Stoichiometric mismatch between phytoplankton and zooplankton under climate warming and eutrophication

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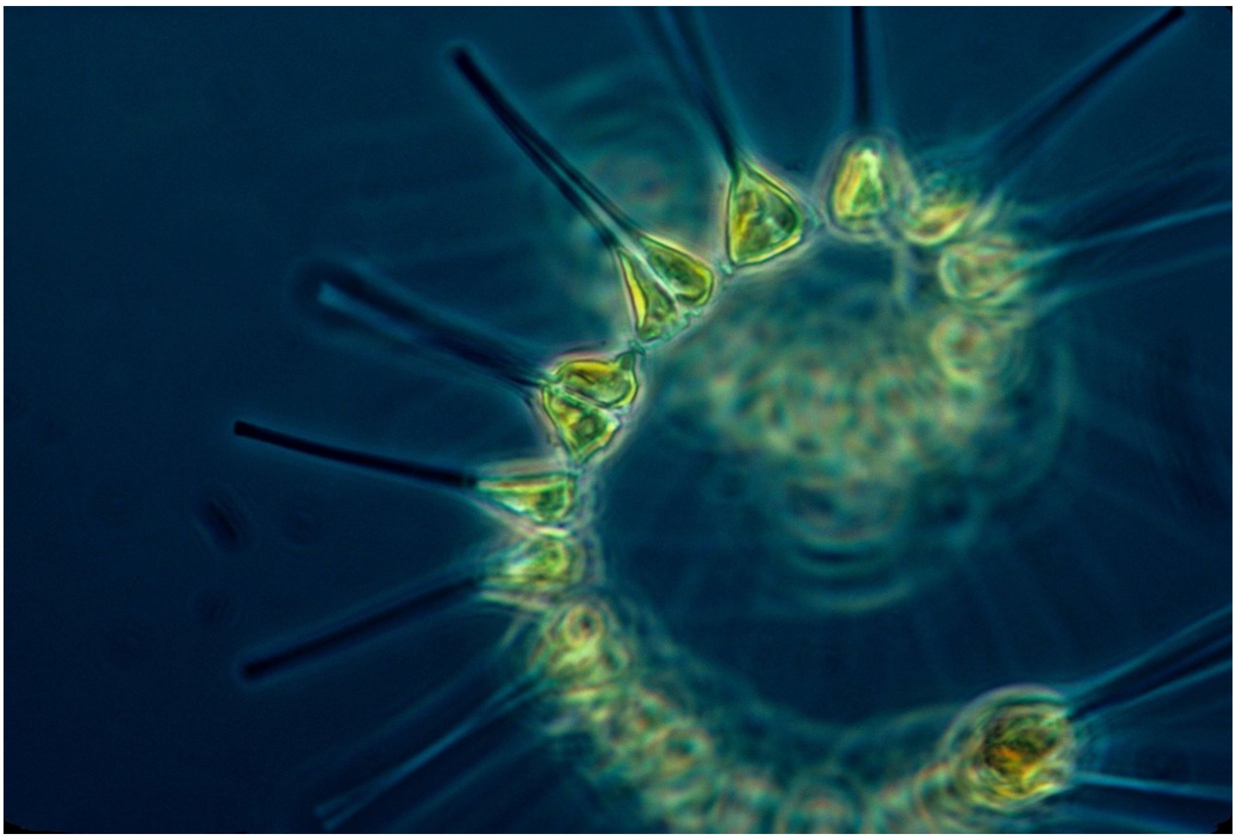

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The aquatic ecosystem functioning is at risk of being disrupted by the stoichiometric mismatch between phytoplankton and zooplankton. When climate warming or eutrophication acted individually, the increase in nutrient demand for zooplankton growth resulted in a growing trend in the stoichiometric mismatch with phytoplankton.

When these stressors acted jointly, the mismatch was reversed due to changes in species composition of the zooplankton community. These results illustrate predicting the effects of global change on stoichiometric mismatches requires consideration not only of cross-trophic levels, but also of compositional changes within communities.

Climate warming and eutrophication have emerged as prominent drivers of global change, posing threats to aquatic ecosystems. Under these ongoing environmental changes, phytoplankton and zooplankton may exhibit divergent responses and result in stoichiometric mismatches between phytoplankton and zooplankton.

This imbalance, as a result, constrains the upward flow of energy within trophic hierarchies. The extent to which climate warming, eutrophication or their interplay intensify these imbalanced elemental ratios between phytoplankton and zooplankton, however, remains unclear.

To investigate this, a team of researchers in China conducted a mesocosm experiment to simulate natural shallow lakes. In a full factorial design, they introduced controlled factors of climate warming (with a consistent temperature rise of 3.5 °C accompanied by heat waves) and eutrophication (via nutrient enrichment).

They observed a growing trend in the stoichiometric mismatch when climate warming or eutrophication acted individually, which was mediated by an increase in nutrient demand by zooplankton for growth. However, when these stressors acted jointly, the mismatch was reversed.

"This phenomenon might be attributed to the tandem influence of climate warming and eutrophication altering the composition of zooplankton species, consequently reshaping the overall stoichiometric configuration within the community," said lead author of the study, Konghao Zhu.

The researchers emphasized that previous studies have primarily focused on the stoichiometric mismatch from a unilateral perspective of phytoplankton or zooplankton, but this mismatch is caused by a combination of changes in phytoplankton and zooplankton.

"This study offered a dual perspective of phytoplankton and zooplankton on the stoichiometric mismatch and revealed the changes in stoichiometric mismatch between phytoplankton and zooplankton under climate warming and eutrophication," added Zhu.

Another challenge came to light during the study. While cross-trophic level stoichiometry enhances comprehension of trophic relationships, it falls short in elucidating the underlying causes of stoichiometric mismatch changes. This limitation arises from the fact that environmental stressors frequently trigger modifications in species composition, consequently introducing complexities to community-level stoichiometry.

"Therefore, understanding the effects of global change on trophic relationships through stoichiometric mismatch requires consideration not only of cross-trophic levels, but also of compositional changes within communities," concluded Zhu.

The research was published in *Water Biology and Security*.

More information: Konghao Zhu et al, Interactive effects of warming and eutrophication on zooplankton could reverse the stoichiometric mismatch with phytoplankton, *Water Biology and Security* (2023). DOI:

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