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The cloudy side of sunscreens

New Swiss research shows that the same sunscreen compounds that protect us from ultraviolet radiation could also be endocrine disruptors bioaccumulating in fish.

In a study posted to *ES&T*'s Research ASAP website today ([10.1021/es052088S](http://pubs.acs.org/subscribe/journals/esthag-w/2006/jan/science/te_sunscreens.html)), a team of scientists report high concentrations of two sunscreen ingredients in fish tissue samples taken from rivers in northern Switzerland. The findings imply that on a hot summer day, chances are that if people are wearing sunscreen, it's also likely to be in their drinking water or fish dinner too.



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New research shows that the ingredients in sunscreens, which are suspected endocrine disruptors, are bioaccumulating in fish. Although both Europe and the U.S. have consumer-protection guidelines in place for many of these UV-inhibitor products, regulatory agencies have placed less emphasis on the environmental risks that they pose.

Many of the lotions, lip balms, and other cosmetics that we slather on to protect us from the deleterious effects of too much sun exposure contain chemical compounds that absorb ultraviolet (UV) radiation. Scientists suspect that some of these compounds are endocrine disruptors. In both Europe and the U.S., consumer protection guidelines are in place for many of these UV inhibitor products, but regulatory agencies have placed less emphasis on the environmental risks that they pose.

Ubiquitous in the environment

The Swiss study shows that skin and lip-care products are nearly ubiquitous in populated environments. When people swim, the UV filters in these products can be transferred from their skin into lakes and streams. The chemicals also wash off in the shower and are funneled to wastewater treatment plants, where traces can escape via treated effluent into the environment.

Suncare and lip-care product sales constitute an estimated \$1 billion industry annually in the United States alone, according to market research. And annual production figures for UV filters are estimated in the hundreds of metric tons in Europe, according to a previous study on the chemical contents of wastewater by the new study's corresponding author

[Marianne Balmer](#) (*Environ. Sci. Technol.* **2005**, *39*, [3013–3019](#)). She conducted this latest study with a team of chemists at the Swiss agriculture department's federal research station ([Agroscope FAW](#)) in Wädenswil and the [Swiss Federal Laboratories for Materials Testing and Research](#)'s Laboratory of Organic Chemistry in Dübendorf.

All of the 19 fish tested in the recent study had traces of two of the most commonly used UV filters in Europe—4-MBC (4-methylbenzylidene camphor) and OC (octocrylene). Both chemicals biodegrade slowly and can bioaccumulate, according to the researchers.

Much higher levels in river fish

Compared to another FAW study that analyzed fish from remote Swiss mountain lakes, the river fish accumulated much higher concentrations of both chemicals (*Environ. Sci. Technol.* **2004**, *38*, [390–395](#)). Lipid weight-based concentrations of 4-MBC in the lake species—white fish (*Coregonus*) and roach (*Rutilus rutilus*)—ranged from 20 to 170 parts-per-billion (ppb). The brown trout (*Salmo trutta fario*) from the rivers tested in the current study had concentrations ranging from 50 to 1,800 ppb. OC was mostly absent in the lake fish study—done in conjunction with the Cantonal Food Inspectorate and Institute of Environmental Chemistry at Umeå University—but was found in the river fish at concentrations from 40 to 2,400 ppb.

One explanation for the higher concentrations is wastewater treatment plant inputs, according to one of the report's coauthors, [Hans-Rudolf Buser](#). All of the fish tissue samples in the river study were taken less than 1 kilometer (km) downstream of treatment plants that serve between 6,600 to 48,000 people.

The nearly 10-fold difference in concentrations among lake and river fish sheds light on the environmental transport and fate of these chemicals. "The study shows that UV filters were present in fish from rivers that receive inputs of wastewater," Buser says. "One might argue, therefore, that aerial transport is not a major pathway for the presence, or the distribution, of UV filters in the environment and fish."

The Swiss government's work takes research on pharmaceuticals and personal care products (PPCPs) in the environment to the next level in the U.S., says Dana Kolpin, a hydrologist with the U.S. Geological Survey (USGS). Kolpin and his colleagues [monitor](#) for nearly 100 such compounds in U.S. surface and groundwaters in an effort to uncover the effects of these chemicals on wildlife.

Although the U.S. EPA does not regulate any personal care products and 4-MBC and OC are not currently on USGS's monitoring list, Kolpin says that Balmer's work will help USGS decide how to prioritize further study on specific PPCPs. USGS is modifying its sediment analysis method to include some UV inhibitors and will soon establish a new monitoring protocol for these substances in water, he adds.

According to Thomas Kupper of the [Laboratory of Environmental Chemistry and Ecotoxicology](#) in Lausanne, Switzerland, treatment removes at least 90% of 4-MBC and OC from wastewater. However, levels entering the environment are so high that the chemicals are still detectable in the effluent. In addition, Kupper says that there are other inputs into the environment—and the human body—besides direct and indirect contact with sunscreens, including [UV filters](#) used as plastic stabilizers.

More data needed

Scientists and lawmakers in both the U.S. and Europe agree that more data is needed on the uptake of these chemicals in specific species, discharge rates from treatment plants, river and fish concentrations, and human health effects.

4-MBC is a known endocrine disruptor and was detected in human milk in a 1997 German study, according to Margret Schlumpf, a toxicologist at the University of Zürich's [GREEN Tox](#), or Group for Reproductive, Endocrine, and Environmental Toxicology, which researches the health effects of UV filters. In studies with rats, Schlumpf has shown that some UV filters, including 4-MBC at levels as low as 7 milligrams per kilogram of body weight each day (mg/kg/day), can alter reproductive function and affect birth weight and postnatal survival rates (*Toxicology* **2004**, *205*, [113–122](#)). The significantly higher concentrations in river fish reported in the new study are shocking, she says, and will help further her research.

“[Balmer] gives me data that helps me explain or support my findings,” says Schlumpf. “We think that there is not only one exposure to UV filters in sunscreens by applying the crème on our skin, but there is a second or additional way of exposure through the foodweb.”

But industry sources maintain that UV filters do not produce harmful endocrine disruption effects. Industry studies on the health impacts and environmental fate of both 4-MBC and OC, which are currently under review by European Union (EU) officials, have shown that there is no risk of these chemicals contaminating the food chain at harmful levels, according to Gerald Renner, director of science and research at the [European Cosmetic Toiletry and Perfumery Association](#).

Nevertheless, many manufacturers replaced 4-MBC with one of the other 25 UV filters deemed safe under the [European Union Cosmetics Directive](#) [144KB PDF] after a splash of bad publicity several years ago in Scandinavia, Renner says. At issue were allegations that 4-MBC had estrogenic effects. A subsequent evaluation by EU health officials determined that was not the case, he adds.

Even if there are not measurable human and environmental health effects from 4-MBC and OC, these compounds could have negative synergistic consequences when combined with other UV filters or chemicals found in PPCPs, according to Christian Daughton, chief of EPA's [Environmental Chemistry Branch](#) at the agency's National Exposure Research Laboratory in Las Vegas, Nevada. “If we assume estrogenic activity is additive, we have to consider the combined activities of 20 to 30 sunscreen agents,” Daughton points out.

But Renner contends that a fear of UV filters is unhealthy. “Sunscreen phobia counteracts cancer prevention,” he says, adding that exposure to UV light causes up to 20,000 skin cancer cases per 1 million people annually.

Meanwhile, Buser reports that environmental levels of 4-MBC have been decreasing since 2002 in the Zürich area. The altered product compositions seemed “to have an immediate effect on environmental concentrations,” he says.

Under EU cosmetics legislation, UV filters are tested for consumer safety, but not environmental risks, says Christoph Studer of the Industrial Chemicals Section of the [Swiss Federal Office for the Environment](#), which commissioned Balmer's study. “The results will show if more information is needed on measurements in water, sediment and biota for the refinement of the risk assessments,” Studer says. —TASHA EICHENSEHER