Electronic Supplementary Information

Changes in physiological profiles and co-occurrence patterns of soil microbial community following exposure to nanoceria and ionic cerium

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Table S1. Two-way ANOVA on effects of cerium on soil microbial utilization of carbon sources.

Carbon sources	Ce type	Ce dose	interaction
Pyruvic Acid Methyl Ester	*	·	·
Tween 40	**	**	**
Tween 80	NS	**	**
α-Cyclodextrin	**	**	**
Glycogen	**	**	**
D-Cellobiose	**	**	**
α-D-Lactose	**	**	**
β-Methyl-D-Glucoside	**	**	**
D-Xylose	**	**	**
I-Erythritol	**	**	*
D-Mannitol	**	**	**
N-Acetyl-D-Glucosamine	**	**	**
D-Glucosaminic Acid	*	**	**
Glucose-1-Phosphate	**	**	**
D,L-α-Glycerol Phosphate	**	**	**
D-Galactonic Acid γ-Lactone	**	**	**
D-Galacturonic Acid	**	**	*
2-Hydroxybenzoic Acid	**	**	**
4-Hydroxybenzoic Acid	**	**	**
γ-Hydroxybutyric Acid	**	**	**
Itaconic Acid	**	**	**
α-Ketobutyric Acid	NS	NS	NS
D-Malic Acid	**	**	**
L-Arginine	**	**	**
L-Asparagine	·	**	NS
L-Phenylalanine	**	**	**
L-Serine	NS	**	NS
L-Threonine	**	**	·
Glycyl-L-Glutamic Acid	**	**	**
Phenylethylamine	**	**	**
Putrescine	·	**	*

*, ** indicates significance at $P < 0.05$ and $P < 0.01$, respectively.

Table S2. Loading scores of the 31 carbon sources in the first two principal components.

Carbon source guild	Carbon source	Well number	PC1	PC2
Monosaccharides and derivatives	β-methyl-D-glucoside	A2	**0.315**	**0.209**
	I-erythritol	C2	0.045	0.024
	D-mannitol	D2	**0.289**	0.089
	N-acetyl-D-glucosamine	E2	**0.314**	**0.284**
	D-glucosaminic acid	F2	0.002	0.079
	glucose-1-phosphate	G2	**0.218**	0.168
	D-galactonic acidγ-lactone	A3	0.130	0.115
	D-galacturonic acid	B3	0.021	-0.074
Disaccharides	D-cellobiose	G1	**0.342**	**0.245**
	α-D-lactose	H1	0.177	0.045
Polysaccharides	α-cyclodextrin	E1	0.069	0.022
	glycogen	F1	**0.341**	0.191
Fatty acids and lipids	tween40	C1	0.103	0.006
	tween80	D1	0.087	-0.035
	pyruvic acid methyl ester	B1	0.089	0.083
	γ-hydroxybutyric acid	E3	**0.262**	**-0.346**
	itaconic acid	F3	0.173	**-0.332**
Metabolites	D,L-α-glycerol phosphate	H2	0.064	0.031
	α-ketobutyric acid	G3	0.000	-0.001
	2-hydroxybenzoic acid	C3	0.001	-0.002
	4-hydroxybenzoic acid	D3	0.113	**-0.486**
	D-malic acid	H3	0.165	0.023
	phenylethylamine	G4	**0.245**	**-0.272**
	putrescine	H4	0.074	-0.027
Amino acids and derivatives	L-arginine	A4	0.167	**-0.256**
	L-asparagine	B4	0.188	**-0.276**
	L-phenylalanine	C4	0.060	-0.072
	L-serine	D4	**0.246**	-0.128
	L-threonine	E4	0.014	0.014
	glycyl-L-glutamic acid	F4	0.095	0.029

Table S3. Soil bacterial alpha diversity indexes among different treatments revealed by high-throughput sequencing.

	Sobs	Shannon	Chao1	Coverage
NC10	4033±386a	9.75±0.29a	4794.01±352.83ab	0.9908±0.0003ab
NC100	4072±157.29a	9.75±0.04a	4913.74±180.89ab	0.9901±0.0006ab
NC500	4102.33±158.19a	9.77±0.16a	4954.14±119.71ab	0.99±0.0002ab
IC10	3922±167.18a	9.68±0.09a	4750.55±230.63ab	0.9903±0.0005ab
IC100	3867.67±90.36a	9.63±0.07a	4703.6±92.5ab	0.9901±0.0002ab
IC500	4264±200.05a	9.68±0.19a	5217.08±372.14a	0.9888±0.0016b
CK	3756.33±67.42a	9.65±0.03a	4424.63±116.76b	0.9918±0.0006a

NC = nanoceria; IC = ionic cerium; 10, 100, and 500 mean concentrations of cerium treatment (mg/kg).

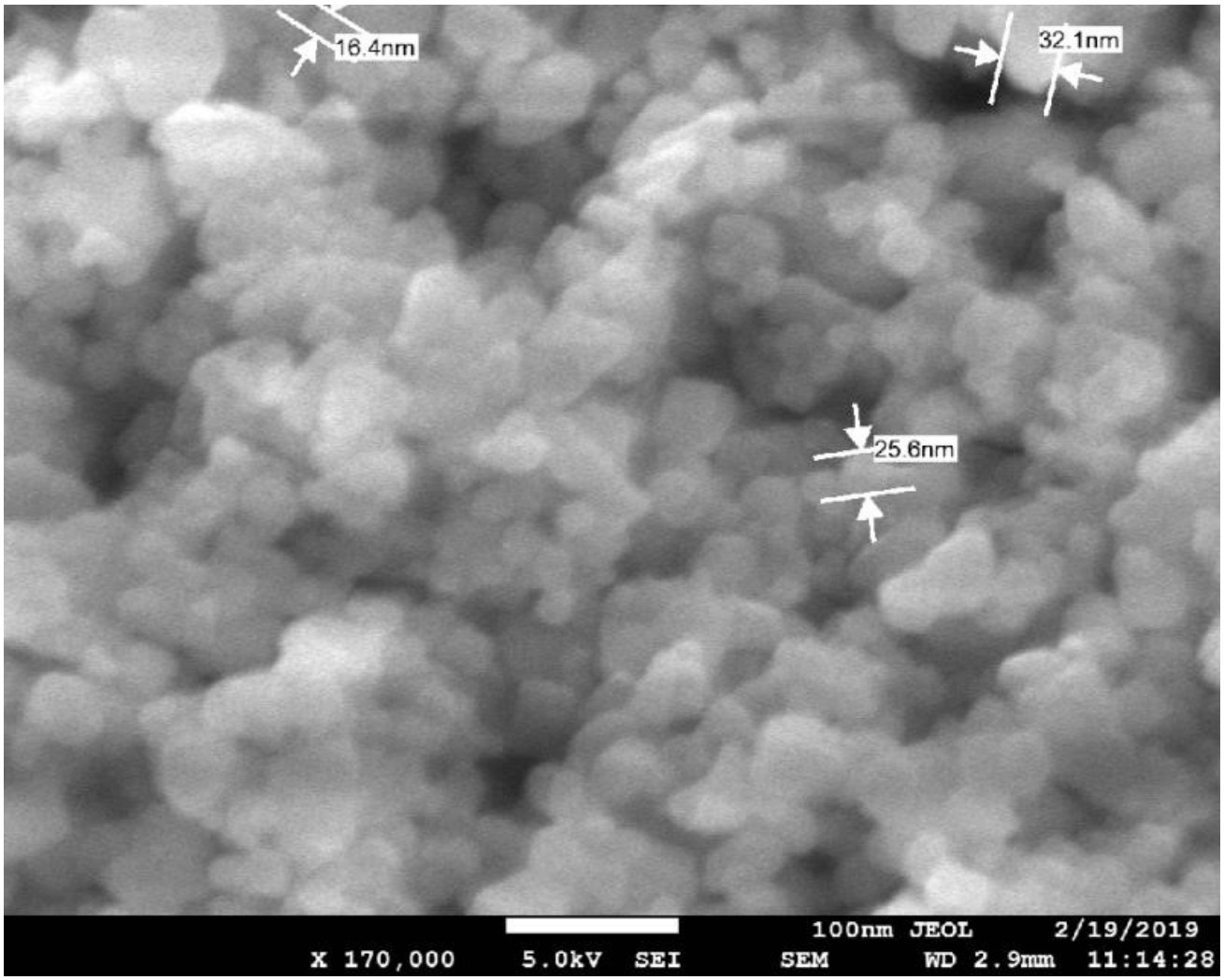

Figure S1. SEM micrograph of nanoceria particles used in this study (Acceleration voltage of 5.0 kV, magnification of 170,000 times).

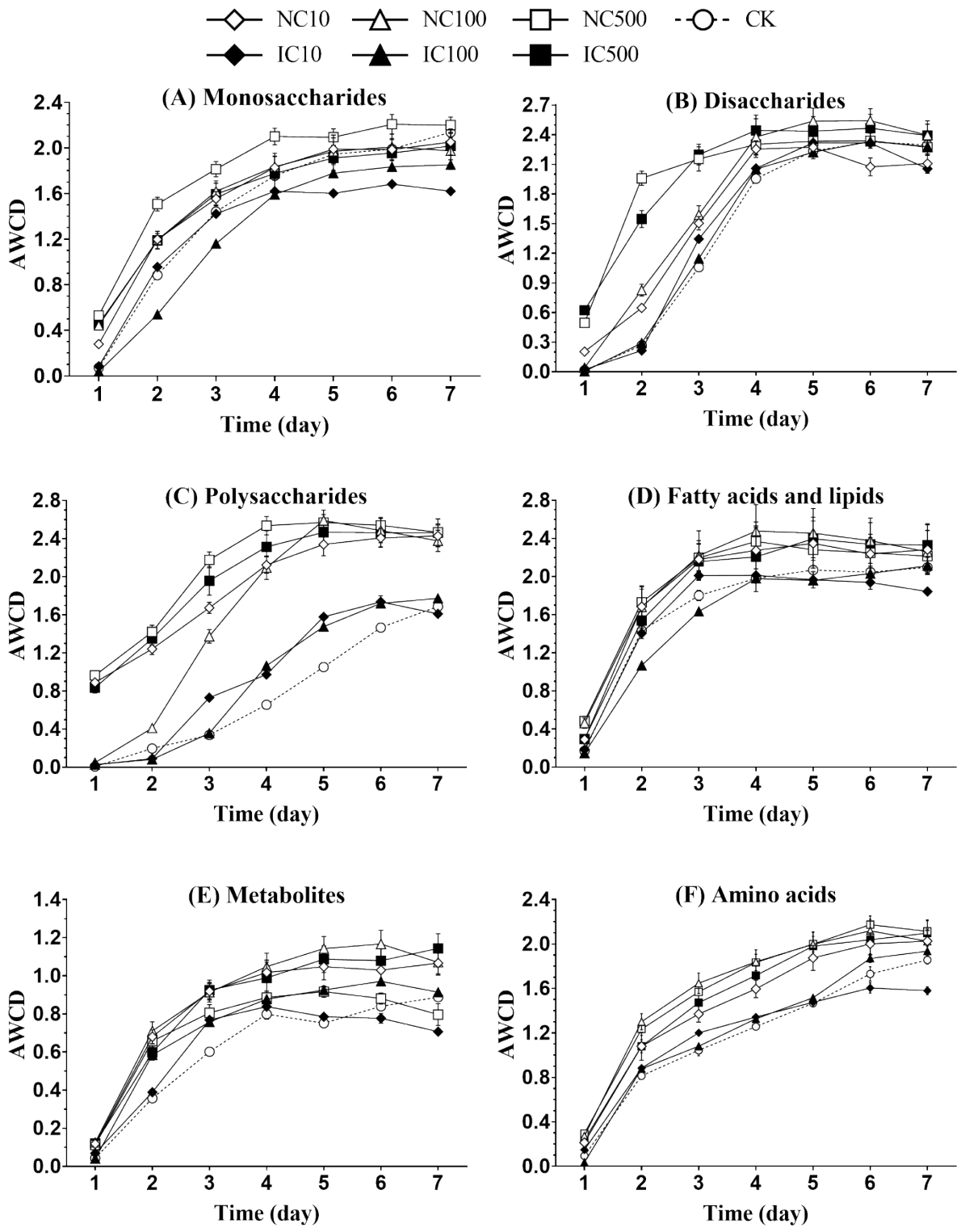

Figure S2. Average well color development (AWCD) of 6 guilds of carbon sources utilized by the microorganisms in different cerium treatments. Values are means ± SD (n = 3).