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Influences of pesticides, nutrients, and local environmental variables on phytoplankton communities in lentic small water bodies in a German lowland agricultural area

Lishani Wijewardene¹; Naicheng Wu¹; Yuesheng Qu¹; Kun Guo²; Beata Messyas³; Stefan Lorenz⁴; Tenna Riis²; Uta Ulrich¹; Nicola Fohrer¹

¹ Christian-Albrechts-Universität Kiel, Institut für Natur- und Ressourcenschutz; ² Aarhus University; ³ Adam Mickiewicz University in Poznan - Institute of Environmental Biology; ⁴ Julius Kühn-Institute

Agrochemicals such as pesticides and nutrients are concurrent chemical stressors in freshwater aquatic ecosystems surrounded by agricultural areas. Lentic small water bodies (LSWB) are ecologically significant habitats especially for maintaining biodiversity but highly understudied. Phytoplankton are ideal indicator species for stress responses. Functional features of the phytoplankton are important in revealing the processes that determine the structure of the communities. In this study, we investigated the effects of pesticides, nutrients, and local environmental variables on the species composition and functional features of phytoplankton communities in LSBW. We studied pesticide toxicity of ninety-four pesticides, three nutrients (NH₄-N, NO₃-N and PO₄-P) and local environment variables (precipitation, water level change, temperature, dissolved oxygen concentration, electrical conductivity, pH) in five LSBW over twelve weeks during the spring pesticide application period. We explored respective changes in species composition and functional features of phytoplankton community. Redundancy analysis and variance partitioning analysis were applied to correlate phytoplankton community compositions with the pesticide toxicity (as maximum toxicity in toxic units), nutrients and local environment variables. We used multiple linear regression models to identify the main environmental variables driving the functional features of phytoplankton communities. Pesticide toxicity, nutrients and local environmental variables significantly ($p < 0.001$) contributed to shaping phytoplankton community composition individually. Local environment variables showed the highest pure contribution for driving phytoplankton composition (12%), followed by nutrients (8%) and pesticide toxicity (2%). Functional features of the phytoplankton community were significantly affected by pesticide toxicity and nutrient concentrations. The functional richness and evenness were negatively affected by PO₄-P concentrations. Pesticide toxicity was positively correlated with functional redundancy indices. Our findings emphasized the relative importance of concurrent multiple stressors (e. g., pesticides and nutrients) on phytoplankton community structure, directing potential effects on metacommunity structures in aquatic ecosystems subjected to agricultural runoff.