

# Zooplankton Structure and Ecological Niche Differentiation of Dominant Species

## in Tahe Bay, Lushun, China

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## Introduction

- Zooplankton are important food organisms in the marine ecosystem, and their community structure and distribution reflect the productivity of the waters.
- The current research on zooplankton mainly focuses on the analysis of the zooplankton community structure, the species composition, and their relationship with environmental factors, but there are relatively few studies on the ecological niche differentiation of dominant species in zooplankton communities.
- Lushun Tahe Bay is located in the sea near Longwangtang Town, Lushun South Road, Dalian City, Liaoning Province. The waters are mainly used for aquaculture with wakame rafts and artificial reefs. It is an important fishery culture area in Lushun.
- This study analyzed the changes in the zooplankton structure and quantity in Tahe Bay, calculated the ecological niche correlation index, and searched for the factors influencing the ecological niche differentiation of the dominant species, which provided basic information for an in-depth understanding of the interspecific relationship of zooplankton and the adaptation mechanism of zooplankton to environmental changes in the waters of Tahe Bay and provided theoretical references for the sustainable development of fisheries in this sea area.

## Results

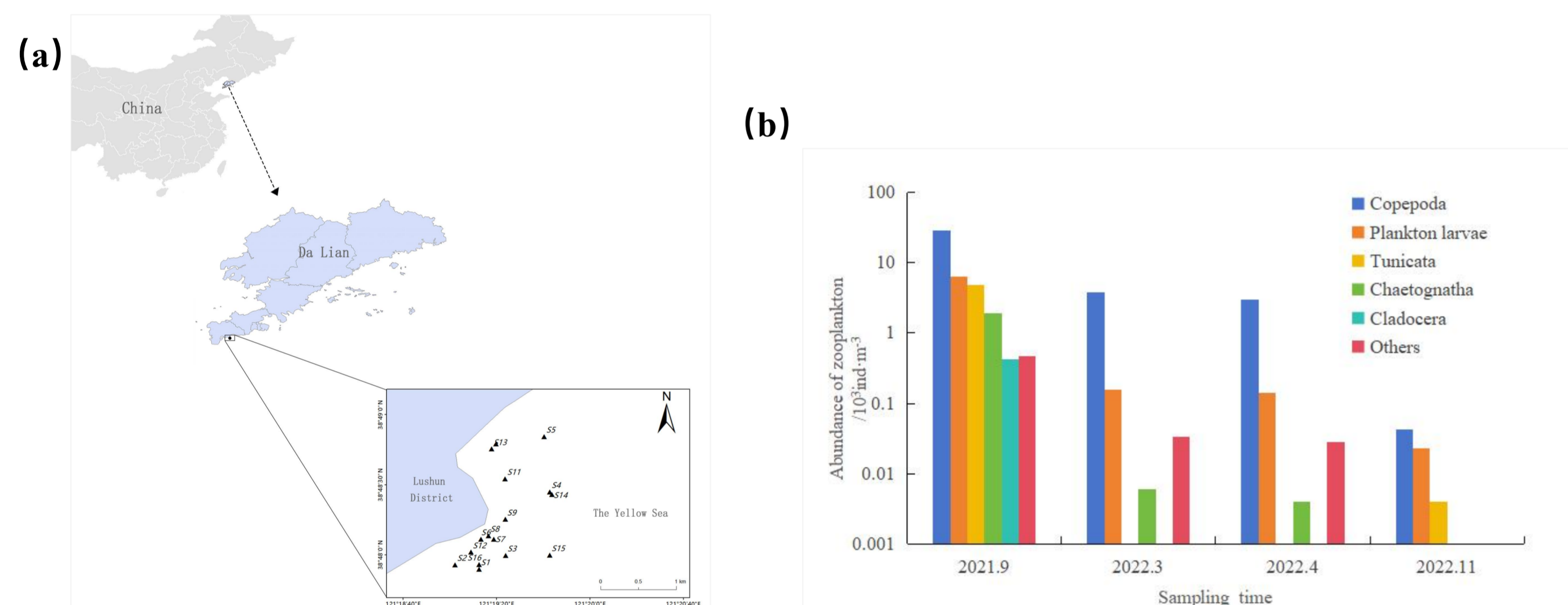


Figure 1. (a) Map of survey stations in the sea area of Tahe Bay, Lushun. (b) The zooplankton abundance at different sampling times in the Tahe Bay waters.

Taxa	September 2021 (End of Summer)	March 2022 (End of Winter)	April 2022 (Spring)	November 2022 (Autumn)
Copepoda	5	8	7	5
Cladocera	1	0	0	0
Planktonic larvae	2	6	6	3
Tunicata	1	0	0	1
Chaetognatha	1	1	1	1
Others	1	3	3	0

Sampling Time	Zooplankton		
	Shannon–Wiener's Diversity Index (H')	Margalef's Index (D)	Pielou Index (J)
September 2021	2.05	0.94	0.70
March 2022	0.86	1.93	0.14
April 2022	2.22	1.81	0.34
November 2022	2.81	4.99	0.29
Median	2.14	1.87	0.32

Table 1. Analysis of zooplankton community structure. (a) Number of zooplankton species in the waters of Tahe Bay in 4 different seasons. (b) Number of zooplankton species and evaluation indices in the sea area of Tahe Bay.

## Conclusion

- During the investigation of the Tahe Bay waters, a total of 31 species, representing four phyla, were identified. The zooplankton taxa were dominated by Copepoda (13 species, accounting for 41.94%). The abundance range of zooplankton was 71~42,458.26 ind/m<sup>3</sup>, with the highest value in summer and the lowest in autumn.
- The number of dominant species was the highest in summer and the lowest in winter, and *Oithona similis* was always the dominant species in all seasons, with a niche width of 0.64–1.00, therefore being the main food organism in the waters of Tahe Bay.
- The degree of ecological niche overlap of dominant species was seasonally related, and the proportion of a severe ecological niche overlap accounted for 86.7% in autumn, 81.0% in summer, and 33.3% in spring, and there was no ecological niche overlap in winter. The competition among zooplankton species may be more intense in autumn, followed by summer. Therefore, increasing the abundance of bait organisms (phytoplankton) in the waters may alleviate interspecific competition.
- Pearson's correlation of zooplankton abundance and community diversity with environmental factors, such as water temperature, salinity, DO, NH<sub>3</sub>-N, and NO<sub>3</sub>-N, was significant in the waters of Tahe Bay. The results of redundancy analysis (RDA) showed that water temperature, salinity, DO, and DIP are the main environmental factors affecting the ecological niche differentiation of dominant zooplankton species.
- The results of this study can provide a reference for understanding the dynamics of planktonic animals and sustainable use of fishery organisms in the waters.

Serial Number	Species Name	Dominance Index			
		September 2021 (End of Summer)	March 2022 (End of Winter)	April 2022 (Spring)	November 2022 (Autumn)
B01	<i>Oikopleura dioica</i>	0.114			0.027
B02	<i>Parvocalanus crassirostris</i>	0.256			
B03	<i>Corycaeus affinis</i>	0.193			
B04	Pluteus	0.091			
B05	<i>Oithona setigera</i>	0.049			
B06	<i>Oithona similis</i>	0.051	0.035	0.044	0.227
B07	<i>Sagitta crassa</i>	0.023			
B08	<i>Euterpina acutifrons</i>		0.820	0.819	
B09	Copepoda nauplius			0.030	
B010	Harpacticidae				0.118
B011	<i>Paracalanus parvus</i>				0.245
B012	Polychaeta larvae				0.082
B013	Copepoda larvae				0.15

Table 2. Analysis of dominant species. Dominant zooplankton species in the waters of Tahe Bay.

Code	B <sub>i</sub>	Q <sub>ik</sub>						
		B01	B02	B03	B04	B05	B06	B07
B01	0.71	1						
B02	0.94	0.78	1					
B03	0.84	0.94	0.82	1				
B04	0.94	0.44	0.89	0.60	1			
B05	0.96	0.75	0.50	0.86	0.29	1		
B06	1.00	0.34	0.84	0.40	0.93	0.00	1	
B07	0.92	0.29	0.80	0.33	0.90	0.00	0.97	1

Code	B <sub>i</sub>	Q <sub>ik</sub>			
		B06	B08	B09	B09
B06	1.00	1			
B08	0.34	0.01	1		
B09	0.96	0.91	0.42	1	

Code	B <sub>i</sub>	Q <sub>ik</sub>						
		B01	B010	B011	B06	B012	B013	
B01	0.90	1						
B010	0.80	0.49	1					
B011	0.88	0.84	0.81	1				
B06	0.64	0.89	0.63	0.95	1			
B012	1.00	0.77	0.55	0.88	0.85	1		
B013	0.68	0.82	0.73	0.89	0.91	0.60	1	

Table 3. Ecological niche analysis of dominant species. Zooplankton niche width (B<sub>i</sub>) and niche overlap (Q<sub>ik</sub>) statistics in September 2021(a), March(b), April(c) and December (d) 2022.

Zooplankton Community Indicator	Water Temperature (°C)	Salinity	pH	Dissolved Oxygen Concentration (mg/L)	Chemical Oxygen Demand (mg/L)	Ammonia-Nitrogen Content (µg/L)	Nitrate-Nitrogen Content (µg/L)	Nitrite-Nitrogen Content (µg/L)	Inorganic Phosphorus Content (µg/L)
H'	0.166	-0.024	-0.094	-0.325	-0.137	0.13	0.017	0.111	-0.159
J	0.379	-0.168	-0.518	-0.864 **	-0.281	0.471	0.014	0.397	-0.705 **
D	-0.645 *	0.677 **	-0.256	0.343	0.244	-0.658 *	-0.560 *	-0.608 *	0.013
Abundance of Copepoda	0.935 **	-0.920 **	0.391	-0.546 *	-0.321	0.909 **	0.778 **	0.848 **	0.015
Abundance of Tunicata	0.780 **	-0.727 **	0.211	-0.582 *	-0.03	0.900 **	0.703 **	0.753 **	-0.088
Abundance of planktonic larvae	0.927 **	-0.837 **	0.286	-0.616 *	-0.467	0.897 **	0.626 *	0.881 **	-0.124
Abundance of other zooplankton	0.408	-0.414	0.118	-0.327	-0.016	0.231	0.486	0.145	0.087
Abundance of Cladocera	0.411	-0.369	0.122	-0.268	-0.319	0.313	0.254	0.179	-0.017
Abundance of Chaetognatha	0.587 *	-0.51	0.18	-0.363	-0.525	0.515	0.267	0.539 *	-0.115

Note: \*\* indicates a significant correlation at the 0.05 level (two sided); \*\*\* indicates a significant correlation at the 0.01 level (two sided).

Table 4. Pearson correlation analysis. Correlation of zooplankton community indicators with environmental factors.

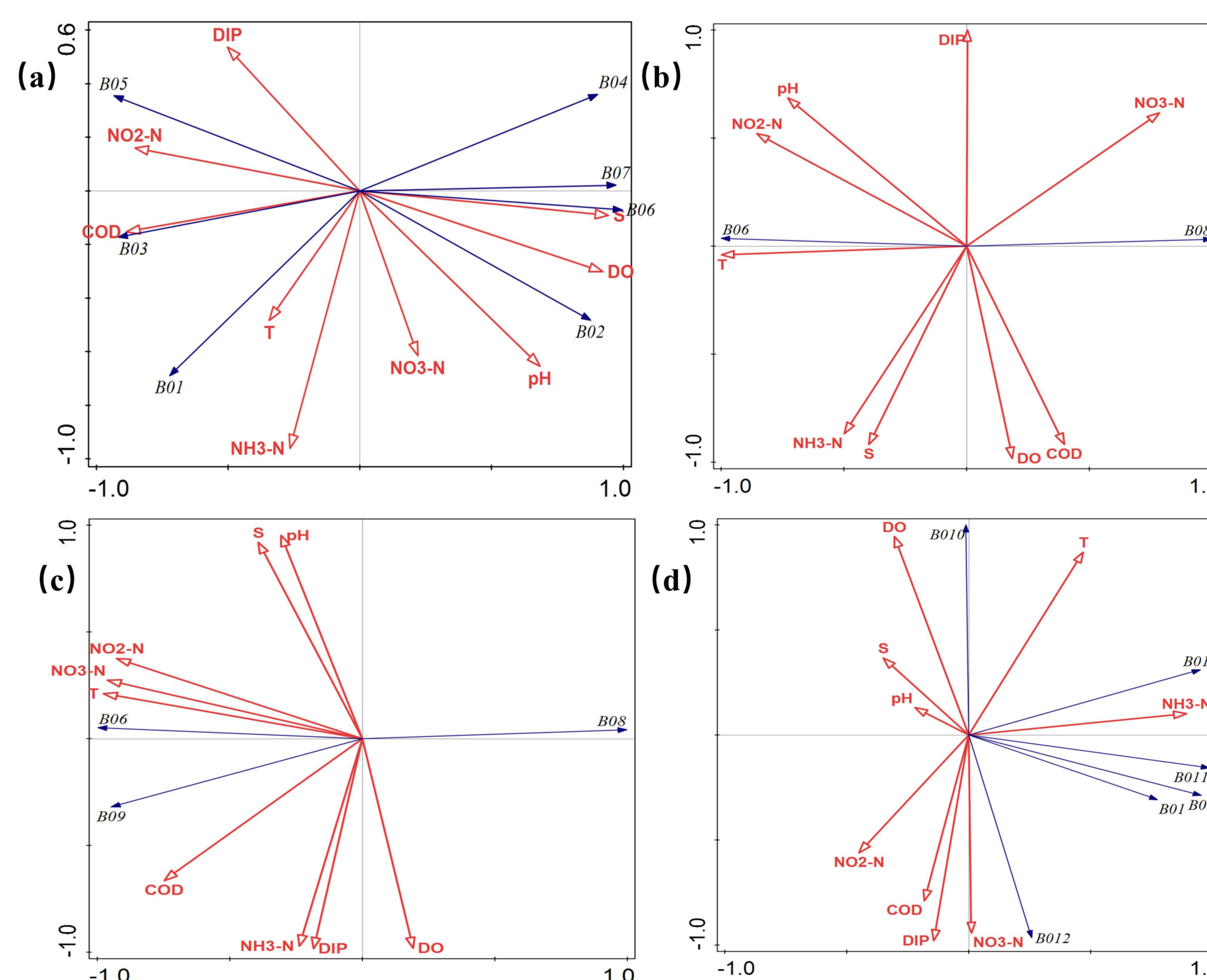


Figure 2. Redundancy analysis of zooplankton and environmental factors in September 2021(a), March(b), April (c) and December (d) 2022.