

**Zooplankton sampling during the 56th Japanese Antarctic Research Expedition
in austral summer 2014–2015**

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1. Introduction

The Japanese Antarctic Research Expedition (JARE) has been conducting routine zooplankton monitoring in the Indian Ocean sector of the Southern Ocean every austral summer (December–March) since 1972 (JARE-14). The monitoring is conducted from an icebreaker, which travels along much the same cruise track at roughly the same time each year. This routine schedule is ideal as a long-term temporal reference for monitoring work. Zooplankton samplings were also carried out from TV *Umitaka-maru*, Tokyo University of Marine Science and Technology, during the 2013/2014 season (JARE-55) as a part of the JARE monitoring program.

Three tools are used for zooplankton sampling: a NORPAC (NORth PACific) standard net, a closing net, and a Continuous Plankton Recorder (CPR). This report presents the data obtained from these three sampling tools during JARE-56 (December 2014 to March 2015).

2. Background and sampling protocol

2.1. NORPAC standard net

The NORPAC standard net was established as a standard for collecting zooplankton in international cooperative surveys at an international meeting held in Honolulu in February 1956

(Motoda, 1957). Although several kinds of plankton nets have been employed from the icebreakers, vertical hauls using a NORPAC standard net have been routinely and frequently carried out to estimate the mean biomass of surface zooplankton and its spatiotemporal variability in the upper layer of the Indian Ocean sector of the Southern Ocean. Samplings were conducted from the icebreaker *Fuji* during JARE-14 to JARE-24 (1972–1983), the icebreaker *Shirase* during JARE-25 to JARE-49 (1983–2008), RSV *Aurora Australis* chartered by JARE-50 (2009), and the new icebreaker *Shirase* during JARE-51 to JARE-55 (2009–2014) (Fukuchi and Tanimura, 1981; Watanabe *et al.*, 1984; Takahashi *et al.*, 1997; Sawabe *et al.*, 2005; Takahashi *et al.*, 2008; Takahashi *et al.*, 2014a; Takahashi *et al.*, 2015).

From JARE-14 to JARE-28 (1986/1987), NORPAC standard net sampling sites were mainly in the western part of the Indian Ocean sector; thereafter, sampling stations were shifted to the east because the cruise tracks of the *Shirase* remained along the same cruise track each season and at the same time of year beginning with JARE-29 (1987/1988). Regular sampling was conducted from *Shirase* along longitude 110°E from 40°S to 60°S in December and along 150°E from 64°S to 45°S in March on each voyage. The *Umitaka-maru* transect was along 110°E from 40°S to 65°S in January.

A twin NORPAC standard net made of nylon bolting cloth (NGG 54, mesh size 315 μm ; NXX 13, mesh size 100 μm) was used at all sampling stations. The net was hauled vertically at a speed of about 1 m/s from a depth of approximately 150 m. The maximum depth reached was estimated from the wire angle and length of wire paid out. All samples obtained were immediately preserved on board in seawater with 5–10% buffered formalin. The volume of water filtered by each net was estimated using a flow-meter mounted at the center of the mouth ring of the net. The locations of sampling stations during two ships' surveys are shown in [Figures 1](#) and [2](#), and zooplankton sampling information and wet weights are presented in [Tables 1](#) and [2](#). For a detailed description of zooplankton processing for wet-weight measurements, see Ukai *et al.* (2014).

2.2. Closing net

The ship-based marine-biological monitoring program for the sea-ice region of Lützow-Holm

Bay, off Syowa Station, Antarctica, began during JARE-52 (Takahashi *et al.*, 2014a). 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 0.60 m, mesh size 100 μm) in various sea-ice environments: fast-ice, pack-ice, and ice-free open ocean. To prevent sea ice from entering the net, an “ice-fence” is employed and the net is closed as it reaches the surface (Takahashi *et al.*, 2012, 2014b). The net is equipped with a flow-meter to estimate the volume of water filtered, and is hauled vertically from a depth of 150 m to the surface at stations where the bottom is deeper than 150 m, or from 5 m above the bottom to the surface at stations where the bottom is shallower than 150 m. All samples are fixed immediately in seawater with 5% buffered formalin. The locations of sampling stations are shown in [Figure 1](#), and the sampling information and wet weight of zooplankton are listed in [Table 3](#).

2.3. Continuous Plankton Recorder

The CPR was designed by Sir Alister Hardy in the mid 1920s and first used in the Antarctic during the 1925–1927 Discovery Expedition. The CPR can collect surface plankton continuously for 450 nautical miles (830 km) during a single tow. CPRs have been used successfully in the monitoring of plankton communities in the North Sea and North Atlantic Ocean over the past 70 years, operated by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) (Reid *et al.*, 2003). The Australian Antarctic Program started a long-term CPR survey in 1991 to monitor zooplankton abundances and distributions in the Southern Ocean (Hosie *et al.*, 2003). The Australian CPR survey covers a wide area through much of the year, reflecting broad logistic and research objectives in each season.

The icebreaker *Shirase* travels along much the same cruise track at roughly the same time each year. The CPR data collected from the *Shirase* provides an important time reference with which to interpret the data collected by the Australian Antarctic Program over the rest of the Indian Ocean sector of the Southern Ocean. Sharing of data and results will greatly benefit both the Australian and Japanese programs. JARE initiated an annual CPR survey beginning in 1999 (JARE-41) as part its monitoring program in the Antarctic (Takahashi *et al.*, 2006, 2009; Takahashi and Hosie, 2014).

CPR tows on the *Shirase* were conducted mainly on three transects south along 110°E from 45°S to the ice edge in December and three or four tows north along 150°E in February and March during each voyage. The *Umitaka Maru* transects were mainly along 110°E from 45°S to 60°S in January and around 110°E to south of Tasmania, Australia, in January and February. We used a Type II (Mark V) CPR, based on the design of the SAHFOS CPRs, with minor modifications to the external design, simplification of the internal cassettes, and built using marine-grade 316 stainless-steel rather than phosphor bronze (Hosie *et al.*, 2003). The CPR was towed horizontally at a ship speed of about 15 knots, deployed from the stern with 100 m of wire cable paid out. The depth of CPR tows was about 10 m.

The CPR has a mouth opening of 1.6 cm² and is fitted with 270- μ m silk gauze. The towing of the CPR through the surface water turns an external propeller that drives the mesh rolls across the tunnel at a rate of approximately 1 cm/nautical mile (1852 m) of tow. The 6-m-long mesh is sufficient to sample 450 nautical miles (833 km) as a normal towing distance. All zooplankton samples were preserved in seawater with 5–10% buffered formalin and were brought to the laboratory for analysis. The CPR mesh rolls were cut into segments, each representing a 5-nautical-mile sample (approximately 9.3 km) along the transect. Complete details of the processing techniques have been described by Hosie *et al.* (2003). CPR data are available at the Australian Antarctic Data Centre through the home page of the Southern Ocean Continuous Plankton Recorder (SO-CPR) Survey (<http://data.aad.gov.au/aadc/cpr/>). The locations of CPR towing transects during two ship's surveys are shown in [Figures 3](#) and [4](#), and information on sampling from the *Shirase* is presented in [Table 4](#) and from the *Umitaka-maru* in [Table 5](#).

3. Scientists on board

The sampling during each cruise was carried out by T. R. Takamura (National Institute of Polar Research) on the *Shirase* and by T. Iida (National Institute of Polar Research) on the *Umitaka-maru*.

4. Data archive

Permission to use these data for publication of presentation should be obtained in writing.

Inquiries about details of the data record should be addressed to:

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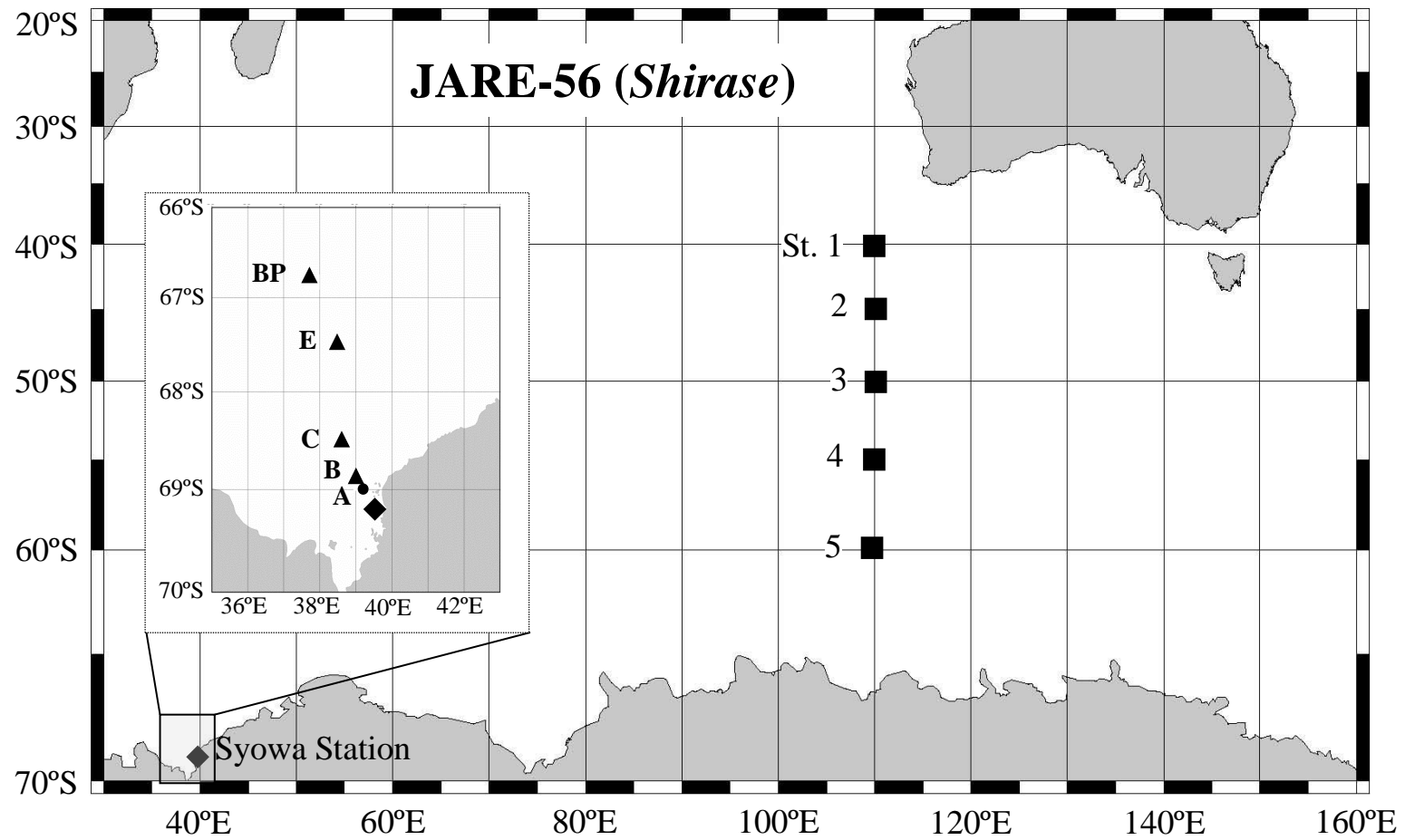


Fig. 1. Icebreaker *Shirase* sampling stations during JARE-56 in 2014/2015. ■: December, ●: January, ▲: February.

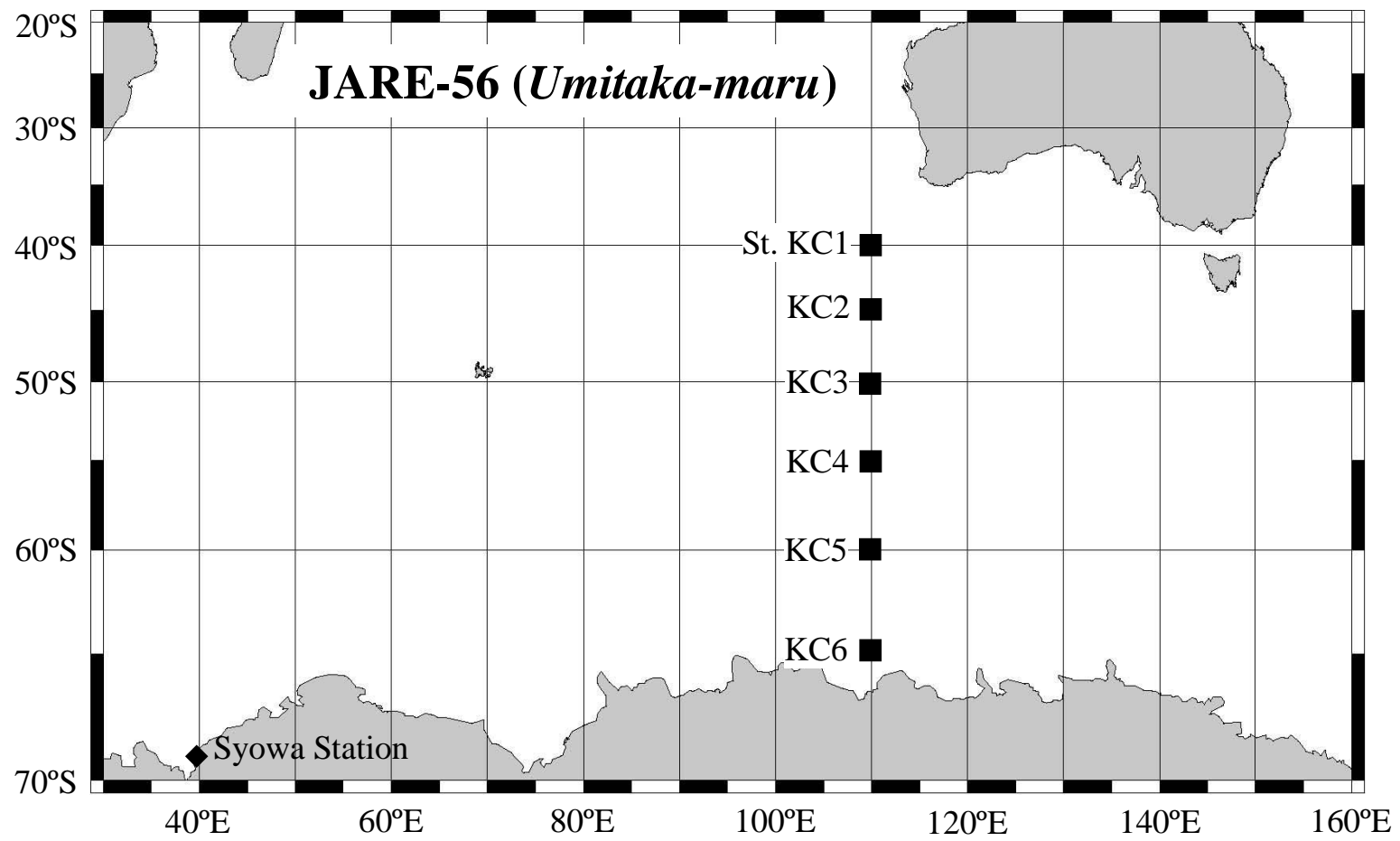


Fig. 2. TV *Umitaka-maru* sampling stations during JARE-56 in January 2015.

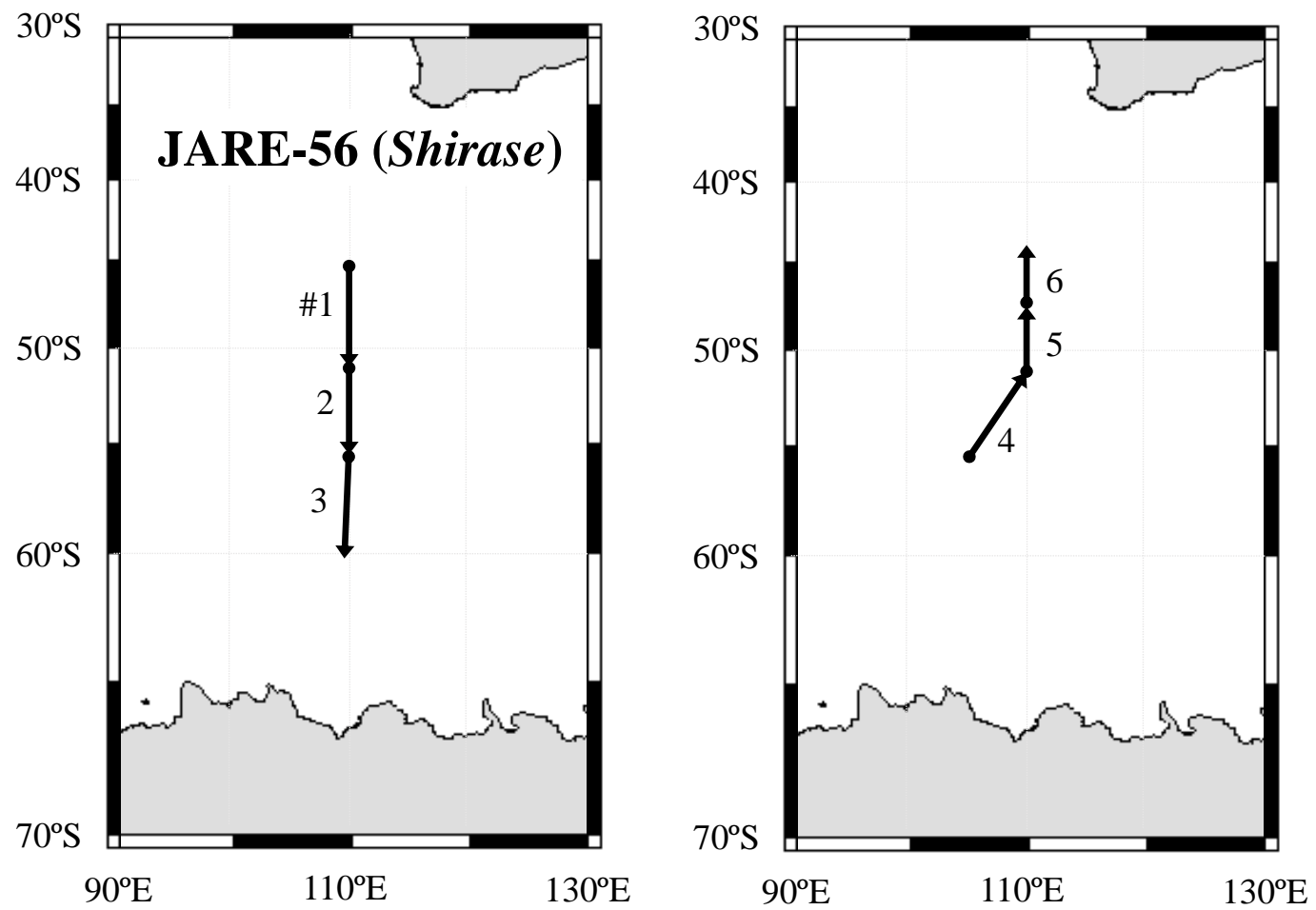


Fig. 3. Transects for CPR surveys by the icebreaker *Shirase* during JARE-56 in 2014/2015. Numbers indicate the sequential number of the CPR run. ●: Starting position, ▼: ending position.

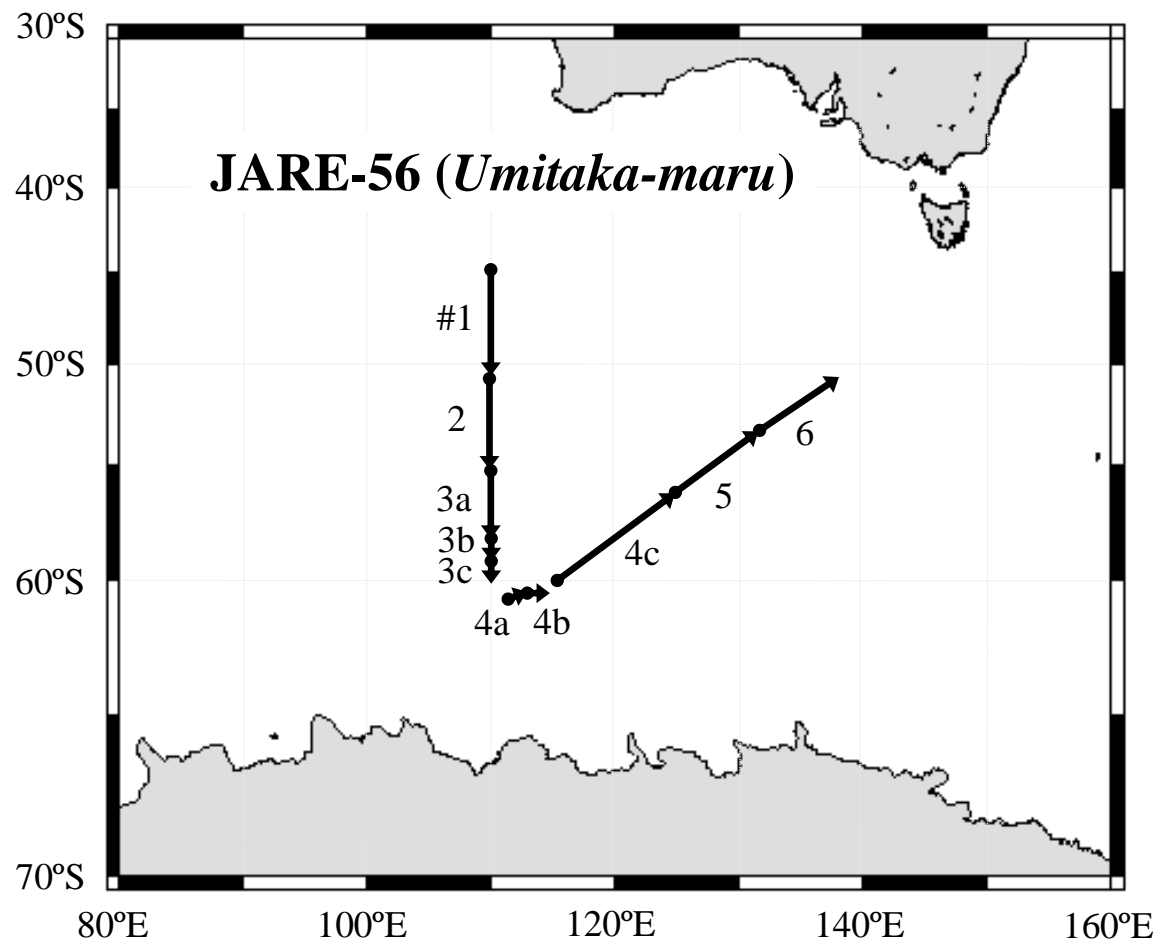


Fig. 4. Transect for CPR surveys by TV *Umitaka-maru* during JARE-56 in 2015. Numbers indicate the sequential number of the CPR run. ●: Starting position, ▼: ending position.

Table 1. Data for plankton samples collected by vertical hauls with twin NORPAC standard nets during the JARE-56 cruise of the icebreaker *Shirase* to the Indian Ocean sector of the Southern Ocean, December 2015. Sampling was conducted by T. Takamura.

Station 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 ³)	Wet weight of sample in a haul (mg)	Wet weight of sample per m ³ (mg)	Mesh size (µm)	Sample No.
		Date	Time				No.	Revolutions					
L01	40°09'S	Dec. 2	0833	162	22	150	2469	1743	24.28	258	10.6	330	L01.GG
	110°01'E						2473	1880	25.05	486	19.4	100	L01.XX
L02	45°07'S	Dec. 3	0837	202	42	150	2469	2996	41.74	1760	42.2	330	L02.GG
	110°02'E						2473	2808	37.42	3237	86.5	100	L02.XX
L03	50°07'S	Dec. 4	0848	250	55	150	2469	4128	57.51	4422	76.9	330	L03.GG
	110°01'E						2473	4328	57.67	8234	142.8	100	L03.XX
L04	55°08'S	Dec. 5	1336	170	28	150	2469	2335	32.53	1383	42.5	330	L04.GG
	109°58'E						2473	2100	27.98	2744	98.1	100	L04.XX
L05	59°59'S	Dec. 6	1539	162	22	150	2469	1920	26.75	2774	103.7	330	L05.GG
	109°51'E						2473	1795	23.92	2243	93.8	100	L05.XX

Table 2. Data for plankton samples collected by vertical hauls with twin NORPAC standard nets during the JARE-56 cruise of TV *Umitaka-maru* to the Indian Ocean sector of the Southern Ocean, January 2015. Sampling was conducted by T. Iida.

Station 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 ³)	Wet weight of sample in a haul (mg)	Wet weight of sample per m ³ (mg)	Mesh size (µm)	Sample No.
		Date	Time				No.	Revolutions					
KC1	40°00'S	Jan. 13	115	162	22	150	3727	2029	27.20	1597	58.7	330	KC1 GG
	110°00'E						3807	2210	29.30	675	23.0	100	KC1 XX
KC2	45°00'S	Jan. 14	453	160	14	150	3727	2050	27.48	1305	47.5	330	KC2 GG
	110°00'E						3807	2706	35.87	760	21.2	100	KC2 XX
KC3	45°00'S	Jan. 15	1649	160	14	150	3923	2930	39.27	6536	166.4	330	KC3 GG
	110°00'E						3807	3570	47.32	9480	200.3	100	KC3 XX
KC4	55°00'S	Jan. 16	2019	150	3	150	3923	2070	27.74	3274	118.0	330	KC4 GG
	110°00'E						3807	2400	31.81	5296	166.5	100	KC4 XX
KC5	60°00'S	Jan. 18	1303	151	6	150	3923	1803	24.17	3275	135.5	330	KC5 GG
	110°00'E						3807	2140	28.37	2559	90.2	100	KC5 XX
KC6	65°00'S	Jan. 22	1644	150	4	150	3923	1315	17.63	1684	95.5	330	KC6 GG
	110°00'E						3807	1977	26.21	1226	46.8	100	KC6 XX

Table 3. Data for plankton samples collected by vertical hauls with a closing net during the JARE-56 cruise of the icebreaker *Shirase* in Lützow-Holm Bay off Syowa Station, Antarctica, January–February 2015. Sampling was conducted by T. Takamura.

Station 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 ³)	Wet weight of sample in a haul (mg)	Wet weight of sample per m ³ (mg)	Mesh size (µm)	Sample No.
		Date	Time				No.	Revolutions					
A	69°01'S 39°18'E	Jan. 31	1828	70	0	70	2469	420	5.85	53	9.1	100	A.XX
B	68°54'S 39°01'E	Feb. 15	1842	140	0	140	2469	1117	15.56	316	20.3	100	B.XX
C	68°28'S 38°37'E	Feb. 16	1734	160	0	160	2469	1270	17.69	1366	77.2	100	C.XX
E	67°31'S 38°32'E	Feb. 17	1411	200	40	150	2469	-	-	-	-	100	<i>Failed</i>
E	67°31'S 38°28'E	Feb. 17	1509	200	39	150	2469	1682	23.43	586	25.0	100	E.XX
BP	66°50'S 37°50'E	Feb. 18	0822	152	9	150	2469	1948	27.14	3024	111.4	100	BP.XX

Table 4. Data for plankton samples collected by Continuous Plankton Recorder (CPR) during the JARE-56 cruise of the icebreaker *Shirase* to the Indian Ocean sector of the Southern Ocean, December 2014–March 2015. Sampling was conducted by T. Takamura.

CPR Run #	Start		End		No. of Segments	Distance towed (km)	Remarks
	Date & Time (GMT)	Position	Date & Time (GMT)	Position			
1	Dec. 3, 2014; 02:00	45° 08.0'S 110° 03.9'E	Dec. 4, 2014; 00:56	50° 06.1'S 109° 59.1'E	60	546	
2	Dec. 4, 2014; 02:12	50° 08.3'S 109° 58.3'E	Dec. 5, 2014; 05:57	55° 07.7'S 109° 58.0'E	61	557	
3	Dec. 5, 2014; 07:08	55° 08.3'S 109° 58.3'E	Dec. 6, 2014; 07:58	59° 59.1'S 109° 50.1'E	59	539	
4	Feb. 28, 2015; 00:49	55° 47.4'S 104° 52.0'E	Mar. 1, 2015; 08:51	51° 31.0'S 110° 00.3'E	79	723	
5a	Mar. 1, 2015; 09:00	51° 30.1'S 110° 00.6'E	Mar. 2, 2015; 08:52	47° 05.5'S 110° 02.5'E	54	493	
5b	Mar. 2, 2015; 09:13	47° 05.2'S 110° 04.5'E	Mar. 3, 2015; 00:55	44° 08.2'S 109° 58.8'E	36	329	

Table 5. Data for plankton samples collected by Continuous Plankton Recorder (CPR) during the JARE-56 cruise of TV *Umitaka-maru* to the Indian Ocean sector of the Southern Ocean, January–February 2015. Sampling was carried out by T. Iida.

CPR Run #	Start		End		No. of Segments	Distance towed (km)	Remarks
	Date & Time (GMT)	Position	Date & Time (GMT)	Position			
1	Jan. 14, 2015; 10:50	45° 02.0'S 109° 59.9'E	Jan. 15, 2015; 15:42	49° 57.9'S 110° 00.6'E	62	569	
2	Jan. 15, 2015; 21:52	50° 01.6'S 109° 59.7'E	Jan. 16, 2015; 19:25	54° 58.5'S 110° 00.1'E	60	550	
3a	Jan. 17, 2015; 01:29	55° 00.5'S 110° 00.2'E	Jan. 17, 2015; 14:14	57° 59.1'S 110° 00.2'E	36	330	
3b	Jan. 17, 2015; 15:42	58° 00.7'S 110° 00.0'E	Jan. 17, 2015; 19:56	58° 57.8'S 110° 00.3'E	12	105	
3c	Jan. 18, 2015; 05:10	59° 16.1'S 110° 00.1'E	Jan. 18, 2015; 08:22	59° 59.2'S 110° 00.1'E	9	80	
4a	Jan. 29, 2015; 06:03	60° 54.5'S 112° 30.6'E	Jan. 29, 2015; 08:25	60° 50.8'S 113° 09.8'E	5	37	
4b	Jan. 29, 2015; 10:36	60° 50.8'S 113° 12.0'E	Jan. 29, 2015; 15:12	60° 50.3'S 114° 09.2'E	6	51	
4c	Jan. 30, 2015; 10:25	60° 17.9'S 116° 05.9'E	Jan. 31, 2015; 19:00	57° 13.7'S 124° 50.7'E	66	608	
5	Jan. 31, 2015; 10:16	57° 12.5'S 124° 51.4'E	Feb. 1, 2015; 09:36	53° 55.3'S 132° 27.5'E	66	602	
6	Feb. 1, 2015; 09:45	53° 54.6'S 132° 28.8'E	Feb. 2, 2015; 08:35	50° 13.8'S 138° 38.3'E	64	586	