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Bad food? How mesozooplankton reacts to blue-green algae blooms

A group of marine researchers around the biologist Natalie Loick-Wilde from the Leibniz-Institute for Baltic Sea Research Warnemünde (IOW) has succeeded in deciphering the mysterious feeding behaviour of mesozooplankton in the presence of cyanobacterial blooms by analysing stable nitrogen isotopes in amino acids. They found out that contradictory observations, according to which both the dominance of herbivorous and carnivorous diets occurred, can be explained by the aging process of a blue-green algal bloom. Apparently, the stage of a bloom determines whether "meat" or "vegetables" are preferred. In view of an assumed future worldwide increase in such blooms, their findings open up new perspectives on potential developments within a key group of the marine food web.

It forms one of the most important pillars of the marine food web worldwide: The so-called mesozooplankton comprises animals floating in the water sized between 0.2 and 20 mm. Their diet varies. There are carnivorous animals as well as "vegetarians", which make direct use of the phytoplankton. Organic material formed by algae and bacteria during primary production is processed by them either directly or in several steps for further use in the oceans' complex food web. Their diet determines whether energy-rich food is available for higher trophic levels – such as fishes – or rather meagre fare, because at each step on the way from phytoplankton to mesozooplankton energy is lost, and larger amounts have to be consumed in order to absorb the same nutritional value. Mesozooplankton thus occupies a key ecological position and the question of whether carnivore or herbivore nutrition prevails at this level can be decisive for the entire oceanic food web.

To determine the exact ratio of carnivores to vegetarians in mesozooplankton, however, has so far only been possible in complex experiments under laboratory or mesocosmic conditions. Natalie Loick-Wilde and her colleagues have now succeeded in making the leap into the real environment with a new approach: Using the analysis of stable nitrogen isotopes in amino acids, she was able to directly determine the ratio of carnivores to herbivores on zooplankton samples from different locations in the Baltic Sea and relate these values to the environmental conditions measured on site.

This approach enables the immediate investigation of a wide range of possible influences on the diet and thus the complexity of the food web as well as the energy content of mesozooplankton. In a recent article published in the international journal "Global Change Biology", the interdisciplinary team of authors consisting of biologists, chemists and physicists describes how these food relationships in mesozooplankton develop under the influence of cyanobacterial blooms.

Large, filamentous, nitrogen-fixing cyanobacteria, such as *Nodularia* or *Trichodesmium*, are regarded as profiteers of the increasingly rapid warming of the oceans. Their influence on mesozooplankton will therefore increase in the future. "The cyanobacteria we are talking about here are relatively large and often produce toxins. They are rather unattractive for zooplankton as food," explains Natalie Loick-Wilde, who heads the working group "Aquatic food webs" at the IOW. How such a rather bad food supply affects feeding behaviour in mesozooplankton

has so far been unclear. Different studies led to contradictory results: Sometimes the dominance of carnivorous was observed, sometimes herbivorous diet prevailed.

Using her new approach, Natalie Loick-Wilde and her interdisciplinary team have now been able to show that the shift towards carnivorous dominance runs parallel to the ageing process of the blooms. The planktonic community became more diverse. In addition to autotrophic primary producers, who only need light and nutrients for their reproduction, heterotrophic microorganisms, which already feed on algae and bacteria, played a major role in the food spectrum of mesozooplankton, which thus became carnivorous instead of herbivorous. The consequences of this for the biogeochemical functions of mesozooplankton and thus also for the higher trophic levels and whether the mechanism can also be transferred to the large, seasonal *Trichodesmium* blooms of the tropical and subtropical oceans are the subject of further research. For Loick-Wilde, however, it is also the biogeochemical models that can benefit from her research: "While the feeding behaviour of mesozooplankton in the models has always been either herbivor or carnivor before, we can now also incorporate the changes into the models that occur under changing environmental conditions. This is a big step towards understanding the dynamics of the food web."

More information:

Loick-Wilde N, Fernández-Urruzola I, Eglite E, Liskow I, Nausch M, Schulz-Bull D, Wodarg D, Wasmund N, Mohrholz V. Stratification, nitrogen fixation, and cyanobacterial bloom stage regulate the planktonic food web structure. Glob Change Biol. 2019;00:1–17. https://doi.org/10.1111/gcb.14546

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