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Article

Metacommunity Concepts Provide New Insights in Explaining Zooplankton Spatial Patterns within Large Floodplain Systems

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Supplementary data

Glossary table: Definitions of the general terms used throughout this paper

Metacommunity: The metacommunity has been defined as a set of local communities that are linked by dispersal of multiple potentially interacting species [13].

Niche theory: one of the three theories embed in the metacommunity concept [13].

Netural theory: one of the three theories embed in the metacommunity concept [13].

Local processes: niche-assemly

Regional processes: dispersal assembly

Spatial heterogeneity: Spatial heterogeneity is a property generally ascribed to a landscape or to a population. It refers to the uneven distribution of various concentrations of each species within an area.

Biotic homogenization: Biotic homogenization refers to an increase in floral and faunal similarity amongst communities or a decrease in beta diversity over time along with environmental homogenization [56].

Flood pulse concept: The flood pulse concept explains how the periodic inundation and drought (flood pulse) control the lateral exchange of water, nutrients and organisms between the main river channel (or lake) and the connected floodplain [2].

Methods

Methods for canonical ordination, variation partitioning

The variation of zooplankton community matrix was explanied by 2 explanatory matrices: flood pulse related physical variables (HYDRO): flow velocity, salinity/degree of mineralization, water depth and secchi depth and limnoligical variables (LIMNO): water temperature, pH, chlorophyll a, oxidation-reduction potentiometer, total nitrogen, total phosphorous, chemical-oxygen demand, turbidity and NH_4). Collinear variables in the explanatory tables were removed prior to partitioning.

Negative values of R^2 are interpreted as zeros; they correspond to cases where the explanatory variables explain less variation than random normal variables would.

We performed a based variation partitioning redundancy analysis (pRDA) to assess the relative effects of environmental and spatial variables on community composition. The amount of variation in species abundance that was explained uniquely by the FLOOD variables and LIMNO variables of the floodplain lakes was compared. When testing for unique effects of FLOOD configuration, all LIMNO variables were used as covariables, and vice versa.

The statistical significance of these different components was evaluated by Monte Carlo permutations tests (1000 permutations under the reduced model).

Results

Zooplankton compositions within and among lakes

During the high water level season, the cladoceran community consisted of *Bosmina*, *Diaphanosoma*, and *Ceriodaphnia* (Figure 4c) in all lakes, the relative abundance of *Ceriodaphnia* being relatively higher in DT and JS than in PY. Among the copepods, nauplii and copepodite stages were more abundant than the adult stages. During the high water level season, PY had the highest zooplankton biomass. In this season, the average zooplankton biomass in DT was only 52.6% of that in PY and 78.9% of that in JS. During the low water level season, the zooplankton biomass was highest in JS, followed by PY and DT. The biomass of DT was only 22.7% of that in PY and less than 1% of that in JS. During the low water level season, the cladocerans consisted almost entirely of large-bodied *Daphnia* in JS and PY, while *Bosmina* dominated in DT (Figure 4c). The biomass of copepods was dominated by adult calanoids (Figure 4d) in Lake PY and DT.

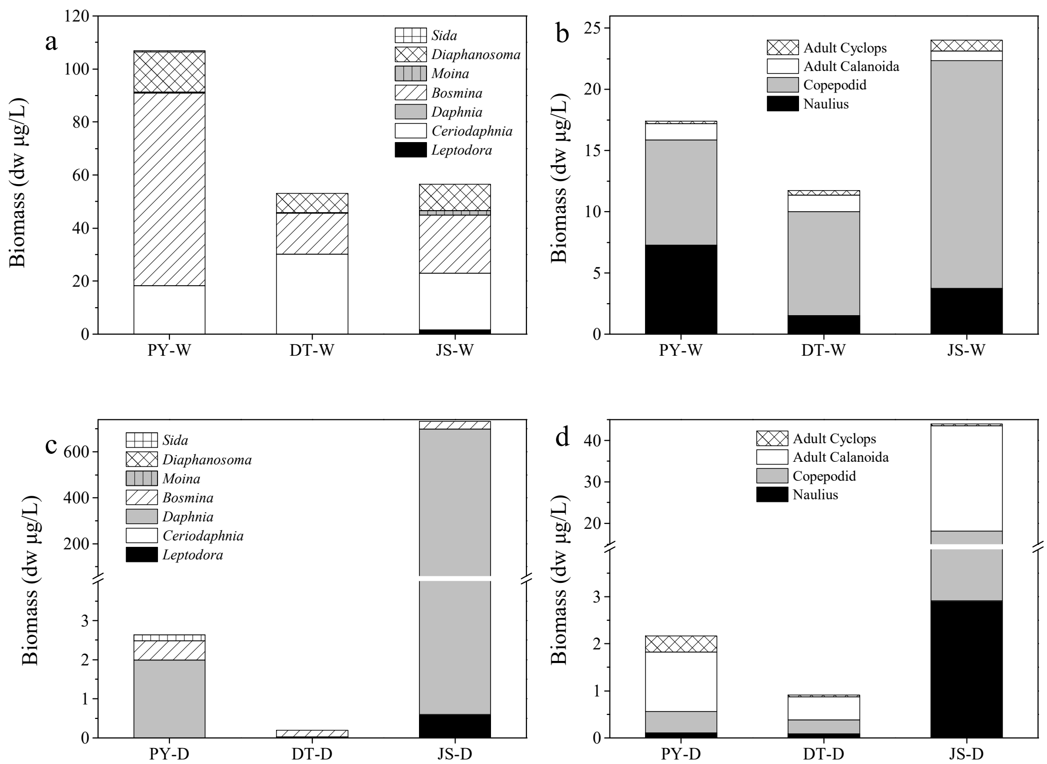

Figure S1. Cladoceran (**a**,**c**) and copepod (**b**,**d**) biomass dynamics of Lake Poyang (PY), Dongting (DT) and Junshan (JS) during the low-water level season (-D) and the high water level season (-W).

Similarity analysis on zooplankton community structures within and among lakes

Similarity analysis (ANOSIM) showed that the biomass composition of cladocerans and copepods differed significantly ($p < 0.05$) between the lakes in both the high and low water level season (Figure S2). During the high water level season. the "R" value being near "0", which implies that the within-lake similarity was as high as between-lakes dissimilarity. Besides, the distribution of the "unifrac distance value" within DT and PY was as high as the between-lake value, implying a high intra-lake spatial heterogeneity in these two lakes. During the low water level season, the zooplankton community showed significant difference between the lakes ($p = 0.001$), whereas intra-lake heterogeneity was low (high R value).

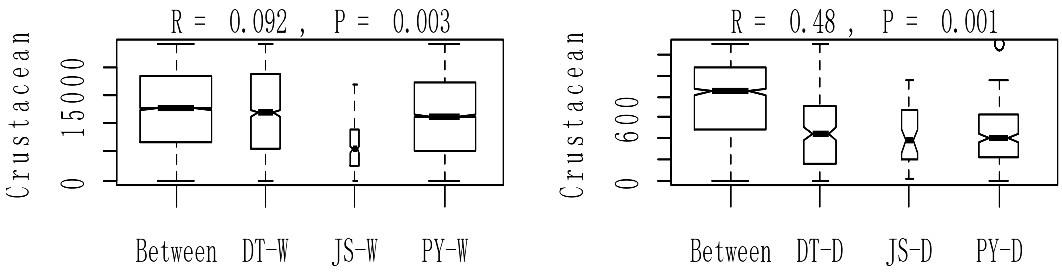

Figure S2. Analysis of cladoceran and copepod biomass similarity between Lakes Dongting (DT), Poyang (PY) and Junshan (JS) during the high water level season (-W, **Left**) and the low water level season (-D, **Right**). The Y axis represents the order of unifrac distance (improving) (−1< R<1: −1<R<0, ingroup differences are larger than inter-group differences; R = 0, no differences; 0<R<1, inter-group differences are larger than ingroup differences).

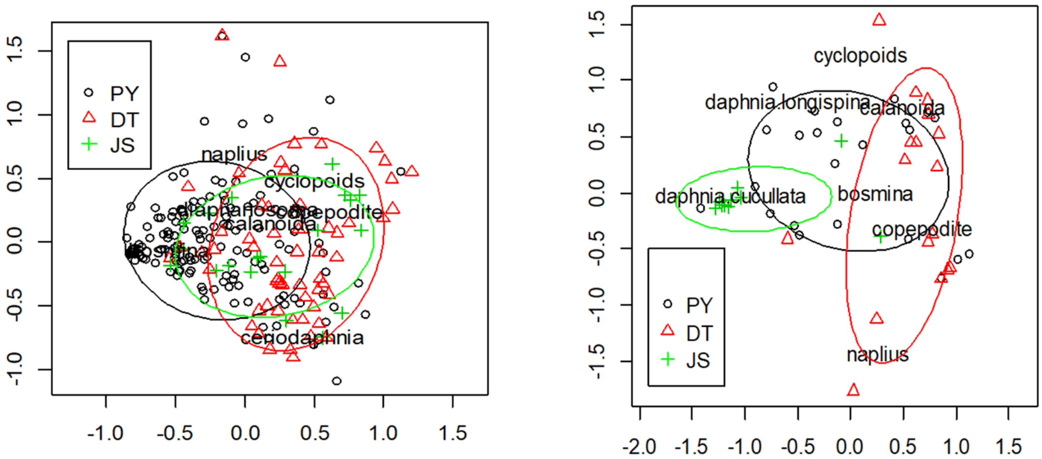

Figure S3. Biplot of the first two axes for the Non-metric Multidimensional Scaling (NMDS) analysis of crustacean zooplankton biomass in Lakes Poyang (PY), Dongting (DT) and Juanshan (JS) during the high-water level season (**Left**) and the low-water level season (**Right**).

The biplot of the first two axes of NMDS showed high inter-lake similarity as also ANOSIM did during the flood seasons. Furthermore, the zooplankton community in Lake DT showed high dissimilarity with Lake PY and characterizing with high biomass ratio of copepodites, and low biomass ratio of *Bosmina* (see also Figure S1). However, with the absence of flood pulse zooplankton community in Lake DT were rather different from Lake JS. The former was characterized by high biomass ratio of juvenile copepods and the latter by *Daphnia*.

Table S1. Comparison of environmental variables between Dongting (DT), Lake Poyang (PY) and Junshan (JS) in the flood and dry seasons; TN: total nitrogen, TP: total phosphorus, COD: chemical oxygen demand.

	High water level season			Low water level season		
	PY	**DT**	**JS**	**PY**	**DT**	**JS**
Secchi depth (m)	0.66	0.49	0.58	0.38	0.57	0.94
Water temperature (℃)	30.5	29.5	30.1	5.4	7.8	12.9
pH	8.40	8.99	8.76	8.08	8.91	8.05
Conductivity(μ S/cm)	88.8	304.4	73.3	152.8	262.5	68.8
Chl a (μg/l)	7.0	7.7	5.7	3.1	3.0	2.1
Turbidity	37.8	46.6	36.0	73.3	71.5	24.3
TN (mg/l)	1.06	1.79	0.83	1.92	2.12	0.56
TP (mg/l)	0.05	0.08	0.04	0.10	0.24	0.01
COD (mg/l)	2.52	2.96	2.92	2.01	1.95	2.02