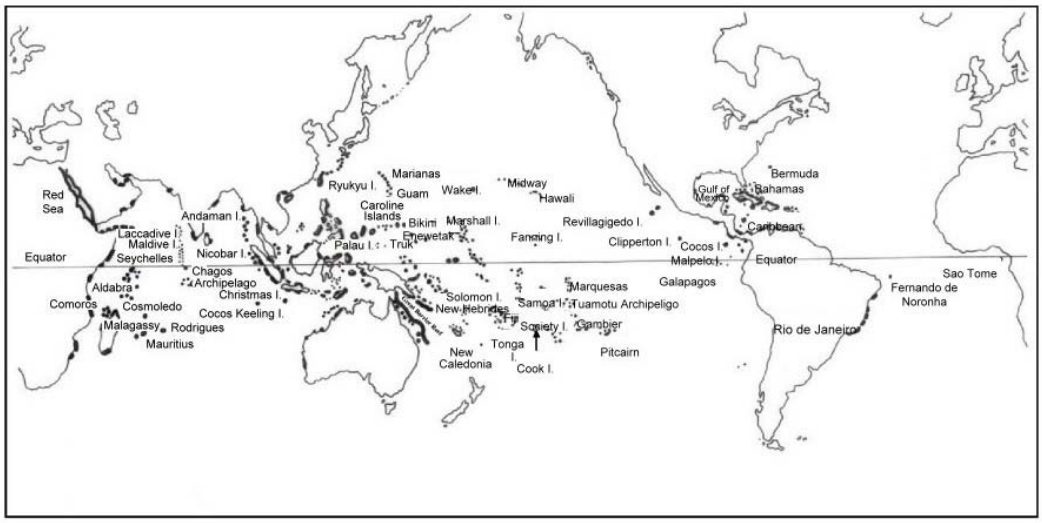

Figure 1: World distribution of coral reefs

Coral reefs are found in shallow waters. This is because light does not penetrate water

well. Most reef corals rely on light to have high calcification rate (see section Light and corals); other reef building species, e.g., calcareous algae, also depend on light as energy source. Most coral reefs are found within 20 m depth. Some species of reef corals, however, have been found to live in deeper waters down to about 150 m, but they do not form reefs there. Besides better light condition, shallow waters also have higher temperature, stronger water motion, and more abundant zooplankton, all of which are important for growth and survival of corals.

Coral reefs are found in clear waters. Since reef formation requires ample light, water clarity becomes a critical factor. Along continental coasts, river discharge often carries with it large quantities of fine particles. These particles tend to remain suspended in water column for a long time and shade corals from sunlight which is needed for photosynthesis by unicellular algae in them. Thus it is difficult for coral reefs to form along estuaries or even along shorelines with sediment supply. Sediments also kill corals directly when they settle on the corals and smother their tissues. Small islands, on the other hand, have no rivers and are thus suitable environments for corals. Waters containing nutrients tend to raise abundant phytoplankton which intercept light before it reaches the bottom where corals inhabit, therefore coral reefs are usually found in waters lacking nutrients.

2.2. Types of Reefs

Coral reefs are built by many different groups of organisms which deposit $CaCO_3$ as skeletons. Calcium carbonate is the major component of this bioherm. There are three major typical types of reefs: fringing reefs, barrier reefs, and atolls. The reef flat found in the fringing reefs is very close to land. In many cases, there is only a narrow lagoon left between reef front and shoreline. Barrier reefs are found much farther away from lands, as in the case of the Great Barrier Reef in Australia. The Great Barrier Reefs are the largest reef formation in the world spanning over two thousand kilometers skirting the northeastern shores of Australia. It is found at a distance of more than one hundred kilometers off shore, with no true lagoon between them. Atolls are shaped like a circular reef with a shallow lagoon in the center. Diameters of atolls range from hundreds of meters to over seventy kilometers. The atoll found in Palau is the largest one in the world.

2.3. Food of Corals

Corals are animals and they feed on small zooplankton which float in the water column. The stinging cells in coral tentacles can paralyze and help capturing preys. The tentacles may be extended in the daytime or at night, depending on species. Since zooplankton is carried passively by water, current speed is an important factor determining how much food a coral may get. Zooplanktons in reef lagoons are more abundant than in neighboring open ocean waters. Many of these planktons are demersal; they hide in the bottom crevices during the daytime and emerge only at night. Thus they may not be adequately represented in a daytime surface sample. Most of the reef planktons are part of the reef ecosystem, i.e., those contributed by oceanic plankton represent a minor portion.

The mucous sheets of corals are also suggested to serve a feeding function. Small particles and bacteria sticking to the mucous may be ingested. Direct absorption of dissolved organic materials in seawater is also a potential source of food of corals.

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Bibliography

Dubinsky, Z. (editor) (1990) *Coral Reefs. Ecosystems of the world 25*. Elsevier, New York 1990. PP. 1-550 [A scientific review of various aspects of coral reefs, with a total of 19 chapters each written by experts of individual fields.]

Veron, J.E.N. (1986) *Corals of Australia and the Indo-Pacific*. University of Hawaii Press. pp.1-644 [Pictures of live corals and maps of their distributions with concise explanations of corals and reefs.]

Wilkinson C.R. and Buddemeier R.W. (1994). Global climate change and coral reefs: Implications for people and reefs. Pp.1-124. Report of the UNEP-IOC-ASPEI-IUCN Global task team on the implications of climate change on coral reefs

Biographical Sketches

Lee-Shing Fang obtained his Batchelor of Science Degree from National Taiwan University, Taiwan, in 1974, in Zoology. He obtained his Master and Doctoral Degree from Scripps Institution of Oceanography, University of California, San Diego in 1982. In 1982-85, he was Associate Professor in Institution of Marine Biology, National Sun Yat-sen University, and then obtained professorship in the Institution of Marine Resources and also became the chairman of the department from 1986. His major interest is in life science of marine organisms, and obtained many awards from doing the related research, for example, Golden Cup award for the best book in natural and applied science of 1987, Bureau of Press and Mass Communication Award for good university textbook, Ministry of Education,1990; Outstanding Researcher Award in biological science, 1987 and 1989, and First Class Award in biological science, 1991-1994, National Science Council; Award of the Best Achievement in Research, National Sun Yat-sen University, 1990; Award of the Best Achievement in Research, China Biology Society, 1996. He is now the Director of National Museum of Marine Biology and Aquarium.

Soong K. obtained his Bachelor of Science degree (Zoology) and Master of Science degree (Marine Biology) from National Taiwan University, respectively in 1977 and 1979. He obtained his Doctoral Degree from University of Texas in 1990 for his dissertation on *Reproduction of colonial reef corals: individuality of coral colonies and colony size related characters*. The dissertation research was done in the Caribbean, mostly Panama. He then returned to Taiwan and worked on marine invertebrates of the western Pacific with an emphasis on coral reef organisms, as a faculty member of the Institute of Marine Biology, National Sun Yat-sen University. Due to the degradation of coral reefs in Taiwan, marine scientists there initiated a Taiwanese Coral Reef Society to focus researches on conservation-relevant issues. He is an active member of the society and served as President from 1999-2000. His present research interests are versatile, and can be covered by the following keywords: corals, recruitment, marine insects, biological clock and population biology.