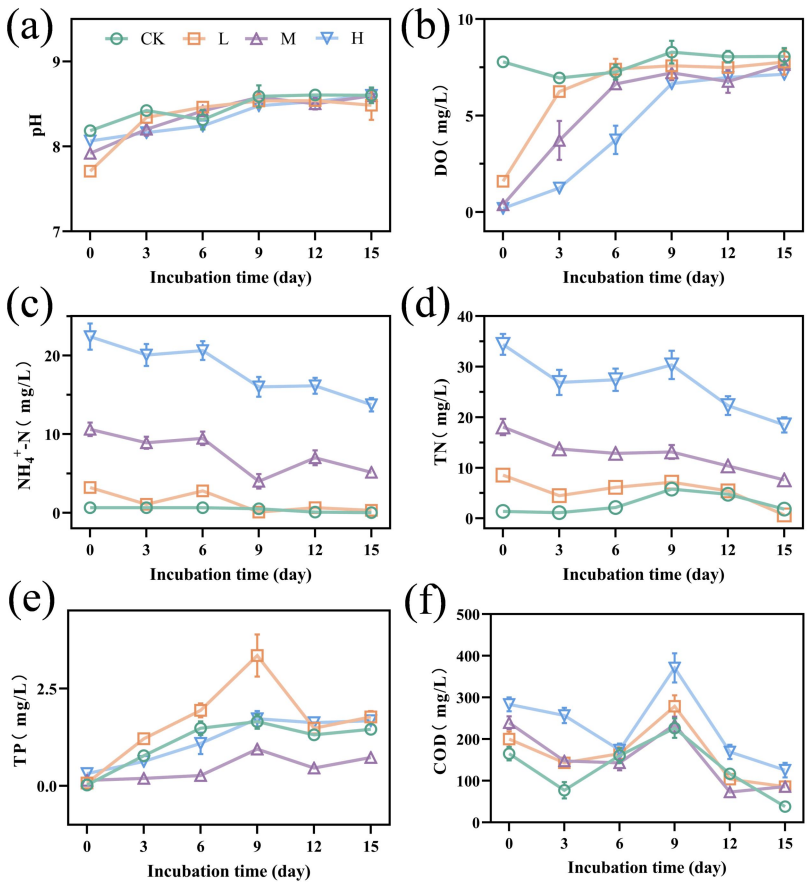

Fig. S1 Changes in physicochemical factors of water bodies during the incubation process. (a) The pH, (b) Dissolved oxygen (DO), (c) Ammonium nitrogen (NH_4^+-N), (d) Total nitrogen (TN), (e) Total phosphorus (TP) and (f) Chemical oxygen demand (COD) in response to HAP.

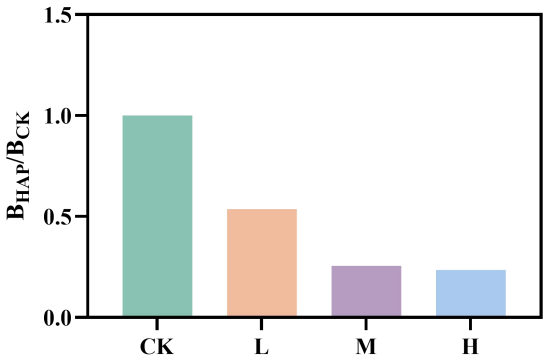

Fig. S2 The ratio of periphyton biomass under HAP Treatments compared with CK.

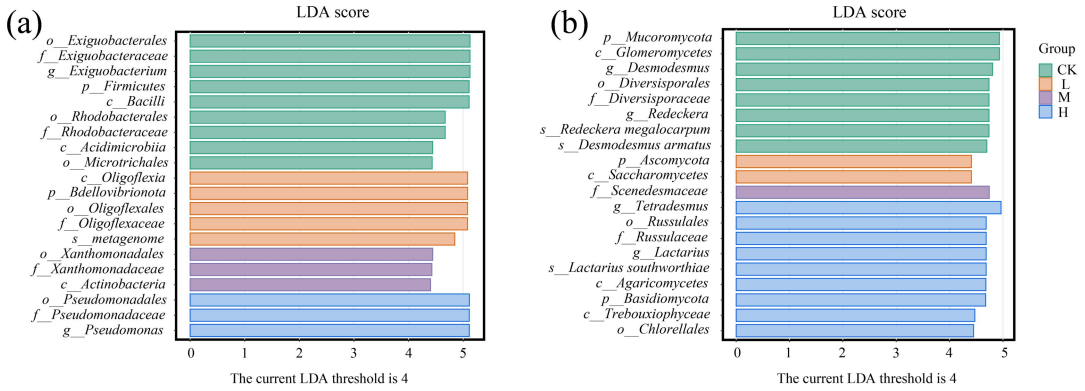

Fig. S3 Identification of differentially abundant taxonomy among different groups using LEfSe analysis in (a) bacterial and (b) eukaryotic species. LEfSe means linear discriminant analysis (LDA) effect size. The current LDA threshold is 4.

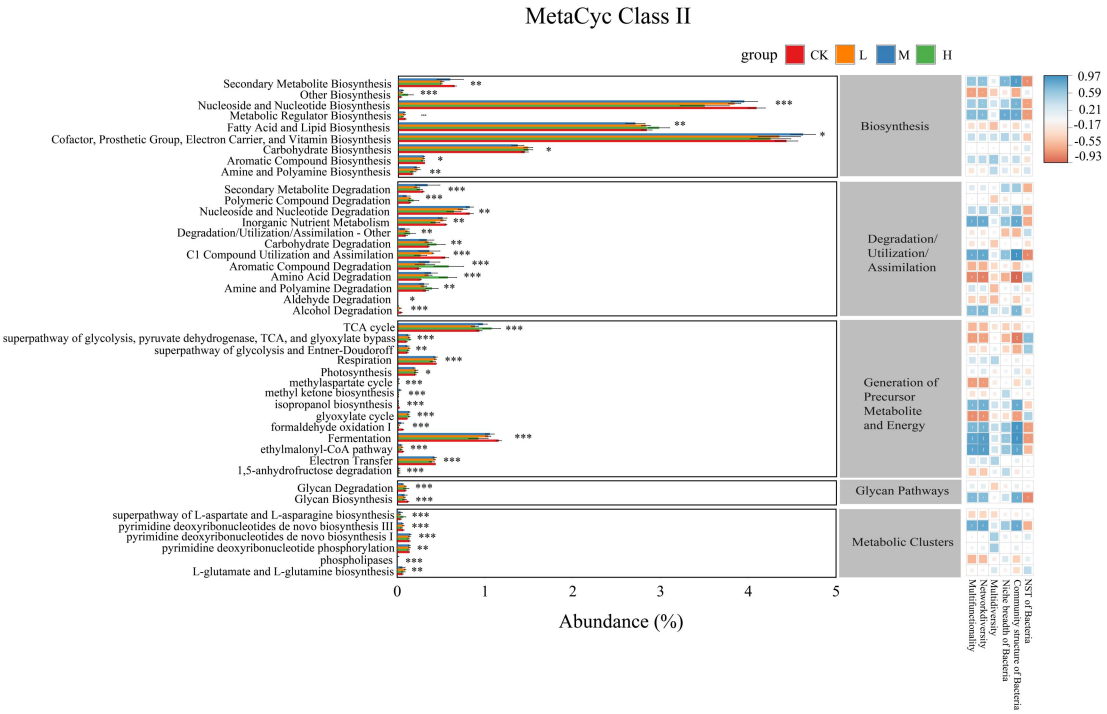

Fig. S4 MetaCyc pathway of bacterial function profiles, as well as the correlations between the relative abundance of metabolic pathways and bacterial niche width, normalized stochasticity ratio, periphyton ecological multifunctionality, multidiversity, and interdomain network complexity.

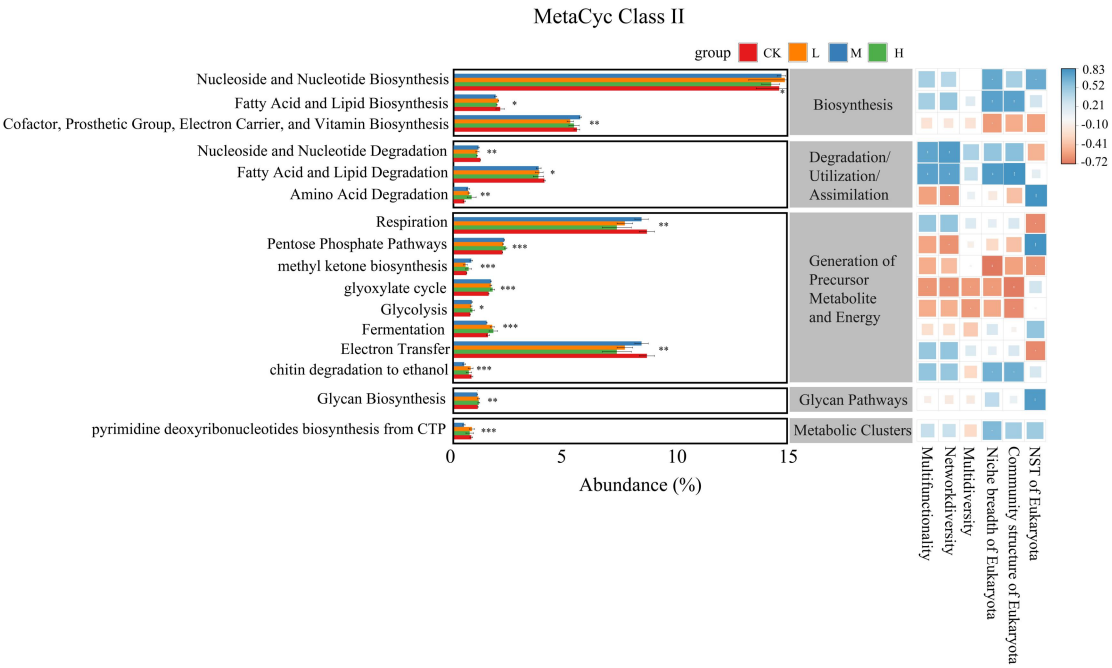

Fig. S5 MetaCyc pathway of eukaryotic function profiles, as well as the correlations between the relative abundance of metabolic pathways and eukaryotic niche width, normalized stochasticity ratio, periphyton ecological multifunctionality, multidiversity, and interdomain network complexity.

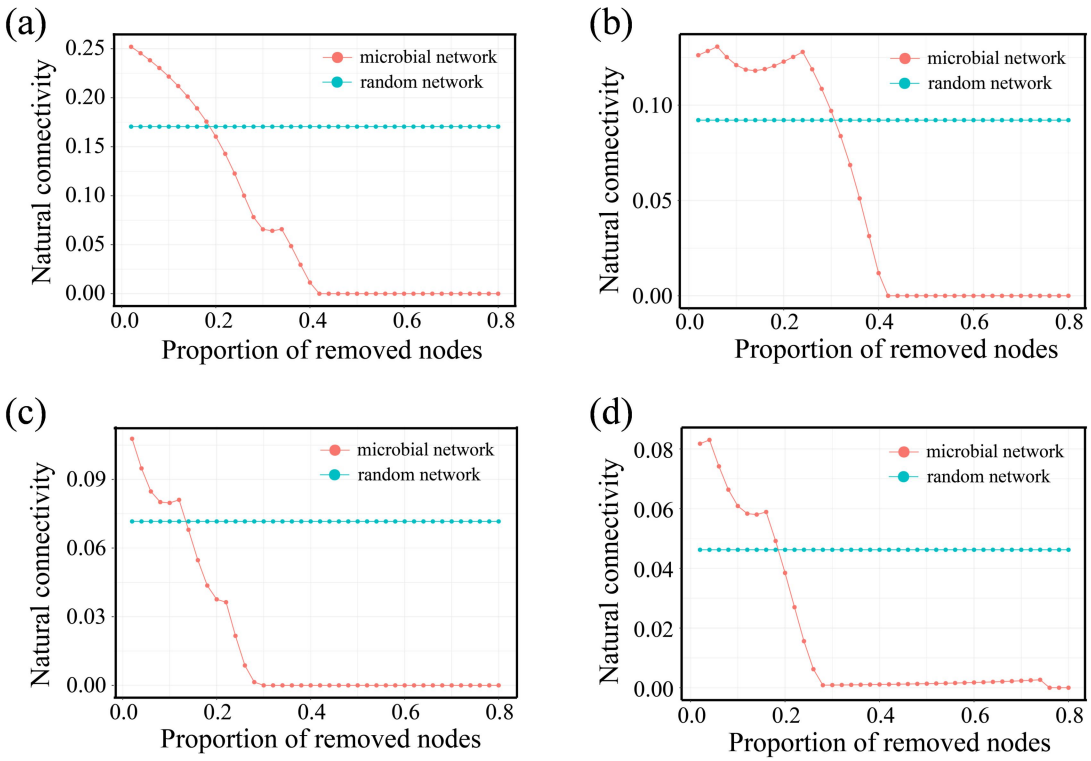

Fig. S6 The robustness of each bipartite network (a-d: CK, L, M, H) was evaluated by measuring natural connectivity during iterative random node removal, with results compared against an Erdős–Rényi random null model.

Table S1 The basic physicochemical properties of hydrothermal carbonization aqueous phase (HAP)

pH	NH_4^+-N (mg/L)	TN (mg/L)	TP (mg/L)	COD (mg/L)	TOC (mg/L)
8.6	2050.4±20.1	3983.4±98.3	91.3±0.3	22202.3±1072.9	8747.1±87.7

Table S2 Combined strategies of periphyton addition and HAP.

Sample	Treatment			
	CK	L	M	H
HAP (mL)	0.0	1.5	3.1	6.2
Pool water (mL)	400.0	398.5	396.9	393.8
Periphyton (mL)	4.0	4.0	4.0	4.0

Table S3 The topological indices of interdomain ecological networks.

Treatment	Average degree	Average path length	Connectance	Network density	Network complexity
CK	13.6	1.51	0.63	0.22	1.00
L	9.13	1.52	0.36	0.13	0.44
M	7.43	1.66	0.43	0.11	0.30
H	5.76	1.87	0.44	0.09	0.08