

Influence of heavy metals on the occurrence of Antarctic soil microalgae

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Table S1. Diacritical characteristics used for the identification of soil algae from Signy Island.

Taxon	Diacritical characteristics
BACILLARIOPHYTA	
Naviculaceae	
<i>Navicula mutica</i> Kützing	Valves elliptical with broadly rounded rostrate apices, have an expanded central area with a distinct stigma in the central area, cells 6.5 – 9 × 12.5 – 15 µm.
<i>Navicula</i> sp.	Valves linear with central parallel margins and distinctly capitate apices, striae radiate, striae number 15 in 10 µm, cell is about 10 × 25 µm.
Pinnulariaceae	
<i>Pinnularia notata</i> (Peragallo & Heribaud) Mills	Valves linear to linear-lanceolate, apices narrow and round, striae are strongly radiate at the valve center and become strongly convergent near the apices, striae number 14 in 10 µm, cell is about 12.5 × 45.5 µm.
<i>Pinnularia</i> sp.	Valves linear with slightly convex sides, apices are broadly apiculate, striae are strongly radiate near the central area and strongly convergent near the apices, striae number 10 in 10 µm, cell is about 7.5 × 47 µm.
CHLOROPHYTA	
Chaetophoraceae	
<i>Desmococcus olivaceus</i> (Persoon ex Acharius) Laundon	Colonies with filaments and sarcinoid cell aggregates, cells in filaments are 2.5 – 5 µm wide, cells in sarcinoid aggregates are 5 – 9 µm diameter, cells spherical if solitary, chloroplast parietal, with pyrenoid, aplanosporangia up to 25 µm diameter.
<i>Desmococcus endolithicus</i> Broady & Ingerfeld	Colonies in sarcinoid cell aggregates or isobilateral tetrads, cells in sarcinoid aggregates are 6 – 11 µm diameter, chloroplast parietal, with pyrenoid.
Chlamydomadaceae	
<i>Chlamydomonas</i> sp.	Cells single, free-living, motile, spherical to broadly ellipsoidal, 14 – 16 × 18 – 21 µm, with two flagella, containing a stigma.
<i>Chloromonas</i> sp.	Cells single, free-living, spherical to broadly ellipsoidal, 5 – 7 × 6 – 9.5 µm, no pyrenoid, no stigma.
Chlorococcaceae	
<i>Tetracystis</i> sp.	Vegetative cells 11 – 19 µm diameter, elliptic (young) or wider elliptic to spherical (mature forms), chloroplast massive, filling almost the whole cell, with many indentations, single pyrenoid, cells grouped in tetrads.
Chlorellaceae	
<i>Chlorella</i> sp. 1	Cells single, spherical to subspherical, 4 – 5 µm diameter, chloroplast parietal which nearly fills the cell, with pyrenoid.
<i>Chlorella</i> sp. 2	Cells single, spherical to subspherical, 4.5 – 5.5 µm diameter, chloroplast parietal, filling ½ to 2/3 of the cell periphery, pyrenoid distinct.
<i>Chlorella reisi</i> Watanabe	Cells spherical (4.5 – 6 µm diameter) or ellipsoidal (3 – 5.5 × 5 – 10 µm), chloroplast parietal, cup shaped.
<i>Chlorella vulgaris</i> Beijerinck	Cells single, free-living, spherical, 3.6 – 7 µm diameter, chloroplast single, cup-shaped, pyrenoid distinct.
Coccomyxaceae	
<i>Coccomyxa gloeobotrydiformis</i> Reisi	Cells single and ellipsoidal, 2.8 – 4 × 5.5 – 9 µm, chloroplast parietal, often divided into two large lobes, no pyrenoid.
Klebsormidiaceae	
<i>Klebsormidium flaccidum</i> (Kützing) Silva, Mattox & Blackwell	Long filamentous cells, non-branching, 5 – 7 µm wide, chloroplast parietal, single, with pyrenoid.
Koliellaceae	

Koliella sp. Present as single cells or cell pairs, cells straight with apices gradually tapering slight curved and to point, 1.5 – 2 × 6.5 – 11 µm, chloroplast parietal, no pyrenoid.

Oocystaceae

Pseudococcomyxa sp. Cells single and ellipsoidal, may form colonies in mucilage, 4.5 – 9 × 9 – 18 µm, single pyrenoid.

Prasiolaceae

Stichococcus sp. 1 Cells single or in short easily broken filaments of 2–8 cells, cylindrical, apices broadly rounded, 3 – 3.5 × 4 - 6.5 µm, chloroplast single, parietal, no pyrenoid.

Stichococcus sp. 2 Filaments of 2–8 cells, cells cylindrical with free ends broadly rounded, 3.5 – 4 × 5 - 9 µm, single or double lobed chloroplast, no pyrenoid.

Ulotrichaceae

Ulothrix sp. Filaments unbranched, uniseriate, 8.2 – 10 µm wide, chloroplasts parietal, plate-like, with pyrenoid.

CYANOBACTERIA

Microcystaceae

Gloeocapsa sp. Sarcinoid, round to elliptical colonies, cells oblong to ellipsoid, 3 – 5.5 µm diameter.

Nostocaceae

Nostoc commune
Vaucher ex Bornet & Flahault Trichome with heterocytes, equal diameter throughout the length, cells 4 – 5 µm wide, no branching, heterocytes intervening or at terminal.

Oscillatoriaceae

Oscillatoria amphibia
Agardh ex Gomont Trichomes straight or bent, 2 – 2.8 µm wide, apical cell rounded, without calyptra, no branching.

Oscillatoria boryana
Kützing Cell dark colored, 5 – 6 µm wide, apical cell circular or a sharp circular cone, without calyptra, no branching.

Oscillatoria raciborskii
Woloszynska Trichomes pale blue-green or yellow-green, 4.5 – 5 µm wide, apical cells rounded, more or less tapered, bluntly conical, without calyptra, no branching.

Phormidium autumnale
Gomont Filaments blue-green to yellowish brown or violet-grey, straight, 5 – 7 µm wide. Trichomes attenuated, apical cell with calyptra, no branching.

Pseudanabaenaceae

Pseudanabaena sp. Trichomes blue-green, straight, cells 2 – 3 µm × 1.5 - 2 µm, joined by small gelatinous pads, no branching.

TRIBOPHYTA

Botrydiopsisaceae

Botrydiopsis constricta
Broady Adult cells single, spherical, 10 – 41 µm diameter. Large cells with many chromatophores, usually spindle-shaped, lacking pyrenoids. Zoospores, 3 – 4 × 5 – 6 µm, biflagellate, with a single chromatophore containing a stigma. Vegetative division give rise to two daughter cells. Old cultures with orange oil globules.

Gloeobotrydaceae

Gloeobotrys sp. Cells ellipsoidal, 2.5 – 4 µm, irregularly arranged throughout hyaline mucilage, single parietal chloroplasts, without pyrenoids.

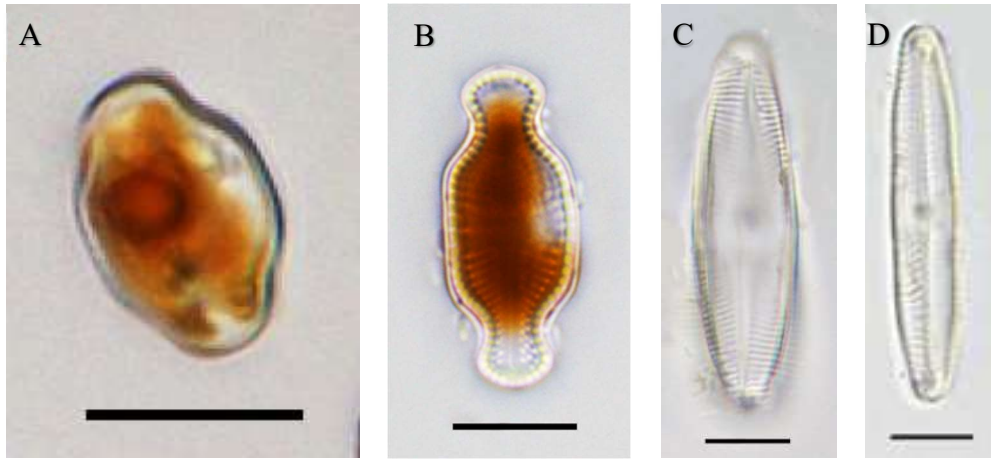


Fig. S1: Diatoms (bacillariophytes) found in soil samples from Signy Island. A: *Navicula mutica*, B: *Navicula* sp., C: *Pinnularia notata*, D: *Pinnularia* sp. Scale bar = 10 μm .

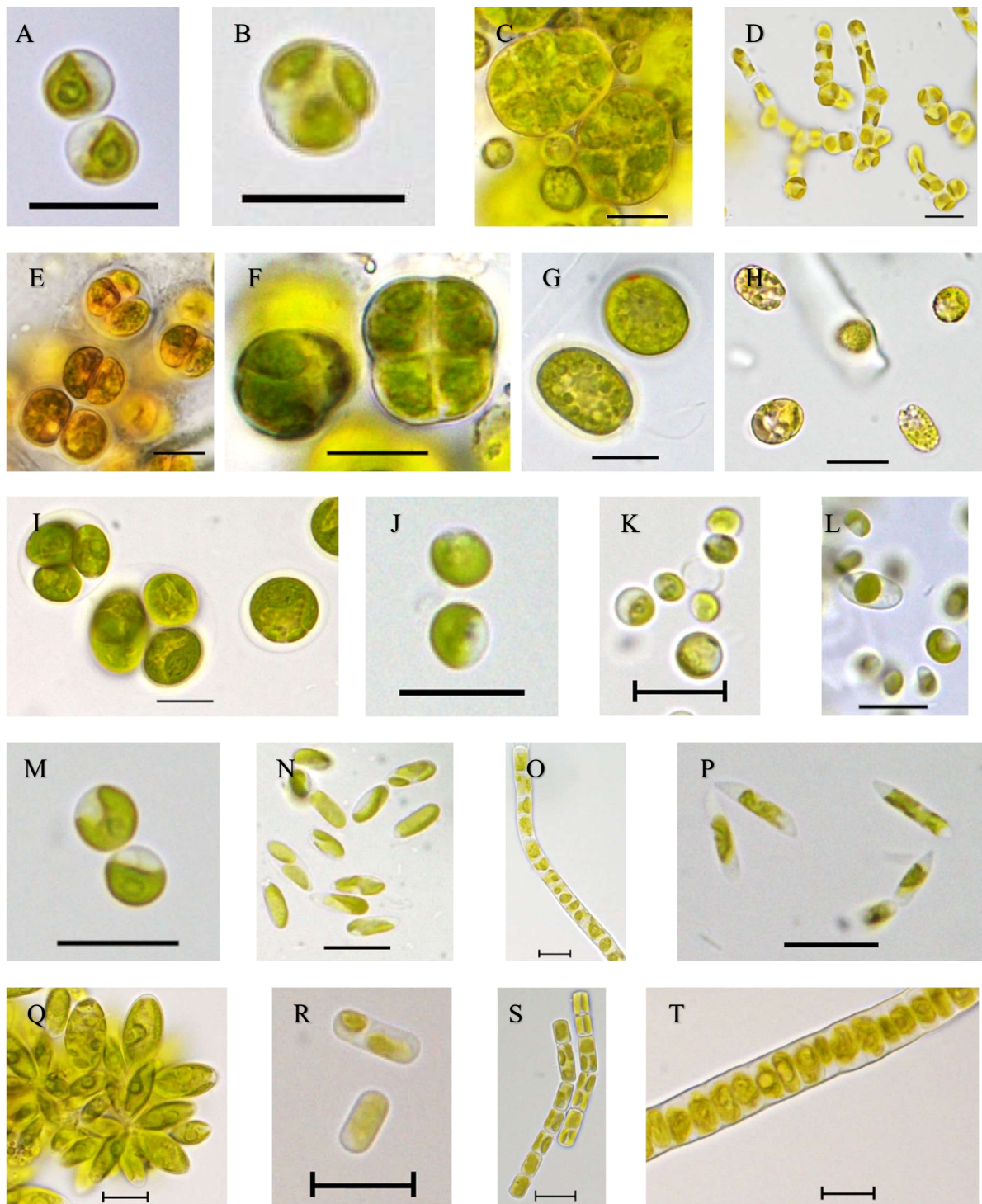


Fig. S2: Chlorophytes found in soil samples from Signy Island. A: *Desmococcus olivaceus* (coccoid cells with pyrenoid), B: *D. olivaceus* (aplanosporangium), C: *D. olivaceus* (aplanosporangium at different stages of formation), D: *D. olivaceus* (sarcinoid cell aggregates that grow to form filaments), E: *D. olivaceus* (old cells filled with carotenoids and oil globules), F: *Desmococcus endolithicus* (sarcinoid cell aggregates), G: *Chlamydomonas* sp., H: *Chloromonas* sp., I: *Tetracyctis* sp., J: *Chlorella* sp. 1, K: *Chlorella* sp. 2, L: *Chlorella reisigii*, M: *Chlorella vulgaris*, N: *Coccomyxa gloeobotrydiformis*, O: *Klebsormidium flaccidum*, P: *Koliella* sp., Q: *Pseudococcomyxa* sp., R: *Stichococcus* sp. 1, S: *Stichococcus* sp. 2, T: *Ulothrix* sp. Scale bar = 10 μ m.

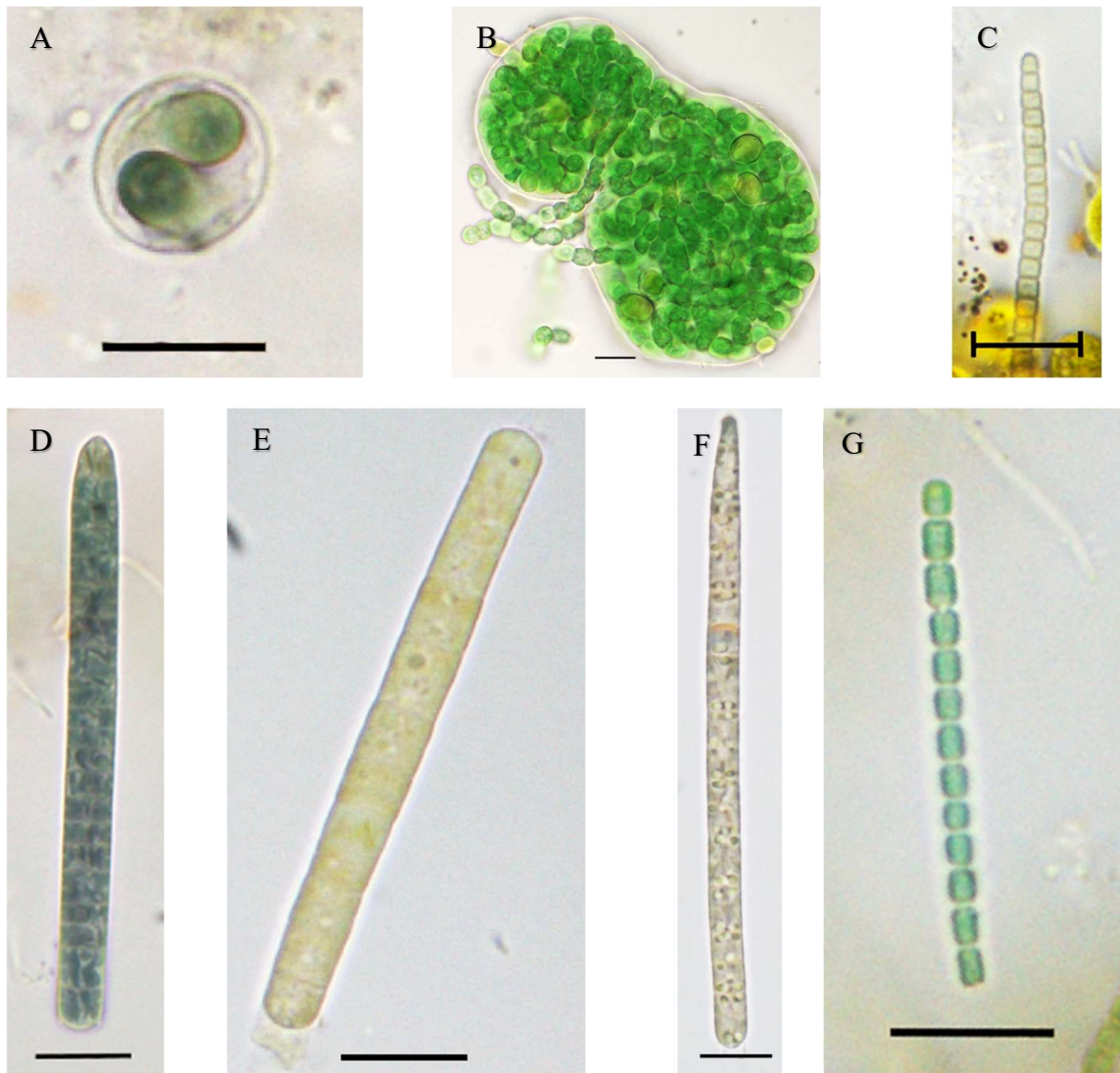


Fig. S3: Cyanobacteria found in soil samples from Signy Island. A: *Gloeocapsa* sp., B: *Nostoc commune*, C: *Oscillatoria amphibia*, D: *Oscillatoria boryana*, E: *Oscillatoria raciborskii*, F: *Phormidium autumnale*, G: *Pseudanabaena* sp. Scale bar = 10 μ m.

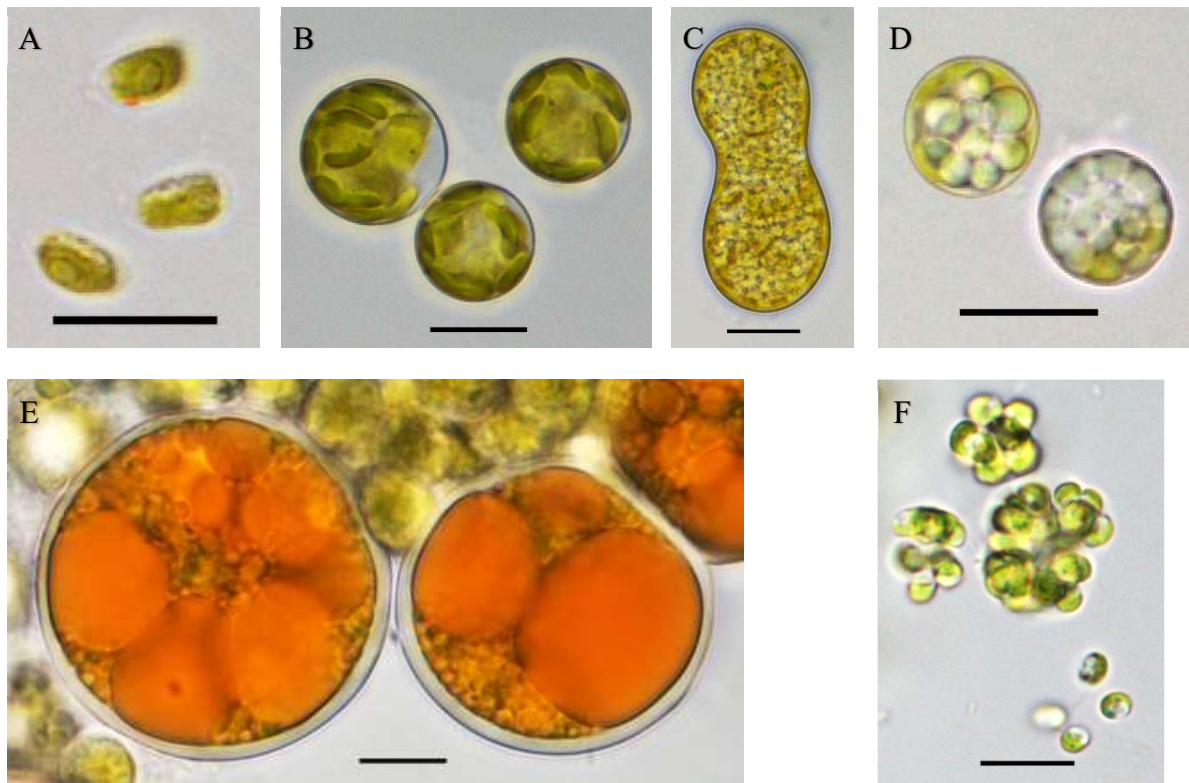


Fig. S4: Tribophytes found in soil samples from Signy Island. A: *Botrydiopsis constricta* (zoospore), B: *Botrydiopsis constricta* (adult cells), C: *Botrydiopsis constricta* (dividing cell), D: *Botrydiopsis constricta* (old cells with oil globules), E: *Botrydiopsis constricta* (red spores; old cultures), F: *Gloeobotrys* sp. Scale bar = 10 μm .

Table S2. Results of permutational multivariate analysis of variance (PERMANOVA) based on the Bray-Curtis similarity for presence-absence transformed data of algal occurrence at five sampling locations on Signy Island. Analysis was carried out using 999 permutations.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Si	4	42180	10545	8.1096	0.001	999
Res	169	2.1975E+05	1300.3			
Total	173	2.6193E+05				

Table S3. Average dissimilarities (SIMPER) between the five sampling sites based on average abundance and percentage contribution of algae on Signy Island.

Average dissimilarity = 91.34	BP Average Abundance	GP Average Abundance	Cum. % Contribution
<i>Botrydiopsis constricta</i>	0.49	0.06	15.94
<i>Desmococcus olivaceus</i>	0.29	0.34	29.99
<i>Oscillatoria boryana</i>	0.03	0.43	43.54
<i>Oscillatoria raciborskii</i>	0.17	0.26	52.97
<i>Chlorella vulgaris</i>	0.17	0.2	61.61
<i>Chloromonas</i> sp.	0.14	0.06	68.82
<i>Chlamydomonas</i> sp.	0.14	0.03	73.81
Average dissimilarity = 91.74	BP Average Abundance	JC Average Abundance	Cum. % Contribution
<i>Botrydiopsis constricta</i>	0.49	0.09	19.88
<i>Desmococcus olivaceus</i>	0.29	0.2	36.95
<i>Chloromonas</i> sp.	0.14	0.09	47.71
<i>Coccomyxa gloeobotrydiformis</i>	0.03	0.2	56.26
<i>Stichococcus</i> sp. 1	0.06	0.11	63.42
<i>Chlorella vulgaris</i>	0.17	0	70.42
Average dissimilarity = 96.00	GP Average Abundance	JC Average Abundance	Cum. % Contribution
<i>Oscillatoria boryana</i>	0.43	0	17.63
<i>Desmococcus olivaceus</i>	0.34	0.2	33.43
<i>Coccomyxa gloeobotrydiformis</i>	0	0.2	41.87
<i>Oscillatoria raciborskii</i>	0.26	0	50.04
<i>Chloromonas</i> sp.	0.06	0.09	55.69
<i>Stichococcus</i> sp. 1	0	0.11	60.8
<i>Chlorella vulgaris</i>	0.2	0	65.81
<i>Klebsormidium flaccidum</i>	0.09	0.03	70.2
Average dissimilarity = 89.08	BP Average Abundance	NP Average Abundance	Cum. % Contribution
<i>Desmococcus olivaceus</i>	0.29	0.4	12.33
<i>Botrydiopsis constricta</i>	0.49	0.11	24.3
<i>Oscillatoria boryana</i>	0.03	0.46	36.15
<i>Oscillatoria raciborskii</i>	0.17	0.34	45.51
<i>Pseudanabaena</i> sp.	0.06	0.31	52.58
<i>Chlorella vulgaris</i>	0.17	0.11	59.13
<i>Chloromonas</i> sp.	0.14	0.06	64.08
<i>Klebsormidium flaccidum</i>	0.03	0.17	68.84
<i>Chlamydomonas</i> sp.	0.14	0.06	73.2
Average dissimilarity = 82.11	GP Average Abundance	NP Average Abundance	Cum. % Contribution
<i>Oscillatoria boryana</i>	0.43	0.46	15.25
<i>Desmococcus olivaceus</i>	0.34	0.4	28.66
<i>Oscillatoria raciborskii</i>	0.26	0.34	39.9
<i>Pseudanabaena</i> sp.	0	0.31	47.05
<i>Chlorella vulgaris</i>	0.2	0.11	53.81
<i>Klebsormidium flaccidum</i>	0.09	0.17	60.14

<i>Navicula mutica</i>	0.11	0.23	65.73
<i>Chlorella</i> sp. 2	0.11	0.09	71.09
Average dissimilarity = 94.65	JC Average Abundance	NP Average Abundance	Cum. % Contribution
<i>Oscillatoria boryana</i>	0	0.46	14.01
<i>Desmococcus olivaceus</i>	0.2	0.4	27.87
<i>Oscillatoria raciborskii</i>	0	0.34	36.97
<i>Pseudanabaena</i> sp.	0.03	0.31	44.6
<i>Klebsormidium flaccidum</i>	0.03	0.17	50.41
<i>Coccomyxa gloeobotrydiformis</i>	0.2	0	55.89
<i>Navicula mutica</i>	0	0.23	60.09
<i>Chlorella</i> sp. 2	0	0.09	64.23
<i>Chlorella vulgaris</i>	0	0.11	68.25
<i>Botrydiopsis constricta</i>	0.09	0.11	72.13
Average dissimilarity = 85.40	BP Average Abundance	PL Average Abundance	Cum. % Contribution
<i>Desmococcus olivaceus</i>	0.29	0.71	23.39
<i>Botrydiopsis constricta</i>	0.49	0	39.15
<i>Oscillatoria boryana</i>	0.03	0.41	52.01
<i>Chlorella vulgaris</i>	0.17	0.15	61.01
<i>Oscillatoria raciborskii</i>	0.17	0.21	69.07
<i>Chloromonas</i> sp.	0.14	0.06	76.04
Average dissimilarity = 78.88	GP Average Abundance	PL Average Abundance	Cum. % Contribution
<i>Desmococcus olivaceus</i>	0.34	0.71	28.24
<i>Oscillatoria boryana</i>	0.43	0.41	48.13
<i>Oscillatoria raciborskii</i>	0.26	0.21	58.78
<i>Chlorella vulgaris</i>	0.2	0.15	67.82
<i>Phormidium autumnale</i>	0.09	0.12	73.98
Average dissimilarity = 89.14	JC Average Abundance	PL Average Abundance	Cum. % Contribution
<i>Desmococcus olivaceus</i>	0.2	0.71	32.35
<i>Oscillatoria boryana</i>	0	0.41	48.08
<i>Coccomyxa gloeobotrydiformis</i>	0.2	0.03	56.61
<i>Chlorella vulgaris</i>	0	0.15	62.49
<i>Oscillatoria raciborskii</i>	0	0.21	67.84
<i>Chloromonas</i> sp.	0.09	0.06	73.11
Average dissimilarity = 77.21	NP Average Abundance	PL Average Abundance	Cum. % Contribution
<i>Desmococcus olivaceus</i>	0.4	0.71	17.71
<i>Oscillatoria boryana</i>	0.46	0.41	32.99
<i>Oscillatoria raciborskii</i>	0.34	0.21	43.71
<i>Pseudanabaena</i> sp.	0.31	0	51.15
<i>Chlorella vulgaris</i>	0.11	0.15	58.02
<i>Klebsormidium flaccidum</i>	0.17	0	63.02
<i>Navicula mutica</i>	0.23	0.03	67.76
<i>Chlorella</i> sp. 2	0.09	0.03	71.78

Table S4. Results of permutational multivariate analysis of variance (PERMANOVA) based on the Euclidean distance for normalised data of metal contents at five sampling locations on Signy Island. Analysis was carried out using 999 permutations.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Si	4	704.56	176.14	17.333	0.001	998
Res	169	1717.4	10.162			
Total	173	2422				