The interaction between warming and enrichment accelerates food-web simplification in freshwater systems

Willem Bonnaffé*[1], Alain Danet[2], Camille Leclerc[3], Victor Frossard[4], Eric Edeline[5], and Arnaud Sentis[6]

[1]Big Data Institute – Royaume-Uni
[2]University of Sheffield [Sheffield] – Royaume-Uni
[3]INRAE, Aix-Marseille Université, UMR RECOVER, 3275 route Cézanne, 13182 Aix-en-Provence, France – Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE), Aix Marseille Université, Aix Marseille Université – France
[4]Centre Alpin de Recherche sur les Réseaux Trophiques et Ecosystèmes Limniques (CARRTEL) – Université de Savoie, Institut national de la recherche agronomique (INRA) : UMR0042 – Station d'Hydrobiologie Lacustre 75 Av. de Corzent Thonon les Bains F-74203 France, France
[5]Écologie et santé des écosystèmes (ESE) – Institut National de la Recherche Agronomique : UMR985, Agrocampus Ouest – AGROCAMPUS OUEST 65 rue de Saint-Brieuc 35042 Rennes cedex, France
[6]Risques, Ecosystèmes, Vulnérabilité, Environnement, Résilience – Aix Marseille Université, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement : UMR1467 – France

Résumé

Nutrient enrichment and climate warming threaten freshwater systems. Metabolic theory and the paradox of enrichment predict that both stressors independently can lead to simpler food-webs having fewer nodes, shorter food-chains, and lower connectance, but cancel each other's effects when simultaneously present. Yet, these theoretical predictions remain untested in complex natural systems. We inferred the food-web structure of 256 lakes and 373 streams from standardised fish community samplings in France. Contrary to theoretical predictions, we found that warming shortens fish food-chain length and that this effect was magnified in enriched streams and lakes. Additionally, lakes experiencing enrichment exhibit lower connectance in their fish food-webs. Our study suggests that warming and enrichment interact to magnify food-web simplification in nature, raising further concerns about the fate of freshwater systems as climate change effects will dramatically increase in the coming decades.

Mots-Clés: biochemical oxygen demand, connectance, fish, lake, maximum trophic level, stream, trophic interaction

*Intervenant