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Coral Bleaching on the Great Barrier Reef and Causes

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Abstract. With the increasing problem of global warming, the Earth's environment has been seriously damaged in recent decades, especially the Marine environment. Covering 71 percent of the Earth, the oceans are an important part of the planet, but such a beautiful and rich resource is now in decline. This paper mainly expounds the embodiment of environmental problems in coral reefs (take the Great Barrier Reef as an example). Large numbers of coral reefs are bleaching and dying because of climate change. Nowadays, the problem of severe Marine environment is getting worse and worse, which has aroused people's great attention in the world. The main causes of coral bleaching are rising temperatures, eating crown-of-thorns starfish and acidification. Finally, this paper expounds the damage to the ecological environment and the disasters faced by human beings if coral reefs are lost. In the future, we should do our best to protect coral reefs and prohibit vandalism, pollution and overfishing. And can artificially cultivate, transplant coral reefs, remove coral pests and so on. This article aims to point out the causes of coral bleaching, so that more people can realize the crisis we are facing, and call on people to take small steps to protect our only planet.

Keywords: global warming, coral reefs, climate change, marine environment, coral bleaching

1. Introduction

At present, the climate problem causes the Marine environment situation is not optimistic. The coral reef ecosystem with reef-building corals as the core is characterized by rich biodiversity, high primary productivity and rapid material cycle. In addition, coral reefs also have many functions such as scientific research, seashore protection, environmental protection, recreation and so on. From the perspective of scientific research, coral reefs, which are extremely sensitive to environmental changes, are also important carriers of a series of environmental information, important sources of new species, new genes and new drugs, and directly participate in the global carbon cycle. The unique three-dimensional structure of coral reefs makes it directly relevant to a range of specialized disciplines. From the perspective of global change, coral reefs, as important carriers of high-resolution environmental change, have made important contributions to reveal the processes, events and mechanisms of climate change. However, the widespread bleaching and even death of coral reefs has a lot to do with human behavior. With the rapid development of global industry, the world's carbon dioxide emissions are increasing. This has contributed to the growing problem of global warming, which has also raised the temperature of the world's oceans. Warmer ocean temperatures have allowed some species to flourish, but not for the better. At the same time, excess carbon dioxide dissolves in seawater, causing it to acidify. Therefore, higher sea temperature, biological explosion and

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acidification are the main causes of coral bleaching. The main purpose of this study is to popularize the related knowledge of coral bleaching and the causes of coral bleaching. I hope that by reading this paper, we can understand how human beings have affected the Marine environment, and correct, reduce or eliminate the behavior of destroying the Marine environment, and protect our ocean.

Coral reefs have been showing signs of bleaching since the late last century. In order to learn the long-term survival of coral reefs in this year and age that face global warming better, modern marine ecology must be studied and must investigate the history of coral bleaching events in the past. The repeated bleaching and die-off of corals occurred before the 1980s, which due to the long-term modern global warming in the last century [1]. For decades, many scientists have been aware of the dangers of coral reefs and have tried to address them. I think the causes of coral bleaching are now clear. What we still need to study is how to solve the problem of coral bleaching, but at the same time, we need to consider whether the protection of coral reefs will affect the development of industry and economy, because human progress and development are also a major cause of coral reef bleaching. In this light, it is not easy to find a win-win solution for environmental protection and national development.

This essay describes the dire situation of the Great Barrier Reef in recent years, how coral bleaching works, and most importantly, what causes coral bleaching and death. At the same time, this paper hope that no matter what occupation, young and old people can make contribution to protect our homeland.

2. The Great Barrier Reef

The Great Barrier Reef is the largest coral reef group all over the world which located in the southern hemisphere. It ranges an area that has a total length of 2011 kilometers and about 161 kilometers at its widest point. There are 2,900 diverse coral reefs with very special natural wonders. The Great Barrier Reef was added to the World Heritage List in 1981. However, scientists have found that most of the original reefs in the northern section of the Great Barrier Reef have been killed off in large numbers in 2016. The reefs in the central part of the Great Barrier Reef, although spared in 2016, are also bleaching, which could be a harbinger of another mass die-off.

2.1. Coral bleaching

In general, coral bleaching refers to the bleaching of colorful coral. In normal conditions, corals appear green, blue, yellow, brown, red, purple and other colors, but these colors do not come from the corals themselves, but from the symbiotic algae inside the corals. In addition to making the coral beautiful, these symbiotic algae also produce food for themselves and their host polyps through photosynthesis. When the seawater environment changes, the corals expel these symbiotic algae from their bodies. As a result, the coral turns white and loses its source of nutrients. The general metabolic function of albino corals showed a different response than that of healthy corals [2]. Fig. 1 shows the coral bleaching on the Great Barrier Reef. Professor Terry Hughes, from Australia's James Cook University, said there had been four bleaching events on the Great Barrier Reef since 1998 and the short interval between the latest two was cause for alarm. In the past 20 years, the Great Barrier Reef has suffered four memorable coral bleaching events.

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Figure 1. The coral bleaching on the Great Barrier Reef.

2.2. Ecological problems of the Great Barrier Reef

2.2.1. Human activities. Coral reefs around the world are degrading because of the climate change. In the last few years, horrible coral bleaching events have become more frequent, leading to sharp declines in coral cover [3]. Evidence from coral reefs around the world, including in Southeast Asia and the Caribbean, suggests that the inflow of sediments and nutrients from terrestrial runoff is a potential threat to coral reef environments. Coastal reefs contain a so-called proxy record of land-based sediment inflow in the form of barium concentrations: when fresh water enters the ocean, barium is released from suspended particles and subsequently absorbed into the coral's carbon skeleton. Using a barium proxy record from a 250-year-old coral, McCulloch et al. found that the rate at which river sediment is transported to the inner reef has increased five to ten times since European settlement in the 1860s, as a consequence of grazing, agriculture, and related activities such as land reclamation. Although the impact of increased river sediment inputs remains uncertain, there is a clear risk of severe environmental damage to the Great Barrier Reef, with the potential for loss of biodiversity and reduced economic value.

2.2.2. Climate change. A climate report released by the United Nations paints a dire picture of the future of the Great Barrier Reef, which is rapidly being transformed by the effects of climate change. Global coral bleaching under heat stress has been identified as a major driver of coral reef degradation [4]. There is much in the report of the Intergovernmental Panel on Climate Change (IPCC) to worry the world. The report bluntly states that the Great Barrier Reef is severely affected by climate change, with rising ocean temperatures causing frequent and severe coral bleaching. As one of the world's largest exporters of coal and liquefied natural gas, and one of the highest per capita emitters of greenhouse gases, Australia is putting the reef in great danger.

3. Causes of coral bleaching on the Great Barrier Reef

3.1. Symbiotic algae

As "framework" of coral reefs, reef building with zooxanthella mutualism, coral hosts for intracellular zooxanthella shelter and inorganic nutrients such as nitrogen, phosphorus, and carbon dioxide in return, zooxanthella for photosynthesis, and most of the product “share” to coral hosts, in order to meet the energy needs of coral and the calcified growth of corals. Healthy reef-building corals typically contain millions of zooxanthellae per square centimeter. The symbiotic zooxanthellae density of all coral species showed obvious seasonal fluctuations, with low summer and high winter (about twice as high as summer), which was the result of the synergistic effect of SST and solar radiation.

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3.2. Temperature

Coral reefs around the world are exposed to increasing heat stress due to global warming [5]. If the coral lives near the upper boundary of the thermal potential, it is actually beneficial for growth and other processes. However, coral bleaching is caused by rising ocean temperatures [6]. The main driver of coral bleaching is rising seawater temperatures, and climate change is accelerating the destructive and severe nature of ocean heat waves, causing coral drives to expel their symbiotic algae, or simply "scour" them to death [7]. Although high water temperatures do not kill corals directly, they eventually starve to death from lack of nutrients as they lose their symbiotic algae, and many Marine organisms that depend on them lose their habitat. The Australian Bureau of Meteorology said sea temperatures in February were the highest since records began, causing serious damage to coral reefs. According to media reports, the Great Barrier Reef was in 1998, 2002, 2016 and 2017 had massive coral bleaching phenomenon, can see is that mass bleaching phenomenon are becoming more and more frequent in this century, the rapid rise and the global temperature, seawater temperature have close relations, it illustrates the importance of currently to slow global warming.

3.3. Eating of Crown-of-thorns starfish

Many corals are closely related to the various types of fish and other fauna that inhabit them. As coral reefs around the world are now threatened by coral bleaching events, understanding how biological interactions affect coral reefs is important for coral bleaching sensitivity [8]. In addition to bleaching caused by deteriorating water quality, Australia's Great Barrier Reef is also facing a life-threatening threat: the crown-of-thorns starfish. Crown-of-thorns starfish is a poisonous sea creature that often causes severe pain when stung. Crown-of-thorns starfish are most likely to eat coral worms on the surface of the coral, leaving only the coral skeleton which is white. Just one crown-of-thorns starfish eats an average of about two square meters of coral per day. Crown-of-thorns starfish are large, up to 20 cm in diameter, with 9 to 20 wrists. The bony plates of the surface are widely spaced, each plate has a long spine, the lower part of the spine has a stalk, and the upper part of the spine is very sharp. Crown-of-thorns starfish not only eat like crazy, but also have incredible fecundity. There are now at least one million crown-of-thorns starfish across millions of square kilometers of the Great Barrier Reef, and the population is still growing rapidly from Cooktown in the north to Cairns in the south. In the last 50 years, Australia has seen three "big outbreaks" of crown-of-thorns starfish (large populations occurring every few years) that have wreaked havoc on corals. The main causes of these "big outbreaks" are still not identified by scientists. Oceanographers speculate that there are several factors: the disappearance of sea snails (natural predators of crown-of-thorns starfish), which allows these starfish to proliferate and disrupt the ecological balance; and the optimization of the marine environment, which leads to the frenzied growth of large amounts of algae, providing an ample food source for starfish larvae and thus increasing the starfish population. Generally, when crown-of-thorns starfish eat some overgrown corals, they are able to allow slower-growing corals to compete for part of the growth space and thus grow upward to avoid being covered by other competitors and losing access to light, thus increasing the diversity of coral species. However, when crown-of-thorns starfish become too numerous, excessive predation can lead to coral reef mortality [9]. Fig. 2 shows a crown-of-thorns starfish attached to a coral reef.

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Figure 2. Crown-of-thorns starfish attached to a coral reef.

Began in 2011, the number of spine crown starfish and rise sharply, the Australian government in addition to send the sea removing spines crown starfish, scientists are from the past a few times after the occurrence of large and sudden disappearance of examples to study, find out some can make the starfish pathogenic vibrio, starfish and search with underwater robot automatic identification, to foster the vibrio let sea star died of disease cause, Vibrio can also cross infect starfish, causing mass death in crown-of-thorns starfish.

3.4. pH

As the water acidifies, zooxanthellae decrease, turning the coral gradually white. Ocean acidification refers to the process of lowering the pH of seawater by dissolving more CO_2 from the atmosphere. Ocean acidification not only changes the chemical composition of the ocean, but also affects the living environment of marine life. Acidified seawater prevents the skeletons and shells of corals from forming properly, and coral reefs are constantly eroding in the acidic environment. Scientists estimate that the pH of the ocean's surface has dropped by 0.1 since the industrial revolution and could continue to drop by 0.3 to 0.4 by the end of the century if current trends in fossil fuel consumption and atmospheric CO_2 concentrations continue. This means that the concentration of hydrogen ions in seawater will increase by 100-150% compared to the pre-industrial revolution. Although the acidity of the world's oceans has been stable for 23 million years, too much extra carbon dioxide has changed the chemistry of the water, making it more acidic. The ocean absorbs CO_2 from the atmosphere at a rate of more than 1 million tons per hour, causing the pH of the upper ocean to fall continuously, causing ocean acidification. Scientists estimate that the pH of the global ocean is dropping by 0.0022 units per year.

Even when coral reefs have natural breakwaters, they can still erode as acidification increases when they are severely inhibited by seawater acidification. In the short run, the phenomenon will not be obvious, but the coral reef ecosystem has been severely damaged which led to the coral's scarcity. Ocean acidification accelerates the reduction of aragonite, a mineral that makes up coral skeletons. With less aragonite, corals can't rebuild their skeletons and slowly disintegrate over time.

4. The dangers of coral bleaching

Coral reefs are diverse and vital ecosystems, so coral bleaching can have destabilizing effects on local ecosystems. As climate change intensifies, researchers have long argued that the frequency of coral bleaching could have a serious impact on fisheries. If coral reefs are bleached, biodiversity will be

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reduced, which is an indirect effect on humans. On the other hand, the direct effects are reflected in the degradation of fishing, tourism and the weakening of coastal protection. Coral reefs have been an important part of the Earth's ecology since 240 million years ago. Scientists now believe that more than a million species of plants and animals are linked to coral reef ecosystems. But today, about 60 percent of the world's coral reefs are under serious threat because of human activity, with marine life declining by 30 percent in a few decades. We can't deny that these extinct biological clocks may hold the key to treating HIV and cancer. If coral reefs continue to decline, humans will lose more valuable marine species faster [10].

5. Conclusion

Coral reefs cover a large area in the ocean. They not only add color and beauty to the ocean, but also have a huge connection and help to human production and life. Coral bleaching is one of the global environmental concerns. Coral bleaching maintains biodiversity and ecosystem balance worldwide, as marine ecosystems are the foundation of life on earth, and the coral bleaching is largely caused by us. Therefore, we have to live with the mistakes we made in the past. Changing our current behavior is the ultimate goal of the intensified environmental movement. Overall, the main causes of coral bleaching are rising temperatures, overbreeding and feeding by crown-of-thorns starfish and acidification. Now, the problem of coral bleaching has attracted the close attention of scholars around the world, and many national leaders have taken measures to address it, improve global warming and promote green and low-carbon development. In the future, I believe more and more environment-friendly technologies will be invented and the problem of coral bleaching will be solved one by one. The purpose of this article is to list the causes of coral bleaching in the hope that people will pay attention to the protection of coral reefs and do their best to protect our blue planet.

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