

What is Coral Bleaching?

Coral bleaching is a stress response of corals characterized by the loss of their vibrant colours, turning them pale or white. This occurs when corals, which live in a symbiotic relationship with microscopic algae called zooxanthellae, expel these algae due to adverse environmental conditions. Since zooxanthellae provide corals with much of their energy through photosynthesis and contribute to their colour, their loss leads to coral starvation and increased vulnerability.

Causes of Coral Bleaching

- **Elevated Sea Temperatures:** The most common trigger is prolonged exposure to unusually warm water, often linked to climate change and marine heatwaves.
- **Solar Radiation:** High levels of sunlight, especially ultraviolet radiation, can exacerbate bleaching during warm conditions.
- **Ocean Acidification:** Changes in seawater chemistry reduce corals' ability to build skeletons and can stress the symbiotic relationship.
- **Pollution and Sedimentation:** Runoff containing pollutants or excessive sediments can stress corals and contribute to bleaching.

Consequences of Coral Bleaching

- **Reduced Coral Growth and Reproduction:** Without zooxanthellae, corals lose vital energy sources.
- **Increased Mortality:** Prolonged bleaching can lead to coral death, degrading reef ecosystems.
- **Loss of Biodiversity:** Coral reefs support diverse marine life; their decline affects entire ecosystems and human livelihoods dependent on them.

Coral bleaching serves as a stark indicator of marine environmental stress, especially from climate change, underlining the urgency of global efforts to reduce greenhouse gas emissions and protect ocean health.

Does Coral Bleaching Affect Genetic Diversity?

Coral bleaching can affect the genetic diversity of coral populations, with significant implications for their resilience and long-term survival.

How Coral Bleaching Impacts Genetic Diversity

- **Selective Mortality:** Bleaching events often cause high mortality rates among corals, but not all coral genotypes respond equally. Some genotypes are more tolerant to heat stress and survive better, while sensitive ones perish. This selective survival can reduce the overall genetic diversity by disproportionately eliminating less tolerant genotypes.
- **Population Bottlenecks:** Severe bleaching can cause population declines or local extinctions, leading to genetic bottlenecks where only a small subset of the original genetic variation remains. This loss reduces the ability of coral populations to adapt to future environmental changes.
- **Reduced Reproductive Capacity:** Bleached corals that survive may have impaired reproduction, producing fewer or less viable offspring, which can further limit genetic diversity and population recovery.
- **Potential for Adaptive Evolution:** On a more hopeful note, repeated bleaching events may drive natural selection favouring heat-tolerant genotypes, potentially increasing the

frequency of resilient traits over time. However, this depends on sufficient genetic variation being retained and the pace of environmental change.

Coral bleaching acts as a strong selective pressure that can reduce genetic diversity by killing susceptible genotypes and causing population bottlenecks. This reduction in genetic variation limits the corals' adaptive capacity, making future recovery and resilience more challenging. However, it may also accelerate natural selection for more heat-tolerant genotypes, offering a pathway for adaptation if genetic diversity is not too severely depleted.

This dynamic underscores the importance of protecting diverse coral populations and mitigating climate change to preserve the evolutionary potential of coral reefs.

Does Coral Bleaching Effect Species Diversity?

Coral bleaching has profound effects on species diversity within coral reef ecosystems, often leading to declines in biodiversity and alterations in community structure.

How Coral Bleaching Affects Species Diversity

- **Loss of Habitat Complexity:** Healthy corals create complex three-dimensional structures that provide shelter, breeding grounds, and feeding habitats for a vast array of marine species. Bleaching weakens and often kills corals, leading to reef degradation and loss of habitat complexity, which directly reduces the diversity and abundance of reef-associated species such as fish, invertebrates, and algae.
- **Decline in Fish and Invertebrate Populations:** Many reef fish and invertebrates depend on live coral for food and shelter. Bleaching-induced coral mortality reduces food availability and protective niches, causing declines in species richness and abundance.
- **Altered Community Composition:** Following bleaching events, reefs may shift from coral-dominated to algal-dominated systems. This phase shift favours species adapted to algae rather than corals, thereby changing species assemblages and reducing overall reef biodiversity.
- **Reduced Resilience and Recovery Potential:** Lower species diversity weakens ecosystem resilience, making reefs more vulnerable to further disturbances and less capable of recovery.

Coral bleaching undermines species diversity by damaging the foundational coral structures that support complex reef communities. The resulting habitat loss and shifts in ecosystem composition reduce the richness and abundance of reef species, weakening ecosystem resilience and function. Protecting coral reefs from bleaching through climate action and local conservation is essential to preserving marine biodiversity and the services reefs provide.

Material Sourced from the Following

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