

**Plankton sampling from the *Aurora Australis* and the *Shirase* in 2009–2013**  
**—NORPAC standard net & closing net samples—**

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**Introduction**

Each austral summer (December–March), plankton are sampled in the Indian Ocean sector of the Southern Ocean as part of routine marine biology surveys of the Japanese Antarctic Research Expedition (JARE). The samplings were conducted from the icebreaker *Fuji* during JARE-14 to -24 (1972–1983), as reported by Fukuchi and Tanimura (1981) and Watanabe *et al.* (1984), and subsequently from the icebreaker *Shirase*, which was launched in 1983. Sampling information and the wet weight of plankton samples obtained during JARE-25 to -49 (1983–2008) have been published previously (Takahashi *et al.*, 1997; Sawabe *et al.*, 2005; Takahashi *et al.*, 2008). While several types of plankton net have been used from the icebreaker *Shirase*, vertical hauls by a NORPAC (North Pacific) standard net have been routinely carried out. This report presents the data obtained using a NORPAC standard net during JARE-50 to -54 (January 2009 to March 2013). Samplings was performed by the RSV *Aurora Australis* (Australian National Antarctic Research Expedition) chartered by JARE-50, and by the new icebreaker *Shirase* that was launched in 2009 (JARE-51).

### **Sampling protocol**

A twin NORPAC standard net, made of nylon bolting cloth NGG 54 (mesh size 330  $\mu\text{m}$ ) and NXX 13 (mesh size 100  $\mu\text{m}$ ), was used at all sampling stations. The net was hauled vertically at a speed of *ca.* 1 m/s from a depth of  $\sim 150$  m. The maximum depth reached was estimated from the wire angle and length of wire paid out. All samples obtained were immediately preserved in 5–10% buffered formalin sea water on board. The volume of water filtered through each net was estimated using a flow-meter mounted on the center of the mouth ring of the net. The locations of sampling stations during the period January 2009 to March 2013 (JARE-50 to -54) are shown in [Figures 1, 2, 3, 4 and 5](#), and sampling data are presented in Tables [1, 2, 3, 4 and 5](#). For a detailed description of the processing technique of wet weight measurements, see Ukai *et al.* (2014).

### **Sampling in the sea-ice region**

Ship-based marine biological monitoring program of the sea ice region of Lützow-Holm Bay, off Syowa station, began during JARE-52. The aim of this program is to investigate biological production and mechanisms in relation to sea ice. Zooplankton samples are collected using a closing net (mouth diameter 0.75 m, mesh size 100  $\mu\text{m}$ ) in various sea ice environments: fast-ice, pack-ice, and ice-free open ocean. To prevent the sea ice from entering the net, an ice-fence was employed and the net was closed as it reached the surface (Takahashi *et al.*, 2012). The net was equipped with a flow-meter to estimate the volume of water filtered, and was vertically hauled from a depth of 150 m to the surface at stations where the bottom was deeper than 150 m, or from 5 m above the bottom to the surface at stations where the bottom was shallower than 150 m. All samples were fixed immediately with buffered 5% formaldehyde and seawater solution. The closing net data obtained during JARE-52 to -54 (February 2011 to February 2013) are also presented in this report. The locations of sampling stations are shown in [Figures 3, 4 and 5](#), and the sampling data are listed in Tables [6, 7 and 8](#).

### Scientists on board

The samplings during each cruise was carried out by the JARE members listed in Table 9, and participants are acknowledged for their assistance.

### Data policy

Written permission is required to publish or present the data of this report. Please address inquiries to:

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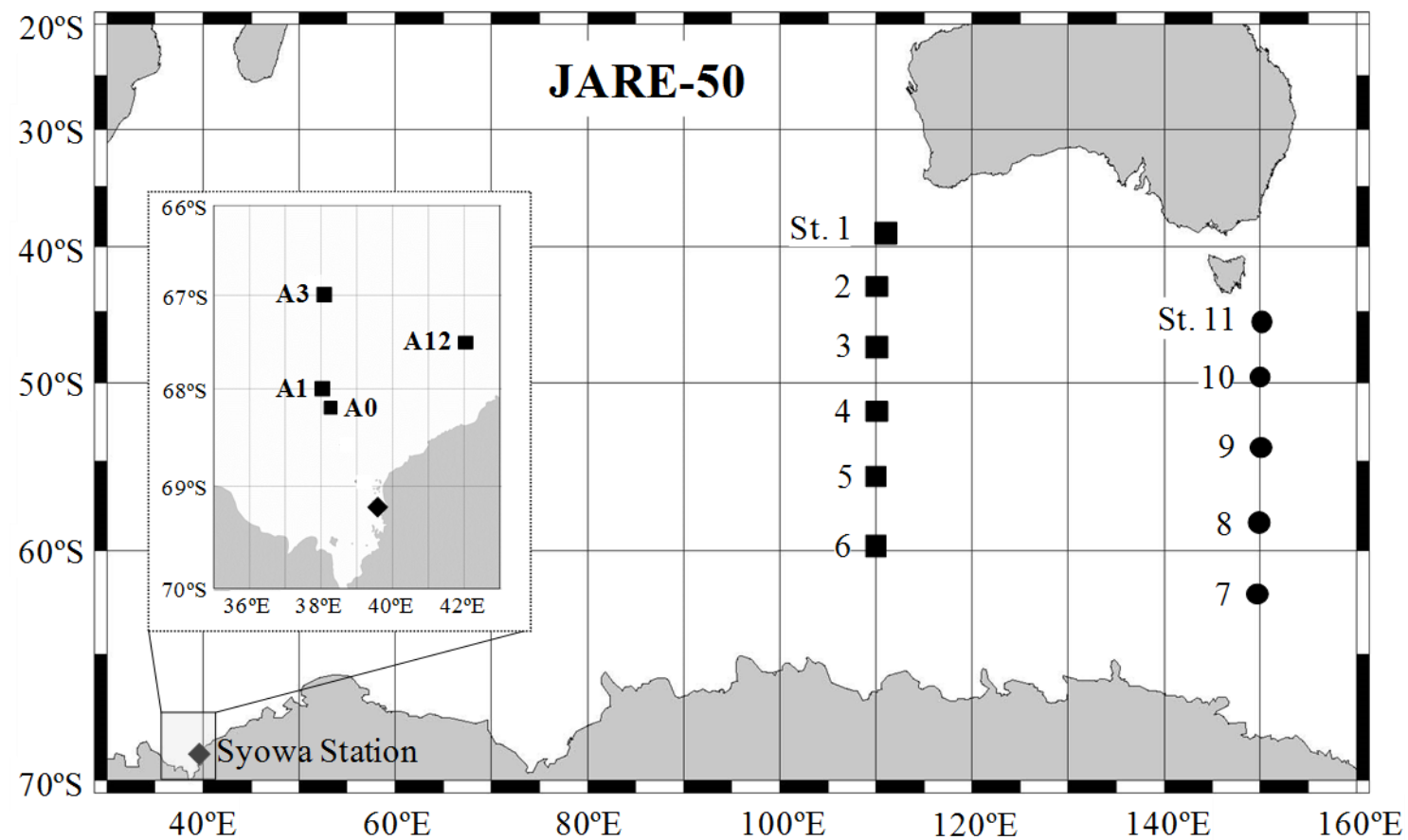


Fig. 1. Sampling stations during JARE-50 in 2009. ■: January, ●: February.

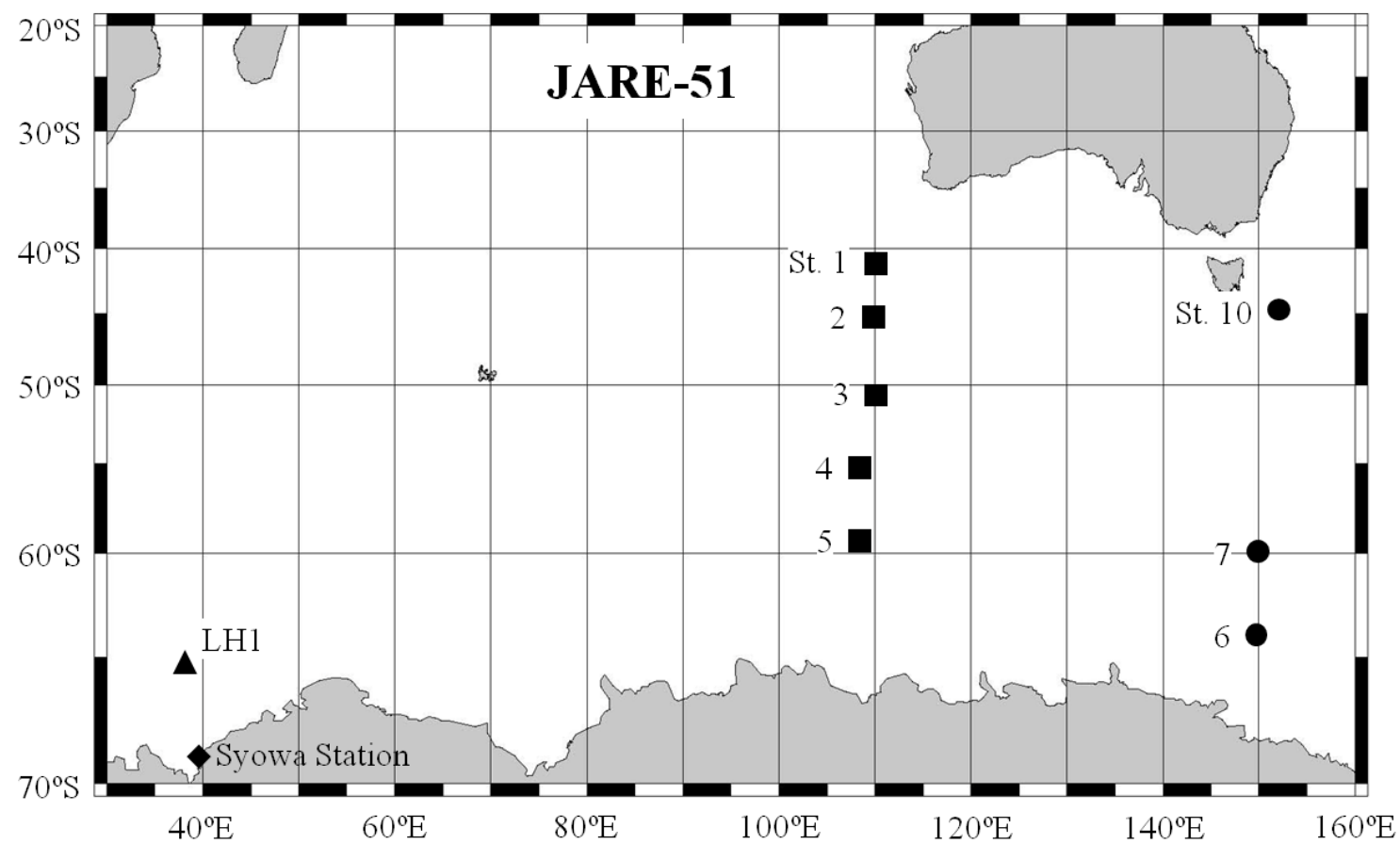


Fig. 2. Sampling stations during JARE-51 in 2009/2010. ■: December, ▲: February, ●: March.

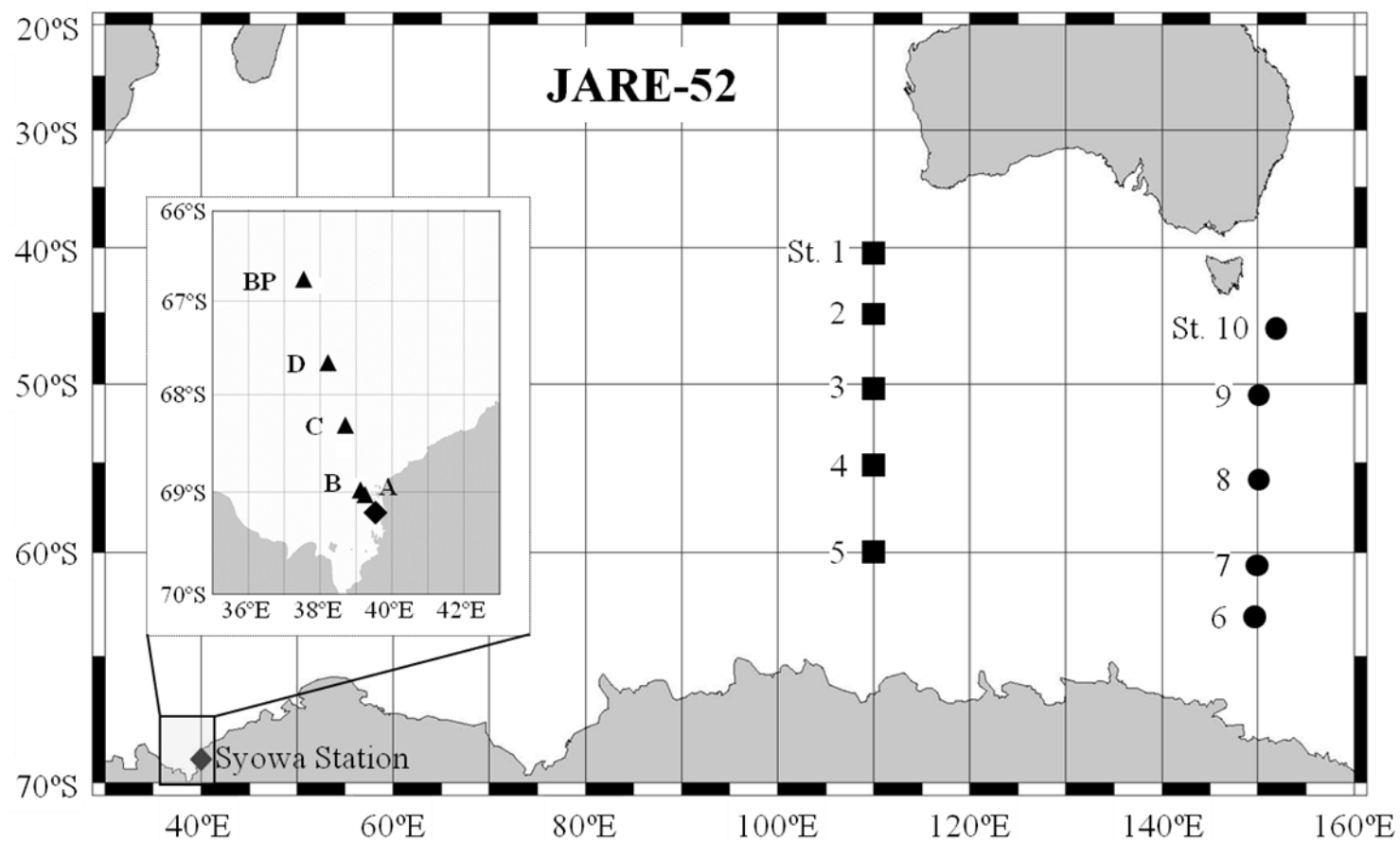


Fig. 3. Sampling stations during JARE-52 in 2010/2011. ■: December, ▲: February, ●: March.

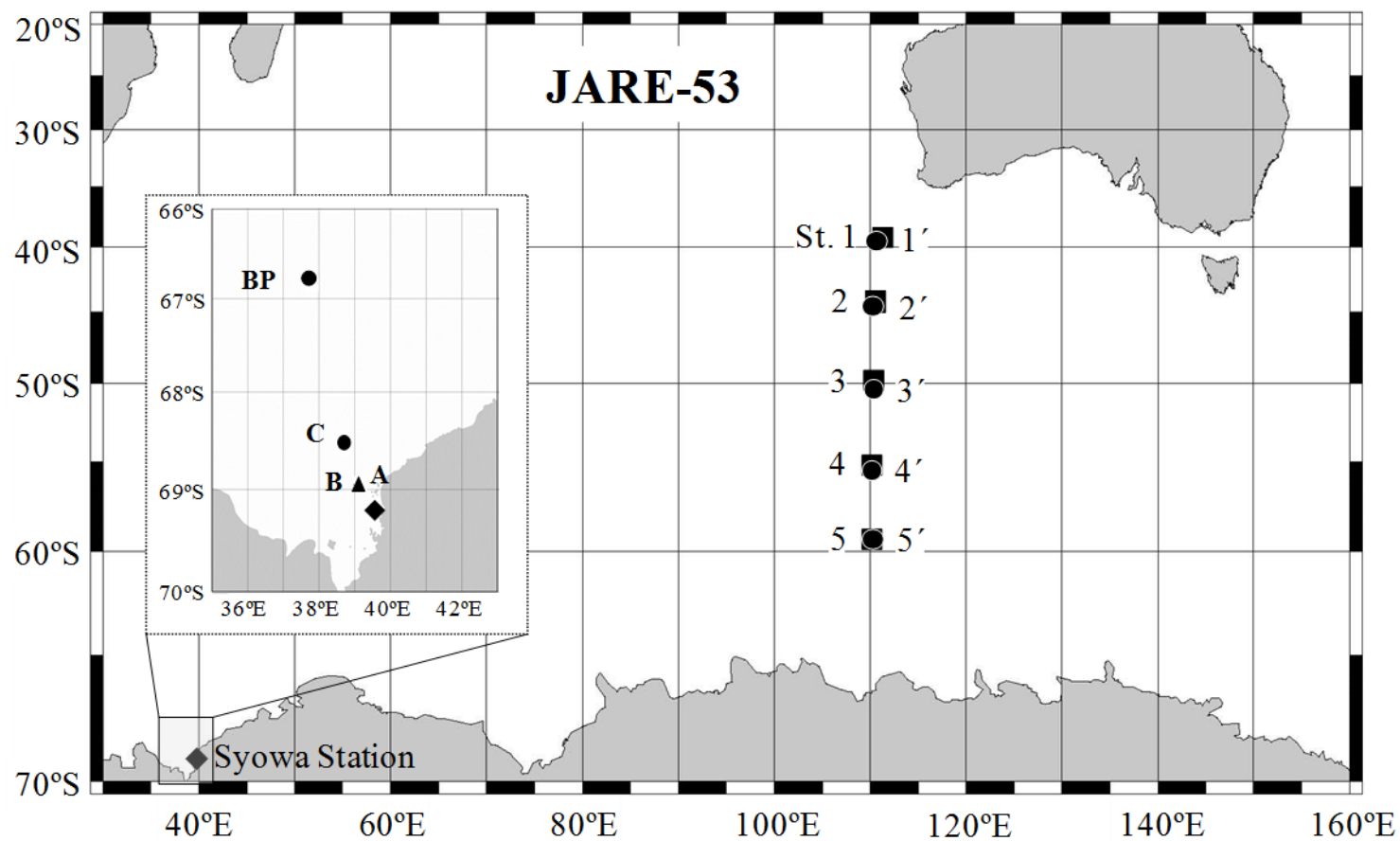


Fig. 4. Sampling stations during JARE-53 in 2011/2012. ■: December, ▲: February, ●: March.



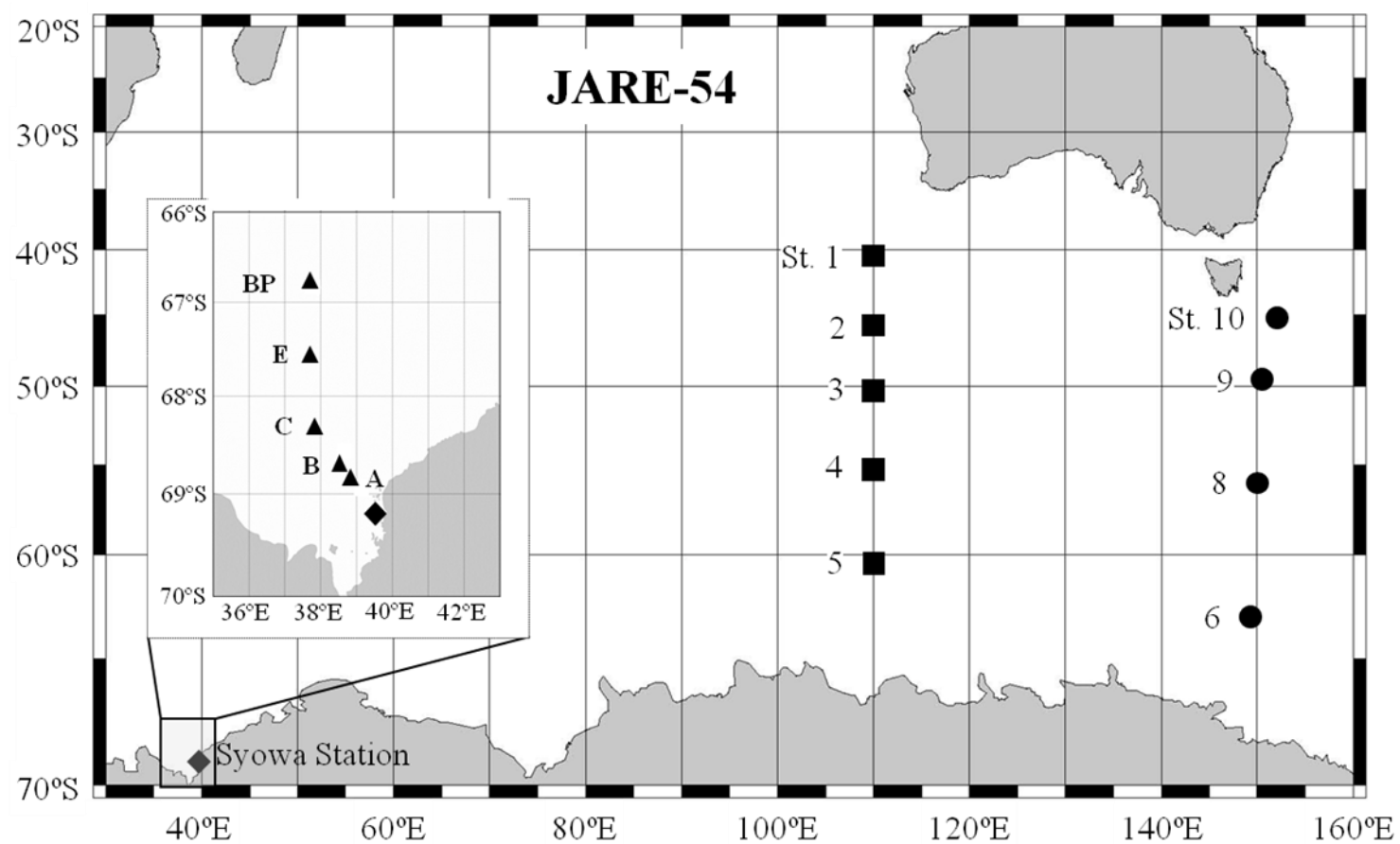


Fig. 5. Sampling stations during JARE-54 in 2012/2013. ■: December, ▲: February, ●: March.

Table 1. Plankton data collected by vertical hauls using a twin NORPAC standard net during the JARE-50 cruise of the *Aurora Australis* to the Indian sector of the Southern Ocean, Jan.–Feb. 2009. Sampling was performed by A. Tanimura & T. Iida.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
1	39°02'S	Jan. 1	1305	173	30	150	2469	2556	32.17	217	6.7	330	St.1 NorpacGG
	110°43'E						2473	2978	35.30	526	14.9	100	St.1 NorpacXX
2	43°26'S	Jan. 2	1140	202	42	150	2469	2833	35.66	709	19.9	330	St.2 NorpacGG
	110°00'E						2473	2642	31.32	1550	49.5	100	St.2 NorpacXX
3	47°33'S	Jan. 3	1125	161	21	150	2469	1973	24.83	6010	242.0	330	St.3 NorpacGG
	109°59'E						2473	1947	23.08	2445	105.9	100	St.3 NorpacXX
4	51°57'S	Jan. 4	1052	150	-	150	2469	2000	25.17	6296	250.1	330	St.4 NorpacGG
	110°05'E						2473	2033	24.10	2367	98.2	100	St.4 NorpacXX
5	56°06'S	Jan. 5	1110	150	-	150	2469	2983	37.54	13118	349.4	330	St.5 NorpacGG
	109°58'E						2473	2751	32.61	5183	158.9	100	St.5 NorpacXX
6	59°59'S	Jan. 6	1121	150	-	150	2469	1772	22.30	1256	56.3	330	St.6 NorpacGG
	109°59'E						2473	1645	19.50	1725	88.5	100	St.6 NorpacXX
A3	67°00'S	Jan. 15	1056	200	-	220	2469	2383	29.99	869	29.0	330	St.A3 NorpacGG
	38°02'E						2473	2350	27.86	373	13.4	100	St.A3 NorpacXX
A1	67°59'S	Jan. 23	0845	200	-	204	2469	1940	24.42	945	38.7	330	St.A1 NorpacGG
	38°01'E						2473	1540	18.26	2235	122.4	100	St.A1 NorpacXX
A12	67°30'S	Jan. 24	0815	200	-	203	2469	2182	27.46	1566	57.0	330	St.A12 NorpacGG
	41°59'E						2473	2061	24.43	429	17.6	100	St.A12 NorpacXX

Table 1. Continued.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
A0	68°18'S	Jan. 30	1012	200	-	203	2469	1873	23.57	1475	62.6	330	St.A0 NorpacGG
	38°16'E						2473	1570	18.61	1206	64.8	100	St.A0 NorpacXX
7	62°04'S	Feb. 15	1119	150	-	159	2469	2500	31.47	25891	822.8	330	St.7 NorpacGG
	149°35'E						2473	2303	27.30	28988	1061.8	100	St.7 NorpacXX
8	58°07'S	Feb. 16	1106	150	-	161	2469	1996	25.12	735	29.3	330	St.8 NorpacGG
	149°46'E						2473	1876	22.24	939	42.2	100	St.8 NorpacXX
9	54°04'S	Feb. 17	1051	150	-	159	2469	2060	25.93	2292	88.4	330	St.9 NorpacGG
	150°07'E						2473	1308	15.51	2222	143.3	100	St.9 NorpacXX
10	49°49'S	Feb. 18	1036	150	-	154	2469	2812	35.39	2489	70.3	330	St.10 NorpacGG
	150°03'E						2473	1121	13.29	1413	106.3	100	St.10 NorpacXX
11	46°00'S	Feb. 19	1036	150	-	158	2469	2010	25.30	869	34.4	330	St.11 NorpacGG
	150°01'E						2473	2050	24.30	937	38.6	100	St.11 NorpacXX

Table 2. Plankton data collected by vertical hauls using a twin NORPAC standard net during the JARE-51 cruise of the *Shirase* to the Indian sector of the Southern Ocean, Dec. 2009–Mar. 2010. Sampling was performed by H. Shinagawa.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
1	40°50'S 109°57'E	Dec. 1	0906	196	40	150	2469	4274	59.54	4450	74.7	330	St.L1 GG
							2891	4150	54.86	1409	25.7	100	St.L1 XX
2	45°52'S 110°01'E	Dec. 2	0752	173	30	150	2469	2355	32.81	2596	79.1	330	St.L2 GG
							2891	2261	29.89	3569	119.4	100	St.L2 XX
3	50°54'S 110°06'E	Dec. 3	0749	196	40	150	2469	4201	58.53	4126	70.5	330	St.L3 GG
							2891	4270	56.45	13679	242.3	100	St.L3 XX
4	55°34'S 108°41'E	Dec. 4	0857	173	30	150	2469	2930	40.82	2886	70.7	330	St.L4 GG
							2891	3132	41.41	7734	186.8	100	St.L4 XX
5	59°20'S 108°41'E	Dec. 5	0747	233	50	150	2469	7820	108.95	5752	52.8	330	St.L5 GG
							2891	8008	105.87	14792	139.7	100	St.L5 XX
LH1	66°51'S 37°43'E	Feb. 14	0001	233	50	150	2469	6370	88.75	1575	17.7	330	St.LH1 GG
							2891	4700	62.14	3725	59.9	100	St.LH1 XX
6	64°07'S 149°41'E	Mar. 7	0858	233	50	150	2469	6280	87.49	6089	69.6	330	St.L6 GG
							2891	5322	70.36	8629	122.6	100	St.L6 XX
7	60°13'S 149°50'E	Mar. 9	0859	233	50	150	2469	8248	114.91	9677	84.2	330	St.L7 GG
							2891	8180	108.14	30763	284.5	100	St.L7 XX
10	44°56'S 152°11'E	Mar. 13	1551	196	40	150	2469	4718	65.73	1349	20.5	330	St.L10 GG
							2891	4845	64.05	2797	43.7	100	St.L10 XX

Table 3. Plankton data collected by vertical hauls using a twin NORPAC standard net during the JARE-52 cruise of the *Shirase* to the Indian sector of the Southern Ocean, Dec. 2010–Mar. 2011. Sampling was performed by T. Odate.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
1	40°24'S	Dec. 2	0832	224	48	150	2469	2408	33.55	2213	66.0	330	52.L01.GG54
	110°10'E						2473	3704	49.35	6428	130.2	100	52.L01.XX13
2	45°11'S	Dec. 3	0832	160	20	150	2469	1826	25.44	1226	48.2	330	52.L02.GG54
	110°00'E						2473	2210	29.45	2192	74.4	100	52.L02.XX13
3	50°35'S	Dec. 4	0835	152	10	150	2469	1822	25.38	11041	435.0	330	52.L03.GG54
	110°01'E						2473	1892	25.21	6557	260.1	100	52.L03.XX13
4	54°53'S	Dec. 5	0841	152	10	150	2469	1944	27.08	2109	77.9	330	52.L04.GG54
	110°00'E						2473	1893	25.22	3257	129.1	100	52.L04.XX13
5	60°01'S	Dec. 6	1445	177	32	150	2469	2959	41.22	6318	153.3	330	52.L05.GG54
	110°00'E						2473	3152	42.00	8234	196.1	100	52.L05.XX13
6	63°04'S	Mar. 10	0651	196	40	150	2469	6952	96.85	15700	162.1	330	52.L06.GG54
	149°49'E						2473	5201	69.30	23691	341.9	100	52.L06.XX13
7	60°53'S	Mar. 11	1653	172	29	150	2469	3580	49.88	4510	90.4	330	52.L07.GG54
	149°50'E						2473	3209	42.76	17448	408.1	100	52.L07.XX13
8	56°00'S	Mar. 12	1749	173	30	150	2469	4720	65.76	5899	89.7	330	52.L08.GG54
	150°03'E						2473	4490	59.83	8527	142.5	100	52.L08.XX13
9	50°57'S	Mar. 13	1540	166	25	150	2469	3327	46.35	543	11.7	330	52.L09.GG54
	150°11'E						2473	3144	41.89	2159	51.5	100	52.L09.XX13
10	45°48'S	Mar. 14	1553	196	40	150	2469	6577	91.63	501	5.5	330	52.L10.GG54
	151°59'E						2473	5800	77.28	3133	40.5	100	52.L10.XX13

Table 4. Plankton data collected by vertical hauls using a twin NORPAC standard net during the JARE-53 cruise of the *Shirase* to the Indian sector of the Southern Ocean, Dec. 2011–Mar. 2012. Sampling was performed by K.T. Takahashi.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
1	39°23'S	Dec. 2	1628	181	34	150	2469	4910	68.41	2483	36.3	330	53.L01.GG54
	110°34'E						2473	5400	71.95	5243	72.9	100	53.L01.XX13
2	44°20'S	Dec. 3	1422	209	44	150	2469	6805	94.81	2996	31.6	330	53.L02.GG54
	110°29'E						2473	6195	82.55	3705	44.9	100	53.L02.XX13
3	49°50'S	Dec. 4	1415	224	48	150	2469	2960	41.24	1459	35.4	330	53.L03.GG54
	110°06'E						2473	3346	44.58	4029	90.4	100	53.L03.XX13
4	54°58'S	Dec. 5	1427	233	50	150	2469	6555	91.32	3795	41.6	330	53.L04.GG54
	110°04'E						2473	6505	86.68	6602	76.2	100	53.L04.XX13
5	59°35'S	Dec. 6	1342	196	40	150	2469	3764	52.44	797	15.2	330	53.AJ2.GG54
	110°00'E						2473	3446	45.92	2502	54.5	100	53.AJ2.XX13
5'	59°33'S	Mar. 10	1336	167	26	150	2469	3100	43.19	2460	57.0	330	53.AJ2'.GG54
	109°58'E						2473	3269	43.56	6890	158.2	100	53.AJ2'.XX13
4'	55°43'S	Mar. 11	0802	151	8	150	2469	2776	38.67	1433	37.1	330	53.L04'.GG54
	109°59'E						2473	3161	42.12	4914	116.7	100	53.L04'.XX13
3'	50°10'S	Mar. 12	0825	212	42	150	2469	3549	49.44	2504	50.6	330	53.L03'.GG54
	110°04'E						2473	4248	56.60	9259	163.6	100	53.L03'.XX13
2'	44°35'S	Mar. 13	0815	159	12	150	2469	2305	32.11	179	5.6	330	53.L02'.GG54
	110°00'E						2473	2813	37.48	565	15.1	100	53.L02'.XX13
1'	39°32'S	Mar. 14	0821	156	16	150	2469	2019	28.13	35	1.2	330	53.L01'.GG54
	110°18'E						2473	2263	30.15	561	18.6	100	53.L01'.XX13

Table 5. Plankton data collected by vertical hauls using a twin NORPAC standard net during the JARE-54 cruise of the *Shirase* to the Indian sector of the Southern Ocean, Dec. 2012–Mar. 2013. Sampling was performed by T. Takamura.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
1	40°39'S	Dec. 2	0856	173	30	150	2469	3215	44.79	519	11.6	330	L01.GG
	110°02'E						2473	3365	44.84	602	13.4	100	L01.XX
2	45°33'S	Dec. 3	0849	179	33	150	2469	2508	34.94	5672	162.3	330	L02.GG
	110°02'E						2473	2510	33.44	8733	261.1	100	L02.XX
3	50°34'S	Dec. 4	0938	268	56	150	2469	6245	87.00	8966	103.1	330	L03.GG
	110°02'E						2473	7808	104.04	10587	101.8	100	L03.XX
4	55°27'S	Dec. 5	0846	162	22	150	2469	1838	25.61	2635	102.9	330	L04.GG
	109°58'E						2473	1948	25.96	11320	436.1	100	L04.XX
5	60°49'S	Dec. 6	0846	151	5	150	2469	2010	28.00	4678	167.1	330	L05.GG
	110°03'E						2473	2740	36.51	9137	250.3	100	L05.XX
6	63°10'S	Mar. 9	0858	222	47	150	2469	4646	64.73	6135	94.8	330	L06.GG
	149°14'E						2473	3462	46.13	5552	120.4	100	L06.XX
8	55°56'S	Mar. 12	1547	179	33	150	2469	3082	42.94	3124	72.8	330	L08.GG
	150°02'E						2473	3074	40.96	4671	114.0	100	L08.XX
9	49°13'S	Mar. 13	0904	300	55	150	2469	6556	91.34	3056	33.5	330	L09.GG
	150°28'E						2473	6455	86.01	5530	64.3	100	L09.XX
10	45°08'S	Mar. 14	0846	199	41	150	2469	2568	35.78	243	6.8	330	L10.GG
	152°27'E						2473	3057	40.73	433	10.6	100	L10.XX

Table 6. Plankton data collected by vertical hauls using a closing net during the JARE-52 cruise of the *Shirase* in the sea ice region of Lützow-Holm Bay off Syowa station, Feb. 2011. Sampling was performed by T. Odate.

St. No.	Position	Ship's time (LMT)		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size ( $\mu$ m)	Sample No.
		Date	time				No.	Revolutions					
A	69°03'S 39°20'E	Feb. 9	1641	75	0	75	2469	396	5.52	1980	358.9	100	52.A.XX13
B	68°59'S 39°11'E	Feb. 12	1618	135	0	135	2469	557	7.76	2355	303.5	100	52.B.XX13
C	68°31'S 38°42'E	Feb. 18	0832	150	0	150	2469	915	12.75	3386	265.6	100	52.C.XX13
D	67°43'S 38°18'E	Feb. 23	2133	233	50	150	2469	533	7.43	5095	686.2	100	52.D.XX13
BP	66°50'S 37°49'E	Feb. 24	0829	170	28	150	2469	435	6.06	1914	315.9	100	52.BP.XX13



Table 7. Plankton data collected by vertical hauls using a closing net during the JARE-53 cruise of the *Shirase* in the sea ice region of Lützow-Holm Bay off Syowa station, Feb.–Mar. 2012. Sampling was performed by K.T. Takahashi.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
A	68°57'S 39°05'E	Feb. 14	1810	150	0	150	2469	660	9.20	1119	121.7	100	53.A.XX13
B	68°56'S 39°05'E	Feb. 17	1100	150	0	150	2469	755	10.52	1275	121.2	100	53.B.XX13
C	68°34'S 38°39'E	Mar. 1	2139	150	0	150	2469	849	11.83	2063	174.4	100	53.C.XX13
BP	66°50'S 37°51'E	Mar. 4	0841	167	26	150	2469	828	11.54	5513	478.0	100	53.BP.XX13

Table 8. Plankton data collected by vertical hauls using a closing net during the JARE-54 cruise of the *Shirase* in the sea ice region of Lützow-Holm Bay off Syowa station, Feb. 2013. Sampling was performed by T. Takamura.

St. No.	Position	Ship's time		Length of wire (m)	Angle of wire (°)	Estimated depth of haul (m)	Flow-meter		Estimated volume of water filtered (m <sup>3</sup> )	Wet weight of sample in a haul (mg)	Wet weight of sample per m <sup>3</sup> (mg)	Mesh size (μ m)	Sample No.
		(LMT)					No.	Revolutions					
		Date	time										
A	68°50'S 38°55'E	Feb. 10	2129	150	0	150	2469	1220	17.00	4005	235.6	100	A.XX
B	68°40'S 38°38'E	Feb. 16	1040	150	0–1	150	2469	1430	19.92	6048	303.6	100	B.XX
C	68°23'S 37°50'E	Feb. 17	1018	185	36	150	2469	493	6.87	3651	531.5	100	C.XX
E	67°39'S 37°49'E	Feb. 17	1539	153	11	150	2469	348	4.85	3651	753.0	100	E.XX
BP	66°49'S 37°49'E	Feb. 18	0850	153	11	150	2469	891	12.41	3627	292.2	100	BP.XX

Table 9. List of scientists on each cruise.

JARE(Year)	Name of members	Affiliations *
JARE-50 (2008/09)	T. Iida	National Institute of Polar Research
	A. Tanimura	Mie University
JARE-51 (2009/10)	H. Shinagawa	University of Tsukuba
JARE-52 (2010/11)	T. Odate	National Institute of Polar Research
JARE-53 (2011/12)	K.T. Takahashi	National Institute of Polar Research
JARE-54 (2012/13)	T. Takamura	National Institute of Polar Research

\*Affiliations are for the year each scientist was on board.