UVB radiation influences behavior of sticklebacks

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Fish cannot see ultraviolet B rays, but still change their behavior when they grow up under increased UVB intensity. According to studies by biologists at the University of Bonn on three-spined sticklebacks (Gasterosteus aculeatus), increased UVB leads to a smaller body size and more risk-seeking behavior when faced with predators. Climate change is likely to increase UVB intensity, possibly with consequences for ecosystems and fish farming. The results are now being published in *Biology Letters*.

The three-spined stickleback (Gasterosteus aculeatus) occurs almost everywhere in the northern hemisphere and is a popular model organism in experimental biology. With a length of up to ten centimeters, its size is manageable. It gets its name from three dorsal fin spines that can be locked into an erect position. At the Dutch Wadden Sea island of Texel, sticklebacks spend the winter in the sea and migrate to freshwater to reproduce. The specimens that the scientists from the Institute for Evolutionary Biology and Ecology of the University of Bonn used for breeding come from this island.

With the aid of the sticklebacks, the researchers of the working group headed by Prof. Dr. Theo C. M. Bakker investigated the effects of natural ultraviolet B radiation (UVB). "Numerous studies have shown that this high-energy radiation can damage the genome and cells," says evolutionary biologist Dr. Ingolf P. Rick. To what extent the UVB, which is invisible to fish, alters their behavior is largely unexplored.

The scientists divided the offspring that had hatched from artificially fertilized eggs into different treatment groups. Out of 28 sibling groups, half of each group grew up under natural light conditions, the other half exposed to artificially enhanced UVB radiation. "However, the more intense ultraviolet radiation remained well below the maximum levels found in nature," reports Simon Vitt, lead author of the study. This ensures that fish are not damaged by unrealistic overdoses.

After a seven-month treatment phase, the researchers found that the fish in the pools with increased UVB conditions were significantly smaller than those exposed to natural radiation. "Presumably, the sticklebacks exposed to a higher UVB dose have to invest more resources into repairing tissue damage," says Vitt. This is evidently at the expense of their body size and shows that increased UVB has a detrimental effect.

Confrontation with a predator

In a three-part aquarium, the researchers tested the behavior of the two types of stickleback groups. In one chamber swam a trout, a typical predator. At the other end of the water tank was one of the sticklebacks in its own compartment, with an artificial aquatic plant as a hiding place. The actual experimental arena was between trout and stickleback. The researchers simultaneously removed a transparent barrier to the hiding place and a visual shield to the trout chamber. Then the predator appeared behind the glass. The stickleback was now able to leave its compartment and explore the middle chamber.

"Remarkably, the stickleback was not fleeing to escape danger, but moved in circles towards the trout and back again," reports Rick. This was well-known inspection behavior from a safe distance: Fish leave shoals and get closer to an unknown animal to test its dangerousness. It was surprising that those sticklebacks that were smaller as a result of being exposed to UVB radiation for months remained in the exploration

zone for almost twice as long as those that had grown up under natural conditions. These diminutive sticklebacks demonstrated that small certainly does not always equal timid.

The increased risk-seeking behavior could have different causes according to the researchers. Vitt describes one of the possibilities: "The specimens under higher UVB stress may initially perform a more thorough risk check than their larger counterparts, so that they can then dedicate themselves entirely to feeding." But it could also be that the physically restricted individuals show stronger exploratory behavior per se, as information about potential dangers has greater importance for them. A third possibility may also be that the strategy of smaller, more agile animals is to clearly show the trout as a predator that it has been recognized as a danger and that stalking is futile.

"The result is clear: Increased UVB intensity leads to a significant change in behavior, although the fish cannot see this radiation," summarizes Vitt. In the face of climate change, UVB exposure is expected to increase even further. "This can affect ecosystems worldwide, as small changes in predator-prey behavior across complex food webs can have far-reaching consequences," explains Rick. Increased UVB may also be detrimental to aquacultures in shallow water zones.

More information: Simon Vitt et al. Long-term UVB exposure promotes predator-inspection behaviour in a fish, *Biology Letters* (2017). DOI: 10.1098/rsbl.2017.0497

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