Development of a retrievable sonobuoy system for whale sounds recording in polar region

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ABSTRACT

A newly retrievable sonobuoy system to record underwater whale sounds in the Antarctic was successfully developed in the JARPA program. Recording of about 7 hours at 6 stations, about 10 hours at 6 stations and about 19 hours at 15 stations were carried out in 1997/98, 1998/99 and 1999/2000 JARPA surveys, respectively. The spar-typed sonobuoy was employed in the 1998/99 JARPA to minimize low frequency "mechanical self-noise" caused by up and down movement of the hydrophone with 10 m cable. Preliminary data analysis shows that the system obtained clear sounds of blue (minimum total 150 calls), fin (400 calls) and humpback (3 calls) whales within short total recording time without substantial technical problems. A lightweight positioning system will be added to the system in the near future so that accurate position can be recorded. These acoustic data will contribute to the whale sound studies in the Southern Ocean such as the IWC/SOWER blue whale research program.

INTRODUCTION

Acoustic experiments to record whale sounds using a retrievable sonobuoy system were conducted in the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) from the 1997/98 to 1999/2000 seasons (Ishikawa *et al.*, 1998, 2000, Nishiwaki *et al.*, 1999). The Institute of Cetacean Research (ICR) developed a specifically designed system to record whale sounds in the Antarctic in cooperation with the System Giken Company Ltd., Kanagawa, Japan. Considering field handing, environmental issues and budgetary constraints, a retrievable sonobouy system was selected. This paper describes the newly developed "ICR sonobuoy system" and presents the results of experiments in JARPA surveys.

DEVELOPMENT OF SONOBUOY SYSTEM

A summary of the ICR sonobuoy system specifications during each cruise is shown in Table 1. Fig. 1 shows the shape of the system used in each cruise. Details of the development of the system are summarized below.

The float type system with GPS used in the 1997/98 cruise

The float type system (sonobuoy length was 700mm, diameter was 140mm) was used in this season. The system consisted of a DAT recorder (SONY-TCD-D100), an alkali battery, a hydrophone (5Hz to 25kHz, ±3db) with cable (10m) and a GPS transmitter to detect position of sonobouy. Consumption of alkali battery power was unexpectedly high due to low water temperature. Recording conditions were inferior especially for low frequencies because of low frequency "mechanical self-noise" that occurred when a hydrophone with a 10m cable that was suspended from the sonobuoy was moved up and down by the waves.

Application of the spar type system used in the 1998/99 cruise

The spar buoy type system (length was 4,500mm, diameter was 140mm) was adapted to minimize low frequency "mechanical self-noise". The system consisted of a DAT recorder, a lithium battery, a hydrophone (5Hz to 25kHz, ±3db) with cable (10m) and a GPS buoy. The lithium battery was used

because it had a longer life than the alkali battery in the low water temperature environment. Preliminary analyses of 1998/99 data showed that the "mechanical self-noise" was much reduced compared to the 1997/98 data. Noise reduction was considered as adoption of the spar buoy.

Lightweight modifications in the 1999/2000 cruise

The spar buoy type system (length was 3,000mm, diameter was 140mm) was used as in the 1998/1999 season but the length was 1500mm shorter than that in 1998/1999 for easier handling in the field. The system consisted of a DAT recorder, a lithium battery, a low frequency hydrophone with a cable (10m) and a radar reflector. The radar reflector was used instead of the GPS transmitter because GPS transmitter was relatively heavy (Fig. 3). Field handling efficiency of the sonobuoy system was significantly enhanced (Fig. 4). Although deployment and recovering operations were improved by these modifications, movement range of the research vessel was reduced (maximum 6 miles that was equivalent to radar range). Since an accurate position of the sonobuoy system during recording is desired, a lightweight positioning system will be added to the system in the near future.

RESULTS OF WHALE SOUNDS RECORDING

The sonobuoy experiments were mainly conducted during blue whale experiments of photo ID and biopsy, when blue whales were sighted. Table 2 shows the summary of the ICR sonobuoy experiments in JARPA from the 1997/98 to the 1999/2000 cruises. Recording of about 7 hours at 6 stations, about 10 hours at 6 stations and about 19 hours at 15 stations were carried out in 1997/98, 1998/99 and 1999/2000 JARPA surveys, respectively.

Clear calls were recorded 150 times for blue, 400 times for fin and 3 times for humpback whales within about 10 hours recording in the 1998/99 cruise. The spectrograms of blue and fin whales are shown in Fig. 5. Further analyses of 1998/99 data and preliminary analyses in 1999/2000 data are planned in the near future. These acoustic data in the Antarctic will contribute to studies on geographical variations of whale sounds such as those being conducted as part of the IWC/SOWER blue whale research program. Our blue whales vocalization data will be useful to separate true blue whales from pygmy blue whales

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REFERENCES

Ishikawa, H., Matsuoka, K., Tohyama, D., Yuzu, S., Shimokawa, T., Ohshima, K., Mizushima, Y., Nibe, T., Kido, T., Asada, M., Nakamura, M., Ichinomiya, D. and Kinoshita, T. 1998. Cruise report of the Japanese Whale research Programme under Special Permit in the Antarctic (JARPA) Area IV and eastern part of Area III in 1997/98. Paper SC/50/CAWS8 presented to the IWC Scientific Committee, May 1998 (unpublished). 26pp.

Ishikawa, H., Murase, H., Tohyama, D., Yuzu, S., Ohtani, S., Mogoe, T., Masaki, T., Kimura, N., Ohshima, T., Konagai, T., Asada, M., Takeuchi, J. and Kinoshita, T. 2000. Cruise report of the Japanese Whale research Program under a Special Permit in the Antarctic (JARPA) Area IV and eastern part of Area III in 1999/2000. Paper SC/52/OS7 presented to this meeting.

Nishiwaki, S., Tohyama, D., Yuzu, S., Bando, T., Watanabe, M., Kitajima, A., Takeda, S., Murase, H., Otose, S., Okubo, J., Tsutsui, S., Takatsuki, M. and Kinoshita, T. 1999. Cruise report of the Japanese Whale research Program under Special Permit in the Antarctic (JARPA) Area V and western part of Area VI in 1998/99. Paper SC/51/CAWS10 presented to the IWC Scientific Committee, May 1999 (unpublished). 20pp.

Table. 1. Developments of the ICR sonobuoy system.

Item	1997/98	1998/99	1999/2000
Sonobuoy type	Float type	Spar buoy type	Spar buoy type
Sonobuoy length (mm)	700	4500	3000
Sonobuoy diameter (mm)	140	140	140
Recorder (SONY)	DAT(TCD-D100)	DAT(TCD-D100)	DAT(TCD-D100)
Battery type	Alkali	Lithium	Lithium
Hydrophone	5Hz - 25kHz	5Hz - 25kHz	5Hz - 25kHz
Hydrophone gauge (mm)	500*500*600	500*500*600	300*300*400
Positioning system	GPS	GPS	Rader reflector

Table. 2. Summary of the ICR sonobuoy experiment in JARPA 1997/98 to 1999/2000 cruises.

Area	Tape No.	Date	Deploy time	Deploy position Lat.		Deploy position Long.		Recovery time	Recovery position Lat.		Recovery position Long.		Sighting no.	Target species	School size	Recording minutes	Sea state	Biological sound 1)
IV	1	19980104	810					830						Test		20	4	-
IV	2	19980105	1403	62.445	S	82.353	E	1551	62.447	S	82.341	E	10	Humpback	2	122	5	-
IV	3	19980107	722	61.223	S	84.403	E	741	61.22	S	84.40	E		Test		38	3	-
IV	3	19980109	1607	60.167	S	86.314	E	1659	60.17	S	86.31	E	17	Fin	4	62	4	-
IV	4	19980112	1115	63.064	S	93.172	E	1300	63.06	S	93.17	E	17	Blue	1	85	3	-
IV	5	19980308	1550	65.172	S	63.538	E	1714	65.174	S	63.553	E		Test		101	4	-
V-NW	1	19990113	1213	60.131	S	127.353	E	1335	60.134	S	127.357	E	-	Test	-	98	2	-
V-NW	2	19990120	1356	65.089	S	148.131	E	1506	65.091	S	148.136	E	10	Humpback	4	89	2	Humpback
V-NW	3	19990121	742	65.363	S	148.568	E	948	65.364	S	148.571	E	4	Blue	1	136	3	Blue
																		Fin
V-NW	4	19990121	1131	65.373	S	149.203	E	1227	65.371	S	149.203	E	13	Blue	2	69	3	Blue
														Humpback	5			Fin
V-SW	5	19990219	823	65.542	S	161.429	E	927	65.543	S	161.433	E	2	S.Bottlenose	3	64	2	-
V-SE	6	19990305	1307	68.44	S	177.013	E	1513	68.446	S	177.04	E	18	Fin	16	136	5	-
IIIE	1	19991211	700	61.251	S	41.085	E	815	61.250	S	41.084	E	-	Test	-	82	4	*
IIIE	2	19991213	1606	63.195	S	46.537	E	1704	63.197	S	46.547	E	2	Blue	2	66	5	*
IIIE	3	19991219	1228	62.156	S	60.136	E	1343	62.157	S	60.141	E	9	Blue	1	116	1	*
IIIE	4	19991219	1605	62.236	S	60.596	E	1717	62.238	S	61.002	E	12	Blue	3	84	1	*
														Sperm	1			
IIIE	5	19991221	901	62.014	S	59.261	E	950	62.012	S	59.267	E	6	Blue	4	58	3	*
IIIE	6	19991224	1320	60.268	S	61.295	E	1445	60.273	S	61.304	E	6	Blue	2	92	2	*
IV-NW	7	20000104	1645	61.079	S	82.452	E	1800	61.077	S	82.455	E	4	Humpback	1	84	3	*
IV-NE	8	20000113	1342	62.119	S	103.036	E	1520	62.128	S	103.015	E	19	Humpback	3	104	2	*
IV-NE	9	20000114	923	62.528	S	104.128	E	1019	62.528	S	104.155	E	16	Blue	2	64	3	*
													17	Blue	2			
IV-NE	10	20000122	1413	63.567	S	102.420	E	1526	63.566	S	120.426	E	10	Blue	1	80	3	*
													12	Blue	2			
													13	Blue	2			
													14	Blue	2			
IV-SE	11	20000208	756	64.583	S	116.402	E	903	64.583	S	116.399	E	4	Minke	30	74	2	*
													5	Minke	33			
IV-SE	12	20000210	933	64.354	S	114.307	E	1038	64.354	S	114-30.6	E	2	Right	1	72	4	*
IV-SE	13	20000211	1149	65.132	S	111.268	E	1244	65.134	S	111.269	E	18	Baleen whales	7	64	2	*
IV-SE	14	20000216	1623	64.171	S	103.000	E	1709	64.17	S	103.001	E	50	Right	1	56	5	*
IV-SW	15	20000219	1758	64.094	S	97.378	E	1835	64.095	S	97.369	E	9	Humpback	2	40	3	*
														Killer	60			

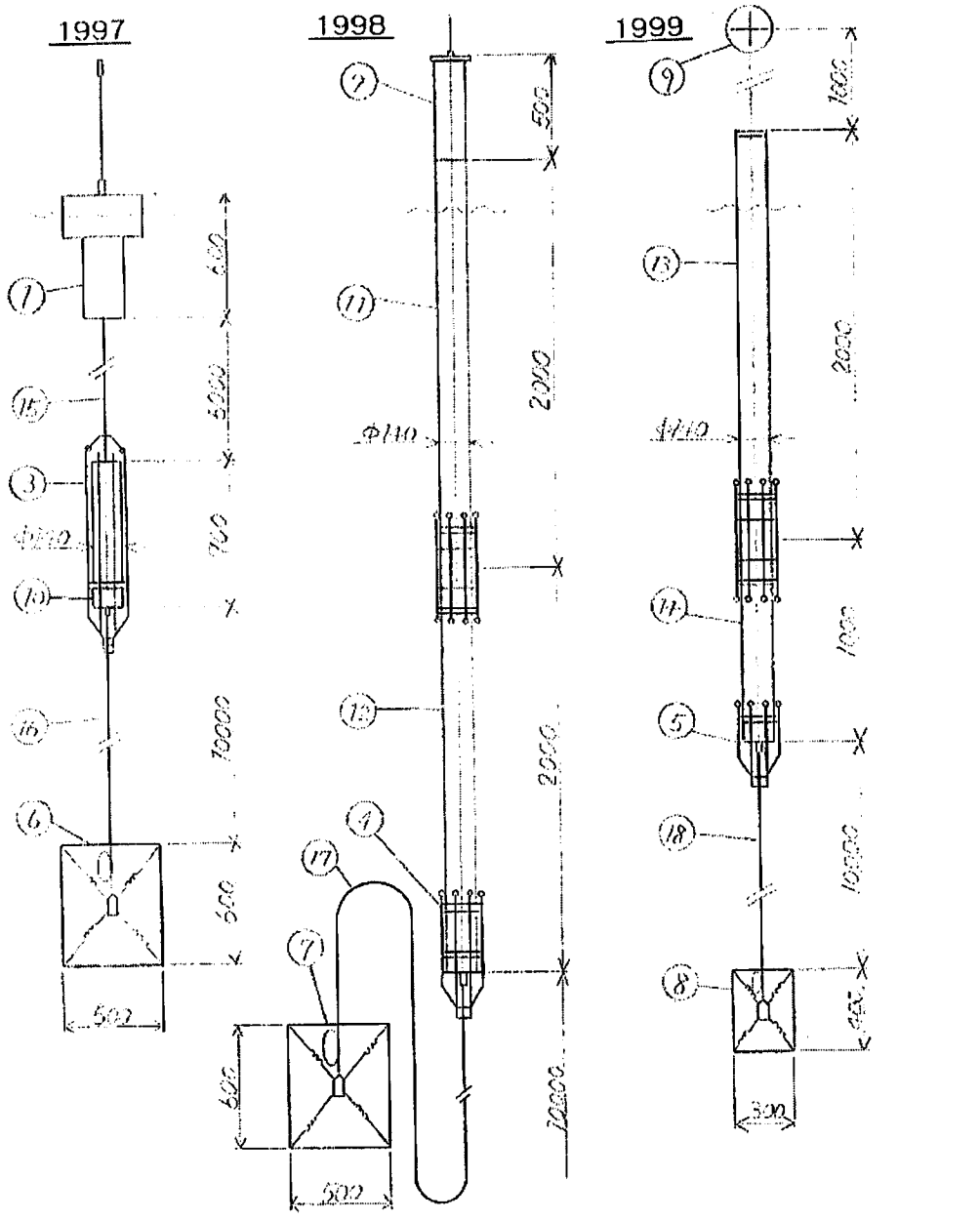

Fig. 1. Outline of the newly developed ICR sonobuoy system from 1997/98 to 1999/2000.

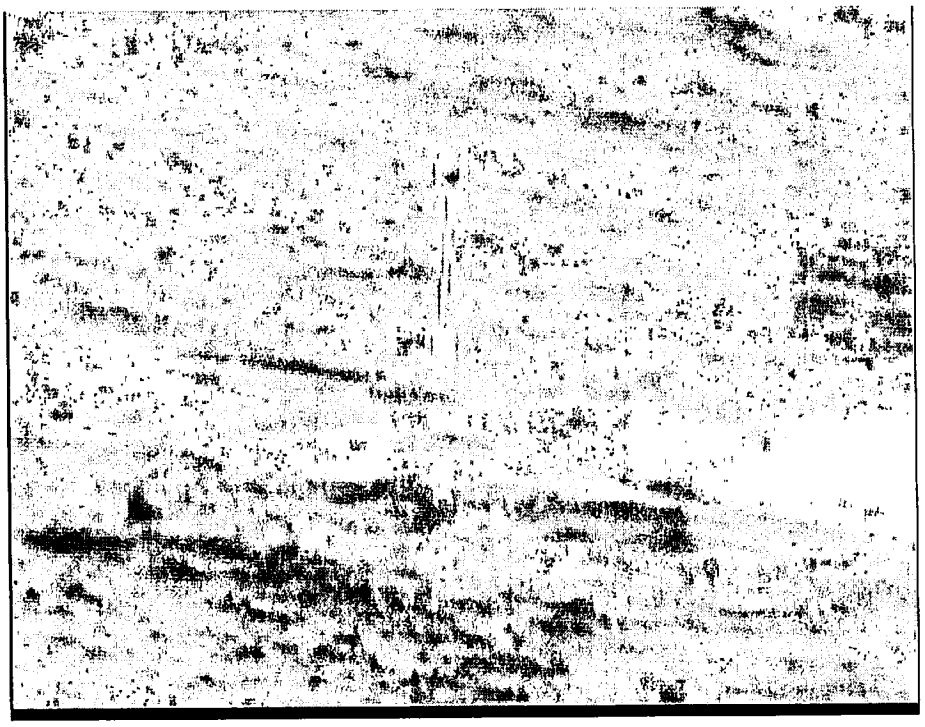

Fig.2. Photograph of the ICR sonobuoy system in 1999/2000 JARPA.

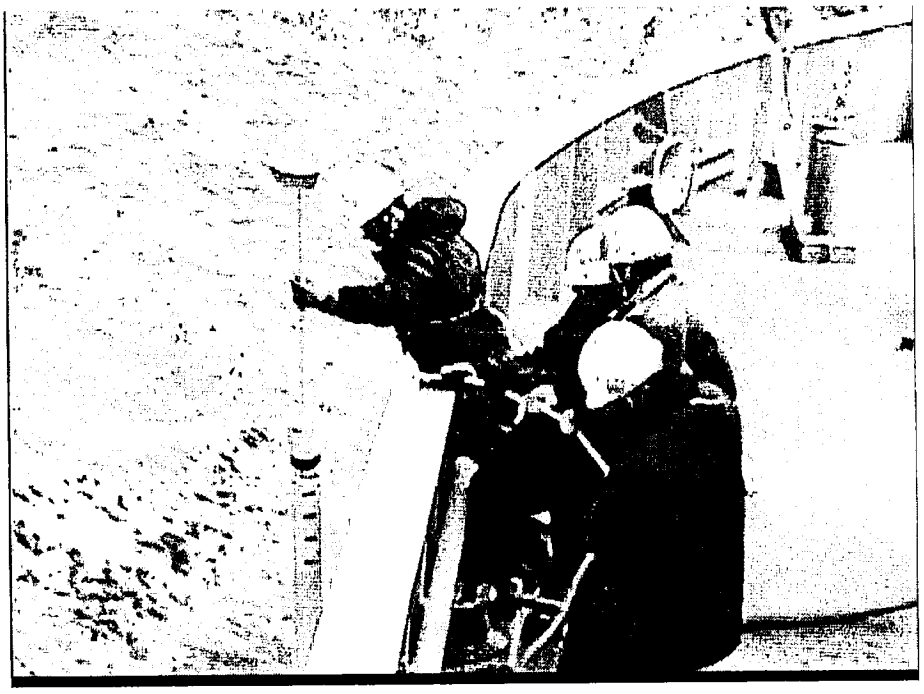

Fig.3. Photograph of deployment the ICR sonobuoy system in 1999/2000 JARPA.

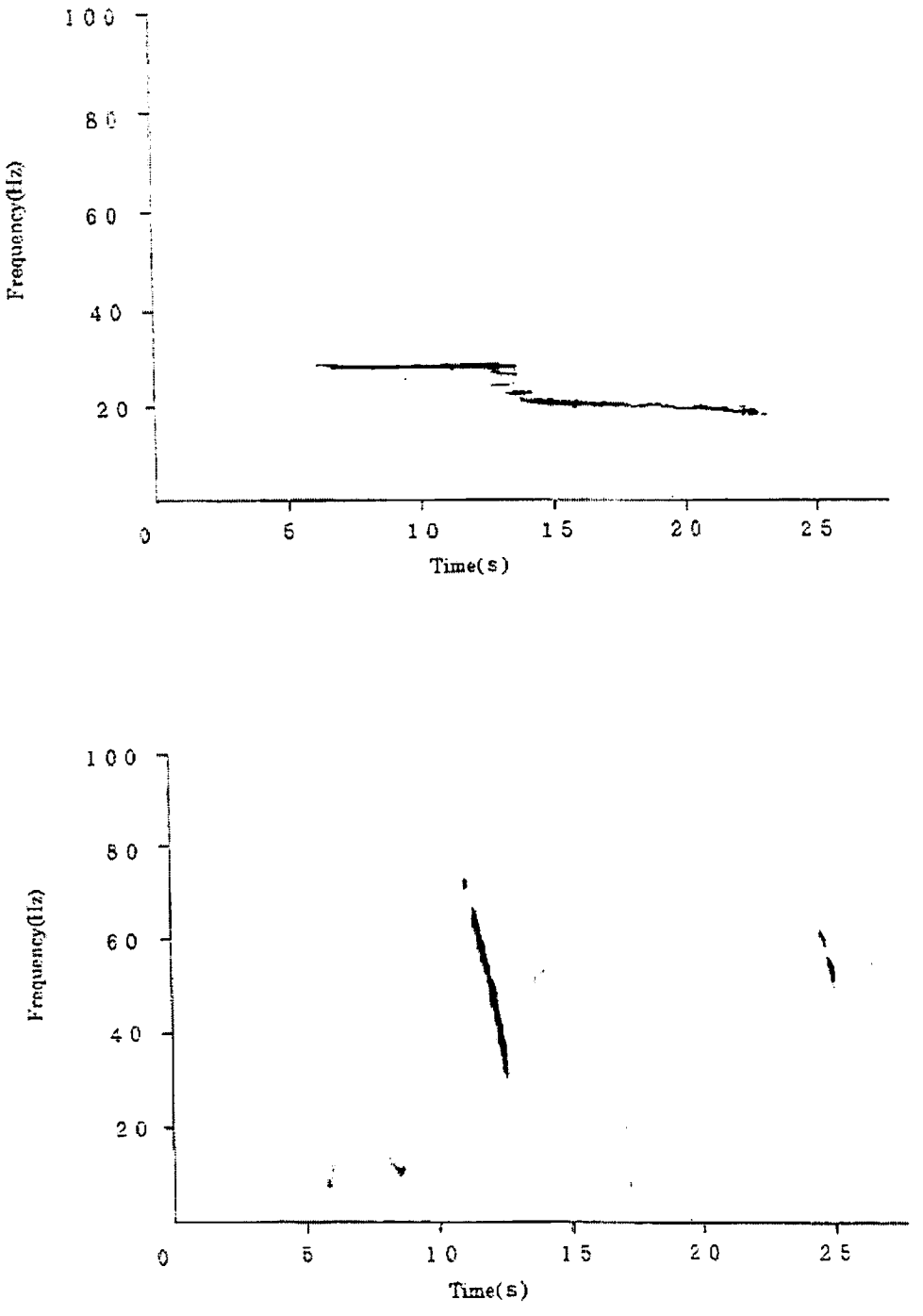

Figure 5. Spectrogram examples of whale sounds recorded during JARPA 1998/99 cruise. Top panel shows the spectrogram of a typical blue whale call as recorded in Area V on 21 January 1999 when blue whales were seen. Bottom panel shows the spectrogram of a typical fin whale call as recorded in Area V on 21 January 1999.