DAVID Y. IGE
GOVERNOR OF HAWAII

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

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. Box 3378
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Testimony COMMENTING on HB0102-HD1
RELATING TO SUNSCREENS

REPRESENTATIVE AARON LING JOHANSON, CHAIR
REPRESENTATIVE LISA KITAGAWA, VICE CHAIR
HOUSE COMMITTEE ON CONSUMER PROTECTION AND COMMERCE
Hearing Date: 2/17/2021 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: HB0102 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.

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
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

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Testimony of
SUZANNE D. CASE
Chairperson

Before the House Committee on
CONSUMER PROTECTION & COMMERCE

Wednesday, February 17, 2021
2:00 PM
State Capitol, Via Videoconference, Conference Room 329

In consideration of
HOUSE BILL 102, HOUSE DRAFT 1
RELATING TO SUNSCREENS

House Bill 102, House Draft 1 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 metabolism.[3] This could reduce coral resilience during bleaching events because bleached corals depend extensively on fat metabolism in order to survive.[3]

[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)
[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)

As a result of these recent scientific findings, we feel 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.

Citations

Ahn, Sungjin, et al (2019), A long-wave UVA filter avobenzone induces obesogenic phenotypes in normal human epidermal keratinocytes and mesenchymal stem cells, Archives of Toxicology https://doi.org/10.1007/s00204-019-02462-1

Bluthgen, Nancy, et al. (2014), Accumulation and effects of the UV-filter octocrylene in adult and embryonic zebrafish (*Danio rerio*), Science of the Total Environment 476–477, 207–217, http://dx.doi.org/10.1016/j.scitotenv.2014.01.015

Boyd, Aaron, et al. (2021), A burning issue: The effect of organic ultraviolet filter exposure on the behaviour and physiology of *Daphnia magna*, Science of the Total Environment 750, 141707, https://doi.org/10.1016/j.scitotenv.2020.141707

Campos, Diana, et al (2017), Toxicity of organic UV-filters to the aquatic midge *Chironomus riparius*, Ecotoxicology and Environmental Safety 143, 210–216

Cocci, Paolo, et al. (2020), Sunscreen active ingredients in loggerhead turtles (*Caretta caretta*) and their relation to molecular markers of inflammation, oxidative stress and hormonal activity in wild populations, Marine Pollution Bulletin 153,111012

Downs, Craig A. (2020), personal communications, Haereticus Environmental Laboratory, haereticus-lab.org.

Fel, Jean-Pierre, et al. (2019), Photochemical response of the scleractinian coral *Stylophora pistillata* to some sunscreen ingredients, Coral Reefs, 38:109–122, https://doi.org/10.1007/s00338-018-01759-4

Gago-Ferrero, Pablo, et al. (2013), First Determination of UV Filters in Marine Mammals. Octocrylene Levels in Franciscana Dolphins, dx.doi.org/10.1021/es400675y | Environ. Sci. Technol., 47, 5619−5625

Giraldo, et al (2017), Ecotoxicological Evaluation of the UV Filters Ethylhexyl Dimethyl p-Aminobenzoic Acid and Octocrylene Using Marine Organisms *Isochrysis galbana*, *Mytilus galloprovincialis* and *Paracentrotus lividus*, Arch Environ Contam Toxicol DOI 10.1007/s00244-017-0399-4

Klopcic, Ivana, and Marija Sollner Dolenc (2017), Endocrine Activity of AVB, 2MR, BHA, and Their Mixtures, TOXICOLOGICAL SCIENCES, 156(1), 240–251

Lozano, et al. (2020), Bioaccumilation and Toxicological Effects of UV-filters on Marine Species, Sunscreens in Coastal Ecosystems: Occurrence, Behavior, Effect and Risk, Julián Blasco, Antonio Tovar, and David Sánchez (eds.), Hdb Env Chem, DOI 10.1007/698_2019_442

Yan, Saihong, et al. (2020). Reproductive toxicity and estrogen activity in Japanese medaka (*Oryzias latipes*) exposed to environmentally relevant concentrations of octocrylene, Environmental Pollution 261 (2020) 114104 . https://doi.org/10.1016/j.envpol.2020.114104.

Zhang, Qiuya Y., et al (2016), Assessment of multiple hormone activities of a UV-filter (octocrylene) in zebrafish (*Danio rerio*), http://dx.doi.org/10.1016/j.chemosphere.2016.06.037. 0045-6535

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

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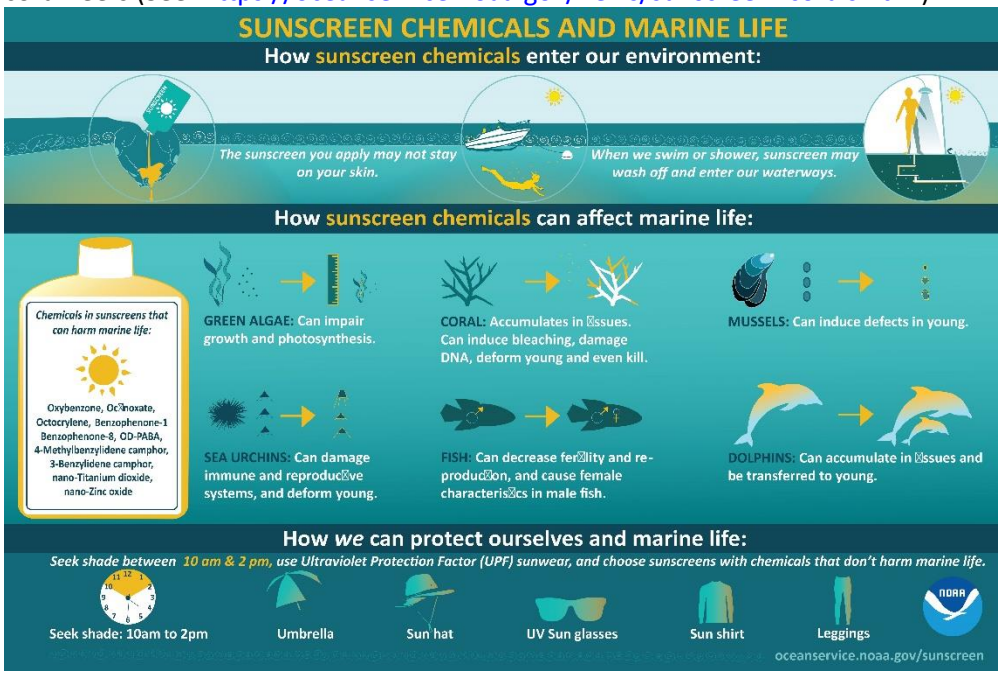
THE KOHALA CENTER®

To: The House Committee on Consumer Protection and Commerce
Re: HB102 RELATING TO SUNSCREENS
Position: STRONG SUPPORT AND TO RECOMMEND EFFECTIVE DATE BE AMENDED BACK TO JANUARY 1, 2023
Hearing Date: Wednesday, February 17, 2021, 2:00 pm, videoconference

Aloha Chair Johanson, Vice Chair Kitagawa, and Consumer Protection and Commerce 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 chemicals 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)



On February 26, 2019, the FDA removed all but two sunscreen ingredients from their GRASE (Generally Recognized As Safe and Effective) Category 1 list. Those two ingredients remaining on the category 1 list are Zinc Oxide and Titanium Dioxide. All other chemical sunscreen ingredients have been placed on the GRASE category 3 "insufficient data for use in sunscreens" list. Included among those chemical ingredients on the category 3 list are oxybenzone, octinoxate, octisalate, octocrylene and avobenzone. (See https://www.fda.gov/media/124655/download).

We ask your **strong support for HB 102 and recommend the effective date be amended back to January 1, 2023** restricting the use of sunscreen chemicals 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,

DocuSigned by:

E60FC35B49284D3...

Cynthia Punihaole Kennedy, Director
Kahalu'u Bay Education Center
a program of The Kohala Center

HAWAII FOOD INDUSTRY ASSOCIATION

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

TO:
Committee on Consumer Protection and Commerce
Rep. Aaron Ling Johanson, Chair
Rep. Lisa Kitagawa, Vice Chair

FROM: HAWAII FOOD INDUSTRY ASSOCIATION
Lauren Zirbel, Executive Director

DATE: February 17, 2021
TIME: 2pm
PLACE: Via Videoconference

RE: HB102 HD1 Relating to Sunscreens

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.

SURFRIDER FOUNDATION
HAWAIʻI REGION

2/15/2021

CPC Committee
Hawaiʻi State Capitol
Honolulu, Hawaiʻi 96813

Dear Chair Johansen and Members of the Consumer Protection and Commerce Committee,

The Surfrider Foundation would like to offer this testimony in support of HB102.

The Surfrider Foundation is a national nonprofit organization dedicated to the protection and enjoyment of our ocean, waves, and beaches. Surfrider maintains a network of over 150 chapters and academic clubs nationwide, including 4 chapters in the Hawaiian Islands. The Surfrider Foundation focuses on many aspects of the environment such as coastal protection, plastic pollution, and water quality.

Already in this state we have banned the chemicals oxybenzone and octinoxate from legal sale in sunscreens. This is a huge step in protecting not only our coral reef areas but also the people who use these products, as they are shown to be harmful to both (Downs et al. 2016, DiNardo and Downs 2017, and Siller et al. 2018). This bill would add avobenzone and octocrylene to this list of banned sunscreen additives. These chemicals are among those that are readily absorbed into the skin (Matta et al. 2019) and have shown toxic hormonal effects in some vertebrates (Zhang et al. 2016).

Because of our inefficient wastewater treatment systems and large number of cesspools around the islands, these chemicals are being transported through the groundwater back out to the coasts and to our agriculture; similar to Australia, where UV filter loads were seen in plants consumed by 48% of the continent, and at levels up to 3.4mg/person/day (O'Malley et al. 2019). Passing this bill would help Hawaiʻi stop this pollution at the source and move towards cleaner water and a healthier populace.

The Surfrider Foundation works with many companies already striving to make a suitable alternative, and there are many zinc based sunscreens on the market that are hugely popular and easily accessible. Making these the norm would help drive down costs as well, further increasing accessibility to lower income sectors of Hawaiʻi. And from personal experience, they just feel better on your skin!

Thank you for your consideration of this testimony in support of HB102, submitted on the behalf of the Surfrider Foundation's 4 Chapters in Hawaiʻi and all of our members who live in the state and visit to enjoy the many coastal recreational opportunities offered by all of the islands' coastlines.

Sincerely,

Kaitlyn Jacobs
Volunteer Policy Coordinator
Surfrider Foundation, Oʻahu Chapter

HB-102-HD-1
Submitted on: 2/15/2021 5:39:11 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

Little Hands Hawaii is in support of this bill banning Avobenzone and Octocrylene. Lets do this for the future of Hawaiis biggest resource and our next generartion keiki o ka aina.

Mahalo nui

HB-102-HD-1
Submitted on: 2/15/2021 5:44:43 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Cathy Goeggel	Animal Rights Hawai'i	Support	No

Comments:

We strongly support HB102, HD1. We hope your committee wil agree.

HB-102-HD-1
Submitted on: 2/15/2021 6:56:22 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Charlie Quesnel	Surfrider Maui Chapter	Support	No

Comments:

I support this bill.

HB-102-HD-1
Submitted on: 2/15/2021 8:49:32 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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 unfortunuately 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 irreprecable damage to our already fragile island economy.

I highly encourage your support for HB102 on behalf of myself and other concerned residents.

HB-102-HD-1
Submitted on: 2/15/2021 11:27:11 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Lauren Blickley	Surfrider Foundation	Support	No

Comments:

Surfrider Foundation strongly supports legislation to ban harmful chemicals in sunscreens that threaten our coastal and coral reef ecosystems.

HDS
Hawaii Dermatological Society

February 16, 2021

The Honorable Aaron Johanson
Chair, House Committee on Consumer Protection and Commerce
415 South Beretania Street, Room 436
Honolulu, HI 96813

Dear Chairman Johanson:

On behalf of the Hawaii Dermatological Society and the over 13,800 U.S. members of the American Academy of Dermatology Association (AADA), we write concerning HB 102, legislation that would prohibit for sale or distribution sunscreens containing avobenzone or octocrylene. As dermatologists, we dedicate our lives to promoting habits in our patients that ensure healthy skin. UV radiation damages the skin's DNA, which is the beginning stage of skin cancer. We urge you and the members of the Committee on Consumer Protection and Commerce to strongly consider the broad implications of banning sunscreens containing certain ingredients, and bear in mind the dangers of sun exposure without adequate protection that the residents and visitors of Hawaii face.

UV light exposure is a risk factor for all types of skin cancer and sunscreen use is one photoprotection method to protect against it. UVA damages deeper layers of the skin and contributes to the development of melanoma, the deadliest form of skin cancer. UVB is the primary cause of sunburn and plays a key role in the development of skin cancer in the skin's

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more superficial layers. In addition, both types of rays can cause suppression of the immune system.[1] Unprotected sun exposure is the most preventable risk factor for skin cancer. According to current estimates, at least one in five Americans will develop skin cancer in their lifetime.[2,3] Melanoma, the deadliest form of skin cancer, is now the second most common form of cancer for females aged 15-29 years old, and Caucasian men over 50 years of age are at a higher risk of developing melanoma than the general population. [4,5,6] In 2021, 460 new cases of melanoma are expected to be diagnosed in Hawaii.[7] Further, the annual cost of treating nonmelanoma skin cancer in the U.S. is estimated at $4.8 billion, while the average annual cost of treating melanoma is estimated at $3.3 billion.[8]

To help prevent skin cancer, the AADA recommends a comprehensive sun protection plan that includes seeking shade; wearing protective clothing, including hats and sunglasses; and generously applying a broad-spectrum, water-resistant sunscreen with an SPF of 30 or higher to exposed skin. Those who are concerned about the reported effects of chemical sunscreen ingredients can opt for a physical sunscreen containing the active ingredients zinc oxide or titanium dioxide.

Dermatologists have an interest in patient and public access to safe and effective sunscreen ingredients. The FDA is currently working with industry on safety testing for currently marketed sunscreen ingredients. The FDA is also considering several time-and-extent applications (TEAs) for new sunscreen ingredients to be added to the FDA over-the-counter (OTC) sunscreen monograph. The FDA's conclusion from recent studies on sunscreen ingredient absorption "supports the need for further studies to determine the clinical significance of these findings." FDA further stated that "these findings do not indicate that individuals should refrain from the use of sunscreen."[9] It should be noted that sunscreen ingredients have been used since

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[1] Lim HW, James WD, Rigel DS, Maloney ME, Spencer JM, Bhushan R. Adverse effects of ultraviolet radiation from the use of indoor tanning equipment: time to ban the tan. Journal of the American Academy of Dermatology. 2011 Apr 30;64(4):e51-60.
[2] Stern RS. Prevalence of a history of skin cancer in 2007: results of an incidence-based model. Arch Dermatol. 2010 Mar;146(3):279-82.
[3] Robinson JK. Sun Exposure, Sun Protection, and Vitamin D. JAMA 2005; 294: 1541-43.
[4] Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. CA Cancer J Clin. 2017; 67:7-30.
[5] Little EG, Eide MJ. Update on the current state of melanoma incidence. Dermatol Clin. 2012:30(3):355-61.
[6] NAACCR Fast Stats: An interactive quick tool for quick access to key NAACCR cancer statistics. North American Association of Central Cancer Registries. http://www.naaccr.org/. (Accessed on 3-10-2016).
[7] American Cancer Society. Cancer Facts and Figures 2021. https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2021/cancer-facts-and-figures-2021.pdf
[8] Guy GP, Machlin S, Ekwueme DU, Yabroff KR. Prevalence and costs of skin cancer treatment in the US, 2002–2006 and 2007–2011. Am J Prev Med. 2015;48:183–7
[9] Matta, MK, Florian, J, Zusterzeel, R, Nageswara RP, Patel, V, Volpe, DAPhD, et al. Effect of Sunscreen Application on Plasma Concentration of Sunscreen Active Ingredients: A Randomized Clinical Trial. Journal of the American Medical Association 323, No. 3 (2020). 267.

the 1970s without any reported systemic adverse side effects. This issue highlights the urgent need for new safe and effective ingredients to be introduced in the United States. With the approval of ingredients that utilize alternative UV filters available to sunscreen product manufacturers, the public's health will be increasingly protected. The AADA will continue to take part in the discussion with the FDA and manufacturers regarding availability of current and new ingredients.

We are aware of and concerned about the potential environmental impact of UV-filters. However, the potential adverse effects, if any, related to the levels of UV-filters in the water supply and marine life (as well as humans) is an emerging science. In a recent review of this topic, 12 studies evaluating up to 14 different organic UV filters in seawater near coral reefs were critically analyzed. The authors concluded that the majority of concentrations found in seawater were in the nanograms per liter range. Nine papers report toxicological findings from no response to a variety of biological effects, however, these effects were detected in the micrograms per liter to milligrams per liter range, namely, at least 1000-fold higher that those reported in seawater in real life.[10] The review concludes "there is currently limited evidence to suggest that corals are adversely impacted by environmental exposure to UV filters."

Our organizations advocated for the enactment of the Further Consolidated Appropriations Act, 2020, under which the U.S. Congress directed the Environmental Protection Agency (EPA) to contract with the National Academy of Sciences (NAS) to conduct a scientific literature review of current sunscreens' potential risk to the marine environment. The study will also consider scientific literature on the potential public health implications as a result of reduced use of sunscreens. This type of further research is required in order to definitively understand how UV-filters may affect the environment. We encourage you to consider these ongoing efforts before taking any action to remove a product that has been proven effective to protect humans from skin cancer. Based on current data, removing specific sunscreen active ingredients and products from the market would be premature, and would deprive the public an integral component of photoprotection to decrease the risk of skin cancer.

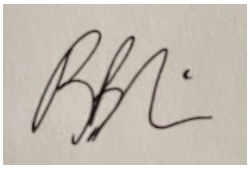
Please consider the public health consequences of removing access or attaching stigma to sunscreens containing certain ingredients. We request that Hawaii give the FDA more time to add new sunscreens for public use and for the NAS to conduct its review and publish a report. We appreciate the opportunity to provide written comments on this important public health

[10] Mitchelmore CS, Burns, EE, Conway A, Heyes A, Davies IA. A critical review of organic ultraviolet filter exposure, hazard, and risk to corals. Environ Toxicol Chem. 2020 (00);00:1-21. Online 2 February 2021 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/etc.4948

issue. For further information, please contact Lisa Albany, director of state policy for the AADA, at **LAlbany@aad.org** or (202) 712-2615.

Sincerely,

Bruce H. Thiers MD, FAAD
President
American Academy of Dermatology Association



Rebecca Luria, MD, FAAD
President
Hawaii Dermatological Society

Chamber of Commerce HAWAII
The Voice of Business

Testimony to the House Committee on Consumer Protection & Commerce
Wednesday, February 17, 2021 at 2:00 P.M.
Via Videoconference

RE: HB 102, HD 1, RELATING TO SUNSCREENS

Chair Johanson, Vice-Chair Kitagawa, and Members of the Committee:

The Chamber of Commerce Hawaii ("The Chamber") **opposes** HB 102, HD 1 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.

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.

This measure is too premature to impose a ban on ingredients used in day-to-day sunscreen products already approved by the FDA. The ban of certain ingredients will eliminate the sale of up to 64% of FDA approved sunscreen products already out in the market which will unnecessarily place the risk of public health by way of increased health related costs to treat skin cancer, UV damage, and melanoma.

One unintended consequence, amongst others, is that people often will not take time off from work, pay a co-payment to see a doctor and then wait in the pharmacy to a get a prescription filled for "sunscreen."

Thank you for this opportunity to provide testimony and ask that the committee hold this measure.

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

TO:
House Committee on Consumer Protection and Commerce
Rep. Aaron Ling Johanson, Chair
Rep. Lisa Kitagawa, Vice Chair

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

DATE: Wednesday, February 17, 2021
TIME: 2:00 PM
PLACE: Via Videoconference

Re: HB102 HD1 - Relating to Sunscreens

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 HB 102 HD1 or any other legislation on sunscreen ingredients, until more data on environmental and public health impacts are available.

The use of sunscreen is an important evidence-based sun-safe practice. It is well known that utilizing comprehensive sun-safe practices is one of the most effective ways to reduce the risk of skin cancer, 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 both UVA and UVB rays, must be combined with comprehensive educational tools to ensure consumer awareness of the risks of skin cancer 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. The early studies, however, 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 has been widely promoted by advocates of the sunscreen ban. Dr. Mitchelmore's study uses rigorous methodology and shows actual levels of oxybenzone sampled from sea water 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 that purported to show a link between sunscreen exposure and coral toxicity are methodologically flawed and should not be used for evidence-based policy making 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 coral decline is primarily caused by rising ocean temperature, ocean acidification, invasive species, land-based source pollution, water quality issues due to poor wastewater management and other causes. 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, sponsored by the U.S. Environmental Protection Agency, will examine research concerning both the 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 to synthesize the best available science.

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

The conclusion of this NAS study – expected in 2022 – will inform future decisions of policymakers to ensure access to sunscreens while also protecting the coral reefs. Until this study is completed, legislation like HB 102 HD1 should be suspended as there are currently insufficient data to inform a risk/benefit analysis between protecting the marine environment and protecting the public's health. It is important for the legislature to wait for unbiased scientific analysis and consensus.

FDA Advises Continued Use of Sunscreens

In addition to the lack of peer-reviewed evidence on the environmental impact of sunscreens, the impact on human health is also still being researched. The Food and Drug Administration (FDA), which regulates sunscreens as over-the-counter (OTC) drugs for the prevention of sunburn and skin cancer, recently posted an article titled, "Shedding More Light on Sunscreen Absorption" that explained that while the FDA is continuing to seek 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 noted that:

> "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."[viii]

The Hawaii state law signed in July 2018 already eliminated the OTC sale of the ingredients oxybenzone and octinoxate. **HB 102 HD 1 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.**

The proposed legislation could significantly reduce consumer choice of and access to sunscreen in Hawaii, where sunscreen is often used not only 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 HB 102 HD1, 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 you 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-voices/shedding-more-light-sunscreen-absorption

CHPA® | CONSUMER HEALTHCARE PRODUCTS ASSOCIATION

Taking healthcare personally.

February 16, 2021

To: Committee on Consumer Protection & Commerce
Chair Aaron Ling Johanson
Vice Chair Lisa Kitagawa

Re: **HB 102 Related to Sunscreens - OPPOSE**

On behalf of the Consumer Healthcare Products Association (CHPA), the national trade association representing the leading manufacturers of over-the-counter (OTC) medications, dietary supplements, and consumer medical devices, I'm writing to express strong opposition to HB 102 HD1 – legislation seeking to ban the sale, offer of sale, or distribution in the State of any sunscreen that contains avobenzone and/or octocrylene.

Avobenzone and octocrylene are Food and Drug Administration (FDA) approved ingredients found in many common sunscreens sold on the market today. They are commonly used in broad spectrum sunscreens to block the full range of ultraviolet rays that are linked to skin cancer – one of the most common, yet preventable forms of cancer in the world according to the World Health Organization.[1] Eliminating sunscreen options for consumers needlessly increases the risk of skin cancer for residents and visitors to the State of Hawai'i and will provide no benefit to the health of the native coral reef population. In fact, the American Cancer Society estimates that melanoma will be one of the leading causes of new cancer cases in Hawai'i in 2021.[2]

The State of Hawai'i remains the only American state to have banned the sale of sunscreens containing oxybenzone and octinoxate. Expanding this ban to also include avabenzone and octocrylene is based on an inaccurate assumption that sunscreen ingredients are unquestionably harmful to coral reefs and other marine life. This notion is contrary to the scientific consensus that global warming, land pollution, and other human activities are the primary cause of coral bleaching around the world.[3] Rising sea temperatures as a result of global warming are the primary cause of coral decline.

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[1] https://www.who.int/news-room/q-a-detail/radiation-protecting-against-skin-cancer
[2] American Cancer Society, Cancer Facts & Figures 2021; available at https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2021/cancer-facts-and-figures-2021.pdf
[3] e.g., see Hughes *et al.*, 2017 Global warming and recurrent mass bleaching of corals. Nature, 543(7645):373-377; Rodgers *et al.*, 2017 Patterns of bleaching and mortality following widespread warming events in 2014 and 2015 at the Hanauma Bay Nature Preserve, Hawai'i. PeerJ, DOI 10.7717/peerj.3355

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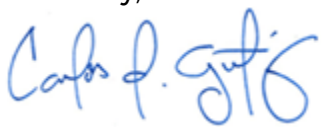
Taking healthcare personally.

Given the lack of convincing scientific evidence that sunscreens are responsible for coral degradation, we strongly oppose the elimination of sunscreen ingredients like avabenzone and octocrylene. Consumer access to sunscreen products containing a broad variety of ingredients, especially in a state with the highest rate of melanoma cases attributed to UV exposure, is a matter of public health and sunscreen use has been proven to reduce the risk of skin cancer.[4] For these reasons, we oppose passage of HB 102 HD1.

Thank you for taking the time to consider our concerns and feel free to contact me or our local representative, Lauren Zirbel, directly with any follow up questions you may have.

Sincerely,



Carlos I. Gutiérrez
Vice President, State & Local Government Affairs
Consumer Healthcare Products Association
Washington, D.C.
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[4] Watts *et al.*, 2018 Sunscreen Use and Melanoma Risk Among Young Australian Adults. JAMA Dermatol, 154(9):1001-1009.

To: The House Committees on Consumer Protection and Commerce
Representative Aaron Ling Johanson, Chair
Representative Lisa Kitagawa, Vice Chair

Re: HB102 HD1 RELATING TO SUNSCREENS

Position: STRONG SUPPORT WITH AMENDMENT

Hearing Date: Wednesday, February 17, 2021 2 p.m. Conference Room 329 Via Videoconference

Aloha Chair Johanson, Vice Chair Kitagawa, and Committee members:

The noted diverse Hawaii Coral Reef Stakeholders strongly support HB102 and SB366 expanding Act 104, Sessions Laws of Hawaii 2018, to include the ban on sale or distribution of sunscreens containing octocrylene and avobenzone to protect the State's marine ecosystems. **However, we urge you to change the effective date back to January 1, 2023.**

We thank the Legislature for passing Act 104 in 2018 which provides for the ban of sunscreens containing oxybenzone and octinoxate, two of the most problematic chemicals that interfere with the life-cycles of marine life, effective as of 1 January 2021. HB102 and SB366 build directly on Act 104 by adding two more harmful chemicals 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.

Furthermore, long-term exposure to avobenzone and octocrylene has been found to be lethal for some organisms living in freshwater environments, and are considered dangerous for freshwater ecosystems. Avobenzone is the leading active ingredient in chemical sunscreens and can cause hormone disruptions. Octocrylene is also quickly metabolized into a mutagen called benzophenone which is regulated by the FDA and included in California's Prop 65 list of chemicals known to cause cancer or reproductive toxicity. And 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.SO

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.

The need for HB102 and SB366 is obvious and critical, and we strongly urge you to support them. Further, please amend the effective date of HB102 to January 1, 2023.

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

Sincerely,

Coral Reef Stakeholders:

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

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
Co-Founders
Legacy Reef Foundation

Pat B. Lindquist
President
Napili Bay and Beach Foundation

Rene Umberger
Executive Director
For the Fishes

Jamie Lung Ka'eo
General Manager
Hale Napili

Ken Staples
Director of Hawai'i Operations
Ocean Defenders Alliance

Ka`imi Kaupiko
Executive Director
Kalanihale

Mike Nakachi
President
Moana Ohana

Caren Loebel-Fried
Artist, Illustrator, Author

Sue Aronson
Owner
Kona Coast Realty Corp.

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
Owner, Kona Glass Bottom Boat

Scott Head
Vice President of Resort Operations
Waikoloa Beach Resort

Marcio Lira
Florin Mosanica
Co-Founders
Koko Beach Rentals

Marcio Lira
Owner
Kaimana Tours

Caroline Duell
CEO
All Good

Brian A. Guadagno
Founder
Raw Elements USA

Elizabeth Reilly
Founder/President
Livable Hawaii Kai Hui

Wilkie McClaren
Safe Sunscreen Coalition

Lauren Blickley
Hawai‘i Regional Manager
Surfrider Foundation

Rick Gaffney
President
Hawaii Fishing & Boating Association

Florin Nica
Owner
Hanauma Bay Snorkel Adventures

Iris Kahaulelio
Aloha Surfing Ohana

Michael Koenigs
Founder
Little Hands Hawai’i

Haereticus
Environmental Laboratory

P.O. Box 92
Clifford, Virginia 2453 U.S.A.
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info@haereticus-lab.org

Aloha Hawaii Legislature,

This letter is testimony for our support of Senate Bill 366 and House Bill 102, amending Act 104.

The inclusion of avobenzone, and especially 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.

Octocrylene is ubiquitous in coastal environments. Octocrylene is found in the fish we eat (Cunha et al. 2018), in shellfish that we consume (Picot-Groz et al. 2018), and has been found in coral reefs and marine environments all over 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 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?

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).

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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Picot-Groz et al. (2018) Diurnal variation in personal care products in seawater and mussels at three Mediterranean coastal sites. Environmental Science and Pollution Research 25:9051-9059.

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Yan et al. (2020) Reproductive toxicity and estrogen activity in Japanese medaka (Oryzias latipes) exposed to environmentally relevant concentrations of octocrylene. Environmental Pollution 261:114104.

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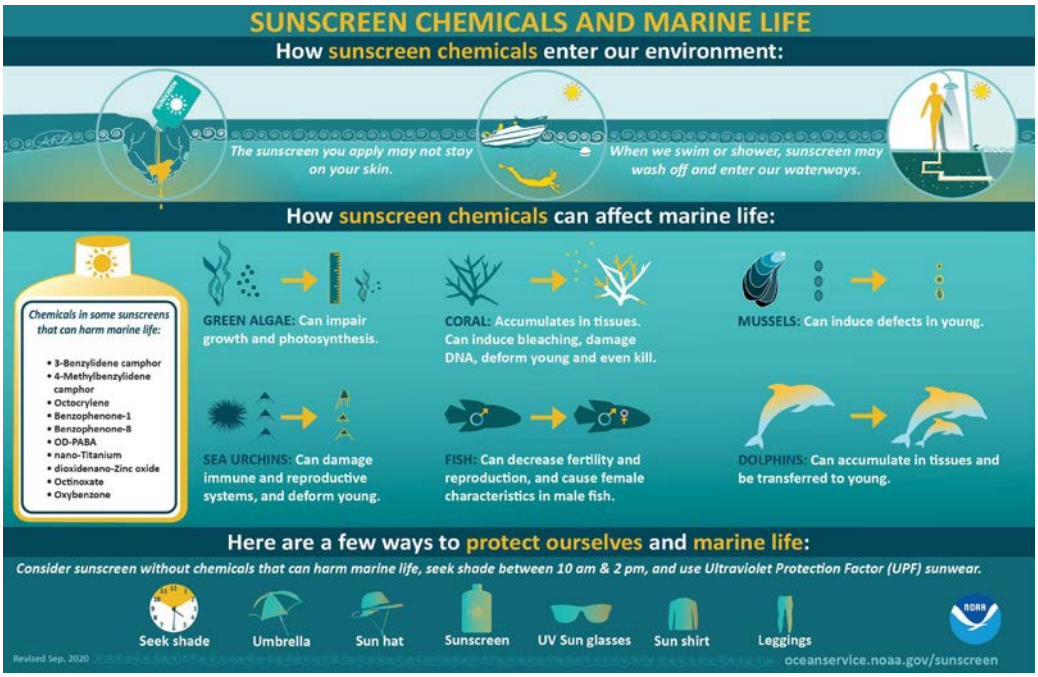
NAPILI
Bay and Beach Foundation

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.

Hawaii State Legislature February 6, 2020

Dear Committee Members,

I am writing in support of two bills, Senate Bill 366 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 both Senate Bill 366 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
achalkgarg@gmail.com
Ph. 513-378-7610

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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

325 Lysander Place,
Ottawa, ON K1K 3X8,
CANADA.
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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אוניברסיטת בן-גוריון בנגב
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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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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

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
Professor Emeritus of Marine Ecology
School of Zoology, Tel Aviv University
Tel Aviv, 69978 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,

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山東農業大學

SHANDONG AGRICULTURAL UNIVERSITY

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

Gao Huiyuan

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

Sincerely,
Xin Zhong

Zhong Xin

State Key Lab. of Crop Biology
College of Horticulture Science and Engineering
Shandong Agricultural University

In Favor of HB102/SB366 Banning the sale, offer of sale, or distribution in Hawaii of sunscreen products that contain Avobenzone and/or Octocrylene. Joe DiNardo (Retired Toxicologist/Hawaiian tourist) **January 30, 2021**:

Dear Senators and Representatives, based on Hawaii's lead in the environmental impact of oxybenzone and octinoxate the world has turned its eyes to evaluating the impact of other organic sunscreen actives that impact the environment and human health. Although the coronavirus has slowed us all down, scientists for all over the world continue to conduct research on these chemicals. With that said, below are a dozen scientific references, recently published, relating to the negative impact to the aquatic environment focusing solely on avobenzone and octocrylene (Note: other chemicals of concern may have also been tested concurrently in the papers referenced below).

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.enn.com/articles/65243-common-sunscreen-ingredients-dangerous-for-freshwater-ecosystems).

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).

Lastly, the toxicity associated with organic sunscreens and the role that these chemicals are thought to play in preventing skin cancer is of concern, therefore, I will let the researchers and medical professional who have evaluated this perspective over the last 6 decades answer this question using their own statements:

Published Research Reviewing the Skin Cancer Prevention of Sunscreens

Statement	Citation
"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 cases, however, there is little or no published evidence that they do so and the relationship is inferential."	Emmett. Ultraviolet radiation as a cause of skin tumors. CRC Crit Rev Toxicol. **1973**;2(2):211-55.
"In summary, the results of this study indicate that inflammation and enhanced melanoma growth are different effects of UV radiation involving different mechanisms and have different sensitivities for sunscreen protection. Furthermore, protection against sunburn does not necessarily imply prevention of other possible UV radiation effects, such as enhanced melanoma growth. In fact, sunscreen protection against UV radiation-induced inflammation may actually encourage prolonged exposure to UV radiation and thereby increase the risk of development of cutaneous melanoma."	Wolf et al. Effect of sunscreens on UV radiation-induced enhancement of melanoma growth in mice. J Natl Cancer Inst. **1994**;86(2):99-105.
"… the topical use of sunscreens reduces the risk of sunburn in humans and that sunscreens probably prevent squamous-cell carcinoma of the skin when used mainly during unintentional sun exposure. No conclusion can be drawn about the cancer-preventive activity of topical use of sunscreens against basal-cell carcinoma and cutaneous melanoma	World Health Organization - Vainio et al. An international evaluation of the cancer-preventive potential of sunscreens. Int J Cancer. **2000**;88(5):838-42.
"Although a sunscreen with an SPF of 15 or higher offers protection from sunburn, 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."	Environmental Protection Agency: Sunscreen the burning facts **2006**. Is sunscreen fail-safe (pg6). www.epa.gov
"Despite the availability and promotion of sunscreen for decades, the incidence of CMM (cutaneous malignant melanoma) continues to increase in the U.S. at a rate of 3% per year. There currently is little evidence that sunscreens are protective against CMM."	Planta. Sunscreen and melanoma: is our prevention message correct? J Am Board Fam Med. **2011**;24(6):735-9.
"The strength of the association between risk of skin cancer and sunscreen use has constantly decreased since the early 1980s, and the association was no longer statistically significant from the early 1990s. While the current evidence suggests no increased risk of skin cancer related to sunscreen use, this systematic review does not confirm the expected protective benefits of sunscreen against skin cancer in the general population."	Saes da Silva et al. Use of sunscreen and risk of melanoma and non-melanoma skin cancer: a systematic review and meta-analysis. Eur J Dermatol. **2018**;28:186–201.
"Could it be that the nearly universal recommendation of dermatologists and professional societies to use sunscreen to prevent skin cancer is unfounded?"	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.

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

Dr. Didier Stien
CNRS Research director
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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

P. Autier

International Agency for Research on Cancer, Lyon, France

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

Conflicts of interest
None to declare.

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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.

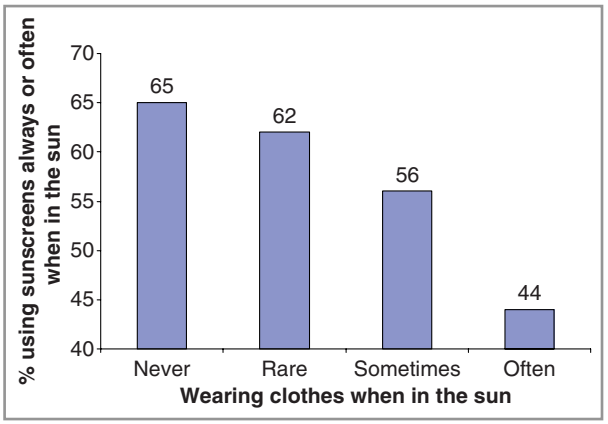

Fig 1. Correlation between sunscreen use and wearing clothes in 623 5- to 7-year-old European schoolchildren (R-square = 0·92, $P < 0{\cdot}0001$) (Ref. 4).

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.

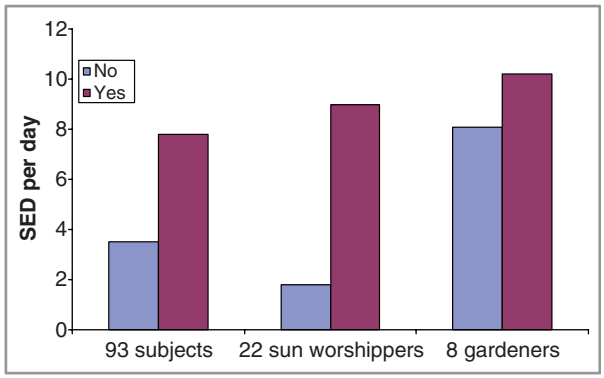

Fig 2. UV doses [in standard erythemal dose (SED) per day] received by volunteers wearing personal UV dosimeters, Denmark (Ref. 14).

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).

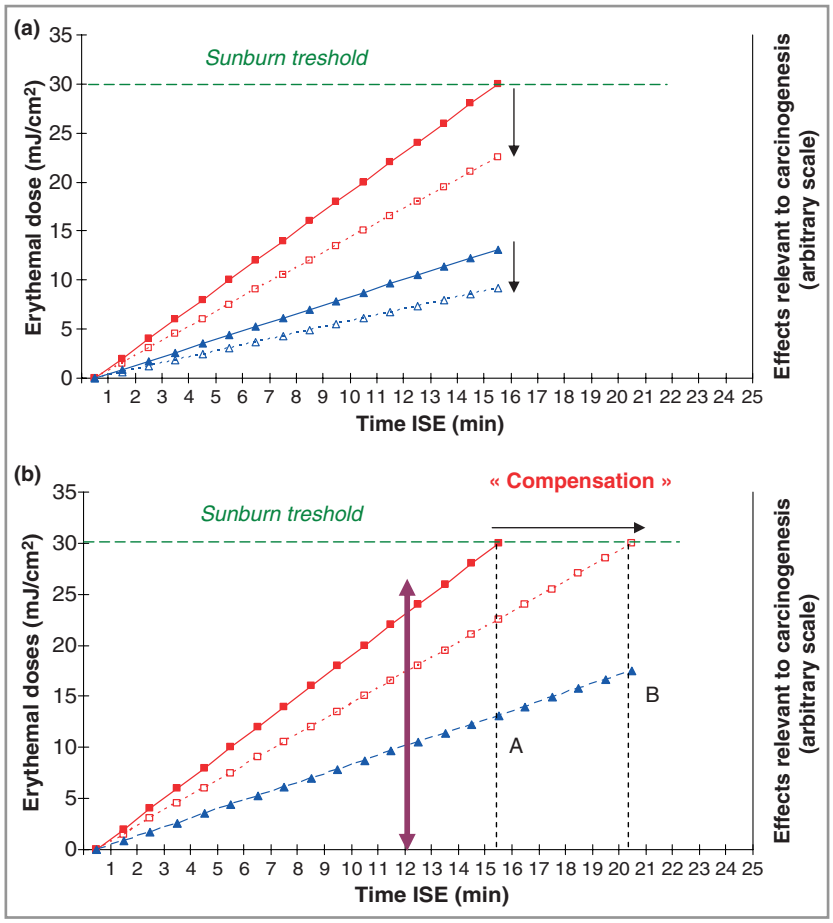

Fig 3. Schematic representation of traditional and alternative views on effects of use (continuous lines, plain squares and triangles) or no use (doted lines, open squares and triangles) of sunscreens in humans. Squares refer to sunburn occurrence according to UV dose received in mJ cm^{-2} on the left 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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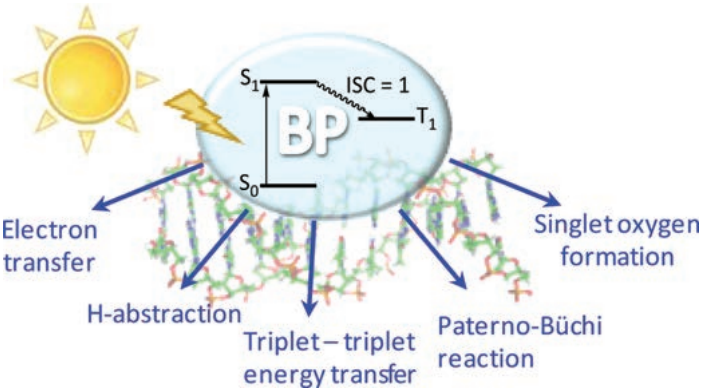

Although the carcinogenic potential of ultraviolet radiation is well-known, UV light may interact with DNA by direct absorption or through photosensitization by endogenous or exogenous chromophores. These chromophores can extend the "active" fraction of the solar spectrum to the UVA region and beyond, 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.

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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

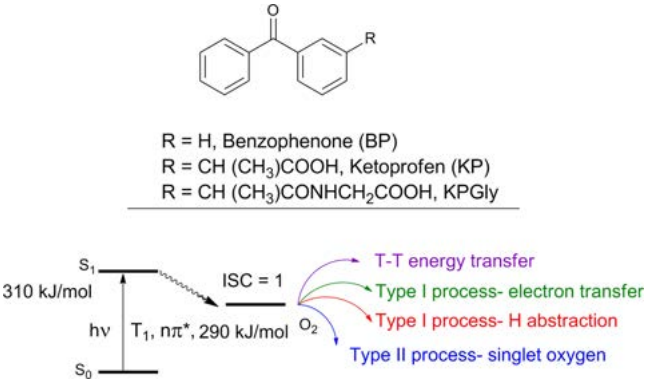

FIGURE 1. Photophysical properties and photoreactions of the benzophenone chromophore.

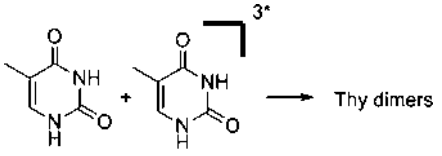

FIGURE 2. Thymine base dimerization.

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

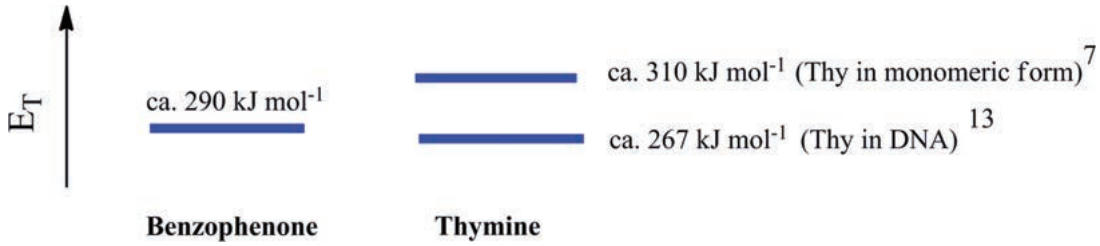

FIGURE 3. Benzophenone and thymine triplet energy levels.

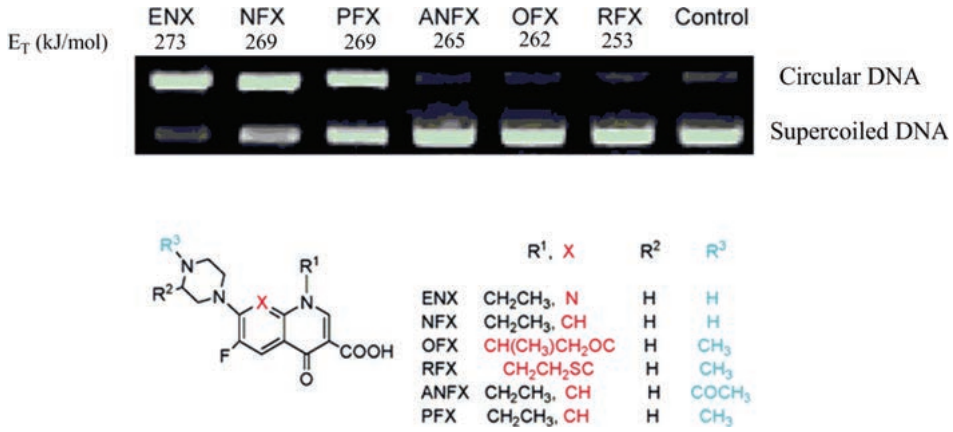

FIGURE 4. Photomixtures of fluoroquinolones of known E_T and plasmid pBR322 DNA after treatment with T4 endo V enzyme and gel electrophoresis.

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

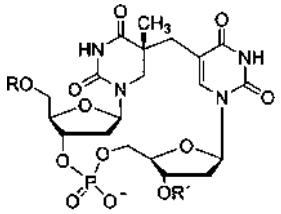

FIGURE 5. Structure of the spore photoproduct.

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

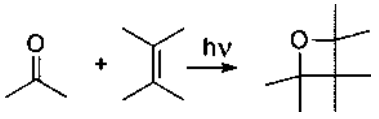

FIGURE 6. The Paternò−Büchi reaction.

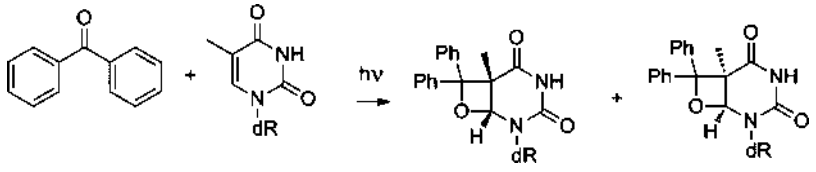

FIGURE 7. Oxetane formation upon irradiation of BP and Thd.

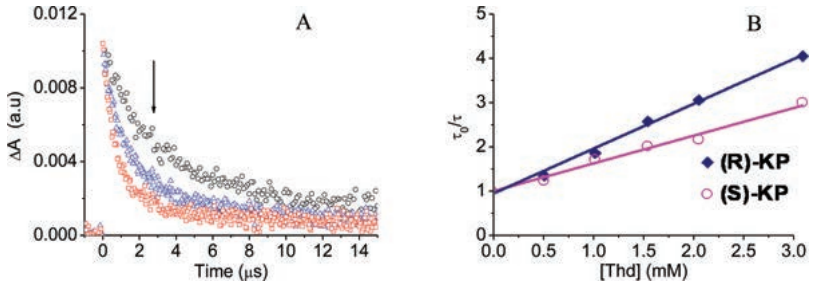

FIGURE 8. (A) Ketoprofen triplet excited state decay upon addition of increasing amounts of Thd using MeCN/H_2O (4:1, v/v) as solvent and (B) Stern−Volmer plots for quenching of (*R*)- and (*S*)-^{3}KP* by Thd.

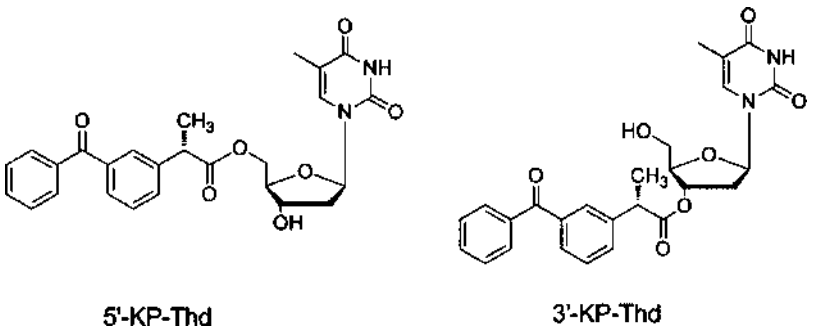

FIGURE 9. Ketoprofen−thymidine dyads.

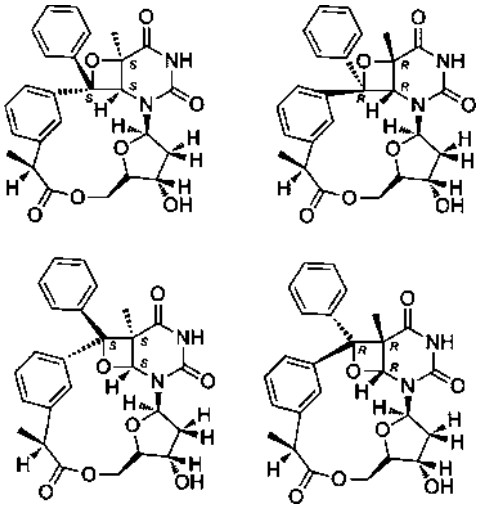

FIGURE 10. Photoproducts isolated from irradiation of the *cisoid* 5′-KP-Thd dyad.

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

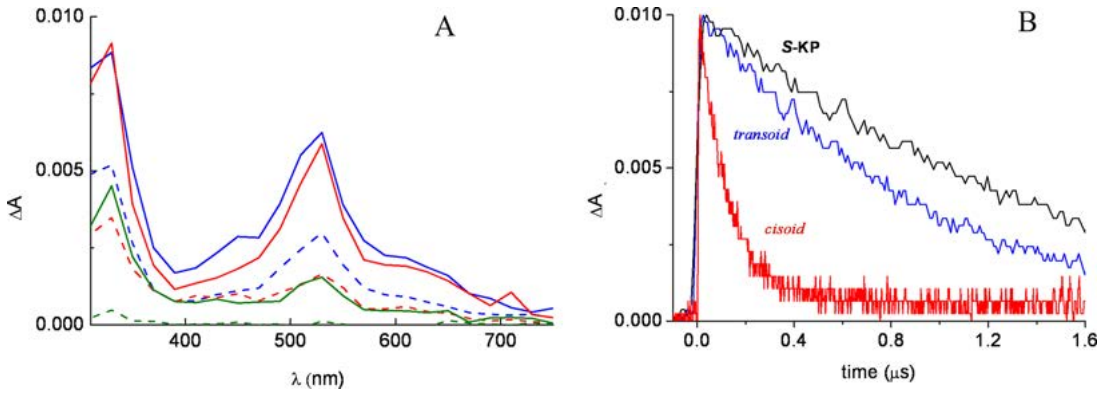

FIGURE 11. (A) Transient absorption spectra of the dyads and (*S*)-KP in acetonitrile, 35 ns (full line) and 2 μs (dashed line) after laser excitation and (B) triplet excited states of (*S*)-KP and the *cisoid* (3′-KP-Thd) and *transoid* (5′-KP-Thd) dyads.

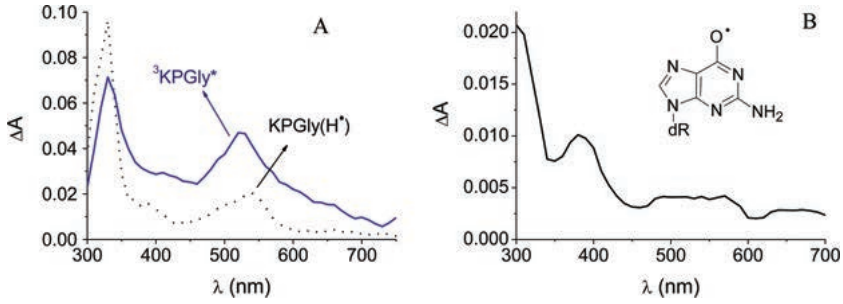

FIGURE 12. (A) Benzophenone-like triplet excited state (full line) and ketyl radical (dotted line) together with (B) dGuo(−H)• radical obtained by laser flash photolysis of KPGly/dGuo mixture in neutral aqueous medium (phosphate buffer).

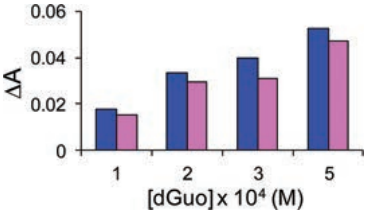

FIGURE 13. Comparison of the amount of ketyl radical formed after flash excitation of a solution of enantiopure (*S*)-KP (pink) or (*R*)-KP (blue) in the presence of dGuo, using MeCN/H_2O (4:1, v/v) as solvent.

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

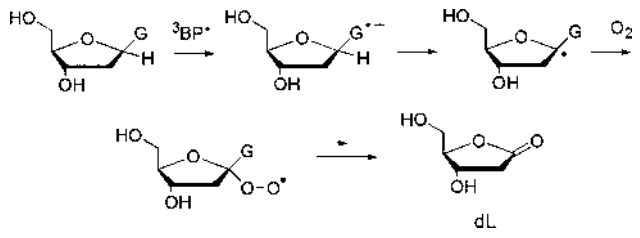

FIGURE 15. Mechanism of 2-deoxyribonolactone (dL) formation.

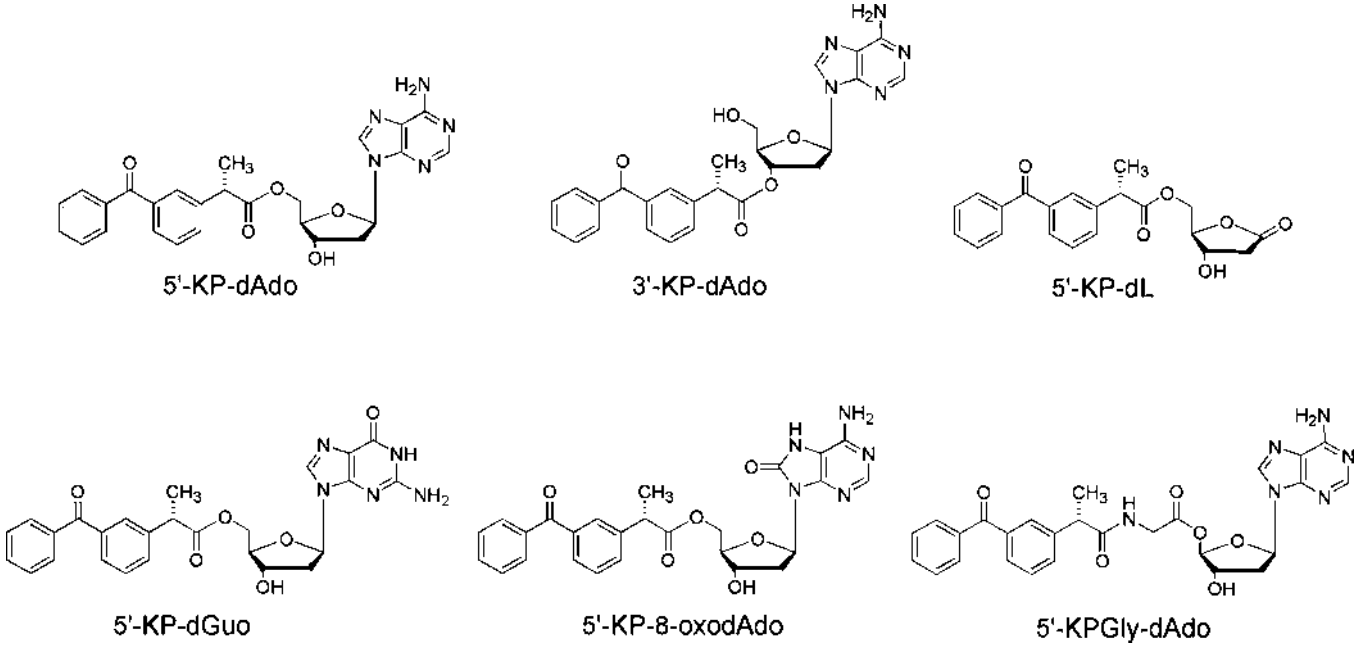

FIGURE 16. Structure of KP−purine dyads and 5′-KP-dL.

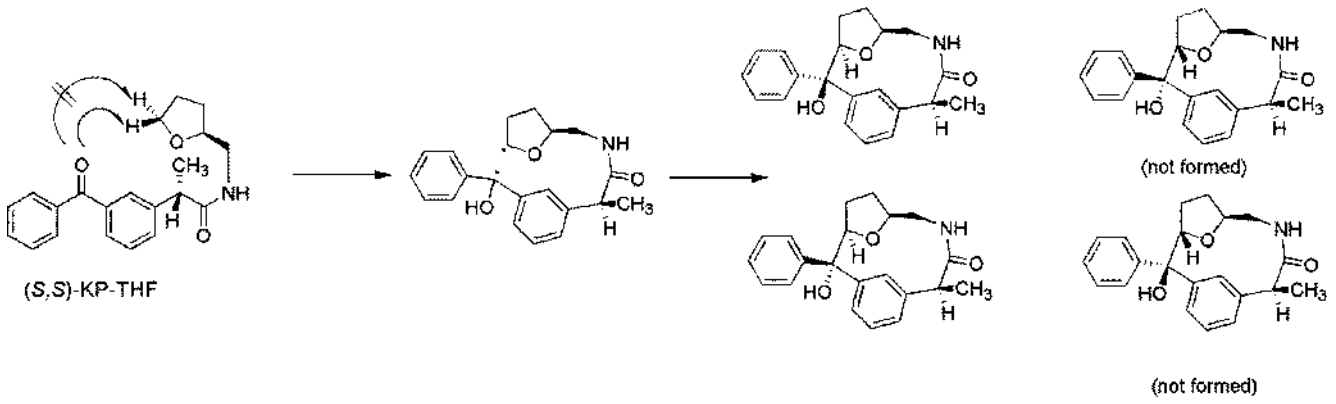

FIGURE 17. Structure and reactivity of the (*S,S*)-KP-THF.

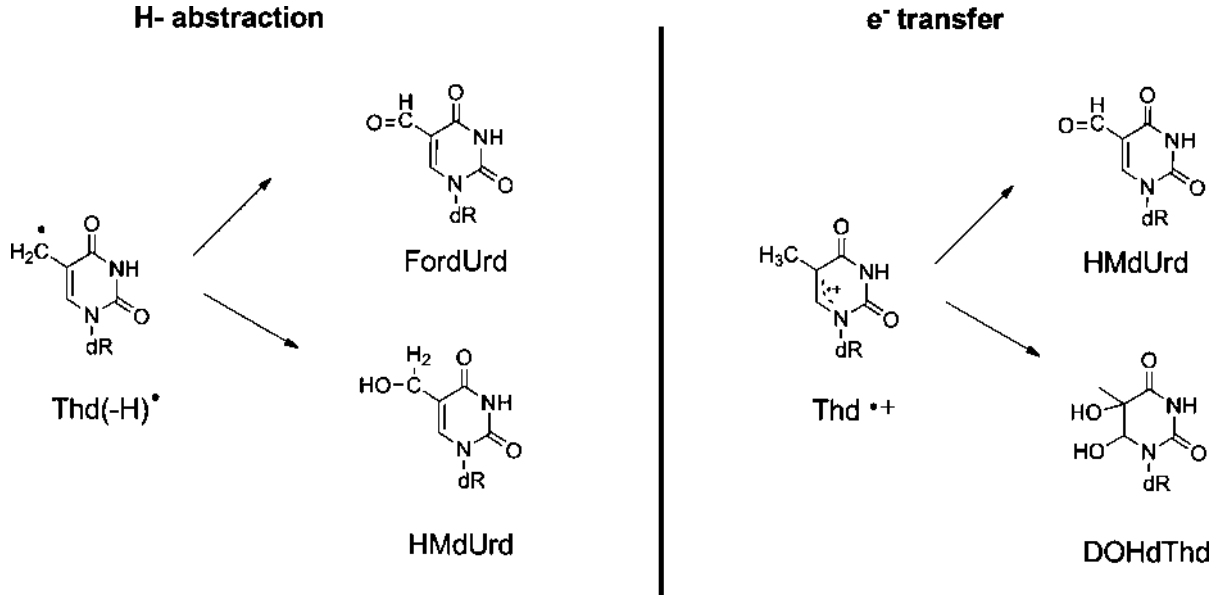

FIGURE 18. Photooxidation of Thd by BP.

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

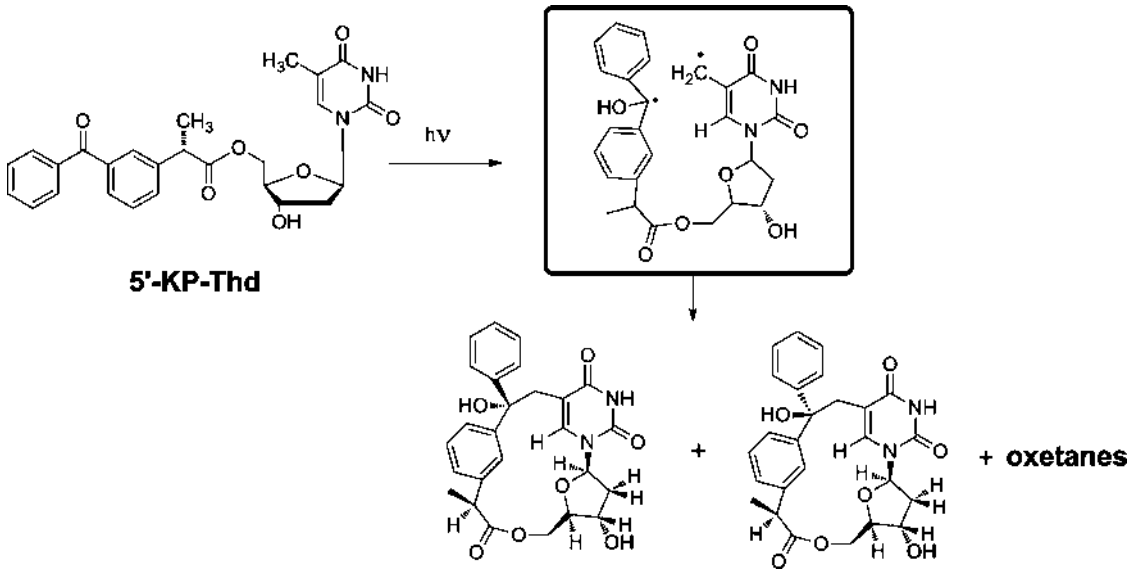

FIGURE 19. Hydrogen abstraction in the photoreaction of the *cisoid* 5′-KP-ThdKP-BP dyad.

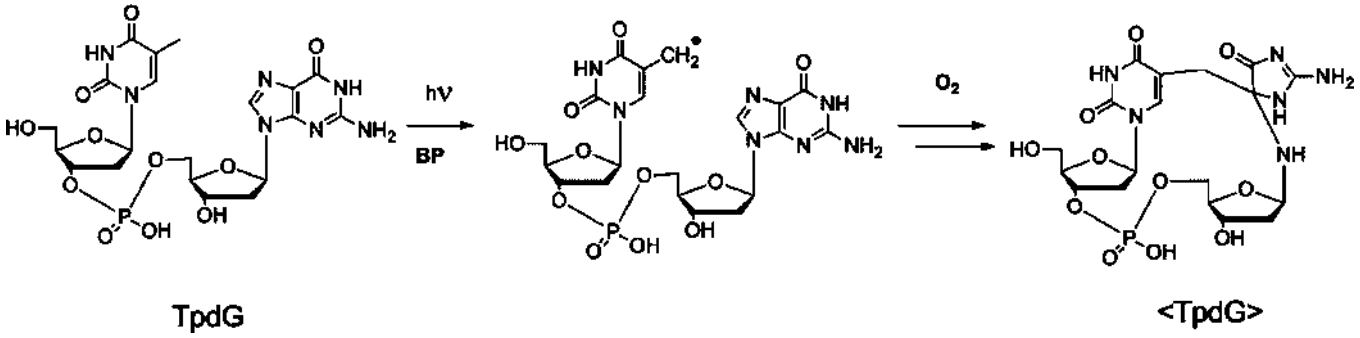

FIGURE 20. Photosensitization of TpdG by BP under aerated conditions.

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

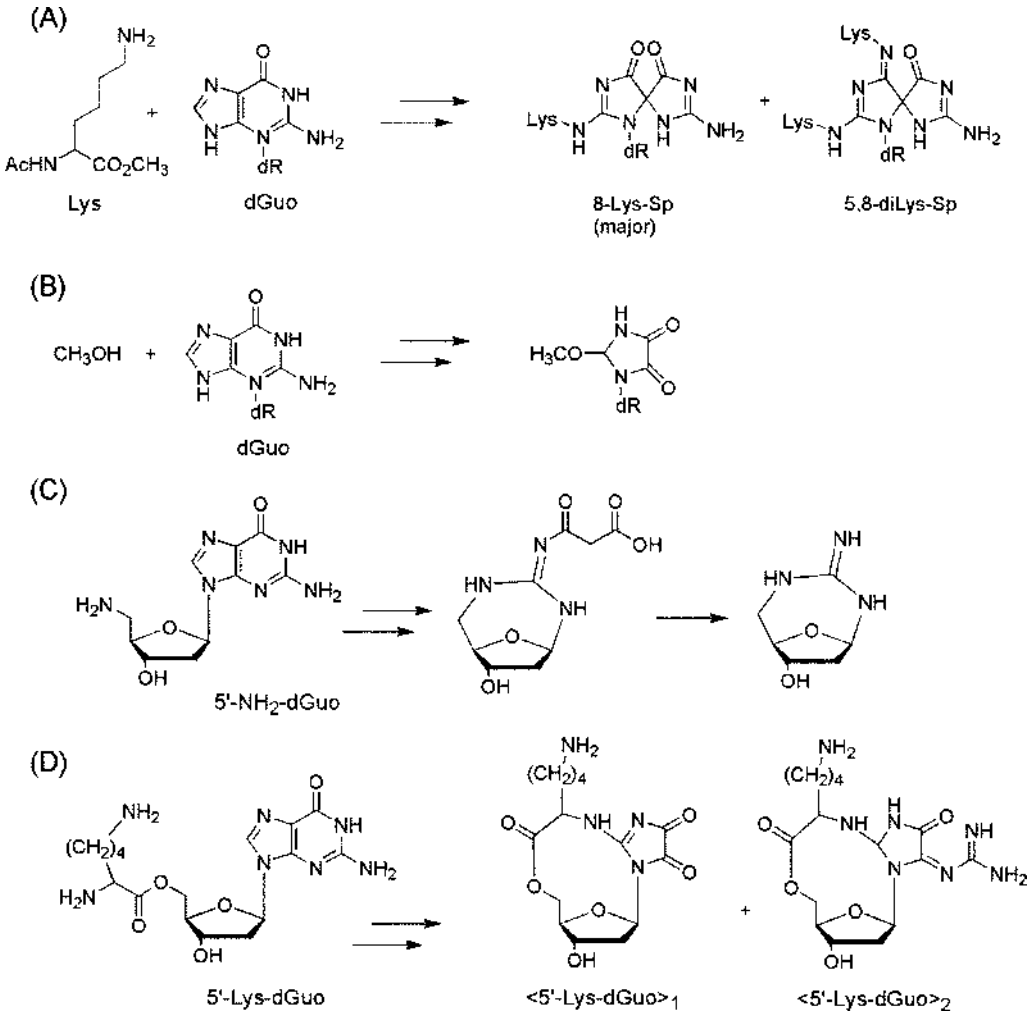

FIGURE 21. Model photoreactions for the BP-sensitized DNA–protein cross-links.

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.

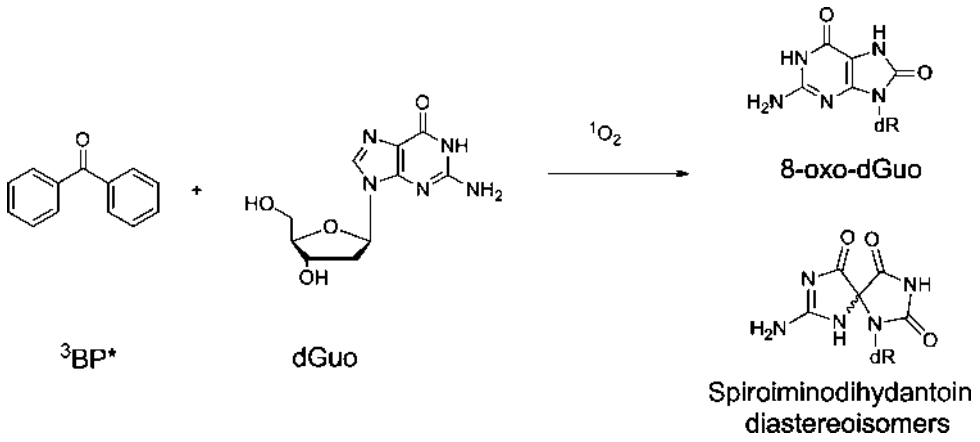

FIGURE 22. Type II photooxidation of dGuo by BP.

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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Aloha State Legislature,

Science has provided ample evidence that long-term exposure to avobenzone and 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 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.

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.

HB-102-HD-1
Submitted on: 2/16/2021 10:35:19 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Rhiannon Chandler-'Iao	Waiwai Ola Waterkeepers Hawaiian Islands	Support	No

Comments:

We strongly support HB102 and recommend that the effective date be amended back to January 1, 2023. There was a time when we allowed these products because we did not understand their impact. Today, we know the harm caused to the marine life that our people and visitors cherish, and there are other alternatives. It is time to act for the best interest of our waters and our long-term economy which is supported by a beautiful marine environment. Mahalo for your leadership.

HB-102-HD-1
Submitted on: 2/16/2021 11:58:16 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

The Center for Biological Diversity **strongly supports HB102** expanding Act 104, Sessions Laws of Hawaii 2018, to include the ban on sale or distribution of sunscreens containing octocrylene and avobenzone to protect the State's marine ecosystems. Mahalo to the Legislature for passing Act 104 in 2018 which banned sale of sunscreens containing oxybenzone and octinoxate. By adding two more harmful petrochemicals to the list: octocrylene and avobenzone, HB102 is a necessary next step to protect our fragile marine ecosystems and the myriad of life that depend on them. Scientific study demonstrates that these pervasive reef toxins irreversibly interfere with the life-cycles of marine life including corals, algae, fish, shellfish, sea urchins and marine mammals. Furthermore, long-term exposure to avobenzone and octocrylene has been found to be lethal for some organisms living in freshwater environments, and are considered dangerous for freshwater ecosystems. Additionally, avobenzone is the leading active ingredient in chemical sunscreens and can cause hormone disruptions.

The Center respectfully requests this committee pass HB102.

HB-102-HD-1
Submitted on: 2/16/2021 12:06:03 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

Aloha,

The State of Hawaii needs coral reefs to survive. They provide crucial habitat for near shore marine life and protect us from coastal erosion. There are MANY truly reef safe sunscreen options available these days that work and are made locally by companies who truly care about what is best for our amazing reefs and for the State of Hawaii. Time is of the essence we must act now if we want to save our reefs for our future generations!

We strongly support this bill.

Mahalo for your attention to our beautiful reefs,

Emily Babel/ Owner Mama KULEANA Reef Safe Sunscreen

February 17, 2021

To: The Honorable Aaron Ling Johanson, Chair
Members, House Committee on Consumer Protection & Commerce

From: Tim Shestek
American Chemistry Council

Re: **HB 102, HD 1 – OPPOSE**

On behalf of the American Chemistry Council (ACC), I am writing to express our concern with HB 102, HD 1 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

Love Life!

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Organic & Natural

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HB102 HD1 RELATING TO SUNSCREEN
House Committee on Consumer Protection & Commerce
February 17, 2021, 2:00pm State Capitol

Aloha Rep. Aaron L. Johanson, Chair, Rep. Lisa Kitagawa, Vice Chair, and Committee Members,

Down to Earth Organic and Natural testifies in support of HB102 HD1.

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 HB102 HD1 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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HB-102-HD-1
Submitted on: 2/16/2021 1:12:15 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

To: The Honorable Aaron Ling Johanson, Chair,

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

House Committee on Cossumer Protection and Commerce

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

Re: Hearing HB102 RELATING TO SUNSCREENS

Hearing Date: Wednesday, February 17, 2021, 2:00 pm, videoconference

Position: STRONG SUPPORT FOR HD102 HD1!

Aloha Chair Johanson, Vice Chair Kitagawa, and Consumer Protection and Commerce Committee members:

The HAWAIʻI REEF AND OCEAN COALITION – HIROC – **STRONGLY SUPPORTS HB102 HD1!**

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. 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 HB102 HD1 expanding Act 104, Sessions Laws of Hawaii 2018, to include the ban on sale or distribution of sunscreens containing octocrylene and avobenzone to protect the State's marine ecosystems.

We thank the Legislature for passing Act 104 in 2018 which provides for the ban on sale of sunscreens containing oxybenzone and octinoxate, two of the most problematic chemicals that interfere with the life-cycles of marine life, effective as of 1 January 2021. HB102 HD1 builds directly on Act 104 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.

Furthermore, long-term exposure to avobenzone and octocrylene has been found to be lethal for some organisms living in freshwater environments, and are considered dangerous for freshwater ecosystems. Avobenzone is a leading active ingredient in chemical sunscreens and can cause hormone disruptions. Octocrylene is also quickly metabolized into a mutagen called benzophenone which is regulated by the FDA and included in California's Prop 65 list of chemicals known to cause cancer or reproductive toxicity. And 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!

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 local 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. This false argument 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." Petrochemical sunscreens are often not applied sufficiently or frequently enough to protect against sun damage to skin, and wash off in water, and so may actually give people a false sense of security that causes them to spend a 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 and sunscreens with zinc oxide or titanium dioxide. This is a much better course than using a petrochemical sunscreen that washes off in water and kills corals and other marine life, gets into your bloodstream, and may disrupt your hormones, potentially causing more cancers.

The need for HB102 is obvious 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)

Personal Care Products Council
Committed to Safety, Quality & Innovation

February 16, 2021

Representative Aaron Ling Johanson, Chair
Representative Lisa Kitagawa, Vice Chair
Hawai'i House Committee on Consumer Protection & Commerce

RE: Oppose House Bill 102

Chair Johanson and Vice Chair Kitagawa:

On behalf of the members of the Personal Care Products Council (PCPC),[1] I am writing to express our opposition to Senate Bill 102, banning the sale, offer for sale or distribution of any sunscreen that contains avobenzone or octocrylene. This bill may lead to a serious public health issue by banning essential, safe and effective sunscreen products that millions of Hawaiians currently trust and rely on, particularly since the U.S. has a limited number of approved ingredients to make these products.

The U.S. has Limited Number of Sunscreen Ingredients to Fight Skin Cancer

Sunscreens are a key factor in preventing and reducing the risk of skin cancer and damage from ultraviolet (UV) rays. 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.

Avobenzone and octocrylene, approved for use by the U.S. Food and Drug Administration (FDA), 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.

Hawai'i Residents at Higher Risk for Skin Cancer

With Hawai'i's previous ban on some sunscreen active ingredients, a ban on avobenzone and octocrylene would further limit access to products that can help prevent skin cancer. Skin cancer is one

[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.

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.

Science on Coral Reefs and Sunscreens to be Evaluated by NAS

House Bill 102 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.

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, sponsored by the U.S. Environmental Protection Agency, will examine research concerning both the environmental and human health impacts of access to sunscreens. Making environmental management decisions on sunscreens based on the current insufficient scientific data may lead to unintended health consequences, such as fewer available sunscreens and an increase in the prevalence of skin cancer.

We fear House Bill 102 may create confusion and potentially discourage the use of sunscreens – an important part of a daily safe-sun regimen – putting consumers' health at risk. We respectfully ask that you oppose House Bill 102. Thank you for your consideration and for the opportunity to comment.

Sincerely,

Karin Ross
Vice President, Government Affairs
Personal Care Products Council

February 15, 2021

TO:
Representative Aaron Ling Johanson, Chair
Representative Lisa Kitagawa, Vice Chair

Members of the House Committee on Consumer Protection and Commerce
Thirty First Legislature
Regular Session of 2021

FROM:
The members of the Hawaii Skin Cancer Coalition

RE: OPPOSITION to House Bill 102, HD1-RELATING TO SUNSCREENS
Hearing Date-Wednesday, February 17, 2021

Dear Chair Johanson, Vice Chair Kitagawa, and Members of the Committee,

Mahalo for the opportunity to submit testimony in strong OPPOSITION to House Bill 102, HD1 (HB 102, HD1) on behalf of the Hawaii Skin Cancer Coalition. This Bill, HB 102, HD1 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 House Bill 102, HD1 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, b a n n ing 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.

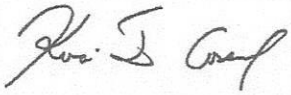
Morbidity and deaths from skin cancers are on the rise in the U.S. and Hawaii. The current focus of Hawaii's legislative policy limiting the sale of sunscreen products will undermine years of progress towards addressing the effects of unprotected sun exposure, a primary risk factor for skin cancer. The 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 to 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

REFERENCES

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 Hawaii Dermatological Society, Kaiser Permanente, Kuakini Health System, the Hawaii Lifeguard Association, Queen's Healthcare Plan, and the Hawaii Ophthalmological Society. All of these organizations share a common goal to help prevent skin cancer.

TESTIMONY OF TINA YAMAKI, PRESIDENT
RETAIL MERCHANTS OF HAWAII
February 17, 2021
Re: HB 102 HD1 Relating to Sunscreen

Good morning Chairperson Johanson and members of the House Committee on Consumer Protection and Commerce. 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 HB 102 HD1 Relating to Sunscreen. This measure beginning 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; and is effective 7/1/2050.

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.

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. The vast majority of 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. 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.

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. Most people will not take time off from their work to have to pay for a visit to the doctors and then must pay for an expensive prescription for sunscreen that may not be covered under their healthcare.

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

Mahalo again for this opportunity to testify.

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HB-102-HD-1
Submitted on: 2/12/2021 8:06:41 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Victoria Anderson	Individual	Support	No

Comments:

Please pass this important bill! Avobenzone and octocrylene are toxic to our precious marine life (and potentially unsafe for humans, too!)

Many thanks,

Victoria Anderson

In Favor of HB102 H1 … Joe DiNardo – Toxicologist/Hawaii Tourist February 14, 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. 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 new to the Luau party the Public Access to Sunscreens (PASS) Coalition also all talk about how the hundreds of scientific publications reporting on the negative environmental and human impact of these toxic chemicals are wrong … based on a few studies conducted by interested/vested supporters of sunscreens and of course who could forget the numerous "sunscreen save lives" campaigns developed/supported by the largest sunscreen manufacturer (who have around 100,000 lawsuits pending on numerous other technologies they own).

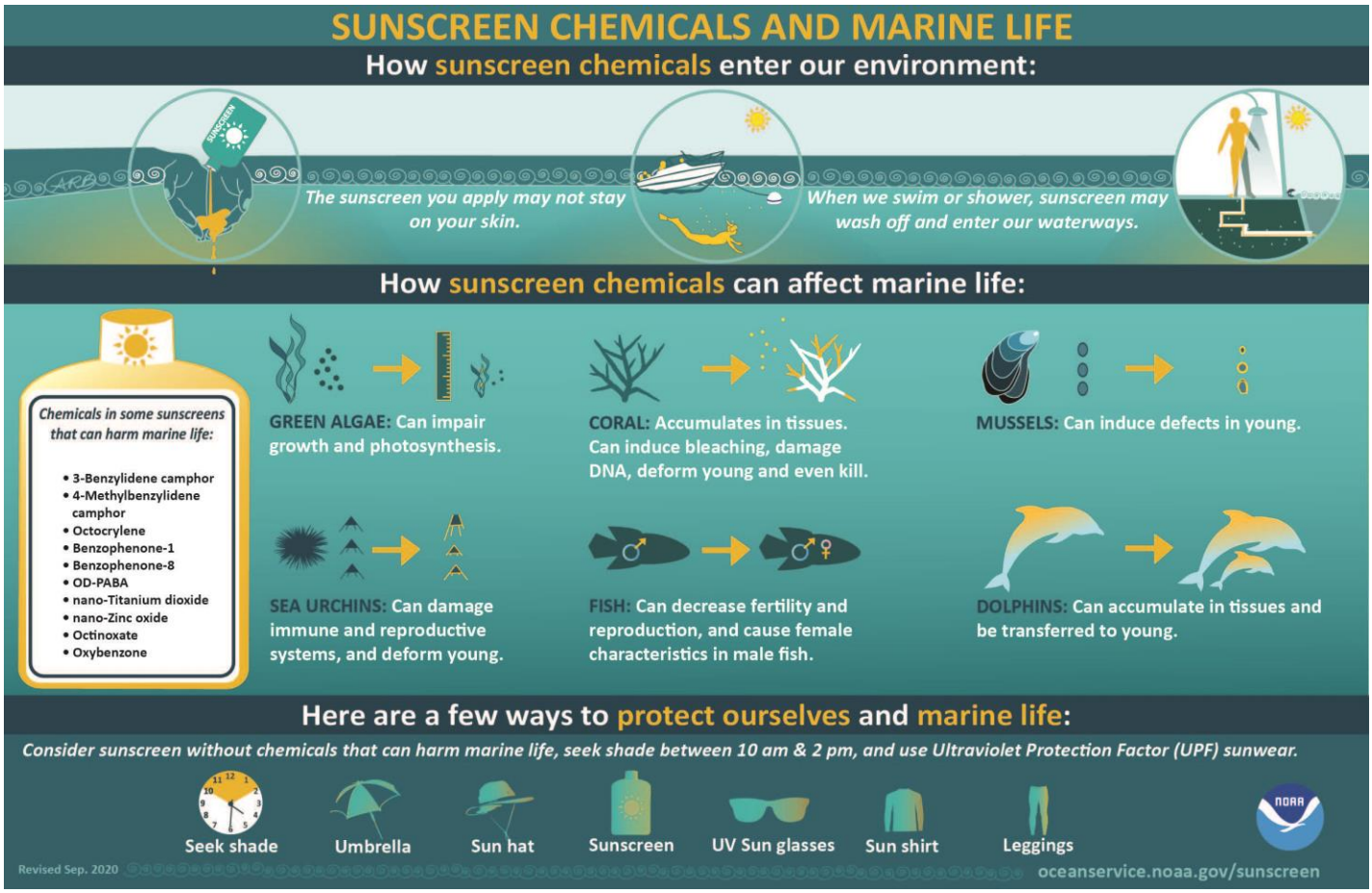
The newest twist in testimonies is a plea to wait another 1.5 years or so until the National Academy of Science (NAS) … a group funded by EPA (who recently increased the amount of several toxic chemicals allowed in our water supply) who was asked by congress (based on political pressure placed on them by the PASS Coalition and possibly other Washington DC Lobbyists groups) … to complete an independent review with impartial scientists (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) erasing 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. BTW – 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 by dermatologist and sunscreen companies or perhaps what the incidence of melanoma is in the US and 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 that increases the risk of skin cancer. This is basically 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:



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

HB-102-HD-1
Submitted on: 2/15/2021 3:22:24 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Maui OFR	Individual	Support	No

Comments:

The coral is the backbone of our reefs, we need to protect it!

HB-102-HD-1
Submitted on: 2/15/2021 6:22:01 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

I strongly support HB 102 and recommend that the effective date be amended back to January 1, 2023.

HB-102-HD-1
Submitted on: 2/15/2021 6:58:28 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

I strongly support SB132 with the following amendments: please expand Act 104, Sessions Laws of Hawaii 2018, to include the ban on sale or distribution for sale of sunscreens containing octocrylene and avobenzone to protect the State's marine ecosystems to align with HB102, and please retain the effective date of 1 January 2023.

HB-102-HD-1
Submitted on: 2/15/2021 7:18:07 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
scott rubenstein	Individual	Support	No

Comments:

Plenty of studies point to the chemicals within sunscreen to be a detriment to our oceans, our coral, and ourselves. With no regulation stopping these chemicals from being mass produced, marketed, and sold, avobenzone and octocrylene are on a path of destruction.

Ironically enough, when Avobenzone is exposed to the sun it releases free radicals believed to increase the risk of cancer. It is not waterproof, can disrupt endocrine function, and reduce viability of sperm.

On the other hand, octocrylene has been linked to reproductive harm, as well as effects to mitochondria. It can store itself in fatty tissues of both humans and aquatic life, resulting in negative effects. On top of the warming of our oceans (yet another cause of coral death), a layer of these chemicals covering coral can be the proverbial dagger which causes the coral to bleach and die.

With so many available mineral options for UV protection which do not harm our ocean, we need to make changes and take a stand for our beautiful coral and our aquatic brethren. If the coral reefs die out, it is just the first domino in a complex interwoven web of ecosystems, with catastrophic possibilities. Not only our ocean, but our coasts will be effected by erosion as well.

Our government needs to make changes and support HB102.

Mahalo

HB-102-HD-1
Submitted on: 2/15/2021 7:36:21 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Audrey Newman	Individual	Support	No

Comments:

I strongly support HB102 HD1 with one critical amendment - please revise the effective date to be 1 January 2023 . This bill will protect our ocean and reefs from harmful chemicals in sunscreens by adding more chemicals to the state's existing ban on sale or distribution for sale of sunscreens. The current law has demonstrated that this is possible and beneficial, so please expand the list of prohibited chemicals.

It is also important to take action as quickly as possible. A 2023 effective date will allow businesses and government agencies enough time to implement the expanded law. We should not wait until 2050 to act, which makes this bill meaningless. Please correct this unfortunate change.

Mahalo a nui loa,

Audrey Newman

HB-102-HD-1
Submitted on: 2/15/2021 8:01:14 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Monica Stone	Individual	Support	No

Comments:

I support HB102. Protect the reef and the delicate ecosystem of Hawaiian waters! Mahalo for receiving my testimony.

Monica Rott Stone

HB-102-HD-1
Submitted on: 2/15/2021 8:50:32 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

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

Comments:

I support HB102.

HB-102-HD-1
Submitted on: 2/15/2021 9:17:30 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Elizabeth Winternitz	Individual	Support	No

Comments:

I strongly support HB102, **Please amend the effective date back to January 1, 2023.**

HB-102-HD-1
Submitted on: 2/15/2021 10:29:13 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Hillary Hendrickson	Individual	Support	No

Comments:

Science has provided ample evidence that long-term exposure to avobenzone & octocrylene commonly found in sunscreens (including sunscreens labelled “reef safe”) have been found to have detrimental impact on people & marine life.

Octocrylene accumulates in fatty tissues of aquatic life (and humans), can alter mitochondrial function and is linked to developmental & 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. Combined with other UV filters it shows endocrine disruption and decreases sperm viability.

The hypothesis that if you prevent a sunburn with chemical sunscreens you prevent skin cancer has never been proven. There’s no need to trade the health of marine life in order to protect ourselves from the sun. We should utilize UV protective clothing, shade, & avoid direct sun mid-day… then choose sunscreen.

There are endless efficient mineral sunscreens on the market, available in thousands of stores across Hawaii. In fact, out of all approved UV filters non-nano zinc oxide is the most efficient, offering the best broad spectrum protection.

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

We urge your support for HB102

HB-102-HD-1
Submitted on: 2/15/2021 10:46:29 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Andrea Nandoskar	Individual	Support	No

Comments:

Aloha,

Please support this important bill!

Science has provided ample evidence that long-term exposure to avobenzone and octocrylene commonly found in sunscreens (including sunscreens labelled as “reef safe”) have been found to have detrimental impact on the life-cycles of Hawaii marine life including corals, algae, fish, shellfish, sea urchins and marine mammals.

Avobenzone is the leading active ingredient in chemical sunscreens and can cause endocrine disruption. Octocrylene is quickly metabolized into a mutagen called benzophenone which is included in California’s Prop 65 list of chemicals known to cause cancer or reproductive toxicity. Both are dangerous to the health of people, corals, marine life.

In Feb 2019, after numerous studies, the U.S. FDA declared it does not have sufficient scientific evidence that any organic ("chemical") UV filters in sunscreens including oxybenzone, octinoxate, octocrylene, avobenzone are safe for human use.

Coral reefs are intrinsic to Hawaiian culture and fundamental to our sustainability and the future of life on Earth. Please help to ensure our reefs can survive and thrive for future generations.

We urge your support for HB102 HD1 to help protect our reefs, marine life and human health, too!

HB-102-HD-1
Submitted on: 2/16/2021 12:58:45 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Brian Alexander	Individual	Support	No

Comments:

It is a moral, ethical, cultural, environmental, and economic imperative to protect Hawaiian marine life, including our reefs. Scientific research suggests the compounds in question have deleterious effects on our fragile ecosystem. I therefore urge you to support HB102.

GREG K. SAKAMOTO, M.D.
DERMATOLOGY

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February 16, 2021

To Whom It May Concern:

I am writing in opposition of House Bill 102. As dermatologists**,** we know that 80% of skin cancer can be prevented by following sun safe practices, yet we see patients with skin cancer on a daily basis. Many of these patients present with multiple skin cancers, with a vast majority of cases related to excessive sun exposure. This proposed ban on more sunscreen ingredients could potentially eliminate about 64% of the sunscreens currently on the shelf. The only sunscreens that will be left are the ones that cause a white cast and feel sticky on the skin, which will deter people from using sunscreen altogether. This bill will severely limit consumer choice. Sun damage is real and it can affect anyone, and is even more critical here in Hawaii where we have one of the highest average UV indexes in the nation. The benefits of sunscreen for reducing skin damage and preventing skin cancer have been well documented and has been proven to reduce your risk of developing melanoma by up to 50%. We know that sunscreen saves lives.

I understand the intention behind this bill is to protect our coral reefs and I believe that is a worthy cause. However, I am not a reef expert, but according to NOAA's website about sunscreen and coral damage, it did **not** list avobenzone, homosalate or octisalate as being harmful to marine life. Given the fact that sunscreen prevents skin cancer, there should be solid, overwhelming evidence that banning it will actually help improve coral health. Think about all the other ingredients that enter the ocean, including insecticides, cleaning chemicals, gasoline, oils etc. Are we planning on banning those as well?

Please consider the public health impacts that such a sweeping ban on sunscreens will have on the people of Hawaii.

If you have any questions, please feel free to call me.

Sincerely,

GREG K. SAKAMOTO, M.D.
DERMATOLOGY

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HB-102-HD-1
Submitted on: 2/16/2021 10:12:34 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Kirstin Kahaloa	Individual	Support	No

Comments:

Aloha,

I support HB 102 and recommend that the effective date be amended back to January 1, 2023. Mahalo for your consideration and support!

HB-102-HD-1
Submitted on: 2/16/2021 10:36:16 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Christopher Hendrickson	Individual	Support	No

Comments:

Mahalo for the opportunity to submit testimony on HB102. Firstly, I would like to thank the Legislature for passing Act 104 in 2018 to enact a ban on the sale of sunscreens containing oxybenzone and octinoxate. Secondly, mahalo to those who introduced this measure which will expand on the work to protect our marine life and coastal reefs.

I am in the waters of West Maui almost every day. I love seeing the vast diversity of marine life and all that the coastal reefs of Maui have to offer. I love sharing this experience with others so I share these moments as a videographer through social media (@Maui.Snorkeling) for all the world to see, honor, and educate on.

There is a vast amount of scientific evidence establishing the destructive impacts that avobenzone & octocrylene have on marine life and people. What is most egregious is that these chemicals are found in "reef safe" sunscreens sold everywhere on Maui. I talked to visitors of our island and this confusion leads folks to make decisions that they believe are environmentally responsible and protect marine life but only continuing to support the destruction of habitat because of this misunderstanding. Regulating the term "Reef Safe" is simply not enough, we must make these compounds unable to be sold in sunscreens.

Most people are also unaware that Octocrylene is toxic to corals and is often a “deciding factor” of whether coral survives or dies a bleaching event or that Avobenzone degrades when exposed to the sun causing the release of free radicals, which can increase the risk of cancers.

These compounds, Octocrylene and Avobenzone, in sunscreen provide no substantial benefit over readily available alternatives like UV protective clothing or mineral sunscreens like non-nano zinc oxide, which offer the best broad-spectrum protection. We shouldn't be allowing the silent assault on our reefs, environment, and health with the continued use of these compounds.

Hawaii has an opportunity to continue setting global standards for environmental protection. As you may know, over 50 percent of the world's coral reefs have died in the last 30 years and up to 90 percent may die within the next century. The ripple effect that this devastation causes will tremendously impact Hawaii and our people. It saddens me

to think of a future where we won't see beautiful fish like our humuhumunukunukuapua'a or experience the astonishment and joy of seeing Honu gracefully swim by and pop their head out of the water to breathe. Thinking that the videos we take and memories make will be the only evidence of the vast diversity and beauty of Hawaii's marine life which we will have to share with future generations is something I don't want to happen.

I urge the support of HB102 because I want to make sure that generations of Hawaiian citizens and visitors to our Islands get to experience these moments themselves and not through video, trying to imagine what could have been.

HB-102-HD-1
Submitted on: 2/16/2021 12:10:24 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Ocean Ramsey	Individual	Support	No

Comments:

I strongly support this bill.

HB-102-HD-1
Submitted on: 2/16/2021 12:14:52 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Kaikea Nakachi	Individual	Support	No

Comments:

We need to be doing everything we can to reduce our impact on reefs and this is one single part we can do to help. I support this bill and hope you will too.

HB-102-HD-1
Submitted on: 2/16/2021 1:23:13 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
josh bogle	Individual	Oppose	No

Comments:

Please consider that the ocean is what gives us all life

please protect it fir future generation

HB-102-HD-1
Submitted on: 2/16/2021 5:16:42 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Shannon Leitner	Individual	Support	No

Comments:

Science has provided ample evidence that long-term exposure to avobenzone and octocrylene commonly found in sunscreens (including those labelled “reef safe”) have been found to have detrimental impact on people and marine life.

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 decreases sperm viability.

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 don't get the body's warning you've been exposed to too much sun. There’s no need to trade the health of marine life in order to protect from the sun exposure. We should utilize UV protective clothing, shade, avoid direct sun mid-day… then choose a safe sunscreen.

There are endless efficient non-nano mineral sunscreens on the market, available in thousands of stores across Hawai'i, offering more efficient broad spectrum protection.

Coral reefs are fundamental to our sustainability. They provide critical habitat for near shore marine life and natural protection against coastal erosion. 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.

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

HB-102-HD-1
Submitted on: 2/17/2021 12:49:33 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Daniel Amato	Individual	Support	No

Comments:

Please support HB102!!

HB-102-HD-1
Submitted on: 2/17/2021 8:01:53 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Linda Soll	Individual	Oppose	No

Comments:

Please oppose HB102 which puts the safety of our reefs above that of our people.

We have melanoma in our family and know the importance of effective sun protection. Removing avobenzone and octocrylene from sunscreens will make them less effective and increase skin cancer in local people. Our only option for good sun protection will be to buy effective sunscreens online. Please allow locally available sunscreens to contain avobenzone and octocrylene so that the local consumer can purchase effective sunscreens at our local stores. Many of us wear sunscreen daily without even going in the ocean, so no harm can possibly come to reefs.

Thank you for your consideration of opposition to HB102 for the good of Hawaii's people!

With aloha,

Linda Soll

HB-102-HD-1
Submitted on: 2/17/2021 8:20:25 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Carol Philips	Individual	Support	No

Comments:

Aloha House Committees on Energy and Environmental Protection and Water and Land,

Please vote to pass HB102 out of committee.

As a life long surfer, (35 years) I have been using "Reef Safe" sunscreens since they have become available and can testify that they work well. There are also other options like wearing surf shirts and hats to protect your skin from the sun. It's not worth the health of our reefs and aquatic life to allow products like these to enter the environment.

Respectfully,

Carol Philips

February 17, 2021

TO: HOUSE OF REPRESENTATIVES HOR COMMITTEE ON CONSUMER PROTECTION & COMMERCE

Wednesday, February 17, 2021 2:00PM Room 329
In SUPPORT of HB102 Relating to sunscreens.

Dear Chair, Vice Chair, and Committee Members,

I, Keely Bruns, a concerned citizen, ocean lover, mother and business owner dedicated to protecting our environment and future, want to pledge my support for bill HB102.

Although the recent Act 104 banning the sale of two toxic chemicals in sunscreen passed, we left a large whole where other toxic chemicals can easily be used in substitution, making the Act 104 ineffective.

Research has found that not only the two toxic chemicals recently banned, Oxybenzone and Octinoxate, are harmful, but up to 14 chemicals found in sunscreen, sunblock and cosmetics, cause significant harm to living organism endocrine systems, causing disruption of hormone levels and the inability to reproduce. These additional chemicals include avobenzone, homosalate, octocrylene, and octisalate.

Palau recently banned 10 ingredients: oxybenzone (benzophenone-3); octinoxate (octyl methoxycinnamate); octocrylene; 4-methyl-benzylidene camphor; triclosan; methyl paraben; ethyl paraben; butyl paraben; benzyl paraben; and phenoxyethanol.

There are many things harming our environment that are may be beyond out control, but by banning ALL harmful, toxic, ingredients in the sale of sunscreen here in Hawaii, we can make a difference.

Hawaii is a year-round market for big industry to make big profits off sunscreen, most likely the biggest sunscreen market in the world. But at what cost to our fragile ecosystem? It is up to us to stand up to big industry that drives profit at the cost of destroying our land.

If we harm our reefs endocrine systems, we harm their ability to reproduce, even if, and when, conditions for a healthy reef begin to thrive. Effective management of these toxic chemicals entering our shorelines can stop and possibly reverse degradation.

There are many non-toxic sunscreens, deemed safe by the FDA, for sale, at price points that are reasonable and even competitive with the toxic sunscreens that contain chemical absorbers. All Good & Raw Elements retails sunscreen at major retails chains across the islands such as (but not limited to) Long's, Target, Costco, Safeway and Foodland for anywhere between $8.99-$21.99. Because alternatives to chemical sunscreens are readily available to keep people safe from burns and skin cancer, there is no need to continue to put an additional stress on our reefs.

Thank you for allowing me to testify on this important issue.

Keely Bruns

concerned citizen, ocean lover, mother and Founder, Good Swell, Inc.

HB-102-HD-1
Submitted on: 2/17/2021 10:15:59 AM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Gabrielle Goodgame	Individual	Support	No

Comments:

February 17, 2021

To: Aaron Ling Johanson, Chair

Lisa Kitagawa, Vice Chair

Members of the Consumer Protection & Commerce Committee

From: Gabrielle Goodgame

Subject: Support of House Bill 102, Relating to Sunscreens

Hello, my name is Gabrielle Goodgame and I am currently a Senior at Kalaheo High School. I strongly believe in House Bill 101 and would like to ask for your support. I urge you to vote in favor of this bill that would ban the sale and distribution of sunscreens that contain avobenzone or octocrylene, without a prescription, to preserve marine ecosystems.

National Geographic states that 14,000 tons of sunscreen are thought to wash into the oceans each year. After Hawaii became the first state in the nation to ban the sale of over-the-counter sunscreens containing oxybenzone and octinoxate, I feel like further efforts to prevent synthetic chemicals like avobenzone and octocrylene from damaging our ecosystems is responsible. For example, research from the journal, Science of the Total Environment, has shown that octocrylene might affect brain and liver development in zebrafish, and has also

been found at detectable levels in various fish species worldwide. By acting now, and not waiting till the marine life and ecosystems that are unique to Hawaii are threatened, we are taking the necessary steps to ensuring that future generations will be able to experience Hawaii's remarkable and distinctive waters in full. Additionally, though suggesting the bill to be put in place in 2023, we are ensuring that the sunscreen market is able to adapt to new needs, and give consumers safe and effective products that do not harm our environment.

If House Bill 102 is passed, measures can be taken against the destructive impacts of oxybenzone and octinoxate to corals and other marine life. Please help this bill pass and take action to preserve our marine ecosystems. Thank you for your time and consideration.

HB-102-HD-1
Submitted on: 2/17/2021 12:13:22 PM
Testimony for CPC on 2/17/2021 2:00:00 PM

Submitted By	Organization	Testifier Position	Present at Hearing
Erin Elizabeth	Individual	Support	No

Comments:

Science has provided ample evidence that long-term exposure to avobenzone and octocrylene commonly found in sunscreens (including those labelled “reef safe”) have been found to have detrimental impact on people and marine life.

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 decreases sperm viability.

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 don't get the body's warning you've been exposed to too much sun. There’s no need to trade the health of marine life in order to protect from the sun exposure. We should utilize UV protective clothing, shade, avoid direct sun mid-day… then choose a safe sunscreen.

There are endless efficient non-nano mineral sunscreens on the market, available in thousands of stores across Hawai'i, offering more efficient broad spectrum protection.

Coral reefs are fundamental to our sustainability. They provide critical habitat for near shore marine life and natural protection against coastal erosion. 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.

Mahalo Nui Loa from reef-safe skincare brand on Maui, HI.