European Commission

Science for Environment Policy

First detection of novel flame retardants in Antarctic species

Groups of chemicals used as flame retardants were present in the bodies of Antarctic rock cod (*Trematomus bernacchii*), young gentoo penguin (*Pygoscelis papua*), and brown skua seabird (*Stercorarius antarcticus*) collected from King George Island, Antarctica. This study is the first to find some of these chemicals in Antarctica, confirming that they undergo long-range transport and can reach isolated areas where they are not widely produced or used.

24 September 2015
Issue 428

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Source: Wolschke, H., Meng, XZ., Xie, Z., Ebinghaus, R. & Cai, M. (2015). Novel flame retardants (N-FRs), polybrominated diphenyl ethers (PBDEs) and dioxin-like polychlorinated biphenyls (DL-PCBs) in fish, penguin, and skua from King George Island, Antarctica. *Marine Pollution Bulletin*. 96(1–2): 513-518. DOI: 10.1016/j.marpolbul.2015.04.012

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Chemicals called polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) were once mass-produced and used as flame retardants globally. In 2004, PCBs were banned by the Stockholm Convention and phased out worldwide, and the European Union and North America both placed restrictions on the use of PBDEs. In 2009, some types of PBDEs were banned globally.

To replace them, industries began producing and using novel flame retardants (N-FRs). All three types of chemicals are potentially persistent organic pollutants (POPs), polluting chemicals that have the ability to persist in the environment for long periods of time.

When smaller organisms or plants are contaminated and eaten by larger and larger organisms, a process called bioaccumulation can occur whereby the concentration of chemicals increases in species higher up the food chain. Additionally, through long-range transportation by the atmosphere and the ocean, chemicals can become trapped in particles dispersed in air and water and travel long distances. This is thought to be the most common reason for their wide dispersal, but the researchers also note that contamination can result from humans working in isolated areas, for example in research stations.

To test if the banned chemicals are still present and if N-FRs have become widely dispersed, researchers tested tissue samples taken from an Antarctic rock cod, a gentoo penguin, and a brown skua collected from King George Island, Antarctica. The seabird and young penguin used in the study were found dead due to natural causes. All three species had several compounds from the three groups of chemicals in their tissues.

Each animal contained a mean concentration of 931 picograms per gram (pc/g) of N-FRs and 681 pc/g of PBDEs. These are both much lower than the mean concentration of PCBs, which was recorded to be 12 800 pc/g. All measurements are dry weights. To the researchers' knowledge, this is the first study showing the presence of N-FRs in organisms in Antarctica.

The skua tissues were the most contaminated. In fact, the amounts in some tissues were between 100 and 1000 times more than in the rock cod and penguin. In the fish and the penguin, the liver had the highest concentrations on average, when compared to the muscle, spleen and stomach. In the skua, the levels were highest in the muscle and spleen. Furthermore, the presence of the chemicals in fish eggs, penguin yolk, and skua ovaries reveal that the chemicals can be passed on to offspring. For example, 85 700 pc/g were found in the skua ovarian sample.

The ecology of the three species may explain why they experience different levels of contamination. Rock cod and penguins have similar diets and places on the food chain, which may be the reason their results were similar. On the other hand, skua is a large, predatory and migratory seabird that feeds on a variety of organisms. It is therefore likely exposed to more contamination.

As all three types of chemicals were usually found together, the researchers say they may have a common source. While long-range dispersal is considered the most common mode of transport, the authors say the effects of tourism and research activities cannot be ignored. They recommend more research and monitoring of chemical flame retardants, particularly those replacing banned ones, and how they are transported to isolated environments.