

< Supplementary information >

Shifts in benthic megafauna communities after glacial retreat in an Antarctic fjord

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Supplementary Table 1. Density (ind. m⁻²) of epibenthic megafauna recorded from 10–90 m depth at MC2 in Marian Cove, Antarctica. Abundance data were obtained using a quadrat frame (50 × 50 cm) attached to the ROV and then transformed to values per square meter. Values are mean ± standard error. (n): number of replicates. The table was adapted from Kim et al., 2021⁷.

Taxa	MC2					
	10 m (11)	20 m (12)	30 m (12)	50 m (18)	70 m (15)	90 m (15)
<i>Aplidium</i> cf. <i>radiatum</i>				39.6 ± 22.4		
<i>Ascidia challengerii</i>			1.0 ± 0.5	52.7 ± 10.2	10.9 ± 3.2	1.9 ± 1.6
<i>Cnemidocarpa verrucosa</i>		1.0 ± 1.0	16.3 ± 5.1	1.3 ± 1.3	0.3 ± 0.3	
<i>Corella eumyota</i>						
<i>Distaplia</i> sp.						
<i>Molgula pedunculata</i>		2.0 ± 2.0	18.3 ± 6.9	1.1 ± 0.6	0.5 ± 0.5	
<i>Pyura</i> cf. <i>discoveri</i>					3.2 ± 1.5	8.8 ± 2.0
<i>Pyura setosa</i>				1.3 ± 0.9	2.7 ± 1.0	4.3 ± 1.6
<i>Pyura</i> sp.1					0.8 ± 0.6	0.5 ± 0.4
<i>Pyura</i> sp.2					1.3 ± 0.9	
<i>Sycozoa sigillinoides</i>			0.3 ± 0.3			
<i>Tylobranchion speciosum</i>			6.0 ± 3.0	2.0 ± 0.9		
Ascidian sp.16				30.0 ± 4.7		
Ascidian sp.17					12.5 ± 5.7	22.7 ± 5.0
<i>Cryptasterias</i> sp.				0.4 ± 0.3		
<i>Diplasterias</i> sp.				0.4 ± 0.3	0.5 ± 0.4	0.5 ± 0.4
<i>Odontaster validus</i>	1.1 ± 0.8	0.7 ± 0.4	1.0 ± 0.5	0.2 ± 0.2		
<i>Perknaster</i> sp.						
<i>Psilaster</i> sp.					0.3 ± 0.3	
Asteroidea sp.3				1.3 ± 0.5	1.1 ± 0.5	0.3 ± 0.3
Asteroidea sp.4					0.3 ± 0.3	
Asteroidea sp.5	0.4 ± 0.4			0.2 ± 0.2		0.5 ± 0.4
Crinoidea					0.3 ± 0.3	0.5 ± 0.5
<i>Abatus</i> sp.				0.2 ± 0.2	0.3 ± 0.3	
<i>Ctenocidaris</i> sp.				0.4 ± 0.3	0.3 ± 0.3	0.5 ± 0.4
<i>Sterechinus</i> sp.						
Ophiuroidea sp.1		0.3 ± 0.3	3.7 ± 0.8	1.8 ± 0.6	1.3 ± 0.5	2.4 ± 0.7
Ophiuroidea sp.2						0.5 ± 0.4
<i>Mycale</i> cf. <i>acerata</i>						
Porifera sp.2					0.3 ± 0.3	
Porifera sp.19						
Porifera sp.22						
Porifera sp.23						
Porifera sp.25						0.3 ± 0.3
Porifera sp.26					1.3 ± 1.1	3.2 ± 3.2

Supplementary Table 1. (continued)

Taxa	MC2					
	10 m (11)	20 m (12)	30 m (12)	50 m (18)	70 m (15)	90 m (15)
Porifera sp.27				2.2 ± 2.0		
<i>Anoxycalyx</i> cf. <i>joubini</i>					0.5 ± 0.4	
<i>Rossella</i> cf. <i>podagrosa</i>				1.8 ± 1.0	40.5 ± 17.8	
<i>Rossella</i> cf. <i>racovitzae</i>					0.5 ± 0.4	0.8 ± 0.4
<i>Rossella</i> cf. <i>villosa</i>						
<i>Reteporella</i> sp.					0.5 ± 0.4	0.5 ± 0.4
Bryozoa sp.5			4.7 ± 2.1			
Bryozoa sp.6				0.4 ± 0.4	0.5 ± 0.4	1.1 ± 0.6
Bryozoa sp.13					1.1 ± 1.1	0.3 ± 0.3
Bryozoa sp.14						
Bryozoa sp.16					0.3 ± 0.3	
Bryozoa sp.17						
Bryozoa sp.18						0.3 ± 0.3
Bryozoa sp.20				0.2 ± 0.2	1.9 ± 1.2	3.7 ± 1.5
<i>Arntzia gracilis</i>			0.7 ± 0.4	1.3 ± 0.6	0.3 ± 0.3	
<i>Tenuisis microspiculata</i>				0.4 ± 0.4		0.3 ± 0.3
<i>Thouarella</i> sp.					0.3 ± 0.3	
Actiniidae sp.2					0.3 ± 0.3	
Actiniidae sp.5						0.3 ± 0.3
<i>Candelabrum penola</i>				0.9 ± 0.5		
Hydrozoa sp.5					2.1 ± 2.1	5.6 ± 3.1
<i>Amythas membranifera</i>					0.53 ± 0.36	5.60 ± 2.06
<i>Flabeggraviera</i> sp.			0.3 ± 0.3		0.5 ± 0.4	1.9 ± 0.7
Sabellidae spp.					7.7 ± 3.9	13.3 ± 2.5
Terebellidae spp.		0.3 ± 0.3	7.3 ± 1.4	4.7 ± 1.5	0.3 ± 0.3	
Serpulidae spp.			2.3 ± 2.3	3.8 ± 3.1	5.3 ± 4.3	
<i>Serolis</i> sp.				0.2 ± 0.2	0.3 ± 0.3	0.3 ± 0.3
Pycnogonida sp.4						
<i>Laternula elliptica</i>	4.0 ± 2.5	12.3 ± 3.4	0.7 ± 0.4	0.9 ± 0.6	12.3 ± 4.2	5.1 ± 3
<i>Doris kerguelensis</i>						
<i>Margarella antarctica</i>	11.3 ± 3.3	22.7 ± 5.9	37.7 ± 13.3			
<i>Neobuccinum eatoni</i>						
<i>Nacella concinna</i>						
<i>Lyrocteis flavopallidus</i>				4.9 ± 1.8	1.9 ± 0.5	0.8 ± 0.4
<i>Parborlasia corrugatus</i>		3.3 ± 1.5	1.0 ± 0.7	0.7 ± 0.5	0.5 ± 0.5	0.5 ± 0.4

Supplementary Table 2. Density (ind. m⁻²) of epibenthic megafauna recorded from 10–90 m depth at MC3 in Marian Cove, Antarctica. Abundance data were obtained using a quadrat frame (50 × 50 cm) attached to the ROV and then transformed to values per square meter. Values are mean ± standard error. (n): number of replicates. The table was adapted from Kim et al., 2021⁷.

Taxa	MC3					
	10 m (11)	20 m (11)	30 m (12)	50 m (13)	70 m (11)	90 m (10)
<i>Aplidium</i> cf. <i>radiatum</i>						
<i>Ascidia challengerii</i>		1.1 ± 0.8	4.0 ± 2.5	5.2 ± 2.0	17.5 ± 7.4	6.8 ± 1.8
<i>Cnemidocarpa verrucosa</i>		0.7 ± 0.7	2.3 ± 1.2	5.5 ± 1.9	5.5 ± 2.7	1.2 ± 1.1
<i>Corella eumyota</i>					1.5 ± 1.1	
<i>Distaplia</i> sp.			1.0 ± 0.7	0.9 ± 0.6		0.4 ± 0.4
<i>Molgula pedunculata</i>		3.3 ± 2.5	6.3 ± 4.6	27.7 ± 8.4	5.8 ± 2.9	7.6 ± 3.5
<i>Pyura</i> cf. <i>discoveri</i>						
<i>Pyura setosa</i>						
<i>Pyura</i> sp.1						0.4 ± 0.4
<i>Pyura</i> sp.2						
<i>Sycozoa sigillinoides</i>				0.3 ± 0.3		
<i>Tylobranchion speciosum</i>					0.7 ± 0.7	
Ascidian sp.16				0.6 ± 0.4	1.1 ± 0.8	
Ascidian sp.17					0.4 ± 0.4	
<i>Cryptasterias</i> sp.						
<i>Diplasterias</i> sp.			0.3 ± 0.3	0.3 ± 0.3	0.4 ± 0.4	
<i>Odontaster validus</i>	1.5 ± 0.8	1.5 ± 0.8	1.7 ± 1.2	1.8 ± 1.0		
<i>Perknaster</i> sp.						
<i>Psilaster</i> sp.						
Asteroidea sp.3				0.3 ± 0.3		
Asteroidea sp.4						
Asteroidea sp.5						
Crinoidea			0.7 ± 0.4	0.9 ± 0.6	0.7 ± 0.5	2.0 ± 1.2
<i>Abatus</i> sp.						
<i>Ctenocidaris</i> sp.						
<i>Sterechinus</i> sp.	9.5 ± 4.0	4.7 ± 2.1	0.7 ± 0.4	1.2 ± 0.7		
Ophiuroidea sp.1			0.3 ± 0.3	0.3 ± 0.3	0.4 ± 0.4	
Ophiuroidea sp.2						
<i>Mycale</i> cf. <i>acerata</i>			11.0 ± 11.0		7.3 ± 4.3	
Porifera sp.2		4.0 ± 4.0	12.7 ± 12.7			
Porifera sp.19				8.0 ± 4.2		
Porifera sp.22		1.1 ± 0.8	1.0 ± 1.0			4.0 ± 2.5
Porifera sp.23			4.0 ± 4.0	0.3 ± 0.3	4.0 ± 4.0	0.4 ± 0.4
Porifera sp.25						
Porifera sp.26						

Supplementary Table 2. (continued)

Taxa	MC3					
	10 m (11)	20 m (11)	30 m (12)	50 m (13)	70 m (11)	90 m (10)
Porifera sp.27						
<i>Anoxycalyx</i> cf. <i>joubini</i>						
<i>Rossella</i> cf. <i>podagrosa</i>						
<i>Rossella</i> cf. <i>racovitzae</i>						
<i>Rossella</i> cf. <i>villosa</i>			0.3 ± 0.3			
<i>Reteporella</i> sp.				0.3 ± 0.3	3.6 ± 1.9	2.0 ± 1.0
Bryozoa sp.5			1.0 ± 1.0	2.5 ± 1.3		
Bryozoa sp.6				0.3 ± 0.3	2.2 ± 1.5	0.8 ± 0.5
Bryozoa sp.13					0.4 ± 0.4	0.4 ± 0.4
Bryozoa sp.14				2.2 ± 1.6		
Bryozoa sp.16					2.9 ± 2.2	1.2 ± 1.1
Bryozoa sp.17					0.4 ± 0.4	
Bryozoa sp.18				0.6 ± 0.4		
Bryozoa sp.20						
<i>Arntzia gracilis</i>						
<i>Tenuisis microspiculata</i>					0.4 ± 0.4	0.4 ± 0.4
<i>Thouarella</i> sp.						
Actiniidae sp.2		0.4 ± 0.4				
Actiniidae sp.5						
<i>Candelabrum penola</i>						
Hydrozoa sp.5						
<i>Amythas membranifera</i>						
<i>Flabegraviera</i> sp.		0.4 ± 0.4	0.3 ± 0.3	0.6 ± 0.6		
Sabellidae spp.				0.3 ± 0.3		
Terebellidae spp.		5.1 ± 2.8	5.3 ± 1.7	2.2 ± 0.9	6.5 ± 0.8	4.0 ± 1.1
Serpulidae spp.				6.5 ± 3.8	8.4 ± 8.4	12.8 ± 12.2
<i>Serolis</i> sp.		0.7 ± 0.5	0.7 ± 0.7	1.5 ± 0.7		
Pycnogonida sp.4						
<i>Laternula elliptica</i>	13.8 ± 7.0	1.8 ± 1.5	0.3 ± 0.3	0.3 ± 0.3		
<i>Doris kerguelensis</i>			1.0 ± 1.0			
<i>Margarella antarctica</i>	1.1 ± 1.1		6.7 ± 4			
<i>Neobuccinum eatoni</i>				1.2 ± 0.7		
<i>Nacella concinna</i>	13.5 ± 5.4	0.4 ± 0.4	1.0 ± 1.0			
<i>Lyrocteis flavopallidus</i>			0.3 ± 0.3	1.2 ± 0.5	6.9 ± 3.8	2.4 ± 1.3
<i>Parborlasia corrugatus</i>	0.4 ± 0.4			0.6 ± 0.4	0.4 ± 0.4	0.8 ± 0.5

Supplementary Table 3. Density (ind. m⁻²) of epibenthic megafauna recorded from 10–90 m depth at MC4 in Marian Cove, Antarctica. Abundance data were obtained using a quadrat frame (50 × 50 cm) attached to the ROV and then transformed to values per square meter. Values are mean ± standard error. (n): number of replicates. The table was adapted from Kim et al., 2021⁷.

Taxa	MC4					
	10 m (12)	20 m (14)	30 m (11)	50 m (15)	70 m (10)	90 m (13)
<i>Aplidium</i> cf. <i>radiatum</i>						
<i>Ascidia challengeri</i>			7.3 ± 2.7	15.5 ± 4.7	15.6 ± 4.6	18.2 ± 5.8
<i>Cnemidocarpa verrucosa</i>		22.6 ± 14.9	35.6 ± 8.5	18.9 ± 4.2	9.6 ± 3.1	12.0 ± 2.9
<i>Corella eumyota</i>			2.9 ± 2.2	2.4 ± 1.5		
<i>Distaplia</i> sp.				0.8 ± 0.8	0.8 ± 0.5	0.3 ± 0.3
<i>Molgula pedunculata</i>		2.0 ± 1.4	32.7 ± 11.7	55.7 ± 11.2	26.0 ± 4.4	14.5 ± 3.8
<i>Pyura</i> cf. <i>discoveri</i>						
<i>Pyura setosa</i>						
<i>Pyura</i> sp.1					0.8 ± 0.8	0.6 ± 0.6
<i>Pyura</i> sp.2						
<i>Sycozoa sigillinoides</i>						
<i>Tylobranchion speciosum</i>			0.4 ± 0.4	0.5 ± 0.5		
Ascidian sp.16				11.5 ± 2.8	0.4 ± 0.4	
Ascidian sp.17						
<i>Cryptasterias</i> sp.						
<i>Diplasterias</i> sp.						
<i>Odontaster validus</i>	0.3 ± 0.3		1.1 ± 0.6	1.1 ± 0.5	0.4 ± 0.4	0.3 ± 0.3
<i>Perknaster</i> sp.				0.3 ± 0.3		
<i>Psilaster</i> sp.				0.3 ± 0.3		
Asteroidea sp.3						0.3 ± 0.3
Asteroidea sp.4						
Asteroidea sp.5						
Crinoidea		0.3 ± 0.3	1.1 ± 0.6	1.1 ± 0.5	4.4 ± 2.1	1.2 ± 0.7
<i>Abatus</i> sp.						
<i>Ctenocidaris</i> sp.						
<i>Sterechinus</i> sp.						
Ophiuroidea sp.1				0.3 ± 0.3		0.3 ± 0.3
Ophiuroidea sp.2						
<i>Mycale</i> cf. <i>acerata</i>					6.0 ± 4.0	0.6 ± 0.6
Porifera sp.2			9.5 ± 9.5	0.3 ± 0.3		
Porifera sp.19				2.9 ± 2.7		
Porifera sp.22				0.3 ± 0.3	6.0 ± 6.0	4.0 ± 3.1
Porifera sp.23			1.5 ± 1.5	0.5 ± 0.5	0.4 ± 0.4	
Porifera sp.25						
Porifera sp.26						

Supplementary Table 3. (continued)

Taxa	MC4					
	10 m (12)	20 m (14)	30 m (11)	50 m (15)	70 m (10)	90 m (13)
Porifera sp.27						
<i>Anoxycalyx</i> cf. <i>joubini</i>						
<i>Rossella</i> cf. <i>podagrosa</i>						
<i>Rossella</i> cf. <i>racovitzae</i>					0.4 ± 0.4	
<i>Rossella</i> cf. <i>villosa</i>					0.4 ± 0.4	
<i>Reteporella</i> sp.				0.5 ± 0.4	3.6 ± 2.4	1.8 ± 0.9
Bryozoa sp.5		4 ± 2.1	15.3 ± 7.2	7.5 ± 3.3	1.6 ± 1.2	
Bryozoa sp.6				1.3 ± 0.8	8.4 ± 3.4	2.5 ± 1.4
Bryozoa sp.13			1.1 ± 1.1	1.1 ± 0.6	3.2 ± 2.4	0.3 ± 0.3
Bryozoa sp.14			4.0 ± 4.0	2.7 ± 1.9		
Bryozoa sp.16					1.2 ± 0.6	0.6 ± 0.6
Bryozoa sp.17						
Bryozoa sp.18						
Bryozoa sp.20						
<i>Arntzia gracilis</i>						
<i>Tenuisis microspiculata</i>					0.4 ± 0.4	
<i>Thouarella</i> sp.						
Actiniidae sp.2				0.3 ± 0.3		
Actiniidae sp.5						
<i>Candelabrum penola</i>						
Hydrozoa sp.5						
<i>Amythas membranifera</i>						
<i>Flabegraviera</i> sp.			0.4 ± 0.4	0.8 ± 0.4		0.6 ± 0.6
Sabellidae spp.				1.6 ± 1.6	0.8 ± 0.8	1.5 ± 1.1
Terebellidae spp.		2.6 ± 0.9	7.6 ± 1.7	14.9 ± 3.1	12 ± 2.1	20 ± 6.6
Serpulidae spp.		6.9 ± 2.9	24 ± 15.8	15.2 ± 6.6	9.2 ± 7.0	0.9 ± 0.7
<i>Serolis</i> sp.		1.4 ± 0.7	0.7 ± 0.7	0.5 ± 0.5	0.4 ± 0.4	
Pycnogonida sp.4						
<i>Laternula elliptica</i>	13.3 ± 6.3	5.7 ± 2.1	1.8 ± 1	0.8 ± 0.6		
<i>Doris kerguelensis</i>						
<i>Margarella antarctica</i>	0.7 ± 0.7	1.7 ± 0.9	0.4 ± 0.4	2.4 ± 0.9	0.4 ± 0.4	0.6 ± 0.4
<i>Neobuccinum eatoni</i>						0.3 ± 0.3
<i>Nacella concinna</i>	1.3 ± 1.3					
<i>Lyrocteis flavopallidus</i>				0.5 ± 0.4	2.4 ± 1.4	1.8 ± 1.1
<i>Parborlasia corrugatus</i>	0.3 ± 0.3	0.6 ± 0.4		1.1 ± 0.8	0.4 ± 0.4	0.3 ± 0.3

Supplementary Table 4. Density (ind. m⁻²) of epibenthic megafauna recorded from 10–90 m depth at MC5 in Marian Cove, Antarctica. Abundance data were obtained using a quadrat frame (50 × 50 cm) attached to the ROV and then transformed to values per square meter. Values are mean ± standard error. (n): number of replicates. The table was adapted from Kim et al., 2021⁷.

Taxa	MC5					
	10 m (14)	20 m (21)	30 m (19)	50 m (16)	70 m (16)	90 m (22)
<i>Aplidium</i> cf. <i>radiatum</i>						
<i>Ascidia challengerii</i>		0.2 ± 0.2	6.5 ± 2.5	7.3 ± 2	7.3 ± 2.9	1.6 ± 0.9
<i>Cnemidocarpa verrucosa</i>	3.7 ± 3.7	30.7 ± 6.9	37.3 ± 7.4	20.0 ± 4.1	9.5 ± 2.3	10.9 ± 3
<i>Corella eumyota</i>						
<i>Distaplia</i> sp.						0.2 ± 0.2
<i>Molgula pedunculata</i>		2.3 ± 1.3	82.7 ± 9.6	81.5 ± 12.1	32.5 ± 6.3	17.5 ± 4.7
<i>Pyura</i> cf. <i>discoveri</i>						
<i>Pyura setosa</i>						
<i>Pyura</i> sp.1					1.3 ± 0.6	
<i>Pyura</i> sp.2						
<i>Sycozoa sigillinoides</i>						
<i>Tylobranchion speciosum</i>			0.2 ± 0.2			
Ascidian sp.16						
Ascidian sp.17						
<i>Cryptasterias</i> sp.						
<i>Diplasterias</i> sp.						
<i>Odontaster validus</i>	0.6 ± 0.4	0.8 ± 0.4	2.1 ± 0.6			
<i>Perknaster</i> sp.			0.2 ± 0.2		0.5 ± 0.3	
<i>Psilaster</i> sp.						
Asteroidea sp.3						
Asteroidea sp.4			0.2 ± 0.2			
Asteroidea sp.5						
Crinoidea		0.6 ± 0.3	1.7 ± 0.6	3.5 ± 1.1	3.8 ± 1.1	0.7 ± 0.3
<i>Abatus</i> sp.						
<i>Ctenocidaris</i> sp.						
<i>Sterechinus</i> sp.						
Ophiuroidea sp.1						
Ophiuroidea sp.2						
<i>Mycale</i> cf. <i>acerata</i>						
Porifera sp.2						0.2 ± 0.2
Porifera sp.19					0.3 ± 0.3	
Porifera sp.22						
Porifera sp.23						
Porifera sp.25						
Porifera sp.26						

Supplementary Table 4. (continued)

Taxa	MC5					
	10 m (14)	20 m (21)	30 m (19)	50 m (16)	70 m (16)	90 m (22)
Porifera sp.27						
<i>Anoxycalyx</i> cf. <i>joubini</i>						
<i>Rossella</i> cf. <i>podagrosa</i>						
<i>Rossella</i> cf. <i>racovitzae</i>						
<i>Rossella</i> cf. <i>villosa</i>						
<i>Reteporella</i> sp.				1.8 ± 1.1	1.5 ± 0.8	0.5 ± 0.4
Bryozoa sp.5		5.1 ± 3.0	74.5 ± 11.8	6.3 ± 3.3		0.2 ± 0.2
Bryozoa sp.6		0.4 ± 0.3	1.1 ± 0.5	1.5 ± 0.6	5.3 ± 1.9	1.8 ± 0.7
Bryozoa sp.13			1.3 ± 0.6	7.8 ± 2.8	1.8 ± 0.8	1.8 ± 0.7
Bryozoa sp.14			12 ± 5.4	5.5 ± 2.4		0.5 ± 0.4
Bryozoa sp.16				0.3 ± 0.3	0.3 ± 0.3	
Bryozoa sp.17						
Bryozoa sp.18						
Bryozoa sp.20						
<i>Arntzia gracilis</i>						
<i>Tenuis microspiculata</i>						
<i>Thouarella</i> sp.						
Actiniidae sp.2						
Actiniidae sp.5						
<i>Candelabrum penola</i>						
Hydrozoa sp.5						
<i>Amythas membranifera</i>						
<i>Flabegraviera</i> sp.						
Sabellidae spp.			12.0 ± 6.7	40.3 ± 17.6	26.0 ± 11.9	4.0 ± 2.0
Terebellidae spp.	1.1 ± 1.1	11.8 ± 2.6	16.4 ± 3.7	10.0 ± 2.5	7.0 ± 1.5	15.8 ± 1.7
Serpulidae spp.			4.4 ± 3.3	4.0 ± 3.0	18.0 ± 12.3	10.9 ± 4.9
<i>Serolis</i> sp.					0.3 ± 0.3	0.2 ± 0.2
Pycnogonida sp.4						
<i>Laternula elliptica</i>	0.6 ± 0.6	0.6 ± 0.4				
<i>Doris kerguelensis</i>						
<i>Margarella antarctica</i>	0.3 ± 0.3	0.8 ± 0.6	2.1 ± 1.1	8.0 ± 3.3		
<i>Neobuccinum eatoni</i>						
<i>Nacella concinna</i>						
<i>Lyrocteis flavopallidus</i>			0.2 ± 0.2	0.3 ± 0.3	1.0 ± 0.6	2.0 ± 0.5
<i>Parborlasia corrugatus</i>		0.2 ± 0.2	0.2 ± 0.2			0.4 ± 0.3

Supplementary Table 5. Density (ind. m⁻²) of epibenthic megafauna recorded from 50–70 m depth at MC6 in Marian Cove, Antarctica. Abundance data were obtained using a quadrat frame (50 × 50 cm) attached to the ROV and then transformed to values per square meter. Values are mean ± standard error. (n): number of replicates.

Taxa	MC6	
	50 m (19)	70 m (14)
<i>Aplidium</i> cf. <i>radiatum</i>		
<i>Ascidia challengerii</i>		
<i>Cnemidocarpa verrucosa</i>		
<i>Corella eumyota</i>		
<i>Distaplia</i> sp.		
<i>Molgula pedunculata</i>	0.6 ± 0.6	
<i>Pyura</i> cf. <i>discoveri</i>		
<i>Pyura setosa</i>		
<i>Pyura</i> sp.1		
<i>Pyura</i> sp.2		
<i>Sycozoa sigillinoides</i>		
<i>Tylobranchion speciosum</i>		
Ascidian sp.16		
Ascidian sp.17		
<i>Cryptasterias</i> sp.		
<i>Diplasterias</i> sp.		
<i>Odontaster validus</i>		
<i>Perknaster</i> sp.		
<i>Psilaster</i> sp.		
Asteroidea sp.3		
Asteroidea sp.4		
Asteroidea sp.5		
Crinoidea		
<i>Abatus</i> sp.		
<i>Ctenocidaris</i> sp.		
<i>Sterechinus</i> sp.		
Ophiuroidea sp.1		
Ophiuroidea sp.2		
<i>Mycale</i> cf. <i>acerata</i>		
Porifera sp.2		
Porifera sp.19		
Porifera sp.22		
Porifera sp.23		
Porifera sp.25		
Porifera sp.26		

Supplementary Table 5. (continued)

Taxa	MC6	
	50 m (19)	70 m (14)
Porifera sp.27		
<i>Anoxycalyx</i> cf. <i>joubini</i>		
<i>Rossella</i> cf. <i>podagrosa</i>		
<i>Rossella</i> cf. <i>racovitzae</i>		
<i>Rossella</i> cf. <i>villosa</i>		
<i>Reteporella</i> sp.		
Bryozoa sp.5	5.5 ± 3.2	
Bryozoa sp.6	1.3 ± 1.1	4.3 ± 2.5
Bryozoa sp.13	1.3 ± 0.9	0.3 ± 0.2
Bryozoa sp.14		
Bryozoa sp.16		
Bryozoa sp.17		
Bryozoa sp.18		
Bryozoa sp.20		
<i>Arntzia gracilis</i>		
<i>Tenuisis microspiculata</i>		
<i>Thouarella</i> sp.		
Actiniidae sp.2		
Actiniidae sp.5		
<i>Candelabrum penola</i>		
Hydrozoa sp.5		
<i>Amythas membranifera</i>		
<i>Flabegraviera</i> sp.		
Sabellidae spp.		
Terebellidae spp.		
Serpulidae spp.	45.1 ± 19.8	3.7 ± 2.1
<i>Serolis</i> sp.		
Pycnogonida sp.4		
<i>Laternula elliptica</i>		
<i>Doris kerguelenensis</i>		
<i>Margarella antarctica</i>		
<i>Neobuccinum eatoni</i>		
<i>Nacella concinna</i>		
<i>Lyrocteis flavopallidus</i>		
<i>Parborlasia corrugatus</i>		

Supplementary Table 6. Indicator megafauna species for clustered groups in Marian Cove. Given groups representing depths and distance from the glacier, such as A: ice-scouring depths of every stations (10–20 m); B: rarely scoured depths of innermost area (50–70 m); C: rarely scoured depths of inner to outer area (20–90 m); D: deep depths of outermost area (50–90 m).

Indicator taxa	Group			
	A	B	C	D
<i>Nacella concinna</i>	0.247***			
Serpulidae spp.		0.213**		
<i>Molgula pedunculata</i>			0.533***	
<i>Cnemidocarpa verrucosa</i>			0.467***	
Ascidian sp.17				0.459***
<i>Ascidia challengerii</i>				0.445***
<i>Amythas membranifera</i>				0.313***
<i>Rossella</i> cf. <i>racovitzae</i>				0.274**
<i>Rossella</i> cf. <i>podagrosa</i>				0.267***
<i>Aplidium</i> cf. <i>radiatum</i>				0.210***
<i>Anoxycalyx</i> cf. <i>joubini</i>				0.178*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Supplementary Table 7. Factors affecting benthic communities and their effects in Antarctica.

Factor		Impact type	Effect	Depth (m)	Reference
Inorganic factor	Ice scour	Physical impact	Decrease of community diversity/density	0–1000	20, 50
			Restrict of community development		1, 3, 19
			Dominated by pioneer species		2, 3
			Reduction of life span of zoobenthos		2
			Modification of seafloor topography and sediment characteristics		4
	Sea ice/Ice foot	Scour	Refer to the 'Ice scour'	0–3	
		Protect from ice scour	Benthic community formation		5
		Light blocking	Benthic fauna density decrease due to food shortage by reduction of primary production		6
	Anchor ice	Organism and sediment removal	Decrease of community diversity/density	0–33	8
			Dominated by pioneer species and mobile species		5, 8
			Restrict of community development		8
	Glacial retreat	Instable environment	Decrease of community diversity/density		11, 49
			Dominated by pioneer species		11
		Sedimentation increase	Dominated by opportunistic species		9
		Substratum gradient	Community structure change		12, 13
	Depth	New habitat supply	Benthic organisms colonization		14
		Ice scouring frequency change	Diversity, density and biomass of benthic community increase with depth		15, 16, 25
			Community structure change		17
	Freshwater	Inundation	Zoobenthos motility increase	0–10	18
	Wave action	Turbulence	Abrasion of biota		5
			Zoobenthos redistribution		21
	Sediment	Slumping	Zoobenthos motility increase		22
		Sedimentation increase	Opportunistic species dominant		9
	Substratum type	Composition	Major factor determining community structure in areas not subjected to ice-scouring		13
	Temperature	Warming/Cooling	Growth rate increase/decrease		23
			Locomotor activity		24
			Zoobenthos motility increase		26, 27
Organic factor	Primary Production	Food supply	Zoobenthos density increase/decrease		6
	Macroalgae	Density	Zoobenthos density increase/decrease		16
	Megafauna	Settlement substrate supply	Increase of community diversity/density		10
		Siliceous mat formation (Hexactinellid)	Substrate quality change		28
		Space and food Competition	Increase of chl-a and species richness		16, 28, 29
			Major factor determining community structure in areas not subjected to ice-scouring		30
		Predation pressure	Major factor determining community structure in areas not subjected to ice-scouring		30

Supplementary Table 8. Environmental characteristics among ROV survey stations (MC2–MC6) in Marian Cove, Antarctica. *Data were obtained from long-term monitoring project for King Sejong Station (KOPRI 2018)⁵⁴. Water temperature and salinity data represent annual mean values. For sediment properties, mean $\pm$ standard deviation values are presented. The table was adapted from Kim et al., 2021⁷ and station was updated at 2021.

Station	Period of sea bed exposure (yr)	Distance from glacier front (km)	Water depth (m)	Water column properties*		Sediment properties								
				Temp. (°C)	Salinity (psu)	TOC (<i>n</i> = 3) (%)	TN (<i>n</i> = 3) (%)	<i>n</i>	Composition (%)				Mean grain size (Φ)	Sorting (Φ)
									Gravel	Sand	Silt	Clay		
MC6	< 5	0.0	50	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
			70	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MC5	8–14	0.2	10	-0.27	33.99	0.4 ± 0.2	0.08 ± 0.05	13	18 ± 7	43 ± 3	27 ± 2	13 ± 1	3.6 ± 0.5	3.5 ± 0.3
			20	-0.27	34.03	0.5 ± 0.2	0.09 ± 0.04	19	3 ± 0	22 ± 0	50 ± 0	25 ± 0	6.0 ± 0.0	2.6 ± 0.0
			30	-0.28	34.05	0.5 ± 0.1	0.07 ± 0.01	16	19 ± 7	22 ± 2	41 ± 3	19 ± 2	4.4 ± 0.7	3.8 ± 0.3
			50	-0.32	34.07	0.3 ± 0.1	0.03 ± 0.01	14	12 ± 19	16 ± 3	44 ± 10	28 ± 6	5.5 ± 2.0	3.2 ± 0.9
			70	-0.38	34.09	0.3 ± 0.1	0.03 ± 0.01	16	19 ± 7	17 ± 1	39 ± 3	25 ± 2	4.9 ± 0.7	3.9 ± 0.4
			90	-0.58	34.15	0.3 ± 0.0	0.03 ± 0.01	22	8 ± 4	12 ± 1	44 ± 2	36 ± 2	6.3 ± 0.4	3.2 ± 0.4
MC4	18–24	0.8	10	-0.26	33.97	0.4 ± 0.1	0.07 ± 0.03	12	45 ± 15	33 ± 9	13 ± 4	9 ± 2	1.4 ± 1.3	3.7 ± 0.3
			20	-0.28	34.02	0.5 ± 0.1	0.09 ± 0.02	14	14 ± 4	31 ± 1	31 ± 1	24 ± 1	4.7 ± 0.4	3.7 ± 0.2
			30	-0.29	34.04	0.5 ± 0.1	0.07 ± 0.01	11	20 ± 1	30 ± 0	27 ± 0	23 ± 0	4.2 ± 0.1	4.0 ± 0.0
			50	-0.33	34.07	0.3 ± 0.1	0.03 ± 0.00	14	10 ± 5	16 ± 1	40 ± 2	34 ± 2	5.9 ± 0.5	3.5 ± 0.4
			70	-0.40	34.09	0.3 ± 0.0	0.03 ± 0.00	10	6 ± 7	10 ± 1	45 ± 3	39 ± 3	6.6 ± 0.7	2.9 ± 0.8
			90	-0.54	34.11	0.3 ± 0.1	0.03 ± 0.01	13	7 ± 2	13 ± 0	43 ± 1	38 ± 1	6.5 ± 0.2	3.2 ± 0.3
MC3	32–34	1.2	10	-0.22	33.97	0.7 ± 0.1	0.12 ± 0.01	9	58 ± 28	12 ± 9	18 ± 12	11 ± 8	0.8 ± 2.7	3.8 ± 1.5
			20	-0.27	34.02	0.7 ± 0.2	0.11 ± 0.04	11	33 ± 27	17 ± 7	33 ± 13	17 ± 7	3.2 ± 2.5	3.8 ± 1.3
			30	-0.29	34.04	0.7 ± 0.1	0.09 ± 0.02	10	36 ± 44	9 ± 7	35 ± 24	20 ± 14	3.3 ± 4.4	2.3 ± 1.6
			50	-0.32	34.07	0.3 ± 0.1	0.04 ± 0.01	13	16 ± 19	24 ± 6	38 ± 9	22 ± 5	4.6 ± 2.0	3.6 ± 0.6
			70	-0.45	34.09	0.4 ± 0.0	0.05 ± 0.01	11	10 ± 5	12 ± 1	48 ± 3	30 ± 2	6.0 ± 0.6	3.3 ± 0.5
			90	-0.55	34.01	0.4 ± 0.0	0.06 ± 0.00	11	6 ± 6	9 ± 1	42 ± 3	43 ± 3	6.9 ± 0.7	2.9 ± 0.8
MC2	> 63	3.5	10	-0.20	34.01	0.3 ± 0.1	0.03 ± 0.01	11	49 ± 21	39 ± 16	4 ± 2	8 ± 3	0.4 ± 1.6	3.1 ± 0.9
			20	-0.25	34.04	0.6 ± 0.3	0.09 ± 0.05	5	29 ± 1	51 ± 1	12 ± 0	8 ± 0	2.1 ± 0.1	3.4 ± 0.0
			30	-0.28	34.06	0.6 ± 0.3	0.09 ± 0.05	7	39 ± 2	36 ± 1	15 ± 0	9 ± 0	1.9 ± 0.1	3.8 ± 0.0
			50	-0.35	34.09	0.7 ± 0.1	0.09 ± 0.01	14	16 ± 3	13 ± 0	42 ± 1	29 ± 1	5.5 ± 0.3	3.8 ± 0.2
			70	-0.42	34.11	0.6 ± 0.1	0.08 ± 0.01	10	1 ± 1	7 ± 0	56 ± 0	35 ± 0	7.1 ± 0.0	2.1 ± 0.1
			90	-0.47	34.13	0.6 ± 0.1	0.08 ± 0.01	15	1 ± 0	5 ± 0	55 ± 0	39 ± 0	7.4 ± 0.0	1.8 ± 0.1

Supplementary Table 9. List of biological traits used for assessing the functional diversity of benthic megafauna community and relative abundance of functional traits (%) in each station.

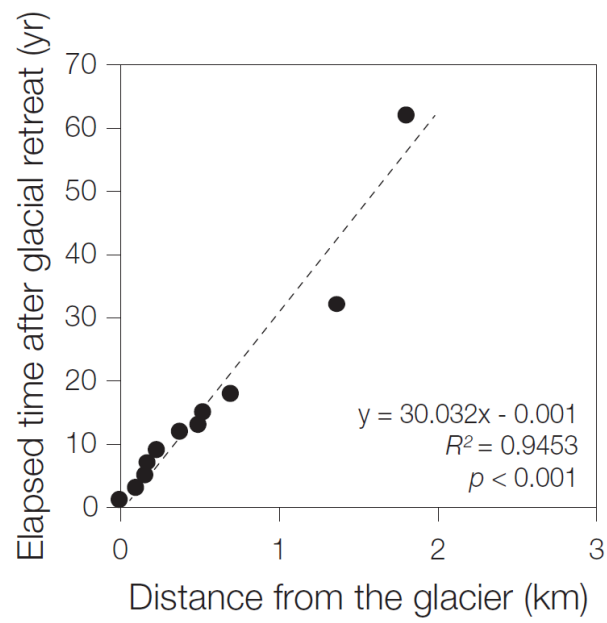
Trait	Categories	Station			
		MC2	MC3	MC4	MC5
Body size	Small (< 5 cm)	28.72	20.00	21.29	21.99
	Small-medium (5–10 cm)	14.22	11.41	1.75	0.99
	Medium-large (10–30 cm)	47.40	57.34	71.49	76.75
	Large (> 30 cm)	9.66	11.25	5.47	0.27
Mobility	Attached	61.99	57.43	70.00	69.43
	Tubed-dweller	9.86	15.65	20.45	26.05
	Burrower	6.78	4.99	3.78	0.16
	Slow moving	0.10	0.11	0.05	4.36
	Fast moving	21.27	21.82	5.72	0.00
Feeding type	Suspension/filter feeder	76.73	75.75	86.55	88.69
	Scraper/Deposit feeder	18.00	14.41	11.58	10.51
	Scraper/Deposit feeder + Scavenger	0.00	4.93	0.00	0.00
	Scavenger	1.30	2.06	0.61	0.49
	Scavenger + Carnivore	0.24	0.38	0.05	0.00
	Carnivore	0.00	0.00	0.00	0.00
	Carnivore + Omnivore	3.38	1.86	1.15	0.17
	Omnivore	0.34	0.61	0.05	0.13
Association	No	72.23	64.42	48.92	37.68
	Yes	27.77	35.58	51.08	62.32
Solitary/Colonial	Solitary	63.08	73.96	81.08	81.10
	Colonial	36.92	26.04	18.92	18.90
Total number of traits		19	20	19	17

Supplementary Table 10. Sampling information on water depth in each station.

Station	Survey date	Depth (m)	ROV (n)	Grab (n)	SCUBA (n)	Trawl (n)
MC2	2018	10	11	-	3	-
		20	12	-	3	-
		30	12	-	3	-
		50	18	3	-	-
		70	15	3	-	-
		90	15	3	-	1
MC3	2018	10	11	-	3	-
		20	11	-	3	-
		30	12	-	3	-
		50	13	3	-	-
		70	11	3	-	-
		90	10	3	-	-
MC4	2018	10	12	-	3	-
		20	14	-	3	-
		30	11	-	3	-
		50	15	3	-	-
		70	10	3	-	-
		90	13	3	-	1
MC5	2018	10	14	-	3	-
		20	21	-	3	-
		30	19	-	3	-
		50	16	3	-	-
		70	16	3	-	-
		90	22	3	-	1
MC6	2019	50	19	-	-	-
		70	14	-	-	-

Supplementary Table 11. Summary of statistical analyses with purpose, data, and software.

Method	Purpose	Remark	Software
Taxonomic diversity	Determine structural difference among benthic megafauna assemblages	Based on abundance and phylogenetic information	PRIMER 6
Functional diversity	Confirm functional diversity of benthic megafauna assemblages	Based on abundance and functional trait	R
Cluster analysis	Grouping of epibenthic megafauna assemblages	Abundance data square root transformed	PRIMER 6
nMDS	Localize assemblages in two-dimensional plot with station and depth	Abundance data square root transformed	PRIMER 6
BIOENV	Confirm the relationship among environmental parameters and megafauna distribution	Abundance data square root transformed Environmental data normalized	PRIMER 6
IndVal	Identify indicator species for each group classified by cluster analysis	$\text{IndVal}_{ij} = A_{ij} \times B_{ij} = 100$ $\text{IndVal}_i = \max [\text{IndVal}_{ij}]$	R



Supplementary Figure 1. Correlation between distance from the glacier and elapsed time after deglaciation.

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