

**Plankton sampling by the training vessel *Umitaka-maru* in the Indian sector of  
the Southern Ocean in the austral summer of 2017**

Hisae SAKURAI<sup>1</sup>, Masato MOTOKI<sup>1,2\*</sup>, Kohei MIZOBATA<sup>2</sup>, Keishi SHIMADA<sup>2</sup>, Kohei  
MATSUNO<sup>4,5</sup>, Yuri OKUBO<sup>2</sup>, Masayoshi SANO<sup>1</sup>, Satoshi NIRAZUKA<sup>2</sup>, Natsuki YAMAMOTO<sup>2</sup>,  
Shintaro TAKAO<sup>1,3</sup>, Ryosuke MAKABE<sup>1,3</sup>, Kunio T. TAKAHASHI<sup>1,3</sup> and Tsuneo ODATE<sup>1,3</sup>

<sup>1</sup> National Institute of Polar Research, Research Organization of Information and Systems,  
10–3 Midori-cho, Tachikawa, Tokyo 190-8518.

<sup>2</sup> Tokyo University of Marine Science and Technology, 4–5–7 Konan, Minato-ku, Tokyo 108-8477.

<sup>3</sup> Department of Polar Science, School of Multidisciplinary Sciences, SOKENDAI (The Graduate  
University for Advanced Studies), 10–3 Midori-cho, Tachikawa, Tokyo 190-8518.

<sup>4</sup> Australian Antarctic Division, 203 Channel Highway, Kingston, Tasmania, 7050 Australia.

<sup>5</sup> Graduate School of Fisheries Sciences, Hokkaido University, 3–1–1, Minato-cho, Hakodate,  
Hokkaido, 041-8611.

\*Corresponding author. E-mail: masato@kaiyodai.ac.jp

## **1. Introduction**

The training vessel (T/V) *Umitaka-maru* II of the Tokyo University of Fisheries [currently Tokyo University of Marine Science and Technology (TUMSAT)] participated in the first Japanese Antarctic Research Expedition (JARE-1) in 1956–1957 as the ship associated with the icebreaker *Soya*. Since then, voyages for marine science research in the Southern Ocean have been undertaken intermittently by T/V *Umitaka-maru* III and IV (the present ship). After many years of collaborative relationship, the National Institute of Polar Research (NIPR) and TUMSAT signed a comprehensive cooperation agreement on 9 February 2009.

During the first half of the six-year plan for JARE phase IX (2016–2022) by NIPR, the new three-year (2016–2019) TUMSAT–NIPR joint program on “Studies on Plankton Community Structure and Environment Parameters in the Southern Ocean” was established. This program focuses on an

integrative study of marine ecosystem in the Indian sector of the Southern Ocean as one of the JARE projects (Project no. AP-0923; Associate Prof. Masato Moteki, TUMSAT, principal investigator).

The present report describes the data from the first research cruise conducted by T/V *Umitaka-maru* IV under the mission of project AP-0923. This report contains information about the samples that were collected using three kinds of plankton nets—Vertical Multiple Plankton Sampler (VMPS) net, the Intelligent Operative Net Sampling System (IONESS), and an Ocean Research Institute (ORI) net—along longitude 110°E off Wilkes Land, Antarctica, during the cruise period between 1 January 2017 and 27 January 2017.

## **2. Cruise number**

Data covered in this report were obtained from the 20th *Kaiyodai* (abbreviated Japanese name for TUMSAT) Antarctic Research Expedition (*KARE-20*) cruise by T/V *Umitaka-maru*, which was conducted as part of the 58th Japanese Antarctic Research Expedition (*JARE-58*) program. This cruise also served as a leg of the long-distance voyage of the Advanced Course of Marine Science and Technology of TUMSAT (voyage number UM-16-08).

## **3. Sampling protocols**

### **3.1. VMPS**

Meso-zooplankton were collected using a VMPS with four nets made of nylon bolting cloth with 100- $\mu$ m mesh and a frame opening of 0.25 m<sup>2</sup> (<http://www.tsk-jp.com/upload/product/pdf/VMPS.pdf>). The samples were collected at three layers from 200 m or 400 m depth with a multiple-net opening–closing system. The wire payout and retrieval speed were 0.7 and 0.5 m/s, respectively.

VMPS was deployed from the stern of the vessel and towed vertically over predetermined depth intervals. Each of the nets was opened and closed sequentially by commands transmitted from an onboard deck unit through an armored cable to an underwater unit. A deployment consisted of the vertical down-cast from the surface to the maximum depth, and the opening and closing sequences through specific depth strata were undertaken during the up-cast. During operation, flow meter counts, and depth and water temperature data were sent to the onboard deck unit. The flow meter was

calibrated by five vertical tows of the VMPS without nets before the UM-16-08 cruise.

Thirteen stations were occupied along the 110°E and 63.5°S transects for vertical sampling with the VMPS net ([Fig. 1](#)). Detailed sampling information is given in [Table 1](#).

### 3.2. IONESS

Macro-zooplankton and micro-nekton were collected using an IONESS with nine nets made of nylon bolting cloth with 335- $\mu$ m mesh and a frame opening of 1.44 m<sup>2</sup>. The IONESS sampling was carried out at eight layers with oblique tows with a multiple-net opening–closing system in the upper 400 m (Kitamura *et al.*, 2001).

The IONESS was deployed from the stern of the vessel and towed obliquely over predetermined depth intervals. Each of the nets was opened and closed sequentially by commands transmitted from an onboard deck unit through an armored cable to an underwater unit. A deployment consisted of an oblique down-cast from the surface to the maximum depth, and the opening and closing sequences through specific depth strata were undertaken during the up-cast.

Although there was a flow-meter (The Tsurumi-Seiki Co., Ltd., Yokohama, Japan) mounted outside the net-mouth opening to estimate towing distance, it was not used during this cruise because of a problem with the reliability of the flow-meter rotation due to rough sea conditions. In the present report, therefore, the volumes of water filtered ( $V$ , m<sup>3</sup>) by each net were estimated with the following equation, assuming a filtration efficiency of 100%:

$$V = D \times A, \quad (1)$$

where  $D$  and  $A$  are the towing distance (m) and the mean working filtration area (m<sup>2</sup>), respectively.  $D$  was calculated as

$$D = \sqrt{D_h^2 + D_v^2}, \quad (2)$$

where  $D_h$  (m) and  $D_v$  (m) are the horizontal distance (towing time [s] multiplied by the ship speed [ $1.0 \text{ m s}^{-1}$ ]) and vertical distance, respectively.  $A$  was calculated as

$$A = a \times \sin (\pi \times R/180), \quad (3)$$

where  $a$  is the mouth area of the net ( $1.44 \text{ m}^2$  [ $1.44 \text{ m high} \times 1.0 \text{ m wide}$ ]) and  $R$  is the mean frame angle during each net tow, calculated using the frame angle recorded every 2 s. Depth, temperature, and salinity were also measured by a conductivity–temperature–depth (CTD) probe (ICTD, Falmouth Scientific, Inc., Cataumet, MA, USA) mounted on the net frame. CTD data were recorded in real time by an onboard computer.

The IONESS samplings were conducted at five stations along  $110^\circ\text{E}$  and the other station ([Fig. 2](#)). Detailed sampling information for the six successful IONESS tows is given in [Table 2](#).

### 3.3. ORI net

Macro-zooplankton and micro-nekton were collected using an Ocean Research Institute net with one net made of nylon bolting cloth with  $500\text{-}\mu\text{m}$  mesh (Omori, 1965). The diameter of the net mouth rings was 160 cm. The ORI net was launched from the stern of the ship. After reaching an approximate depth of 200 m or 400 m, the net was hauled obliquely. The net was retrieved at a rate of approximately  $0.5 \text{ m s}^{-1}$ , while the ship moved at  $1 \text{ m s}^{-1}$ . The maximum depth reached was measured by a COMPACT-TD (ATD-HR, JFE Advantech Co. Ltd., Nishinomiya, Japan, [www.jfe-advantech.co.jp/eng/ocean/compact/compact-td.html](http://www.jfe-advantech.co.jp/eng/ocean/compact/compact-td.html)) mounted in the mouth of the net. The volume of water filtered was estimated using a calibrated flow-meter (#5571-B; Rigo Co., Ltd., Tokyo, Japan) mounted at the center of the mouth ring of the net.

ORI net samplings were conducted at 14 stations along the  $110^\circ\text{E}$  and  $63.5^\circ\text{S}$  transects ([Fig. 3](#)). Detailed sampling information is given in [Table 3](#).

### 3.4. Zooplankton sample processing

All zooplankton samples were immediately preserved in 5% borate-buffered formalin-seawater

on board and stored in a cool, dark place on the ship.

#### 4. Data policy

The purpose of this data report is to provide information about the collection of zooplankton samples for scientists and students conducting research on Antarctic ecosystems and zooplankton. This report should also make interested researchers aware of the opportunity to use these samples to quantitatively describe zooplankton distribution and biomass in the Southern Ocean. All underlying physical data are available for scientific use. We expect the information in this report, in combination with the available samples and environmental data set, to be utilized in various future studies.

Permission to use the data and the preserved samples for publication or presentation should be obtained in writing. Inquiries about details of the data record should be addressed to one of the following:

Tsuneo Odate, Professor	Masato Moteki, Associate Professor
National Institute of Polar Research	Tokyo University of Marine Science and Technology
10-3 Midori-cho, Tachikawa	4-5-7 Konan, Minato-ku
Tokyo 190-8518, Japan	Tokyo 108-8477, Japan
Phone: +81-42-512-0735	Phone: +81-35-463-0527
Facsimile: +81-42-528-3492	Facsimile: +81-35-463-0523
E-mail: odate@nipr.ac.jp	E-mail: masato@kaiyodai.ac.jp

#### Acknowledgments

We acknowledge Captain Akira Noda and his crew of T/V *Umitaka-maru*, and all cadets on board participating in the Advanced Course for Marine Science and Technology of TUMSAT, for their invaluable assistance during oceanographic observations. We also thank our scientific colleagues and graduate students for their excellent support during the KARE-20 cruise.

### References

- Kitamura, M., Tanaka, Y., Ishimaru, T., Mine, Y., Noda, A., Hamada, H. (2001): Sagami Bay Research Report: improvement of multiple opening/closing net, IONESS (Intelligent Operative Net Sampling System). Cruise Rep., **10**, 149–158 (in Japanese). Available at: <http://ci.nii.ac.jp/naid/110000481863/en/>.
- Omori, M. (1965): A 160-cm Opening-Closing Plankton Net: I. Description of the Gear. J. Oceanogr. Soc. Japan, **21**, 212–220, doi:10.5928/kaiyou1942.21.212.

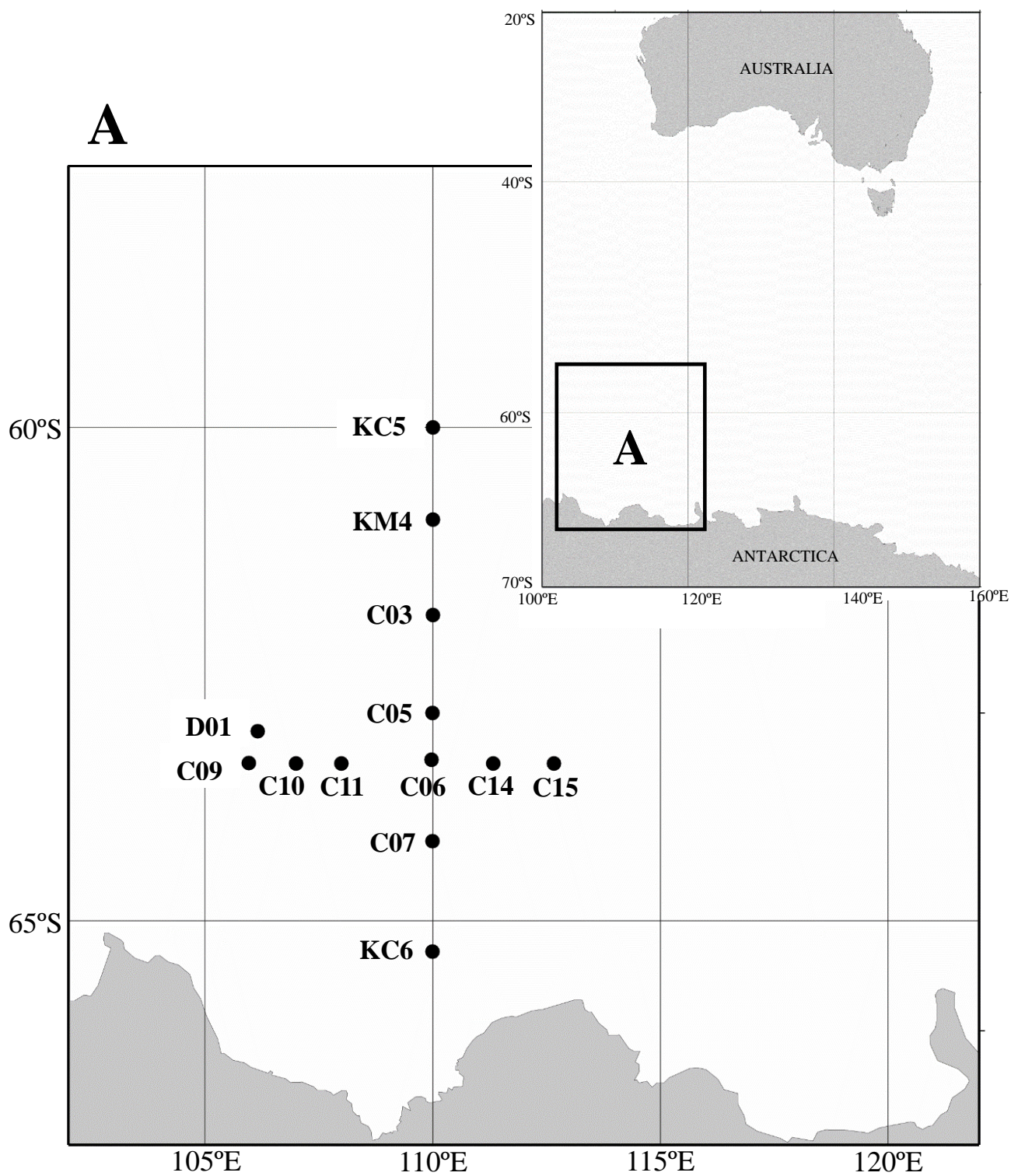


Fig. 1. Stations sampled with a VMPS net from on board the training vessel *Umitaka-maru* in the Indian sector of the Southern Ocean, January 2017.

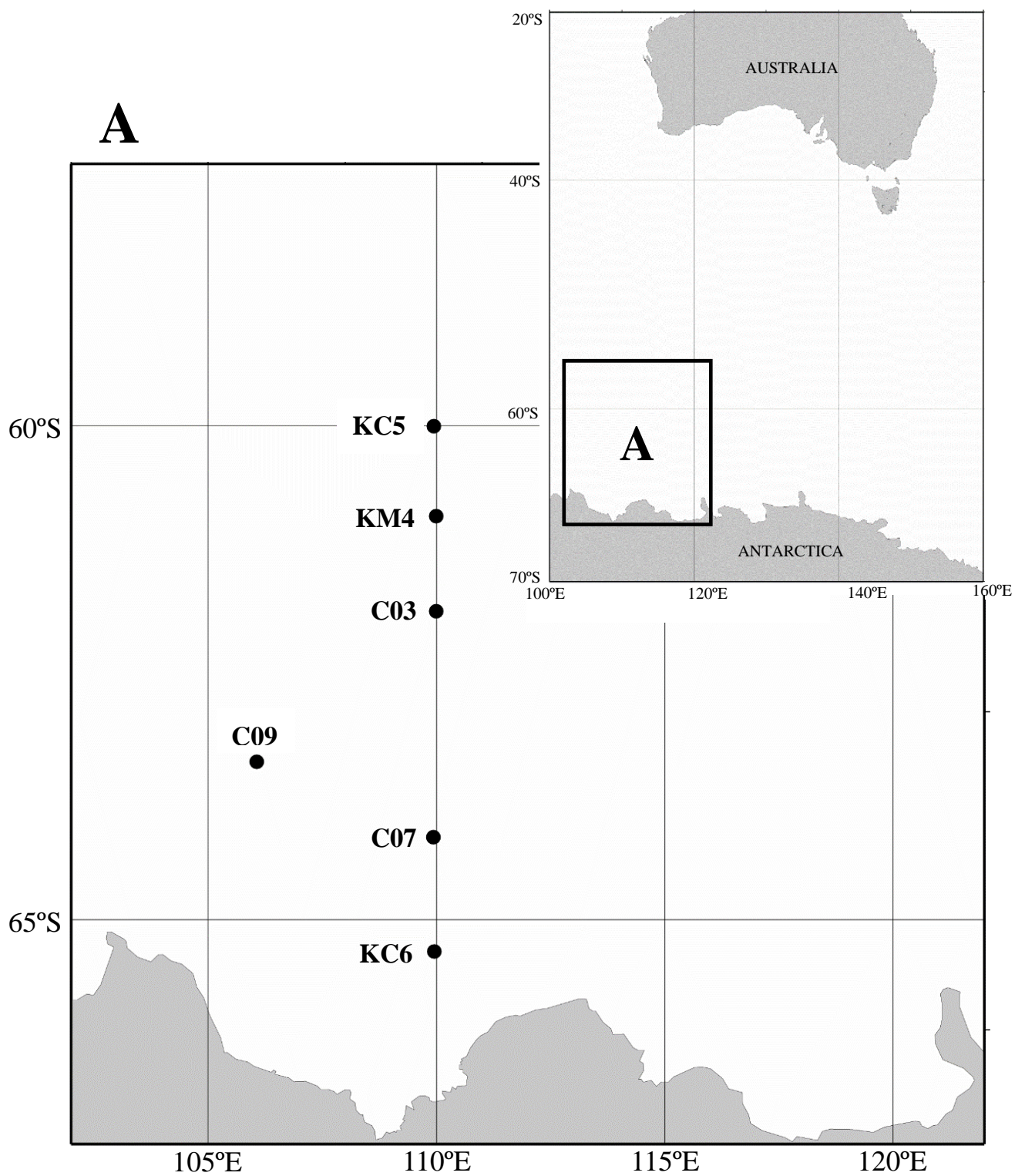


Fig. 2. Stations sampled with IONESS opening/closing multiple-net systems from on board the training vessel

*Umitaka-maru* in the Indian sector of the Southern Ocean, January 2017.



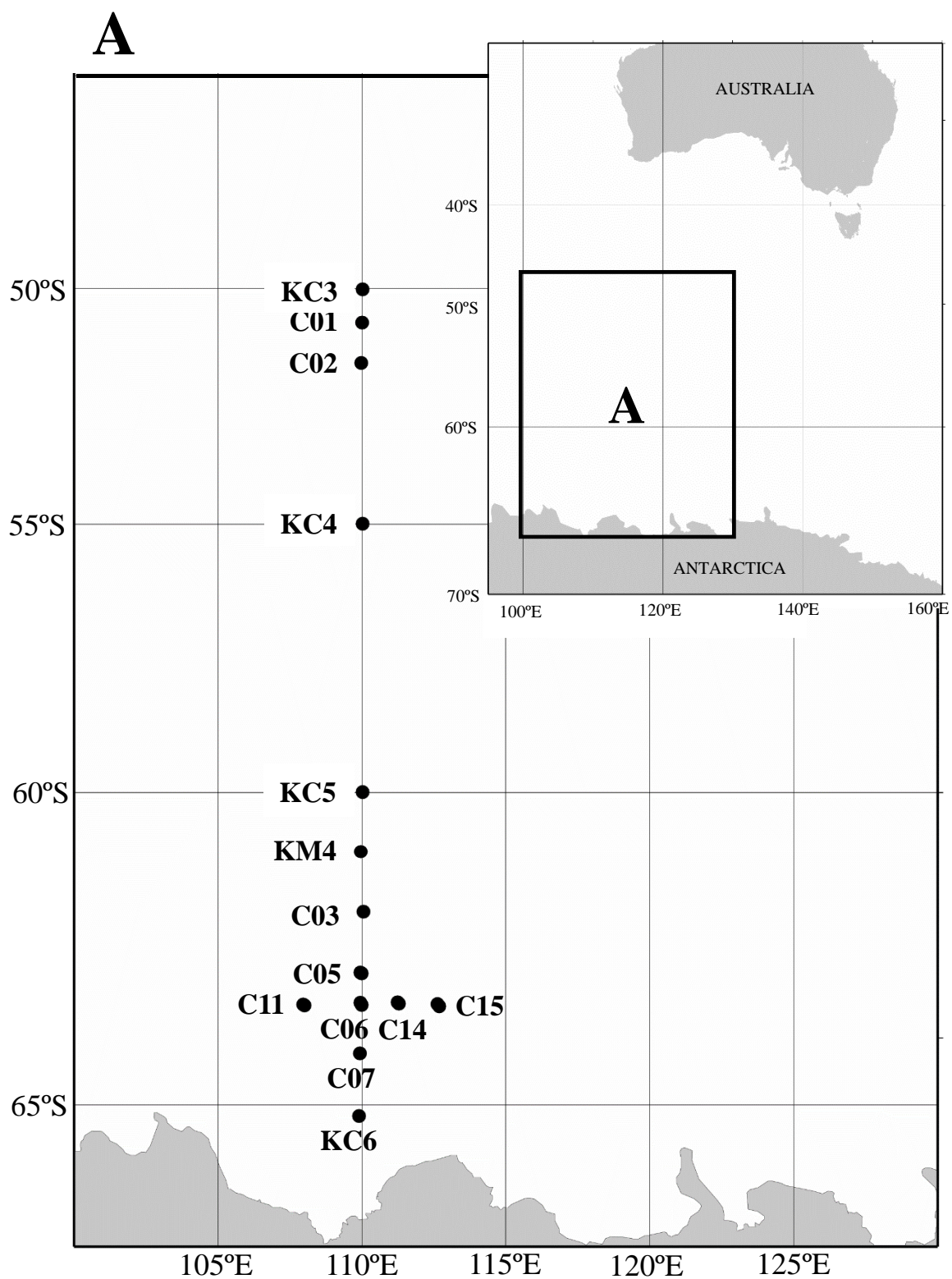


Fig. 3. Stations sampled with an ORI net by oblique tows from on board the training vessel *Umitakamaru* in the Indian sector of the Southern Ocean, January 2017.

Table 1. Sampling data of a VMPS along the 110°E transect in the Southern Ocean in January 2017. (1 of 2)

Stn.	Position		Date (yyyy/mm/dd) & Time (UTC) <sup>a</sup>		Bottom depth (m)	Sampling depth interval (m)	Volume filtered (m <sup>3</sup> ) <sup>b</sup>	Sample No.
	Start	Finish	Start	Finish				
KC5	60.0003 °S	59.9990 °S	2017/01/07 06:44	2017/01/07 07:19	4397	0 - 50	10.987	1
	110.0001 °E	110.0049 °E				50 - 100	11.164	2
						100 - 200	20.910	3
KM4	60.9969 °S	60.9957 °S	2017/01/08 14:13	2017/01/08 14:32	4282	0 - 50	22.859	4
	110.0059 °E	110.0050 °E				50 - 100	20.733	5
	61.0007 °S	60.9988 °S	2017/01/08 13:05	2017/01/08 13:43	4282	100 - 200	15.239	6
	110.0048 °E	110.0068 °E						
C03	61.9995 °S	62.0000 °S	2017/01/09 05:19	2017/01/09 05:45	3997	0 - 50	18.252	7
	109.9987 °E	110.0016 °E				50 - 100	14.353	8
						100 - 200	31.188	9
C07	64.2496 °S	64.2491 °S	2017/01/10 11:14	2017/01/10 11:46	2956	0 - 50	20.024	10
	109.9980 °E	109.9944 °E				50 - 100	11.518	11
						100 - 200	24.631	12
KC6	65.2838 °S	65.2840 °S	2017/01/11 04:36	2017/01/11 05:00	2186	0 - 50	7.088	13
	109.9967 °E	109.9974 °E				50 - 100	8.860	14
						100 - 200	15.771	15
C09	63.4933 °S	63.4929 °S	2017/01/13 13:02	2017/01/13 13:21	3645	0 - 50	8.328	16
	105.9663 °E	105.9659 °E				50 - 100	3.367	17
						100 - 200	12.936	18
D01	63.1834 °S	63.1834 °S	2017/01/14 05:25	2017/01/14 05:46	3711	0 - 50	7.620	19
	106.1609 °E	106.1614 °E				50 - 100	5.670	20
						100 - 200	11.518	21
C10	63.4995 °S	63.4983 °S	2017/01/14 15:14	2017/01/14 15:43	3009	0 - 50	14.176	22
	106.9994 °E	106.9969 °E				50 - 100	11.518	23
						100 - 200	21.973	24
C11	63.4996 °S	63.4996 °S	2017/01/14 23:54	2017/01/15 00:04	3253	0 - 50	8.506	25
	107.9972 °E	107.9967 °E				50 - 100	15.062	26
						100 - 150	8.860	27
	63.4993 °S	63.4994 °S	2017/01/15 00:33	2017/01/15 00:58	3252	150 - 200	11.518	28
	107.9962 °E	107.9958 °E				200 - 300	15.417	29
						300 - 400	16.125	30
C05	62.9999 °S	62.9998 °S	2017/01/16 02:45	2017/01/16 03:00	3896	0 - 50	10.987	31
	109.9980 °E	109.9963 °E				50 - 100	13.645	32
						100 - 150	14.531	33
	63.0000 °S	63.0002 °S	2017/01/16 01:43	2017/01/16 02:17	3897	150 - 200	10.455	34
	109.9992 °E	109.9984 °E				200 - 300	26.049	35
						300 - 400	25.517	36
C06 (Day time)	63.4745 °S	63.4747 °S	2017/01/17 08:23	2017/01/17 08:36	3677	0 - 50	9.214	37
	109.9795 °E	109.9795 °E				50 - 100	8.683	38
						100 - 150	8.860	39
	63.4737 °S	63.4739 °S	2017/01/17 07:27	2017/01/17 07:55	3678	150 - 200	9.214	40
	109.9759 °E	109.9779 °E				200 - 300	19.492	41
						300 - 400	20.910	42

<sup>a</sup>Ship mean time = UTC + 8 h<sup>b</sup>Mesh size 100 µm

Table 1. Continued. (2 of 2)

Stn.	Position		Date (yyyy/mm/dd) & Time (UTC) <sup>a</sup>		Bottom depth (m)	Sampling depth interval (m)	Volume filtered (m <sup>3</sup> ) <sup>b</sup>	Sample No.
	Start	Finish	Start	Finish				
C06 (Night time)	63.4554 °S	63.4562 °S	2017/01/17 17:30	2017/01/17 17:50	3674	0 - 50	10.100	43
	109.9586 °E	109.9572 °E				50 - 100	9.392	44
						100 - 150	9.214	45
	63.4571 °S	63.4564 °S	2017/01/17 15:45	2017/01/17 16:17	3676	150 - 200	11.518	46
	109.9669 °E	109.9692 °E				200 - 300	21.619	47
						300 - 400	22.859	48
C14	63.5001 °S	63.5003 °S	2017/01/18 13:16	2017/01/18 13:33	3422	0 - 50	10.278	49
	111.3296 °E	111.3288 °E				50 - 100	11.164	50
						100 - 150	11.341	51
	63.5002 °S	63.5000 °S	2017/01/18 13:58	2017/01/18 14:30	3423	150 - 200	11.164	52
	111.3294 °E	111.3272 °E				200 - 300	21.441	53
						300 - 400	21.796	54
C15	63.5004 °S	63.4998 °S	2017/01/19 01:19	2017/01/19 01:34	3534	0 - 50	14.353	55
	112.6624 °E	112.6616 °E				50 - 100	13.467	56
						100 - 150	12.404	57
	63.5005 °S	63.5008 °S	2017/01/19 00:28	2017/01/19 00:57	3535	150 - 200	11.341	58
	112.6633 °E	112.6628 °E				200 - 300	22.682	59
						300 - 400	24.985	60

<sup>a</sup>Ship mean time = UTC + 8 h<sup>b</sup>Mesh size 100 µm

Table 2. Sampling data of an IONESS along the 110°E transect in the Southern Ocean in January 2017.

Stn.	Tow	Position		Date (yyyy/mm/dd) & Time (UTC) <sup>a</sup>		Bottom depth (m)	Sampling depth interval (m)	Volume filtered (m <sup>3</sup> ) <sup>b</sup>	Sample No.
		Start	Finish	Start	Finish				
KC5	1	60.0044 °S	59.9955 °S	2017/01/07 02:03	2017/01/07 03:42	4395	0 - 25	521	1
		109.9395 °E	110.0774 °E				25 - 50	391	2
							50 - 75	354	3
							75 - 100	464	4
							100 - 150	752	5
							150 - 200	730	6
							200 - 300	774	7
							300 - 400	800	8
KM4	2	60.9794 °S	61.0262 °S	2017/01/08 16:04	2017/01/08 17:34	4283	0 - 25	550	9
		109.9997 °E	110.0003 °E				25 - 50	473	10
							50 - 75	475	11
							75 - 100	500	12
							100 - 150	618	13
							150 - 200	624	14
							200 - 300	794	15
							300 - 400	704	16
C03	3	61.9752 °S	62.0421 °S	2017/01/09 01:07	2017/01/09 02:49	3941	1 - 25	547	17
		109.9993 °E	110.0404 °E				25 - 50	474	18
							50 - 75	557	19
							75 - 100	402	20
							100 - 150	635	21
							150 - 200	482	22
							200 - 300	1051	23
							300 - 400	724	24
C07	4	64.2229 °S	64.2854 °S	2017/01/10 14:07	2017/01/10 15:56	3010	0 - 25	525	25
		109.9364 °E	110.0460 °E				25 - 50	426	26
							50 - 75	523	27
							75 - 100	390	28
							100 - 150	629	29
							150 - 200	640	30
							200 - 300	1001	31
							300 - 400	813	32
KC6	5	65.2910 °S	65.2695 °S	2017/01/11 11:26	2017/01/11 12:50	2096	0 - 150	1759	33
		109.9538 °E	110.0699 °E				150 - 200	572	34
							200 - 300	723	35
							300 - 400	835	36
C09	6	63.4960 °S	63.5014 °S	2017/01/13 08:34	2017/01/13 10:09	3607	0-25	721	37
		106.0602 °E	105.9268 °E				25 - 50	551	38
							50 - 75	598	39
							75 - 100	573	40
							100 - 150	530	41
							150 - 200	604	42
							200 - 300	717	43
							300 - 350	695	44

<sup>a</sup>Ship mean time = UTC + 8 h<sup>b</sup>Mesh size, 335µm

Table 3. Sampling data for oblique tows of an ORI net along the 110°E transect in the Southern Ocean in January 2017.

Stn.	Position		Date (yyyy/mm/dd) & Time (UTC) <sup>a</sup>		Maximum depth reached (m) <sup>b</sup>	Volume filtered (m <sup>3</sup> ) <sup>c</sup>	Sample No.
	Start	Finish	Start	Finish			
KC3	50.0194 °S	50.0046 °S	2017/01/04 02:22	2017/01/04 02:58	183	4342	1
	110.0270 °E	109.9974 °E					
C01	50.7546 °S	50.7385 °S	2017/01/04 13:29	2017/01/04 14:07	183	3988	2
	110.0038 °E	109.9930 °E					
C02	51.6350 °S	51.6248 °S	2017/01/04 19:39	2017/01/04 20:20	208	5000	3
	109.9771 °E	109.9319 °E					
KC4	54.9888 °S	55.0089 °S	2017/01/05 12:26	2017/01/05 13:08	190	5564	4
	110.0193 °E	109.9896 °E					
KC5	59.9874 °S	59.9606 °S	2017/01/07 11:00	2017/01/07 11:41	191	5158	5
	110.0206 °E	110.0572 °E					
KM4	61.0137 °S	60.9939 °S	2017/01/08 10:05	2017/01/08 10:52	215	7190	6
	109.9668 °E	110.0223 °E					
C03	62.0137 °S	62.0493 °S	2017/01/09 10:31	2017/01/09 11:18	162	*	7
	110.0461 °E	110.0652 °E					
C07	64.2346 °S	64.2454 °S	2017/01/10 06:20	2017/01/10 06:57	235	4976	8
	109.9339 °E	109.9796 °E					
KC6	65.1644 °S	65.1959 °S	2017/01/10 23:03	2017/01/10 23:46	193	5491	9
	109.8965 °E	109.9237 °E					
C11	63.4907 °S	63.4971 °S	2017/01/15 06:57	2017/01/15 07:33	229	4580	10
	107.9584 °E	107.9918 °E					
C11	63.5008 °S	63.5191 °S	2017/01/15 07:54	2017/01/15 08:35	206	4876	11
	108.0022 °E	108.0509 °E					
C05	62.9886 °S	62.9975 °S	2017/01/16 05:59	2017/01/16 06:38	249	4526	12
	109.9385 °E	109.9863 °E					
C05	62.9996 °S	63.0116 °S	2017/01/16 06:55	2017/01/16 07:34	236	5042	13
	109.9974 °E	110.0490 °E					
C06	63.4947 °S	63.4627 °S	2017/01/17 05:40	2017/01/17 06:43	397	6996	14
	109.9932 °E	109.9572 °E					
C06	63.4611 °S	63.4622 °S	2017/01/17 18:30	2017/01/17 19:19	364	*	15
	109.9495 °E	109.8723 °E					
C14	63.4512 °S	63.4697 °S	2017/01/18 06:57	2017/01/18 07:36	221	4986	16
	111.2372 °E	111.2733 °E					
C14	63.4745 °S	63.4931 °S	2017/01/18 08:00	2017/01/18 08:39	254	4715	17
	111.2899 °E	111.3216 °E					
C15	63.4845 °S	63.5058 °S	2017/01/19 03:37	2017/01/19 04:16	178	5485	18
	112.6193 °E	112.6710 °E					
C15	63.5154 °S	63.5350 °S	2017/01/19 04:37	2017/01/19 05:16	169	5309	19
	112.6918 °E	112.7428 °E					

<sup>a</sup>Ship mean time = UTC + 8 h

<sup>b</sup>COMPACT-TD

<sup>c</sup>Mesh size, 500 µm

\*no data