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专论与综述

珊瑚礁白化研究进展

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摘要 珊瑚礁白化是由于珊瑚失去体内共生的虫黄藻和（或）共生的虫黄藻失去体内色素而导致五彩缤纷的珊瑚礁变白的生态现象。近年来，频繁发生的珊瑚礁白化导致了珊瑚礁生态系统严重退化，并已经影响到全球珊瑚礁生态系统的平衡，受到了人们的高度重视。研究认为：（1）大范围珊瑚礁白化主要是全球环境变化引起的，尤其是全球变暖和紫外辐射增强；（2）导致珊瑚礁白化的机制主要在于细胞机制和光抑制机制；（3）珊瑚礁白化后的恢复与白化程度有关，大范围白化的珊瑚礁完全恢复需要几年到几十年；（4）珊瑚礁白化的后果在于降低珊瑚繁殖能力、减缓珊瑚礁生长、改变礁栖生物的群落结构，导致大面积珊瑚死亡和改变珊瑚礁生态类型，如变为海藻型等；(5) 与珊瑚共生的D系群虫黄藻更适应高温环境，珊瑚礁有可能通过D系群逐渐取代C系群的方式适应全球环境变化。

关键词 珊瑚礁白化 _ 诱发因素 _ 机制 _ 恢复 _ 生态影响

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Recent development in coral reef bleaching research

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Abstract Coral reef bleaching, the ecological phenomenon of whitening of reefs, results from the loss of symbiotic zooxanthellae and/or a reduction in photosynthetic pigment concentrations in zooxanthellae residing within the gastrodermal tissues of host animals. Bleaching can be triggered by a variety of environmental factors including extremes of temperature (heat shock and cold shock), ultraviolet radiation, pollution, disease, etc.. Although any of these processes may act on a local scale, large-scale bleaching (or mass bleaching) events have generally been linked to elevated sea surface temperature (or high irradiance) as a result of recent global warming, accompanied by intensified El Nio-Southern Oscillation(ENSO) events. Mass bleaching events often result in large-scale coral mortality, such as the 1998 widespread bleaching event that led to massive mortality of global reefs. Furthermore, such coral reef bleaching has increased in frequency, intensity, and geographical extent over the past decade. It has been suggested that bleaching will become even more common in the next 30-50 years.

There are two mechanisms that are responsible for coral reef bleaching: one is cellular mechanism, involving a variety of processes such as degeneration of zooxanthellae in situ, apoptosis and necrosis, release of zooxanthellae from gastrodermal tissues and release of algae within host cells; the other is photoinhibition of photosynthesis which involves photodamage to photosystem Ⅱ (PSⅡ) of the zooxanthellae, with the sequent increase in the production of damaging reactive oxygen species (ROS).

Although bleached coral reefs may recover, their full recovery from a mass bleaching event will take several years to decades. Approximately 40% of the 16% of the world's reefs that were seriously damaged in 1998 are either recovering well or have recovered in 2004, and others are continue to recover, with stronger recovery in well-managed and remote reefs. However, such recover

y could be reversed if anthropogenic pressures continue to increase on coral reefs. Coral reef ble aching will have impact on reef ecology in terms of ecological system degradation, coral growth ra te reduction, coral community structure change, reef fish community change, as well as reef skelet al structure loss.
There is an adaptive bleaching hypothesis, in which stressed corals first lose their symbionts (blea ching) and then regain a new mix of symbionts that are better suited to the stressed environmen t. Accordingly, coral reef may survive in further warming environment through adapting to new alg al symbionts (such as clade D-Zooxanthellae).

Key words _ coral _ reef _ bleaching _ trigger _ factor _ mechanism _ recovery _ ecol ogical _ impacts

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