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Editorial: Freshwater biodiversity and ecosystem functioning: novel ideas and approaches

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Editorial on the Research Topic
Freshwater biodiversity and ecosystem functioning: novel ideas and approaches

The extensive loss of the biodiversity in recent decades has sparked interest in exploring the mechanisms that control distribution and coexistence of both terrestrial and aquatic organisms. There has also been growing enthusiasm for better understanding the biodiversity and ecosystem functioning relationship (BEF relationship). However, studying biodiversity is inherently complicated due to its multifaceted characteristics in dimensions, scales, and measures. In most studies, the focus has been on taxonomic biodiversity, such as species richness, as the only measure of biodiversity. The importance of functional and phylogenetic diversity is increasingly recognized, as they encompass other dimensions of biodiversity. Functional diversity, which can be calculated from species trait compositions, is thought to be more strongly associated with ecosystem functioning than does taxonomic composition. Phylogenetic diversity, usually inferred from genetic data, also provides complementary information on ecological functioning.

This Research Topic aims to provide a platform for freshwater ecologists to present and elaborate their research ideas and findings regarding (i) the couplings among taxonomic, functional, and phylogenetic diversity in freshwater ecosystems, (ii) the freshwater BEF relationships, and (iii) the drivers of these couplings and/or relationships. We finally included eight papers in the Research Topic. These papers cover wide ranges of geographic regions, ecosystem types, organism groups, and methods for quantifying biodiversity and ecosystem functioning. The study regions encompass Asia, Eastern North America and Northwestern Europe, and the studied organisms include phytoplankton, submerged macrophytes, and microbes in lakes, as well as benthic macroinvertebrates and benthic diatoms in streams and rivers. Among these eight papers, six were based on field studies, of which a majority focused on both taxonomic and functional or genetic diversity metrics, or addressing the BEF relationships. Additionally, there is one hypothesis and theory paper and one methods paper.

Meng et al. found spatiotemporal variation in taxonomic diversity of phytoplankton in a Chinese shallow lake. In the dry season, lake water physical variables and nutrients had greater impacts on phytoplankton community composition, while spatial factors influenced phytoplankton community composition and α diversity during the wet season. TN, TP, and ammonium exerted greater influence on community composition in the dry and normal seasons.

Lento et al. examined trait patterns of Arctic stream benthic invertebrate communities along latitudinal and climatic gradients in Eastern North America and Northwestern Europe. They found differences in taxonomic compositions but similar functional trait niches between continents. Their data show a greater diversity of trait modalities at lower latitudes but a reduced trait diversity at higher latitude. The invertebrate trait compositions at higher latitudes reflected adaptations to extreme cold conditions. The strong relationship with air temperature suggests Arctic warming will shift trait compositions.

Liu et al. investigated the ecological processes shaping benthic macroinvertebrate communities in a Chinese river network. They found that environmental filtering, spatial processes, and biotic interactions jointly determined taxonomic and trait compositions. Spatial processes were more important than environmental filtering, while biotic interactions had lesser impacts. The importance of the processes varied among trait groups.

Zhao et al. analyzed microbial communities in 51 Chinese lakes with different terrain ladders. They observed six taxa dominating across the lakes, although the microbial abundance differed among terrain ladders. Further analysis on the metagenomics of six lakes from different ladders revealed that the six dominant taxa played lake-specific roles in multiple metabolic processes.

Wen et al. surveyed the submerged macrophyte communities in a Chinese plateau Lake. They found a positive correlation between community biomass and species richness in both shallow and deeper water. The regression slope became more pronounced in deeper waters, indicating variation in the richness-biomass relationship along depth and light gradients.

Liu et al. examined the effects of species and functional diversity on community biomass of benthic diatoms in a Chinese mountainous river network. They found that species richness and evenness had mixed effects on community biomass, with no clear interaction. Species diversity directly and indirectly influenced community biomass, suggesting a dominant selection effect with a minor role of complementary effect.

Thorp et al. extended the Riverine Ecosystem Synthesis framework describing the critical environmental elements that change from upstream to downstream and from the main channel to the riverscape and floodscape. In this updated version, they added four conceptual tenets to address the varying importance of Functional Process Zones to lotic biodiversity and ecosystem functions along the longitudinal and lateral dimensions of rivers.

Lai et al. developed the Freshwater Algae Database (FWAlgaeDB), an open-access platform integrating taxonomic classifications, distributions, genome sequences, and gene-function annotations for 204 freshwater algal species. FWAlgaeDB is designed as a continuously updated resource, with the aim of including more algal species in the future and serving as a valuable tool for algal research.

Overall, this Research Topic provides valuable field data, theoretical models, and a novel platform that shed light on the underlying drivers of spatiotemporal patterns of freshwater biodiversity and associated ecosystem functioning. Findings from these studies highlight the importance of combining the use of taxonomic, functional, and phylogenetic diversity measures to deepen our understanding of freshwater biodiversity. We have also recognized the context-dependence of BEF relationship and that different ecological mechanisms simultaneously determine these relationships.

We hope that our readers will enjoy this Research Topic, and this Research Topic will stimulate more investigations on freshwater biodiversity and ecosystem functioning, and more research collaborations among aquatic ecologists in the future.

Author contributions

TT: Writing – original draft, Writing – review & editing. DL: Writing – review & editing. M-CC: Writing – review & editing. PV: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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