DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Testimony of
SUZANNE D. CASE
Chairperson

Before the House Committee on
ENERGY & ENVIRONMENTAL PROTECTION

Tuesday, March 16, 2021
9:00 AM
State Capitol, Via Videoconference, Conference Room 325

In consideration of
SENATE BILL 132, SENATE DRAFT 2
RELATING TO WATER POLLUTION

Senate Bill 132, Senate Draft 2, proposes, beginning January 1, 2023, to ban the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to preserve marine ecosystems. **The Department of Land and Natural Resources (Department) supports this measure and offers the following comments.**

The Department recognizes the concerns about the presence of avobenzone and octocrylene in the nearshore marine environment. There is growing body of science that suggests these chemicals may have negative effects on corals and other marine life.

Octocrylene is now the dominant UV-sunscreen contaminant in coastal waters.[1] Recent scientific studies suggest that octocrylene may have negative impacts in aquatic environments equivalent to oxybenzone (already banned from Hawaii sunscreens). Octocrylene functions as an endocrine disruptor, a metabolism disruptor, and a reproductive disruptor. It has also been shown to reduce the ability of coral symbionts to photosynthesize. Scientific evidence suggests that it can have toxic impacts to a variety of aquatic organisms from corals, to fish, to mammals, to plants.[2]

Avobenzone has been shown to cause toxicity to the light-reactions of photosynthesis which can cause corals to bleach. Avobenzone is also an endocrine disruptor, and can disrupt fat

[1] Downs, Craig A., personal communication (2021)
[2] Fel et al. (2019), Lozano et al. (2020), Giraldo et al. (2017), Boyd et al. (2021), Yan et al. (2020), Zhang et al (2016), Campos et al (2017), Gago-Ferrero et al. (2013), Cocci et al. (2020),Bluthgen et al. (2014)

metabolism.[3] This could reduce coral resilience during bleaching events because bleached corals depend extensively on fat metabolism in order to survive.[3]

As a result of these recent scientific findings, the Department believes that prohibiting the sale of products containing avobenzone and octocrylene would likely benefit the health and resiliency of Hawai‘i’s coral reef ecosystems. At the very least, the Department would recommend support for increased monitoring of various sunscreen chemicals at high-use swimming areas and further research examining the effects of these chemicals on the nearshore marine environment in Hawai‘i.

The Department supports the use of sunscreens that do not contain chemicals that are harmful to marine life, as well as sun protective clothing, as alternatives. The Department continues to conduct outreach efforts to help the public understand the issues regarding using oxybenzone and similar chemicals in the ocean so they can be better informed and make better choices regarding sun protection. These efforts include information on the Department’s Division of Aquatic Resources website, focused one-on-one outreach, news releases, videos, interaction with partner organizations, and meetings with boat tour operators and vendors who sell sunscreen. The Department continues to explore other ways to inform the public on this issue.

It should be noted that, although it is important to address all potential coral reef ecosystem stressors, the primary concerns with Hawaii’s coral reefs continue to be related to land-based source pollution, unsustainable fishing practices, invasive species, and climate change. Continued legislative support to reduce these main stressors will have the largest impact on coral reef resilience and recovery.

Thank you for the opportunity to comment on this measure.

[3] Fel et al. (2020), Boyd et al. (2021), Klopcic and Delenc (2017), Lozano et al. (2020), Ahn et al (2019), Yang et al. (2018)

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Yang, Changwon, et al. (2018), Avobenzone suppresses proliferative activity of human trophoblast cells and induces apoptosis mediated by mitochondrial disruption, Reproductive Toxicology 81, 50–57, https://doi.org/10.1016/j.reprotox.2018.07.003

DAVID Y. IGE
GOVERNOR OF HAWAII

ELIZABETH A. CHAR, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. Box 3378
Honolulu, HI 96801-3378
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Testimony COMMENTING on SB0132 SD2
RELATING TO WATER POLLUTION

REPRESENTATIVE NICOLE LOWEN, CHAIR
REPRESENTATIVE LISA MARTEN, VICE CHAIR
HOUSE COMMITTEE ON ENERGY AND ENVIRONMENTAL PROTECTION
Hearing Date: 3/16/2021 Room Number: Videoconference

Fiscal Implications: This measure may impact the priorities identified in the Governor's Executive Budget Request for the Department of Health's (Department) appropriations and personnel priorities.

Department Testimony: SB 0132 SD2 seeks to add avobenzone and octocrylene to the list of active ingredients restricted from sale or distribution in Hawaii in non-prescription sunscreens. The Department has the following comments.

The Department recognizes the benefits of the 2018 Act 104 prohibiting the sale of oxybenzone and octinoxate containing sunscreen products in Hawaii. It is heartening to see the dramatic increase in availability, variety and consumer acceptance of oxybenzone and octinoxate-free options and mineral sunscreen products that have entered the consumer market in the past few years. Use of these products meets standards for public health protection and offers the public a concrete choice to help protect Hawaii's coral reefs and marine environment when enjoying our beaches. However, the risk of skin cancer from sun exposure remains a hazard for the people of Hawaii and visitors and it is imperative to consider the potential public health consequences of additional prohibition on sunscreen ingredients.

The Department strongly supports public education efforts and outreach strategies to inform Hawaii beachgoers about steps they can take to reduce the unintended impacts of sunscreen use while safely enjoying our tropical marine waters and sunny beaches. The Department also supports academic and applied research efforts further investigating the fate and environmental effects of avobenzone, octocrylene, and other sunscreen compounds in the nearshore marine environment.

Offered Amendments: None

Thank you for the opportunity to testify on this measure.

REBECCA VILLEGAS
Council Member
District 7, Central Kona

PHONE: (808) 323-4267
FAX: (808) 323-4786
EMAIL: *Rebecca.villegas@hawaiicounty.gov*

HAWAI'I COUNTY COUNCIL

West Hawai'i Civic Center, Bldg. A
74-5044 Ane Keohokalole Hwy.
Kailua-Kona, Hawai'i 96740

March 15, 2021

TESTIMONY OF REBECCA VILLEGAS
COUNCIL MEMBER, HAWAI'I COUNTY COUNCIL
ON SB132, RELATING TO WATER POLLUTION
Committee on Energy and Environmental Protection
Tuesday, March 16, 2021
9:00 a.m.
Conference Room 325

Aloha Chair Lowen and Members of the Committees:

I thank you for the opportunity to testify in support of SB132, relating to water pollution. My testimony is submitted in my individual capacity as a member of the Hawai'i County Council and Chair of the Hawai'i County Council Climate Resilience and Natural Resources Protection Committee.

The purpose of this measure is to further prohibit the sale and distribution of sunscreen containing certain chemicals within the State and allow the Department of Health to prevent the sale of additional chemicals through its administrative rulemaking process. A number of sunscreens have recently demonstrated to pose intolerable toxicological threats such as; environmental contamination in coastal waters, harmful impacts on Hawai'i's marine environment, coral reefs and other residing ecosystems, increases the risk of breast cancer, birth defects, development disorders in children and other issues. The State in the interest to preserve our marine ecosystem has banned sunscreen that contain oxybenzone or octinoxate through the enactment of Act 105, session laws of Hawai'i 2018.

Additional action must be taken to prevent any potential harmful impacts of sunscreens containing ingredients other ingredients that is harmful to the environment and public health. Allowing the Department of Health to prevent the sale of additional chemicals through its rulemaking process can ensure future protections.

For the reasons stated above I urge the Committee on Energy and Environmental Protection to support this measure as well. Should you have any questions, please feel free to contact me at (808) 323-4267.

Mahalo for your consideration.

Rebecca Villegas
Council Member, Hawai‘i County Council

SB-132-SD-2
Submitted on: 3/13/2021 10:43:51 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Dr Richard Bennett	KONA COAST WATERKEEPERS	Support	No

Comments:

Dear Legislators,

On behalf of the Kona Coast Waterkeepers, we offer our unwavering support of SB132. The toxic ingredients in commercial sunscreens are deleterious for coral and humans. Reef and human health safe alternatives exist to mitigate the harmful effects of our intense UV sunlight.

Please pass SB132 for the benefit of our reefs, our people, and our visitors.

HAWAII FOOD INDUSTRY ASSOCIATION

1050 Bishop St. PMB 235 | Honolulu, HI 96813
P: 808-533-1292 | e: info@hawaiifood.com

TO:
Committee on Energy and Environmental Protection
Rep. Nicole E. Lowen, Chair
Rep. Lisa Marten, Vice Chair

FROM: HAWAII FOOD INDUSTRY ASSOCIATION
Lauren Zirbel, Executive Director

DATE: March 16, 2021
TIME: 9am
PLACE: Via Videoconference

RE: SB132 SD2 Relating to Water Pollution

Position: Oppose

The Hawaii Food Industry Association is comprised of two hundred member companies representing retailers, suppliers, producers, and distributors of food and beverage related products in the State of Hawaii.

HFIA proposes that since this bill would ban many products that are used to prevent skin cancer, that a higher standard of review should be conducted to ensure that taking this action would indeed improve outcomes for reefs. The primary causes of damage to reefs are increased water temperatures, run-off, sewage, and overfishing.

It's important to understand that it's nearly impossible to enforce a State specific ban of products that can be bought online, including skin protecting moisturizers and sunscreens. Functionally this law will just make it harder for Hawaii consumers to buy products they use to prevent skin cancer, and force them to buy from online sellers rather than local stores.

In Hawaii where skin cancer is a major health concern[1] we believe it's important for people to have access to products that have been proven to offer effective sun protection for daily use. Many products that have sun protection factor, such as lotions, tinted moisturizers, and anti-

[1] http://www.staradvertiser.com/2018/02/28/editorial/island-voices/heathy-people-healthy-places-include-sunscreen/

aging products are intended for daily use in small amounts. These products are not used in large quantities anywhere near the ocean. However, all of these products would be unnecessarily banned under this bill, as would other federally approved and regulated healthcare products.

Given that this ban would not do anything to alleviate the known primary causes of coral bleaching, and that it would try to deprive people of products they use to prevent possibly life-threatening skin cancers, we do not think the potential benefit is worth the risk and we ask that this measure be held.

Thank you for the opportunity to testify.

P.O. Box 437462 | Kamuela, Hawai'i 96743 | +1 808 887-6411 | Fax +1 808 885-6707 | kohalacenter.org

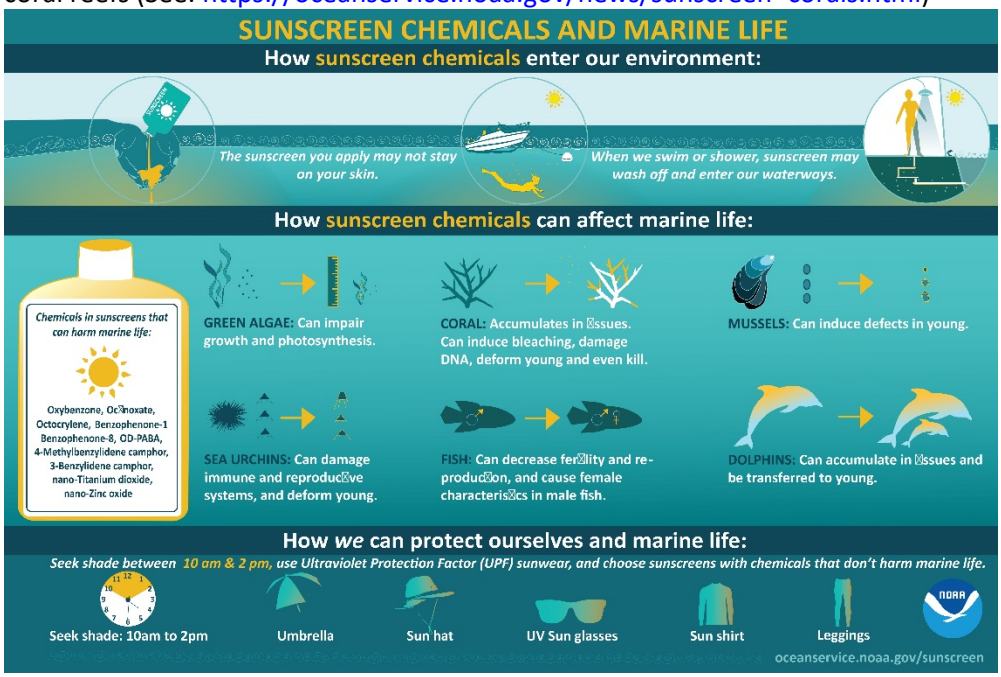
THE KOHALA CENTER®

To: The House Committee on Energy & Environment Protection (EEP)
Re: SB 132 RELATING TO WATER POLLUTION
Position: STRONG SUPPORT
Hearing Date: Tuesday, March 16, 2021 9AM videoconference

Aloha Chair Lowen, Vice Chair Marten, and Energy & Environment Protection Committee Members

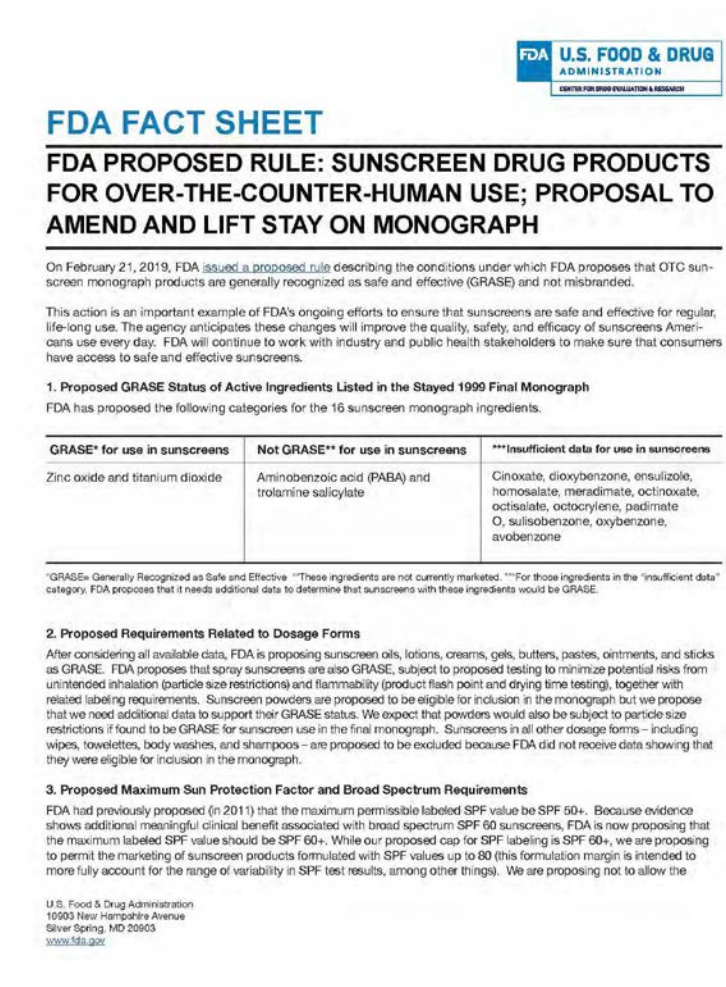
Coral reefs are intrinsic to Hawaiian culture and provide critical natural protection against coastal erosion and sea level rise. Further our coral reefs underpin our vibrant tourism industry, Hawai'i's primary and vital economic engine. Currently, these reefs we depend on are at risk. Where people use marine environments as recreational resources, there is sunscreen pollution. Swimmers put on sunscreen products before they get into the water and over a period of an hour much of that sunscreen will slough off, potentially contaminating the surrounding water. This is a grave concern because it has been reported in the scientific literature that specific petrochemicals in sunscreen can have irreversibly detrimental effects on marine life, including changes in fish behavior, damage to coral DNA and larvae, and the health of algae, fish, shellfish, urchins, and marine mammals.

The National Oceanic and Atmospheric Administration has already recognized this existential threat to our coral reefs (See: https://oceanservice.noaa.gov/news/sunscreen- corals.html)



Because sunscreen companies could not prove efficacy of their petrochemical ingredients, the FDA placed them on the GRASE category 3 "**insufficient data for use in sunscreens**" list. Included among those petrochemical ingredients on the category 3 list are oxybenzone, octinoxate, octisalate, homosalate, **octocrylene and avobenzone**.

(See https://www.fda.gov/media/124655/download).



U.S. FOOD & DRUG ADMINISTRATION

FDA FACT SHEET

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH

On February 21, 2019, FDA issued a proposed rule describing the conditions under which FDA proposes that OTC sunscreen monograph products are generally recognized as safe and effective (GRASE) and not misbranded.

This action is an important example of FDA's ongoing efforts to ensure that sunscreens are safe and effective for regular, life-long use. The agency anticipates these changes will improve the quality, safety, and efficacy of sunscreens Americans use every day. FDA will continue to work with industry and public health stakeholders to make sure that consumers have access to safe and effective sunscreens.

1. Proposed GRASE Status of Active Ingredients Listed in the Stayed 1999 Final Monograph

FDA has proposed the following categories for the 16 sunscreen monograph ingredients.

GRASE* for use in sunscreens	Not GRASE** for use in sunscreens	***Insufficient data for use in sunscreens
Zinc oxide and titanium dioxide	Aminobenzoic acid (PABA) and trolamine salicylate	Cinoxate, dioxybenzone, ensulizole, homosalate, meradimate, octinoxate, octisalate, octocrylene, padimate O, sulisobenzone, oxybenzone, avobenzone

*GRASE= Generally Recognized as Safe and Effective **These ingredients are not currently marketed. ***For those ingredients in the "insufficient data" category, FDA proposes that it needs additional data to determine that sunscreens with these ingredients would be GRASE.

2. Proposed Requirements Related to Dosage Forms

After considering all available data, FDA is proposing sunscreen oils, lotions, creams, gels, butters, pastes, ointments, and sticks as GRASE. FDA proposes that spray sunscreens are also GRASE, subject to proposed testing to minimize potential risks from unintended inhalation (particle size restrictions) and flammability (product flash point and drying time testing), together with related labeling requirements. Sunscreen powders are proposed to be eligible for inclusion in the monograph but we propose that we need additional data to support their GRASE status. We expect that powders would also be subject to particle size restrictions if found to be GRASE for sunscreen use in the final monograph. Sunscreens in all other dosage forms – including wipes, towelettes, body washes, and shampoos – are proposed to be excluded because FDA did not receive data showing that they were eligible for inclusion in the monograph.

3. Proposed Maximum Sun Protection Factor and Broad Spectrum Requirements

FDA had previously proposed (in 2011) that the maximum permissible labeled SPF value be SPF 50+. Because evidence shows additional meaningful clinical benefit associated with broad spectrum SPF 60 sunscreens, FDA is now proposing that the maximum labeled SPF value should be SPF 60+. While our proposed cap for SPF labeling is SPF 60+, we are proposing to permit the marketing of sunscreen products formulated with SPF values up to 80 (this formulation margin is intended to more fully account for the range of variability in SPF test results, among other things). We are proposing not to allow the

U.S. Food & Drug Administration
10903 New Hampshire Avenue
Silver Spring, MD 20993
www.fda.gov

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to oxybenzone that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor.

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Article

Benzophenone Accumulates over Time from the Degradation of Octocrylene in Commercial Sunscreen Products

C. A. Downs,* Joseph C. DiNardo, Didier Stien, Alice M. S. Rodrigues, and Philippe Lebaron

Cite This: https://dx.doi.org/10.1021/acs.chemrestox.0c00461

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ABSTRACT: Benzophenone is a mutagen, carcinogen, and endocrine disruptor. Its presence in food products or food packaging is banned in the United States. Under California Proposition 65, there is no safe harbor for benzophenone in any personal care products, including sunscreens, anti-aging creams, and moisturizers. The purpose of this study was to determine (1) if benzophenone was present in a wide variety of commercial sun protection factor (SPF)/sunscreen products, (2) whether benzophenone concentration in the product increased over time, and (3) if the degradation of octocrylene was the likely source for benzophenone contamination. Benzophenone concentration was assayed in nine commercial sunscreen products from the European Union and eight from the United States (in triplicate), including two single ingredient sources of octocrylene. These same SPF items were subjected to the United States Food and Drug Administration (U.S. FDA)-accelerated stability aging protocol for 6 weeks. Benzophenone was measured in the accelerated-aged products. Sixteen octocrylene-containing product lines that were recently purchased had an average concentration of 39 mg/kg benzophenone, ranging from 6 mg/kg to 186 mg/kg. Benzophenone was not detectable in the product that did not contain octocrylene. After subjecting the 17 products to the U.S. FDA-accelerated stability method, the 16 octocrylene-containing products had an average concentration of 75 mg/kg, ranging from 9.8 mg/kg to 435 mg/kg. Benzophenone was not detectable in the product that did not contain octocrylene. Benzophenone was detected in the pure octocrylene manufactured ingredient. Octocrylene generates benzophenone through a retro-aldol condensation. *In vivo*, up to 70% of the benzophenone in these sunscreen products may be absorbed through the skin. U.S. FDA has established a zero tolerance for benzophenone as a food additive. In the United States, there were 2999 SPF products containing octocrylene in 2019. The safety of octocrylene as a benzophenone generator in SPF or any consumer products should be expeditiously reviewed by regulatory agencies.

INTRODUCTION

Octocrylene (CAS no. 6197-30-4) is one of 14 United States Food and Drug Administration (U.S. FDA) active ingredients approved for use in sun protection factor (SPF) over-the-counter drugs which include sunscreens, moisturizers, lip balms, and anti-aging products. In March of 2019, 2999 SPF products that were registered for sale in the United States contained octocrylene.[1] Octocrylene is also used in non-SPF-labeled personal care products such as shampoos, hair sprays, tanning oils, and conditioners.

The personal care product industry has known for some time that octocrylene is contaminated with benzophenone (CAS no. 119-61-9). When purchasing raw octocrylene for sunscreen or personal care product manufacturing, industry admits that benzophenone is a contaminant found in octocrylene and, for some reason, "cannot be removed by its entirety when octocrylene is being processed..."[2,3] Furthermore, industry members have also stated that the concentration of benzophenone in octocrylene manufactured ingredients and consumer products is "negligible".[2]

Benzophenone is associated with a wide range of toxicities, including genotoxicity, carcinogenicity, and endocrine disruption. Benzophenone and its common metabolites, benzhydrol and *p*-hydroxybenzophenone, were positive mutagens in the Ames test platforms (strain TA102) and in the SOS/Umu mutagenicity platform.[4−7] Benzophenone was also demonstrated to induce thymine dimerization and double-stranded DNA break formation in the presence of UV light.[8]

Benzophenone is an established carcinogen.[9−11] Signs of this pathology induced by benzophenone were first observed in the liver of guinea pig.[12] In mice, oral ingestion of benzophenone resulted in significant manifestations of hepatocellular

Received: October 23, 2020

Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

We ask your **strong support for SB 132** restricting the use of sunscreen petrochemicals that have **questionable effects on the health of humans and marine life** in alignment with **the Precautionary Principle, affording us the opportunity to protect our environment and communities for future generations.**

Sincerely,

Cynthia Punihaole Kennedy, Director
Kahaluʻu Bay Education Center
a program of The Kohala Center

SB-132-SD-2
Submitted on: 3/14/2021 10:07:46 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Inga Gibson	For the Fishes	Support	No

Comments:

March 16, 2021 EEP 9am

RE: SUPPORT SB132 RELATING TO WATER POLLUTION

Dear Chair Lowen and Members of the Committee,

For the Fishes respectfully requests your support of SB132 SD2, to protect both human and marine animal health.

We thank Chair Lowen and the Committee for the actions taken and proposed to protect our reefs and reef wildlife wherever possible; from over-exploitation by the aquarium pet trade to development related pollution and runoff and other human-caused impacts to Hawaii's critically important reefs.

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii’s fragile marine environment. With climate changed induced coral bleaching and ocean acidification forecast to grow in both intensity and frequency over the next decades, we must take every step possible to protect our coral reefs and the marine life and livelihoods they provide the residents of Hawaii.

Thank you for your consideration of this testimony.

Inga Gibson, On behalf of For the Fishes

SB-132-SD-2
Submitted on: 3/14/2021 10:32:06 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Yasuko Banville	Kahalu'u Bay Education Center	Support	No

Comments:

Sunscreens currently on the market still contain a lot of petroleum-based chemicals. Chemicals should be eliminated to protect corals, humans and the planet. I want to live on safe and alive the earth.

SB-132-SD-2
Submitted on: 3/14/2021 5:39:09 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Jonathan Menton	Kahaluâ€™u Bay Education Center	Support	No

Comments:

Aloha,

I have volunteered and worked with Kahalu'u Bay Education Center for the past 2 years. I strongly support removing all dangerous chemicals from sunscreen that is used in Hawaii. We have an incredible treasure here that we are fortunate to be able to share with folks from all over the world. One of the great treasures is the abudance of the life in the sea that is very accessible for snorkelers at many sites in the islands. I

I believe if we don't take care of our resources and fail to practice our kuleana, then we will not only lose our resource, but will also lose the very thing that draws so many guests to our islands each year.

While helping out with ocean activities at Kahalu'u Bay I have noticed how our visitors are very excited to find out how they can help our ocean life. I have found that the vast majority of visitors are more than happy to change their sunscreen usage habits when they find out what chemicals can do our sealife.

It seems like a clear choice to make the change now. Later may be in fact too late to get back what we may lose forever.

Humbly submitted for your consideration,

Jon Menton

March 14, 2021

TO: Representative Nicole E. Lowen, Chair

Representative Lisa Martin, Vice Chair

Members of the House Committee on Energy & Environmental Protection

Thirty First Legislature, Regular Session of 2021

FROM: The members of the Hawaii Skin Cancer Coalition

RE: OPPOSITION to Senate Bill 132, SD2 -RELATING TO WATER POLLUTION
Hearing Date - March 16, 2021

Dear Chair Lowen, Vice Chair Martin, and Members of the Committee,

Mahalo for the opportunity to submit testimony in strong OPPOSITION to Senate Bill 132, SD2 (SB 132, SD 2) on behalf of the Hawaii Skin Cancer Coalition. This Bill, SB 132, SD2 proposes to ban the sale, offer of sale, or distribution in the State of any sunscreen protection personal care products that contain avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to preserve marine ecosystems.

The publicity surrounding this bill has created tremendous misconceptions regarding the effects of sunscreens containing these ingredients on our precious coral reef ecologies. The Hawaii Skin Cancer Coalition members emphasize that the scientific studies identified to support Senate Bill 132, SD 2 do not substantiate the contention that these chemicals, when used as ingredients in sunscreen, contribute significantly to the degradation of coral reefs. Further, there is no evidence that banning or reducing their use will favorably affect coral reefs.

We agree that damage to coral reefs is precipitated by human interaction. However the primary sources of this damage are not swimmers wearing sunscreen, but rather land-based source pollution (e.g., industrial waste), over-fishing, invasive species, and climate change. In fact, the foundational studies that report reef effects of

chemicals in sunscreens were conducted in laboratory settings and did not test the actual risks to coral in a natural setting. One study even states that the sample obtained for testing from Hawaii's coral reefs had minimally detectable levels of avobenzone or octocrylene (Schneider& Lim 2019).

In fact, banning sunscreen products that contain avobenzone or octocrylene in favor of "reef safe" products opens the door to potentially more harm, both to our reef to individuals at risk for skin cancers. The ingredients of many "reef safe" products currently have not been tested for their environmental effects or, to our knowledge, for their ability to provide adequate sun protection according to standards set by the U.S. Food and Drug Administration. Their acceptability to the public has been mixed in online reviews of some "reef safe" sunscreen products. However, many people in Hawaii who use sunscreen to prevent sunburn and skin cancer **DO NOT** go into the ocean at all - they walk, run, play in land sports, etc. It is not and should not be the business of the state government to restrict their consumer choice of sunscreen products because of beliefs about effects on marine environments. Additionally, pharmacists have stated that they would not have the capacity to fill prescriptions from doctors whose patients may need the added sun protective benefits of these products if they are banned in our state.

Morbidity and deaths from skin cancers are on the rise in the U.S. and Hawaii. The current focus of Hawaii's legislative policy limiting the sale of sunscreen products will undermine years of progress towards addressing the effects of unprotected sun exposure, a primary risk factor for skin cancer. The leading scientific agencies in the U.S., all emphasize that using sunscreens is a critical part of regimens to prevent skin cancers, along with protective clothing, hats with brims, and shade. In open water, hats and shade are not options.

According to the National Cancer Institute, nearly 5 million people in the US and at the cost of over 8 billion dollars to our U.S. health care system. In Hawaii, 7,000 people are treated for skin cancers each year. Melanoma, the deadliest form of skin cancer, is now the second most common form of cancer for females aged 15-29 years old. Each year more than 10,000 people die of melanoma across the U.S. In Hawaii, 400 people are diagnosed, and 50 people die each year.

It is essential that we conduct valid research to understand the potential environmental effects of sunscreen use to better protect Hawaii's natural resources. Currently, there is insufficient scientific evidence demonstrating that avobenzone or octocrylene are responsible for coral bleaching. The Hawaii Skin Cancer Coalition members suggest that Hawaii's legislators put forth efforts and resources to utilize the vast scientific expertise found at the University of Hawaii, including its world-renowned School of Ocean and Earth Science and Technology, and the Department of Chemistry, to identify the cause of coral decline and develop and test safe, effective sunscreen products in collaboration with the many environmental advocacy groups in support of this bill. We believe that together, we can work simultaneously towards the development of effective, affordable and acceptable sunscreen products that are effective for cancer prevention and safe for our environment. We can also initiate efforts to address and ameliorate other major causes of damage to coral reefs.

Thank you for the opportunity to submit testimony on behalf of the Hawaii Skin Cancer Coalition. For more information, please contact us at 808-284-9097.

Sincerely,

Kevin D. Cassel, DrPH President, Hawaii Skin Cancer Coalition

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Schneider SL, Lim HW. Review of environmental effects of oxybenzone and other sunscreen active ingredients. J Am Acad Dermatol. 2019 Jan; 80(1):266-271. doi:10.1016/j.jaad.2018.06.033. Epub 2018 Nov 14. PMID: 29981751

The Hawaii Skin Cancer Coalition's mission is to provide clear, concise messages on skin cancer prevention, and early detection for both the **public and health professionals based upon current and accurate information. The Coalition is a collaborative effort between concerned local organizations and businesses including, the University of Hawaii Cancer Center, American Cancer Society, Hawaii Pathologists' Laboratory, the Friends of the University of Hawai'i Cancer Center, the Hawai'i Dermatological Society, Kaiser Permanente, Kuakini Health System, the Hawai'i Lifeguard Association, Queen's Healthcare Plan, and the Hawaii Ophthalmological Society. All of these organizations share a common goal to help prevent skin cancer.**

To: The Committee on Energy and Environmental Protection
Representative Nicole Lowen, Chair
Representative Lisa Marten, Vice Chair

Re: SB132 SD2 RELATING TO WATER POLLUTION

Position: <u>STRONG SUPPORT</u>

Hearing Date: Tuesday, March 16, 2021 9:00 AM Conference Room 325 & Videoconference

Aloha Chair Lowen, Vice Chair Marten and Committee Members,

The Hawaii Coral Reef Stakeholders Hui includes over 50 organizations, businesses, individuals and eminent scientists from around the world including Canada, France, Israel, Iran, and China. Collectively, the Hui speaks for more than one thousand constituents and concerned citizens who strongly support SB132 SD2.

Octocrylene and avobenzone pose an existential threat to coral reefs and other marine life. Evolving science around the world clearly demonstrates that these ubiquitous and pervasive reef toxins irreversibly interfere with the life cycles of Hawaii's foundational and endemic marine life including corals, algae, fish, shellfish, sea urchins and marine mammals. Their threat to Hawai'i is especially acute because we have a higher-than-average number of endemic marine species that we struggle to protect.

Because it is found in most of the sunscreen products and anti-aging creams throughout the world, often at a concentration of 10% octocrylene per product, octocrylene is the most prevalent environmental pollutant in coastal environments. It has been found in coral reefs and marine environments in many places around the world, including Hawaii's (Tsui et al. 2017; Mitchelmore et al. 2019).

Octocrylene accumulates in coral tissues and causes dysfunction of the coral cell's mitochondria (Stein et al 2019, 2020). It can act as a metabolic toxicant in corals and induces lower thresholds of coral bleaching, potentially decreasing the resiliency of coral reefs to climate change.

Studies indicate that octocrylene exhibited an ecological threat at environmental concentrations to other marine organisms, such as algae, sea urchins, mussels, and an arthropod critical in marine food webs (Giraldo et al. 2017).

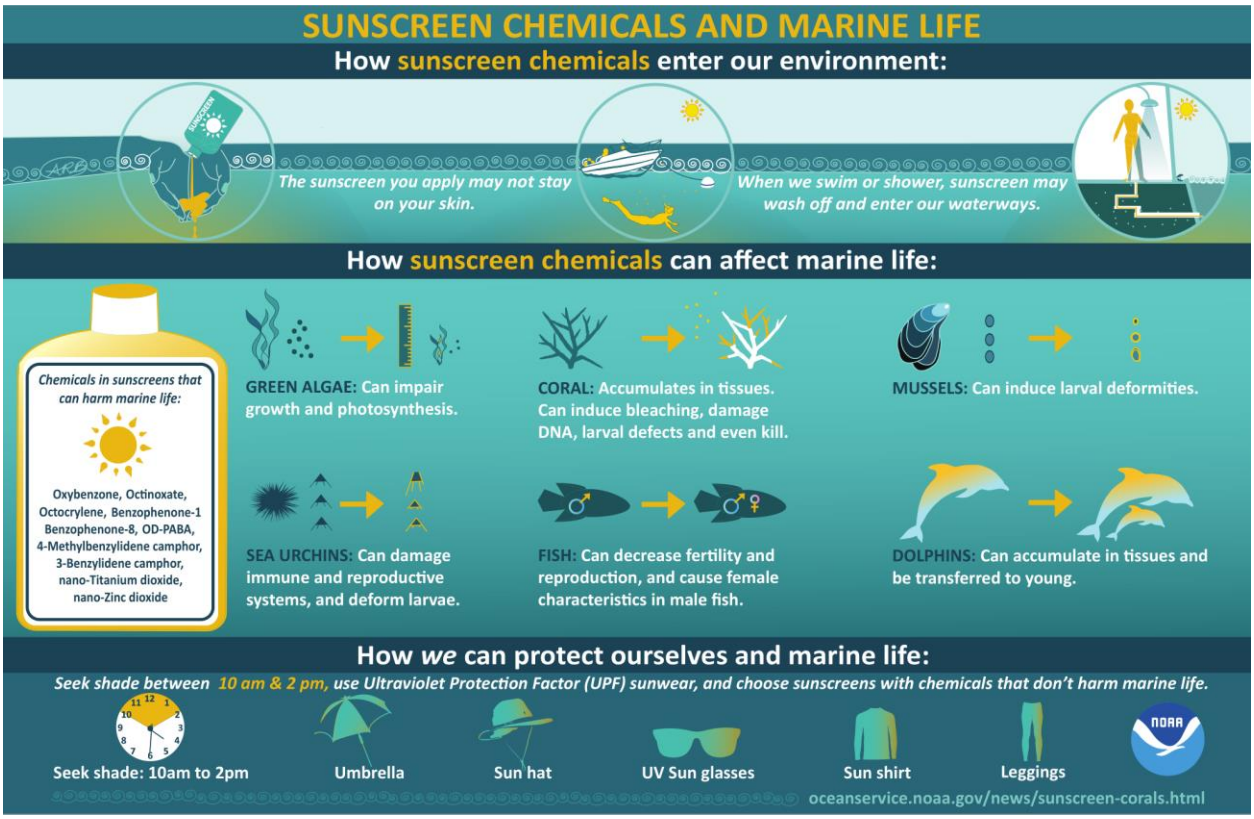
Octocrylene caused endocrine disruption and developmental deformities in the brain and testes of larval fish (Blüthgen et al. 2014), and caused reproductive tissue deformities in developing fish larvae (Zhang et al. 2016). Environmentally relevant concentrations of octocrylene acted as estrogenic endocrine disruptors and caused reproductive toxicity in fish – essentially threatening the continuity of populations (Yan et al. 2020).

Octocrylene can be found in both the fish we eat (Cunha et al. 2018) and the shellfish that we consume (Picot-Groz et al. 2018), eliciting a growing concern of bioaccumulation/biomagnification of organic sunscreen actives in the contamination of our food chain.

Avobenzone is a leading active ingredient in chemical sunscreens and can cause hormone disruptions. Further, it reacts to chlorination and bromination of fresh or seawater, increasing its toxicity by transforming into over 60 more toxic disinfection by-products that can be found in swimming pools (Lebedev et al Environment International Volume 137, April 2020, 105495).

Long-term exposure to avobenzone and octocrylene has also been found to be lethal for some organisms living in freshwater environments and are considered dangerous for freshwater ecosystems.

Approximately one-fourth of the plants, fish, and invertebrates found in Hawaiian coral reefs are endemic to Hawaii. Coral reefs are intrinsic to Hawaiian culture, and fundamental to the fabric of our local communities. They provide critical habitat for near shore marine life, natural protection against coastal erosion and sea-level rise, and ecosystem services worth billions of dollars. Further, our coral reefs underpin tourism, Hawaii's primary economic engine. It is therefore critical to eliminate as many existential threats to our marine ecosystems as possible, like these additional reef-toxic petrochemicals, to ensure our coral reefs and other marine life can both survive and thrive for future generations.



Even more alarming, **despite testimony by industry propagandists** like the Personal Care Product Council (PCPC), Consumer Healthcare Products Association (CHPA), Public Access to Sunscreens (PASS) Coalition, and the American Chemistry Council (ACC), **both octocrylene and avobenzone pose significant known risks to human health as well as Hawaii's fragile marine environment.**

In February 2019, the U.S. Food and Drug Administration declared that even after 40 years or marketing their products, industry has still not provided sufficient scientific evidence that any of the petrochemical UV filters in sunscreens are safe and effective for human use, including oxybenzone, octinoxate, octocrylene, and avobenzone. The only two UV filters the FDA has determined are safe and effective for human use are zinc oxide and titanium dioxide [1].

FDA U.S. FOOD & DRUG ADMINISTRATION
CENTER FOR DRUG EVALUATION & RESEARCH

FDA FACT SHEET

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH

On February 21, 2019, FDA issued a proposed rule describing the conditions under which FDA proposes that OTC sunscreen monograph products are generally recognized as safe and effective (GRASE) and not misbranded.

This action is an important example of FDA's ongoing efforts to ensure that sunscreens are safe and effective for regular, life-long use. The agency anticipates these changes will improve the quality, safety, and efficacy of sunscreens Americans use every day. FDA will continue to work with industry and public health stakeholders to make sure that consumers have access to safe and effective sunscreens.

1. Proposed GRASE Status of Active Ingredients Listed in the Stayed 1999 Final Monograph

FDA has proposed the following categories for the 16 sunscreen monograph ingredients.

GRASE* for use in sunscreens	Not GRASE** for use in sunscreens	***Insufficient data for use in sunscreens
Zinc oxide and titanium dioxide	Aminobenzoic acid (PABA) and trolamine salicylate	Cinoxate, dioxybenzone, ensulizole, homosalate, meradimate, octinoxate, octisalate, octocrylene, padimate O, sulisobenzone, oxybenzone, avobenzone

*GRASE= Generally Recognized as Safe and Effective **These ingredients are not currently marketed. ***For those ingredients in the "insufficient data" category, FDA proposes that it needs additional data to determine that sunscreens with these ingredients would be GRASE.

https://www.fda.gov/media/124655/download

The first rule of toxicology, unlike the democratic process, states that a chemical is guilty of being toxic until proven non-toxic; this is why the FDA published the above ruling based on the overwhelming scientific evidence currently in the public record. With that said, the scientific evidence below is enough to find both octocrylene and avobenzone guilty of being toxic to the environment and human health.

Octocrylene degrades into benzophenone, a known carcinogen and endocrine disruptor regulated by the FDA.

https://pubs.acs.org/doi/pdf/10.1021/acs.chemrestox.0c00461

Octocrylene affects thyroid function as well as inducing anti-androgenic activity, delaying testicular development and causing anatomic difficulties with female reproductive organs. Benzophenone is banned in food products and packaging in the United States, and is listed as a carcinogen and developmental disruptor under California Proposition 65. **Under California Proposition 65, there is no safe harbor for benzophenone in any personal care products, including sunscreens, anti-aging creams, and moisturizers**[2].

Industry has admitted that its octocrylene-products may be contaminated with benzophenone. Dermal absorption of benzophenone into the body may exceed 70%, based on dermal absorption studies conducted by Prof. Howard Maibach and colleagues in the 1990s – a strong argument for regulatory prohibition of this chemical in perfumes and other topical products. That octocrylene products are tainted by benzophenone clearly questions the overall safety of these products for public use.

Knowing what we know now, why would anyone apply sunscreens containing octocrylene or avobenzone on their children or grandchildren even once a day, not to mention several times a day, as recommended by Industry?

Hawai'i is smarter than that.

The attached letters of support from eminent scientists from around the world urging the Hawai'i State Legislature to ban the sale of sunscreens containing octocrylene and avobenzone attest to the global dangers of these two chemicals, and acknowledge Hawaii's ongoing leadership in prohibiting the sale of chemicals in sunscreen that have been known to be reef toxins for years.

It has been argued that banning sunscreens containing petrochemicals like avobenzone and octocrylene from the market would lead to additional skin cancers, because people therefore won't use any sunscreen.

Sunscreen preparations were designed to protect against sunburn and because of this they are assumed to protect against skin cancer, but unfortunately this relationship is inferential only[3]. **There are no definitive studies that demonstrate that sunscreens protect against skin cancers** as evidenced by research published by the World Health Organization, US Environmental Protection Agency and dermatologists alike[4-6].

The argument also ignores what the World Health Organization has called "sunscreen abuse." Petrochemical sunscreens are often not applied sufficiently or frequently enough, and wash off in water, so may not actually protect from sunburn as much as people are led to believe. A false sense of protection against both UVB and UVA pathologies[7] may cause people to spend more time in the sun. This additional exposure to the sun, or "sunscreen abuse," increases the risk of melanoma and may cause MORE skin cancers.

Banning the sale of sunscreens containing octocrylene or avobenzone may only remove at most 30% of the chemical sunscreens from the market, not 60%, as industry states. Yet since Act 104 was enacted in 2018, the availability of affordable sunscreens containing zinc oxide and titanium dioxide which the FDA has determined to be safe and effective for human use has proliferated. Retailers across the board are requesting mineral sunscreens in response to high customer demand for sunscreen products with ingredients the FDA says are safe and effective, instead of sunscreens with octocrylene and avobenzone which the FDA can not determine are safe and effective. Comfortable, fashionable and affordable UPF clothing is also widely available due to this evolved customer demand for safer products. We must move away from using octocrylene, avobenzone, oxybenzone, octinoxate and other soluble petrochemical UV filters which have achieved nothing in benefit and only bioavailability, bioaccumulation, and toxicity to humans and wildlife, while polluting the entire global water supply.

https://www.ewg.org/sunscreen/best-sunscreens/best-beach-sport-sunscreens/

The best course is to avoid the mid-day sun, but if you will be in the sun, wear a protective hat and clothing and use sunscreens with zinc oxide or titanium dioxide. This is a much better course for both public health and our fragile marine environments than using a petrochemical sunscreen that washes off in water and kills corals and other marine life, gets absorbed into your bloodstream, and may disrupt your hormones, potentially causing more cancers.

The need for SB132 SD2 is obvious and critical. **We strongly urge you to pass this bill and apply the Precautionary Principle and choose the "better safe than sorry" course of action, costly only to industry, and safer for both the public and our marine ecosystems**.

This photograph was taken on Waikiki Beach in 1995. Hawai'i residents knew 26 years ago that petrochemical sunscreens harm our marine environment.

Photo credit Dr. Denis Dudley, MD, FRCS(C)

<u>Please do not allow the $10B a year Personal Care Product Industry to continue to profit from endangering Hawai'i residents and our critical marine resources</u>.

Although some of the testimony from international scientists in our Hui refer to earlier 2021 petrochemical sunscreen bills like SB366 and HB102 which are no longer viable this Legislative Session, the content of their testimonies remains the same: the petrochemicals octocrylene and avobenzone in sunscreens pose a clear and known threat to both our fragile marine environment and public health.

Mahalo for the opportunity to testify on behalf of Hawaii's coral reefs!

With aloha,

Coral Reef Stakeholders Hui:

Melodie R. Aduja
Alan B. Burdick
Co-chairs
Environmental Caucus of the
Democratic Party of Hawaii

Jamie Lung Ka'eo
General Manager
Hale Napili

Ted Bohlen
Hawaii Reef and Ocean Coalition

Cindi Punihaole
Director Kahalu`u Bay Education Center
The Kohala Center

Mendy Dant
Executive Vice President
Fair Wind Cruises

Lisa Bishop
President
Friends of Hanauma Bay

Craig Downs, Ph.D.
Executive Director
Haereticus Environmental Laboratory

Maxx Phillips
Hawai'i Director
Center for Biological Diversity

William T. White, III
President, Wailea Property Owners Association

Bill Coney
Dr. Susanne Otero
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Legacy Reef Foundation

Pat B. Lindquist
President
Napili Bay and Beach Foundation

Rene Umberger
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Owner
Kona Coast Realty Corp.

Ken Staples
Director of Hawai'i Operations
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Elizabeth Reilly
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Safe Sunscreen Coalition

Lauren Blickley
Hawai'i Regional Manager
Surfrider Foundation

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Owner
Hanauma Bay Snorkel Adventures

Kealoha Pisciotta
Founder
Kai Palaoa

Ryan Scalf and Christy Johnson
Co-Owners
Nudi Wear

Ray Hollowell
Founder
Sea Inspiration

Christine Zalewski, Ph.D.
Founder
Silver Spiral Seas, LLC

Matt Zimmerman
Owner
Island Divers Hawaii and Honolulu Scuba Company

Jeannie Jewell
President
Destination Kona Coast

Iris Kahaulelio
Aloha Surfing Ohana

Scott Head
Vice President of Resort Operations
Waikoloa Beach Resort

Marcio Lira
Florin Mosanica
Co-Founders
Koko Beach Rentals

Marcio Lira
Owner
Kaimana Tours

Doug Harper
Executive Director
Malama Maunalua

Gabe Canevari
Sabina Funasaki
Co-Founders
Relief for the Reef

Doni Chong
Founder
Hawai'i Skin Probiotics

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1. https://www.fda.gov/news-events/press-announcements/fda-advances-new-proposed-regulation-make-sure-sunscreens-are-safe-and-effective

2. National Drug Code Directory Database on March 8, 2019, U.S. Food and Drug Administration, Washington, DC. https://www.fda.gov/drugs/drug-approvals-and-databases/national-drug-code-directory

3. Emmet. Ultraviolet radiation as a cause of skin tumors. CRC Crit REV Toxicol. 1973;2(2:211-55. Conclusion: "The preparations are all designed to protect against the acute effects of ultraviolet, namely sunburn. Because of their effectiveness in this regard, they are often assumed to protect against ultraviolet carcinogenesis. In most, however, there is little or published evidence that they do so and the relationship is inferential."

4. World Health Organization - Vainio et al. An International evaluation of the cancer-preventive potential of sunscreens. Int J Cancer. 2000;88(5);838-42. Conclusion: "... the topical use of sunscreens reduces the risk of sunburn in humans...No conclusion can be drawn about the cancer-preventative activity of topical use of sunscreens against basal-cell carcinoma and cutaneous melanoma ..."

5. Environmental Protection Agency: Sunscreen the burning fact 2006. Is sunscreen fail-safe (pg6). www.epa.gov Conclusion: "Although a sunscreen with an SPF of 15 or higher offers protection from the sun's damaging rays, it does not block all of the sun's damaging rays. In fact, there is no evidence that sunscreens protect you from malignant melanoma, the deadliest form of skin cancer, even though sunburns have been linked with the development of melanoma."

6. Waldman et al. The role of sunscreen in the prevention of cutaneous melanoma and nonmelanoma skin cancer. J Am Acad Dermatol. 2019 Feb;80(2):574-576. Conclusion: "Could it be that the nearly universal recommendation of dermatologists and professional societies to use sunscreen to prevent skin cancer is unfounded?"

7. World Health Organization - Autier P. Sunscreen abuse for international sun exposure. British Journal of Dermatology 2009 161 (Suppl. 3), ppg 40-45. Conclusion: "The increased duration could be the reason why melanoma risk is increased when sunscreen is used. Hence, sunscreen abuse may extend sun exposure behaviors that would not be possible otherwise."

Haereticus
Environmental Laboratory

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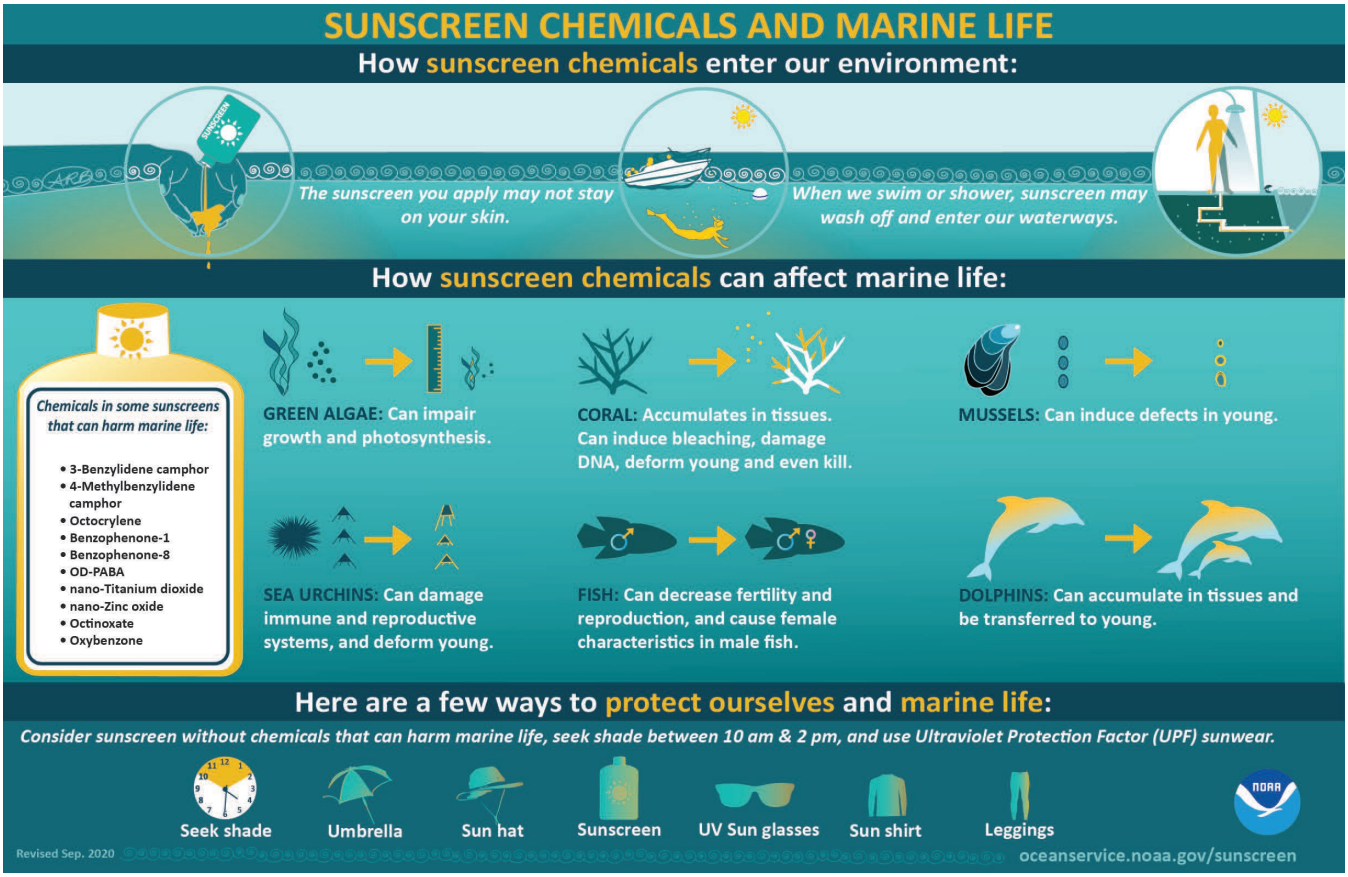
Aloha Hawaii Legislature,

This letter is testimony for our support of Senate Bills 132, SD2 (Relating to Water Pollution).

The inclusion of avobenzone and octocrylene, as amendments to 2018 Hawaii Act 104, is an important step in coral reef and marine conservation against the threat of localized plumes of sunscreen pollution. Hawaii's leadership in banning oxybenzone and octinoxate inspired the rest of the world to pass their own regulations, but also inspired millions of tourists to consider their impact to the places they love to visit.

These chemicals pose a potential threat to coral reefs and other marine life. I would like to point out that even U.S. NOAA recognizes their capacity to afflict harm to a variety of marine life, from corals to marine mammals.



Many in the product-protection lobby (including those in academia who have been "captured" by industry) will say that there is no proof that these chemicals are a threat to marine life. They pose a twisted and corrupt narrative – by Federal law, the onus is on industry to provide to the public the scientific validated data of the potential harm that these chemicals can afflict onto wildlife. Industry has not provided any data regarding their ecotoxicity or relevant and authentic environmental contamination. All of the data has been generated by academic, government, or non-profit organizations. This is a grievous short-coming, and industry should be required to provide objective information that is reviewed by a consensus of non-conflict of interest experts. Until such assurances can be provided by industry, these chemicals should not be allowed to be used in such massive commercial quantities. The threat is too great!

Octocrylene is ubiquitous in coastal environments. Octocrylene can be found in the fish we eat (Cunha et al. 2018), in the shellfish that we consume (Picot-Groz et al. 2018), and it has been found in coral reefs and marine environments in many places around the world, including Hawaii's (Tsui et al. 2017; Mitchelmore et al. 2019). Its environmental pollution stems from the fact that it is found in most of the sunscreen products and anti-aging creams throughout the world, and often at a concentration of 10% octocrylene (v/v) per product.

The ecotoxicity of octocrylene has been known to be a threat to wildlife since 2014, when it was shown that fish exposed to octocrylene exhibited endocrine disruption action, as well as inducing developmental deformities in the brain and testes of larval fish (Blüthgen et al. 2014). Recently, the danger of octocrylene has been further discovered to cause reproductive tissue deformities in developing fish larvae (Zhang et al. 2016). Just this past year, scientists documented that environmentally relevant concentrations of octocrylene acted as estrogenic endocrine disruptors and caused reproductive toxicity in fish – essentially threatening the continuity of populations (Yan et al. 2020). What are the impacts of octocrylene pollution to Hawaii's reef fish? And if our fish are contaminated with octocrylene, what does that mean for people eating these fish, especially pregnant women and keiki?

The ecotoxicity of octocrylene to aquatic invertebrates is just as alarming. Octocrylene induced toxic metabolic effects in coral that could have implications in reducing their resiliency to climate change (Stien et al. 2019; Stien et al. 2020). Octocrylene causes an ecdysone endocrine disruption and an induction of the protein stress response (Ozaez et al. 2016; Muniz-Gonzalez & Martinez-Guitarte, 2018). Furthermore, studies indicate that octocrylene exhibited an ecological threat at environmental concentrations to marine organisms, such as algae, sea urchins, mussels, and an arthropod critical in marine food webs (Giraldo et al. 2017).

The week of March 8, 2021, my colleagues from Sorbonne University, the French government's scientific agency (CNRS), and the U.S. published a paper in the journal, **Chemical Research in Toxicology (https://pubs.acs.org/doi/10.1021/acs.chemrestox.0c00461)**, which demonstrated that sunscreens containing octcrylene are also necessarily contaminated with benzophenone. Benzophenone is an officially acknowledge carcinogen, mutagen, reproductive poison, and endocrine disruptor under California Proposition 65 and IARC, the International Agency for Research on Cancer (a division within the World Health Organization). The U.S. Food and Drug Administration has banned it in all food products, as well as in all food product packaging.

Furthermore, as octocrylene-formulated sunscreens sit on the shelf, the octocrylene transforms into benzophenone, increasing the concentration of this carcinogen over time. The way sunscreen bottles are often displayed in store shelves in Hawaii, or left in hot cars, or out in the sun, accelerates this benzophenone-generation rate.

The newspaper headlines speak for themselves in signaling the danger to public health:


THE Sun

THE SUN, A NEWS UK COMPANY

WS | MONEY | DEAR DEIDRE | TECH | TRAVEL | MOTORS | PUZZLES | SU

All News | UK News | World News | Brexit | Politics | Opinion

TOXIC RAYS Sunscreens like Neutrogena and L'Oreal 'may cause CANCER if they're left on shelf for too long,' study finds

Catherina Gioino

10 Mar 2021, 4:38 | Updated: 10 Mar 2021, 5:13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Top brand sunscreens risk causing CANCER if left on the shelf for too long because they start to release toxic chemicals, scientists warn

- Researchers selected a range of sunscreens purchased from a retail outlet
- They artificially aged them over six weeks to reflect a year in a normal house
- The team found that those with octocrylene developed a dangerous chemical
- This was in the form of the carcinogen benzophenone that builds up over time
- It was found in products from Garniere, Bioderma, LeRoche-Posay, L'Oreal, Coppertone, Banana Leaf and Neutrogena including some made for children

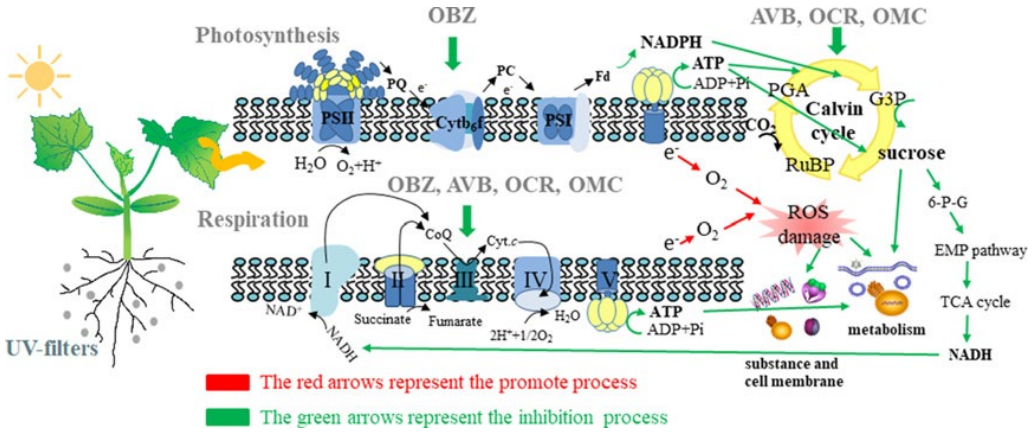
Avobenzone is a suspected metabolic-disrupting obesogen – a toxicant that can either cause an animal to inappropriately store fat, or inappropriately cause it to "burn up" its fat reserves (Ahn et al. 2019). Additional evidence indicates that avobenzone may act as metabolic obesogen by causing a dysfunction with the cell's mitochondria (the power-house of the cell), which may lead to cell death and accelerated aging (Yang et al. 2018).

A study published this year showed that the combination of avobenzone and octocrylene cause an aquatic invertebrate to die 7-days after it was initially exposed (Boyd et al. 2021). Avobenzone exposure cause a change in both reproductive and metabolic outputs in this aquatic invertebrate. This study concluded that "…that the most well-studied UV filter, oxybenzone, may not be the most toxic to *Daphnia* (an aquatic invertebrate), as both avobenzone and octocrylene induced behavioural and physiological disruption at environmentally realistic concentrations." This study was very alarming because this aquatic invertebrate is a key component of the food web, and the loss of this species threatens ecological integrity.

Avobenzone can also pose a threat to plants (sea grasses) and algae, including coral. Colleagues from China and I published work on how avobenzone is toxic to photosynthesis and mitochondrial metabolism in plants (Zhong et al. 2020).

AVB = Avobenzone exposed plants

Could this toxicity occur in corals and causing a bleaching? A single industry-funded study says no, but their experimental design has a number of significant flaws, and its questionable any of the corals were actually exposed to avobenzone (its not very water soluble).



Please consider this legislation as an important conservation tool in the judicious and effective management to mitigate the toxic effects of sunscreen pollution.

Respectfully submitted,

Craig A. Downs, Ph.D.
Executive Director

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Chemical Research in Toxicology

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Article

Benzophenone Accumulates over Time from the Degradation of Octocrylene in Commercial Sunscreen Products

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Cite This: https://dx.doi.org/10.1021/acs.chemrestox.0c00461

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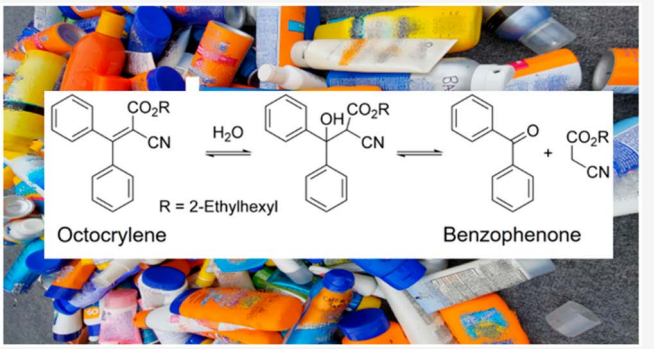
ABSTRACT: Benzophenone is a mutagen, carcinogen, and endocrine disruptor. Its presence in food products or food packaging is banned in the United States. Under California Proposition 65, there is no safe harbor for benzophenone in any personal care products, including sunscreens, anti-aging creams, and moisturizers. The purpose of this study was to determine (1) if benzophenone was present in a wide variety of commercial sun protection factor (SPF)/sunscreen products, (2) whether benzophenone concentration in the product increased over time, and (3) if the degradation of octocrylene was the likely source for benzophenone contamination. Benzophenone concentration was assayed in nine commercial sunscreen products from the European Union and eight from the United States (in triplicate), including two single ingredient sources of octocrylene. These same SPF items were subjected to the United States Food and Drug Administration (U.S. FDA)-accelerated stability aging protocol for 6 weeks. Benzophenone was measured in the accelerated-aged products. Sixteen octocrylene-containing product lines that were recently purchased had an average concentration of 39 mg/kg benzophenone, ranging from 6 mg/kg to 186 mg/kg. Benzophenone was not detectable in the product that did not contain octocrylene. After subjecting the 17 products to the U.S. FDA-accelerated stability method, the 16 octocrylene-containing products had an average concentration of 75 mg/kg, ranging from 9.8 mg/kg to 435 mg/kg. Benzophenone was not detectable in the product that did not contain octocrylene. Benzophenone was detected in the pure octocrylene manufactured ingredient. Octocrylene generates benzophenone through a retro-aldol condensation. *In vivo*, up to 70% of the benzophenone in these sunscreen products may be absorbed through the skin. U.S. FDA has established a zero tolerance for benzophenone as a food additive. In the United States, there were 2999 SPF products containing octocrylene in 2019. The safety of octocrylene as a benzophenone generator in SPF or any consumer products should be expeditiously reviewed by regulatory agencies.



INTRODUCTION

Octocrylene (CAS no. 6197-30-4) is one of 14 United States Food and Drug Administration (U.S. FDA) active ingredients approved for use in sun protection factor (SPF) over-the-counter drugs which include sunscreens, moisturizers, lip balms, and anti-aging products. In March of 2019, 2999 SPF products that were registered for sale in the United States contained octocrylene.[1] Octocrylene is also used in non-SPF-labeled personal care products such as shampoos, hair sprays, tanning oils, and conditioners.

The personal care product industry has known for some time that octocrylene is contaminated with benzophenone (CAS no. 119-61-9). When purchasing raw octocrylene for sunscreen or personal care product manufacturing, industry admits that benzophenone is a contaminant found in octocrylene and, for some reason, "cannot be removed by its entirety when octocrylene is being processed..."[2,3] Furthermore, industry members have also stated that the concentration of benzophenone in octocrylene manufactured ingredients and consumer products is "negligible".[2]

Benzophenone is associated with a wide range of toxicities, including genotoxicity, carcinogenicity, and endocrine disruption. Benzophenone and its common metabolites, benzhydrol and *p*-hydroxybenzophenone, were positive mutagens in the Ames test platforms (strain TA102) and in the SOS/Umu mutagenicity platform.[4−7] Benzophenone was also demonstrated to induce thymine dimerization and double-stranded DNA break formation in the presence of UV light.[8]

Benzophenone is an established carcinogen.[9−11] Signs of this pathology induced by benzophenone were first observed in the liver of guinea pig.[12] In mice, oral ingestion of benzophenone resulted in significant manifestations of hepatocellular

Received: October 23, 2020

adenoma, hepatocellular carcinoma, hepatoblastoma (male mice), and histiocytic sarcoma (female mice). Benzophenone also induced the incidence of mononuclear-cell leukemia and renal tubule adenoma in male rats, while female rats saw an increase in histiocytic sarcoma.[10,11]

A preponderance of evidence indicates that benzophenone and its metabolites are potential endocrine disruptors with diverse axis impacts.[13−15] Recent evidence indicated that benzophenone could alter thyroid-hormone balances. In an *in vitro* rat thyroid follicular cell line, benzophenone up-regulated the sodium/iodide symporter and thyroid globulin genes, while down-regulating the thyroid peroxidase gene.[16] In an *in vitro* pituitary cell line, benzophenone down-regulated the thyroid stimulation hormone β-subunit gene, the thyrotropin releasing hormone receptor gene, and the thyroid receptor β-subunit gene.[16]

p-Hydroxybenzophenone, a metabolite of benzophenone, exhibits estrogenic activity both *in vitro* and *in vivo*, as demonstrated by uterotrophic assays.[13,17,18] *p*-Hydroxybenzophenone was also shown *in vitro* to induce anti-androgenic activity.[13,15] Subcutaneous injection into female, juvenile rats with *p*-hydroxybenzophenone resulted in the proliferation of uterine luminal epithelium cells and cornified vaginal epithelium cells as well as increased uterine weight.[14] Besides direct interaction with hormone receptors, benzophenone was demonstrated to induce the expression of a number of cytochrome P450 isoforms in male rat livers. This cytochrome P450 induction seems to be elicited by activating both the pregnane X receptor and the steroid receptor coactivator 1.[19] There is some evidence, though not rigorously studied, that benzophenone exposure resulted in a gross morphological pathology; mature male rats exhibited small seminal vesicles which were at an immature stage of development as well as testicular hypoplasia.[10]

Based on litigation and MSDS/literature provide by manufacturers of octocrylene, it could easily be perceived that benzophenone is a contaminant from the manufacturing synthesis of octocrylene and that current manufacturing cleanup processes are unable to purify octocrylene to <1 mg/kg.[2,3] Another possibility is that benzophenone is created from the degradation of octocrylene. If this possibility is true, then octocrylene products potentially pose a serious health hazard because benzophenone concentration would increase over time in that product. Under the State of California Proposition 65, there is no "safe harbor" or allowable level of benzophenone contamination in a product.[20] This lack of forbearance is consistent with the danger of dermal absorption of benzophenone; 70% of the benzophenone in a dermatological product would be absorbed through skin and into the body.[21] Dermal absorption of other benzophenones (e.g., oxybenzone) and octocrylene is a serious public health conundrum, finally recognized by the U.S. FDA.[22,23]

Octocrylene is quickly becoming the dominant UV-sunscreen environmental contaminant, found in coastlines, rivers, and lakes all over the world.[24−26] Most environmental surveys look for this common sunscreen compound, but few environmental or biomonitoring studies examine metabolites or degradation products.[27,28] Benzophenone has been seen in some surveys, but its inclusion into methodical target-analyte surveys has largely been ignored because its presence was assumed to be negligible or nonexistent. If octocrylene does give rise to benzophenone, then environmental and public health surveys should actively include benzophenone as a targeted analyte.[29]

To begin to address this issue of the relationship between octocrylene and benzophenone, we sought evidence for whether (1) benzophenone was present in a wide variety of commercial SPF/sunscreen products, (2) benzophenone concentration in the product increased over time, and (3) the degradation of octocrylene was the likely source for benzophenone contamination.

MATERIALS AND METHODS

Sunscreen Product Samples. The following products were purchased in triplicate from retail stores in both France and the United States. Product names, sunscreen actives/UV absorbers, ingredient labeling, lot numbers, and expiration dates are presented in Table 1 and Table 2.

Products purchased in France in December 2019 (Supplemental Figure S1): Nivea Sun Protect and Hydrate SPF 50+ (does not contain octocrylene). The remaining products all identified octocrylene in the ingredient labeling: Garnier Ambre Solaire Resisto Enfant FPS 50+, Bioderma Photoderm AR SPF 50+ Teinte Naturelle, Uriage Age Protect Fluide Multi-Actions SPF 30, LaRoche-Posay Sans Traces Blanches SPF 50+, LaRoche-Posay 50+ SPF Brume Invisible/Transparentes Spray, Cosmia Sun BB Creme SPF 50 Haute Protection, Cosmia Sun Haute-High Protection SPF 30, and L'Oreal Age Perfect Soin Rose Re-Fortifiant FPS 20.

Products purchased in the United States of America in January 2020 (Supplemental Figure S2): Coppertone Kids Sport SPF 50 Spray, Coppertone Sunscreen Lotion Defend and Care Face Oil Free 50 Lotion, Coppertone Sunscreen Spray Water Babies 50, Coppertone Clear Sunscreen Sport Clear 30, Banana Boat Clear UltraMist Sport Performance 30, Banana Boat Sport Performance Sunscreen Lotion 50+, Neutrogena Beach Defense Sunscreen Spray 100, and Neutrogena Beach Defense Sunscreen Lotion 70. All products identified octocrylene at levels between 4.5% and 10% in the active ingredients section of the drug facts labeling.

Testing of benzophenone contamination in manufactured octocrylene for use in commercial formulated products were:

(1) Symrise Neo Heliopan 303 (Octocrylene), product no. 600154. www.symrise.com. Code: 0978, impurities = 200 ppm benzophenone.
(2) TRI-K Galsorb Octocrylene, Lot S/3006. http://www.tri-k.com/wp-content/uploads/2016/02/GalSORB-Octocrylene-Specifications-v2.pdf (accessed 2020-06-01.

All commercial sunscreens were sampled for testing after being purchased directly from stores and represent products stored under normal conditions of use. The same products were retested after being stored for 6 weeks in a 40 °C incubator (Cincinnati Sub-Zero Model STH-24.25-H/AC StableClomate II Temperature/humidity Stability Chamber; U.S.A.) with 75% relative humidity and represents accelerated aging of one year at room temperature. These test conditions are commonly used to evaluate the stability of product formulations for over-the-counter drug stability in the United States.[30]

Chemical Analysis. A set of four standard solutions of acetonitrile containing known benzophenone concentrations of 0, 1, 5, and 25 μg/mL was prepared by successive dilutions from a stock solution at 233 μg/mL benzophenone. Sunscreens were analyzed in a random order. Four samples of each sunscreen were weighted in four 2 mL Eppendorf tubes ($\approx$ 100 mg per each, measured accurately with a 0.1 mg accuracy Mettler Toledo XP204 balance). The different acetonitrile solutions (1 mL) were added, each one in one Eppendorf tube. The mixtures were sonicated for 30 min in the sweep mode and then centrifuged at 23,000 *g* for 10 min.[31] For each tube, the supernatant (20 μL) was collected and diluted in acetonitrile (980 μL) in an HPLC vial. For every seven sunscreens, a control analysis (no sunscreen in the Ependorf tubes) was conducted similarly.

The HPLC/MS instrument and method is described by Stien et al. with modifications.[27] Here the gradient was 5% B 3 min before

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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Table 1. List of Commercial Sunscreen Products Purchased in France and the United States, Presence of an Active UV Ingredient, Concentration of an Active UV ingredient[a], and Ingredient Formulation

product	ingredients
French Products	
Nivea Sun SPF 50+	**control sample − no octocrylene**, aqua, homosalate, glycerin, alcohol denat., butyl methoxydibenzoylmethane (avobenzone), bis-ethylhexyloxyphenol methoxyphenyl triazine (Tinosorb S), ethylhexyl salicylate (octisalate), dibutyl adipate, ethylhexyl triazone, copernicia cerifera cera, panthenol, vp/hexadecene copolymer, phenylbenzimidazole sulfonic acid (ensulizole), tocopheryl acetate, tetrasodium iminodisuccinate, cellulose gum, acrylates/C10-30 alkyl acrylate crosspolymer. microcrystalline cellulose, xanthan gum, butylene gylcol dicaprylate/dicaprate, polyglyceryl-4 diisostearate/polyhydroxystearate/sebacate, sucrose polystearate, sodium stearoyl glutamate, hydrogenated polyisobutene, trisodium edta, sodium hydroxide, sodium chloride, ethylhexylglycerin, phenoxyethanol, linalool, limonene, benzyl alcohol, alpha-isomethyllonone, citronellol, geraniol, parfum
Garnier Ambre Solaire FPS 50	**octocrylene**, aqua/water, glycerin, alcohol denat., homosalate, ethylhexyl salicylate (octisalate), butyl methoxydibenzoylmethane, styrene/acrylates copolymer, diisopropyl sebacate, dicaprylyl carbonate, ethylhexyl triazone, dimethicone, polyester-5, bis-ethylhexyloxyphenol methoxyphenyl triazine, parfum/fragrance, drometrizole trisiloxane (Mexoryl XL), tocopherol, PEG-8 laurate, ethylenediamine/stearyl dimer dilinoleate copolymer, triethanolamine, pentaerythrityl tetra-di-*t*-butyl hydroxyhydrocinnamate (Tinogard TT), caprylyl glycol, acrylates copolymer, terephthalylidene dicamphor sulfonic acid (ecamsule/Mexoryl SX), disodium EDTA
Bioderma Photoderm AR SPF 50+	**octocrylene**, aqua/water/eau, dicaprylyl carbonate, dipropylene glycol, methylene bis-benzotriazolyl tetramethylbutylphenol (Tinosorb M - Nano), butyl methoxydibenzoylmethane, cylcopentasiloxane, bis-ethylhexyloxyphenol methoxyphenyl triazine, hydroxypropyl dimethicone behenate, potassium cetyl phosphate, glyceryl stearate, PEG-100 stearate, glycyrrhetinic acid, gingo biloba leaf extract, tocopheryl acetate, ectoin, mannitol, xylitol, rhamnose fructooucosaccharides, laminaria ochroleuca extract, glycerin soja (soybean) germ extract, propylene glycol, silica, hydrogenated vegetable oil, ammonium acryloyldimethyltaurate/VP copolymer, xanthan gum, citric acid, trilinolein, trilinoleinin, triolein, tripalmitin, caprylic/capric triglyceride, tristrin, iron oxides (77492), iron oxides (77491), iron oxides (77499), titanium dioxide (77891), disodium EDTA, phenoxyethanol, chlorphenesin
Uriage Age Protect SPF 30	**octocrylene**, aqua (water, eau), ethylhexyl methoxycinnamate (octinoxate), ethylhexyl salicylate, butyl methoxydibenzoylmethane, poly (methyl methacrylate), isononyl isononanoate, propanediol, glycerin, dimethicone, steareth-2, steareth-21, diisopropyl sebacate, propylene glycol dicaprylate/dicaprate, C12-15 alkyl benzoate, diisopropyl adipate, phenoxyethanol, butylene glycol, cetyl alcohol, parfum (fragrance), CI 77891 (titanium dioxide), chlorphenesin, polyacrylate-13, acrylates/C10-30 alkyl acrylate crosspolymer, tetrasodium EDTA, caesalpinia spinosa fruit extract, mica, polyisobutene, ascorbyl tetraisopalmitate, *o*-cymen-5-ol, tocopheryl acetate, xanthan gum, retinyl palmitate, *Kappaphycus alvarezii* extract, adenosine, sodium hyaluronate, polysorbate-20, croton lechleri resin extract, sorbitan isostearate, theobroma cacao (cocoa) seed extract, tin oxide, BHT, tocopherol
LaRoche-Posay SPF 50	**octocrylene**, aqua/water, homosalate, silica, ethylhexyl salicylate, butyl methoxydibenzoylmethane, ethylhexyl triazone, bis-ethylhexyloxyphenol methoxyphenyl triazine, drometrizole trisiloxane, aluminum starch octenylsuccinate, glycerin, pentylene glycol, styrene/acrylates copolymer, potassium cetyl phosphate, dimethicone, perlite, propylene glycol, acrylates/C10-30 alkyl acrylate crosspolymer, aluminum hydroxide, *p*-anisic acid, caprylyl glycol, disodium EDTA, inulin lauryl carbamate, isopropyl lauroyl sarcosinate, PEG-8 laurate, *Scutellaria baicalensis* extract, *Scutellaria baicalensis* root extract, silica silylate, stearic acid, stearyl alcohol, terephthalylidene dicamphor sulfonic acid, titanium dioxide, titanium dioxide (nano)/titanium dioxide, tocopherol, triethanolamine, xanthan gum, zinc gluconate, parfum/fragrance
LaRoche-Posay SPF 50 Spray	**octocrylene**, butane, aqua/water, homosalate, dicaprylyl ether, ethylhexyl salicylate, dimethicone, styrene/acrylates copolymer, butyl methoxydibenzoylmethane, drometizole trisiloxane, PEG-30 dipolyhydroxystearate, nylon-12, dicaprylyl carbonate, methyl methacrylate crosspolmer, cyclohexasiloxane, polymethylsilsesquioxane, *p*-anisic acid, caprylyl glycol, disodium EDTA, disteardimonium hectorite, dodecene, ethylhexyl triazone, isododecane, lauryl PEG-8/PPG-18/18 methicone, PEG-8 laurate, phenoxyethanol, poloxamer 407, poly C10-30 alkyl acrylate, propylene carbonate, sodium chloride, tocopherol, parfum/fragrance
Cosmia Sun BB Creme SPF 50	**octocrylene**, aqua, ethylhexyl methoxycinnamate , C12-15 alkyl benzoate, butyl methoxydibenzoylmethane, ceteareth-20, polyglyceryl-6 stearate, triacontanyl PVP, glycerin soja oil, glycerin, diethylhexyl butamido triazone (DEB triazone), cocos nucifera oil, cetearyl alcohol, glyceryl stearate, helianthus annuus seed oil, tocopherol, phenoxyethanol, cyclopentasiloxane, benzyl alcohol, ceteareth-12, dimethicone, sorbitan caprylate, parfum, nylon—10/10, carbomer, cyclohexasiloxane, triethanolamine, ethylparaben, bis-ethyl-hexyloxyphenol methoxyphenyl triazine, polyglyceryl-6 behenate, tetrasodium EDTA, trimethoxybenzylidene pentanedione, sodium citrate, xanthan gum, CI 77891 (TiO_2), CI 77492, CI 77491, CI 77499
Cosmia Sun SPF 50	**octocrylene**, aqua/water/eau, alcohol denat., C12-15 alkyl benzoate, homosalate, butyl methoxydibenzoylmethane, polyglyceryl-6 stearate, ceteareth-20, Zea Mays (corn) starch, dicaprylyl carbonate, diethylhexyl butamido triazone, glycerin soja (soyabean), triacontanyl PVP, bis-ethylhexyloxyphenol methoxyphenyl triazine, ceteareth-12, cetearyl alcohol, cocos nucifera (coconut) oil, glycerin, glyceryl stearate, parfum (fragrance), sodium benzoate, polyglyceryl-6 behenate, acrylates/C10-30 alkyl acrylate crosspolymer, citric acid, potassium sorbate, tocopherol, helianthus annuus (sunflower) seed oil
L'Oreal Age Perfect FPS 20	**octocrylene**, aqua/water, glycerin, ethylhexyl salicylate, niacinamide, dimethicone, C12-15 alkyl benzoate, alcohol denat., pentylene glycol, butyl methoxydibenzoylmethane, octyldodecanol, isopropyl isostearate, triethanolamine, behenyl alcohol, phenylbenzimidazole sulfonic acid, ammonium polyacryloyldimethyl taurate, iris florentina root extract, paeonia suffruiticosa root extract, calcium pantetheine sulfonate, capryloyl salicylic acid, disodium EDTA, cetyl alcohol, alumina, ammonium acryloyldimethyltaurate/steareth-25 methacrylate crosspolymer, butylene glycol, caprylyl glycol, carbomer, cetearyl alcohol, cetearyl glucoside, CI 77491/iron oxides, CI 77891/titanium dioxide, disodium stearoyl glutamate, mica, myristic acid, palmitic acid, PEG-100 stearate, PTFE, stearic acid, synthetic fluorphlogopite, tin oxide, titanium dioxide (nano)/titanium dioxide, dimethiconol. alpha-isomethyl ionone, benzyl alcohol, benzyl benzoate, citronellol, coumarin, geraniol, limonene, linalool, CI 15510/orange 4, CI 19140/yellow 5, silica, phenoxyehanol, parfum/fragrance
American Products	
Coppertone Kids Sport SPF 50 Spray	**octocrylene**, SD alcohol 40-B (75.5% v/v), neopentyl glycol diheptanoate, polyester-27, dimethicone, tocopherol (vitamin E), fragrance, avobenzone, octisalate, oxybenzone
Coppertone Defend & Care Face SPF 50 Lotion	**octocrylene**, water, aluminum starch, octenylsuccinate, styrene/acrylates copolymer, glycerin, polyester-27, silica, phenoxyethanol, isododecane, arachidyl alcohol, beeswax, ethylhexylglycerin, neopentyl glycol diheptanoate, acrylates/C10-30 alkyl acrylate

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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Table 1. continued

product	ingredients
American Products	crosspolymer, behenyl alcohol, tocopherol, arachidyl glucoside, glyceryl stearate, PEG-100 stearate, potassium hydroxide, disodium EDTA, sodium ascorbyl phosphate, avobenzone, homosalate, octisalate
Coppertone Water Babies SPF 50 Spray	**octocrylene**, water, dimethyl ether, aloe barbadensis leaf juice, C12-15 alkyl benzoate, neopentyl glycol, diheptanoate, butylene glycol, styrene/acrylates copolymer, VP/eicosene copolymer, 1,2-hexanediol, hydroxyacetophenone, fragrance, tocopherol, acrylates/C10-30 alkyl acrylate crosspolymer, potassium hydroxide, disodium EDTA, avobenzone, homosalate, octisalate
Coppertone Sport Clear SPF 30 (#1 and #3)	**octocrylene**, SPF 30 = SD alcohol 40-B (60.3% v/v), dicaprylyl ether, ethylhexyl isononanoate, PVP, dimethicone/vinyl dimethicone crosspolymer, polyester-27, silica dimethicone silylate, beeswax, acrylates/C12-22 alkyl methacrylate copolymer, fragrance, silica, avobenzone, homosalate
Banana Boat Clear UltraMist SPF 30 Spray	**octocrylene**, alcohol denat. isobutane, isododecane, diisopropyl adipate, lauryl PEG-8 dimethicone, phenylisopropyl dimethicone, polyglyceryl-3 stearate/isostearate/dimer dilinoleate crosspolymer, caprylyl glycol, methyl dihydroabietate, fragrance, ascorbyl palmitate, tocopheryl acetate, mineral oil, panthenol, water, aloe barbadensis leaf juice, avobenzone, homosalate
Banana Boat SPF 50 Lotion	**octocrylene**, water, ceteareyl alcohol, stearyl alcohol, glycerin, phenoxyethanol, acrylates C12-22 alkyl methacrylate copolymer, caprylyl glycol, cetyl alcohol, carbomer, ceteth-10 phosphate, dicetyl phosphate, coco-glucoside, methylparaben, xathan gum, propylparaben, sodium hydroxide, disodium EDTA, lauryl PEG-8 dimethicone, methyl dihydroabietate, phenylisopropyl dimethicone, polyglyceryl-3 stearate/isostearate/dimer dilinoleate crosspolymer, sodium ascorbyl phosphate, tocopheryl acetate, aloe barbadensis leaf juice, avobenzone, homosalate, octisalate, oxbenzone
Neutrogena Beach Defense SPF 100 Spray	**octocrylene**, alcohol denat. isobutane, octyldodecyl neopentanoate, acrylates/octylacrylamide copolymer, butyloctyl salicylate, dimethicone, acrylates/dimethicone copolymer, fragrance, tocopheryl acetate, chrysanthemum parthenium (feverfew) flower/leaf/stem juice, avobenzone, homosalate, octisalate, oxybenzone
Neutrogena Beach Defense SPF 70 Lotion	**octocrylene**, water, styrene/acrylates copolymer, dimethicone, potassium cetyl phosphate, benzyl alcohol, silica, diethylhexyl 2,6-naphthalate, dimethicone/PEG-1-/15 crosspolymer, trisiloxane, cetyl dimethicone, beeswax, ethylhexylglycerin, sodium polyacrylate, xanthan gum, ethylhexyl stearate, acrylates/C12-22 alkyl methacrylate copolymer, behenyl alcohol, trideceth-6, disodium EDTA, glyceryl stearate, PEG-100 stearate, caprylyl glycol, chlorphensin, fragrance, avobenzone, homosalate, octisalate, oxybenzone

[a]U.S. products only.

injection, then from 1 to 12 min, a linear gradient increase of B up to 100%, followed by 100% B for 6 min in which A was water with 0.1% formic acid and B was acetonitrile with 0.1% formic acid. The column was a Phenomenex Kinetex F5 150 × 2.1 mm, 1.7 μm. The flow was diverted (not injected into the mass spectrometer) before injection, up to 1 min after injection. With this method, benzophenone was eluted at ≈8.3 min. Eventually, another chromatographic method was also used to shorten the analysis time. In this case, the gradient was 5% B 3 min before injection, then from 1 to 8 min, a linear gradient increase of B up to 100%, followed by 100% B for 5 min. With this method, benzophenone was eluted at ≈7.5 min.

In ThermoFisher FreeStyle software, the ion at m/z 183.0804 corresponding to the protonated molecular ion of benzophenone was extracted from the UHPLC-MS profiles at 5 ppm mass tolerance. The chromatographic peak was integrated automatically using the Genesis algorithm with the following parameters: percent of highest peak 10.0, minimum peak height 1.0, S/N threshold 1.0, with valley detection disabled. The extracted ion peak was clearly detected for each run, and the integrations were repeatable. In order to ensure an optimal quality control, blanks and control samples were analyzed to check carryover, background noise, precision, and accuracy of the detection. Selectivity, specificity, accuracy, precision, linearity, range, limit of detection (LOD), limit of quantification (LOQ) for benzophenone are listed in Table S1 (Supporting Information). The integration values were reported in an Excel sheet for linear regression calculation. The linear regression equation was in the form:

$$\text{benzophenone (BP) peak area} = a \times m_{\text{added\_BP}} + b$$

where $m_{\text{added\_BP}}$ was the mass of benzophenone added to the sunscreen samples with the different solution of benzophenone in acetonitrile (0, 1, 5, and 25 μg). The equation provided the mass of benzophenone (μg) in the sunscreen product (m_{BP_0}) as follows:

$$m_{\text{BP}_0} = \left|\frac{-b}{a}\right|$$

This value was corrected by the amount of benzophenone (BP) in the corresponding blank analysis:

$$m_{\text{BP}_{\text{corrected}}} = m_{\text{BP}_0} - m_{\text{BP}_{\text{blank}}}$$

A blank of the same day as the analysis was used for correction. When several blanks were available, the "most advantageous" one (i.e., the highest $m_{\text{BP}_{\text{blank}}}$) was used for correction. Finally, the concentration of benzophenone (BP) in the sunscreen product was calculated as:

$$C_{\text{BP}} = \frac{m_{\text{BP}_{\text{corrected}}}}{\text{average mass of cream}}$$

and was expressed in mg/kg. The results are provided in Table 2.

RESULTS

Benzophenone was detected in all of the octocrylene-containing commercial products, while it was not present in significant or detectable quantities in the only nonoctocrylene product that was tested (third column from the left, indicated as "baseline", Table 2).

Product samples were subjected to a U.S. FDA accelerated stability testing protocol for 6 weeks; this duration is supposed to reflect a single year of shelf life. In the E.U. samples, the increase in benzophenone concentrations after the 6 week accelerated stability incubation ranged from a geometric mean of 38.7% to 199.4% (Table 2). The lowest concentration of benzophenone in a product was Uriage Age Protect SPF30 (GM of 6.3 mg/kg), but the concentration increased to a geometric mean of 38.6 mg/kg after the accelerated stability incubation (GM of 38.6 mg/kg). L'Oreal Age Perfect FPS 20 had the highest concentration of benzophenone for both the starting material (GM of 64.6 mg/kg) and accelerated-stability incubated (GM of 193.4 mg/kg). It should be noted that the E.U. and France do not require the concentrations of

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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Table 2. List of Products, Product Lot Number, Product Expiration Date, Concentration of Benzophenone at the Baseline Sampling, Concentration of Benzophenone after the 6 Week FDA Accelerated Stability Incubation, and Percent Increase of the Geometric Mean (GM) of Benzophenone Concentration for Each Product Set between the Baseline Sampling and the 6 Week Accelerated Stability Sampling[a]

product	lot no. /expiration (exp) date	baseline mg/kg (ppm)	6 week mg/kg (ppm)	% GM increase from baseline
Nivea Sun SPF 50+ **(Sunscreen Control)**	083105007/no exp listed	0.0	1.5	0
	083105007/no exp listed	0.2	−2.9	no change
	083105001/no exp listed	−0.2	−1.1	
Garnier Ambre Solaire FPS 50	28S400 8846255/no exp listed	8.7	21.2	121.6
	28S400 8846255/no exp listed	11.4	26.0	
	28S400 8846255/no exp listed	10.6	20.7	
Bioderma Photoderm AR SPF 50+	13391/exp 05/22	21.3	31.9	46.9
	13391/exp 05/22	23.0	33.1	
	13391/exp 05/22	22.2	32.7	
Uriage Age Protect SPF 30	91931J/exp 07/22	6.6	9.8	55.6
	91931J/exp 07/22	7.3	12.8	
	91931J/exp 07/22	5.0	6.7	
LaRoche-Posay SPF 50	54S103/exp 01/22	5.9	16.7	43.9
	54S400/exp 03/22	11.7	13.9	
	54S103/exp 01/22	14.6	15.4	
LaRoche-Posay SPF 50 Spray	14S200/exp 02/13/22	15.1	20.3	52.7
	14S200/exp 02/13/22	13.1	20.1	
	14S200/exp 02/13/22	16.7	28.3	
Cosmia Sun BB Creme SPF 50	7702C0802/exp 03/20	64.1	79.8	38.7
	7702B0803/exp 02/20	64.5	87.9	
	7702A1801/exp 01/21	28.0	49.7	
Cosmia Sun SPF 50	042419002/exp 03/22	10.1	24.4	116.0
	042419002/exp 03/22	13.7	27.1	
	042319001/exp 02/22	12.0	25.5	
L'Oreal Age Perfect FPS 20	28S900/no exp listed	31.1	213.9	199.4
	28S500/no exp listed	80.8	163.6	
	28S500/no exp listed	81.9	202.6	
Coppertone Kids Sport SPF 50 Spray	CV019AX/exp 12/2020	34.9	43.0	14.5
	CV019AX/exp 12/2020	33.7	40.9	
	CV019AX/exp 12/2020	40.9	41.5	
Coppertone Defend & Care Face SPF 50 Lotion	CV01956/exp 01/2021	27.3	40.2	59.3
	CV01956/exp 01/2021	22.8	38.9	
	CV01956/exp 01/2021	24.3	39.5	
Coppertone Water Babies SPF 50 Spray	029117/exp 02/2021	59.9	92.3	59.3
	029117/exp 02/2021	71.3	95.4	
	029117/exp 02/2021	60.0	116.8	
Coppertone Sport Clear SPF 30	9B06CS/exp 02/21	143.0	408.3	134.4
	9B06CS/exp 02/21	227.9	461.4	
Banana Boat Clear UltraMist SPF 30 Spray	18139FF/exp 04/2021	17.1	19.3	59.5
	18139FF/exp 04/2021	8.4	17.8	
	18139FF/exp 04/2021	7.8	16.0	
Banana Boat SPF 50 Lotion	9C12CS/exp 03/2021	29.3	43.3	63.5
	9C12CS/exp 03/2021	26.2	40.1	
	9C12CS/exp 03/2021	24.3	47.2	
Neutrogena Beach Defense SPF 100 Spray	06319F54/exp 02/2021	65.9	86.9	45.6
	06319F54/exp 02/2021	71.7	112.6	
	06319F54/exp 02/2021	71.6	105.2	
Neutrogena Beach Defense SPF 70 Lotion	1449L0640/exp 04/2022	15.8	23.3	54.5
	1449L0640/exp 04/2022	11.8	21.1	
	1449L0640/exp 04/2022	12.6	17.6	

[a]The Nivea Sun SPF 50+ is the only commercial product that does not contain octocrylene in its active ingredients.

octocrylene or other sunscreen active ingredients on their label, so the starting concentration of octocrylene is unknown.

In the U.S. samples, benzophenone concentrations at the end of the 6 week accelerated stability incubation ranged from a geometric mean of 14.5% to 134.4% (Table 2). The lowest concentration of benzophenone in a product was Banana Boat Clear UltraMist SPF30 (GM of 11.1 mg/kg), but the concentration increased to a geometric mean of 17.7 mg/kg

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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after the accelerated-stability incubated. It should be noted that Banana Boat Clear UltraMist contained only 5% octocrylene, one of the lowest octocrylene concentration formulations. Coppertone Sport Clear SPF30 had the highest concentration of benzophenone for both the starting material (GM of 185.45 mg/kg) and accelerated stability incubation (GM of 434.85 mg/kg). Surprisingly, Coppertone Sport Clear SPF30 only contained 6% octocrylene.

Symrise Neo Heliopan 303 octocrylene contained 151 mg/kg benzophenone. TRI-K Galsorb Octocrylene contained 47.7 mg/kg benzophenone.

DISCUSSION

The presence of octocrylene in a commercial product implies a threat of considerable contamination by benzophenone. Octocrylene is a 2-cyano cinnamic ester that can be synthesized by aldol condensation of benzophenone with 2-ethylhexyl 2-cyanoacetate.[32] The aldol condensation is catalyzed either by acidic or basic conditions and the rate can be accelerated by protic solvents, such as water.[33] The aldol condensation is reversible, and both the aldol, and the retro-aldol condensation rates accelerate under these conditions (Figure 1). Our work unambiguously establishes that

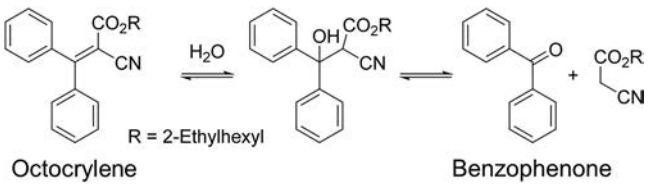

Figure 1. Retro-aldol condensation reaction between octocrylene and benzophenone.

octocrylene does undergo a slow retro-aldol condensation reaction that gives rise to benzophenone. This process occurred in all commercial sunscreens tested that contain octocrylene, resulting in the concomitant increase of the benzophenone concentration upon aging the product.

The source of benzophenone in a product arises from two main sources: (1) benzophenone contamination in the octocrylene used to manufacture the commercial product and (2) accumulation of benzophenone from the degradation of octocrylene as the product ages. All of the octocrylene products we tested from the retail stores had benzophenone contamination, violating the State of California Proposition 65. If industry is to continue to use octocrylene in its formulas, it would need to better purify octocrylene from its benzophenone contaminant before selling it to personal care product manufacturers and develop a "safe" stabilizer that prevents the retro-aldol condensation reaction resulting in the formation of benzophenone (Figure 1). Our results did indeed demonstrate that the rate of benzophenone concentration increase depends more on the product formulation than on the initial octocrylene concentration (e.g., Banana Boat Clear UltraMist SPF30 vs Coppertone Sport Clear SPF30).

Benzophenone and its structurally related compounds (e.g., benzophenone-1, benzophenone-3) are notorious for inducing dermatological pathologies, including contact dermatitis, erythema, urticaria, and photoinduced dermatitis.[34−38] Dermatological pathologies from benzophenone occur not just from personal care product exposure but also from noncosmetic products that come into direct and prolonged contact with the skin.[39,40] Benzophenone-induced dermatitis could also arise from prolonged exposure to paper packaging material, plastics, and food that was in contact with these paper packaging materials.[41,42]

Signs of liver morbidity and homeostatic distress when exposed to benzophenone were often recognized in guinea pig, rat, and mouse models, but the risks have been underestimated in both toxicology journal papers and organizational reports.[11,43,44] This is unfortunate because the earliest reports regarding benzophenone toxicology in a whole organism study concluded that a 15 day exposure to benzophenone induced changes resembling chronic hepatitis.[45] Cellular necrosis was "prominent in different parts of the liver", and histopathological examination in non-necrotizing cells indicated the presence of "double-nucleated cells." In both guinea pigs and rats, benzophenone exposure induced significant increases in liver weight.[10,43] Significant increases in alanine aminotransferase levels are consistent with hepatotoxic necrosis.[10,43] Furthermore, increased mitotic divisions of biliary epithelial cells with reduced glycogen reserves and increased glycolysis activity in proximate hepatocytes is an environment conducive to potential carcinogenic transformation. This liver pathology is consistent with the conclusion that benzophenone is a carcinogen by creating both mutagenic events as well as a localized unstable cellular/histological environment that could promote carcinogenesis.[9]

Based on the dermal absorption studies of benzophenone and its structurally similar sunscreen active ingredients of oxybenzone and avobezone, benzophenone that is associated with octocrylene products suggests that parts per million exposures and absorption of benzophenone could be expected.[21−23] Besides use of sunscreen for sun exposure, sunscreen marketing and advertising claims encourage daily and constant use of sunscreen to protect against the "perceived" dangers of "blue light"-induced dermal damage from LCD displays from computers and other personal devices as well as from light transmission through building and car windows.[46−49] If dermatologists and marketing propaganda are to be taken seriously, consumers would be using octocrylene-based sunscreens every day, with multiple reapplications through the day, throughout the entire year. Unlike the claims made by various propaganda sources in response to the two studies by Matta and co-workers that their exposure design in their two studies were unrealistic, benzophenone exposure concentration may easily exceed the 100 mg/kg/day.[50−52]

As with other chemicals in mass-produced personal care products, benzophenone can be a potential "emerging contaminant of concern". It can enter environmental systems from at least three routes of contamination: swimmer discharges (sunscreen and fragrances), sewage discharges (sunscreen, cosmetics, and fragrances), garbage and debris leachate (personal care products, paper, and plastic packaging). Environmental contamination surveys are costly and human-resource intensive, requiring ample justification to survey and monitor for a target analyte. This work gives ample justification for launching studies to determine if benzophenone is a significant environmental contaminant and whether it poses an untenable risk when it contributes to a plume mixture of other contaminants that are known to pose potential ecological threats, such as octocrylene, oxybenzone, avobenzone, and octinoxate.

There are few ecotoxicological studies regarding benzophenone. A marine copepod chronically exposed to benzophenone

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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exhibited decreased egg viability and hatching success as well as significant genomic DNA methylation, raising concerns for potential intra- and trans-generational evolutionary effects.[53] In rainbow trout, benzophenone binds to the trout estrogen receptor and induces vitellogenin mRNA in liver slices.[54] A more fascinating historical examination of benzophenone is that the first patents on benzophenone were for its herbicidal properties. In 1954, the Monsanto Chemical Company patented benzophenone for its "valuable herbicidal compositions and methods of destroying or preventing plant growth".[55] In 1976, benzophenone and a number of its derivatives were patented by the Rohm and Haas Company as pre-emergent and post-emergent herbicides.[56] In 1978, benzophenone and benzhydrols were patented for their ability to control "undesirable growth of suckers in tobacco plants".[57] This small amount of information regarding its use and toxicities is a concern for marine and aquatic ecological integrity, from coral reefs and seaweed forests to river and lake systems.

Octocrylene products that contain benzophenone may pose a threat to the public health and even ecological health.[28,29,58] Safety evaluations done in the past were limited, and in-depth studies need to be conducted to ascertain the full range of toxicity of octocrylene and benzophenone products, so that a more appropriate threat evaluation can be conducted to preserve public health. Mixed xenobiotic exposure-effect studies need to be conducted using chemicals that are commonly found with octocrylene/benzophenone products. Octocrylene by itself is an endocrine disruptor, a developmental toxicant, and a metabolic stressor, both to mammal receptor models and to various wildlife models, including fish and coral.[27,59−62] Preliminary evidence potentially suggests that octocrylene may have a role in the behavior of tumorigenesis and carcinogenesis.[59,63] What is the danger of being exposed to a product that simultaneously contains oxybenzone, octinoxate, or homosalate as well as octocrylene and benzophenone?

Based on the final decision by the E.U. to allow benzophenone as a flavor agent and the U.S. FDA making no ruling regarding the contamination of over-the-counter SPF drugs, the decisions regarding public health safety regulatory thresholds can be argued to be unjustified and irresponsibly reckless.[3,64,65] Both examples, when examined closely, can be argued to be reminiscent of the debacle of beryllium and the U.S. Occupational Safety and Health Administration.[66] Whether benzophenone and octocrylene products should be allowed for public consumption should not be decided "in the back seat of a taxi by industry consultants" (taxicab standard), but by careful and meticulous review of the literature and publicly available data.[67,68]

There is enough scientific literature to make an argument that octocrylene/benzophenone products can pose a threat to individual and public health. Several jurisdictions, including the Republics of Palau and the Marshall Islands as well as the U.S. Virgin Islands, have banned octocrylene in sunscreen and cosmetic products, effective in January 2020. It is agreeable that there needs to be more refined and rigorously produced, unbiased data regarding exposure and toxicity of both these chemicals and the products that contain them. Consideration must be given to the responsible regulatory response to prohibit the manufacture and sale of these octocrylene/benzophenone formulated products until industry can *prove* beyond a reasonable doubt that chronic exposure does not cause harm over any aspect of the life history of the receptor model or in public health clinical trials. An alternative to this current system of regulatory *laissez faire* would be a cogent and detailed prescriptive argument for a precautionary principle framework whose goal is the protection of public health.[68]

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.chemrestox.0c00461.

Figure S1: Tested sunscreen products purchased in December of 2018 in retails stores in France. Figure S2: Tested sunscreen products purchased in January of 2019 in retails stores in the United States of America. Methodological description and sample chromatograms (PDF)

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Notes

Haereticus Environmental Laboratory has received funding from the U.S. Environmental Protection Agency and the U.S. Department of Interior, but this funding did not contribute and is in no way associated with this study.

The authors declare the following competing financial interest(s): Declaration of competing financial interests One Laboratoire de Biodiversit et Biotechnologies Microbiennes project is financed in the context of the Pierre Fabre Skin Protect Ocean Respect action. The work reported in this manuscript was not supported by Pierre Fabre Laboratories.

■ ACKNOWLEDGMENTS

We would like to thank the four anonymous reviewers for the constructive comments and their time and effort in improving the manuscript.

https://dx.doi.org/10.1021/acs.chemrestox.0c00461
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Chem. Res. Toxicol. XXXX, XXX, XXX−XXX

In Favor of SB132 SD2 … Joe DiNardo – Toxicologist/Hawaii Tourist March 13, 2021

Dear Representatives,

I have been submitting testimonies in favor of banning sunscreen actives since 2017, when the Hawaii Food Industry Association and the Consumer Healthcare Products Association first inaccurately reported to you that "oxybenzone was the ONLY UVA sunscreen that was approved by FDA" and implied that if you banned sunscreen active(s) you would cause many to get skin cancer. The Personal Care Products Council (PCPC) concurred with these inaccurate views and added that these sunscreen chemicals were approved by the Food and Drug Administration (FDA) as "safe and effective" for human use. They also wisely hired a research scientists who sampled Hawaii waters for petrochemical sunscreen content from a boat 0.5 km from the shoreline away from tourists and identified that the levels in Hawaii waters were far below the concern that could harm coral based on the one, no two, no three, oh no - the now nine studies published in the scientific literature demonstrating concern for coral. Of course, that information would not include the recent research from the National Oceanic and Atmospheric Administration (NOAA) infographic noted below which clearly states that sunscreen chemicals affect marine life … green algae, coral, mussels, sea urchins, fish and dolphins. Nor does it discuss the other aquatic effects caused by avobenzone or octocrylene (see recent studies listed below). The other supporters of sunscreens who opposed this bill - American Chemical Council, Hawaii Skin Cancer Coalition, American Academy of Dermatology, Retail Merchants of Hawaii and the Public Access to Sunscreens (PASS) Coalition also claim that the other numerous scientific publications reporting the negative environmental and human impact of these toxic chemicals is wrong and that "sunscreens save lives".

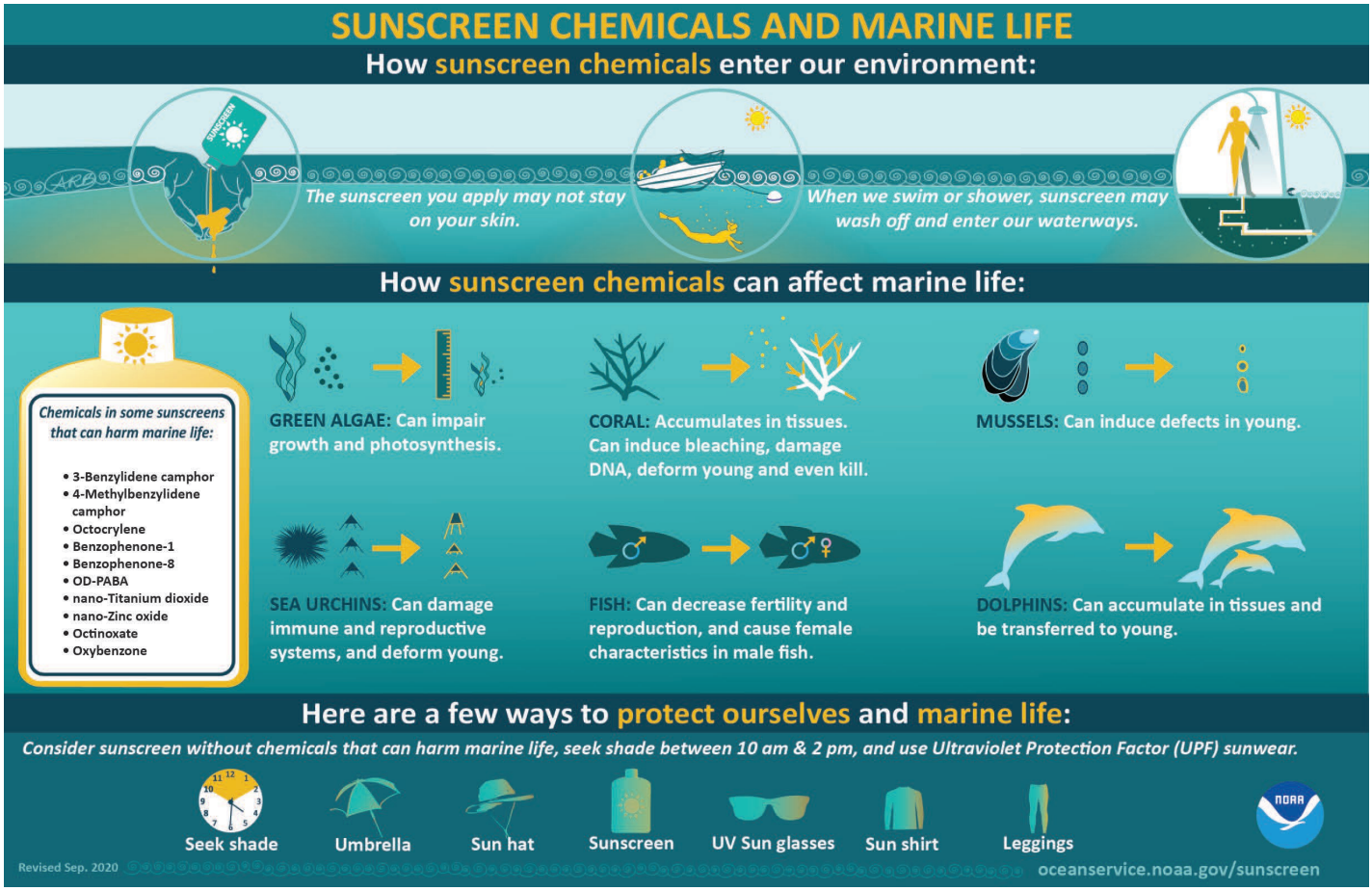
The newest twist in testimonies is a plea to wait another 1.5 years or so until the National Academy of Science (NAS) … a group funded by EPA (who recently increased the amount of several toxic chemicals allowed in our water supply) who was asked by congress (based on political pressure placed on them by the PASS Coalition and possibly other Washington DC Lobbyists groups) … to complete an independent review with scientists that are partial (like the one who recently wrote the paper about how wrong the 9 coral published studies are that was co-authored and paid for by the PCPC) and who recently removed their invitation from a known Hawaii published coral researcher to participate on the panel (because of his recent publication reporting on a known carcinogenic byproduct in a sunscreen active that is currently in this bill - octocrylene). The only thing more compelling than that story, is trying to understand how the US Senate included legislation in the CARES Act (a pandemic bill) which attempted to erase 20 years of science that the FDA used to conclude that petrochemical sunscreen actives are either unsafe (PABA and Trolamine Salicylate) or require more safety testing (the remaining 12 actives) and not a panel discussion to demonstrate that they are safe and effective for human use. By the way, the FDA has never stated that their opinion has changed, regardless of the CARES Act; data is still requested and required to demonstrate that these chemicals do not cause cancer or reproductive damage to our children among other things.

In case you are wondering how many people have died from skin cancer since sunscreens began being promoted about 40 years ago by dermatologist and sunscreen companies or perhaps what the incidence of melanoma is in the US vs. Australia (known to have high skin cancer rates), I've attached 2 data tables. One showing that over 400,000 people have died (a 54% increase adjusting for population growth) from skin cancers between 1975 and 2017, the other shows that the US incidence of melanoma is increasing rapidly, especially compared to Australia's rates – which is approximately twice what the US is experiencing. These should be very important statistics to dermatologists who despite the global epidemic of skin cancers, still insist that sunscreens are beneficial. What is beneficial

is sun avoidance, excessive sun exposure causes skin cancer – of that there is no doubt – using sunscreen, especially those with high SPF values, increases intentional sun exposure which in turn increases the risk of skin cancer. This is the opinion of the World Health Organization; they go on to state that sunscreens "may prevent" squamous cell carcinoma during "unintentional" sun exposure and that "No conclusion can be drawn about the cancer-preventive activity of topical use of sunscreens against basal cell carcinoma and cutaneous melanoma". For this reason, we need to all be part of educating consumers about skin cancer prevention and the harm that these petrochemicals have – based on the published scientific literature - on the environment and on human health - emphasizing that the risks associated with these sunscreen actives are greater than the benefits (if any) they provide.

Everyone should practice sun avoidance measures when possible, especially during peak hours of UV exposure (10 AM – 2 PM); wear protective clothing including a broad-brimmed hat and sunglasses and/or use a oversized umbrella/cabana when at the beach or pool; if sunscreen is desired, use a non-nano mineral based zinc oxide or titanium dioxide sunscreen - which are still considered safe and effective for human use according to the FDA.

National Oceanic and Atmospheric Administration (NOAA) Infographic:



Recent Aquatic Toxicity Studies Published on Avobenzone and Octocrylene

1) Irrigation with water containing avobenzone and octocrylene significantly inhibit the aboveground growth of cucumber plants by interfering with photosynthesis. (Zhong et al Sci Total Environ. **2020 Apr 20**;714:136879). These findings should cause great concern since aquatic plants (currently growing in sunscreen contaminated waters) also use photosynthesis to grow that feed a variety of aquatic species.

2) Octocrylene was the most toxic UV filter tested in brine shrimp followed by avobenzone (Thorel et al Toxics. **2020 Apr 10**;8(2):29).

3) Octocrylene was considered to be a great threat to Japanese medaka (Oryzias latipes) based on its reproductive toxicity (Yan Environ Pollut. **2020 Jun**;261:114104)

4) Both avobenzone and octocrylene induced behavioral and physiological disruption at environmentally realistic concentrations in Daphnia magna (Boyd et al Sci Total Environ. **2021 Jan 1**;750:141707).

5) Long-term exposure to avobenzone and octocrylene was lethal for some organisms living in freshwater environments and were considered dangerous for freshwater ecosystems (University of Alberta – **Sept 1,2020** https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

6) Octocrylene was reported to alter in a negative manner mitochondrial function of hexacoral *Pocillopora damicornis* (Stien et al Sci Rep. **2020 Jun 15**;10(1):9601).

7) Octocrylene accumulates in Pocillopora damicornis tissues as fatty acid conjugates and triggers coral cell mitochondrial dysfunction (Stien et al Anal Chem. **2019 Jan 2**;91(1):990-995).

8) Octocrylene and avobenzone were found in multiple species of fish from markets in the Canary Islands and Catalonia (Spain) with Thunnus thynnus being the most heavily polluted species (Gimeno-Monforte et al Foods. **2020 Dec 9**;9(12):1827). This finding continues to demonstrate the growing concern of bioaccumulation/biomagnification of organic sunscreen actives in the contamination of our food chain.

9) Octocrylene may pose high risk to aquatic organisms in the riverine and estuarine environment in Thailand (Juksu et al Ecotoxicol Environ Saf. **2020 Nov**;204:110952).

10) In the Enoggera Reservoir (Australia), seven UV filters were detected, of which the most prevalent were octocrylene and avobenzone (O'Malley et al Sci Total Environ. **2021 Feb 1**;754:142373).

11) Octocrylene was one of three chemicals mixed together that modified genes related to the endocrine system, detoxification mechanisms, and the stress response in Chironomus riparius (Muñiz-González Ecotoxicol Environ Saf. **2020 Dec 15**;206:111199).

12) Over 60 disinfection by-products were identified as transformation products of avobenzone in different disinfection reactions of chlorination and bromination of fresh or seawater … increasing its toxicity (Lebedev et al Environment International Volume 137, **April 2020**, 105495).

Annual malignant skin cancer deaths, 1975-2017

Year of death	Skin cancer deaths	US Population (in millions)*	Deaths/Million People
1975	5,256	219	24
1976	5,697		
1977	5,904		
1978	6,035		
1979	6,155		
1980	6,151	229	27
1981	6,444		
1982	6,774		
1983	7,048		
1984	7,282		
1985	7,595	240	32
1986	7,925		
1987	7,943		
1988	8,078		
1989	8,350		
1990	8,589	252	34
1991	8,658		
1992	8,816		
1993	8,893		
1994	8,826		
1995	8,976	265	34
1996	9,363		
1997	9,316		
1998	9,490		
1999	9,572		
2000	9,734	282	35
2001	10,032		
2002	9,958		
2003	10,269		
2004	10,349		
2005	10,845	295	37
2006	11,109		
2007	11,279		
2008	11,385		
2009	12,172		
2010	12,125	309	39
2011	12,263		
2012	12,516		
2013	12,807		
2014	13,116		
2015	12,868	321	40
2016	12,098	323	37
2017	12,098	325	37
	Total Deaths: 400,159		**54% Increase in Deaths****

Data source: American Cancer Society/National Center for Health Statistics, 2019.

* Population Data obtained from https://www.populationpyramid.net/united-states-of-america/1975/ Accessed January 23, 2021

** % Increase in deaths calculated by: 2017 deaths/million people (minus) 1975 deaths/million people (divided by) 1975 deaths/million people (times) 100.

Comparative Incidence of Melanoma Australia vs. United States 1982 – 2015

Incidence rates of melanoma of the skin, all ages. Age-standardized rate (world) per 100,000

	Australia			United States (SEER 9 registries)		
Year	Males	Females	Both sexes combined	Males	Females	Both sexes combined
1982	20.8	20.7	20.6	9.3	8.0	8.6
1983	21.4	22.3	21.6	9.4	7.8	8.5
1984	23.0	22.3	22.4	9.5	8.1	8.7
1985	24.8	24.5	24.4	11.2	8.8	9.8
1986	26.2	24.2	25.0	11.6	9.2	10.2
1987	30.6	27.3	28.7	11.7	9.6	10.5
1988	33.5	27.9	30.4	11.0	8.9	9.8
1989	31.5	25.4	28.1	12.0	9.3	10.4
1990	31.2	25.2	27.9	12.1	9.3	10.5
1991	30.8	25.7	28.0	12.8	9.7	11.1
1992	34.0	26.9	30.1	13.1	9.5	11.1
1993	34.4	27.1	30.4	13.1	9.4	11.0
1994	35.0	27.2	30.7	14.1	9.8	11.7
1995	37.3	28.5	32.5	14.4	10.7	12.3
1996	37.8	29.4	33.2	15.5	11.0	13.0
1997	39.9	30.9	35.0	15.5	11.4	13.2
1998	36.9	28.2	32.2	15.6	11.5	13.3
1999	38.1	28.6	33.0	16.1	11.8	13.6
2000	38.4	29.0	33.4	16.7	12.0	14.0
2001	38.9	29.2	33.7	17.0	12.7	14.5
2002	42.0	31.0	36.1	16.6	12.5	14.2
2003	40.1	28.8	34.1	16.8	12.6	14.4
2004	39.6	30.0	34.4	17.5	13.3	15.1
2005	42.2	32.1	36.8	19.3	14.1	16.3
2006	41.0	28.4	34.3	19.1	14.0	16.2
2007	39.1	28.5	33.4	18.4	13.7	15.7
2008	40.9	29.2	34.7	19.5	14.4	16.6
2009	40.5	28.8	34.3	19.6	14.1	16.5
2010	40.2	28.1	33.8	19.8	14.8	16.9
2011	39.7	28.2	33.6	18.9	14.0	16.1
2012	40.5	28.8	34.3	19.4	13.7	16.2
2013	41.1	29.4	34.9	20.1	14.4	16.9
2014	40.7	29.7	34.8	20.9	15.1	17.6
2015	41.7	30.1	35.6	20.9	15.8	18.0
Delta %	**100%**	**45%**	**73%**	**220%**	**161%**	**192%**

SOURCES:

Data provided by the American Cancer Society

Australia: Australian Institute of Health and Welfare (AIHW) 2018 Cancer Data in Australia; Australian Cancer Incidence and Mortality (ACIM) books: melanoma of the skin Canberra: AIHW. <https://www.aihw.gov.au/reports/cancer/cancer-data-in-australia/>.

United States: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 9 Regs Research Data, Nov 2018 Sub (1975-2016) <Katrina/Rita Population Adjustment> - Linked To County Attributes - Total U.S., 1969-2017 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, released April 2019, based on the November 2018 submission.

Delta % (Percent Change from Baseline) = data for 2015 – data for 1982/data for 1982 * 100

COLLEGE of CHARLESTON
1770
Department of Biology
February 3, 2021

Hawaii State Legislature
Dear Members,

I write in support of two bills that will come before you (SB366/HB102) that ban the use of sunscreens containing oxybenzone and avobenzone. These sunscreens are found in all the world's coastal waters principally due to human application to prevent UV skin damage. However, it is also found in seafood and marine organisms that humans consume (oysters, fish, crabs, shrimp). The toxicity of these compounds has been shown to be alarming including being toxic to reef corals and fish. I support legislative Senate Bill 366 and House Bill 102 because it will mitigate pollution that threatens the conservation and restoration of coral reefs and the overall health of the oceans.

My 50 years as a coral reef ecologist put me in the witness box to the global collapse of coral reef ecosystems from human stress. Science is now demonstrating that decreased local stress improves resiliency to global stressors like thermal bleaching. The continued use of toxic chemicals is unnecessary and can only push reefs closer to the brink of extinction.

Sincerely,

Phillip Dustan

Phillip Dustan PhD FLS
Professor of Biology

66 GEORGE ST. | CHARLESTON, SC 29424-0001

Hawaii State Legislature February 6, 2020

Dear Committee Members,

I am writing in support of two bills, Senate Bill 366, Senate Bill 132, and House Bill 102, that will soon be coming before you to ban the use of sunscreens containing avobenzone and octocrylene in Hawaii. In 2019 alone, about 10.5 million tourists visited Hawaii. Most visitors use sunscreens containing the above chemicals. I implore you to pass these bills for the long-term sustainability of Hawaii's marine environment and the tourism economy that relies on Hawaii's beautiful ecosystems.

Sunscreen chemicals cause damage to the marine life and environment at multiple levels. Many research studies have reported that these chemicals are toxic to fish, shellfish, coral and microplants (Tsui et al, 2014). Small fish depend on microplants for food. When the sunscreen chemicals destroy microplants, small fish are the first to go, followed by bigger fish. The loss of microplants can impact the entire food chain. Large fish and shellfish can store these chemicals to a very high concentration (Fent et al., 2010). In a study in Switzerland rivers, high levels of octocrylene were detected in brown trout (Poiger et al., 2004). In another study, high levels of octocrylene were detected in mussels (Bachelot et al. 2012). When people eat seafood with high levels of sunscreen chemicals, they are unwittingly exposed to the toxicity of these chemicals. Many of these chemicals penetrate coral cells and kill them by causing coral bleach. Fifty percent of the world's coral reefs have already died because of physical and chemical pollution. Coral reefs support 25% of all aquatic life in our oceans (Boyce et al, 2010). The loss of reefs would have direct impact on millions of people around the globe including all of Hawaii's residents. In addition to killing fish and corals, sunscreen chemicals can also change the water chemistry by destroying the chemical balance of sea water. Change in marine chemistry will have long-term implications on the whole marine ecosystem. US Food and Drug Administration (FDA) is seriously considering banning several chemicals in the sunscreens (Matta et al., 2020). Additional information on the toxicity of sunscreen compounds on the environment and human health can be found in the following research papers (Downs et al., 2016; Goikaas et al, 2007; Laffoley et al., 2019; Song, 2020).

From my experience as an environmental toxicologist with 24 years of research experience in drinking water, wastewater treatment, and environmental toxicology, I strongly support Senate Bill 366, Senate Bill 132 and House Bill 102. Banning sunscreens containing toxic chemicals such as oxybenzone and avobenzone in Hawaii is the right decision for the environment and for Hawaii's economic sustainability long term. It will protect Hawaii's marine life and protect people's health in Hawaii and the tourists who visit Hawaii to be able to enjoy the pristine beaches and oceans for generations to come.

Respectfully submitted,

Achal Garg, Ph.D.
Board of Directors at Chemists Without Borders
Adjunct Professor, Miami University, Oxford, Ohio
Research and Development Manager, Wastewater Division, City of Cincinnati (Retd.)
Fulbright Scholar, Namibia, 2012
Fulbright Scholar, Peru, 2019
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References:

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אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

February 3, 2021

Re: Letter of support for ban of Octocrylene

To whom it may concern
I support legislative Senate Bill 366 and House Bill 102 that will help to mitigate pollution that threatens the conservation and restoration of coral reefs in Hawaii. There is increasing scientific evidence that traces of chemicals such as octocrylene originating in cosmetics and sunscreens can be found in aquatic environments with high swimmer pressure. In these studies various effects of these chemicals and their derivatives were reported to have deleterious affects on marine life including corals. Studies by our group further showed that the active ingredients found in these common sunscreens and cosmetics affect coral larval viability and is toxic to coral cells *in vitro*. We demonstrated that these chemicals can cause disruption of coral physiology and may even cause their death. It was found that these chemicals accumulate in coral tissues and causes dysfunction of the coral cells' mitochondria (Stein et al 2019, 2020). These effects occur at concentrations that are found in the environment. The information published in these papers is significant and should hopefully be taken into account by legislators in Hawaii
In light of these deleterious effects and the large number of swimmers in areas where corals are found, we call for the prevention of further harm to our marine life from this chemical. This is especially important in light of possible additive effects of these chemicals with additional pollutants and with the deleterious effect of climate change. We therefore call for a ban of this chemical and its derivatives in sunscreens used in Hawaii in order to maintain healthy reefs and marine environment in the wonderful Hawaiian Islands.

Sincerely

E. Kramarsky - Winter

Dr Esti Kramarsky Winter
Dept of Biotechnology Engineering
Ben Gurion University
Beersheva Israel

Institute of Geophysics
University of Tehran

No. .....
Date.....

In The Name of God

Date: For the 2021 Hawaii Legislative Season
To: The State of Hawaii Legislature, its Committees and Chairpersons, and Governor Ige

Re: Restriction of the Sale of Octocrylene & Avobenzone SPF products
DANGER of UV chemicals to climate change and its carbon footprint.

I am an environmental scientist and oceanographer at the Institute of Geophysics within the University of Tehran, Tehran, Iran. I am one of the foremost experts in my country that studies the impact of human activities on the marine environment.

To the point, I want to express my support for HB102 and SB366. These bills were written with the broad input of a number of independent scientists that strikes a wise and effective balance to diminish Oxybenzone/Octinoxate environmental pollution to coral reefs and other marine habitats, while NOT impacting tourism.

I am sure there will be a number of scientists worldwide who will provide scientific testimony to the toxicology and pollution of these two dangerous chemical that impacts all matter of marine life, but also the integrity of human health.

Carbon footprint - I would like to point out something that my other scientific colleagues may not. The CARBON FOOTPRINT of hydrocarbon-based sunscreens is considerable. If Hawaii DLNR is correct, that over 55 gallons of sunscreen pollutes the coast line of Maui per day, then we can calculate that the input of octocrylene alone is contributing to 4,444lbs (2.02 metric tons) of CO2 per year. If you include avobenzone into the calculation, that is almost 1.5 metric tons of CO2 per year. For Hanauma Bay, assuming that 6,025 pounds of octocrylene pollutes the bay per year, that is equivalent to more than 8.5 metric tons of CO2 per year.

Sunscreen pollution is not just the direct toxic impact it has to nearshore and mesophotic reef habitats, and migrating cetaceans. The use of these chemicals in Hawaii has a direct contribution of the CO2 load to atmospheric and oceanic condition. The State of Hawaii government has made a promise to recognize and mitigate the overall size of their carbon footprint. Sunscreen pollution and its impact to climate change is an issue that Hawaii can show leadership and responsibility.

Your efforts in legislative conservation have been noted around the world, and we applaud your effort and leadership.

Respectfully submitted,

S. A. Haghshenas

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山東農業大學
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February 12, 2021

Dear Members of the Hawaii Legislature,

We appreciate very much the legislative Senate Bill 366 and House Bill 102 which intend to ban the use of toxic chemicals such as octocrylene and, avobenzone in personal care products.

Our research team has recently found that all avobenzone and octocrylene, as well as oxybenzone and octinoxate have severe damaging effect on plants (including algae and terrestrial plants). These chemicals are readily absorbed by plants, and may instantly inhibit photosynthesis and respiration processes; the two most important processes in plants. This inhibition further interferes with a wide variety of metabolic activities, leading to the over-accumulation of Reactive Oxygen Species (leading to oxidative stress) and causing a deficiency of ATP (the fundamental energy units of all cells), resulting in adversely effecting disease in all affected plants.

The application of these chemicals has severely led to pollution of marine and freshwaters, potentially inhibiting the growth of plants in those habitats, and damaging the ecosystems. In addition, the concentrations of damaging effect of these UV-filters have been proven to be extremely low. And the damaging effect of these chemicals will be aggravated when other stresses also exist.

Thus, limiting the use of these chemicals will greatly protect the marine and terrestrial ecosystems, which will finally benefit mankind.

Sincerely,
Prof. Dr. Huiyuang Gao

State Key Lab. of Crop Biology
College of Life Sciences
Shandong Agricultural University

Sincerely,
Xin Zhong

State Key Lab. of Crop Biology
College of Horticulture Science and Engineering
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TEL AVIV UNIVERSITY
אוניברסיטת תל אביב

Re: Letter of support Feb. 04, 2021

To whom it may concern
I would like to support legislative Senate Bill 366 and House Bill 102 that will help to mitigate chemical pollution that threatens the conservation of coral reefs in Hawaii.
I would like to stress that there is increasing scientific evidence that traces of the octocrylene, a chemical found in many sunscreens and personal care products can be found in aquatic environments at various concentrations. In these studies the effects of these chemicals and their derivatives have been reported to have deleterious effects on marine life including corals. This is based on a number of published studies showing that the active ingredients found in some common sunscreens and cosmetics affect coral health. These chemicals can cause disruption of coral physiology and may even cause their death. Recent studies showed that octocrylene accumulates in coral tissues and causes dysfunction of the coral cells' mitochondria. Indeed these effects occur at concentrations that are found in the environment. The information published in these papers is significant and should hopefully be taken into account by legislators in Hawaii
In light of these effects on corals we call for the prevention of further harm to the reefs of Hawaii by this chemical. This is important in light of possible additive effects of these chemicals with effects of climate change. We therefore call for a ban of this chemical and its derivatives in sunscreens used in the Hawaiian Islands.

Yossi Loya, PhD
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אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

Re: Letter of support Feb. 4, 2021

To whom it may concern

I support legislative Senate Bill 366 and House Bill 102 that will help to mitigate pollution that threatens the conservation and restoration of coral reefs in Hawaii. There is increasing scientific evidence that traces of the chemical **octocrylene** found in many sunscreens can be found in aquatic environments. Studies demonstrated various deleterious effects of these chemicals and their derivatives on marine life ranging from corals to fish. In addition to that studies by a number of researchers further showed that the active ingredients found in some common sunscreens and cosmetics affect coral larval viability and is toxic to coral cells *in vitro*. These chemicals can cause disruption of coral physiology and may even cause their death. It was found that these chemicals accumulate in coral tissues and causes dysfunction of the coral cells' mitochondria (Stein et al 2019, 2020). It is important to note that these effects occur at concentrations that are found in the environment. The information published in these papers is significant and should hopefully be taken into account by legislators in Hawaii.
In light of these deleterious effects, we call for the prevention of further harm to our marine life from this chemical. This is especially important in light of possible additive effects of these chemicals with additional pollutants and climate change. I therefore call for a ban of this chemical and its derivatives in cosmetics used in Hawaii in order to maintain healthy reefs and marine environment in the Hawaiian Islands.

Thank you

Professor Ariel Kushmaro

Prof. Ariel Kushmaro
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FEB 5, 2021.

To: Honourable Members, Senate and House of Representatives, 31st Legislature 2021, and Governor Inge, State of Hawaii.

Re: Soluble Organic UV filters and the Parallels between Human and Wildlife Toxicity. A Common Precautionary Approach for Humans and The Marine Eco-system.

The Government of Hawaii is considering extending the ban of ***soluble*** organic UV filters to include octocrylene and avobenzone in addition to oxybenzone and octinoxate, the filters restricted in 2018. We strongly support SB 366 and HB 102 as physicians who cherish the first dictum or the sacred trust in medicine - First Do No Harm. All four belong to the group of twelve ***soluble*** organic UV filters watchlisted by the US-FDA in February 2019 and classified as Category III or insufficient data to be designated Generally Regarded As Safe or Effective (GRASE). Only two ***insoluble*** inorganic UV filters were placed in Category I or classified as GRASE [1]. The FDA merely affirmed over two decades of peer-reviewed literature that these 12 ***soluble*** organic UV filters were bioavailable and were associated with diverse toxic effects in humans and wildlife [1]. More alarmingly, they do not appear to prevent skin cancer [1]. The FDA also re-confirmed 25 years of science that permeation (percutaneous absorption) through human skin leads to systemic bioavailability. The six ***soluble*** organic filters in the FDA Maximum use Studies Trial (MuST) were avobenzone, oxybenzone, octinoxate, homosalate, octocrylene and octisalate. All attained blood levels after only one application > the threshold for non-clinical toxicology testing [2].

Bioavailability

There appears to be a common pathway for toxicity to humans and the marine eco-system. It is established that human toxicity begins with permeation then bioavailability resulting in binding to various cell receptors, causing hormone disruption, DNA mutation, and damage to enzymes that methylate genes leading to the alarming consequence of epigenetic changes or transgenerational effects, in the progeny of exposed individuals. The pathogenetic pathway in humans – first permeation – then endocrine disruption, DNA mutation or genotoxicity – is also likely to occur in the marine environment, given the similar properties of human skin to coral epidermis and the external membranes of many marine organisms. Oxybenzone at relatively low concentrations degraded coral acting as a skeletal endocrine disruptor in planula of *Stylophora pistillata* [3]. *Coral has an epidermis similar to human skin but less complex, and an unintended consequence of human use of* ***soluble*** *organic UV filters may be the degradation of the marine habitat* [3,4].

A 1997 study warned about the human danger posed by cutaneous absorption of oxybenzone from sunscreens. Basic physiology instructs that any substance with a molecular weight (MW) < 500 Daltons applied to skin will enter human blood [5]. Bioavailability in humans is a fact established by many studies over 25 years. Only a few can be cited here in the interest of brevity. The CDC confirmed 96.8% of Americans had oxybenzone contamination from its pervasive use in sunscreens and cosmetics [6]. International studies proved bioavailability to the fetus and newborn - 85.2% of nursing mothers in the EU had at least one UV filter in breast milk [7], and another CDC study found oxybenzone in the urine (99%) and amniotic fluid (61%) of pregnant patients [8]. The lipophilic (fat soluble) nature of soluble organic UV filters ensure widespread contamination of humans literally bathing every cell in the human body and brain. They are found in blood, urine, amniotic fluid, placenta, fetal and cord blood, semen, ovarian follicular fluid, and adipose tissue [9].

A Benefit Risk Assessment of Sunscreens using Soluble organic UV Filters

Benefit Risk Assessment (BRA) is a compulsory precept in medicine, drug research, and a prudent practice for life in general. A "net risks test" or similar has never been applied to the use of sunscreens, now allowed to make therapeutic label claims in some regulatory jurisdictions. These label claims are largely based on the assumption that sunscreens could prevent sunburn and by extrapolation skin cancer and sun damage. They were never preceded by

the mandatory rigorous clinical research trials required for any medication making a serious claim like preventing skin cancer.

For over 60 years, applying sunscreen to UV exposed skin is promoted to prevent sunburn, skin cancer, and other effects of sun damage like photoaging and immune suppression. Most sunscreens deliver some degree of sunburn protection, largely by reducing the effects of UVB and UVA2 radiation, but there is little or no evidence in published literature that they prevent skin cancer to a significant degree. Prior to 2010 some studies suggested that sunscreens caused skin cancer, particularly melanoma [10-15]. These early studies detail the uncertainty that sunscreens actually prevent skin cancer, and more recently, the two most encyclopedic and exhaustive reviews DO NOT show that sunscreens prevent skin cancer to any useful degree [16,17]. Not surprising, as early sunscreens were designed to prevent sunburn, not skin cancer.

Early and current sunscreens use combinations of soluble organic UV filters providing UVB and UVA2 attenuation but with minimal or no UVA1 extinction, resulting in 10X more UVA than UVB passing through the sunscreen to reach the skin [18].This asymmetric UV or UVB-BIASED protection over the past 6-7 decades parallels the global rise in skin cancer. Non- Melanoma Skin Cancer (NMSC) continues to rise in the USA and worldwide at an average annual rate of 1-2% [19,20]. The National Cancer Institute reports that melanoma rates in the United States tripled between 1975 and 2014 [21]. Skin cancer is now the most common cancer in the USA and in N. America, and accounts for more than 50% of all human cancers i.e. skin cancer cases outnumber all other cancers combined [19,21]. The rate of new melanoma cases among American adults has tripled from 7.9 per 100,000 people in 1975 to 25.2 per 100,000 in 2014 [21]. Melanoma is the leading cause of cancer death in women ages 25-30, the second leading cause of cancer death in women ages 30-35, and melanoma is the second most commonly diagnosed cancer age 15-29 [21]. From 1970 to 2009, the incidence of melanoma increased by 8-fold among young women and 4-fold among young men, and in the USA, one person dies of melanoma every 54 minutes, and an estimated 9,730 people will die of melanoma in 2017 [19,21]. The Global Burden of Disease Study (2015) reported that from 2005 to 2015 there was a 27.2% and 42.9% increase in the global death rate from melanoma and NMSC respectively [22].

The detailed review above explaining the global rise in all skin cancers is necessary to refute the misconception fostered by stakeholders that sunscreens using combinations of soluble UV filters actually prevent skin cancer. It establishes along with the studies cited [10-17] that there is no measurable BENEFIT from using these sunscreens. There is a logical and intellectual explanation for the parallel rise in global skin cancer provided by understanding the concept of UVB-BIASED protection [18]. If there is **NO BENEFIT** in using these petrochemical UV filters, any level of risk, however minimal becomes significant and arguably unacceptable, particularly for the most vulnerable to toxic effects – expectant or nursing mothers, young or adolescent children, and couples trying to conceive. Definitive fetal toxicity studies to identify mutagenic, and epigenetic effects, or to assess the NOAEL (No Observed Adverse Effect Level) in a fetus are either unethical or methodically impractical. It would require exposing women in pregnancy to chemicals thought to be harmful and could require observation and data collection involving their progeny for at least two generations. For sunscreens using petrochemical organic filters, the Benefit Risk Assessment (BRA) equation has only **risk to the fetus and the environment** (terrestrial and marine) and **no intended benefit.** This fact strongly resonates with the authors, one of whom was a former obstetrician.

The **first** precept in medicine 'first do no harm' (primum non nocere) - taken from the writings of Hippocrates), and the Precautionary Principle [23] are more stringent standards than 'not generally regarded as safe'. The Precautionary Principle is applied variably, but fundamentally asserts "that the burden of proof for potentially harmful actions by industry or government rests on the assurance of safety and that when there are threats of serious damage, scientific uncertainty must be resolved in favor of prevention". This approach supports the physician's **first rule** and is long overdue for soluble organic sunscreens

These ***soluble*** organic filters share functional properties along with their structural analogues that include human estrogen, pesticides like DDT (an organochlorine), organophosphate pesticides like malathion or diazinon, dioxin, and other hormone disruptors like BPA and phthalates. The risks to humans and wildlife have been well described for almost 3 decades [24,25]. In humans they represent ***a primary exposure*** to hormone disruptors in a first world modern society where sunscreen use is highest - now more likely than DDT, dioxin, BPA, and others.

Human Risks

The 12 watchlisted FDA Category III soluble organic filters are similar in chemical structure and are all potential or proven hormone disruptors, sharing these properties with BPA, DDT, and other persistent organo-phosphates. ***The human and wildlife effects are numerous and diverse, described by several hundred publications, too numerous to be referenced here.*** There is another instructive often forgotten first principle from basic endocrinology – ***isoform function*** – chemicals with the same structure will act at a cellular level in a similar manner, and bind to the same receptors [24]. Hence if oxybenzone exhibits endocrine disrupting properties, then all soluble organic UV filters are suspect, and the Precautionary Principle should be applied. This principle should also apply to the marine eco-system.

The peer-reviewed literature implicates oxybenzone, octinoxate, octocrylene, homosalate, and 4-methyl benzilidene camphor as hormone disruptors in humans and animal models, and suggest generally that reproductive organs and the central nervous system represent sensitive targets for developmental effects of endocrine active xenobiotics [24,26]. Contemporary studies document widespread effects in human and wildlife from soluble organic UV filters and their structural analogues like DDT, BPA, and other hormone disruptors. A review of 85 scientific papers in humans and lower species concluded that aromatic hydrocarbon UV filters are generally involved in the disruption of the hypothalamic–pituitary–gonadal system [26].

Oxybenzone, homosalate, avobenzone and 4-methyl benzylidene camphor (4-MBC, not used in the USA) show variable interaction with estrogen, androgen, and progesterone receptors using Reporter Gene Assays [27], and reports showed that octinoxate and 4-MBC had equal effects to 17 β-estradiol on gene induction, reproductive, and skeletal systems in mammalian, amphibian, and other animal models cells [28]. A change in a hormone level is arguably evidence of Hormone Disruption. In one of several recent studies in healthy premenopausal women, various phenols, including oxybenzone and parabens, changed the levels of key reproductive hormones - FSH (Follicle Stimulating Hormone), (LH) Luteinising Hormone, estradiol, and progesterone [29]. Contemporary reviews show the disruption of endocrine, reproductive, metabolic systems, leading to a variety of human disorders and cancers [29,30,31]. Some effects from fetal exposure are seen in newborns – spina bifida [32] and Hirschsprung's Disease [33,34], others in adolescents – delayed puberty [35,36], and others delayed until adult life – endometriosis [37,38] and infertility [39], usually serious and often irreversible.

Environmental/Wildlife/Marine Eco-System Risks

Soluble organic UV filters contaminate every link in the land-based aquifer leading to the oceans. Most of the twelve watchlisted by the FDA are found in Waste Water Treatment Plant (WWTP) influents and effluents, since most WWTP do not remove the traditional soluble aromatic hydrocarbon sunscreen filters [40]. As of 2015, thirty-three scientific publications confirmed these UV filters polluting not only WWTP inflow and outflow, but swimming pools, tap-water, urban groundwater, freshwater (rivers and lakes), estuaries, and seawater [41]. The ubiquitous contamination by soluble organic UV filters of the entire global environment from industrial, lifestyle, and recreational activities is supported by their presence in the open waters of the Pacific Ocean, the surface waters of China, Japan, the USA, Thailand, the Arctic [41], and every global coral reef system [42]. Fifteen studies confirmed significant concentrations of these filters in sediments from rivers and lakes, beach sand, soils and sludge [4].

The contamination of the entire global water supply is intimidating [4,41,42]. No other chemical, drug, pesticide or agent is apparently a contaminant on this scale. With the toxicity in wildlife and the eco-system these petrochemical UV filters have arguably become the world's number one POLLUTANT. Recent reviews confirmed significant concentrations of organic UV filters in sediments from rivers and lakes, beach sand, soils and sludge, ultimately reaching land-based and marine wildlife [4,41]. Reviews describe their biomagnification in mussels, corals, crabs, shrimps, prawns, squids, fish, dolphins, cormorants, and in unhatched eggs of bird's species, where the same effects of hormone disruption in marine species and aquatic biota are observed [4,43]as in humans [25]. Reports spanning a decade focused global attention on their effects on coral and ocean reefs [4,42,44]. Contamination of the marine food supply is a secondary source of human exposure. The hormone disrupting and other effects on marine species have also been consistent for 20 years [45,46,47,48,49].

A Solution based on a Precautionary Approach

The most persuasive argument for adopting a precautionary approach to UV filters and human/environmental safety – whatever the level of risk – is the mere possibility for congenital, teratogenic, hormone disruption, and carcinogenic effects in the exposed individual – human or wildlife - and the risk for transgenerational and multigenerational sequelae. Human safety may be ***the pre-emptive consideration*** when looking at the marine eco-system and sunscreens. The toxic petrochemical filters have a low MW < 500 Daltons that enable bioavailability leading to systemic toxicity. They are benzyl chemicals with properties to cause photocontact or irritant dermatitis. They are consistently in the top 30 contact allergens, although the prevalence is low.

The approach is simple – avoiding bioavailable UV filters eliminates any human risks and the unintended consequences to the environment and wildlife. Larger filters with MW > 500 Daltons are not bioavailable through intact human skin and are less likely to harm wildlife. Mineral oxides, new organic agents like bemotrizinol, bisoctrizole, and drometrizole trisiloxane meet this objective and satisfy the safety first concept of the Precautionary Principle. These insoluble filters provide the best UVA protection and have a better chance of preventing skin cancer and sun damage, since modern science now confirms that UVA is the primary driver of skin cancer [18]. The authors prefer 25% zinc oxide as a safe and effective sunscreen. It does not permeate human skin and even if it did zinc is a normal and important mineral in human physiology, as a co-factor in over 200 enzyme reactions. There is no evidence that zinc is accumulating in the marine environment and it is a small component in sea water. Industry and their consultants argue that banning the toxic UV filters will discourage sunscreen use, particularly in people of colour who disliked old goopy-white mineral sunscreens. Products with soluble UV filters have no benefit anyway, and contaminate our bodies and the world we live in. Modern zinc oxide sunscreens are no longer white or chalky on even dark skin. They are available in 25% zinc oxide dispersions that apply clear on any skin colour. Safe, esthetic, and effective. A former First Lady, Venus Williams (tennis icon), and others with coloured or dark skin now use transparent 25% zinc oxide sunscreens.

The worry that nanoparticles from mineral sunscreens are marine contaminants is overstated, since most modern mineral products with either zinc oxide or titanium dioxide particles are no longer nanoscale but are in the micron range. They are insoluble particles that mostly fall to the ocean floor and do not travel on surface ocean currents for thousands of miles like soluble petrochemical UV filters. Marine contamination from mineral sunscreens is a valid environmental concern requiring thoughtful investigation. At this time it is theoretical rather than empirical, as there is little or no present evidence that mineral oxide particles - nano or larger - from sunscreen use are accumulating in the ocean environment.

Eventually, the FDA and others will develop a regulatory framework from valid evidence of safety and efficacy. While it evolves, a good place to start would be with a WARNING Label on BIOAVAILABILITY and a CAUTION to pregnant or nursing mothers and the most vulnerable among us – young or adolescent children, and couples trying to conceive. This occurs for almost everything that is bioavailable to vulnerable groups, particularly the fetus, including low dose aspirin and many other OTC non-prescription items, such as vitamins, cigarettes, and alcohol. A Warning Label is justified based on the absolute proof of bioavailability, and allows the consumer to make their own informed choice.

Thoughtful and strategic future marine research on sunscreen ingredients and finished products may confirm that large insoluble UV filters, which avoid human permeation, bioavailability, and any systemic toxicity are also better for the entire environment. This research must transcend borders, financial and political interests, and involve a global team of multidisciplinary scientists. Meanwhile, a simple solution is to apply the Precautionary Principle to sunscreen use. Label warnings of permeation and bioavailability should convince expectant and nursing mothers, and prudent parents to avoid soluble filters. A ban on ineffective sunscreens that are toxic to humans and the environment is one simple measure, compared to other initiatives to protect the reefs. warming. Wearing highly effective UV protective clothing outdoors, reduces the amount of sunscreen used on exposed skin and lowers the amount available to reach terrestrial and marine water. Applying a sunscreen using insoluble large MW UV filters in conjunction with UV protective clothing is very effective photoprotection for humans. Both measures will support reef and marine conservation. This precautionary approach for humans is in harmony with a precautionary measure for coral and all wildlife, land- based and marine. Banning these 4 soluble organic UV filters in Hawaii leads by example, but only a partial solution. As these four toxic petrochemicals are removed from your marine environment, the others in the group of twelve FDA Category III are still toxic to humans. Others like homosalate or ecamsule may

begin to emerge as environmental toxins with effects on marine life as they are used in greater relative frequency. Banning all 12 of the FDA Category III filters is best for the human condition, and will likely be better for the coral and remove these non biodegradable petrochemicals from your streams and ocean. A definite precautionary measure for the health of your citizens, your millions of visitors, and their progeny.

SUBMITTED BY

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February 7, 2021.

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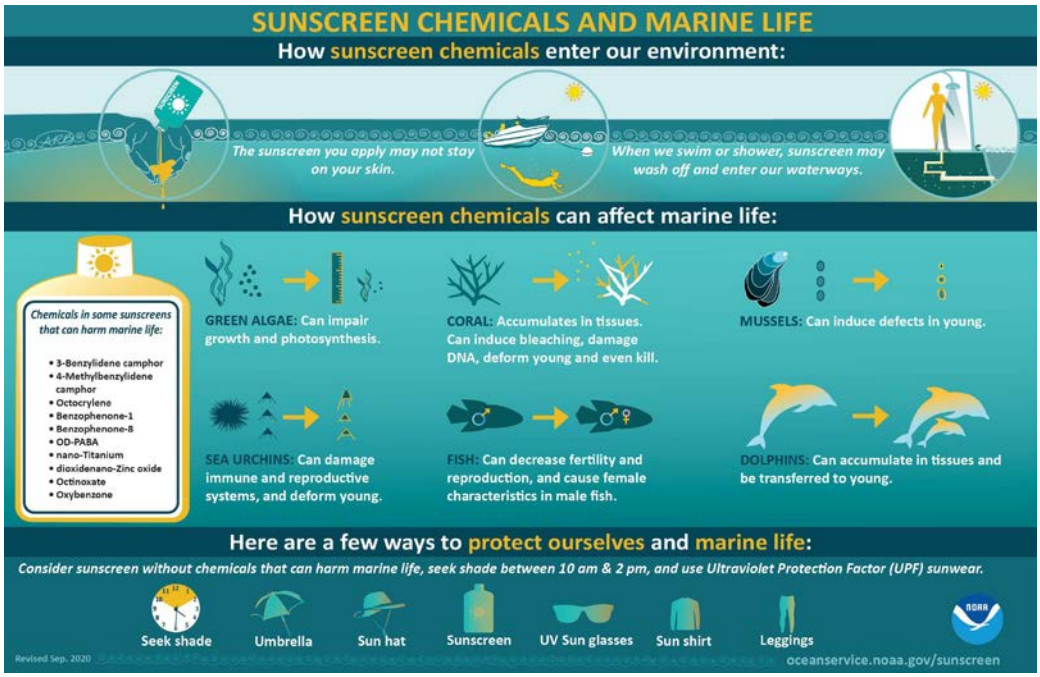
NAPILI
Bay and Beach Foundation

February 8, 2021

Aloha Members of Hawaii State Legislature:

Napili Bay and Beach Foundation, Inc. supported the 2018 legislative efforts which resulted in the ban of sales of sunscreens containing octinoxate and oxybenzone in the new Hawaiian law. Likewise we are in support of Senate Bill 366 and House Bill 102, amending 2018 House Act 104 by including avobenzone, and especially octocrylene, as an important step in coral reef and marine conservation against the threat of localized plumes of sunscreen pollution.

We have recently become aware of increasing scientific evidence that traces of the chemical octocrylene found in many sunscreens can be found in aquatic environments. Multiple recent (2014 – 2020) studies have demonstrated various deleterious effects of octocrylene and octinoxate and their derivatives on marine life ranging from corals to fish. NOAA has recently updated their public information on sunscreen chemicals that harm the marine environment, and added octocrylene to the list of ingredients known to be harmful to marine life.



Respectfully ,

Pat B. Lindquist

We are a non-profit organization formed to protect and improve the health of Napili beach and bay.

Gregg Nelson, GM Napili Kai Resort & VP
Nane Aluli, GM The Mauian, & Secretary
Norm Runyan, GM Napili Shores Resort & Dir.
Jamie Lung-Ke'o, GM Hale Napili Resort & Dir.
Tano Taitano, GM Napili Surf Resort & Dir.

SAFE SUNSCREEN COUNCIL

February 11, 2021
RE: In Support of Senate Bill 366 and House Bill 102 - Amending Act 104

TO: Hawai'i Legislature

We are the Safe Sunscreen Council, a coalition of companies working to raise public awareness about the impact sunscreen ingredients may have on people and planet. As such, we believe it is our responsibility to offer alternatives to harmful ingredients and we would like to show our **support of Senate Bill 366 and House Bill 102, amending Act 104**.

We request that the State of Hawai'i continue its global leadership role in protecting coral ecosystems by amending Act 104 to include two other toxic ingredients: Octocrylene and Avobenzone.

Emerging scientific studies indicate that ingredients found in many chemical sunscreens may cause damage to coral reefs and oceanic ecosystems. We know that these chemical sunscreen pollutants impact not just coral larvae and recruitment, but they also impact other important species such as algae, sea urchins, mussels, and an arthropod critical in marine food webs.

There are better ways - safer ways - to protect from UV rays without putting the health of our oceans at risk. Safer ingredients, like the ones found in mineral sunscreens made by members of the Safe Sunscreen Council and many other companies, all comply with U.S. Food & Drug Administration's regulations on SPF values and UV protection and are cost-competitive to products made with harmful chemical ingredients.

Please consider this legislation as a way to combat aquatic contamination within the State of Hawai'i and beyond. Thank you for your consideration.

With Gratitude,

Caroline Duell, Spokesperson & Members of the
Safe Sunscreen Council

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CNRS Research director
Laboratoire de Biodiversité et Biotechnologie Microbienne
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Dear Hawaii Legislature,

This letter is testimony for my support of Senate Bill 132.

The inclusion of octocrylene in the context of the Hawaii Law 104 Amendment of 2018 is an important step in the conservation of coral reefs against the threat of localized haloes of sunscreen pollution in areas frequented by swimmers.[1]

Our group has used an innovative method to evaluate and quantify the impact on UV filters on reef building coral *Pocillopora damicornis*.[2–4] We have been able to demonstrate that the effect of octocrylene is of particular concern. On the one hand, this compound alters mitochondrial function in coral, whereas mitochondria are the source of energy for the animal cell. By way of illustration, in humans, many conditions including Alzheimer's disease, muscular dystrophy, and cancer can induce mitochondrial dysfunction.

On the other hand, we also established that octocrylene accumulates in coral by "hiding" into it. Indeed, where octocrylene itself is present in relatively small quantities, larger amounts of octocrylene derivatives have also been found. These derivatives result from the transformation of octocrylene by coral enzymes. They can be 10 to 100 times more concentrated than octocrylene. As a result, the concentrations of octocrylene measured in the coral in Hawaii are likely very largely underestimated because octocrylene derivatives concentrations were never measured.[5] This is all the more worrying since these derivatives are very closely related to octocrylene itself and are expected to be just as toxic for coral.

Another concern is that similar compounds have also been found in human urine after topical (on the skin) application of sunscreens containing octocrylene.[6,7] This highlights the fact that (1) octocrylene does penetrate animal membranes, including human skin, and (2) these biological mechanisms of octocrylene transformation are possibly ubiquitous, and therefore these derivatives should be systematically considered in octocrylene concentration measurements. It should be mentioned that we have found these same analogues in other marine animals in a work that has not been published yet.

Our second article demonstrated that octocrylene was the most toxic of all the 10 UV filters tested on coral. Ethylhexyl salicylate comes second, and benzophenone-3 third. In another work, we also demonstrated that octocrylene was somewhat toxic towards the brine shrimp *Artemia*

salina and the microalgae *Tetraselmis* sp..[8] In an unpublished work, we have found huge localized concentration of octocrylene in beach sand and water column, and I am convinced owing to our work and literature data on this compound that it represents one of the major threat for coral reef in bathing areas.

Respectfully submitted,

Dr. Didier Stien.

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REVIEW ARTICLE

BJD British Journal of Dermatology

Sunscreen abuse for intentional sun exposure

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Summary

Skin cancer is caused by exposure to ultraviolet radiation (UV) and the sun is the main source of this radiation. Sunscreens were initially formulated to prevent sunburns; laboratory studies later revealed that in rodents they could reduce UV-induced skin cancer which resembles human squamous cell carcinoma. Three randomized trials in older adults showed the ability of sunscreens to moderately reduce the occurrence of solar keratoses and of squamous cell carcinoma. However, no effect was observed for basal cell carcinoma. There is no animal model for human melanoma and observational studies often found sunscreen use associated with a higher risk of nevus, melanoma and basal cell carcinoma. These higher risks were found when sun exposure appeared to be intentional, that is, with the desire to acquire a tan, a healthy look or simply to spend as long as possible in the sun with as much skin exposed as possible. Three randomized trials showed that sunscreen use by sun sensitive subjects engaging in intentional sun exposure could increase the duration of exposure without decreasing sunburn occurrence. This increased duration could be the reason why melanoma risk is increased when sunscreen is used. Hence, sunscreen abuse may extend sun exposure duration thus allowing sun exposure behaviours that would not be possible otherwise. Advertising for sunscreens and labeling of sunscreen bottles should inform consumers of the carcinogenic hazards associated with sunscreen abuse. It would be good to use a personal UV dosimeter which would give an alert when one's individual sunburn threshold in the absence of sunscreen use is nearing. The combination of sunscreen and a UV dosimeter may be an option for reducing the melanoma risk among sun worshippers.

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Accepted for publication
7 August 2009

Key words
behaviour, melanoma, radiation, skin cancer, sunscreen, ultraviolet

Conflicts of interest
None to declare.

DOI 10.1111/j.1365-2133.2009.09448.x

The advent of sunscreens paralleled the tanning fashion that spread in light skinned populations starting in the 1930s.[1] Their initial formulation was designed to block ultraviolet (UV) B radiation (UVB, 280–320 nm), which causes most sunburns. Epidemiological studies in the 1980s found a strong link between sunburn history and skin cancer, including melanoma. At the same time many laboratory experiments showed that besides delaying the erythemal reaction, sunscreens could reduce a variety of other UV-induced skin lesions, including squamous cell cancer. As a result, these products have been advocated for the prevention of skin cancers, including melanoma despite the absence of a good animal model mimicking human skin melanoma. Until recently, it was generally assumed that the greater the ability of a sunscreen to delay sunburn (i.e., its sun protection factor – SPF), the higher the protection against deleterious effects of the sun. In the 1990s the carcinogenic properties of ultraviolet A radiation (UVA, 320–400 nm) began to be suspected, and a new generation of broad-band sunscreens has emerged, having high SPF (30 and more) and containing agents specifically blocking the UVA.

However, contrary to the expectations based on laboratory experiments, population-based case-control studies often found an increased risk of melanoma associated with sunscreen use (revised in ref. 2). Prospective and retrospective cohort studies found sunscreen use to be associated with increased risk of basal cell cancer in adult women,[3] and higher numbers of acquired melanocytic nevi among school children and adolescents.[4,5] Concerns raised by epidemiological studies were emphasized by laboratory experiments showing that sunscreens could enhance the stimulation of melanoma growth by UV radiation.[6]

After 1995, epidemiological studies and randomized trials found that the most probable reason why sunscreen use increased the risk of melanoma was that by delaying sunburn occurrence, these products extended the time spent in the sun.[7] In this paper, we review the evidence backing this finding and propose a model for explaining why sunscreen extended sun exposure may increase melanoma risk. Based on this model, we propose a way to control time spent in the sun when a sunscreen is used.

Sunscreens and intentional or non-intentional patterns of sun-exposure

Understanding the sunscreen-melanoma association requires distinguishing between two different types of sun exposure patterns.

The non-intentional sun exposure (NISE) pattern represents sun exposure during daily life activities, without a special willingness to acquire a tan or to be able to spend a long time in the sun. The so-called chronic sun exposure pattern usually equates to NISE. Examples of NISE are outdoor activities such as walking, hiking, gardening, skiing, or construction and farming work. Lifetime accumulated NISE is mainly associated with solar keratoses and squamous cell carcinoma.

The intentional sun exposure (ISE) pattern is sun exposure with an intention to stay in the sun with large uncovered skin areas, or/and to acquire a tan. ISE is characteristic of light-skinned subjects who spend most of their daily life indoors but enjoy intense sun exposure during holidays. The usually called intermittent sun exposure pattern is often intentional as subjects look for a biological effect. Sunbathing is the most typical ISE behaviour. Melanoma is commonly found on the usually covered sites such as the trunk, and this clinical evidence fits with the ISE patterns being the cause of most melanoma.

Reasons for the increased melanoma risk associated with sunscreen use

It was first hypothesized that the increased risk of melanoma or high nevi numbers was found in populations not using modern high SPF, anti-UVA broad-band sunscreens. However, many of these studies are quite recent and included people who already used the broad-band type of sunscreens.[2]

Secondly, it was argued that because sunscreen users were generally more sun sensitive than non-users, the increased risk of melanoma observed in sunscreen users merely reflected their inherently greater risk of melanoma. The epidemiological literature describes this phenomenon as 'bias by indication'. However, this bias can likely be excluded because of the 'sunscreen-clothes paradox' found in many studies: sunscreen use and wearing of clothes when in the sun are more prevalent in sun sensitive subjects.[2,8] The study on nevi in European schoolchildren showed that during sunny holidays, an inverse correlation existed between sunscreen use and sun protection through the wearing of clothes (Fig. 1): the more sunscreens were used, the fewer clothes protected the skin against the sun. This and other studies found that while sunscreen use was associated with higher nevus counts, wearing clothing was associated with decreasing numbers of nevi.[4,5] Only one population-based case-control study examined the risk of melanoma with sunscreen use and wearing of clothes, and found a melanoma risk reduced by 52% ($P < 0{\cdot}001$) when the primary site of the tumour was usually covered with clothes during outdoor work in the summer.[9] In contrast, the melanoma risk associated with sunscreen use was 1·15 (95% CI 0·78–1·68) in subjects who used sunscreens for 10 years or more.

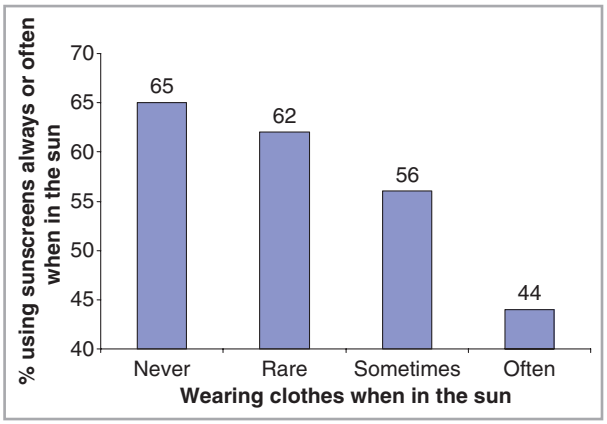

Fig 1. Correlation between sunscreen use and wearing clothes in 623 5- to 7-year-old European schoolchildren (R-square = 0·92, $P < 0{\cdot}0001$) (Ref. 4).

If wearing clothing and using sunscreen represent real barriers against the transmission of UV to the skin, then why does the former actually protect against melanoma and nevus formation, while the latter seems unable to protect against melanoma and rather increases nevus development. This paradox made credible the hypothesis that sunscreen use could be involved in nevus and melanoma occurrence.

The third hypothesis was that due to their ability to delay sunburns, sunscreen use would encourage sun exposures of longer duration; this would be especially true when sun exposure is motivated by a desire to tan or to remain in the sun for longer periods. This hypothesis was supported by the common observation that in NISE situations, sunscreen use can reduce sunburn occurrence. In contrast, in ISE situations, sunscreen use did not change the risk of sunburn.[2,8]

Sunscreen use and duration of sun exposure

Three randomized trials demonstrated that during ISE, use of relatively small amounts of sunscreen (i.e., amounts 3–4 times smaller that those used for measuring the SPF) was able to increase time spent in the sun. Two trials were conducted in France, Switzerland and Belgium with sun-sensitive volunteers 18–24 going to sunny areas for summer holidays.[10,11] These volunteers were randomized in a double blind design to receive SPF 10 or SPF 30 sunscreen. These trials showed that high SPF sunscreen extended sunbathing time by 19–25%, while there was no difference in sunburn experience and no difference in quantity of sunscreen used. Another key finding of these two trials was that as their holiday progressed, subjects using the SPF 30 sunscreen usually started sunbathing around noon, whereas those using the SPF 10 sunscreen tended to start sunbathing steadily later in the day. Hence, sun exposure duration of sun sensitive subjects engaged in ISE is limited by sunburn acquisition, and delaying sunburn occurrence leads to profound changes in sun behaviours.

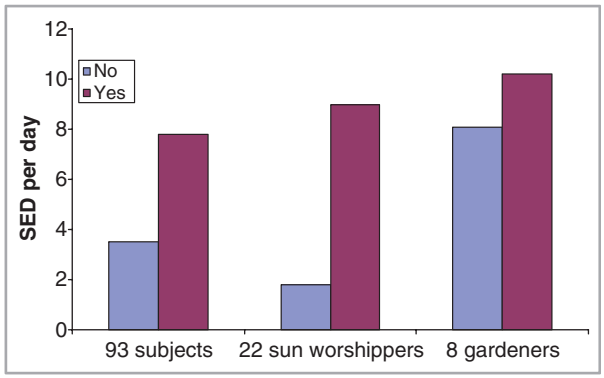

Fig 2. UV doses [in standard erythemal dose (SED) per day] received by volunteers wearing personal UV dosimeters, Denmark (Ref. 14).

The third trial took place in 2003 in a French holiday village and randomized 308 adults 18–78 years of age into three groups using sunscreen of different SPF and having different labelling.[12] Results of this trial indicated that after 1 week of use, higher SPF was associated with longer ISE duration.[7]

What about sunscreen use and sun exposure duration during NISE? The few available data suggest that in NISE situations, there is no increased duration of sun exposure associated with sunscreen use. The Australian randomized trials for prevention of squamous and basal cell carcinoma found no evidence for increased duration of time spent in the sun when high SPF sunscreen was used.[13] A Danish group with great experience in individual UV dosimetry monitored time spent in the sun and UV doses experienced during various types of outdoor activities (Fig. 2).[14] Although samples were relatively small, sunscreen use during a NISE activity like gardening did not increase the UV dose received, while among sun worshippers sunscreen use was associated with a considerable increase in UV dose received.

ISE, NISE, sunscreens and skin cancer

Three randomized controlled trials (two in Australia and one in the U.S.A.) in subjects over 50 years old, many of whom had a history of actinic skin lesions, have shown that when used during NISE, sunscreen use (moderately) decreases the incidence of squamous cell carcinoma and of solar keratoses, but not of basal cell carcinoma.[15–17]

Essentially because of intractable practical and ethical difficulties, no randomized trial has ever tested the ability of sunscreen use to protect against skin cancer and melanoma in particular during ISE situations. The trial in Vancouver, Canada tested the ability of a broad-band sunscreen to limit nevi numbers in schoolchildren.[18] It is not clear whether the Vancouver trial was representative of ISE situations. Results of this trial are difficult to interpret, as, for yet unknown reasons, all the effect of sunscreens was confined to children with high freckling. Furthermore, the statistical analysis did not adjust for nevi counts at baseline.

Epidemiological data relevant to the associations found between sunscreen use and skin cancer is summarized in the Table 1. Studies conducted during NISE situations were close to conditions encountered in laboratory experiments that demonstrated the cancer prevention properties of sunscreens, e.g., application of high doses of sunscreens, subjects eager to protect themselves from harmful effects of the sun and not attracted by tan acquisition. These laboratory experiments did not at all reflect sunscreen use during ISE situations.

These data led a Working Group convened by the IARC in 2000 to conclude that:[2]

1 Sunscreen use may decrease occurrence of SCC.
2 Sunscreen use has no demonstrated influence on BCC.
3 In ISE situations, sunscreen use may increase the risk of melanoma.

The traditional and alternative view on the biological effects of sunscreen use in humans

The traditional view is that the greater the SPF of the sunscreen actually applied onto the skin (usually 2–4 times lower than doses used for measuring the SPF), the greater the sun protection. This view schematized in Figure 3a suggests that the application of a potent sunscreen will decrease the UV

Table 1 Likely effects of sunscreen use in sun sensitive subjects during non-intentional and intentional sun exposure

	Non-intentional sun exposure	Intentional sun exposure
Examples	Outdoor professional activities, gardening, skiing, walking	Sunbathing, outdoor sport with naked trunk
Type of subjects in studies	Old adults or elderlies not sun to tan attracted, often with history of actinic skin damage	Young adults, suntan seekers
Sunburn occurence	Decrease	No difference[a]
Time spent in the sun	No change	Increase
Influence on risk of		
Squamous cell carcinoma	Decrease	No data
Basal cell carcinoma	No change	No difference or increase
Cutaneous melanoma	No data	No difference or increase

[a]The increase reported in some studies was probably due to lack of control for sun-sensitivity (ref. 7).

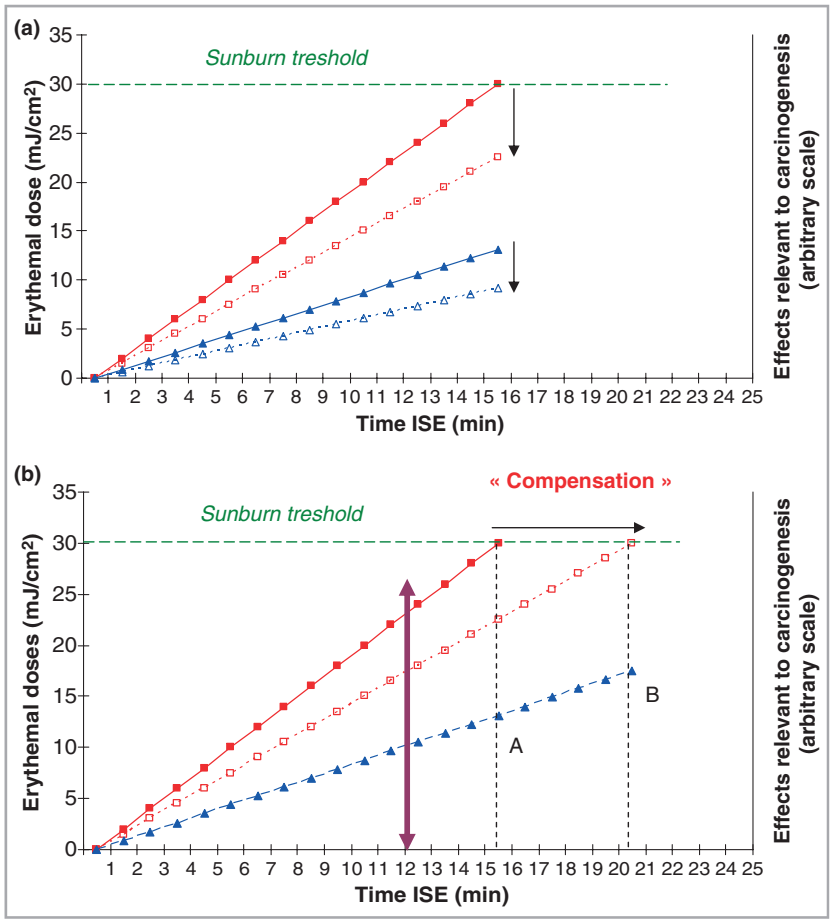

Fig 3. Schematic representation of traditional and alternative views on effects of use (continuous lines, plain squares and triangles) or no use (doted lines, open squares and triangles) of sunscreens in humans. Squares refer to sunburn occurrence according to UV dose received in mJ cm^{-2} on the left Y-axis. Triangles refer to carcinogenic effects, with an arbitrary scale of Y-axis on the right. For simplification, sunburn occurrence and carcinogenic effects are assumed to linearly increase with time spent in the sun. In this example, a sunburn threshold of 30 mJ cm^{-2} was chosen, but this threshold varies from subject to subject according to skin complexion and phototype. Black arrows indicate effects of sunscreens, and the large double arrow indicates the threshold for the alert displayed by an individual UV dosimeter.

dose delivered to the skin. The immediate consequence is the prevention of sunburn. In this case, the decrease in erythemal effect is paralleled by a proportional decrease in carcinogenic effects. This view assumes that the duration of sun exposure remains equivalent with or without sunscreen use. This traditional view mirrors the results from laboratory studies during which exposure duration parameters are controlled.

The assumption that duration of sun exposure remains equivalent with or without sunscreen use is not tenable as nothing indicates to sunscreen users that without the sunscreen, they would already be sunburned. So, the alternative view schematized in Figure 3b is based on evidence that sunscreen use will just delay sunburn occurrence but not prevent it, and lead to increased duration of sun exposure. This increased duration is sometimes labelled 'compensatory behaviour'.[2] Also, the alternative view assumes that the ability to prevent sunburns (as measured by the SPF) probably does not imply the ability to prevent melanoma or basal cell carcinoma. This view agrees with results of randomized trials on sunscreen use and sun exposure duration during ISE and also agrees with laboratory data suggesting that wavelengths other than the UVB may be involved in melanoma initiation and growth.[6,19] Extension of sun exposure duration induced by sunscreen use will result in the increase from point A to point B of the carcinogenic effects.

So, the traditional view would apply to typically UVB-induced skin lesions, including squamous cell cancer and solar keratoses. The alternative view would apply to cutaneous melanoma, mainly for melanoma occurring on usually sun protected sites such as the trunk.

Adding specific UVA filters to sunscreens is now common, and is deemed to improve their anti-cancer properties. But there is still disagreement on the standard test for evaluating their anti-UVA properties.[20] Indeed, filtering out some of the UVA may affect biological pathways other than those involved in erythema but possibly involved in skin carcinogenesis. However, because the quantity of sunscreen typically applied to the skin is small and sunlight is very rich in UVA, it is quite possible that the anti-carcinogenic defences provided by UVA filters might be overwhelmed during sunbathing in the midday sun, especially if exposure time is increased due to a high SPF. We thus do not think that the schematic view we outlined would be fundamentally different if sunscreens did or did not contain specific UVA filters. Our reasoning is supported by studies in volunteers using sunscreen of the same SPF formulated with essentially UVB filters or with essentially UVA filters.[21] No difference between the two types of sunscreens was found in their capacity to decrease UV induced DNA damage or erythema.

Sunscreen abuse

Sunscreen abuse has two complementary facets. The first is that most subjects engaging in ISE use a sunscreen in order to best take advantage of their sun exposure without, do they believe, incurring side effects, mainly sunburns. The second, less obvious facet is that sunscreen use during ISE allows sun exposure behaviors that would not be possible otherwise. The recommendation to re-apply sunscreen after a certain length of sun exposure probably represents a form of abuse.

Many studies and prevention campaigns have been conducted with the belief that recreational sun exposure, specially sunbathing, is safer when a sunscreen is used. When there is no control of sun exposure duration, that belief is questionable. So, the basic question is, 'what is most dangerous: sunbathing with or without using a sunscreen?' Until a method is found to prevent subjects unable to refrain from ISE from extending the time they spend in the sun, they should be advised not to use sunscreen but rather to let their skin adapt and set strict limits on the time they spend in the sun. This may be somewhat shocking but it follows the logic outlined in the alternative view in Figure 3b, because not using a sunscreen would prevent the stimulation of carcinogenic processes induced by unfiltered radiation.

Sunscreen abuse is encouraged by the false sense of security promoted by sunscreen advertisements, claiming or suggesting that these products protect against carcinogenic processes when used during ISE, and especially during tan acquisition. Such advertising encourages sunscreen abuse during ISE and thus contributes to increasing the risk of melanoma. This raises consumer protection issues. One day, melanoma patients could sue sunscreen makers because they were not warned against excessive sun exposure induced by sunscreen use and rather lulled by messages promoting sunscreen use during sunbathing as a way to safely acquire a nice, deep tan. This is not science fiction as in 2006 in the U.S.A., a class action suit was filed at the Los Angeles Superior Court for misleading advertising and fraudulent misrepresentation in the labelling of sunscreen bottles that, according to the plaintiffs, did not correctly indicate the hazards associated with the absence or low UVA blocking capacity of sunscreens.[22]

How to avoid sunscreen abuse and its deleterious consequences?

Trying to discourage tan acquisition and deliberate sun exposure during the holidays is not very cost effective, especially among teenagers and young adults.

Consumer information on sunscreens should better reflect current knowledge of potential health hazards associated with their use during ISE. Cosmetic companies should not pretend that 'safe tanning' exists when using sunscreen.

Sunscreen bottles could bear messages on the hazards associated with ISE, mainly the longer stay in the sun that may end up in sunburn and the possibility of higher melanoma risk. However, such labelling of sunscreen products is not likely to be well understood, especially if on the other hand, it is rightly claimed that sunscreen use during non-intentional sun exposure may decrease skin cancer risk. Sunburns would remain frequent and no one would understand why lotions preventing sunburns during NISE would be discouraged during ISE.

A wiser approach would be to avoid excess sun exposure thanks to information on individual UV exposure. Referring back to Figure 3b, if a subject engaged in ISE is informed after say 12 min that he or she is nearing his or her specific sunburn threshold in the absence of sunscreen use, and if that subject covers up or moves to a shaded area, then the erythemogenic UV dose and the carcinogenic effect would be lower than if no information was provided.

Practically speaking, UV dosimeters could inform sunscreen users engaged in ISE. The dosimeter could be worn as a watch [22] or inlayed in the caps of the sunscreen bottle. Indeed, dosimeters should be calibrated according to individual sun sensitivity in the absence of sunscreen use. The technology for cheap individual UV dosimeters already exists that could be adapted for controlling sun exposure duration.[23–25]

This approach would reconcile sunscreen and educational efforts. If feasible such a method would transform an ISE situation into a NISE situation and sunscreen use could then decrease skin cancer risk, and probably also melanoma.

Users of dosimeters and sunscreens will surely complain that tan acquisition is longer, and that they would like to stay longer in the bright sunshine than allowed by the dosimeter, but at the end of the day, subjects complying with the method will understand their health benefit.

Testing this approach may first be done though randomized trials on sunburn occurrence comparing sunscreen users vs. sunscreen and dosimeter users. Normally, the latter group should experience fewer sunburn episodes. A second, test would be the assessment of changes in nevi count and shape on the trunk of young adults spending holidays in sunny areas, again with randomization of sunscreen alone vs. sunscreen combined with dosimeters.

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ACCOUNTS
of chemical research

Benzophenone Photosensitized DNA Damage

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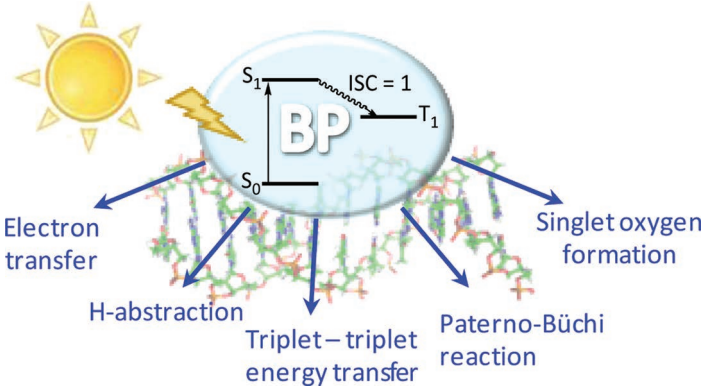

Although the carcinogenic potential of ultraviolet radiation is well-known, UV light may interact with DNA by direct absorption or through photosensitization by endogenous or exogenous chromophores. These chromophores can extend the "active" fraction of the solar spectrum to the UVA region and beyond, which means that photosensitizers increase the probability of developing skin cancer upon exposure to sunlight. Therefore researchers would like to understand the mechanisms involved in photosensitized DNA damage both to anticipate possible photobiological risks and to design tailor-made photoprotection strategies. In this context, photosensitized DNA damage can occur through a variety of processes including electron transfer, hydrogen abstraction, triplet–triplet energy transfer, or generation of reactive oxygen species.

In this Account, we have chosen benzophenone (BP) as a classical and paradigmatic chromophore to illustrate the different lesions that photosensitization may prompt in nucleosides, in oligonucleotides, or in DNA. Thus, we discuss in detail the accumulated mechanistic evidence of the BP-photosensitized reactions of DNA or its building blocks obtained by our group and others. We also include ketoprofen (KP), a BP-derivative that possesses a chiral center, to highlight the stereodifferentiation in the key photochemical events, revealed through the dynamics of the reactive triplet excited state (^{3}KP*). Our results show that irradiation of the BP chromophore in the presence of DNA or its components leads to nucleobase oxidations, cyclobutane pyrimidine dimer formation, single strand breaks, DNA–protein cross-links, or abasic sites. We attribute the manifold photoreactivity of BP to its well established photophysical properties: (i) it absorbs UV light, up to 360 nm; (ii) its intersystem crossing quantum yield (ϕ_{ISC}) is almost 1; (iii) the energy of its nπ^* lowest triplet excited state (E_T) is ca. 290 kJ mol^{-1}; (iv) it produces singlet oxygen ($^1O_2$) with a quantum yield (ϕ_Δ) of ca. 0.3.

For electron transfer and singlet oxygen reactions, we focused on guanine, the nucleobase with the lowest oxidation potential. Among the possible oxidative processes, electron transfer predominates. Conversely, triplet–triplet energy transfer occurs mainly from ^{3}BP* to thymine, the base with the lowest lying triplet state in DNA. This process results in the formation of cyclobutane pyrimidine dimers, but it also competes with the Paternò–Büchi reaction in nucleobases or nucleosides, giving rise to oxetanes as a result of crossed cycloadditions. Interestingly, we have found significant stereodifferentiation in the quenching of the KP triplet excited state by both 2′-deoxyguanosine and thymidine. Based on these results, this chromophore shows potential as a (chiral) probe for the investigation of electron and triplet energy transport in DNA.

10.1021/ar300054e

1. Introduction

Photochemical DNA damage is currently a matter of public health concern.[1,2] This adverse effect can be induced by direct absorption of UV light or through indirect light absorption by endogenous or exogenous chromophores near the biomacromolecule. By extending the "active" fraction of solar radiation to the UVA and beyond, photosensitizers increase the risk of developing skin cancer upon exposure to sunlight. For this reason, it is of paramount importance to understand the mechanisms involved in photosensitized formation of DNA damage, in order to develop efficient photoprotection strategies.

Benzophenone (BP) is a classical and paradigmatic sensitizer in photochemical studies. Irradiation of this chromophore in the presence of DNA leads to formation of nucleobase modifications, cyclobutane pyrimidine dimers (CPDs), DNA−protein cross-links, single strand breaks (ssb), or abasic sites. The photophysical properties of BP have been intensively studied and are well established (Figure 1): (i) it absorbs UV light, up to 360 nm, (ii) its intersystem crossing quantum yield (ϕ_{ISC}) is near 1, (iii) the energy of its nπ^* lowest triplet excited state (E_T) is ca. 290 kJ mol^{-1}, and (iv) it produces singlet oxygen ($^1O_2$) with a quantum yield (ϕ_Δ) of ca. 0.3.[3,4]

In this Account, we use BP to illustrate the advances in the investigation of the reaction mechanisms involved in photosensitized DNA damage, paying special attention to stereodifferentiation. Detailed information is provided on the main photoinduced reactions of DNA mediated by BP and related derivatives like ketoprofen (KP), a 2-arylpropionic acid with a BP chromophore that possesses a chiral center.[5,6] These reactions include triplet−triplet energy transfer (TTET) to nucleobases, together with both type I (hydrogen atom or electron transfer) and type II (singlet oxygen) processes.[7]

2. Benzophenone Photosensitized Reaction of Pyrimidine (Pyr) Bases: Triplet−Triplet Energy Transfer (TTET)

Photosensitized TTET may occur from BP to the nucleobases, especially to thymine (Thy), which is the DNA base with the lowest E_T (310 kJ mol^{-1}).[8] Subsequent reaction of ^{3}Thy* with another Thy or a cytosine (Cyt) in their ground states, gives rise to CPDs through a [2 + 2] photocycloaddition (Figure 2). As a result, a number of regio- and diastereoisomers can be obtained in solution with free 2′-deoxyribonucleosides, although there is certain prevalence of the *trans−anti* forms.[9]

In complex systems like oligonucleotides or DNA itself, the scenario is different. Thus, photosensitization of

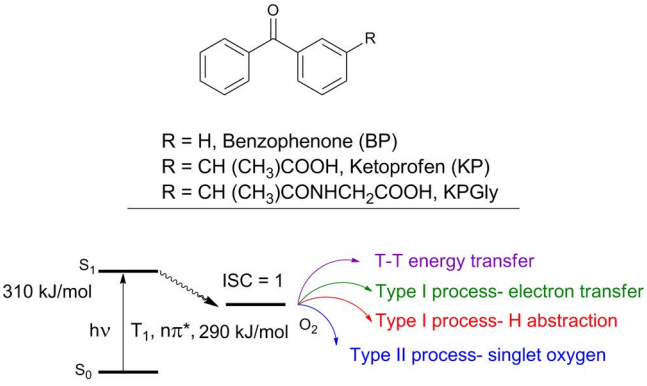

FIGURE 1. Photophysical properties and photoreactions of the benzophenone chromophore.

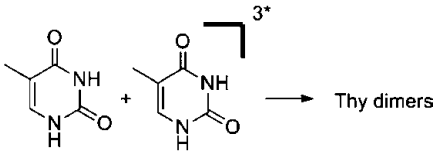

FIGURE 2. Thymine base dimerization.

oligonucleotides and ss-DNA gives mainly rise to *cis−syn* and *trans−anti* cyclobutane thymine dimers (Thy<>Thy), while in ds-DNA *cis−syn* CPDs clearly predominate[10] due to orientation restrictions imposed by the double strand.

Analysis of CPD formation photoinduced by BP in calf thymus DNA reveals a relative distribution of Thy<>Thy, 5′-Cyt<>Thy-3′ and 5′-Thy<>Cyt-3′ of 1, 0.23, and 0.25, respectively.[11] Cyclobutane cytosine dimers (Cyt<>Cyt) are not detected likely because ^{3}BP* is not energetic enough to populate ^{3}Cyt* (334 kJ mol^{-1}).[9] Absolute photodimerization quantum yields (ϕ_D) are difficult to obtain experimentally given that it has to be ensured that light is absorbed *exclusively* by the photosensitizer. For this reason, there are only a few ϕ_D values in the literature, one of them corresponding to ketoprofen; specifically, ϕ_D (KP) in supercoiled DNA has been determined to be 0.0002.[12]

According to their relative triplet energies, TTET between ^{3}BP* and Thy is a slightly disfavored process, yet it is still observed in solution due to thermal population of upper vibrational states of ^{3}BP*.[8,9,13] Notably, this process is more feasible in DNA, where π-stacking and base pairing result in a shift of the E_T of Thy down to 267 kJ mol^{-1} (Figure 3).[9,12,14,15]

We have determined the triplet energy of Thy in DNA by photosensitization experiments, in which supercoiled DNA is irradiated in the presence of a family of fluoroquinolones. The known E_T values of these drugs are within a narrow

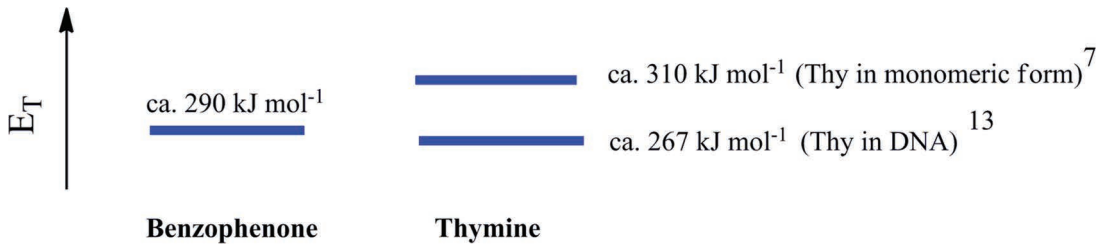

FIGURE 3. Benzophenone and thymine triplet energy levels.

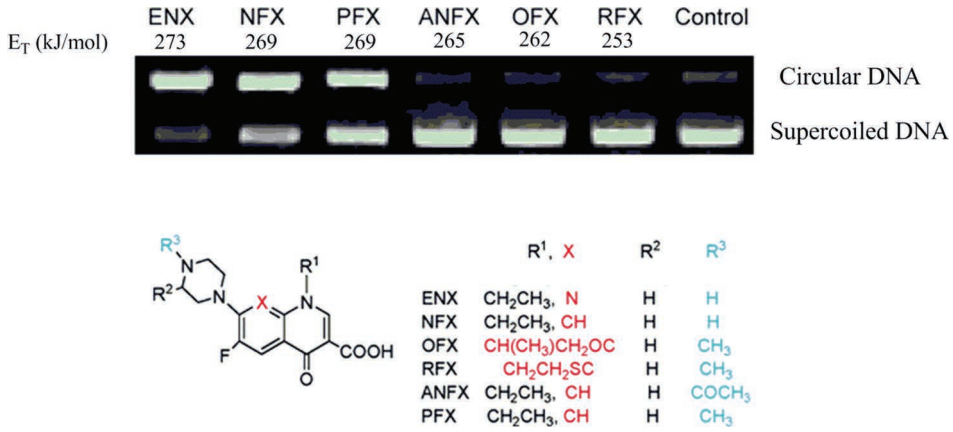

FIGURE 4. Photomixtures of fluoroquinolones of known E_T and plasmid pBR322 DNA after treatment with T4 endo V enzyme and gel electrophoresis.

range (from 273 to 253 kJ mol^{-1}), close to the expected E_T of Thy in the biomacromolecule. Following UVA irradiation, the samples are digested with T4 endonuclease V, which cleaves the double helix at those points where Thy<>Thy are formed, converting supercoiled DNA into its circular form. Subsequently, Thy<>Thy are revealed by electrophoresis, based on the different mobility of supercoiled and circular DNA (Figure 4). In this way, we have clearly shown that those drugs with $E_T > 269$ kJ mol^{-1} photoinduce Thy<>Thy, while those with $E_T < 265$ kJ mol^{-1} do not. Hence, any compound with $E_T > 267$ kJ mol^{-1} should be considered as a potential photosensitizer via Thy dimerization. This value is higher than the E_T of other well-known DNA photosensitizers, such as riboflavin (ca. 200 kJ mol^{-1}).[16]

Furthermore, studies performed on oligonucleotides have demonstrated that CPD formation is sequence-dependent.[12,17−20] In particular, the amount of these lesions increases when an additional Pyr base is located in the 5′ side of two consecutive Thy as shown by irradiation of 5′-TGA GCG TTA GTT TAA GTC GGC TAT C-3′ in the presence of BP, which leads to the highest CPD formation yields at the TTT sites.[12]

Competing with TTET, the contribution of the type I mechanism to photoinduce DNA damage has been

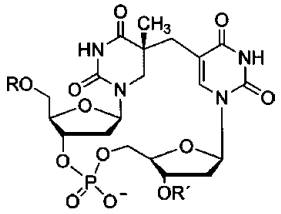

FIGURE 5. Structure of the spore photoproduct.

evaluated by irradiating BP in the presence of the dinucleotide thymidylyl-(3′→5′)-thymidine (TpT) under aerobic conditions.[10] By quantification of Thy<>Thy dimers, we have shown that the energy transfer mechanism clearly predominates over Thy oxidation (17:1 ratio).

Another structurally interesting type of Pyr dimer, found in the dry environment of bacterial spores, is the 5-thyminyl-5,6-dihydrothymine adduct, commonly known as spore photoproduct (SP, Figure 5).[9,11,21,22] The formation of this bipyrimidine lesion can be photosensitized by BP in dry films.[22] The photosensitized formation of SP in DNA gives rise uniquely to the 5*R* diastereomeric form and is conditioned by the presence of α/β acid soluble protein, which converts β-DNA into α-DNA. In the spores, dipicolinic acid seems to play the role of a natural photosensitizer.

After generation of ^{3}Thy* by TTET, we have proposed two alternative mechanisms of SP formation: (i) C−C coupling of a radical pair generated by H-abstraction from a ground state Thy and, less likely, (ii) a concerted mechanism.[22,23]

3. Benzophenone Photoreaction with Pyrimidine Bases: The Paternò−Büchi Reaction

Carbonyl compounds may react with olefins through a [2 + 2] photocycloaddition giving rise to oxetanes through a Paternò−Büchi reaction (Figure 6). This competes with TTET and is favored for nπ* triplets when the E_T of the alkene is comparable to or higher than that of the carbonyl compound. Because this is the case for the BP/Thy system, oxetane formation is possible.[3,13,24]

Actually, upon irradiation of BP in the presence of thymidine (Thd), we have isolated two stereoisomeric oxetanes (Figure 7).[24]

To gain a deeper insight into the reaction mechanism, we have performed time-resolved laser flash photolysis (LFP) experiments to study the interaction between the triplet excited states of BP or KP and Thd. Because both ^{3}BP* and ^{3}KP* are nπ* in nature, a fast triplet−triplet quenching by Thd is observed, (ca. 5.0×10^8 M^{-1} s^{-1}). This supports a Paternò−Büchi photoreaction,[24] in view of the endergonic nature of TTET. Accordingly, oxetanes prevail over CPDs after steady-state irradiation of Thy in the presence of BP.[8,10,24] Indeed, BP-photosensitized Thy dimerization is concentration dependent, and CPDs are only detected when the nucleobase is present in a large excess.

It is worth noting that this scenario may vary in DNA, where the contribution of TTET would be higher, due to the lower E_T of Thy in the biomacromolecule. Thus, the double helix would prevent the Paternò−Büchi photoreaction from taking place but at the same time would enhance the prospects for Thy dimerization.

3.1. Chiral Discrimination. Direct photophysical evidence for chiral discrimination in the triplet excited state has only been found in a few cases;[13,25−29] this includes the interaction between ^{3}KP* and Thd, which we have studied by LFP in aqueous acetonitrile, monitoring the kinetics of KP nπ* triplet state decay upon addition of increasing amounts of Thd.[13] Plotting the reciprocal lifetimes of (*S*)- and (*R*)-^{3}KP* vs Thd concentration, we obtained quenching rate constants of $k_S = 3.6 \times 10^8$ M^{-1} s^{-1} and $k_R = 5.1 \times 10^8$ M^{-1} s^{-1} for (*S*)- and (*R*)-KP, respectively (Figure 8).

We have investigated the intramolecular version of this reaction in the *cisoid* (5′-KP-Thd) or *transoid* (3′-KP-Thd) dyads (Figure 9) where KP is attached to positions 5′ or 3′ of the 2-deoxyribose moiety.[30]

Long wavelength irradiation of the *transoid* form leads to polymerization. Conversely, a mixture of photoproducts is obtained from the *cisoid* isomer, where the oxetanes arising from a Paternò−Büchi reaction (Figure 10) are clearly predominating (combined yield of ca. 52%). In addition, minor

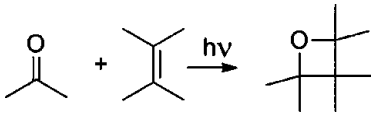

FIGURE 6. The Paternò−Büchi reaction.

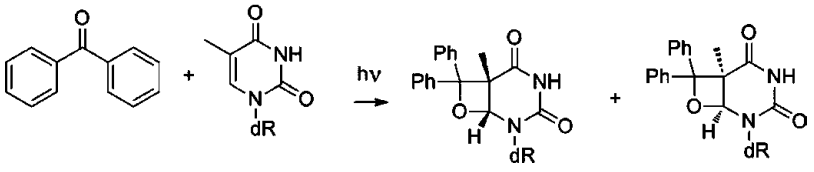

FIGURE 7. Oxetane formation upon irradiation of BP and Thd.

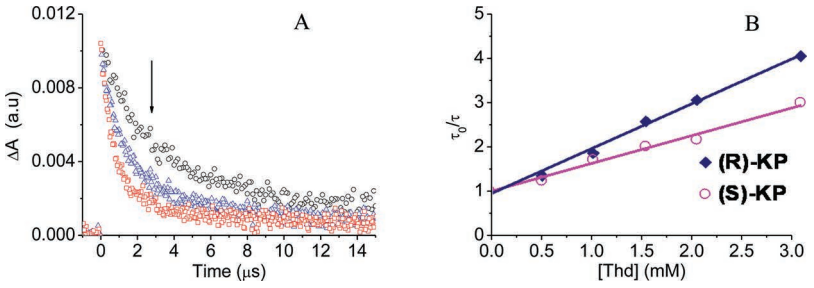

FIGURE 8. (A) Ketoprofen triplet excited state decay upon addition of increasing amounts of Thd using MeCN/H_2O (4:1, v/v) as solvent and (B) Stern−Volmer plots for quenching of (*R*)- and (*S*)-^{3}KP* by Thd.

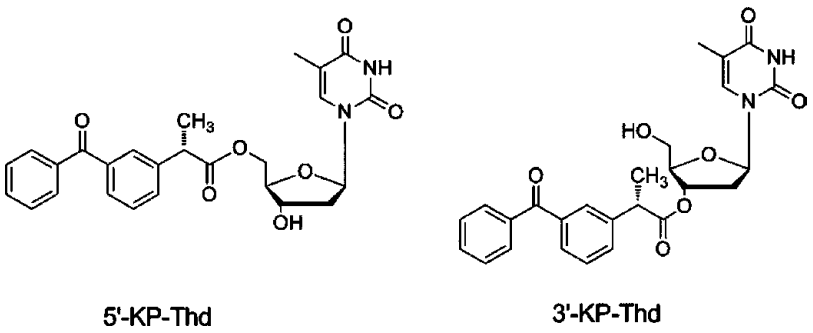

FIGURE 9. Ketoprofen–thymidine dyads.

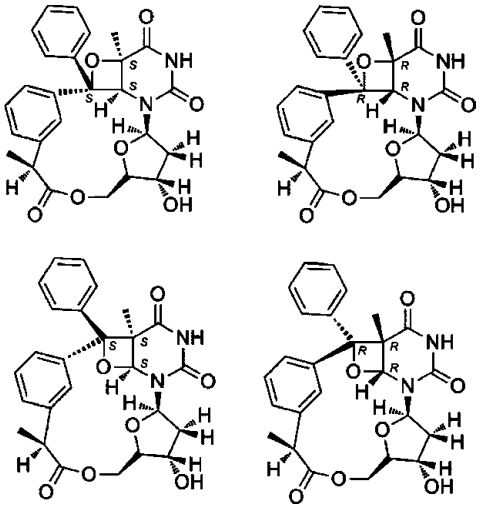

FIGURE 10. Photoproducts isolated from irradiation of the *cisoid* 5′-KP-Thd dyad.

amounts of products resulting from initial hydrogen abstraction by the excited ketone from the 5-methyl group of Thy are also detected.

Our results showed a good correlation between the photoproduct yields and the LFP measurements. Thus, the transient absorption spectra of the dyads essentially coincide with the TT bands of (*S*)-KP, displaying two maxima centered at 330 and 530 nm (Figure 11). However, the triplet lifetimes of the reference compound, τ_T((*S*)-KP) = 1.3 μs, and the dyads are strikingly different. This is particularly noteworthy in the case of the *cisoid* form whose τ_T is 20 ns, much shorter than the value obtained for the *transoid* isomer (τ_T = 300 ns, Figure 11).

4. Benzophenone-Photosensitized Type I Oxidation

In addition to its above-mentioned capability to photosensitize the formation of Thy lesions by TTET and Paternò–Büchi reaction, BP is also able to oxidize DNA. The ability of BP to photosensitize oxidatively generated DNA damage is extensively reported in the literature.[31−38] Most of the published work deals with an electron transfer mechanism triggered by BP in its triplet excited state. Indeed, the Rehm–Weller equation allows determination of free energy changes of −70 and −30 kJ mol^{-1} for the reaction with 2′-deoxyguanosine (dGuo) and Thd, respectively.[12] Nonetheless, although ^{3}BP* is in principle able to oxidize all nucleobases, a particular emphasis has been placed on dGuo, the nucleoside with the lowest oxidation potential. When BP is compared with a typical DNA type I photosensitizer, such as riboflavin, the latter exhibits a lower oxidizing ability, with free energy changes ca. 30 kJ mol^{-1} more positive than BP.[16] Thus, both compounds mediate one-electron oxidation of guanine (and to a lesser extent adenine) in double-stranded DNA; however, thymine oxidation has only been reported for BP.[39]

4.1. Reaction with Purine Bases: An Electron Transfer Mechanism. Information on the primary processes involved in the interaction between excited BP and dGuo is provided by LFP studies. Thus, the decay kinetics of ^{3}BP* (or its derivatives KP and KPGly, Figure 1) in the presence of dGuo demonstrates a high reactivity, with a bimolecular rate constant close to diffusion ($k_q > 10^9$ M^{-1} s^{-1}).[13,40,41] Moreover, we have confirmed the electron transfer nature of the process by detection of ketyl radical (KPGly(H$^•$)), obtained by protonation of the initially formed KP radical anion, together with the neutral dGuo(−H)$^•$ radical (Figure 12).[40]

Our results revealed a stereodifferentiating interaction between enantiopure (*S*)- or (*R*)-KP triplet excited state and dGuo, for which we determined quenching rate constants of k_S(dGuo) = 1.00 × 10^9 M^{-1} s^{-1} and k_R(dGuo) = 1.23 × 10^9 M^{-1} s^{-1} in aqueous acetonitrile. This agrees well with the relative amounts of (*R*)- and (*S*)-KP ketyl radical formation (Figure 13).

Steady-state irradiation studies also point to a type I mechanism. As a first clue, the hallmark of an electron transfer process is observed in double-stranded oligonucleotides

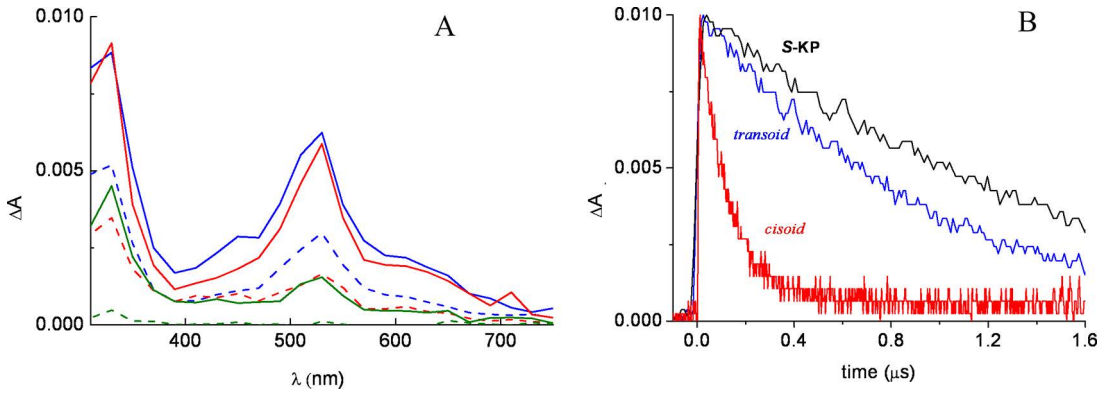

FIGURE 11. (A) Transient absorption spectra of the dyads and (*S*)-KP in acetonitrile, 35 ns (full line) and 2 μs (dashed line) after laser excitation and (B) triplet excited states of (*S*)-KP and the *cisoid* (3′-KP-Thd) and *transoid* (5′-KP-Thd) dyads.

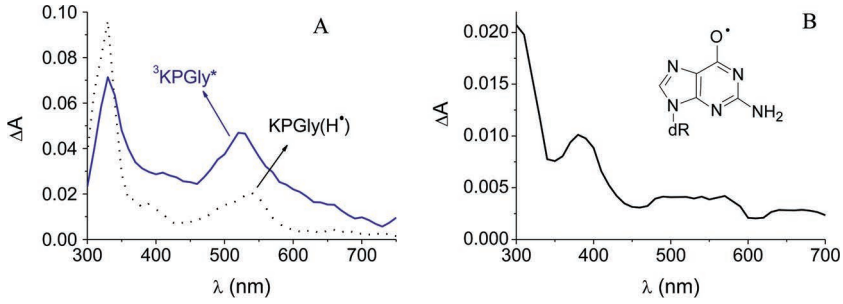

FIGURE 12. (A) Benzophenone-like triplet excited state (full line) and ketyl radical (dotted line) together with (B) dGuo(−H)$^•$ radical obtained by laser flash photolysis of KPGly/dGuo mixture in neutral aqueous medium (phosphate buffer).

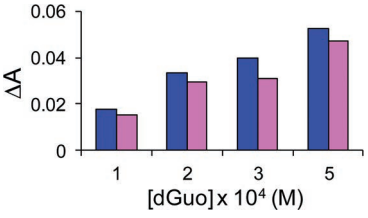

FIGURE 13. Comparison of the amount of ketyl radical formed after flash excitation of a solution of enantiopure (*S*)-KP (pink) or (*R*)-KP (blue) in the presence of dGuo, using MeCN/H_2O (4:1, v/v) as solvent.

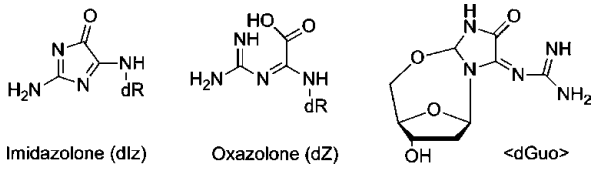

FIGURE 14. Structures of imidazolone and oxazolone, the typical product for BP-photosensitized type I oxidation of dGuo, together with the intrabase product <dGuo>.

irradiated in the presence of BP. Gel sequencing experiments show a highly specific alkali-labile site at the hot spot 5′-G of -GG- and in the middle G of -GGG- sequences.[12,36,42] Moreover, prolonged irradiation leads to degradation of all G residues, with efficiency decreasing in the order 5′-GG > 5′-GA > 5′-GC > 5′-GT, in good agreement with the calculated ionization potentials of stacked nucleobase models.[12] The capability of BP to act as a strong electron acceptor has been exploited to attach covalently this chromophore to predetermined sites of oligodeoxynucleotides, without perturbing the base stack, in order to investigate hole migration to remote sites.[42] This principle can be applied to the development of new probes for the study of electron transport in DNA.

In the case of isolated dGuo, typical photoproducts derived from electron transfer from the nucleobase to ^{3}BP* are mainly obtained. They correspond to the unstable 2-amino-5-[(2-deoxy-β-D-*erythro*-pentofuranosyl)amino]-4*H*-imidazol-4-one (dIz), which is further hydrolyzed to 2,2-diamino-4-[(2-deoxy-β-D-*erythro*-pentofuranosyl)amino]-5(2*H*)-oxazolone (dZ) (Figure 14).[41,43−46] Interestingly, we also obtained photoproduct <dGuo> based on an intrabase link as a result of a primary electron transfer, followed by nucleophilic attack by the 5′ hydroxyl group to the C8 position of the nucleobase (Figure 14).[47]

In similar studies on the dinucleotide thymidylyl-(3′→5′)-2′-deoxyguanosine (TpdG), we described the corresponding oxazolone product (TpdZ) as the main photoproduct,

together with a 2-deoxy-D-ribono-1,4-lactone derivative TpdL.[48] This sugar oxidation, also reported in the case of dGuo, is of special interest because it leads to the formation of an oxidized abasic site. The proposed mechanism is based on electron transfer oxidation of the nucleobase, followed by deprotonation at C1′ of the guanine radical cation giving rise to a neutral radical, which after oxygen trapping, release of superoxide radical anion, and hydration of the resulting 2-deoxyribose cation gives rise to 2-deoxy-D-ribono-1,4-lactone (dL) (Figure 15).[49] However, direct hydrogen abstraction cannot be totally discarded as initial step. Mechanistic confirmation has been provided by combining photoproduct characterization and time-resolved experiments with appropriate model systems.

Thus, the KP−purine dyads shown in Figure 16 have been first considered.[50] Their structural variations have allowed us to evaluate the different factors influencing the electron transfer mechanism. In this way, changes associated with the *cisoid* versus *transoid* spatial arrangement have been investigated with dyads 5′-KP-dAdo and 3′-KP-dAdo respectively, while compounds 5′-KP-dGuo, 5′-KP-dAdo, and 5′-KP-8-oxodAdo have been chosen to obtain information on the relative base reactivity. In addition, the length of the spacer has also been considered by comparing 5′-KP-dAdo with 5′-KPGly-dAdo. The experimental results fulfilled our expectations for an electron transfer from the purine to ^{3}KP*. As a first piece of evidence, only *cisoid* 5′-KP-purines lead to the formation of a 2-deoxyribonolactone (5′-KP-dL, Figure 16) as major photoproduct. Accordingly, while triplet lifetime of the *transoid* 3′-KP-dAdo is similar to that of isolated KP, used as standard, a much faster decay is observed for 5′-KP-dAdo. In general, we determined lifetimes in submicrosecond range for all the 5′-KP-purines in agreement with an efficient interaction between the excited KP and the nucleobase. As a matter of fact, the intramolecular quenching rate constants, ranging from 3.3×10^7 s^{-1} for 5′-KP-dAdo to 1.1×10^8 s^{-1} for 5′-KP-dGuo, correlate well with the one-electron oxidation potentials of nucleobases. Additional evidence is provided by the influence of the spacer length, which results in a markedly lower reaction rate constant for 5′-KPGly-dAdo (ca. 2.2×10^6 s^{-1}) than for 5′-KP-dAdo.

The behavior of diastereoisomeric (*S*,*S*)- and (*S*,*R*)-KP-THF conjugates bearing tetrahydrofuran as a base-free model of the 2-deoxyribose moiety (Figure 17) allowed us to rule out the possibility of a direct H-abstraction from the sugar at C1′.[51] Kinetic analysis of the transient absorption spectra reveals that the (*S*,*S*)-KP-THF triplet signal decays

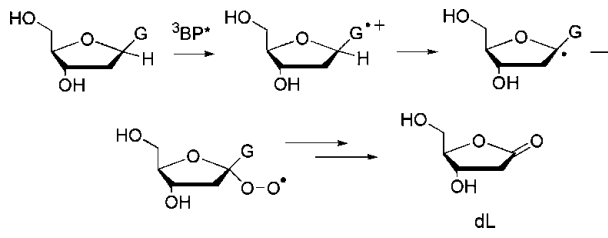

FIGURE 15. Mechanism of 2-deoxyribonolactone (dL) formation.

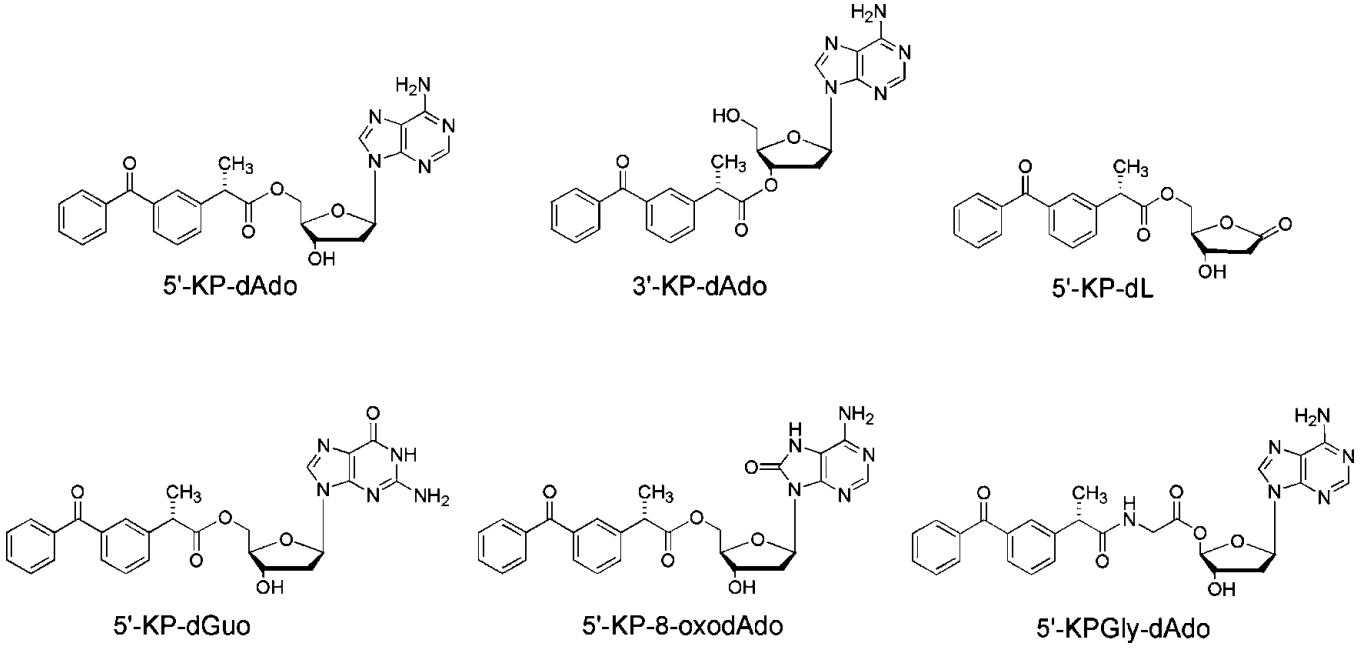

FIGURE 16. Structure of KP−purine dyads and 5′-KP-dL.

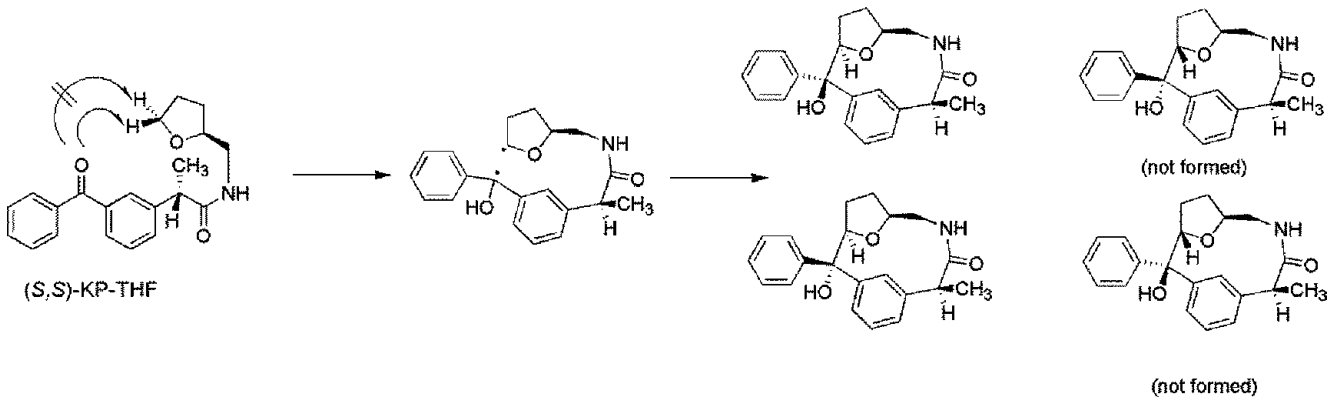

FIGURE 17. Structure and reactivity of the (*S,S*)-KP-THF.

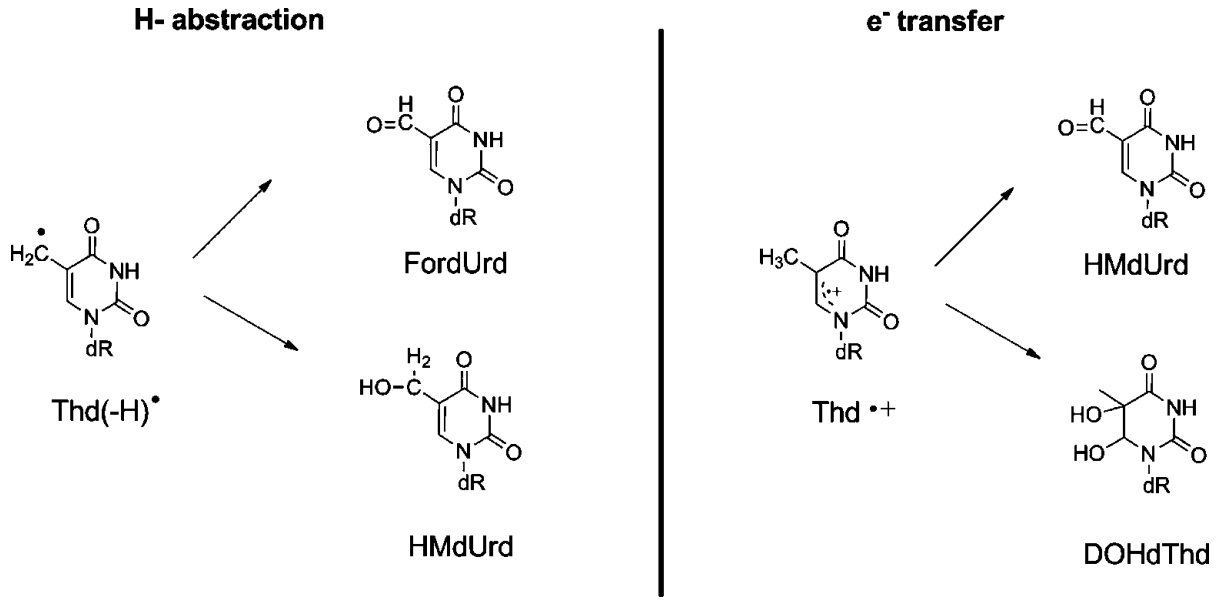

FIGURE 18. Photooxidation of Thd by BP.

significantly faster than that of the (*S,R*)-isomer. Moreover, the reaction rate constants of 5.9 and 3.2 $\times$ 10^5 s^{-1} are at least 2 orders of magnitude lower than for the 5′-KP−purine dyads. This demonstrates that a different primary process is involved in the photochemistry of these two types of systems. We have obtained the same conclusion from photoproduct studies, where biradicals initially formed via remote hydrogen abstraction undergo intramolecular recombination to macrocyclic ring systems with high regio- and stereoselectivity (Figure 17). In all cases, the products with *cisoid* ring junction are preferentially or even exclusively obtained, in agreement with their smaller ring strain.

Altogether our results are consistent with the predominance of an electron transfer mechanism during the BP-photosensitized oxidation of purine nucleosides to dL as detailed in Figure 15.

4.2. Reaction with Pyrimidine Bases: One-Electron Oxidation, H-Abstraction and Intrabase Cross-Link. In addition to the Paternò−Büchi photoreaction and the TTET between ^{3}BP* and Thd, oxidation of Thd may occur as a secondary reaction, given the ability of the chromophore to abstract hydrogen or to participate in electron transfer processes.[10,45] We have studied this photoreaction in aerated medium and identified the products as 5,6-dihydroxy-5,6-dihydrothymidine diastereomers (DOHdThd), 5-(hydroxymethyl)-2′-uridine (HMdUrd) and 5-formyl-2′-deoxyuridine (FordUrd) (Figure 18). Formation of a neutral radical centered on the 5-methyl of Thd after a formal H-abstraction by the excited ketone or deprotonation of thymine radical

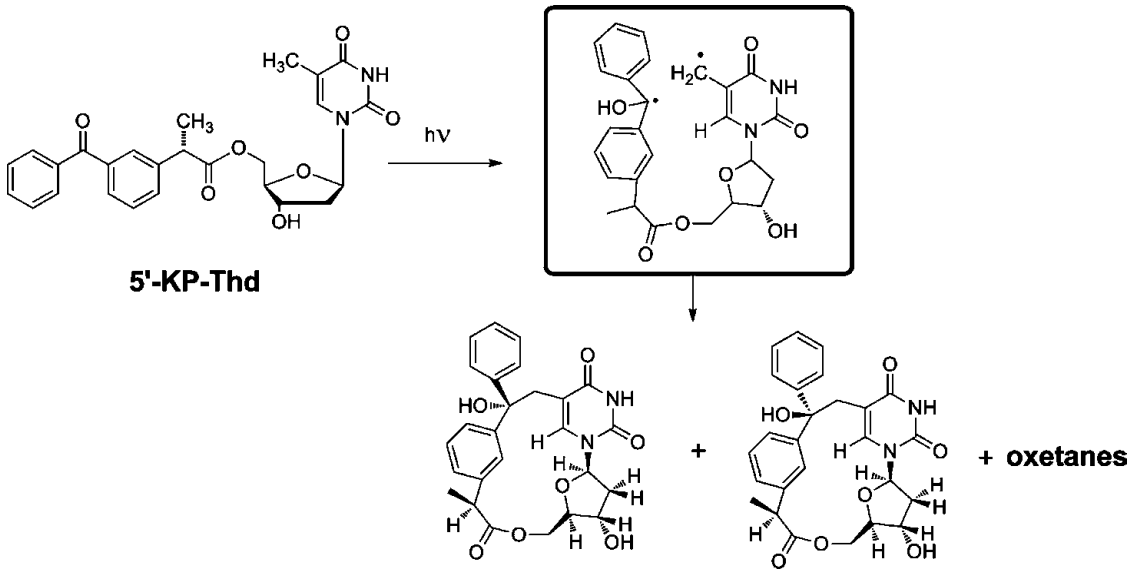

FIGURE 19. Hydrogen abstraction in the photoreaction of the *cisoid* 5′-KP-ThdKP-BP dyad.

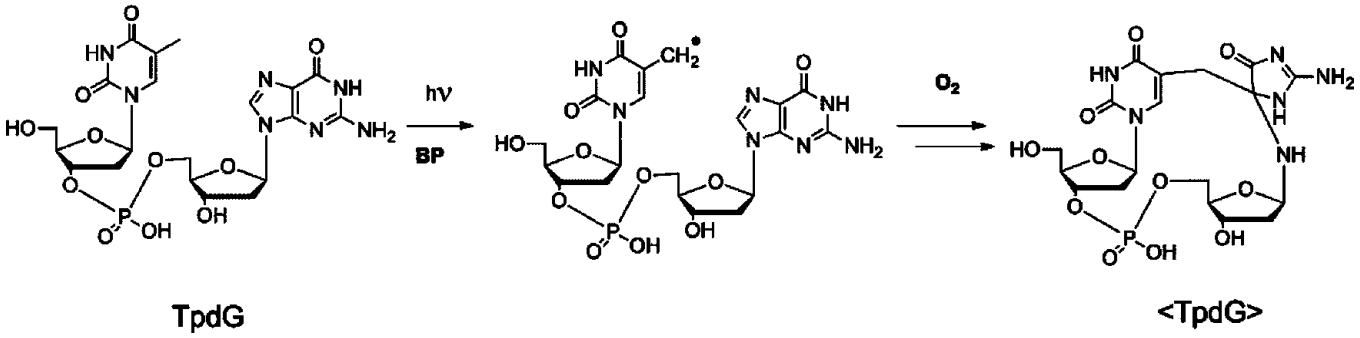

FIGURE 20. Photosensitization of TpdG by BP under aerated conditions.

cation at the methyl group leads to FordUrd and HMdUrd, while DOHdThd arises from hydration of Thd radical cation. The former pathway is in agreement with LFP results, while the presence of the four DOHdThd diastereomers in the reaction mixture supports the formation of Thd radical cation.

We have observed hydrogen abstraction at the C-5 of the base by ^{3}BP* upon irradiation of the *cisoid* KP-Thd dyad presented in the TTET (section 3.1), which leads to a couple of minor products (14% combined yield, Figure 19) arising from recombination of a primary biradical.[30]

Type I reactions induced by BP have also been assessed in TpdG dinucleotides.[45] In our hands, photosensitization of TpdG in the presence of BP leads to formation of an adduct (<TpdG>, Figure 20) resulting from formal hydrogen abstraction at the C-5 of the Thy base by ^{3}BP*. Generation of a carbon-centered radical would be the first step in a sequence of reactions ultimately producing a covalent linkage to the C-4 of the guanine.

4.3. Modeling DNA−Protein Cross-Links. In eukaryotic cells, DNA−protein cross-links are important contributors to the deleterious effects of solar radiation, because of the close contact between DNA and proteins such as histones. Thus, the role of type I oxidation in the formation of these adducts has been investigated using BP as photosensitizer and dGuo as a simple unit of the DNA biomolecule.

In this context, BP-photosensitized reaction between dGuo and the methyl ester of acetylated lysine leads to the spiroiminodihydantoin derivative 8-Lys-Sp as the main photoproduct, together with small amounts of 5,8-Lys-Sp (Figure 21A).[52] These compounds are the result of an electron transfer process leading to covalent adduct formation between the ε-amino group of lysine and the C8 position of the nucleobase, which further undergoes rearrangement to give the spirocyclic adducts. We have also used methanol as a mimic of the hydroxyl group of tyrosine, threonine, or serine side chain. In this case, two 4,5-imidazolidinedione diastereoisomers are obtained as

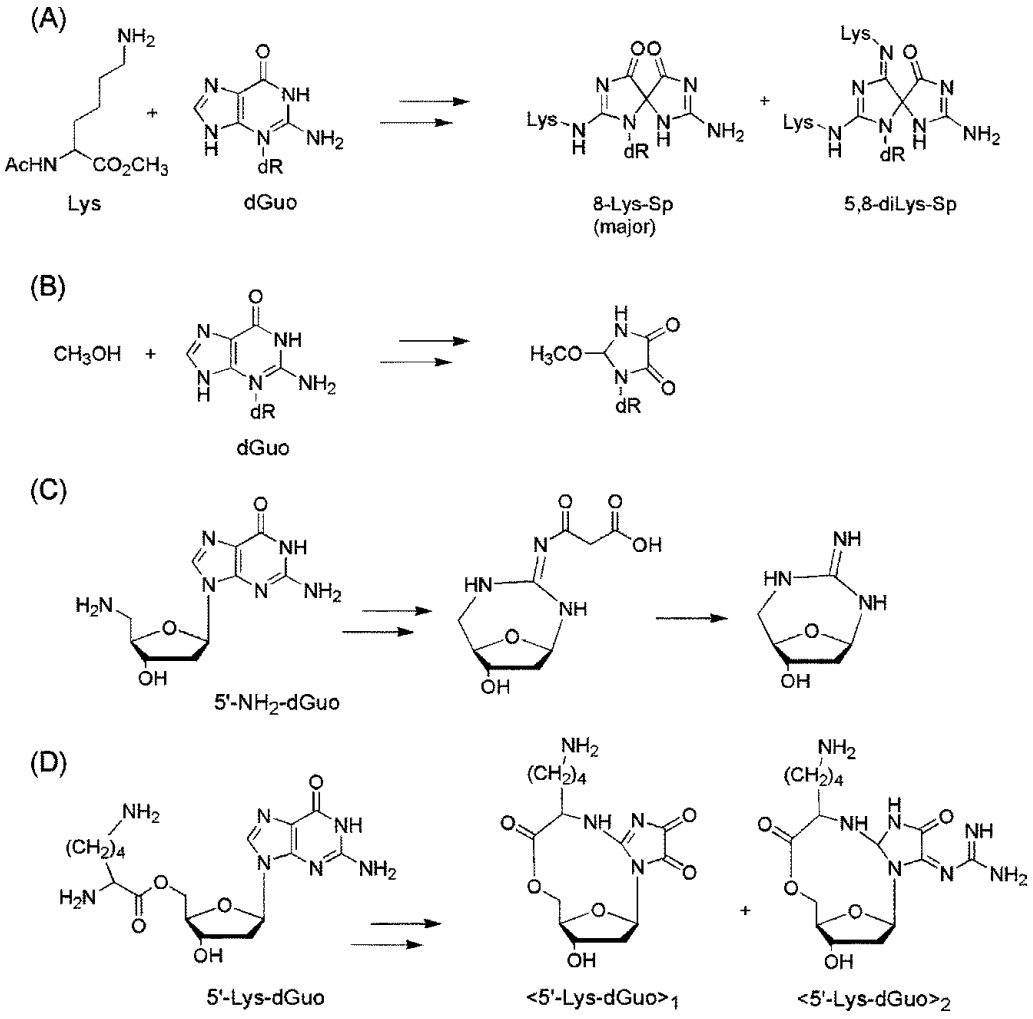

FIGURE 21. Model photoreactions for the BP-sensitized DNA–protein cross-links.

products of the nucleophilic addition of methanol to the guanine base (Figure 21B).[44]

Furthermore, we have modeled the intimate association between DNA and histones using different systems containing an amino group or a lysine residue tethered at the C5′ of dGuo. Thus, BP mediated oxidation of 2′-amino-2′,5′-dideoxyguanosine (5′-NH_2-dGuo, Figure 21C)[53] in aerated aqueous solution leads to the formation of two cyclic nucleosides, where the heterocyclic guanine ring is missing (Figure 21C). In the case of a lysine residue linked at C5′ of dGuo (5′-Lys-dGuo, Figure 21D), two intramolecular adducts are formed in low yield (ca. 2%).[54] Although both compounds derive from a reaction between the α-NH_2 of lysine and the C8 position of electron transfer oxidized guanine, <5′-Lys-dGuo>$_1$ would be formed by a nucleophilic attack to the guanine radical cation, whereas <5′-Lys-dGuo>$_2$ can be explained by addition of the α-NH_2 group to the 7,8-double bond of the neutral dGuo radical.

5. Type II Processes: Singlet Oxygen

A photosensitizer in its triplet excited state may interact with molecular oxygen, generating $^1O_2$, which is a very potent oxidizing agent. This is the case for BP and KP; they produce $^1O_2$, which in turn reacts with guanine yielding spiroiminodihydantoin diastereoisomers or 8-oxodGuo, in double stranded DNA (Figure 22). The ability of this reactive species to photoinduce DNA lesions through a type II mechanism has been examined in aqueous solutions, in the presence of single-stranded oligonucleotides. When D_2O is used instead of H_2O, the BP-photosensitized DNA damage increases, indicating that, to a certain extent, a type II mechanism is involved.[12]

Nevertheless, dGuo sensitization studies indicate that BP-mediated photooxidation is dominated by the type I mechanism.[41,45] Consistently, dGuo conversion upon UVA irradiation in the presence of BP is not affected by the presence of D_2O and is lower in aerated solution.

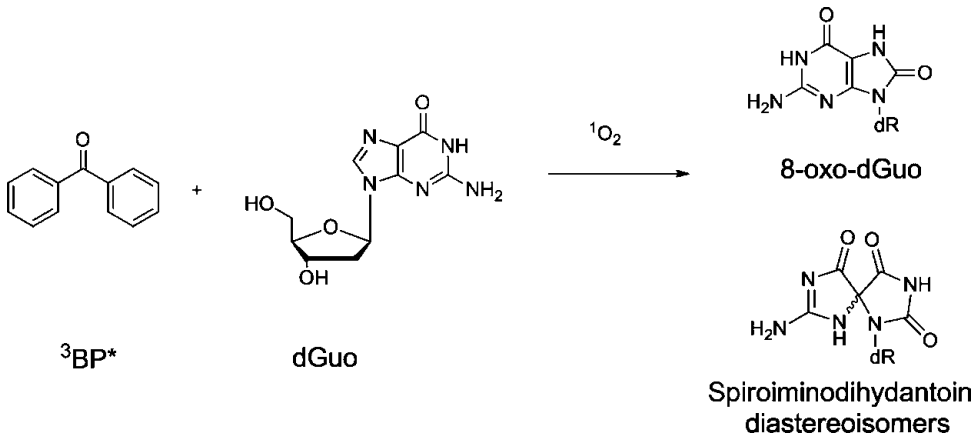

FIGURE 22. Type II photooxidation of dGuo by BP.

6. Summary and Outlook

Light is a potentially carcinogenic agent. For this reason, it is of paramount importance to understand the mechanisms involved in photoinduced DNA damage, in order to develop efficient photoprotection strategies. Ultraviolet radiation can interact with the biomacromolecule by direct light absorption or through photosensitization by endogenous or exogeneous chromophores, which extend the "active" fraction of the solar spectrum to the UVA and beyond. As a consequence, photosensitizers increase the risk of developing skin cancer upon exposure to sunlight. Photosensitized DNA damage may occur through processes comprising electron transfer, hydrogen abstraction, triplet–triplet energy transfer, or reactive oxygen species generation.

Here, we have chosen benzophenone (BP) as a classical and paradigmatic chromophore to illustrate the different lesions that photosensitizers may provoke in systems of increasing complexity: nucleosides, oligonucleotides, or DNA itself. Thus, we provide detailed mechanistic information on the main photoinduced reactions of DNA mediated by BP. Related derivatives like ketoprofen (KP), a BP-like compound that possesses a chiral center, have been included to highlight the possibility of stereodifferentiation. In this context, irradiation of the BP chromophore in the presence of DNA or its building blocks leads to nucleobase oxidations, cyclobutane pyrimidine dimers formation, single strand breaks, DNA–protein cross-links or abasic sites. The manifold photoreactivity of BP is attributed to its well established photophysical properties: (i) it absorbs UV light, up to 360 nm, (ii) its intersystem crossing quantum yield (ϕ_{ISC}) is near 1, (iii) the energy of its nπ^* lowest triplet excited state (E_T) is ca. 290 kJ mol^{-1}, and (iv) it produces singlet oxygen ($^1O_2$) with a quantum yield (ϕ_Δ) of ca. 0.3. When these properties of BP are compared with those of riboflavin, a well-known DNA photosensitizer, the main difference is related to the much lower triplet energy value of the latter (ca. 200 kJ mol^{-1}). Accordingly, excited riboflavin is a markedly weaker oxidizing agent and is unable to act as donor in triplet–triplet energy transfer to thymine.

Electron transfer, hydrogen abstraction, and singlet oxygen reactions have been discussed centering attention on guanine, since this is the nucleobase with the lowest oxidation potential. Among oxidative processes, electron transfer is the predominating pathway. Conversely, triplet–triplet energy transfer occurs mainly from ^{3}BP* to thymine, the base with the lowest lying triplet state in DNA. This process results in the formation of cyclobutane pyrimidine dimers, although it competes with the Paternò–Büchi reaction in nucleobases or nucleosides, giving rise to oxetanes as a result of crossed cycloadditions.

In summary, we have presented key insight into the diverse mechanistic pathways of the biologically relevant DNA modifications photosensitized by BP. On the basis of the accumulated experimental data, this chromophore shows potential as a probe for the investigation of electron and triplet energy transport in DNA. The introduction of a chiral center, as in KP, provides a useful tool to examine stereochemical aspects of the involved processes.

We thank our co-workers who contributed to this research whose names appear in the references. Financial support from the Spanish Government (Grant CTQ2009-13699, JAE Doc fellowship for M.C.C., and Ramon y Cajal contract for V.L.-V.) is gratefully acknowledged.

BIOGRAPHICAL INFORMATION

M. Consuelo Cuquerella obtained her Ph.D. from the Technical University of Valencia at the Institute of Chemical Technology

(UPV-CSIC) studying the oxidative DNA damage induced by fluoroquinolones. In June 2004, she moved to the Department of Physics of the University of Liverpool as a postdoctoral fellow. Back to Spain in 2007, she was granted a Juan de la Cierva contract at the University of Valencia. Since 2009, she has been a member of Prof. Miranda's group as a JAE-Doc researcher and her work is mainly focused in the investigation of photoinduced damage to DNA.

Virginie Lhiaubet-Vallet graduated in 1997 and obtained her PhD degree in 2001 from the University Paul Sabatier (France), working on DNA damage photoinduced by nonsteroidal anti-inflammatory drugs. She then joined the group of Prof. M. A. Miranda at the Institute of Chemical Technology (UPV-CSIC) as a postdoctoral researcher benefiting from an Individual Marie Curie European Fellowship. Virginie Lhiaubet-Vallet received the Young Investigator Award from the European Society for Photobiology in 2007. Since 2008, she has been a "Ramón y Cajal" Researcher from Spanish National Research Council at the Institute of Chemical Technology.

Jean Cadet received his Ph.D. in chemistry from the University of Grenoble in 1973 and has been the Head of Laboratory of "Lésions des Acides Nucléiques" at the French Atomic Energy Commission, CEA/Grenoble, until 2001. He is currently Scientific Adviser at CEA/Grenoble and Adjunct Professor at University of Sherbrooke. He is involved in research activities on various aspects of the chemistry and biochemistry of oxidatively generated and photoinduced damage to DNA (mechanisms of reactions, measurement in cells, assessment of biological features, such as substrate specificity of DNA repair enzymes, and mutagenesis of base lesions). He has received several awards including Research Award from American Society for Photobiology, the medal of Excellence from European Society for Photobiology, the Charles Dhéré Award, and Berthelot Medal from the French Academy of Sciences.

Miguel A. Miranda is Professor of Organic Chemistry at the Polytechnical University of Valencia and Head of the Institute of Chemical Technology (UPV-CSIC). He was Associate Professor at the University of Valencia before accepting his present position in 1990. His research interests are mainly focused on photochemistry and photobiology. Miguel A. Miranda has received the Honda-Fujishima Award of the Japanese Photochemistry Association, the Organic Chemistry Award of the Spanish Royal Society of Chemistry, and the Theodor Förster Award of the German Chemical Society and the Bunsen Society of Physical Chemistry. He has been the President of the European Society for Photobiology from 2009 to 2011.

FOOTNOTES

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The authors declare no competing financial interest.

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Re: Letter of support

Aloha Hawaii State Legislature,

Hanauma Bay Snorkel Adventures and Koko Beach Rentals support Bill 366 and House Bill 102, amending Act 104 to stop using avobenzone, and especially octocrylene in sunscreen.

We believe that , Hawaii State Legislature and Hawaii's leadership can take an important step to marine conservation and coral reef preservation by banning this toxic chemicals from sunscreen products. The studies in the effects of these toxic chemicals to marine life including corals has been shown to be alarming, threatens the conservation and restoration of coral reefs.

We all need to do our part to preserve and protect our Hawaii's ocean and the marine life, and we strongly support the need for HB102 and SB366

Mahalo for the opportunity to testify on behalf of Hawaii's coral reefs!

Sincerely

Florin Moisan Nica
President
Hanauma Bay Snorkel Adventures
Co-Founder
Koko Beach Rentals

P.O. BOX 25354 • HONOLULU, HI 96825
PHONE: (808) 306-3393 • EMAIL: ADMIN@HANAUMABAYSNORKEL.COM
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MĀLAMA PŪPŪKEA-WAIMEA
PROTECTING OUR OCEAN'S RESOURCE

Mālama Pūpūkea-Waimea
Post Office Box 188
Hale'iwa, HI 96712

Federal Nonprofit Organization
501(c)(3) FEIN 27-0855937
www.pupukeawaimea.org
info@pupukeawaimea.org

March 13, 2021

Re: **STRONG SUPPORT** for **SB132 SD2** scheduled to be heard by EEP on Tuesday, 03-16-21 9:00AM in House conference room 325 Via Videoconference.

Aloha House Committee on Energy & Environmental Protection Chair Lowen and Members,

Mālama Pūpūkea-Waimea (MPW) is the community non-profit that cares for, educates about, and protects the fragile marine ecosystem of the Pūpūkea Marine Life Conservation District located on the North Shore of O'ahu. Due to the area's extreme popularity with visitors, military and locals alike, we see first-hand the unfortunate destructive and cumulative impacts chemicals in sunscreens have on our nearshore environment. We **strongly support** SB132 to prohibit the sale of sunscreens containing avobenzone and octocrylene.

We make an effort to educate beachgoers about coral health and the detrimental effects chemical sunscreens have on them. In speaking with visitors, they often say they chose their sunscreen because a sticker on the front of the bottle said "reef safe – no oxybenzone" but after learning more, they realize that those products do indeed still contain coral-killing chemicals such as avobenzone and octocrylene. It is our hope that the only choices available in stores will be "really reef safe" sunscreens – and thanks to environmentally conscious companies, many of which are local, there are numerous mineral sunscreen options readily available for consumers.

Please support and pass SB132 SD2. Prohibiting the sale of products containing avobenzone and octocrylene will benefit the health and resiliency of Hawai'i's coral reef ecosystems.

Mahalo nui,

Jenny L Yagodich

Jenny Yagodich
Director of Educational Programs
Mālama Pūpūkea-Waimea

LEGACY REEF FOUNDATION

To: COMMITTEE ON ENERGY & ENVIRONMENTAL PROTECTION

Rep. Nicole E. Lowen, Chair
Rep. Lisa Marten, Vice Chair

Re: SB132 RELATING TO WATER POLLUTION.

Position: <u>STRONGLY</u> <u>SUPPORT</u>

Hearing Date: Thursday, March 16, 2021 9:00 a.m. Via Videoconference

Aloha Chair Lowen, Vice Chair Martin and Committee members,

The members of the Legacy Reef Foundation strongly support SB 132. Our coral reefs are at a critical state today. We ask that the state of Hawaii eliminate the sale of sunscreens that are known to be harmful to coral.

Sincerely,

Bill Coney
Co-Founder
Legacy Reef Foundation

Dr. Didier Stien
CNRS Research Director
Laboratoire de Biodiversité et Biotechnologie Microbienne
Observatoire Océanologique
66650 Banyus-sur-Mer, France
didier.stien@cnrs.fr

Dear Hawaii Legislature,

This letter is testimony for my support of Senate Bill 132.

The inclusion of octocrylene in the context of the Hawaii Law 104 Amendment of 2018 is an important step in the conservation of coral reefs against the threat of localized haloes of sunscreen pollution in areas frequented by swimmers.[1]

Our group has used an innovative method to evaluate and quantify the impact on UV filters on reef building coral *Pocillopora damicornis*.[2–4] We have been able to demonstrate that the effect of octocrylene is of particular concern. On the one hand, this compound alters mitochondrial function in coral, whereas mitochondria are the source of energy for the animal cell. By way of illustration, in humans, many conditions including Alzheimer's disease, muscular dystrophy, and cancer can induce mitochondrial dysfunction.

On the other hand, we also established that octocrylene accumulates in coral by "hiding" into it. Indeed, where octocrylene itself is present in relatively small quantities, larger amounts of octocrylene derivatives have also been found. These derivatives result from the transformation of octocrylene by coral enzymes. They can be 10 to 100 times more concentrated than octocrylene. As a result, the concentrations of octocrylene measured in the coral in Hawaii are likely very largely underestimated because octocrylene derivatives concentrations were never measured.[5] This is all the more worrying since these derivatives are very closely related to octocrylene itself and are expected to be just as toxic for coral.

Another concern is that similar compounds have also been found in human urine after topical (on the skin) application of sunscreens containing octocrylene.[6,7] This highlights the fact that (1) octocrylene does penetrate animal membranes, including human skin, and (2) these biological mechanisms of octocrylene transformation are possibly ubiquitous, and therefore these derivatives should be systematically considered in octocrylene concentration measurements. It should be mentioned that we have found these same analogues in other marine animals in a work that has not been published yet.

Our second article demonstrated that octocrylene was the most toxic of all the 10 UV filters tested on coral. Ethylhexyl salicylate comes second, and benzophenone-3 third. In another work, we also demonstrated that octocrylene was somewhat toxic towards the brine shrimp *Artemia*

salina and the microalgae *Tetraselmis* sp..[8] In an unpublished work, we have found huge localized concentration of octocrylene in beach sand and water column, and I am convinced owing to our work and literature data on this compound that it represents one of the major threat for coral reef in bathing areas.

Finally, we also demonstrated that octocrylene naturally degrades into a chemical named benzophenone (different from benzophenone-3), in over a dozen popular cosmetic products.[9] Benzophenone concentration in the products quickly increases as the product ages, and this starts to occur when the ingredients of the cosmetic preparation are mixed together. This discovery was very disturbing because benzophenone can cause contact dermatitis, and may induce uticaria and anaphylaxis. It can act as a photo-mutagen; in the presence of light, it increases the rate of DNA lesions, thus increasing the risk of skin cancers. Benzophenone is also readily absorbed through the skin posing a potential threat to toxicities and diseases of other organs. In mammalian-model studies, benzophenone exposure quickly gave rise to liver cancers and lymphomas, and benzophenone is an endocrine disruptor, affecting thyroid function as well as inducing anti-androgenic activity, delaying testicular development and causing anatomic difficulties with female reproductive organs.

Respectfully submitted,

Dr. Didier Stien.

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SB-132-SD-2
Submitted on: 3/15/2021 5:54:00 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Maxx Phillips	Center for Biological Diversity	Support	No

Comments:

Please accept the Center for Biological Diversity's testimony in strong support of Senate Bill 132 SD2.

Chamber of Commerce HAWAII
The Voice of Business

Testimony to the House Committee on Energy & Environmental Protection
Tuesday, March 16, 2021 at 9:00 A.M.
Written Only

RE: SB 132, SD 2, RELATING TO WATER POLLUTION

Chair Lowen, Vice-Chair Marten, and Members of the Committee:

The Chamber of Commerce Hawaii ("The Chamber") **opposes** SB 132, SD 2 which bans the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider beginning January 1, 2023,

The Chamber is Hawaii's leading statewide business advocacy organization, representing about 2,000+ businesses. Approximately 80% of our members are small businesses with less than 20 employees. As the "Voice of Business" in Hawaii, the organization works on behalf of members and the entire business community to improve the state's economic climate and to foster positive action on issues of common concern.

we recognize and appreciate the intent of this measure but respectfully oppose given that Environmental Protection Agency (EPA) and the National Academies of Sciences (NAS) are reviewing the methodology of the currently available science – which could include sampling bias and other methodology flaws – we respectfully ask the Committee to defer this issue until 2022. Deferring the effective date will only confuse and water down the issue when the Legislature returns with additional emerging science, facts, and information.

Additionally, this measure will hurt local retailers by encouraging consumers to buy their favorite sunscreens online, where it is unlikely this law will be enforceable. This measure also does little to deter tourists from bringing sunscreen products containing avobenzone or octocrylene into the state.

While we understand the intent of this measure, we respectfully ask that we return in 2022 with expected science results from EPA and NAS.

Thank you for this opportunity to provide testimony.

733 Bishop Street, Suite 1200 • Honolulu, Hawaii 96813 • Phone: (808) 545-4300 • Facsimile: (808) 545-4369

Personal Care Products Council
Committed to Safety, Quality & Innovation

March 15, 2021

Representative Nicole E. Lowen, Chair
Representative Lisa Marten, Vice Chair
Hawai'i House Committee on Energy and Environmental Protection

RE: Oppose Senate Bill 132 SD2

Chair Lowen and Vice Chair Marten:

On behalf of the members of the Personal Care Products Council (PCPC),[1] I am writing to express our opposition to Senate Bill 132 SD2, banning the sale, offer for sale or distribution in the State of any sunscreen that contains avobenzone and octocrylene.

Environmental Management Decisions on Sunscreens Based on Insufficient Scientific Data

Senate Bill 132 SD2 lacks the necessary scientific evidence to demonstrate that sunscreen ingredients are responsible for Hawai'i's coral bleaching. There are well-recognized causes of coral reef decline in Hawai'i and the rest of the world, including climate change, land-based pollution and other human activities, such as physical damage to corals from recreational activities, not sunscreens. Making environmental management decisions on sunscreens based on insufficient scientific data may lead to unintended health consequences, such as fewer available sunscreens and an increase in the prevalence of skin cancer. Ensuring that consumers have access to products containing a broad variety of sunscreen active ingredients is critical to public health.

We remain concerned that sunscreen ingredients continue to be depicted as unquestionably harming coral reefs and other marine life. Available scientific evidence on the environmental impact of sunscreen active ingredients is limited and indicates organic UV filters are unlikely to threaten coral reefs. There are also major knowledge gaps and data reliability issues with published coral toxicity studies that have been used to justify recent state sunscreen/UV filter restrictions. A recent scientific review of published coral toxicity and environmental occurrence data supports our concern and makes recommendations for additional research that would allow the scientific community to reach a consensus.[2] PCPC continues to work with leading environmental and coral experts to address open research questions by evaluating the risk of sunscreen active ingredients to U.S. corals.

Policy decisions that will adversely impact public health should not be made ahead of a scientific consensus on this issue. To reduce bias and to synthesize the best available science, the United States Congress has directed the National Academy of Sciences (NAS) to evaluate the correlation between coral reefs and sunscreens and the potential public health impact of limiting access to sunscreens. This study,

[1] Based in Washington, D.C., the Personal Care Products Council (PCPC) is the leading national trade association representing global cosmetics and personal care products companies. Founded in 1894, PCPC's 600 member companies manufacture, distribute and supply the vast majority of finished personal care products marketed in the U.S. As the makers of a diverse range of products millions of consumers rely on and trust every day – from sunscreens, toothpaste, and shampoo to moisturizer, makeup and fragrance – personal care products companies are global leaders committed to product safety, quality and innovation.

[2] Mitchelmore CL, Burns, EB, Conway A, Heyes, A, Davies IA. 2021. A critical Review of Organic Ultraviolet Filter Exposure, Hazard, and Risk to Corals. Environ Toxicol Chem. DOI: 10.1002/etc.4948.

sponsored by the U.S. Environmental Protection Agency, will examine research concerning both the environmental and human health impacts of access to sunscreens.

Organic Sunscreen Ingredients Critical in Fight Against Skin Cancer

Avobenzone and octocrylene, approved for use by the U.S. Food and Drug Administration (FDA) and regulated as over-the-counter drugs, are two critical ingredients in sunscreen products, a crucial and well-recognized step in the fight against skin cancer and premature skin aging. The U.S. has a limited number of approved organic sunscreen ingredients to make products that protect consumers from the harmful effects of solar radiation. Two of these ingredients – avobenzone and oxybenzone – protect against UVA rays, which penetrate more deeply into the skin and have been scientifically proven to contribute to skin cancer. Only sunscreen products with ingredients protecting against both UVB and UVA rays may be labeled as "broad-spectrum protection," preventing premature aging and skin cancer. With Hawaii's previous ban on some sunscreen active ingredients, a ban on avobenzone would further limit access to products that can help prevent skin cancer. FDA previously proposed that all sunscreens with a SPF (sun protection factor) higher than 15 should be broad-spectrum sunscreens.

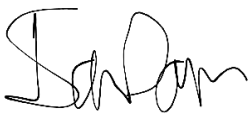
Hawai'i Residents at Higher Risk for Skin Cancer

Skin cancer is one of the most common yet preventable cancers. According to the World Health Organization (WHO), four out of five cases can be prevented by following safe sun practices, including using sunscreen regularly. Hawai'i residents are at high risk for developing skin cancer. The American Cancer Society estimates that melanoma, the most serious form of skin cancer, will be one of the leading causes of new cancer cases in Hawai'i in 2021. Native Hawaiians and other Pacific Islanders suffer from double the melanoma mortality rate than the State average, according to Hawai'i Health Matters, an innovative web-based community information tool developed by the Hawai'i Health Data Warehouse and the Hawai'i Department of Health. Hawai'i has one of the highest daily UV index averages in the nation, making protecting residents from sun exposure a major health priority.

Sunscreens are a key factor in preventing and reducing the risk of skin cancer and UV damage. Nonprofit health organizations, including the American Cancer Society, American Academy of Dermatology, the Mayo Clinic and the Skin Cancer Foundation, recommend using sunscreen as part of a safe sun regimen to prevent skin cancer. The Centers for Disease Control and Prevention's Sun Safety recommendations note the importance of daily sunscreen use, including on cloudy and overcast days, to help prevent most skin cancers.

For all of the above reasons, we respectfully ask that you vote NO on Senate Bill 132 SD2. Thank you for your consideration and for the opportunity to comment.

Sincerely,



Iain Davies, Ph.D.
Director, Environmental Science Programs
Personal Care Products Council

Supporting Science

The following report outlines the state of the science pertaining to the risk UV filters pose to coral and these risks are put in the context of proven local and global stressors of coral reef decline. The risk UV filters pose to corals is important to investigate and manage; however, current data to assess this risk is limited. A roadmap to assessing risk is presented along with the knowledge gaps that industry, academia, and third-party experts are currently working to fill.

Local and Global Causes of Coral Reef Decline

Coral reefs are immensely valuable ecosystems and an essential habitat for numerous threatened and endemic species. They provide not only a buffer against coastal erosion, a wide variety of food resources, pharmaceutical materials, but also facilitate tourism and recreation.[3] Therefore, the degradation of coral reefs is a serious concern for Hawai'i and reef ecosystems globally. Significant efforts to determine and address the causes of reef decline are critical for protecting these ecologically and economically important ecosystems. Much work has been conducted to investigate the role of various stressors on reef decline, including local stressors such as land-based pollution (e.g., nutrients), coastal development, sedimentation (e.g. land runoff and dredging), and human recreation; while global stressors such as increased sea temperatures and ocean acidification as a result of climate change.

Many studies have examined the impact of local stressors on corals. Sedimentation, resulting from dredging or land-based runoff, has been studied in 89 coral species.[4] Sensitivity to sedimentation is species-dependent, but it can cause adult coral mortality and reduce the successful recruitment and survival of coral larvae. For example, Ricardo et al.[5] determined that a very thin (< 150 µm, similar to the thickness of paper) layer of sediment inhibited successful settlement and therefore the successful recruitment of *Acropora millepora* larvae. Increased nutrient loads from land-based runoff can trigger algal blooms which can kill corals, reduce coral growth, and also inhibit larval recruitment.[6,7] The threat of nutrient-based pollution is particularly pronounced in Hawai'i as large-scale cesspools and septic systems are utilized for waste management. These large-capacity cesspools have been found to violate the Safe Drinking Water Act by US Environmental Protection Agency (EPA),[8] and are a significant source of land-based pollution to coastal Hawaiian waters.[9] Human recreation such as snorkeling has also been identified as a mechanism to cause physical damage to corals (due to fragmentation and breakage).[10]

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[3] Weijerman, M. *et al.* Managing local stressors for coral reef condition and ecosystem services delivery under climate scenarios. *Front. Mar. Sci.* **5**, 1–16 (2018).

[4] Erftemeijer, P. L. A., Riegl, B., Hoeksema, B. W. & Todd, P. A. Environmental impacts of dredging and other sediment disturbances on corals: A review. *Mar. Pollut. Bull.* **64**, 1737–1765 (2012).

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[8] US EPA News Release. July 22, 2020. https://www.epa.gov/newsreleases/epa-fines-hawaii-local-and-state-governments-requires-three-cesspool-closures-effort.

[9] Mezzacapo, M. *et al.* Hawai'i's Cesspool Problem: Review and Recommendations for Water Resources and Human Health. J. Contemp. Water Res. Educ. **170**, 35-75 (2020).

[10] Hannak, J. S., Kompatscher, S., Stachowitsch, M. & Herler, J. Snorkelling and trampling in shallow-water fringing reefs: Risk assessment and proposed management strategy. *J. Environ. Manage.* **92**, 2723–2733 (2011).

An extensive review by Brainard et al.[11] identified both an increase in sea temperatures and ocean acidification (resulting from climate change) as major threats to coral reefs. Ocean acidification leads to reduced calcification rates, indicating that the overall growth of calciferous reef structure is inhibited.[12] Meanwhile a clear connection between increased ocean temperatures and coral bleaching has also been established. In a landmark 2017 study, the cause of mass coral bleaching events in Australia's Great Barrier Reef in 1998, 2002 and 2015-2016 was examined.[13] The authors concluded that sea temperature increases resulting from climate change was responsible for the bleaching events and that local pressures (water quality and fishing) were of minimal effect comparatively. The authors concluded that interventions targeting local pressures would provide little or no protection from the effects of climate change. In a follow-up study, Hughes et al.[14] demonstrated that the mass coral mortality stemming from the 2015-2016 Great Barrier Reef bleaching events reduced coral recruitment (settlement and subsequent growth of sexually produced coral larvae) by 89%. This reduction in coral recruitment severely hampers coral recovery from the impacts of global warming. A 2017 University of Hawai'i study by Rodgers et al.[15] examined the causes of coral bleaching in Hawai'i and considered visitor numbers, water currents and elevated sea temperatures. The authors concluded that climate change (increased sea temperatures) was the dominant factor driving coral bleaching in comparison to the other factors studied.

Taken together, there is a clear scientific consensus that both global and local stressors contribute to the degradation of coral reefs through a variety of mechanisms. It has been postulated that resilience to global stressors can be enhanced by addressing local stressors. A key 2018 modelling study conducted for Maui Nui, Hawai'i, by Weijerman et al. evaluated how different local management approaches (sedimentation mitigation and the designation of marine protected areas) could improve coral reef conditions under various climate change scenarios.[16] Multiple pressures were included in the model such as fishing; sedimentation from river mouths and dredging; land-based nutrient release from cesspools septic systems; and fertilizers, and hurricane damage. The comprehensive study identified that strict sedimentation mitigation could reduce coral cover decline; however, the benefit of these local management scenarios was lost when accounting for climate change impacts, a similar conclusion to that for the Great Barrier Reef.[17] This is aligned with the position of multiple national and international governmental and environmental organizations including the National Oceanic and Atmospheric Administration (NOAA), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the U.S. Coral Reef Task Force, all of which have identified rising sea temperatures from global warming as the primary cause of coral bleaching. It is critical that the findings from studies like those presented by Weijerman et al., which integrate proven local and global stressors on coral reef decline to optimize coral ecosystem management, are utilized to give the best chance of protecting threatened reef ecosystems.

Coral Toxicity to UV Filters

Considering coral reefs are expected to be exposed to UV filters through wash-off during recreational activity, considering and evaluating their impact as a local stressor is important. An environmental risk assessment (ERA) should be conducted to fully assess the environmental impact of UV filters on coral. The

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[11] Brainard, R. E. *et al.* Incorporating Climate and Ocean Change into Extinction Risk Assessments for 82 Coral Species. *Conserv. Biol.* **27**, 1169–1178 (2013).

[12] Weijerman, M. *et al.* Managing local stressors for coral reef condition and ecosystem services delivery under climate scenarios. *Front. Mar. Sci.* **5**, 1–16 (2018).

[13] Hughes, T. P. *et al*. Global warming and recurrent mass bleaching of corals. *Nature* **543**, 373–377 (2017).

[14] Hughes, T. P. *et al.* Global warming impairs stock–recruitment dynamics of corals. *Nature* **568**, 387–390 (2019).

[15] Rodgers, K. S., Bahr, K. D., Jokiel, P. L. & Donà, A. R. Patterns of bleaching and mortality following widespread warming events in 2014 and 2015 at the Hanauma Bay Nature Preserve, Hawai'i. *PeerJ* **5**, e3355 (2017).

[16] Weijerman, M. *et al.* Managing local stressors for coral reef condition and ecosystem services delivery under climate scenarios. *Front. Mar. Sci.* **5**, 1–16 (2018).

[17] Hughes, T. P. *et al.* Global warming and recurrent mass bleaching of corals. *Nature* **543**, 373–377 (2017)

ERA considers the level at which UV filters are found near coral reefs and whether this level exceeds the concentration that is expected to cause harm to corals. If safe levels are exceeded, then risks can be managed through mitigation measures. This is the fundamental approach used for chemical management in the U.S. and around the world.

A recent review by Mitchelmore et al. critically analyzed existing near reef UV filter concentrations and coral toxicity data.[18] As this is the only comprehensive review of all relevant science thus far, the work reported in the review are discussed herein. A total of 12 studies have measured organic UV filters in the water near coral reefs. Generally, average concentrations of each organic UV filter were very low, below 0.1 microgram per liter (µg/L). Of the 12 studies, only two presented data relevant to the Hawaiian reef environment. Mitchelmore et al.[19] measured all organic UV filters permitted for use in the U.S. at 19 sites in Hawai'i, while Downs et al.[20] measured oxybenzone at 15 sites in Hawai'i. The organic UV filter concentrations in Hawai'i reported by Mitchelmore et al. were either similar to or less than concentrations reported for other regions. The review by Mitchelmore et al. highlighted significant analytical problems with the oxybenzone monitoring data reported by Downs et al., thereby limiting the usefulness of that data for ERA. For example, Downs et al. reported extraordinarily high limits of quantification, 0.5 µg/L, over 5000 times greater than the other studies. Furthermore, the values reported by Downs et al. are extraordinarily high, 1-3 orders of magnitude greater than any other study. For example, the average and maximum oxybenzone concentrations reported by Mitchelmore et al. (2019) were 0.02 and 0.14 µg/L, respectively, compared to 145 and 1395 µg/L reported by Downs et al. (2016). The exceptionally high oxybenzone values reported by Downs et al. exceed the total dissolved organic carbon (TDOC) concentrations typical in seawater near coral reefs. This would mean that a TDOC concentration would be double the typical ranges in Hawai'i due to the presence of oxybenzone alone. Taken together, the Downs et al.'s data are a clear outlier, and the methodological issues identified indicate the data is not reliable for ERA and will not be considered further.

In terms of organic UV filter toxicity to coral, Mitchelmore et al. reported that only nine studies have been published to date. Of these nine studies, only four attempted to demonstrate a dose-response relationship where toxic effects increase as UV filter concentrations increase.[21,22,23,24] Observation of a dose-response relationship is a cornerstone of ecotoxicology, as it enables toxicity results to be translated into an environmental context.[25] If a study is not designed to observe a dose-response, it is of no value for ERA or decision-making. Therefore, only these four studies are relevant for determining toxicological thresholds or the safe levels of UV filters that coral can be exposed to before exhibiting toxic effects.

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[18] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

[19] Mitchelmore, C. L. *et al.* Occurrence and distribution of UV-filters and other anthropogenic contaminants in coastal surface water, sediment, and coral tissue from Hawai'i. *Sci. Total Environ.* **670**, 398–410 (2019).

[20] Downs, C. A. *et al.* Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawai'i and the U.S. Virgin Islands. *Arch. Environ. Contam. Toxicol.* **70**, 265–288 (2016).

[21] He, T. *et al.* Toxicological effects of two organic ultraviolet filters and a related commercial sunscreen product in adult corals. *Environ. Pollut.* **245**, 462–471 (2019a).

[22] He, T. *et al.* Comparative toxicities of four benzophenone ultraviolet filters to two life stages of two coral species. *Sci. Total Environ.* **651**, 2391–2399 (2019b).

[23] Fel, J. P. *et al.* Photochemical response of the scleractinian coral Stylophora pistillata to some sunscreen ingredients. *Coral Reefs* **38**, 109–122 (2019).

[24] Downs, C. A. *et al.* Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawai'i and the U.S. Virgin Islands. *Arch. Environ. Contam. Toxicol.* **70**, 265–288 (2016).

[25] Harris, C. A. *et al.* Principles of Sound Ecotoxicology. *Environ. Sci. Technol.* **48**, 3100–3111 (2014).

Avobenzone has only been included in a single ecotoxicity study.[26] Danovaro et al. included it in their preliminary study,[27] but that study is not acceptable for determining toxicological thresholds for multiple reasons reported in the Mitchelmore et al. review. Fel et al. monitored photosynthetic yield, which is thought to be a precursor for coral bleaching. [28] If the UV filter suppresses photosystem II in the coral symbiont algae, photosynthetic yield will be reduced. The lowest concentration of avobenzone that caused a significant reduction in photosynthetic yield was 516 µg/L. To put this value in an environmental risk context, it needs to be compared to relevant exposure data. Tsui et al. have reported the highest near-reef avobenzone concentration globally as 0.7 µg/L.[29] This level is **700 times less than the lowest level needed to cause an effect** based on the only coral toxicological data available to date. Furthermore, Mitchelmore et al. did not even detect avobenzone in Hawaiian waters above their limit of detection, indicating that less than 0.003 µg/L was present, **over 170 000 times less than the level that causes an effect (516 µg/L).**

Octocrylene was also included in the Fel et al. study.[30] The concentration required to significantly reduce photosynthetic yield was even higher than avobenzone, 1318 µg/L. Additionally, octocrylene was included in a toxicity study carried out on two adult coral species by He et al. (2019). [31] A range of effects were studied and the lowest concentration that caused an effect was 1000 µg/L. At this concentration, a significant reduction in the symbiotic algae within the coral host was observed and the coral condition was impacted as evidenced by polyp retraction. Importantly, He et al. did not observe any coral bleaching, even at the highest concentration studied (1000 µg/L). Therefore, the lowest toxicity concentration for octocrylene reported to date is 1000 µg/L, **over 13 000 higher than average octocrylene levels measured in near-reef environments near reefs**, as reported by Mitchelmore et al. [32] The highest near-reef concentration of octocrylene reported in Hawai'i to date is 0.027 µg/L, [33] indicating that based on current data environmental concentrations of octocrylene near reefs are far too low to cause an effect on coral.

Similarly to avobenzone, octinoxate has appeared only in a single coral ecotoxicity study. He et al. (2019) exposed adult corals and monitored a range of toxic effects. [34] Polyp retraction was the lowest observed effect at 10 µg/L, while the lowest concentration to cause bleaching was 100 µg/L. The maximum concentration of octinoxate reported in near reef environments globally was observed by Tsui et al. (2014) at 4 µg/L, while the average concentration across seven monitoring studies as reviewed by Mitchelmore et al. was 0.1 µg/L. [35] Mitchelmore et al. were unable to detect octinoxate in near-reef Hawaiian waters,

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[26] Fel, J. P. *et al.* Photochemical response of the scleractinian coral Stylophora pistillata to some sunscreen ingredients. *Coral Reefs* **38**, 109–122 (2019).

[27] Danovaro, R. *et al.* Sunscreens cause coral bleaching by promoting viral infections. *Environ. Health Perspect.* **116**, 441–447 (2008).

[28] Fel, J. P. *et al.* Photochemical response of the scleractinian coral Stylophora pistillata to some sunscreen ingredients. *Coral Reefs* **38**, 109–122 (2019).

[29] Tsui, M. M. P. *et al.* Occurrence, distribution and ecological risk assessment of multiple classes of UV filters in surface waters from different countries. *Water Res.* **67**, 55–65 (2014).

[30] Fel, J. P. *et al.* Photochemical response of the scleractinian coral Stylophora pistillata to some sunscreen ingredients. *Coral Reefs* **38**, 109–122 (2019).

[31] He, T. *et al.* Toxicological effects of two organic ultraviolet filters and a related commercial sunscreen product in adult corals. *Environ. Pollut.* **245**, 462–471 (2019a).

[32] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

[33] Mitchelmore, C. L. *et al.* Occurrence and distribution of UV-filters and other anthropogenic contaminants in coastal surface water, sediment, and coral tissue from Hawai'i. *Sci. Total Environ.* **670**, 398–410 (2019).

[34] He, T. *et al.* Toxicological effects of two organic ultraviolet filters and a related commercial sunscreen product in adult corals. *Environ. Pollut.* **245**, 462–471 (2019a).

[35] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

meaning levels were below 0.002 µg/L[36]. Therefore, the most sensitive coral toxicological response to octinoxate, polyp retraction, would not be expected to occur in Hawai'i as **environmental concentrations are over 5000 times lower than the effect concentration (10 µg/L).**

Two studies have conducted coral toxicological investigations of oxybenzone. Downs et al. exposed coral planulae (fertilized larvae) and determined a median lethal concentration (LC50) and median effect concentration (EC50) for planulae deformity under light and dark conditions. [37] Downs et al. also included a coral cell line assay, but this was not correlated with effects in whole organisms and is therefore not suitable for risk assessment, as discussed in the Mitchelmore et al. review. [38] The LC50 was reported as 139 µg/L, while the deformity EC50 was lower, 49 µg/L. In Hawai'i specifically, Mitchelmore et al. recorded an average near-reef oxybenzone concentration of 0.02 µg/L and a maximum concentration of 0.14 µg/L. [39] This means the average concentration of oxybenzone in near reef environments in Hawai'i **is over 2000 times less** than the concentration required to cause an effect, according to the toxicity data reported by Downs et al. for coral larvae. [40] He et al. also studied the impacts of oxybenzone on two coral species in both larval and adult life stages. [41] In adults, polyp retraction was observed at the lowest concentration, 10 µg/L, while bleaching was observed at 1000 µg/L of oxybenzone. He et al. concluded that coral larvae were not as sensitive to oxybenzone exposure as adults. Therefore, the lowest effect concentration for oxybenzone was observed by He et al. at 10 µg/L for polyp retraction. This effect concentration is still below far the average concentration of oxybenzone in Hawaiian waters reported by Mitchelmore et al. (0.02 µg/L) and below the global near-reef maximal values reported in the environment by Bargar et al.[42] and Tsui et al.[43] of 6.2 and 5.4 µg/L globally.

Octisalate and homosalate were not included in any suitable ecotoxicological coral study to date. Therefore, there is **no ecotoxicological evidence** these UV filters harm coral. Octisalate is included in the Danovaro et al. study (in addition to avobenzone, oxybenzone, octocrylene and octinoxate) but as mentioned the study was conducted so poorly that it is not possible to draw any conclusion from it as discussed in the Mitchelmore et al. review. [44]

Quality of Published UV Filter Coral Toxicity Studies

[36] Mitchelmore, C. L. *et al.* Occurrence and distribution of UV-filters and other anthropogenic contaminants in coastal surface water, sediment, and coral tissue from Hawai'i. *Sci. Total Environ.* **670**, 398–410 (2019).

[37] Downs, C. A. *et al.* Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawai'i and the U.S. Virgin Islands. *Arch. Environ. Contam. Toxicol.* **70**, 265–288 (2016).

[38] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

[39] Mitchelmore, C. L. *et al.* Occurrence and distribution of UV-filters and other anthropogenic contaminants in coastal surface water, sediment, and coral tissue from Hawai'i. *Sci. Total Environ.* **670**, 398–410 (2019).

[40] Downs, C. A. *et al.* Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawai'i and the U.S. Virgin Islands. *Arch. Environ. Contam. Toxicol.* **70**, 265–288 (2016).

[41] He, T. *et al.* Comparative toxicities of four benzophenone ultraviolet filters to two life stages of two coral species. *Sci. Total Environ.* **651**, 2391–2399 (2019b).

[42] Bargar, T. A., Alvarez, D. A. & Garrison, V. H. Synthetic ultraviolet light filtering chemical contamination of coastal waters of Virgin Islands national park, St. John, U.S. Virgin Islands. *Mar. Pollut. Bull.* **101**, 193–199 (2015).

[43] Tsui, M. M. P. *et al.* Occurrence, distribution and ecological risk assessment of multiple classes of UV filters in surface waters from different countries. *Water Res.* **67**, 55–65 (2014).

[44] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

Major scientific flaws have been found for all published UV filter coral toxicity studies. These issues reduce the confidence we can have in their findings, which ultimately makes them unsuitable for environmental risk assessment. For ERA to be successful and protective, high quality data need to be used. There are several methods to assess the reliability of a study, and these approaches are routinely applied by regulatory bodies (such as the U.S. Environmental Protection Agency and Environmental and Climate Change Canada) to ensure that data used to inform decision-making is suitable. These coral studies are not the first ecotoxicity studies to be criticized for failing to meet basic requirements for conducting reliable experiments.[45] To improve the usefulness of ecotoxicity studies published in the peer-reviewed literature for ERA, data reliability assessments have been established, such as the CRED method.[46] These methods evaluate the quality of five key areas of a study: test setup, test compound, test organism, test design/conditions, and results and statistics. This covers aspects such as whether adequate controls were used, whether the test medium suitable for the test animal, and whether the concentration of the test compound was measured and maintained throughout the test.

Applying the CRED method to the four coral toxicity studies extensively discussed, no study is 'reliable without restriction,' which is considered the scientific gold standard, and use of those data in an ERA would be suitable. The two He et al. studies contained the fewest reliability issues; however, the test concentrations they used meant they were not able to observe statistically important effects (for example EC50s or LC50s). They also demonstrated that the UV filters degraded (broke-down) so much so that by the end of their tests oxybenzone, octocrylene and octinoxate were no longer detectable. Therefore, we cannot say what level of UV filter the coral were actually exposed to and this can lead to an under or overestimate of toxicity.[47] A similar problem was observed with the Downs et al. study; no concentrations were measured throughout the whole test. [48] Turner and Renegar observed similar issues in a review of coral toxicity studies with petroleum hydrocarbons, where test concentrations were either not measured or measured too infrequently to determine an average exposure.[49] The purpose of a toxicity study is to determine a threshold concentration that can be compared with concentrations observed in the environment to inform chemical management. If this threshold concentration is not measured, then the study is of little value. On the other hand, Fel et al. [50] did monitor the concentration of UV filters throughout the test; significant UV filter degradation was also identified, but due to the frequency of measurement, a mean exposure concentration could be calculated.

Using the CRED method, the Fel et al. and Downs et al. studies are considered unreliable due to the number and severity of studies' flaws (and the remaining six UV filter toxicity studies that were not discussed). For the Fel et al. study specifically, a significant dose-response relationship was not observed, and the experiment was not adequately replicated. For the Downs et al. study, test concentrations were not analytically verified; the test chemical was incorrectly identified; a reference toxicant was not included (which was required as part of the guideline the authors cited); too little data provided to assess basic study acceptability criteria including control mortality and effects; the exposure conditions were not

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[45] Harris, C. A. & Sumpter, J. P. Could the Quality of Published Ecotoxicological Research Be Better? *Environ. Sci. Technol.* **49**, 9495–9496 (2015).

[46] Moermond, C. T. A., Kase, R., Korkaric, M. & Ågerstrand, M. CRED: Criteria for reporting and evaluating ecotoxicity data. *Environ. Toxicol. Chem.* **35**, 1297–1309 (2016).

[47] Harris, C. A. *et al.* Principles of Sound Ecotoxicology. *Environ. Sci. Technol.* **48**, 3100–3111 (2014).

[48] Downs, C. A. *et al.* Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawai'i and the U.S. Virgin Islands. *Arch. Environ. Contam. Toxicol.* **70**, 265–288 (2016).

[49] Turner, N. R. & Renegar, D. A. Petroleum hydrocarbon toxicity to corals: A review. *Mar. Pollut. Bull.* **119**, 1–16 (2017).

[50] Fel, J. P. *et al.* Photochemical response of the scleractinian coral Stylophora pistillata to some sunscreen ingredients. *Coral Reefs* **38**, 109–122 (2019).

suitable for the coral larvae; and the use of a solvent, dimethyl sulfoxide, which is not considered acceptable by the US EPA. Together, these flaws limit the usefulness of these studies for drawing any conclusions about the harm UV filters may cause coral and **would not** be suitable for any ERA conducted by regulatory authorities such as the U.S. EPA, European Chemicals Agency or Environment and Climate Change Canada.

Critical Knowledge Gaps for the Impacts of UV Filters on Coral

At this time, we cannot conclusively determine that UV filters do not harm coral; however, the presented synthesis of existing data demonstrate that based on current environmental levels, UV filters are not suspected of harming coral. This is because there is currently limited or no ecotoxicological data for some UV filters and much of the existing data are considered unreliable based on the results of systematic data quality evaluation approaches. These ecotoxicological knowledge gaps need to be addressed with robust ecotoxicological tests that are repeatable and reliable for all UV filters. The design of these studies should provide comparable toxicological thresholds that are suitable for ERA and can therefore support evidence-based decision making. Conducting an ERA for UV filters is also a priority of the U.S. EPA as recently they tasked the U.S. National Academy of Sciences (NAS) with determining data gaps and/or risks UV filters pose to both the freshwater and marine environment and to assess the impact on public health of potential changes in sunscreen use.[51]

A significant barrier exists for generating reliable coral toxicological data. There is no standardized coral toxicity test system, which describes basic acceptability criteria, water quality thresholds, replication, animal husbandry, and endpoints to observe. This is likely a significant reason why most of the toxicity studies to date are unreliable; there is no core method or suitable modified guideline method to follow. In response to this need, PCPC is working to develop a standardized coral ecotoxicological test system. This work is in conjunction with scientists at the University of Maryland Center for Environmental Science and the Nova Southeastern University and can be used to generate reliable, comparable and consistent data for ERA purposes. Development of a coral toxicity test system will be critical for filling knowledge gaps with reliable coral toxicity data for UV filters so that an ERA with appropriate data can be conducted.

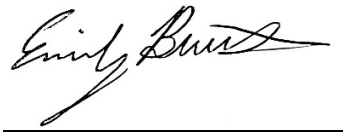
More broadly, PCPC published the first comprehensive review on the UV filter occurrence, effects and risks to coral reefs.[52] The review identified a series of actions that need to be taken in order to effectively assess the environmental risk of UV filters to coral environments. This includes the prediction of UV filter concentrations in marine environments due to recreational and down-the-drain use. A scoping exercise to determine appropriate models for this purpose has already been initiated by a coalition of industry and non-industry scientists. Predicted environmental concentrations are better suited to ERA as they don't reflect a snapshot in time and can incorporate spatial variability within a probabilistic framework. The review also identified the use of an eco-epidemiological approach which could be a useful strategy for evaluating combinations of physical, chemical and environmental conditions over time to identify dominant stressors. A feasibility assessment for the eco-epidemiological approach has already been commissioned by PCPC. This approach is similar to Weijerman et al.'s modelling study (discussed previously) that evaluated the

[51] NASEM [NASEM] National Academies of Sciences, Engineering, and Medicine. 2020. Environmental impact of currently marketed sunscreens and potential human impacts of changes in sunscreen use. https://www.nationalacademies.org/our-work/environmental-impact-of-currently-marketed-sunscreens-and-potential-human-impacts-of-changes-in-sunscreen-usage.

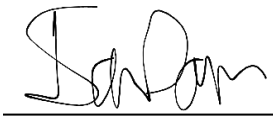
[52] Mitchelmore, C. L., Burns, E. E., Conway, A., Heyes, A. & Davies, I. A. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. *Environ. Toxicol. Chem.* 1-22 (2021). 10.2002/etc.4948.

effectiveness for different local management approaches to improve coral reef conditions under various climate change scenarios in Hawai'i.[53]

There is currently limited evidence to suggest that corals are adversely impacted by environmental exposure to UV filters; however, these major knowledge gaps need to be addressed with high-quality UV filter toxicity and environmental occurrence data. Together these studies can be used to appropriately quantify the risk of UV filters to coral, thus enabling assessors to make informed, evidence-based decisions that will truly be of benefit for coral health.



Emily Burns, Ph.D.
Environmental Scientist
Personal Care Products Council



Iain Davies, Ph.D.
Director, Environmental Science Programs
Personal Care Products Council

[53] Weijerman, M. *et al.* Managing local stressors for coral reef condition and ecosystem services delivery under climate scenarios. *Front. Mar. Sci.* **5**, 1–16 (2018).

SB-132-SD-2
Submitted on: 3/15/2021 8:04:39 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Ted Bohlen	Hawaii Reef and Ocean Coalition	Support	No

Comments:

To: The Honorable Nicole Lowen, Chair,

The Honorable Lisa Marten, Vice Chair, and Members of the

House Committee on Energy and Environmental Protection

From: Climate Protectors Hawaii (by Ted Bohlen)

Re: Hearing **SB132 SD2– RELATING TO WATER POLLUTION**

Tuesday March 16, 2021, 9:00 a.m., by videoconference

Aloha Chair Lowen, Vice Chair Marten, and Energy and Environmental Protection Committee members:

Position: **The Hawaii Reef and Ocean Coalition STRONGLY SUPPORTS SB132 SD2!**

The HAWAIʻI REEF AND OCEAN COALITION – HIROC – was formed in 2017 by coral reef scientists, educators, local Hawaii environmental organizations, elected officials, and others to address the crisis facing Hawaii's coral reefs and other marine life. The Hawaiʻi Reef and Ocean Coalition worked hard in 2017-18 to help persuade the Legislatur to pass the ban on sunscreens containing oxybenzone and octinoxate because they are harmful to reefs. **Studies now show that octocrylene and avobenzone are also harmful to reefs and human health, and so HIROC STRONGLY SUPPORTS SB132 SD2!**

Coral reefs are already being severely harmed by ocean waters that are warming and becoming more acidic as a result of greenhouse gas emissions worldwide. Coral reefs are also being harmed in Hawaii by sediment and nutrient runoff from the land, by overfishing, especially of herbivores, **and sunscreen petrochemicals.**

HIROC is joining the diverse Hawaii Coral Reef Stakeholders who strongly support SB132 SD2, expanding Act 104, Sessions Laws of Hawaii 2018 by adding

two more harmful petrochemicals to the list: octocrylene and avobenzone. Evolving science clearly demonstrates that these pervasive reef toxins irreversibly interfere with the life-cycles of Hawaii marine life including corals, algae, fish, shellfish, sea urchins and marine mammals.

Avobenzone, which is the leading active ingredient in petrochemical sunscreens, can cause hormone disruptions and disrupt the powerhouse of the cell, reducing coral resilience and contributing to coral bleaching.

Octocrylene, which is often used with avobenzone to stabilize it, metabolizes into benzophenone, a known carcinogen and endocrine disrupter that affects thyroid function, is regulated by the FDA and included in California's Prop 65 list of chemicals known to cause cancer or reproductive toxicity. A recent study finds that octocrylene degrades into benzophenone over time sitting on the shelf. Octocrylene can act as a metabolic toxicant in corals, potentially decreasing the resiliency of coral to climate change. Long-term exposure to avobenzone and octocrylene has been found to be lethal for some organisms living in freshwater environments, and these two petrochemicals are considered dangerous for freshwater ecosystems.

In February 2019, **the U.S. Food and Drug Administration declared that it does not have sufficient scientific evidence that any of the organic UV filters in sunscreens including oxybenzone, octinoxate, octocrylene, and avobenzone are safe and effective for human use - never mind our marine ecosystems!** The health risks of having these petrochemicals absorbed into the body through the skin are very troubling and have not been adequately studied.

Approximately one-fourth of the plants, fish, and invertebrates found in Hawaiian coral reefs are endemic to Hawaii. Coral reefs are intrinsic to Hawaiian culture, and fundamental to the fabric of our local communities. They provide critical habitat for near shore marine life, and natural protection against coastal erosion and sea level rise - ecosystem services worth billions of dollars. Further, our coral reefs underpin tourism, Hawaii's primary economic engine. It is therefore critical to eliminate as many existential threats to our marine ecosystems as possible, like these additional reef-toxic chemicals, to ensure our reefs can both survive and thrive for future generations.

It has been argued that banning sunscreens containing certain chemicals like avobenzone and octocrylene from the market would lead to additional skin cancers, because people therefore won't use any sunscreen. Sunscreen preparations were designed to protect against sun**burn** and because of this they are assumed to protect against skin cancers, but unfortunately this relationship is inferential only. **There are no definitive studies that demonstrate that sunscreens protect against skin cancers** as evidenced by research published by the World Health Organization, US Environmental Protection Agency, and dermotologists alike.

It is claimed that people won't use sunscreens if sales of these two petrochemicals are banned. This false claim ignores the fact that there are ample safer alternatives available on the market containing active ingredient minerals zinc oxide or titanium dioxide. It also ignores what the World Health Organization has called "**sunscreen abuse,**" which refers to the fact that petrochemical sunscreens are usually not applied sufficiently or frequently enough, and many wash off in water, and so may actually give people a false sense of security that causes them to spend longer time in the sun and have MORE skin cancers.

The best course is to avoid the mid-day sun, but if you will be in the sun, wear a protective hat and clothing or sunscreens with zinc oxide or titanium dioxide. This is a much better course than using a petrochemical sunscreen that washes off in water, kills corals and other marine life, gets into your bloodstream, and may disrupt your hormones, potentially causing more skin cancers.

The need for SB132 SD2 to protect Hawaii's corals and other aquatic species and human health is clear and critical, and we strongly urge you to pass this bill!

Mahalo for the opportunity to testify on behalf of Hawaii's coral reefs!

HAWAIʻI REEF AND OCEAN COALITION – HIROC (by Ted Bohlen)

TO:
House Committee Energy & Environmental Protection
Rep. Nicole E. Lowen, Chair
Rep. Lisa Marten, Vice Chair

FROM:
Lynn Miyahira representing Public Access to SunScreens (PASS) Coalition

DATE: Tuesday, March 16, 2021
TIME: 9:00 AM
PLACE: Via Videoconference

Re: SB 132 SD 2 - Relating to Water Pollution

Position: OPPOSED

The Public Access to SunScreens (PASS) Coalition is a multi-stakeholder coalition composed of public health groups, dermatologists, sunscreen manufacturers, and leading advocates for skin cancer patients. The PASS Coalition opposes this measure as it will create additional barriers for consumers to access their choice of safe, effective and FDA-approved sunscreens as a skin cancer prevention tool.

We ask that the legislature hold off on passing SB 132 SD 2 or any other legislation on sunscreen ingredients until more data on environmental and public health impacts are available.

The use of sunscreen is an essential evidence-based sun-safe practice. It is well known that utilizing comprehensive sun-safe practices is one of the most effective ways to reduce skin cancer risk, including the regular use of sunscreen, wearing sun protective clothing, hats and sunglasses, and seeking shade. Skin cancer prevention tools, such as broad-spectrum sunscreens that protect against UVA and UVB rays, must be combined with comprehensive educational tools to ensure consumer awareness of skin cancer risks due to excessive sun exposure.

Hawaii Residents Are at Higher Risk for Skin Cancer

Some notable skin cancer and sun safety behavioral statistics include:

- Native Hawaiians and other Pacific Islanders suffer from double the melanoma mortality rate than the state average[i]
- In 2018, more than one in three Hawaii residents surveyed reported having a sunburn in the last 12 months, nearly double from the previous year[ii] – and having just five or more sunburns in your lifetime is known to double your risk for melanoma[iii]

- Researchers have found that just *one* blistering sunburn in childhood or adolescence more than doubles a person's chance of developing melanoma later in life[iv]
- Hawaii has one of the highest daily UV index averages in the nation,[v] making protecting residents from sun exposure a crucial public health issue

Science Touted by Sunscreen Ban Advocates Is Flawed

Despite the known risk of skin cancer, Hawaii and a handful of other jurisdictions have placed restrictions on the sale of sunscreens based on limited laboratory testing that led policymakers to believe banning sunscreen would improve coral reef health. However, the early studies did not fully consider the complexity of a coral reef system and had scientific limitations. Importantly, findings from a 2019 study by Dr. Carys Mitchelmore of the University of Maryland contradicts an earlier study by Dr. Craig Downs that advocates of the sunscreen ban have widely promoted. Dr. Mitchelmore's study uses rigorous methodology and shows actual levels of oxybenzone sampled from seawater in Hawaii to be 141 times lower than previously stated by Dr. Downs and 1,020 times below levels considered toxic to coral.[vi]

The limited studies purported to show a link between sunscreen exposure and coral toxicity are methodologically flawed and should not be used for evidence-based policymaking based on EPA data reliability standards. Subsequent follow-up studies with more rigorous analyses have not replicated the work by Dr. Downs and do not support the conclusions.

Congress Has Directed the National Academy of Sciences to Conduct a Comprehensive Study

For that reason, banning sunscreen will have little impact on protecting coral reefs. The overwhelming consensus amongst the scientific community is that rising ocean temperature, ocean acidification, invasive species, land-based source pollution, water quality issues due to poor wastewater management are the primary causes of coral decline. As a result, the United States Congress directed the National Academy of Sciences (NAS) to evaluate the latest science available on the correlation between coral reefs and sunscreens and the potential public health impact of limiting access to sunscreen.

This NAS study, titled "Environmental Impact of Currently Marketed Sunscreens and Potential Human Impact of Changes in Sunscreen Usage," will conduct an objective review of these issues by leading scientific experts. The project description is as follows:

> "Concerns have been raised about the potential toxicity of sunscreens to a variety of marine and freshwater aquatic organisms, particularly corals. At the same time, there are concerns that people will use less sunscreen rather than substituting sunscreens with UV filters that are considered environmentally safe. This study will review the state of science on use of currently marketed sunscreen ingredients, their fate and effects in aquatic environments, and the potential public health implications associated with changes in sunscreen usage."[vii]

This study, contracted through the U.S. Environmental Protection Agency (EPA) with NAS, will examine research concerning environmental and human health impacts of access to sunscreen. This independent study will evaluate the scientific merit of current science and identify gaps in

our current understanding of coral reef environmental health and human health risks of skin cancer. All NAS studies involve multiple strategies to reduce bias and synthesize the best available science.

The fact that the NAS is reviewing the currently available science and methodology to determine data gaps on these issues should point out that there is not "overwhelming" evidence supporting an expansion on the sunscreen ban in Hawaii. Instead, it is an emerging science and there are still gaps in information that need to be filled.

NAS Study Should be Completed Before Legislators Make Further Decisions on Consumer Sunscreen Choice

The NAS Study held its first public meeting on February 23, 2021. Attached is the public meeting presentation that lays the groundwork for how the committee will be reviewing the scientific literature on sunscreen. On slide 16, there is an explanation of their points of emphasis and what kind of questions they will be considering.

The conclusion of this NAS study – expected in the first half of 2022 – should inform policymakers' future decisions on sunscreens. Until this review is completed, legislation like SB 132 SD2 should be suspended as there is currently insufficient data to inform a risk/benefit analysis between protecting the marine environment and protecting the public's health. It is important that the legislature wait for unbiased scientific analysis and consensus.

FDA Advises Continued Use of Sunscreens

In addition to the lack of peer-reviewed evidence on sunscreens' environmental impact, the impact on human health is also still being researched. On **January 21, 2021**, the Food and Drug Administration (FDA), which regulates sunscreens as over-the-counter (OTC) drugs for the prevention of sunburn and skin cancer, announced results from a second sunscreen absorption study[viii] and also posted an article titled, "Shedding More Light on Sunscreen Absorption[ix]" that explained that while the FDA is seeking more information on the absorption levels of sunscreen ingredients, including avobenzone, oxybenzone, octocrylene, homosalate, octisalate, and octinoxate, it still advises their continued use. The FDA clearly stated, "Absorption does NOT equal risk – the FDA advises continued use of sunscreens" and according to Janet Woodcock, M.D., director of the FDA's Center for Drug Evaluation and Research:

> "Given the recognized public health benefits of sunscreen use, the U.S. Food and Drug Administration (FDA) urges Americans to use sunscreens in conjunction with other sun protective measures (such as protective clothing). To support sunscreen safety, the FDA tested whether various sunscreen ingredients can be absorbed through the skin into the body."
>
> "Results from our study released today show there is evidence that some sunscreen active ingredients may be absorbed. **However, the fact that an ingredient is absorbed through the skin and into the body does not mean that the ingredient is unsafe, nor does the FDA seeking further information indicate such**. Rather, this finding calls for further industry testing to determine the safety and effect of systemic exposure of

> sunscreen ingredients, especially with chronic use."
>
> "That's why as part of the proposed rule on sunscreen, the FDA requested additional information on active ingredients in sunscreen to evaluate their GRASE (Generally Recognized As Safe and Effective) status in light of changed conditions, including substantially increased sunscreen usage and evolving information about the potential risks associated with these products since they were originally evaluated. We look to sharing further updates on this important area of research."[x]

It is important to note that on May 4, 2020, the FDA officially withdrew[xi] the proposed sunscreen rule and has made it clear that it is *not* asking the public to stop using sunscreens with avobenzone, octocrylene or any of the other ingredients within the rule.

Eliminating Alternative Ingredients Reduces Consumer Choice

The Hawaii state law signed in July 2018 already eliminated the OTC sale of the ingredients oxybenzone and octinoxate. SB 132 SD 2 would expand this ban to include the most utilized alternative sunscreen ingredients and could **potentially remove approximately 64% of the sunscreens currently available in the United States from being sold in Hawaii.**

On average, currently marketed mineral sunscreens can cost up to 30% more than other sunscreens and this proposed legislation could significantly reduce consumer choice of and access to sunscreen in Hawaii. It is important to remember that sunscreen is not only used in the ocean, but whenever people are outdoors doing activities such as hiking, golfing, walking, running, cycling, or working outside. This puts Hawaii residents at greater risk for skin cancer with only limited peer-reviewed scientific evidence on sunscreen ingredients and its impact on environmental and human health.

Again, we ask that the legislature hold off on passing SB 132 SD 2 or any other legislation on sunscreen ingredients until more data on environmental and public health impacts are available.

If you have any questions about the PASS Coalition or the content of this testimony, please feel free to contact me at lmiyahira@iq360inc.com.

Mahalo for the opportunity to testify.

Sincerely,

Lynn Miyahira
Public Access to SunScreens (PASS) Coalition

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[i] http://www.hawaiihealthmatters.org/indicators/index/view?indicatorId=2389&localeId=14&localeChartIdxs=1%7C2%7C4
[ii] http://www.hawaiihealthmatters.org/indicators/index/view?indicatorId=3029&localeId=14
[iii] https://www.skincancer.org/skin-cancer-information/skin-cancer-facts/
[iv] https://www.skincancer.org/skin-cancer-information/skin-cancer-facts/
[v] https://www.epa.gov/sunsafety/sun-safety-monthly-average-uv-index
[vi] https://www.sciencedirect.com/science/article/pii/S0048969719310125?via%3Dihub

[vii] https://www.nationalacademies.org/our-work/environmental-impact-of-currently-marketed-sunscreens-and-potential-human-impacts-of-changes-in-sunscreen-usage
[viii] https://www.fda.gov/news-events/fda-brief/fda-brief-fda-announces-results-second-sunscreen-absorption-study
[ix] https://www.fda.gov/news-events/fda-voices/shedding-more-light-sunscreen-absorption
[x] https://www.fda.gov/news-events/fda-brief/fda-brief-fda-announces-results-second-sunscreen-absorption-study
[xi] https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202004&RIN=0910-AF43

Environmental Impact of Currently Marketed Sunscreens

The National Academies of Sciences, Engineering and Medicine

February 23, 2021

Jennifer Orme-Zavaleta, Ph.D., Acting Assistant Administrator
Suzanne van Drunick, Ph.D., National Program Director, Safe and Sustainable Water Resources
Sandy Raimondo, Ph.D., Research Ecologist, Gulf Ecosystem Measurement and Modeling Division
Office of Research and Development
U.S. Environmental Protection Agency

EPA's Statutory Authority & Appropriation

Clean Water Act 33 U.S.C. 1251 (1972) Section 101 (a)

"…restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

Biological integrity – A balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of a region

FY20 Omnibus

Environmental Impact of Currently Marketed Sunscreens – To better assess any potential environmental impacts of currently marketed sunscreen filters on the environment, the Agency is directed to contract with the National Academy of Sciences (NAS) to conduct a review of the scientific literature of currently marketed sunscreens' potential risks to the marine environment. This review should include any risks that sunscreen filters might pose to freshwater ecosystems, coral reefs, aquatic and marine life, and wetland ecosystems, and should identify any additional research needed to conduct aquatic environmental risk assessments. Additionally, the study should also review the current scientific literature on the potential public health implications associated with reduced use of currently marketed sunscreen ingredients for protection against excess ultraviolet radiation.

Sunscreen Media Attention

News Headlines

- NPR: Chemicals in sunscreen are harming coral reefs, says new study (Oct 20, 2015)
- Consumer Reports: The truth about 'reef safe' sunscreen (Feb 7, 2019)
- USA Today: Some sunscreens may kill corals, but should they be banned? Scientists are not so sure (Mar 9, 2019)
- National Geographic: What sunscreens are best for you – and the planet?(May 21, 2019)
- CNN: Florida could require a prescription for certain sunscreens that could harm coral reefs (Oct 16, 2019)
- BBC News: Palau is first country to ban 'reef toxic' sun cream (Jan 1, 2020)
- ABC News: Sunscreen pollution accelerating demise of coral reefs, experts say (Feb 22, 2020)

The New York Times

Hawaii Passes Bill Banning Sunscreen That Can Harm Coral Reefs

The legislation prohibits the distribution of sunscreens containing chemicals that scientists have found contributes to coral bleaching when washed off in the ocean.

Recent studies have led to a global push for more reef-safe sunscreens.
Chip Litherland for The New York Times

By Elaine Glusac

May 3, 2018

Benefits of Sunscreen

Skin Cancer (source: the Skin Cancer Foundation)

- Skin cancer is the most common cancer in the U.S. and worldwide.
- 1 in 5 Americans will develop skin cancer by age 70.
- More than 2 people die of skin cancer in the U.S. every hour.
- Having 5 or more sunburns doubles the risk for melanoma.
- The annual cost of treating skin cancers in the U.S. is estimated at $8.1 billion.
- Regular daily use of an SPF 15 or higher sunscreen reduces the risk of developing squamous cell carcinoma by about 40%.

EPA – NASEM

June 2020 EPA contracted with NASEM to review the state of science on sunscreen mineral and organic components' fate and effects in aquatic environments.

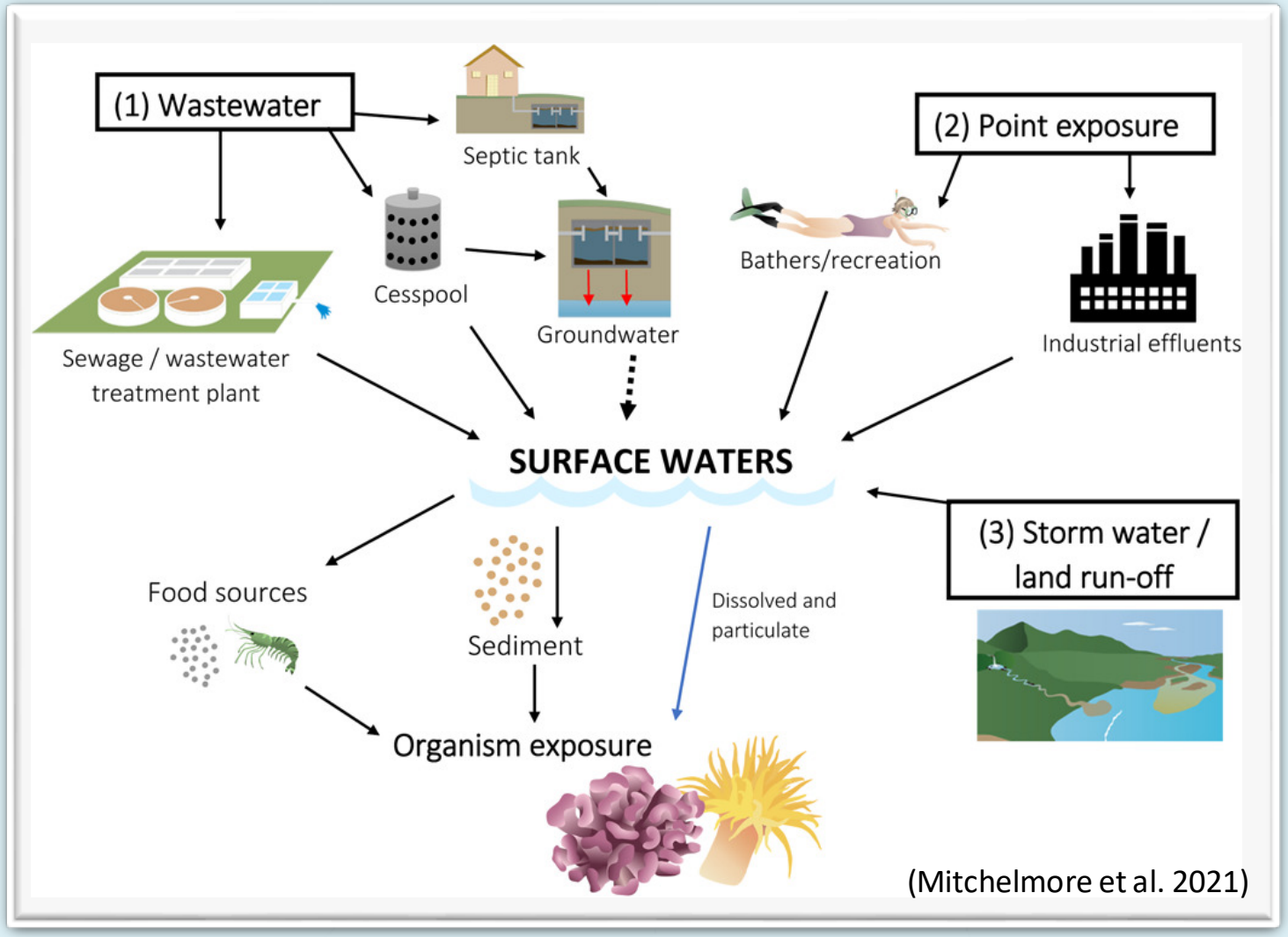
- Document of the scientific literature on active ingredients in currently marketed sunscreens that protect against ultra-violet radiation (UV filters)
- Summarize the scientific literature that informs:
  - potential risks of UV filters on aquatic environments
  - additional research needed (data gaps) to conduct adequate aquatic ecological risk assessments
  - potential public health implications of reduced sunscreen use

Scope of Work

- Sunscreen UV filters
  - Active ingredients (e.g., chemicals/oxybenzone, octinoxate; minerals/zinc oxide, titanium dioxide)
  - Formulations (e.g., sprays/nanoparticles, lotions)
- Ecological receptors (e.g., plants, invertebrates, vertebrates)
- Aquatic environments (freshwater ecosystems, estuaries, marine environments, wetland ecosystems, coral reefs, and inhabiting biota)
- Components of reports will inform the ecological risk assessment process
  - Problem formulation
  - Exposure analysis
  - Effects analysis
  - Identification of research needs (uncertainty)

Background

- Sunscreens enter the environment through recreational activities and waste effluent
- While various organisms can be exposed to sunscreen ingredients and their degradates, the source of urgency with the issue pertains to the global decline of coral reefs



(Mitchelmore et al. 2021)

Coral Reef Benefits

- Cover less than 1% of the ocean floor and support ~25% of all marine species
- Important food source for local communities
- Nurseries that are vital to world fisheries
- Coastal protection (erosion, storm surge, hurricanes, typhoons, tsunamis)
- Support jobs (fishing, tourism)
- Therapeutics (cancer treatment)
- Ecosystem services value ($375+ billion year)



Coral Reef Stressors

- Climate – increased ocean temperature, acidification, tropical storms, altered ocean circulation patterns
- Physical damage/destruction – dredging, quarrying, destructive fishing practices and gear, boat anchors and groundings, and recreational misuse
- Pollutants – sedimentation, nutrients, toxic substances, pathogens, trash
- Overfishing
- Coral harvesting
- Invasive species
- Sunscreen ingredients

Aggregate effects can decrease coral reef resilience and increase susceptibility to disease and invasive species

Knowledge Assessment

- Some active ingredients in marketed sunscreens have been reported to have adverse health outcomes in animals or biological processes (endocrine disruption, coral bleaching)
- Expanding research also reporting adverse health outcomes in other aquatic species (algae, crustaceans, fish)
- Concerns about effects of chemical UV filters have promoted use of mineral UV filters and alternatives to sunscreen
- Reduced use of sunscreen (without alternative protection) can result in increased skin cancer
- Municipalities that banned some sunscreen ingredients have not assessed human health consequences of their removal or replacement with mineral filters

Knowledge Assessment – Gaps

- Fate and transport of active sunscreen ingredients and degradation byproducts

- Caveats and limitations of research studies
  - Environmental concentrations
  - Exposure
  - Adverse Outcome Pathway
  - Surrogate species representation
  - Lab to field translation

- Social/behavioral

Comprehensive Literature Review

Focal areas of review

1. Potential risks of sunscreen on aquatic environments Consistent with risk assessment framework

2. Potential public health implications of reduced sunscreen use

3. Uncertainties and additional research needed (i.e., data gaps)

Area 1. Potential risks of sunscreen on aquatic environments

A. Characterization of sunscreen
   - Identification of sunscreen active ingredients and their degradates

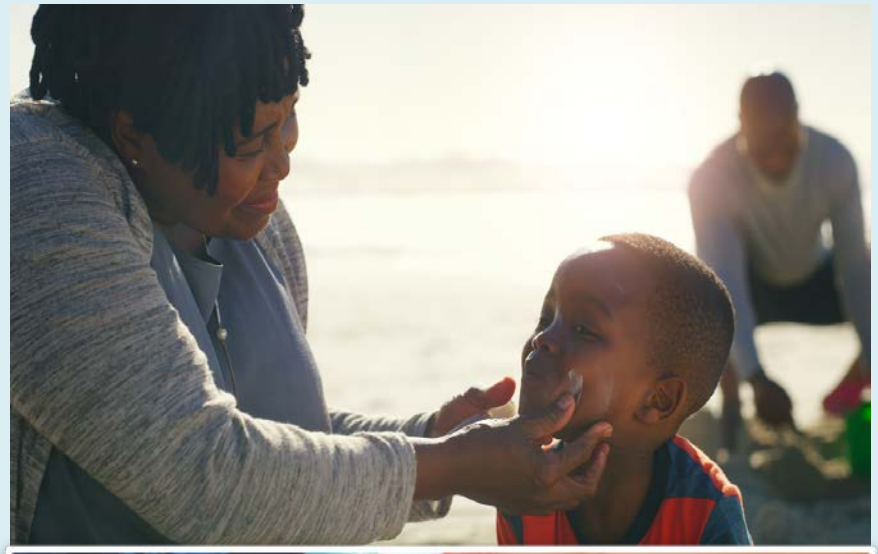
B. Environmental Exposure
   - Sources of sunscreens entering the environment
   - Potential routes of exposure to aquatic organisms
   - Factors influencing environmental fate and transport
   - Measured concentrations of sunscreen in aquatic environments

C. Ecological Effects
   - Organisms potentially exposed
   - Potential effects to aquatic organisms
   - Communities of ecological, economical, and commercial importance

Area 2. Potential public health implications of reduced sunscreen use

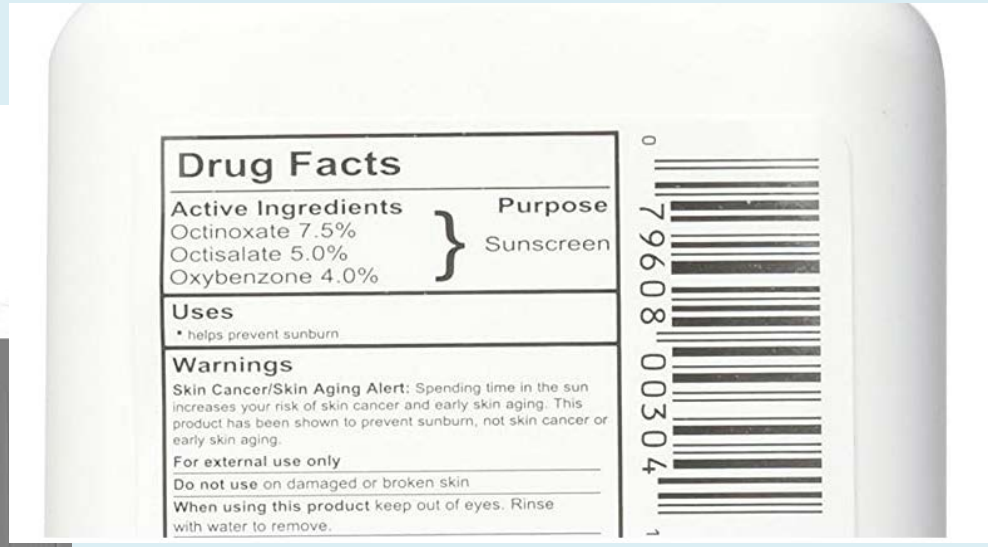
A. Identify public health concerns/consequences of reduced use of chemical sunscreen

B. Efficacy of alternative active ingredients



Area 3. Uncertainties and additional research needed (i.e., data gaps)

- Identify information gaps
  - Environmental relevance of laboratory studies
  - Half-life of sunscreen
  - Fate (degradation vs bioaccumulation)
- Highlight research priorities
- Assess feasibility of conducting comparative human and ecological risk assessments
- Industry standard labeling



Emphases and Considerations

Points of Emphasis

- Ranges and frequency of environmental concentrations in the water
- Aquatic organisms with highest risk of adverse effects
  - Taxa based on chemical mode of action
  - Threatened or endangered
- Relative risks of various sunscreen ingredients

Questions to Consider

- Do available data on environmental concentrations contain sampling bias?
- Do available effects data represent broad taxonomic diversity?
- Can susceptible taxa be identified for which data are lacking?
- Do data exist to identify environmentally-friendly sunscreen alternatives?

Questions?

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vanDrunick.Suzanne@epa.gov

FDA In Brief: FDA announces results from second sunscreen absorption study

January 21, 2020

Media Inquiries

Amanda Turney (mailto:amanda.turney@fda.hhs.gov)
301-796-2969

The following quote is attributed to Janet Woodcock, M.D., director of the FDA's Center for Drug Evaluation and Research.

"Given the recognized public health benefits of sunscreen use, the U.S. Food and Drug Administration (FDA) urges Americans to use sunscreens in conjunction with other sun protective measures (such as protective clothing). To support sunscreen safety, the FDA tested whether various sunscreen ingredients can be absorbed through the skin into the body."

"Results from our study released today show there is evidence that some sunscreen active ingredients may be absorbed. However, the fact that an ingredient is absorbed through the skin and into the body does not mean that the ingredient is unsafe, nor does the FDA seeking further information indicate such. Rather, this finding calls for further industry testing to determine the safety and effect of systemic exposure of sunscreen ingredients, especially with chronic use."

"That's why as part of the proposed rule on sunscreen, the FDA requested additional information on active ingredients in sunscreen to evaluate their GRASE (Generally Recognized As Safe and Effective) status in light of changed conditions, including substantially increased sunscreen usage and evolving information about the potential risks associated with these products since they were originally evaluated. We look to sharing further updates on this important area of research. "

- Today, the FDA published the study, "*Effect of Sunscreen Application on Plasma Concentration of Sunscreen Active Ingredients: A Randomized Clinical Trial* (https://jamanetwork.com/journals/jama/fullarticle/2759002)

(http://www.fda.gov/about-fda/website-policies/website-disclaimer)" in the Journal of the American Medical Association (JAMA). This study describes the results of a clinical trial evaluating the absorption through the skin and into the body of six sunscreen active ingredients under single dose and maximal use conditions. The study included ingredients not previously evaluated. A prior pilot study (https://jamanetwork.com/journals/jama/fullarticle/2733085) (http://www.fda.gov/about-fda/website-policies/website-disclaimer)was published in JAMA in May 2019.

- The study used four commercially available sunscreen products (lotion, aerosol spray, non-aerosol spray and pump spray). The publication results show that when sunscreen is applied to the skin, even a single application, all six tested active ingredients and all of the formulations, result in measurable blood levels of the active ingredient.

Related Information

- Sunscreen Drug Products for Over-the-Counter Human Use Proposed Rule (https://www.federalregister.gov/documents/2019/02/26/2019-03019/sunscreen-drug-products-for-over-the-counter-human-use)
- Sunscreen: How to Help Protect Your Skin from the Sun (/drugs/understanding-over-counter-medicines/sunscreen-how-help-protect-your-skin-sun)
- FDA: Shedding More Light on Sunscreen Absorption (/news-events/fda-voices/shedding-more-light-sunscreen-absorption)

The FDA, an agency within the U.S. Department of Health and Human Services, protects the public health by assuring the safety, effectiveness, and security of human and veterinary drugs, vaccines and other biological products for human use, and medical devices. The agency also is responsible for the safety and security of our nation's food supply, cosmetics, dietary supplements, products that give off electronic radiation, and for regulating tobacco products.

Shedding More Light on Sunscreen Absorption

New research adds to our understanding of sunscreens

By: Theresa M. Michele, M.D., Director, Office of Nonprescription Drugs, Office of New Drugs, Center for Drug Evaluation and Research, and David Strauss, M.D., Ph.D., Director, Division of Applied Regulatory Science, Office of Translational Sciences, Center for Drug Evaluation and Research

Even on cold, cloudy winter days, sunscreen safety remains a top priority at the U.S. Food and Drug Administration, as well it should since sunscreens are recommended for year-round use. Today, the FDA's newly-published research in the Journal of the American Medical Association (JAMA)External Link Disclaimer provides much-needed additional information about the absorption of the active ingredients in sunscreens into the body's bloodstream after they are applied to the skin. It's an important follow-up study to prior researchExternal Link Disclaimer, published in JAMA in May 2019, that showed when certain sunscreens were used at their maximal recommended use (according to the product's label), their active ingredients were absorbed through the skin and into the body.

Important new information builds on last year's initial findings

Theresa M. Michele, M.D.

Today's newly-published information adds to those key findings from last May. It describes the results of a clinical trial evaluating the absorption of a wider range of sunscreen active ingredients, six as opposed to four in the original study. This second study, in addition to studying application every 2 hours according to the product label (maximal use), also studied absorption after a single use. In the new study, we tested absorption of active ingredients contained in four commercially available sunscreen products (lotion, aerosol spray, nonaerosol spray and pump spray). While additional data are needed, results showed that all six active ingredients were absorbed into the body's bloodstream – even after a single use. An additional finding from this new study is that once absorbed, these active ingredients can remain in the body for extended periods of time. This study evaluated absorption of the active ingredients avobenzone, oxybenzone, octocrylene, homosalate, octisalate, and octinoxate. The prior study evaluated absorption of avobenzone, oxybenzone, octocrylene, and ecamsule.

The FDA is seeking more information on sunscreen ingredients

Importantly, both of these studies support an FDA proposed rule, issued in February of 2019, aimed at bringing over-the-counter (OTC) sunscreens up to date with the latest scientific standards. It's a high priority for the FDA and we continue to work toward establishing final marketing requirements for sunscreens. As part of this rule, the FDA has asked industry and other interested parties for additional safety data on 12 active sunscreen ingredients currently available in marketed products. While both of these studies make a great start, additional data are needed for each of these 12 active sunscreen ingredients in order to fully understand their absorption into the body as well as the long-term effects of absorption. Without further testing, the FDA does not know what levels of absorption can be considered safe.

Absorption does NOT equal risk – The FDA advises continued use of sunscreens

David Strauss, M.D., Ph.D

The findings in these studies do not mean that the FDA has concluded that any of the ingredients tested are unsafe for use in sunscreens, nor does the FDA seeking further information indicate such. The agency's proposed rule requested additional safety studies to fill in the current data gaps for these ingredients. The rule also proposed that two active ingredients (zinc oxide and titanium dioxide) are generally recognized as safe and effective for use in sunscreens, and additional data was not requested for them.

Given the recognized public health benefits of sunscreen use, the FDA strongly advises all Americans to continue to use sunscreens in conjunction with other sun protective measures (such as protective clothing) as this important rulemaking effort moves forward. Broad Spectrum sunscreens with SPF values of at least 15 are only one element of a skin-cancer prevention strategy that should also include other sun protective behaviors such as wearing protective clothing that adequately covers the arms, torso, and legs; wearing sunglasses and a hat that provides adequate shade to the whole head; and seeking shade whenever possible during periods of peak sunlight. Other medical authorities, such as the Centers for Disease Control and Prevention, the American Academy of Dermatology, and other major physicians' associations endorse similar recommendations. More about sun protection and sunscreens can be found on the FDA website.

The FDA's research and studies, as well as our ongoing work to update the regulatory framework for sunscreens, reflected in the proposed rule on Sunscreen Drug Products for Over-the Counter Human Use, are two of many ways the agency is working to help ensure safe use of sunscreens for the American public.

URL: https://www.fda.gov/news-events/fda-voices/shedding-more-light-sunscreen-absorption

SB-132-SD-2
Submitted on: 3/15/2021 8:59:09 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Jennifer Johansen	Cyanotech Corporation	Support	No

Comments:

Aloha,

Cyanotech Corporation's values our island community, the environment and sustainability. We strongly support SB132 and ask that this bill is passed.

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH **clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.**

We ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Aloha State Legislature,

Science has provided ample evidence that long-term exposure to avobenzone, homosalate, octisalate, and particularly octocrylene commonly found in sunscreens (including those labelled "reef safe") have been found to have detrimental impacts on people and marine life. The intention was always to include these dangerous UV filters to the original sunscreen bill, as we waited for the released studies to be published. Now there is more than enough solid science to back up the urgency to update our sunscreen laws.

Octocrylene accumulates in fatty tissues of aquatic life (and humans), can alter mitochondrial function and is linked to developmental and reproductive toxicity. It can contribute as a "deciding factor" of whether coral survives or dies a bleaching event. It's one of the more inefficient UV filters and one of the most toxic to corals. **Avobenzone degrades when exposed to the sun causing the release of free radicals**, which can increase the risk of cancers. It must be used with other chemicals because it breaks down so quickly and is not waterproof. It shows endocrine disruption and decrease sperm viability. Octocrylene and avobenzone typically go together in formulations, making them even more dangerous. **Octisalate and homosalate** are absorded into the blood, cross into the womb & can cause birth defects and miscarriages.

The hypothesis that if you prevent a sunburn with chemical sunscreens you prevent skin cancer has never been proven. By preventing a burn you certainly miss the body's natural warning you're being exposed to too much sun. There's no need to trade the health of marine life in order to protect from sun exposure. People can utilize UV protective hats / sunglasses / clothing, shade, avoid direct sun mid-day… *then choose a safe sunscreen*. **There are a multitude of non-nano mineral sunscreens on the market**, easily available across Hawai'i, offering more efficient broad spectrum protection. It's embarassing to continue making the excuse that there are no safe, effective options to chemical UV filters.

Covid has given Hawai'i a time-out from extreme tourism. We need to step back, reevaluate human impact, and consider the negative effects these chemicals have been having on our environment, food supply (these UV filters are being found in Hawaii-caught fish we eat), in coastal waters we swim, in the air we breathe (via aerosols sprayed constantly at beaches, parks, hotels… which are impossible to avoid inhaling), in the sand honu lay their eggs…. Are we truly working to be an eco-destination or is that simply green-washing used year after year at Hawaii's tourism conventions.

Coral reefs are fundamental to our sustainability. They provide critical habitat for near shore marine life and natural protection against coastal erosion. Their health also provides for our tourism economy. It's vital we eliminate as many existential threats to our marine ecosystems as possible, including reef-toxic chemicals, to ensure they can survive and thrive for future generations.

We urge your support for HB102 and SB132. Mahalo.

LATE *Testimony submitted late may not be considered by the Committee for decision making purposes.

TESTIMONY OF TINA YAMAKI, PRESIDENT
RETAIL MERCHANTS OF HAWAII
March 16, 2021
Re: SB 132 SD2 Relating to Water Pollutants

Good morning Chairperson Lowen and members of the House Committee on Environmental Protection. I am Tina Yamaki, President of the Retail Merchants of Hawaii and I appreciate this opportunity to testify.

The Retail Merchants of Hawaii was founded in 1901, RMH is a statewide, not for profit trade organization committed to the growth and development of the retail industry in Hawaii. Our membership includes small mom & pop stores, large box stores, resellers, luxury retail, department stores, shopping malls, local, national, and international retailers, chains, and everyone in between.

We are opposed to SB 132 SD2 Relating to Water Pollutants. This measure beginning on January 1, 2023, bans the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to preserve marine ecosystems.

Hawaii is known for its many sunny days and **many residents and visitors who uses sunscreen include little leaguers, hikers, golfers, soccer and baseball players, and joggers to name a few**. With the pandemic we are seeking more people and families enjoying outdoor sports biking, playing outside, and going to the park. **Sunscreen is not just used for beach and other water activity purposes**. Sunscreen also comes in many forms that include not only lotions and sprays, but also in foundation makeup, lipsticks, lip balm and more.

Many of us wear sunscreen daily to protect ourselves from the effects of the sun like skin cancer - the most common form of cancer. Every year there are more cases of skin cancer in the United States than incidences of breast cancer, prostate cancer, lung cancer, and colon cancer combined. One out of five Americans will develop skin cancer in their lifetime, and one person dies of melanoma (the deadliest form of skin cancer) every hour. Most melanomas are caused by the sun, and **a person's risk of melanoma doubles if he or she has had more than five sunburns.**

This measure is too premature to ban ingredients. It is our understanding that there is no peer-reviewed evidence that these UV filters (avobenzone and octocrylene) actually cause harm to coral reefs. In addition, the Environmental Protection Agency (EPA) and the National Academies of Sciences (NAS) are currently doing a thorough review of all the different studies as many are conflicting about sunscreens. The fact that the EPA and NAS are reviewing the methodology of the currently available science – which could include sampling bias and other methodology flaws – should point to the fact that there is not "overwhelming" evidence that supports an expansion on the sunscreen ban in Hawaii. It is "emerging" science and the fact that there are studies that contradict each other means there are still a lot of gaps in information that need to be filled. We ask the legislature WAIT until this study is done sometime in 2022.

We may also run the risk of people no longer wearing sunscreen and thus increasing their chances of skin cancer. This ban would also penalize those who do not go to the beach but use sunscreen on a regular basis like hikers, golfers, tennis players and joggers to name a few. Sunscreen products should be affordable and accessible first line of defense for individuals seeking protection from the sun's cancer-causing UV rays. Banning the sale of these products will drastically reduce the selection of sunscreen products available in Hawaii as well as compel local residents to purchase products online or not use sunscreen at all and our visitors to bring their own in their suitcases. How many will actually take time off from work, pay a co-payment to see a doctor and then watt in the pharmacy to a get a prescription for suntan lotion? Not to mention having to pay for the sunscreen because insurance may not cover it.

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We are wondering why the legislature wants to take away consumer choice for something that the EPA and NAS and FDA are still reviewing?

For these reasons, we respectfully urge you to hold this bill.

Mahalo again for this opportunity to testify.

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Love Life!

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SB 132 SD2 RELATING TO WATER POLLUTION
House Committee on Energy and Environmental Protection
March 16, 2021, 9:00am State Capitol

Aloha Rep. Nicole Lowen, Chair, Lisa Marten, Vice Chair, and Committee Members,

Down to Earth *Organic and Natural* testifies in support of SB 132 SD2.

Down to Earth Organic and Natural has six locations on Oahu and Maui. Since we opened in 1977, we have supported healthy lifestyles and preservation of the environment by selling local, fresh, organic and natural products, and by promoting a healthy, plant-based and vegetarian lifestyle.

We are in support of SB 132 SD2 which will ban the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to preserve marine ecosystems.

Down to Earth is a trusted source for toxin-free, natural products. Our customers appreciate that we put the health of our communities and the environment first by only providing products whose ingredients have been thoroughly scrutinized.

When exposed to sunlight, avobenzone is photodegradable, increasing free radicals in the skin and increasing the risks for skin cancers. Octocrylene has been shown to accumulate in various types of aquatic life causing DNA damage, developmental abnormalities, and adverse reproductive effects. Additionally, within just a few hours, coral bleaching can occur with exposure to avobenzone or octocrylene.

With many alternative products available, including all the sun protection products available at our Down to Earth stores, these chemicals are simply not necessary for common, every day use. In our warm climate, sunscreen is used on a daily basis and it is crucial to have strict regulations that reflect the aloha we have for our environment and each other.

Thank you for the opportunity to comment on this bill.

Alison Riggs
Public Policy & Government Relations Manager
Down to Earth

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LATE *Testimony submitted late may not be considered by the Committee for decision making purposes.

SB-132-SD-2
Submitted on: 3/15/2021 11:11:20 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Michael Koenigs	Littlehandshawaii	Support	No

Comments:

We are in strong support of this bill. Please lets get this passed for our keiki and our aina. Its now or never. Our oceans are our largest resource. Lets give back what it has given you/us for generations.

Mahalo nui

Little Hands Hawaii Ohana

American Chemistry Council

March 16, 2021

TO: Representative Nicole E. Lowen, Chair
Representative Lisa Marten, Vice Chair
Members of the Committee on Energy and Environmental Protection

FR: Tim Shestek
American Chemistry Council

RE: **SB132 SD2 Relating to Water Pollution. – OPPOSE**

On behalf of the American Chemistry Council (ACC), I am writing to express our concern with SB132 SD2, legislation that would ban non-prescription sunscreens containing avobenzone or octocrylene. If passed, this bill would eliminate many of the U.S. Food and Drug Administration (FDA) approved sunscreen active ingredients that protect skin against the damaging effects of ultraviolet light. In addition to these comments, ACC supports the comments submitted by the Personal Care Products Council (PCPC) and the Consumer Healthcare Products Association (CHPA).

The FDA, the Centers for Disease Control and Prevention (CDC), the U.S. Surgeon General, the American Academy of Dermatology (AAD), the Skin Cancer Foundation, and health care professionals worldwide emphasize that using sunscreens is a critical part of a safe sun regimen. The dangers of sun exposure are clear and universally recognized by public health professionals and dermatologists. The National Institutes of Health Report on Carcinogens identifies solar UV radiation as a "known human carcinogen." A single bad burn in childhood doubles the risk of developing skin cancer later in life.

ACC shares the concerns regarding the threat to the world's coral reefs. Climate change and ocean warming are the most notable culprits for reef bleaching. According to the U.S. National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program, coral reefs are impacted by an increasing array of hazards, primarily from global climate change, ocean acidification, and unsustainable fishing practices.

Thank you for the opportunity to share these comments. Should you have any questions, please do not hesitate to contact me at 916-448-2581 or tim_shestek@americanchemistry.com. You may also contact ACC's Hawai'i based representative Ross Yamasaki at 808-531-4551 or ryamasaki@808cch.com

SB-132-SD-2
Submitted on: 3/15/2021 12:09:01 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Shelby Serra	Pacific Whale Foundation	Support	No

Comments:

Testimony to the Hawaii State House Committee on Energy & Environmental Protection

March 16th, 2021

9:00 am

Hawaii State Capitol – Conference room 325

RE: SB 132 – Relating to Water Pollution

Aloha Chair Lowen, Vice-Chair Marten, and members of the Committee,

Thank you for the opportunity to submit testimony on Senate Bill 132.

My name is Shelby Serra and I am the Conservation Coordinator for Pacific Whale Foundation, based on the island of Maui. For the last 40 years, Pacific Whale Foundation's (PWF) mission has been to protect the ocean through science and advocacy, and to inspire environmental stewardship. Our nonprofit work includes active research, education, and conservation projects here in Hawai'i and abroad in Australia and Ecuador.

On behalf of our nearly 20,000 supporting members, PWF would like to support SB 132, banning the sale and distribution of sunscreen containing avobenzone or octocrylene.

Coral reefs are among the most biologically diverse ecosystems in the world, supporting nearly one million species of algae, invertebrates and fish. Research has shown that some chemicals commonly found in sunscreen can damage coral reefs by disrupting coral reproduction, inhibiting growth, deforming coral DNA, and increasing the rate of zooxanthellae viruses and coral bleaching (1). We can reduce the risk of harming coral by taking a reef-friendly approach to sun protection.

PWF advocates for the use of protective clothing and reef-safe sunscreen to help protect fragile coral reefs and to promote a healthy ocean environment. We support the statewide ban on sunscreens containing oxybenzone and octinoxate and we have

moved from encouragement to enforcement and instituted our own ban onboard PacWhale Eco Adventure's vessels of sunscreens containing: oxybenzone, octinoxate, avobenzone, avobenzine, homosalate, octisalate, octocrylene, and ethylhexyl methoxycinnamate in order to alleviate any additional stress on coral reefs.

Hawai'i's coral reef ecosystems provide economic and social benefits to the community, as well as act as natural protection of our shorelines from powerful storms, which are increasing in both frequency and severity (2). We believe adding avobenzone and octocrylene to the list alongside oxybenzone and octinoxate will further help protect these fragile reef ecosystems.

Thank you for allowing me the opportunity to testify on SB 132.

References

1. Wood, E., 2018. Impacts of sunscreens on coral reefs. Report by the International Coral Reef Initiative (ICRI). 2018 - crm.gov.mp.. https://crm.gov.mp/wp-content/
2. Chu, P.-S., Chen, Y. R., & Schroeder, T. A. (2010). Changes in precipitation extremes in the Hawaiian Islands in a warming climate. Journal of Climate, 23(18), 4881–4900. doi:10.1175/2010JCLI3484.1

SB-132-SD-2
Submitted on: 3/15/2021 8:59:47 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Robyn Fukumoto	Lani & Kai	Support	No

Comments:

Representatives,

Thank you for your consideration with this essential bill.

As a state, we have made massive strides in leading the way in groundbreaking ocean regulation. We made it clear that our people stand for the preservation of our land and will go to great lengths to protect it.

The regulation of reef harming sunscreen is urgent, and preservation is unfortunately not something that can be taken halfway. Reefs are in grave peril due to the ocean temperature fluctuations from global warming. We know from extensive scientific backing that, even in the smallest amount, avobenzone and octocrylene stress coral to the point of death. We've done our part to ban oxybenzone and octinoxate, but we cannot stop there if we want to make an impact.

Beyond balancing our ocean's biodiversity and producing the majority of the world's oxygen, the coral reefs are the backbone to our economy. They protect our coastline real estate from devastation, they sustain our island fish and fuel the jobs of our island fisherman, and fuel our tourist economy. The decision to oppose this bill would do irreperable damage to our already fragile island economy.

I highly encourage your support for SB132 on behalf of myself and other concerned residents.

Yours in solidarity!
Robyn Fukumoto

Lani & Kai, Co-Founder

LATE *Testimony submitted late may not be considered by the Committee for decision making purposes.

SB-132-SD-2
Submitted on: 3/15/2021 9:17:10 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Emily Babel	Mama Kuleana Reef Safe Sunscreen Company	Support	No

Comments:

Mama Kuleana Reef Safe Sunscreen strongly supports SB132.Chemicals octocrylene and avobenzone are known to cause risks to our marine life as well as to humans. There are plenty of reef safe sunscreen options on the market today that will not destroy our oceans. Time is of the essence, we must ACT NOW or else we risk losing our reefs for good!

Nicole Chatterson
Director, Zero Waste Oʻahu
March 15, 2021

March 15, 2021

Aloha Chair Lowen, and EEP Committee Members,

Mahalo for the opportunity to testify on this matter. As the Executive Director of Zero Waste Oʻahu, a local non-profit working to rebuild an equitable and waste-free Hawaiʻi, I am testifying in **support of SB 132: RELATING TO WATER POLLUTION.**

Swimming in Waikiki one can smell, taste, and see the sheen of chemical sunscreens in our water. There is no need for our sun protection to cause this kind of impact on our marine ecosystem. This bill bans the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to **preserve marine ecosystems**.

Hawaiʻiʻs coral reefs are an important part of society providing economic, social, and subsistence benefits. This bill will get us closer to protecting our precious reefs from the impact of chemicals from our personal care products by including chemicals that were left out of previous legislation.

Studies show that compounds like avobenzone and octocrylene negatively impact reefs and marine life putting our precious nearshore waters in harm. The ban on the sale of sunscreens with these chemicals will reduce the amount of these pollutants in our waters. Those needing the sunscreen will still be able to purchase it with a prescription ensuring only those in need of the chemical protection will be provided for reducing the amount of chemicals in our environment.

Mahalo for your time and consideration,

Nicole Chatterson, Executive Director of Zero Waste Oʻahu

In Favor of SB132 SD2 … Joe DiNardo – Toxicologist/Hawaii Tourist March 13, 2021

Dear Representatives,

I have been submitting testimonies in favor of banning sunscreen actives since 2017, when the Hawaii Food Industry Association and the Consumer Healthcare Products Association first inaccurately reported to you that "oxybenzone was the ONLY UVA sunscreen that was approved by FDA" and implied that if you banned sunscreen active(s) you would cause many to get skin cancer. The Personal Care Products Council (PCPC) concurred with these inaccurate views and added that these sunscreen chemicals were approved by the Food and Drug Administration (FDA) as "safe and effective" for human use. They also wisely hired a research scientists who sampled Hawaii waters for petrochemical sunscreen content from a boat 0.5 km from the shoreline away from tourists and identified that the levels in Hawaii waters were far below the concern that could harm coral based on the one, no two, no three, oh no - the now nine studies published in the scientific literature demonstrating concern for coral. Of course, that information would not include the recent research from the National Oceanic and Atmospheric Administration (NOAA) infographic noted below which clearly states that sunscreen chemicals affect marine life … green algae, coral, mussels, sea urchins, fish and dolphins. Nor does it discuss the other aquatic effects caused by avobenzone or octocrylene (see recent studies listed below). The other supporters of sunscreens who opposed this bill - American Chemical Council, Hawaii Skin Cancer Coalition, American Academy of Dermatology, Retail Merchants of Hawaii and the Public Access to Sunscreens (PASS) Coalition also claim that the other numerous scientific publications reporting the negative environmental and human impact of these toxic chemicals is wrong and that "sunscreens save lives".

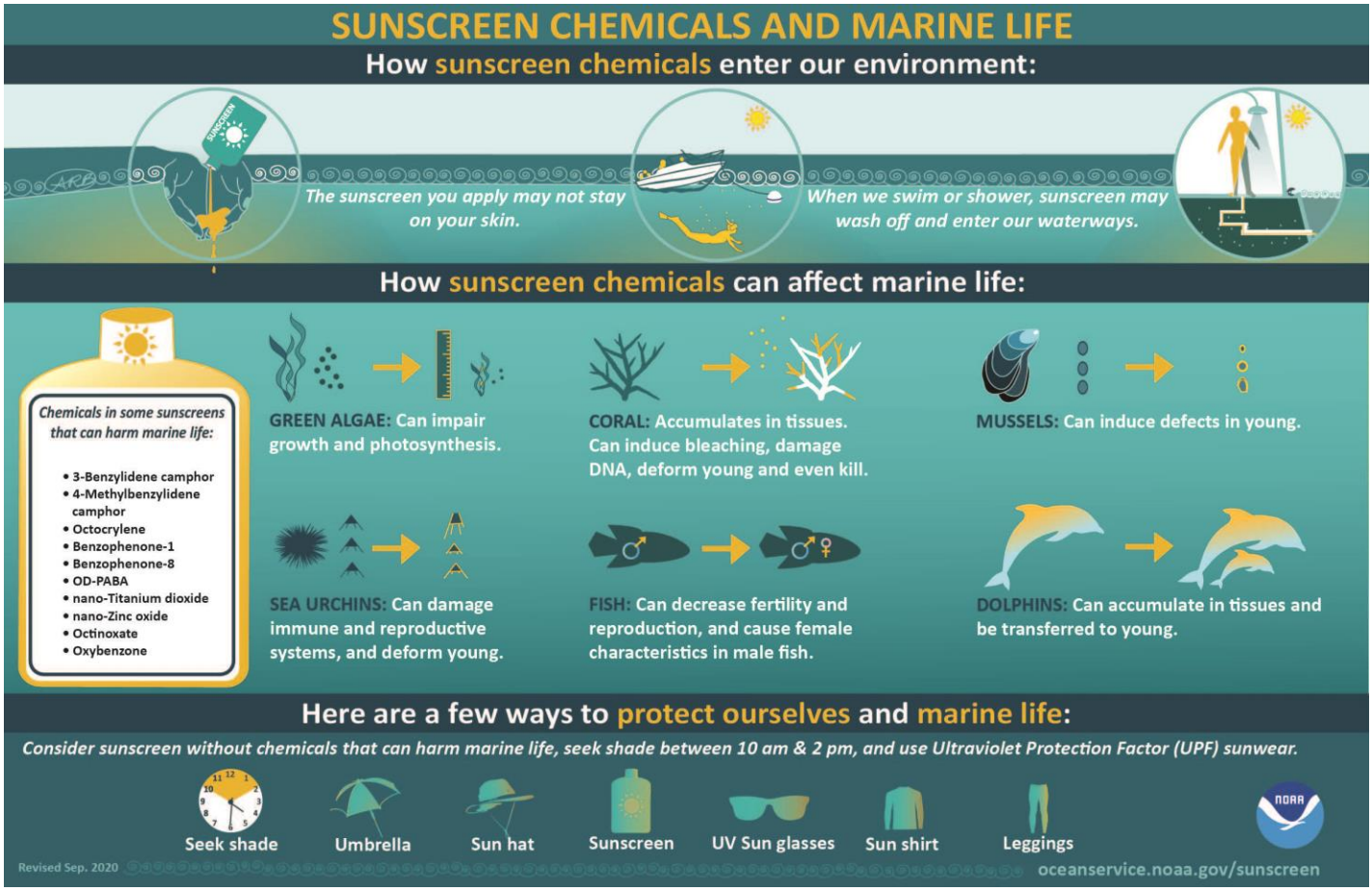
The newest twist in testimonies is a plea to wait another 1.5 years or so until the National Academy of Science (NAS) … a group funded by EPA (who recently increased the amount of several toxic chemicals allowed in our water supply) who was asked by congress (based on political pressure placed on them by the PASS Coalition and possibly other Washington DC Lobbyists groups) … to complete an independent review with scientists that are partial (like the one who recently wrote the paper about how wrong the 9 coral published studies are that was co-authored and paid for by the PCPC) and who recently removed their invitation from a known Hawaii published coral researcher to participate on the panel (because of his recent publication reporting on a known carcinogenic byproduct in a sunscreen active that is currently in this bill - octocrylene). The only thing more compelling than that story, is trying to understand how the US Senate included legislation in the CARES Act (a pandemic bill) which attempted to erase 20 years of science that the FDA used to conclude that petrochemical sunscreen actives are either unsafe (PABA and Trolamine Salicylate) or require more safety testing (the remaining 12 actives) and not a panel discussion to demonstrate that they are safe and effective for human use. By the way, the FDA has never stated that their opinion has changed, regardless of the CARES Act; data is still requested and required to demonstrate that these chemicals do not cause cancer or reproductive damage to our children among other things.

In case you are wondering how many people have died from skin cancer since sunscreens began being promoted about 40 years ago by dermatologist and sunscreen companies or perhaps what the incidence of melanoma is in the US vs. Australia (known to have high skin cancer rates), I've attached 2 data tables. One showing that over 400,000 people have died (a 54% increase adjusting for population growth) from skin cancers between 1975 and 2017, the other shows that the US incidence of melanoma is increasing rapidly, especially compared to Australia's rates – which is approximately twice what the US is experiencing. These should be very important statistics to dermatologists who despite the global epidemic of skin cancers, still insist that sunscreens are beneficial. What is beneficial

is sun avoidance, excessive sun exposure causes skin cancer – of that there is no doubt – using sunscreen, especially those with high SPF values, increases intentional sun exposure which in turn increases the risk of skin cancer. This is the opinion of the World Health Organization; they go on to state that sunscreens "may prevent" squamous cell carcinoma during "unintentional" sun exposure and that "No conclusion can be drawn about the cancer-preventive activity of topical use of sunscreens against basal cell carcinoma and cutaneous melanoma". For this reason, we need to all be part of educating consumers about skin cancer prevention and the harm that these petrochemicals have – based on the published scientific literature - on the environment and on human health - emphasizing that the risks associated with these sunscreen actives are greater than the benefits (if any) they provide.

Everyone should practice sun avoidance measures when possible, especially during peak hours of UV exposure (10 AM – 2 PM); wear protective clothing including a broad-brimmed hat and sunglasses and/or use a oversized umbrella/cabana when at the beach or pool; if sunscreen is desired, use a non-nano mineral based zinc oxide or titanium dioxide sunscreen - which are still considered safe and effective for human use according to the FDA.

National Oceanic and Atmospheric Administration (NOAA) Infographic:



Recent Aquatic Toxicity Studies Published on Avobenzone and Octocrylene

1) Irrigation with water containing avobenzone and octocrylene significantly inhibit the aboveground growth of cucumber plants by interfering with photosynthesis. (Zhong et al Sci Total Environ. **2020 Apr 20**;714:136879). These findings should cause great concern since aquatic plants (currently growing in sunscreen contaminated waters) also use photosynthesis to grow that feed a variety of aquatic species.

2) Octocrylene was the most toxic UV filter tested in brine shrimp followed by avobenzone (Thorel et al Toxics. **2020 Apr 10**;8(2):29).

3) Octocrylene was considered to be a great threat to Japanese medaka (Oryzias latipes) based on its reproductive toxicity (Yan Environ Pollut. **2020 Jun**;261:114104)

4) Both avobenzone and octocrylene induced behavioral and physiological disruption at environmentally realistic concentrations in Daphnia magna (Boyd et al Sci Total Environ. **2021 Jan 1**;750:141707).

5) Long-term exposure to avobenzone and octocrylene was lethal for some organisms living in freshwater environments and were considered dangerous for freshwater ecosystems (University of Alberta – **Sept 1,2020** https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

6) Octocrylene was reported to alter in a negative manner mitochondrial function of hexacoral *Pocillopora damicornis* (Stien et al Sci Rep. **2020 Jun 15**;10(1):9601).

7) Octocrylene accumulates in Pocillopora damicornis tissues as fatty acid conjugates and triggers coral cell mitochondrial dysfunction (Stien et al Anal Chem. **2019 Jan 2**;91(1):990-995).

8) Octocrylene and avobenzone were found in multiple species of fish from markets in the Canary Islands and Catalonia (Spain) with Thunnus thynnus being the most heavily polluted species (Gimeno-Monforte et al Foods. **2020 Dec 9**;9(12):1827). This finding continues to demonstrate the growing concern of bioaccumulation/biomagnification of organic sunscreen actives in the contamination of our food chain.

9) Octocrylene may pose high risk to aquatic organisms in the riverine and estuarine environment in Thailand (Juksu et al Ecotoxicol Environ Saf. **2020 Nov**;204:110952).

10) In the Enoggera Reservoir (Australia), seven UV filters were detected, of which the most prevalent were octocrylene and avobenzone (O'Malley et al Sci Total Environ. **2021 Feb 1**;754:142373).

11) Octocrylene was one of three chemicals mixed together that modified genes related to the endocrine system, detoxification mechanisms, and the stress response in Chironomus riparius (Muñiz-González Ecotoxicol Environ Saf. **2020 Dec 15**;206:111199).

12) Over 60 disinfection by-products were identified as transformation products of avobenzone in different disinfection reactions of chlorination and bromination of fresh or seawater … increasing its toxicity (Lebedev et al Environment International Volume 137, **April 2020**, 105495).

Annual malignant skin cancer deaths, 1975-2017

Year of death	Skin cancer deaths	US Population (in millions)*	Deaths/Million People
1975	5,256	219	24
1976	5,697		
1977	5,904		
1978	6,035		
1979	6,155		
1980	6,151	229	27
1981	6,444		
1982	6,774		
1983	7,048		
1984	7,282		
1985	7,595	240	32
1986	7,925		
1987	7,943		
1988	8,078		
1989	8,350		
1990	8,589	252	34
1991	8,658		
1992	8,816		
1993	8,893		
1994	8,826		
1995	8,976	265	34
1996	9,363		
1997	9,316		
1998	9,490		
1999	9,572		
2000	9,734	282	35
2001	10,032		
2002	9,958		
2003	10,269		
2004	10,349		
2005	10,845	295	37
2006	11,109		
2007	11,279		
2008	11,385		
2009	12,172		
2010	12,125	309	39
2011	12,263		
2012	12,516		
2013	12,807		
2014	13,116		
2015	12,868	321	40
2016	12,098	323	37
2017	12,098	325	37
	Total Deaths: 400,159		**54% Increase in Deaths****

Data source: American Cancer Society/National Center for Health Statistics, 2019.

* Population Data obtained from https://www.populationpyramid.net/united-states-of-america/1975/ Accessed January 23, 2021

** % Increase in deaths calculated by: 2017 deaths/million people (minus) 1975 deaths/million people (divided by) 1975 deaths/million people (times) 100.

Comparative Incidence of Melanoma Australia vs. United States 1982 – 2015

Incidence rates of melanoma of the skin, all ages. Age-standardized rate (world) per 100,000

	Australia				United States (SEER 9 registries)		
Year	Males	Females	Both Sexes combined		Males	Females	Both Sexes combined
1982	20.8	20.7	20.6		9.3	8.0	8.6
1983	21.4	22.3	21.6		9.4	7.8	8.5
1984	23.0	22.3	22.4		9.5	8.1	8.7
1985	24.8	24.5	24.4		11.2	8.8	9.8
1986	26.2	24.2	25.0		11.6	9.2	10.2
1987	30.6	27.3	28.7		11.7	9.6	10.5
1988	33.5	27.9	30.4		11.0	8.9	9.8
1989	31.5	25.4	28.1		12.0	9.3	10.4
1990	31.2	25.2	27.9		12.1	9.3	10.5
1991	30.8	25.7	28.0		12.8	9.7	11.1
1992	34.0	26.9	30.1		13.1	9.5	11.1
1993	34.4	27.1	30.4		13.1	9.4	11.0
1994	35.0	27.2	30.7		14.1	9.8	11.7
1995	37.3	28.5	32.5		14.4	10.7	12.3
1996	37.8	29.4	33.2		15.5	11.0	13.0
1997	39.9	30.9	35.0		15.5	11.4	13.2
1998	36.9	28.2	32.2		15.6	11.5	13.3
1999	38.1	28.6	33.0		16.1	11.8	13.6
2000	38.4	29.0	33.4		16.7	12.0	14.0
2001	38.9	29.2	33.7		17.0	12.7	14.5
2002	42.0	31.0	36.1		16.6	12.5	14.2
2003	40.1	28.8	34.1		16.8	12.6	14.4
2004	39.6	30.0	34.4		17.5	13.3	15.1
2005	42.2	32.1	36.8		19.3	14.1	16.3
2006	41.0	28.4	34.3		19.1	14.0	16.2
2007	39.1	28.5	33.4		18.4	13.7	15.7
2008	40.9	29.2	34.7		19.5	14.4	16.6
2009	40.5	28.8	34.3		19.6	14.1	16.5
2010	40.2	28.1	33.8		19.8	14.8	16.9
2011	39.7	28.2	33.6		18.9	14.0	16.1
2012	40.5	28.8	34.3		19.4	13.7	16.2
2013	41.1	29.4	34.9		20.1	14.4	16.9
2014	40.7	29.7	34.8		20.9	15.1	17.6
2015	41.7	30.1	35.6		20.9	15.8	18.0
Delta %	**100%**	**45%**	**73%**		**220%**	**161%**	**192%**

SOURCES:

Data provided by the American Cancer Society

Australia: Australian Institute of Health and Welfare (AIHW) 2018 Cancer Data in Australia; Australian Cancer Incidence and Mortality (ACIM) books: melanoma of the skin Canberra: AIHW. <https://www.aihw.gov.au/reports/cancer/cancer-data-in-australia/>.

United States: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence – SEER 9 Regs Research Data, Nov 2018 Sub (1975-2016) – Katrina/Rita Population Adjustment> – Linked To County Attributes – Total U.S., 1969-2017 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, released April 2019, based on the November 2018 submission.

Delta % (Percent Change from Baseline) = (data for 2015 – data for 1982/data for 1982) * 100

SB-132-SD-2
Submitted on: 3/13/2021 10:17:50 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Paul Montague	Individual	Support	No

Comments:

I strongly support SB132 to rid our marine environment of unecessary toxic chemicals. Mineral based sunscreens are far beter for our coral reefs and, I believe, people, too. Thank you for your efforts in this matter.

SB-132-SD-2
Submitted on: 3/13/2021 10:18:20 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Rosanne Shank	Individual	Support	No

Comments:

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Please make a stand for Hawaii's environment.

Thank you for your consideration of passing this bill.

SB-132-SD-2
Submitted on: 3/13/2021 10:26:22 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Akiko Masuda	Individual	Support	No

Comments:

I support the passage of SB132 SD2. We want to honor all sea life for generations to come, and stop the polluting of our waters, our oceans once and for all. in gratitude, the wailea ancestors and akiko masuda

SB-132-SD-2
Submitted on: 3/13/2021 10:27:21 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Marc R. Rice	Individual	Support	No

Comments:

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

SB-132-SD-2
Submitted on: 3/13/2021 10:29:51 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
WILBUR F. VAN PELT	Individual	Support	No

Comments:

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaiiâ€™s fragile marine environment. Â Octocrylene degrades into BENZOPHENONE - a â€œsisterâ€Â• chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor.Â **Hawaii law bans the sale of Oxybenzone.** Â Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments.

I spent 30 years in the US Public Health Service working in the FDA and along the way researching sunscreen and skin cancer, especially the research done in Australia, and believe that proper use of sunscreen is vital, but I have also worked wirh the Kohala Cente'rs program at Kahaluu Bay, and have seen the devestation that sunscreen products containing Oxybenzone and afilliated chemicals, among other stressors,have done to the bay. I usge you to pass SB 132.

Wilbur F Van Pelt

SB-132-SD-2
Submitted on: 3/13/2021 10:30:17 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Mary Ellen Jaske	Individual	Support	No

Comments:

I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

I am a member of Reef Teach at Kahaluu Bay and have seen the positive impact of restricting these harmful chemicals. Thank you.

SB-132-SD-2
Submitted on: 3/13/2021 11:08:17 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Fern Anuenue Holland	Individual	Support	No

Comments:

Aloha Representatives. My ohana and I are in strong support of HB1102. Mahalo! Fern Ä€ Holland

SB-132-SD-2
Submitted on: 3/13/2021 11:40:53 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Arthur John Tarsa. Jr.	Individual	Support	No

Comments:

I ask for your strong support for SB 132, with the effective date of January 1. 2023, restricting the use of petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

SB-132-SD-2
Submitted on: 3/13/2021 12:12:34 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
val coleman	Individual	Support	No

Comments:

I have traveled to Hawaii for the past 30 years and am shocked at how much the coral has been destroyed over the years.

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH **clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.**

We ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

SB-132-SD-2
Submitted on: 3/13/2021 5:49:42 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Kathleen Clark	Individual	Support	No

Comments:

Please support SB132. Marine environments in Hawai‘i are at a tipping point and it is critical that we do all we can to help protect them. This bill is a smart, simple strategy to alleviate one of the known stressors to the marine environment in Hawai‘i. I work closely with the visitor industry and talk with people everyday about safe sun protection. Almost all of the people I speak to actively seek out what they think are "reef-friendly" sunscreens only to find out that what they have purchased still contains many of the chemicals that are known to degrade marine environments-- they are so dissapointed. People want to make choices to protect the environment. This bill will help clarify the existing laws and ensure that they keep up with the vast body of peer reviewed research that now exists. There are plenty of safer, widely available alternatives for sun protection. Now is the time to act.

Passing this bill will continue to show that Hawai‘i is a leader in protecting the natural resources that we rely on for so much. Please support this legislation for our future.

SB-132-SD-2
Submitted on: 3/13/2021 5:51:44 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Douglas Perrine	Individual	Support	No

Comments:

I support SB132 to help protect our coral reefs.

SB-132-SD-2
Submitted on: 3/13/2021 6:22:06 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Michael McGuire	Individual	Support	No

Comments:

Please stop the use of these harmful chemicals in sunscreen. These chemicals damage our reefs and wildlife. There are many other options to block the damaging effects of the sun and doing so without environmental damage. Mahalo

SB-132-SD-2
Submitted on: 3/13/2021 6:25:42 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Donna Goodale	Individual	Support	No

Comments:

Dear Legislators:

I am also asking for your STRONG SUPPORT for SB 132. We need to restrict the use of avobenzone and octocrylene sunscreen chemicals. They have questionable effects on the health of both humans who use them as sunscreen and the marine life exposed to them in the near shore waters of Hawaii. In alignment with the Precautionary Principle, banning them will give us the opportunity to protect both our environment and communities for future generations.

Mahalo for your support for our ocean environment and our personal health.

Donna R. Goodale

Kailua Kona, HI

SB-132-SD-2
Submitted on: 3/13/2021 6:42:01 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Ilene Grossman	Individual	Support	No

Comments:

Aloha Chair Rep. Nicole E. Lowen and Co-Chair Lisa Marten,

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai'i's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.**

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Thank you for taking strong action for the future of our state.

With best wishes,

Ilene Grossman

Kamuela, HI 96743

SB-132-SD-2
Submitted on: 3/13/2021 8:50:00 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Karen	Individual	Support	No

Comments:

Aloha, I am writing in support of SB132, banning octocrylene and avobenzone from sunscreen and cosmetics. Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai‘i’s fragile marine environment. Octocrylene degrades into benzophenone - a “sister” chemical to oxybenzone that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. Hawaii law bans the sale of Oxybenzone.

FDA proposed rule: sunscreen drug products for over-the-counter-human use; proposal to amend and lift stay on monograph clearly states that avobenzone and octocrylene lack sufficient data for use in sunscreen.

We ask for your strong support for SB 132, with the effective date of January 1. 2023, restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Coral reef ecosystems in Hawai‘i are in decline and it is critical that we do all we can to protect them. Mahalo for taking the time to read my testimony and consider supporting SB 132.

SB-132-SD-2
Submitted on: 3/14/2021 5:14:37 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Rebecca Canright	Individual	Support	No

Comments:

Greetings and Aloha! I am a young person who supports protecting our magnificent marine ecosystems. I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Coral reef ecosystems in Hawai‘i are in decline and it is critical that we do all we can to protect them. Thank you for your time! Mahalo, Rebecca

SB-132-SD-2
Submitted on: 3/14/2021 6:06:26 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Terry Lyons	Individual	Support	No

Comments:

As a Canadian citizen living in a cold climate I am so grateful to have visited Hawaii on numerous occasions. Over the years I have witnessed the decline in fish and coral in the waters of Kahalu'u Bay on the island of Hawaii. There is no doubt that the increased tourism, with millions of people using sunscreens with harsh chemicals, has contributed to unhealthy waters. All sea creatures and plant life deserve protection of their home. I fully support this bill and hope to see it passed.

SB-132-SD-2
Submitted on: 3/14/2021 8:07:56 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Adam Maire	Individual	Support	No

Comments:

Hello,

*Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai'i's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor.* ***Hawaii law bans the sale of Oxybenzone.***

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH ***clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.***

We ask for your ***strong support for SB 132, with the effective date of January 1. 2023,*** *restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.*

Coral reef ecosystems in Hawai'i are in decline and it is critical that we do all we can to protect them. Thank you for considering these additional steps to protect Hawaii's marine ecosystems.

Adam Maire

SB-132-SD-2
Submitted on: 3/14/2021 8:09:55 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Dennis Solberg	Individual	Support	No

Comments:

*Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai'i's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.***

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

*We ask for your **strong support for SB 132, with the effective date of January 1. 2023**, restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.*

Coral reef ecosystems in Hawai'i are in decline and it is critical that we do all we can to protect them.

Thank you.

SB-132-SD-2
Submitted on: 3/14/2021 9:22:05 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Susan Menton	Individual	Support	No

Comments:

I volunteer at Kahalu'u Bay ReefTeach on the Big Island of Hawaii, and I ask for your ***support for SB 132, with the effective date of January 1. 2023,*** *restricting the use of octocrylene and avobenzone in sunscreen, both being chemicals which research shows pose known risks to human health as well as to Hawai'i's fragile marine environment.* Hawaii's precious resource, coral reefs - which honestly, is one of the main tourist attractions here in Hawaii- so if you want to have a booming economy you need to protect them and have them thrive---, are in decline and it is critical that we do all we can to protect them NOW. Not in 2050. Why even bother at that point? They probably will no longer exist if we don't step up and do something NOW. Wouldn't you agree that it's our kuleana? Mahalo.

SB-132-SD-2
Submitted on: 3/14/2021 10:03:04 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Jamie Pardau	Individual	Support	No

Comments:

I am writing in strong support of SB132, which would become effective Jan. 1, 2023. This ban on petrochemicals will add more protection to the reefs and the people of Hawaii. We have already recognized the dangers of oxibenzone and octinoxate. Now we must eliminate related chemicals, octocrylene and avobenzone becaue they also are mutagens. They degrade into benzophenone which is carinogenic and an endocrine disruptor. Every possibly step needs to be taken to protect the coral polyps that create our reefs. Hawaiian reefs are a home for fish, a protection from coastline erosion, and a huge economic driver in this tourist-based economy. We must do all that we can to mitigate the effects of climate change. Eliminating petrochemicals from our coastal waters is the right step forward. Mahalo for the opportunity to share my thoughts.

SB-132-SD-2
Submitted on: 3/14/2021 10:08:21 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Joan Katter	Individual	Support	No

Comments:

As a many time visitor to the State of Hawaii, and especially to the Big Island, I wholeheartedly support the ban on these sunscreen chemicals. We humans must do whatever we can to help the native flora and fauna grow and return to the healthy state they were in generations ago, before our use of chemicals and plastics so damaged their environment. This ban will help both the health of the islands and their continued enjoyment by natives and visitors.

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH **clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.**

We ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Thank you,

Joan Katter

SB-132-SD-2
Submitted on: 3/14/2021 10:28:12 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Vincent J Carr	Individual	Support	No

Comments:

March 14,2021

Aloha,

I am writing today to voice my wholehearted support for SB 132 with the effective date of January 1, 2023. The restriction of sunscreen petrochemicals will protect our marine resources as well as the health of the human users. Octocrylene and Avobenzone pose known risks to human health as well as fragile marine environments. Hawaii became the first state in the USA to ban chemicals in sunscreen with the banning of Oxybenzone and Octtinoxate which went into effect earlier this year. You should be proud of that achievement. However, there are many sunscreen products that are sold in Hawaii as "reef safe" or "reef friendly" which contain Avobenzone and/or Octocrylene. That practice confuses consumers who are trying to support safe practices for themselves and the marine environment.

For the protection of Hawaii's precious marine resources, the health of human users of sunscreen and to stop consumer confusion, please support SB 132.

Mahalo,

Vincent J. Carr

75-6009 Alii Dr. Apt. F-4

Kailua-Kona, HI 96740

SB-132-SD-2
Submitted on: 3/14/2021 10:35:03 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
John joseph Banville	Individual	Support	No

Comments:

I have worked in the boating/diving industry for many years and have seen first hand what damage these chemicals have on the environment. They MUST be banned!

SB-132-SD-2
Submitted on: 3/14/2021 12:37:21 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Cynthia Urry	Individual	Support	No

Comments:

We ask for your strong support for SB 132, with the effective date of January 1. 2023, restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

SB-132-SD-2
Submitted on: 3/14/2021 12:54:48 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Martha Weissbaum	Individual	Support	No

Comments:

Dear Legislators:

*Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai'i's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.***

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

*We ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.*

Please note that many of the leading sunscreen consumer product companies already sell sunscreen brands without these chemicals, making their products truly ' reef safe', while a number of companies that have not eliminated these two chemicals label their products as 'reef safe', which is legal but misleading to consumers that are trying to 'do the right thing'.

Mahalo,

Martha Weissbaum

Kamuela, Hawai‘i 96743

kohalacenter.org | Facebook | Instagram

The Kohala Center is an independent, community-based center focused on research, education, and ‘Ä• ina stewardship for healthier ecosystems. By turning ancestral knowledge and research into action, we cultivate conditions that reconnect us with our place, water, food, and people, so that communities in Hawai‘i and around the world can thrive—ecologically, economically, culturally, and socially.

SB-132-SD-2
Submitted on: 3/14/2021 2:47:54 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Robert P Thomas Jr	Individual	Support	No

Comments:

Please Read and Vote,

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawai‘i’s fragile marine environment. Octocrylene degrades into BENZOPHENONE - a “sister” chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.**

FDA PROPOSED RULE: SUNSCREEN DRUG PRODUCTS FOR OVER-THE-COUNTER-HUMAN USE; PROPOSAL TO AMEND AND LIFT STAY ON MONOGRAPH clearly states that Avobenzone and Octocrylene LACK SUFFICIENT DATA FOR USE IN SUNSCREEN.

*We ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.*

Thank you for your time today,

Robert Thomas

SB-132-SD-2
Submitted on: 3/14/2021 4:01:10 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Fernando L Alvarado	Individual	Support	No

Comments:

I support this bill.

SB-132-SD-2
Submitted on: 3/14/2021 5:21:30 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Janet Goodmanson	Individual	Support	No

Comments:

I support the restriction on sales of sunscreens with petrochemicals Octocrylene and Avobenzon in order to protect our reefs.

SB-132-SD-2
Submitted on: 3/14/2021 5:27:52 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Paul Herring	Individual	Support	No

Comments:

I would like to submit testimony in favor of SB132 SD2, the bill aimed at banning the sale and distribution of sunscreens containing avobenzone or octocrylene. I find it appalling that Hawaii allows the sale of suncreens that are harmful to coral reefs which are such an important part of the ecosystem of the islands. Not only are coral reefs vital for the health of the fish and oceans that suround our islands but these nataural wonders are also a great draw for tourists. From my experience both as an avid snorkeler and as a Reefteach volunteer at Kahaluu bay I have seen first-hand how fragile our reef ecosystem is and believe the faster that we can keep harmful chemicals out of the water the better. During this last year of beach closings and decreased tourism due to COVID the reefs have had a little bit of a natural break from heavy human use and its associated contamination from sunscreen chemicals. Although it is too soon to see what effects this may have had on coral, which grows very slowly, I would say that based on my own observations the fish populations on the reef seem to be doing better. I have seen many more juvenile fish in Kahaluu bay than I have in previous years. The decrease in out of state visitors has also allowed us to better educate more locals about the reef ecosystem and the harmful effects of chemicals in sunscreens. What I have found depressing is that although many locals and now more recently also tourists have been trying to protect the reefs and ocean by purchasing ‘Reef friendly‘ sunscreens, the lack of control of what ‘Reef Friendly‘ actually means has led to the continued use of sunscreens with chemicals such as Avabenzone and Octocrylene. Once I have talked to them about these harmful chemicals they are usually only too glad to switch to truly ‘Reef Friendly‘ mineral based sunscreens. Based on these conversations I have no doubt that locals and visitors alike will continue to buy and use sunscreen and that they will gladly use mineral based sunscreens. This would seem to negate the arguments that banning these chemicals would increase skin cancer or decrease revenue obtained from sunscreen sales. In fact, many tourists already are of the impression that the only sunscreen you can buy in Hawaii is reef friendly and specifically wait until they get here to purchase sunscreen. It is really veryembarrasing to have to tell them that this is not actually the case and that many sunscreens that can be purchased here are neither reef or human friendly, despite what their labels may claim. Clearly this kind of attitude displayed by the tourists should alleviate fears of lost sales due to banning harmfull chemicals from sunscreens as the visitors will buy whatever sunscreens are available in the local stores. So if local stores stock only true ‘reef friendly‘ sunscreens they should have no trouble selling them. In

conclusion I strongly urge you to pass this bill and enact it into law as soon as possible to help protect the fragile reeef ecosystems that are so crutial to our islands.

Sincerely,

Dr. Paul Herring

Professor Emeritus

SB-132-SD-2
Submitted on: 3/14/2021 8:20:46 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Cory Harden	Individual	Support	No

Comments:

Aloha legislators,

Please act to protect our ocean life!

mahalo,

Cory Harden

SB-132-SD-2
Submitted on: 3/14/2021 8:34:59 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Victoria Anderson	Individual	Support	No

Comments:

Please support this very important bill!

SB-132-SD-2
Submitted on: 3/14/2021 9:21:40 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
P TIBBS	Individual	Support	No

Comments:

Please support this important bill!

SB-132-SD-2
Submitted on: 3/14/2021 10:40:43 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Dorothy Norris	Individual	Support	No

Comments:

The coral reefs in Hawaii are our most valuable natural resource. Many Ohana depend on the ocean to stay healthy and provide food, recreation and quality of life. The sunscreens chemicals in this bill have been shown to not only be detrimental to the coral but also are not safe for human use. Please pass this bill so that we can continue to be self sufficient on our island.

SB-132-SD-2
Submitted on: 3/15/2021 5:40:16 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Judith Matsunobu	Individual	Support	No

Comments:

I urge the House Engergy & Environmental Protection Committee to support SB132, restricting the use of octocylene and avobenzone in sunscreens. These substances have been shown through research to harm human health and Hawaii's fragine marine environment.

SB-132-SD-2
Submitted on: 3/15/2021 6:35:29 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Dena Sedar	Individual	Support	No

Comments:

I ask for your **strong support for SB 132, with the effective date of January 1. 2023,** restricting the use of sunscreen petrochemicals that have questionable effects on the health of humans and marine life in alignment with the precautionary principle, affording us the opportunity to protect our environment and communities for future generations.

Hawaii needs to do all it can to protect the health of our priceless coral reefs, and this bill will provide a bit more protection for corals and all of the species that depend on them.

SB-132-SD-2
Submitted on: 3/15/2021 8:05:17 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Camile Cleveland	Individual	Support	No

Comments:

I strongly support this bill as it relates to preserving the health of Hawai'i's oceans.

SB-132-SD-2
Submitted on: 3/15/2021 8:16:34 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Kelly Miyahara	Individual	Support	No

Comments:

Please ban these toxic chemcials! Protect Hawaii, our children, our planet!

Research shows both octocrylene and avobenzone pose known risks to human health as well as to Hawaii's fragile marine environment. Octocrylene degrades into BENZOPHENONE - a "sister" chemical to O**xybenzone** that is recognized by the FDA, State of California Prop65, and the WHO to be a mutagen, carcinogen, and an endocrine disruptor. **Hawaii law bans the sale of Oxybenzone.** Long term exposure to avobenzone and octocrylene is lethal for some organisms living in freshwater environments. See https://www.ualberta.ca/folio/2020/09/common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems-study.html

Thank you!

Kelly Miyahara

SB-132-SD-2
Submitted on: 3/15/2021 8:29:40 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Ann Humphrey	Individual	Support	No

Comments:

Hello,

I am writing in strong support of SB132.

The FDA has not determined that octocrylene and avobenzone are safe and effective for use in sunscreen.

Sunscreen ingredients must be safe for people and marine life. Massive amounts of it end up in the ocean and near shore enviroment. People trust that products are safe to use and this is not the case currently with sunscreen.

I strongly urge passage of this bill.

Ann Humphrey

SB-132-SD-2
Submitted on: 3/15/2021 8:50:47 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Kathy J Heffernan	Individual	Support	No

Comments:

I support SB132 which protects our coral reefs. Avobenzene harms reefs and so-called "reef-safe" sun screens contain avobenzene. Other suncreens exist that are safer for corals (titanium dioxide and zinc dioxide) and they are priced about the same as avobenzene sunscreens.

Please protect our coral reefs. Ban avobenzene sunscreens in Hawaii.

SB-132-SD-2
Submitted on: 3/15/2021 9:50:15 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Daniel Amato	Individual	Support	No

Comments:

I am writing in support of Bill **SB132.** As a scientist, ocean user, and resident of Oahu, Intact healthy reefs are a huge priority. Corals did not evolve in the presence of sunscreen chemicals and these chemicals put our reefs at risk. Hawaii's reef health is closely related to human and economic health in this state. Please vote for legislation that prioritizes reef health instead of the interests of corporations and their lobbyists. Thank you. -Daniel Amato

SB-132-SD-2
Submitted on: 3/15/2021 10:14:35 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Renee Perrington	Individual	Support	No

Comments:

Hawai'i can be the leader in protecting our oceans, and all the people, present and future who rely on the oceans for life. If we care for the Aina, she will care for us. Chemicals do not belong in the water. Please ban these petrochemicals now. Even this bill puts the timeline too far out. Thank you.

SB-132-SD-2
Submitted on: 3/15/2021 10:14:40 AM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Stephanie Benitz	Individual	Support	No

Comments:

I strongly support SB132 to add octocrylene and avobenzone in sunscreens to Act 104, Session Laws of 2018. Both octocrylene and avobenzone pose known risks to human health and Hawaii's fragile marine environment. If Hawaii wants to continue the process we started, of removing sunscreen chemicals that have a detrimental impact upon the health of our people and marine ecosystems – and remain a leader in this fight – we need to add these dangerous chemical UV filters. Mahalo.

SB-132-SD-2
Submitted on: 3/15/2021 12:12:12 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
James Stolte	Individual	Support	No

Comments:

I wholeheartedly support SB132 to protect our waters, our marine life and or people.

Please vote yes for SB132 and add octocrylene and avobenzone to Act 104.

Octocrylene and avobenzone pose known risks to human and marine health in Hawaii.

Thank You

SB-132-SD-2
Submitted on: 3/15/2021 12:45:11 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Julia Beyer	Individual	Support	No

Comments:

I strongly support SB132 to add octocrylene and avobenzone in sunscreens to Act 104, Session Laws of 2018. Both octocrylene and avobenzone pose known risks to human health and Hawaii's fragile marine environment. If Hawaii wants to continue the process we started, of removing sunscreen chemicals that have a detrimental impact upon the health of our people and marine ecosystems – and remain a leader in this fight – we need to add these dangerous chemical UV filters. Mahalo.

SB-132-SD-2
Submitted on: 3/15/2021 7:33:01 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Sherry Pollack	Individual	Support	No

Comments:

Please pass this important legislation.

SB-132-SD-2
Submitted on: 3/15/2021 8:35:44 PM
Testimony for EEP on 3/16/2021 9:00:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Kaimi	Individual	Support	No

Comments:

Aloha Chair Lowen,

I am in support of Bill SB 132. Sunscreen continues to an environmental concern for the health and of our ecosystems especially the waters off Hawaii. SB 132 SD2 will ban the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone or octocrylene, or both, without a prescription issued by a licensed healthcare provider to preserve marine ecosystems. It is important that the state supports these initiatives for the safety of our sea life within Hawaii waters.

mahalo,

Kaimi Kaupiko

808.937.1310