The Effects of Oxybenzone on the Regeneration of Hawaiian Coral Reefs

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Abstract

Coral reefs are an ecosystem of corals used by thousands of organisms in the ocean. Ten percent of coral reef populations are unbleached and intact in the Caribbean ocean, meaning reefs are beginning to decline in size as corals stress (Hongo et al., 2013). Corals in Hawaii have begun to stress because of sunscreen chemicals leaking into the oceans from human use in care products and sunscreens. As more chemicals spill into the ocean, the less coral reefs there will be due to coral being affected by chemicals in the ocean. Oxybenzone, a chemical sunscreen ingredient that causes genetic diseases to occur in coral, is the leading chemical responsible for the bleaching of coral populations all across the world. The paper will be conducted through systematic literature review and secondary data based to analyze the effects of Oxybenzone on the coral reef ecosystem. The results concluded that Oxybenzone is a leading ingredient in thousands of sun care products and will not be possible to ban in every aquatic setting due to human skin health. Because of this, alternate chemicals will be evaluated to replace Oxybenzone while still protecting humans.

Purpose

To investigate the effects of Oxybenzone on the regeneration of Hawaiian coral reefs. Coral Reef bleaching is important to today's society because coral colonies house diverse species of plants and aquatic life, act as a barrier to the shore and ocean, and are a tourism industry. If coral continue to bleach, they will become deformed and pass on unwanted mutations in their DNA and genetics. As mutations accumulate over time, undamaged corals will be affected and may die.

Research Question

What is the effect of Oxybenzone on the regeneration of Hawaiian coral reefs?

Hypothesis

Alternative Hypothesis:

Oxybenzone in the sunscreen products decreases the regeneration of coral reefs over time.

Null Hypothesis:

Oxybenzone in the sunscreen products does not affect the regeneration of coral reefs over time.

Introduction

Sunscreens rub off into oceans when applied. With the surface of the ocean being covered with toxic oils, the amount of sunlight that is able to reach the corals is limited due to the reflection of light off the oils back into the atmosphere.

The washed off sunscreen from tourists sinks into the ocean, coating the coral, acting as a physiological support structure, unable to be broken down by the coral due to its inorganic composition. Because the lack of light entering the ocean, dinoflagellates, photosynthesis creating algaes living in symbiosis on the exoskeleton with zooxanthellae, detach from the coral, leaving the coral unable to produce enough photosynthesis to support the production of the calcium skeleton that stabilizes the growing coral.

Due to Oxybenzone, colonies are genetically affected, creating mutations in coral colonies such as reproduction mutations, affecting the reproductive systems of corals, interrupting the remodeling of calcium branch repair, acting as a skeletal endocrine disruptor, damaging cell makeup and weakening DNA, and creating an excess amount of calcium, encasing the coral in a calcium shell (Downs et al., 2015). This will cause mutations in offspring as coral pass on unwanted characteristics through reproduction.

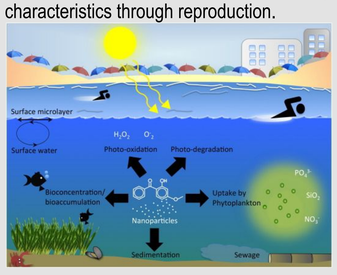

Fig. 1 Diagram of chemicals and pollution entering aquatic ecosystem.

Fig. 2 A bleached coral reef.

Methods

The research paper is a systematic literature review of peer reviewed articles. Articles were gathered from various databases such as NOAA, Google Scholar, Ebscohost, PLoS, Cross Mark, Wiley Interscience Journals, Environmental International, Oxford Journals, Environmental Health Perspectives, and Springer. Data was collected on cell mortality rates to support how growth and development is affected by coral bleaching. Mortality rates of cells shows the breakdown of coral internally due to bleaching. Data was entered in google sheets to begin and then transferred to Excel for data analysis and to perform T-tests.

Discussion

Coral species with a lower LC count are vulnerable at a lower sunscreen concentration. The LC of the coral species is the concentration at which the coral can begin to decrease in responsiveness and die off. The concentration tested is sunscreen chemicals entering the water in amounts large enough to be gathered and tested on. This shows that sunscreens are entering aquatic ecosystems at concentrations significant enough to damage corals.

Oxybenzone is lethal to coral reef ecosystems as concentration levels begin to kill coral cells as the amount of Oxybenzone in the environment increases. With the comparison of Oxybenzone concentrations being related to cell death, a p-value of 0.0061 was gathered. The null hypothesis is rejected and the alternative hypothesis is accepted. This justifies Oxybenzone having an impact on growth and development of Hawaiian coral reefs due to the small p-value.

Results

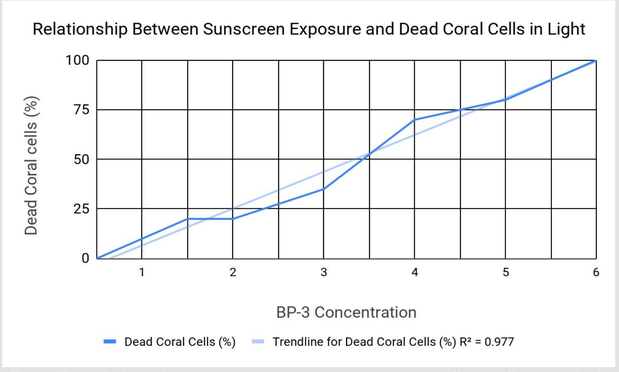

Fig. 3 The relationship between sunscreen exposure and cell mortality rates in the light.

Coral Species	OB -LC50 (ug/L)
Indo-Pacific species	
Stylophora pistillata (light)	42
Stylophora pistillata (dark)	671
Pocillopora damicornis	8
Caribbean-Atlantic Species	
Acropora cervicornis	9
Montastrea annularis	74
Montastrea cavernosa	52
Porites asteoides	340
Porites divaricata	36

Table 1. The Lethal Contaminations (LC) of Oxybenzone (OB) according to specific coral species.

Conclusion

Because sunscreen ingredients cannot be eliminated from consumer use due to sun exposure, Oxybenzone will continue to bleach coral reefs unless the use of Oxybenzone containing sunscreen products are limited. With the Hawaii bill banning the use of chemical sunscreens on beaches, harmful chemicals will be limited, but not fully out of ecosystems due to other oceanside locations using sunscreen products. While Oxybenzone is poisonous to the coral ecosystem, sunscreen is necessary to protect humans from UV radiation. Humans will not stop using sunscreen for the purpose of protecting their bodies, meaning the chemical makeup of sunscreen will have to be altered to support human skin as well as the aquatic ecosystem.

Further Work

Titanium Dioxide could be an alternative solution to the chemical sunscreen ingredient Oxybenzone because it is less harmful to the coral reef ecosystem. While it has been discussed above, Titanium Dioxide still impacts reef life, but not as widely as Oxybenzone. Because of this, Titanium Dioxide can be implemented into sunscreens more often than more harmful chemicals. While Titanium Dioxide still impacts reefs, it is the only other option available on market that works to block UV sun rays for human purposes.

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