

The following supplement accompanies the article

Food sources of macrozoobenthos in an Arctic kelp belt: trophic relationships revealed by stable isotope and fatty acid analyses

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Content Overview:

Stable isotope compositions ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) of sources and consumers (Table S1) and relative composition of fatty acids (FA, mass %) of various food sources (Table S2) and consumers (Table S3) sampled at Hansneset (Spitsbergen, Svalbard, Norway) in summer 2013. FAs were assigned to different groups according to the literature (see Table 3).

Table S1. Stable isotope composition ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, mean \pm standard deviations (SD), ‰) of potential food sources and consumers sampled at Hansneset (Spitsbergen, Svalbard, Norway). * indicates species also used for fatty acid analyses. Trophic level (TL) was calculated using the equation from Post et al. 2002 (see material and methods). References: 1: Petersen 2007, 2: Petersen et al. 2003, 3: Beninger et al. 1991, 4: Guerra-Garcia and Tierno de Figueroa 2009, 5: Eckman and Duggins 1993, 6: Wessels et al. 2011, 7: Latyshev et al. 2004, 8: Brown et al. 2012, 9: Graeve et al. 1997, 10: Nielsen et al. 1995, 11: Barnes and Clarke 1994, 12: Himmelman and Hamel 1993, 13: Berge et al. 2009, 14: Birkely and Gulliksen, 2003.

	Feeding type	Taxa sampled	$\delta^{13}\text{C}$ (‰)		$\delta^{15}\text{N}$ (‰)		TL	
			Mean	SD	Mean	SD	Mean	SD
Potential food sources	-	<i>Acrosiphonia</i> spp.	-21.3	1.1	3.8	0.4	-	-
	-	<i>Phycodrys rubens</i>	-36.5	0.6	4.0	0.4	-	-
	-	<i>Ptilota gunneri</i> *	-36.3	0.4	3.6	0.4	-	-
	-	Encrusting Rhodophyta *	-28.3	0.4	4.3	0.3	-	-
	-	Encrusting Corallinaceae	-17.0	0.9	4.2	0.1	-	-
	-	<i>Desmarestia aculeata</i>	-26.5	2.9	4.0	0.8	-	-
	-	<i>Alaria esculenta</i> *	-20.0	0.3	3.6	0.5	-	-
	-	<i>Laminaria digitata</i> *	-17.5	0.2	4.8	0.5	-	-
	-	<i>Saccharina latissima</i> *	-18.9	0.8	5.3	0.3	-	-
	-	<i>Saccorhiza dermatodea</i> *	-19.4	1.5	5.4	0.2	-	-
	-	Epiphytes *	-18.4	0.5	3.5	0.1	-	-
	-	Epilithic organic matter *	-25.8	0.6	1.6	0.7	-	-
	-	Detritus (10 m)	-24.0	2.4	5.1	0.9	-	-
	-	Detritus (15 m)	-30.5	1.0	3.0	0.4	-	-
	-	Suspended particulate organic matter (June) *	-23.8	0.5	6.0	0.7	-	-
	-	Suspended particulate organic matter (July)	-28.3	1.9	4.0	0.8	-	-
	-	Suspended particulate organic matter (August)	-24.8	3.2	3.8	1.5	-	-
-	Trapped particulate organic matter *	-20.8	1.1	4.1	0.7	-	-	
Consumers	Filter feeder	Bryozoa *	-22.5	-	4.7	-	1.6	-
	Filter feeder ¹	<i>Synoicum turgens</i> *	-21.5	0.1	6.0	<0.1	2.0	0.01
	Filter feeder ¹	<i>Halocynthia pyriformis</i>	-22.4	0.1	6.8	0.1	2.3	0.04
	Filter feeder ²	<i>Hiatella arctica</i> *	-20.9	0.5	5.6	0.2	1.9	0.09
	Filter feeder ³	<i>Musculus</i> sp. *	-21.8	0.2	5.2	0.1	1.7	0.04
	Filter feeder	<i>Sycon</i> sp.	-17.1	0.8	5.2	0.3	1.7	0.1
	Filter feeder ⁴	<i>Caprella septentrionalis</i> *	-18.8	1.0	5.9	0.3	2.0	0.1
	Filter feeder ⁵	<i>Balanus</i> sp.*	-20.7	0.4	6.5	0.3	2.2	0.1
	Grazer ⁶	<i>Gammarillus homari</i>	-21.0	<0.1	6.3	1.2	2.1	0.4
	Grazer	<i>Margarites groenlandicus</i> *	-19.3	0.2	6.9	0.5	2.3	0.2
	Grazer	<i>Boreotrophon truncatus</i>	-21.3	0.6	6.9	0.6	2.3	0.2
	Grazer ⁷	<i>Tonicella rubra</i> *	-20.2	1.0	7.8	0.4	2.7	0.1
	Grazer ⁸	<i>Strongylocentrotus droebachiensis</i> *	-21.1	0.5	4.4	0.8	1.4	0.3
	Omnivore ⁹	<i>Ophiopholis aculeata</i> *	-21.6	0.3	7.6	0.2	2.6	0.09
	Omnivore ^{10,11}	<i>Hediste diversicolor</i>	-21.0	0.1	7.7	0.2	2.6	0.06
	Omnivore ¹²	<i>Buccinum</i> sp.	-20.3	0.9	8.9	0.6	3.1	0.2
	Omnivore ¹³	<i>Hyas araneus</i> *	-20.1	1.1	8.9	1.3	3.1	0.5
Omnivore ¹¹	<i>Pagurus pubescens</i>	-19.6	0.9	7.4	0.3	2.5	0.1	
Omnivore ¹⁴	<i>Lebbeus polaris</i>	-21.3	0.2	7.8	<0.1	2.7	0.01	

Table S2. Relative composition of fatty acids (FA, mass %) of various food sources at Hansneset (Spitsbergen, Svalbard, Norway) in 2013. FAs were assigned to different groups according to the literature (see table 3).

Fatty acid	Group	Rhodophyta	Phaeophyta blades				Phaeophyta stipes			Epiphytes	Composite food sources			
		<i>P. gunneri</i>	<i>S. dermatodea</i>	<i>A. esculenta</i>	<i>L. digitata</i>	<i>S. latissima</i>	<i>A. esculenta</i>	<i>L. digitata</i>	<i>S. latissima</i>		ENRH	SPOM	EOM	TPOM
Saturated														
14:0	Diatoms	1.88	5.12	2.13	6.25	7.48	5.64	7.81	8.34	3.61	2.38	5.94	4.67	7.40
16:0	Ubiquitous	24.10	14.77	15.74	12.27	11.71	14.27	18.76	14.56	15.45	16.98	20.19	21.84	18.10
18:0	Ubiquitous	0.68	0.85	0.66	0.35	0.47	0.62	0.55	0.68	1.34	7.24	6.58	6.39	1.93
20:0		0.06	0.39	0.42	0.22	0.28	0.40	0.42	0.62	0.39	1.15	0.50	0.70	0.15
24:0	Vascular plants	0.04	0.03	0.11	0.03	0.03	0.13	0.08	0.13	0.13	0.03	1.09	0.85	0.18
Monoenoic														
16:1(<i>n</i> -5)		0.07	0.52	0.09	0.18	0.13	0.26	0.28	0.73	0.33	0.02	0.70	0.36	0.35
16:1(<i>n</i> -7)	Diatoms	8.74	-	0.84	1.76	1.11	6.42	7.84	7.32	5.23	0.38	4.45	6.72	5.98
16:1(<i>n</i> -9)		0.48	0.20	0.49	0.26	0.34	0.16	0.22	0.20	1.26	0.14	1.43	3.33	0.59
18:1(<i>n</i> -4)		0.01	-	-	-	-	-	-	-	-	-	-	-	-
18:1(<i>n</i> -7)	Bacteria / Macroalgae	1.82	0.09	0.29	0.09	0.10	0.24	0.54	0.39	4.15	0.11	5.07	4.55	1.94
18:1(<i>n</i> -9)	Ubiquitous	5.16	22.01	10.46	11.36	10.69	17.92	22.10	16.14	14.35	32.13	13.11	13.93	23.82
20:1(<i>n</i> -6)		-	-	0.03	-	0.02	-	0.04	0.02	-	-	0.10	0.26	0.06
20:1(<i>n</i> -7)		0.06	-	-	-	-	-	-	-	0.08	-	0.15	0.48	0.24
20:1(<i>n</i> -9)	Animal	0.11	-	-	-	-	-	-	-	0.20	-	0.28	0.41	0.87
20:1(<i>n</i> -11)	Animal	0.05	-	0.04	-	0.02	-	-	-	0.09	0.01	-	0.60	0.07
20:1(<i>n</i> -15)		-	-	-	-	-	-	-	-	-	-	-	-	-
22:1(<i>n</i> -5)		-	-	-	-	-	-	-	-	-	-	0.03	0.16	0.02
22:1(<i>n</i> -7)		0.01	-	-	-	-	-	-	-	0.04	-	0.05	0.19	0.09
22:1(<i>n</i> -9)		0.08	0.03	0.06	0.03	-	-	0.04	-	0.10	0.02	0.19	0.24	0.26
Polyenoic														
16:2(<i>n</i> -7)	Diatoms	0.03	-	0.01	-	-	0.02	-	-	0.13	-	0.33	0.36	0.10
16:4(<i>n</i> -1)	Diatoms	0.03	-	-	-	-	-	-	-	0.01	-	0.06	0.19	0.03
16:4(<i>n</i> -3)	Flagellates	1.10	0.03	0.06	0.48	0.58	0.04	0.12	0.22	0.22	0.02	0.43	0.44	0.58
18:2(<i>n</i> -6)	Phaeophyta	1.47	14.29	6.54	8.36	8.89	9.37	9.01	8.08	7.08	7.60	4.70	2.49	2.21
18:3(<i>n</i> -3)	Phaeophyta	0.64	6.51	8.31	6.23	6.52	2.22	2.33	2.19	5.26	5.69	1.17	0.57	2.24
18:3(<i>n</i> -6)		0.33	0.97	0.72	0.81	1.23	1.08	0.33	0.64	0.69	0.91	0.32	0.08	0.40
18:4(<i>n</i> -1)		0.05	0.01	-	0.02	0.02	0.02	-	0.03	0.02	-	-	0.13	-
18:4(<i>n</i> -3)	Flagellates / Macroalgae	1.21	12.26	18.60	14.11	15.40	2.47	1.67	2.77	8.52	3.99	2.92	2.27	8.70
20:2(<i>n</i> -6)	Animal	0.20	0.09	0.16	0.20	0.14	0.49	0.63	0.45	0.35	0.04	0.28	0.30	0.15
20:2(<i>n</i> -9)		-	-	-	-	-	-	-	-	-	-	-	-	-
20:3(<i>n</i> -3)		0.07	0.13	0.11	0.11	0.10	0.14	0.15	0.12	0.20	0.05	0.04	0.07	0.05
20:3(<i>n</i> -4)		-	-	-	-	-	-	-	-	-	-	-	-	0.02

20:4(<i>n</i> -3)		0.15	0.37	1.01	0.68	0.57	1.19	0.22	0.54	1.17	0.31	0.28	0.17	0.49
20:4 NMI *		0.31	0.75	1.08	1.61	1.59	2.15	1.69	2.37	0.39	0.71	0.06	0.11	0.07
20:4(<i>n</i> -6)	Phaeophyta	2.82	6.77	9.72	14.49	14.33	19.32	15.20	21.36	3.54	6.39	0.54	1.03	0.64
20:5(<i>n</i> -3)	Diatoms / Macroalgae	42.59	11.22	18.27	16.62	14.98	12.13	6.11	7.66	14.63	10.41	6.29	6.15	5.53
22:2(<i>n</i> -7)		-	-	-	-	-	-	-	-	-	-	0.05	0.08	0.02
22:5(<i>n</i> -3)	Flagellates	0.65	-	0.02	0.04	0.03	0.03	0.07	0.03	0.30	0.03	0.19	0.31	0.83
22:6(<i>n</i> -3)	Flagellates	0.45	-	0.16	0.04	0.11	0.03	0.06	0.07	3.22	0.07	7.16	2.40	4.31
Odd numbered, iso- and anteiso- branched	Bacteria	1.26	1.33	2.17	1.43	1.56	1.27	1.12	1.41	3.54	1.59	7.70	8.62	4.11
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Sums of fatty acid trophic markers														
Bacteria		1.26	1.33	2.17	1.43	1.56	1.27	1.12	1.41	3.54	1.59	7.70	8.62	4.11
Flagellates		2.20	0.03	0.24	0.56	0.72	0.10	0.25	0.32	3.74	0.12	7.78	3.15	5.72
Diatoms		10.68	5.12	2.98	8.01	8.59	12.08	15.65	15.66	8.98	2.76	10.78	11.94	13.51
Animal		0.36	0.09	0.20	0.20	0.16	0.49	0.63	0.45	0.64	0.05	0.56	1.31	1.09
Phaeophyta		4.93	27.57	24.57	29.08	29.74	30.91	26.54	31.63	15.88	19.68	6.41	4.09	5.09
Vascular plants		0.04	0.03	0.11	0.03	0.03	0.13	0.08	0.13	0.13	0.03	1.09	0.85	0.18
Bacteria / Macroalgae		1.82	0.09	0.29	0.09	0.10	0.24	0.54	0.39	4.15	0.11	5.07	4.55	1.94
Flagellates / Macroalgae		1.21	12.26	18.60	14.11	15.40	2.47	1.67	2.77	8.52	3.99	2.92	2.27	8.70
Diatoms / Macroalgae		42.59	11.22	18.27	16.62	14.98	12.13	6.11	7.66	14.63	10.41	6.29	6.15	5.53

* 20:4 NMI is a non-methylene-interrupted fatty acid with double bonds located on the carbons 5, 11, 14 and 17.

Table S3. Relative composition of fatty acids (FA, mass %) of consumers at Hansneset (Spitsbergen, Svalbard, Norway) in 2013. FAs were assigned to different groups according to the literature (see table 3).

Fatty acid	Group	Bryozoa	<i>Balanus</i> sp.	<i>S. turgens</i>	<i>H. arctica</i>	<i>Musculus</i> sp.	<i>C. septentrionalis</i>	<i>H. araneus</i>	<i>M. groenlandicus</i>	<i>T. rubra</i>	<i>O. aculeata</i>	<i>S. droebachiensis</i>
Saturated												
14:0	Diatoms	1.97	3.52	4.75	2.81	3.62	2.25	1.66	1.55	8.23	7.30	8.56
16:0	Ubiquitous	14.43	11.42	10.28	12.39	12.31	12.91	11.80	13.69	16.21	6.47	11.05
18:0	Ubiquitous	4.48	2.48	4.14	3.16	1.02	1.33	2.77	3.77	2.22	4.77	1.63
20:0		0.08	0.16	1.30	0.15	0.10	0.12	0.27	0.06	0.21	0.31	0.65
24:0	Vascular plants	0.20	0.09	0.08	0.03	0.05	0.02	0.03	0.10	0.09	0.02	0.02
Monoenoic												
16:1(<i>n</i> -5)		0.22	0.12	0.42	0.34	0.28	0.19	0.12	0.24	0.86	0.09	2.84
16:1(<i>n</i> -7)	Diatoms	3.00	6.06	2.88	6.09	6.83	4.81	6.92	3.25	16.37	2.80	3.62
16:1(<i>n</i> -9)		0.07	0.09	0.17	0.16	0.23	0.19	0.18	0.17	0.33	0.14	0.25
18:1(<i>n</i> -4)		-	-	-	0.21	0.25	-	-	1.31	-	0.07	-
18:1(<i>n</i> -7)	Bacteria / Macroalgae	1.80	7.29	7.61	4.83	1.07	3.60	7.62	13.14	10.03	5.00	3.13
18:1(<i>n</i> -9)	Ubiquitous	5.53	7.08	7.40	2.11	2.83	13.87	11.53	4.85	7.72	1.51	1.05
20:1(<i>n</i> -6)		-	-	-	-	-	0.08	-	-	1.76	0.36	4.37
20:1(<i>n</i> -7)		1.89	1.41	2.07	3.79	3.49	0.65	2.21	1.61	0.53	1.28	2.05
20:1(<i>n</i> -9)	Animal	0.75	1.30	0.92	1.69	2.26	1.57	1.66	0.25	1.61	0.30	3.47
20:1(<i>n</i> -11)	Animal	0.84	0.04	0.05	0.36	0.38	0.07	0.76	3.27	0.85	3.64	0.49
20:1(<i>n</i> -15)		0.02	-	-	0.09	0.07	-	-	0.04	1.10	2.51	5.42
22:1(<i>n</i> -5)		0.70	0.02	0.01	0.31	0.16	0.02	0.32	0.05	1.72	0.07	0.34
22:1(<i>n</i> -7)		0.14	1.53	1.08	0.06	0.03	0.30	0.68	0.09	0.16	0.20	0.10
22:1(<i>n</i> -9)		0.07	0.39	0.31	0.08	0.06	0.25	0.28	0.03	0.32	0.21	1.50
Polyenoic												
16:2(<i>n</i> -7)	Diatoms	0.82	0.05	0.97	0.47	0.65	0.36	0.46	2.22	0.20	0.09	0.07
16:4(<i>n</i> -1)	Diatoms	0.03	0.04	0.09	0.38	0.49	0.04	0.13	2.28	0.08	0.15	0.05
16:4(<i>n</i> -3)	Flagellates	1.92	2.64	1.35	0.99	2.14	1.43	0.70	0.93	0.77	4.63	1.00
18:2(<i>n</i> -6)	Phaeophyta	1.17	1.32	4.90	0.99	1.85	2.95	1.11	0.13	0.76	1.60	0.88
18:3(<i>n</i> -3)	Phaeophyta	1.04	0.36	1.40	1.03	1.42	1.42	0.63	0.49	0.91	0.57	1.32
18:3(<i>n</i> -6)		0.12	0.22	0.52	0.16	0.22	0.36	0.10	0.14	0.11	0.24	0.17
18:4(<i>n</i> -1)		0.16	0.06	0.04	0.18	0.31	0.10	0.16	3.91	0.04	0.62	0.14
18:4(<i>n</i> -3)	Flagellates / Macroalgae	2.35	6.20	4.58	9.08	9.09	3.88	2.08	1.47	1.66	14.47	4.78
20:2(<i>n</i> -6)	Animal	0.95	0.55	0.35	1.96	1.14	0.75	1.21	0.20	1.14	0.57	1.51
20:2(<i>n</i> -9)		0.03	-	0.04	0.63	0.79	0.04	0.26	0.16	0.42	1.20	1.96
20:3(<i>n</i> -3)		0.35	0.11	0.43	0.15	0.07	0.59	0.32	0.02	0.50	0.31	1.65
20:3(<i>n</i> -4)		0.02	-	0.05	0.06	-	0.02	0.06	0.09	0.25	0.06	1.22
20:4(<i>n</i> -3)		1.16	0.68	0.67	1.62	0.80	0.67	0.71	-	0.89	1.02	1.84
20:4 NMI *		0.12	0.06	0.18	-	0.13	0.31	0.29	0.38	0.24	0.16	0.75

20:4(<i>n</i> -6)	Phaeophyta	1.07	0.58	1.58	-	1.13	2.83	2.61	3.46	2.18	1.44	6.77
20:5(<i>n</i> -3)	Diatoms / Macroalgae	9.95	27.02	16.59	18.65	17.14	21.89	20.56	24.45	6.59	17.40	12.03
22:2(<i>n</i> -7)		0.02	0.04	0.07	0.52	1.06	0.02	0.19	0.20	0.38	0.72	1.83
22:5(<i>n</i> -3)	Flagellates	1.37	0.20	0.46	0.78	0.49	0.58	1.35	3.05	0.41	0.32	0.25
22:6(<i>n</i> -3)	Flagellates	25.78	9.62	8.42	12.85	12.54	11.82	9.76	-	0.74	1.54	2.32
Odd numbered, iso- and anteiso-branched	Bacteria	5.81	1.25	6.01	2.83	3.77	2.50	2.24	3.41	3.06	4.32	2.19
Sum of fatty acid trophic markers												
Bacteria		5.81	1.25	6.01	2.83	3.77	2.50	2.24	3.41	3.06	4.32	2.19
Flagellates		29.07	12.46	10.23	14.62	15.17	13.83	11.81	3.98	1.92	6.49	3.57
Diatoms		5.82	9.67	8.69	9.75	11.59	7.46	9.17	9.30	24.88	10.34	12.3
Animal		2.54	1.89	1.32	4.01	3.78	2.39	3.63	3.72	3.60	4.51	5.47
Phaeophyta		3.28	2.26	7.88	2.02	4.40	7.20	4.35	4.08	3.85	3.61	8.97
Vascular plants		0.20	0.09	0.08	0.03	0.05	0.02	0.03	0.10	0.09	0.02	0.02
Bacteria / Macroalgae		1.80	7.29	7.61	4.83	1.07	3.60	7.62	13.14	10.03	5.00	3.13
Flagellates / Macroalgae		2.35	6.20	4.58	9.08	9.09	3.88	2.08	1.47	1.66	14.47	4.78
Diatoms / Macroalgae		9.95	27.02	16.59	18.65	17.14	21.89	20.56	24.45	6.59	17.40	12.03

* 20:4 NMI is a non-methylene-interrupted fatty acid with double bonds located on the carbons 5, 11, 14 and 17.