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Sunscreen and Coral Reef

AK Mohiuddin

Department of Pharmacy, World University of Bangladesh

ABSTRACT

Coral reefs also provide major essential benefits to people, like food production, tourism, biotechnology development, and coastal protection. While covering less than 1% of the ocean surface, coral reefs provide habitat for nearly one third of marine fish species as well as 10% of all fish captured for human consumption. In some situations, primarily related to the number of swimmers and the geography of the shoreline, concentrations of oxybenzone far exceed the levels shown to be harmful to corals [1]. Coral reefs consist of organisms in delicate equilibria that are susceptible to small changes in their surroundings. Recent natural and man-made disruptions, direct or indirect, such as changes in ocean temperature and chemistry, ingress of invasive species, pathogens, pollution and deleterious fishing practices, have been blamed for the poor health, or even the outright destruction, of some coral reefs [2]. Florida has the world's third largest barrier reef, with nearly 1,400 species of plants and animals and 500 species of fish, but the reef is vanishing fast. Research has found that roughly half of the reef has disappeared over the past 250 years. Coverage of acropora, the primary genus of reef-building corals, has plummeted 97% [3]. In 2015, the nonprofit Haereticus Environmental Laboratory surveyed Trunk Bay beach on St. John, where visitors ranged from 2,000 to 5,000 swimmers daily, and estimated over 6,000 pounds of sunscreen was deposited on the reef annually. The same year, it found an average of 412 pounds of sunscreen was deposited daily on the reef at Hanau Bay, a popular snorkeling destination in Oahu (Hawaii) that draws an average of 2,600 swimmers each day. Over the past three years, one - fifth of the world's coral reefs have died off — and there is a growing awareness that sunscreen is playing a role [4,5]. 82,000 chemicals from personal-care products may be tainting the seas; about 80 percent of corals in the Caribbean have been lost in the last 50 years due to pollution, coastal development, and warming waters [6]. From 6,000 to 14,000 tons

*Correspondence to Author:

AK Mohiuddin

Department of Pharmacy, World University of Bangladesh

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of sunscreen slide off of humans into coral reef areas each year, exposing the gorgeous underwater ecosystems to chemicals that can kill them. Global warming is the main reason that coral reefs are dying — but sunscreens play a role, too. Over the past three years, one-fifth of the world's coral reefs have died off — and there is a growing awareness that sunscreen is playing a role [7,8]. In some situations, primarily related to the number of swimmers and the geography of the shoreline, concentrations of oxybenzone far exceed the levels shown to be harmful to corals [1]. Hawaii will ban two major ingredients of sunscreens-- oxybenzone and octinoxate. But sunscreens also save lives by decreasing the risk of UV-induced skin cancers [2], [9,10]. It is said that a single drop of oxybenzone in more than 4 million gallons of water is enough to endanger organisms [7]. Studies have identified UV filters such as oxybenzone, octocrylene, octinoxate, and ethylhexyl salicylate in almost all water sources around the world and have commented that these filters are not easily removed by common wastewater treatment plant techniques. Additionally, in laboratory settings, oxybenzone has been implicated specifically as a possible contributor to coral reef bleaching. Furthermore, UV filters such as 4-methylbenzylidene camphor, oxybenzone, octocrylene, and octinoxate have been identified in various species of fish worldwide, which has possible consequences for the food chain [11]. Coral bleaching has negative impacts on biodiversity and functioning of reef ecosystems and their production of goods and services. Bleaching is a stress response by corals, where they turn pale due to a decline in the symbiotic microalgae that lives inside their tissues. This increasing world - wide phenomenon is associated with temperature anomalies, high irradiance, pollution, and bacterial diseases. Sunscreens, by promoting viral infection, potentially play an important role in coral bleaching in areas prone to high levels of recreational use by humans [12]. Hard-coral

bleaching and the increase in viral abundance in seawater were also seen after coral treatment with mitomycin C, an antibiotic commonly used to induce the lytic cycle in latent viral infections [2], [11-16]. Marine biologists say that the chemicals alter corals' DNA and weaken their immunity to disease [3]. Unfortunately, the World Conservation Institute estimates that 20% of coral reefs are already destroyed, another 25% are in great immediate threat, and another 25% will be threatened by 2050 [17,18]. Haereticus Environmental Lab publishes a list each year of what sunscreens are safe for the environment, and the Environmental Working Group rates products with SPF values—including some 650 sunscreens and 250 moisturizers—on their environmental impact [6]. Although, medical and skin cancer specialists have warned of the public health risks of a ban on widely used sunscreens, describing the prohibition as risky and unjustified, in part because the few studies that have addressed the environmental impacts of sunscreens experimentally “are not representative of real-world conditions” [12]. The American Academy of Dermatology reiterated that skin cancer was the most common cancer in the United States, and that people should protect themselves with sunscreen and protective clothing, and by staying out of the sun [19]. Mineral (or physical) sunscreens, which typically feature zinc or titanium oxide as active ingredients, tend to be less damaging to coral reefs than chemical counterparts and synthetic preservatives. However, not all mineral formulas are created equal [20]. One estimate from the National Oceanic and Atmospheric Administration put the economic contribution of coral reefs around the world at \$30 billion each year. Reefs also protect the global environment by serving as carbon sinks, absorbing carbon dioxide that would otherwise contribute to global warming [21]. Certain preservatives found in sunscreens are also toxic: parabens such as the commonly used methyl paraben and butyl paraben, or phenoxyethanol, which was originally used as a mass fish anesthetic [22].

The degradation of reefs has direct impacts on coastal communities that depend on reef resources for their livelihoods. One of the main challenges of ecosystem and conservation management plans is to account for the connection between local habitats and the conflicting demands of different stakeholders on reef resources [23]. Little is known about its effects on small-polyp stony corals that are the main framework builders in coral reefs. Pollution of marine environments with microplastic particles has increased rapidly during the last decades [24]. Additionally, coral reefs are faced with the dual emerging threats of ocean warming and acidification due to rising CO₂ emissions, with dire predictions that they will not survive the century [25]. In 2016, record high temperatures caused the third global-scale mass coral bleaching event—a key consequence of climate change-affecting 93% of reefs in the Great Barrier Reef (GBR), one of the most recognized and well-managed ecosystems on the planet [26]. Ecosystem-based management combined with resilience thinking can be used to better effect than approaches which do not take into account the multi-use, complex social-ecological nature of coral reef systems. Improving marine protected areas (MPA) design to enable coral reef organisms to adapt, acclimate or disperse under climate change is necessary but not sufficient: a range of other conservation tools will need to be employed including management of external stressors, alternative fisheries restrictions, novel approaches such as active restoration, inclusion of social–ecological factors and action on multiple scales.

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Abbreviations

Great Barrier Reef (GBR); Marine protected areas (MPA)

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