Organic Carbon and Eukaryotic Predation Synergistically Change Resistance and Resilience of Aquatic Microbial Communities

Wenwen Fang

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Xiaokun Liu

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Xing Mu

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Jiangjian Shi

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Zhiwei Liang

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Shengzhi Zheng

China State Science Dingshi Environmental Engineering Co., Ltd., Beijing, PR 9 China 100028

Xiang Tu

State Environmental Protection Key Laboratory of Source Water Protection, Chinese 11 Research Academy of Environmental Sciences, Beijing, PR China 100012

Zhili He

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275

Shanquan Wang (wangshanquan@mail.sysu.edu.cn)

Environmental Microbiomics Research Center, School of Environmental Science 5 and Engineering, Guangdong Provincial Key Laboratory of Environmental Pollution 6 Control and Remediation Technology, Southern Marine Science and Engineering 7 Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China 510275 https://orcid.org/0000-0002-5880-5894

Research Article

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Abstract

With dramatic global rise of urbanization, anthropogenic activities alter aquatic ecosystems in urban rivers through inputs of dissolved organic carbon (DOC) and nutrients. Microorganisms play crucial roles in global biogeochemical element cycles, providing functions to sustain microbial ecology stability. The DOC (bottom-up control) and microbial predation (top-down control) may synergistically drive the competition and evolution of aquatic microbial communities, and their resistance and resilience, of which experimental evidences remain scarce. In this study, laboratory sediment-water column experiments were employed to mimic the organic carbon-driven water blackening and odorization process in urban rivers and to elucidate impacts of DOC on the microbial ecology stability. Results showed that low DOC (25-75 mg/L TOC) and high DOC (100-150 mg/L TOC) changed the aquatic microbial community assemblies in different patterns: (1) the low DOC enriched K-selection microorganisms (e.g., bacteria and predators) with low biomass and low resilience, as well as high resistance to perturbations in changing microbial community assemblies; (2) the high DOC was associated with r-selection microorganisms with high biomass and improved resilience, together with low resistance detrimental to microbial ecology stability. Overall, this study provided new insights into impacts of DOC on aquatic microbial ecology stability, which may guide sustainable urban river management.

Full Text

This preprint is available for download as a PDF.

Figures

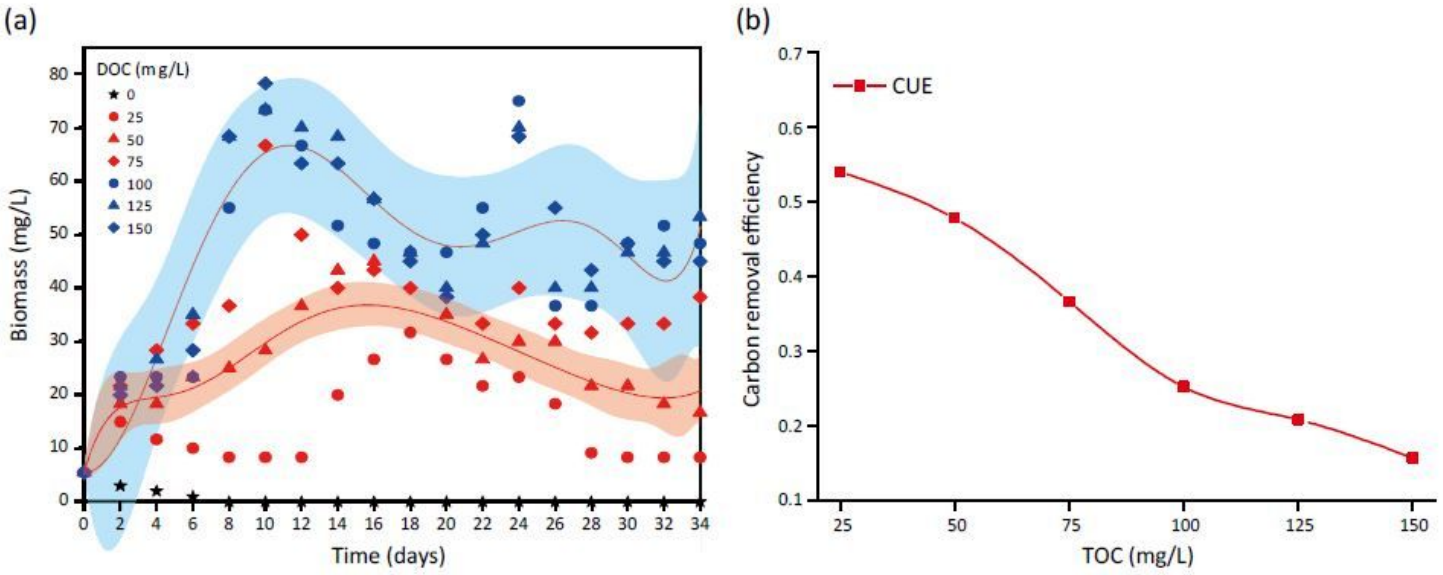

Figure 1

Impact of gradient concentrations of DOC on the biomass and carbon use efficiency (CUE) of water microbial communities (a) Biomass (b) CUE

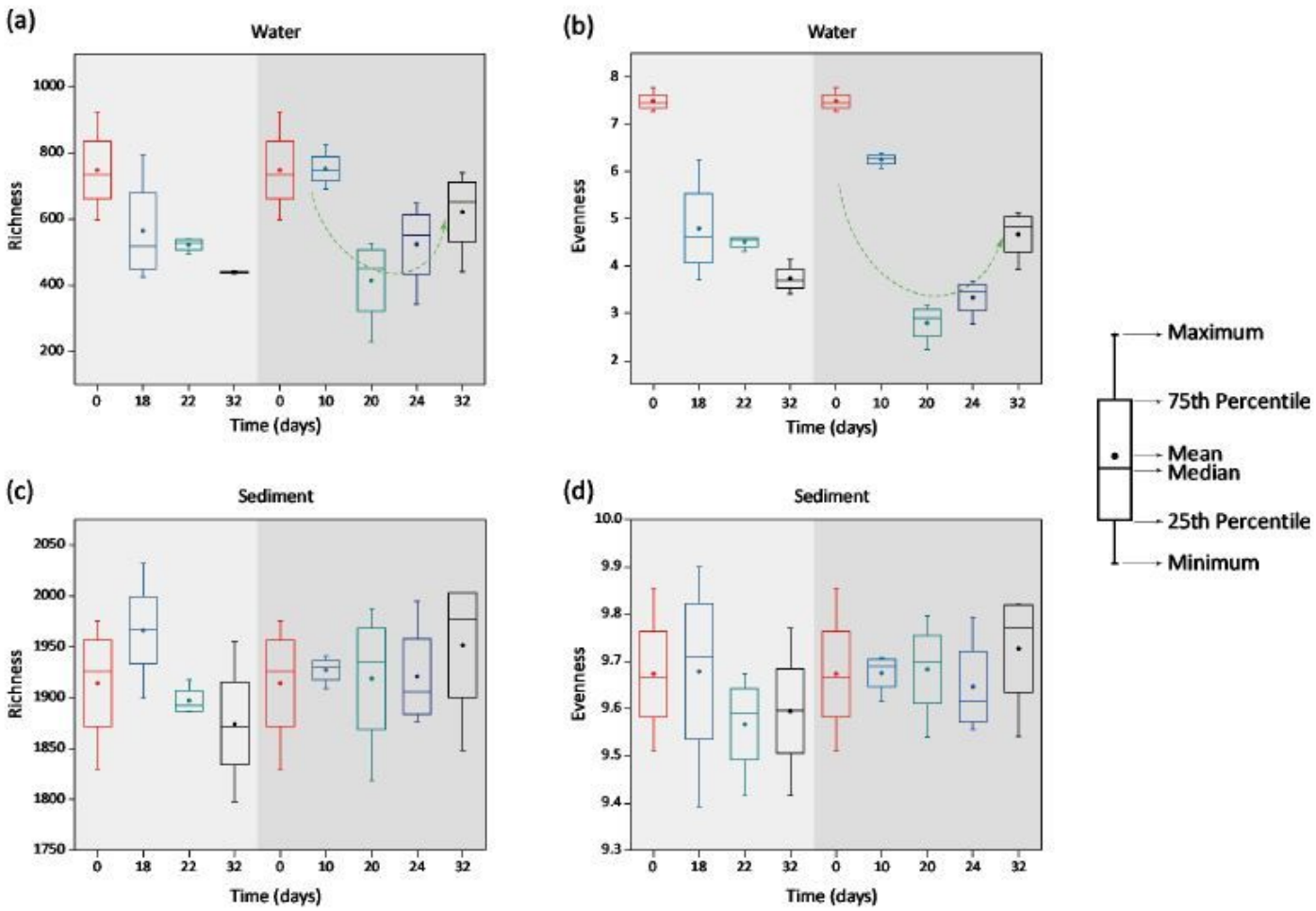

Figure 2

Temporal changes of community richness and evenness in both water and sediment samples (a) Richness change in water samples (b) Evenness change in water samples (c) Richness change in sediment samples (d) Evenness change in sediment samples. Samples of low- and high-DOC impacted communities were shaded in light grey and grey colors, respectively

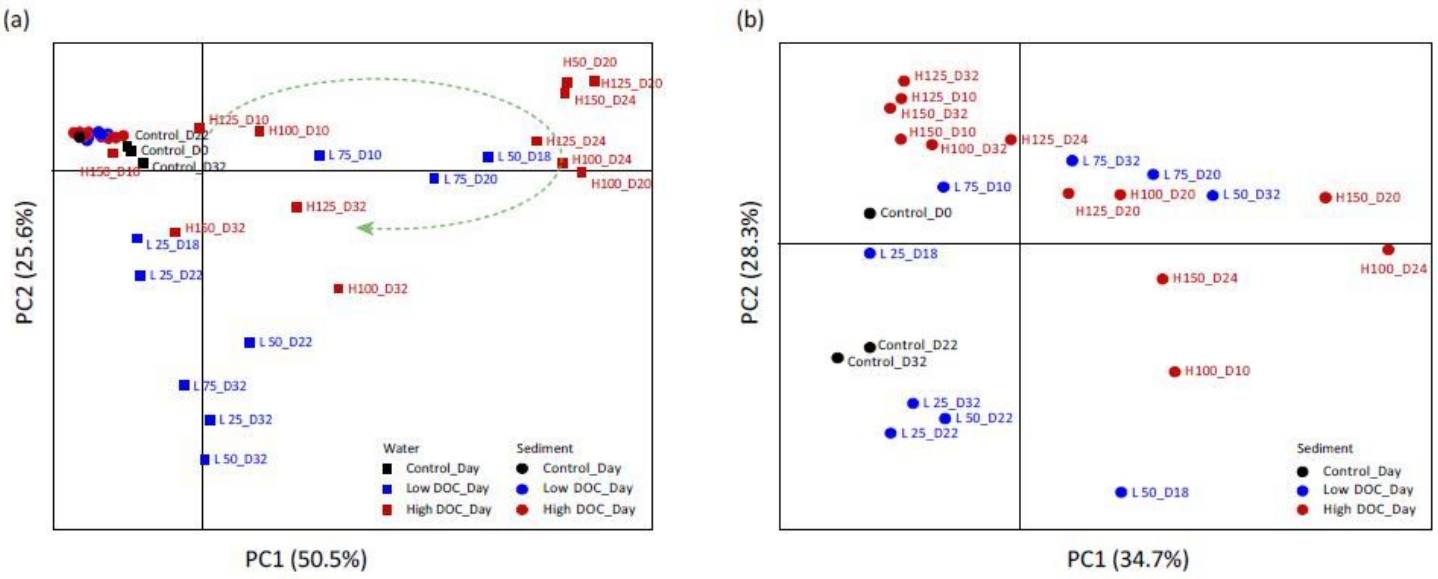

Figure 3

Principal coorindates analysis (PCoA) of DOC-impacted microbial communities (a) Water and sediment samples (b) Sediment samples. Each point represented one sample (water, n = 24; sediment, n = 24)

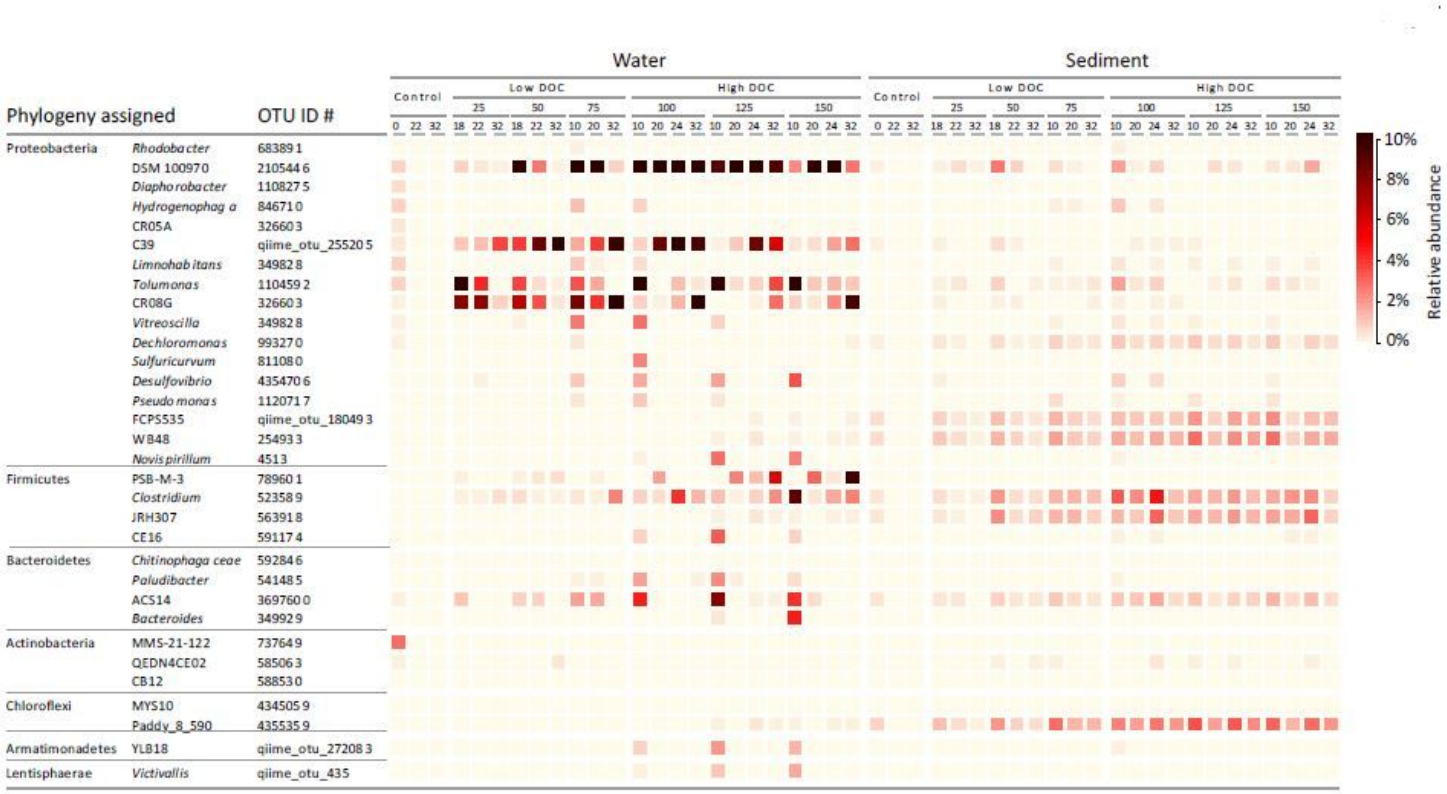

Figure 4

Temporal changes in microbial community composition in water and sediment samples Lineages with relative abundance >0.1% in at least one sample were shown in the figure. The water and sediment samples were collected on day 0, 10, 18, 22 and 32

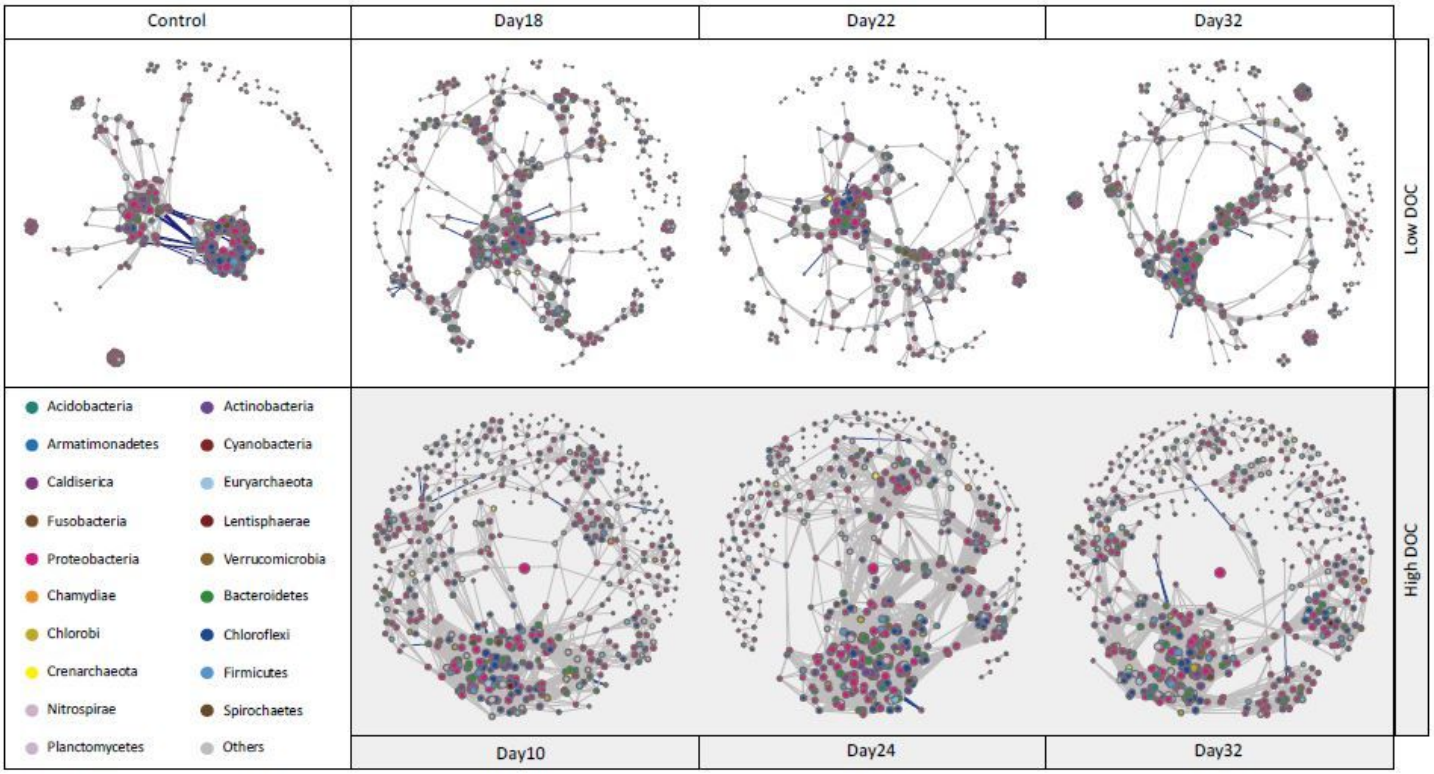

Figure 5

Cooccurrence networks of aquatic microbial taxa in low- and high-DOC impacted communities Nodes represent microbial taxa, and edges represent positive (grey lines) or negative (blue dotted lines) correlations between pairs of taxa. The node color and size mark lineages of the same phylum and the connection numbers, respectively

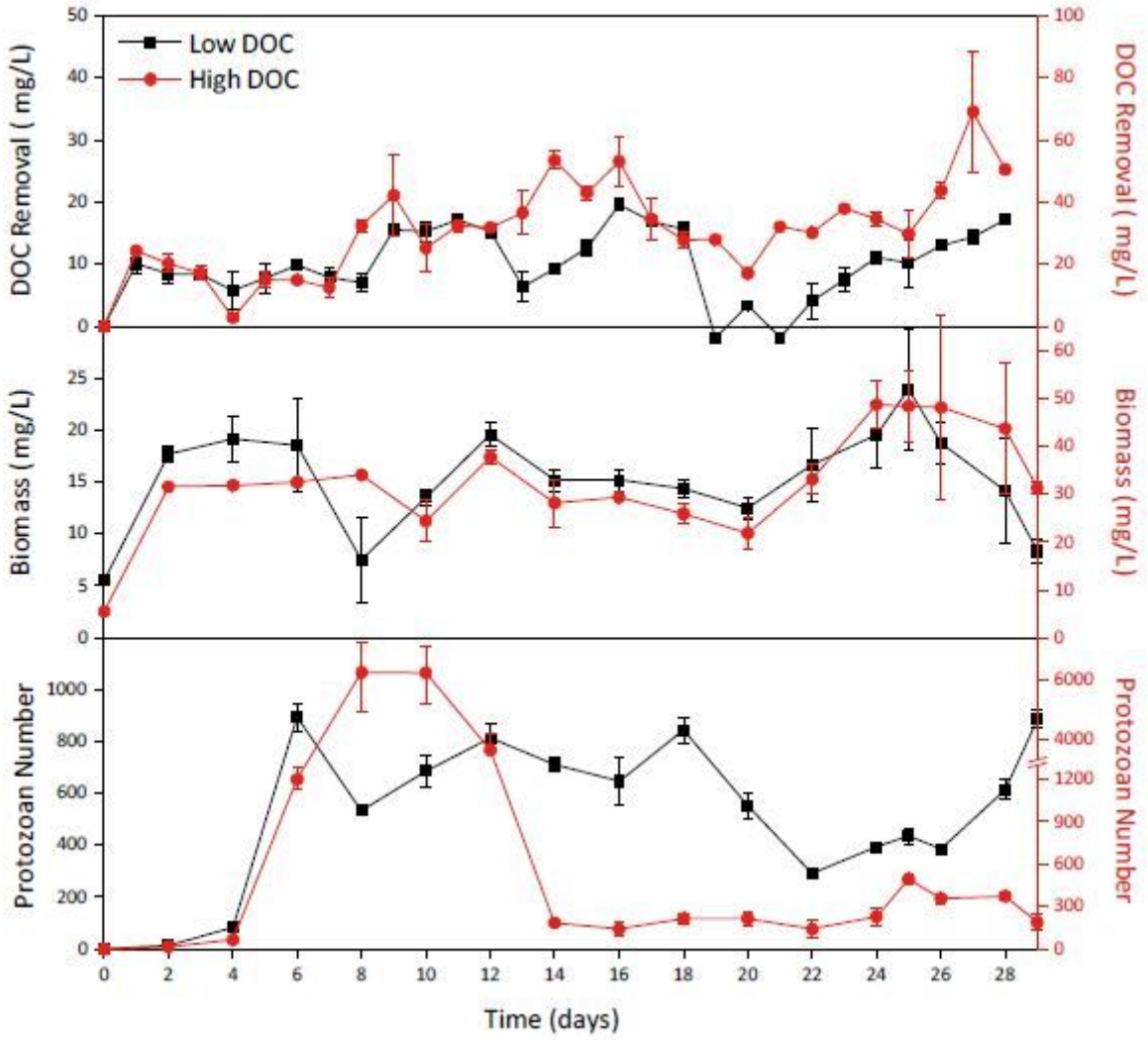

Figure 6

Temporal changes of TOC removal, biomass and protozoan abundance in low- and high-DOC impacted water samples Growth of bacterial predator depending on resource dynamics. (a) DOC removal; (b) Biomass; (c) Protozoan abundance

Supplementary Files

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- SI.pdf