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# Application of the XCTD oceanographic survey in the Antarctic Areas IIIE and IV ( 35 ° -130 ° E) during 1997/98 JARPA cruise

- Preliminary report -

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## ABSTRACT

The first application of the XCTD (eXpendable CTD) oceanographic survey was successfully conducted in the Antarctic Areas III East and IV (longitudinal 35 ° -130 ° E) during 1997/98-JARPA whale sighting survey by *Kyosin-Maru No.2* (KS2). Total of 93 profile (0-1,000 meter) data were collected during this whale sighting survey in the Antarctic south of 60 ° S through 17th December 1997 to 11th March 1998 (Fig.1). As a result, the southern boundary of the Antarctic Circumpolar Current (ACC) appeared to 63 ° - 64 ° S from off shore of the Enderby Land (50 ° E) to of the Wilks Land (130E), and there was the large meander that seemed going up north along the continent rise to 61 ° S (i.e. between 80 ° and 100 ° E). The concentrations of humpback (*Megaptera novaeangliae*) and southern bottlenose (*Hyperoodon planifrons*) whales were clearly linked to the meander of the southern boundary of the ACC, especially between 80 ° and 100 ° E. Further analyses are required to quantify the relationship between whale distributions and water masses.

## INTRODUCTION

The Japanese Whale Research Programme under Special Permit in the Antarctic (JARPA) had conducted in eastern part of Area III (longitudinal 35 ° – 70 ° E) and Area IV (70 ° – 130 ° E) in 1997/98 season (Ishikawa *et al.*, 1998). The research vessel KS2 conducted the line transect sighting survey and some experiments (photo-ID, biopsy sampling, XCTD) during cruise. In previous JARPA cruise, we usually conducted the XBT (depth, water temperature) system from 1989/90 to

1996/97 season (Naganobu, 1995). In order to investigate more of the oceanographic condition and save the oceanographic survey hours during whale sighting survey, it was recommended that using XCTD system instead of XBT (Shimada *et al.*, 1997). This was the first attempt to use this system in the JARPA cruises. This paper analyzes the oceanographic condition and examines the relationship between southern boundary of the ACC and distribution of principal sighted whales in the research area.

## MATERIAL AND METHOD

### Research area and research period

The research area was composed of the eastern part of Area III (Area III E, 35 ° - 70 ° E) and the entire Area IV (70 ° - 130 ° E) south of 60 ° S to ice-edge line (Fig.1). The research period of the XCTD oceanographic survey was from 17th December 1997 to 11th March 1998. Area III E was surveyed once before and once after the survey of Area IV.

### Cruise track line, research vessel and sighting procedure

Cruise track line of this survey was shown in Fig.1. Construction of the cruise track line was same as the previous JARPA cruises (Nishiwaki *et al.*, 1997a) which similar to the line transect procedure as used for IWC-SOWER cruises. The research vessel, *Kyoshin-maru No.2* (KS2: 361.00 GT) was dedicated to the sighting survey, using closing and passing mode at research speed of 11.5 knot. The KS2 was operated under optimal research weather conditions (when the wind speed was below 25 knot near the ice-edge or 20 knot in the off shore and visibility was over 2 n. miles).

### XCTD operation

The KS2 conducted XCTD oceanographic survey using probes enable covered from the surface to 1,000 meter in the water depth (Mizuno and Watanabe, 1998) during searching effort (usually vessel was steaming at 11.5 knot). The XCTD stations were set along the track line which continuously from northern strata to southern strata. Stations also were set every one degree latitude in the northern strata and every 10 minutes latitude in the southern strata in order to allow a even coverage of the major water-mass properties. Total 93 XCTD profiles were measured in the research area (Fig.1).

### Data handling

The profile data were processed removing the part of the sea surface (0-10 m) and sea bottom data. All profile data divided into seven transects which considered by each location and period. Each

seven profiles were processed for sectioned drawings of temperature and salinity. Temperature–Salinity diagrams of each transect considered by each location and period.

## RESULT AND DISCUSSION

### Thermohaline Structure

In order to get the large-scale oceanographic condition; the seven meridional temperature and salinity sections were constructed as shown in Fig. 2. In the every section, the temperature minimum structure is commonly observed in the surface layer. The subsurface temperature minimum layer is thicker and colder in the coastal area. There is obvious subsurface temperature front in the coastal side on several sections. The Antarctic Circumpolar Water exists in the north of the front. The front indicates the southern boundary of the Antarctic Circumpolar Current (ACC).

### Meandering of the Southern boundary of the ACC

The southern boundary of the ACC was detected from each meridional section and the map of dynamic height. The large-scale meandering of the boundary was found. The southern boundary of the ACC appears to 63 ° -64 ° S from off the Enderby Land (50 ° E) to off the Wilks Land (130 ° E) and there is the large meander that seems going up north along the continent rise to 61 ° S between 80 ° and 100 ° E (Fig. 3). The high productivity of the waters around the Antarctic continent has been linked to the southern boundary of the ACC (Tynan, 1988), and the BROKE, Australian Antarctic survey, indicated the possibility of the occurrence of the large-scale upwelling between 80 ° and 100 ° E (Thiele and Gill, in press).

### Relationship between southern boundary of the ACC and whale distributions

Humpback and southern bottlenose whales tended to be concentrated in the meander of the southern boundary of the ACC (i.e. between 80 ° and 100 ° E) and were widely dispersed other part of research area (Fig.4a and 4b). Sperm whales also tend to be more or less abundant in the meander (Fig.4c). On the other hand, minke whales tended to distribute south of the southern boundary of the ACC, especially near ice-edge line (Fig.4d). Similar distribution patterns of these spices between 80 ° and 100 ° E were also observed in previous JARPA cruises (Nishiwaki *et al.*, 1997b).

The distribution patterns of the whales suggests abundant occurrence of krill and squid in the meander of the southern boundary of the ACC. It is therefore suggested both krill ecosystem and squid ecosystem may be developed in the meander of the southern boundary of the ACC.

The continuations of the XCTD oceanographic surveys and further analyses are recommended to elucidate the relationship between the distribution patterns of whales and their circumstance.

## ACKNOWLEDGEMENTS

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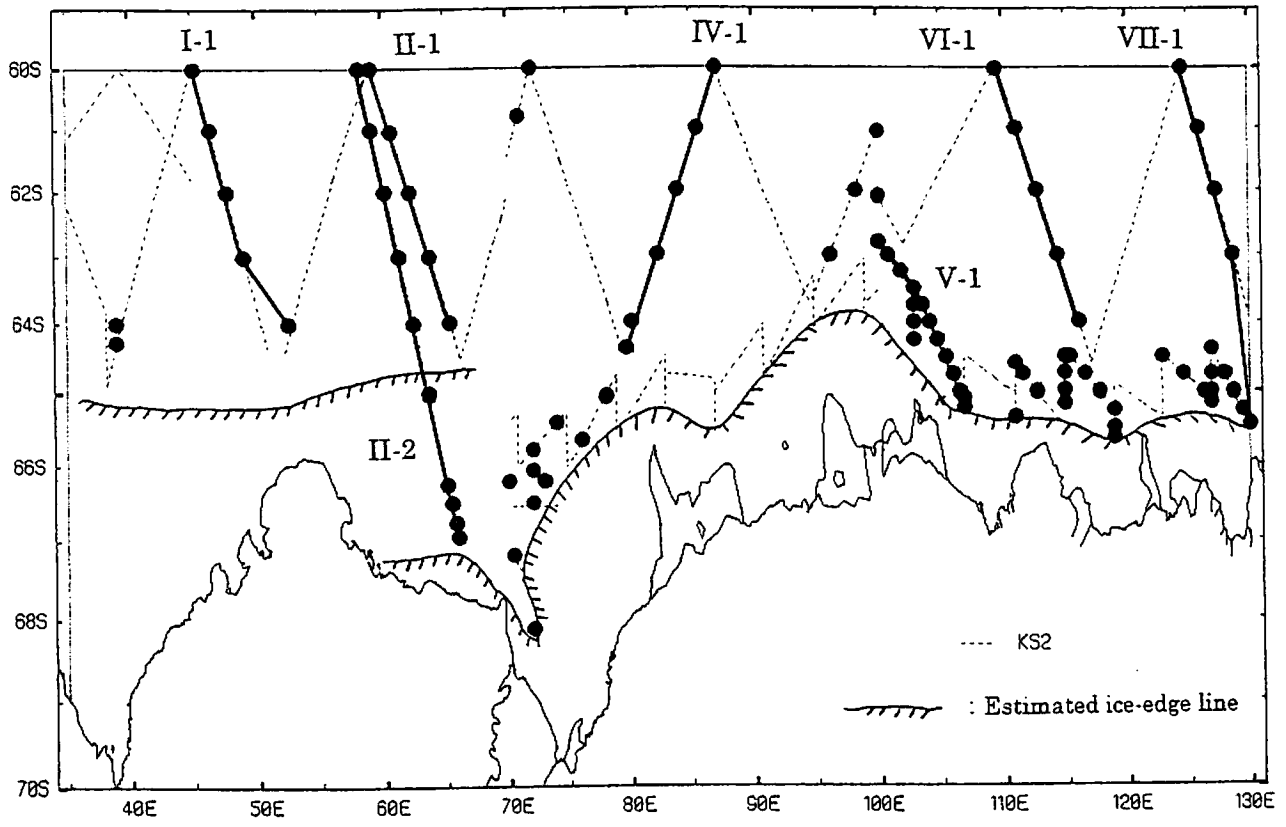



Fig.1. Cruise track, XCTD stations and each transects in 1997/98 JARPA by the *Kyosin-Maru No.2*.

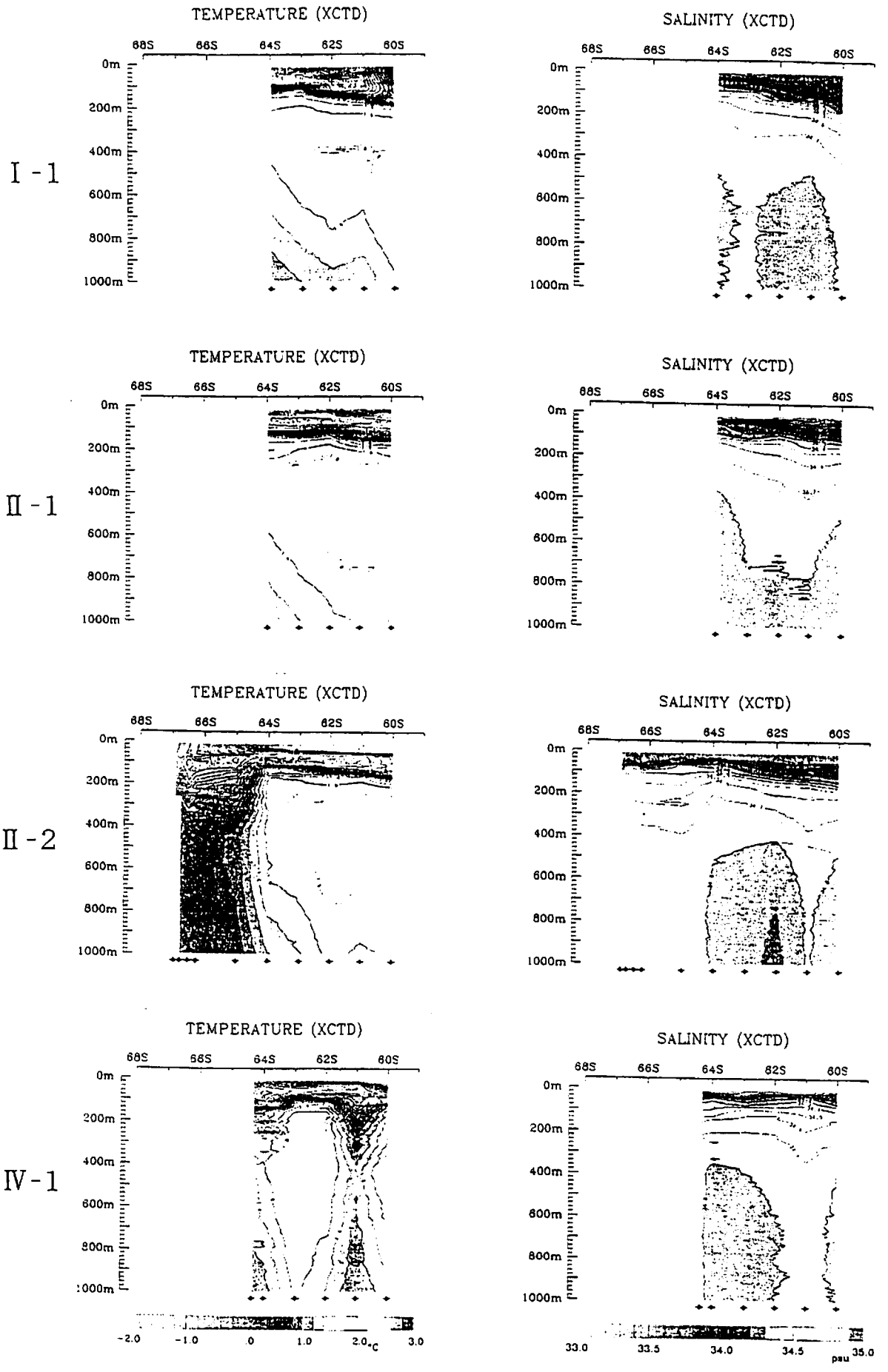



Fig.2. Meridional temperature and salinity sections of each transect I-1 to VII-1.

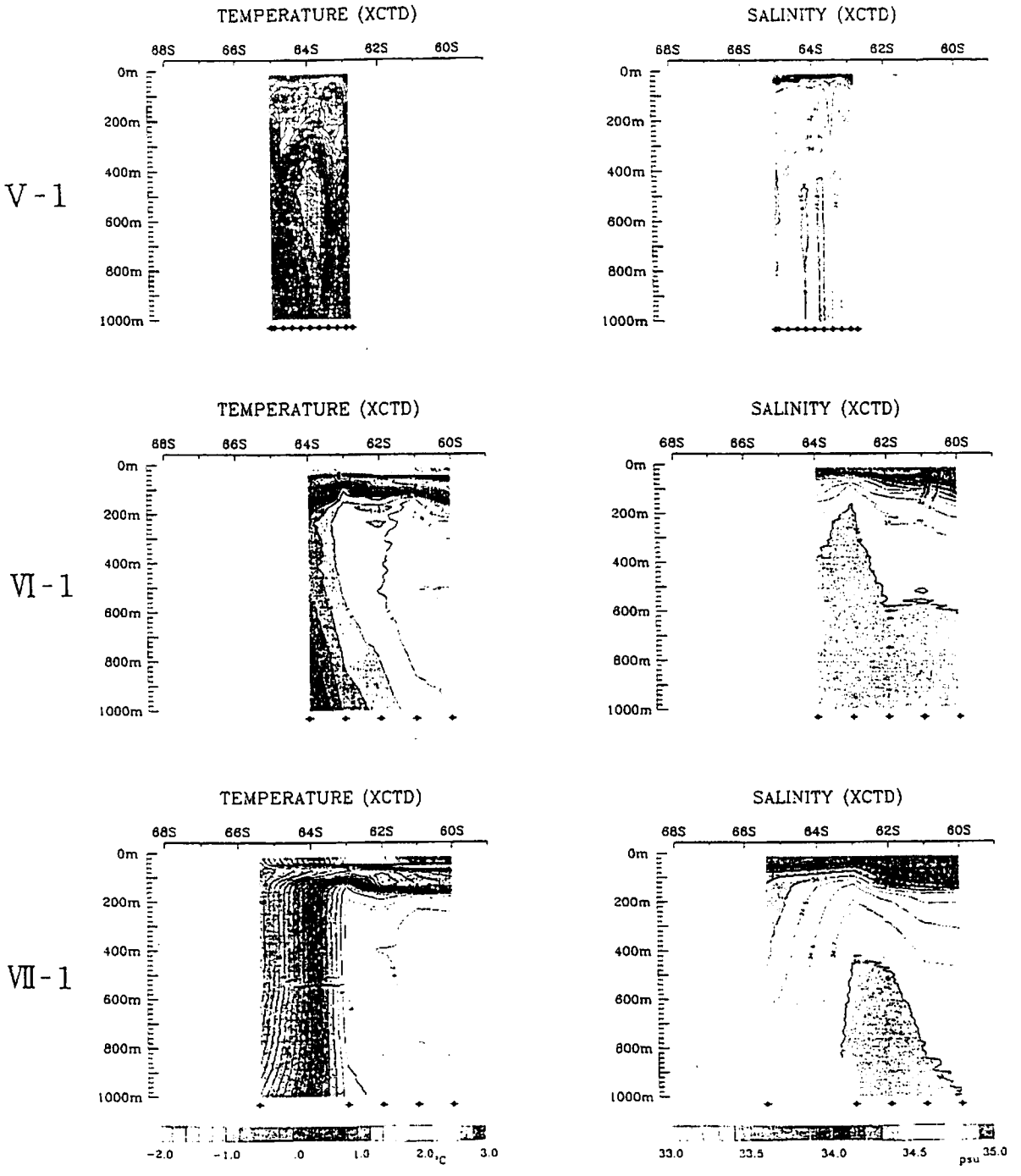



Fig.2. (Continued)

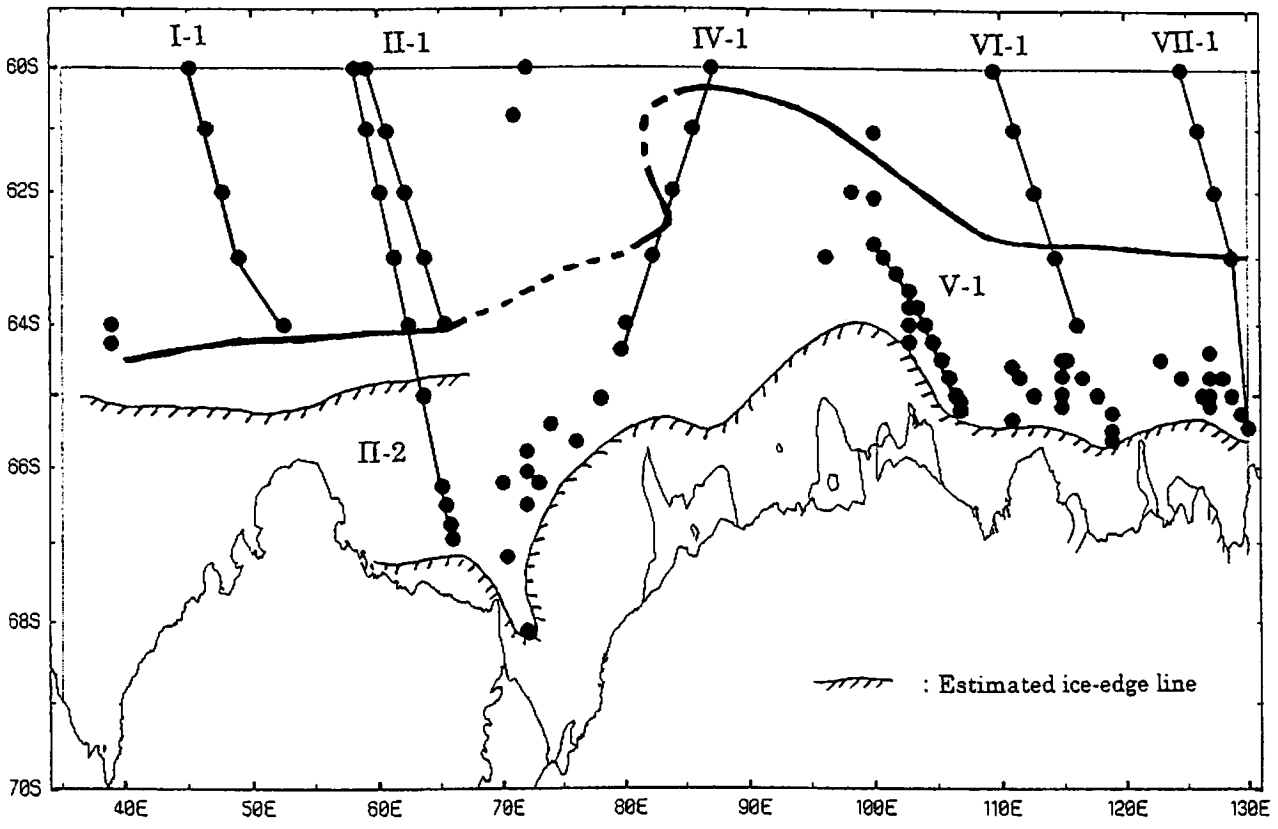



Fig.3 XCTD stations and each transects I-1 to VII-1.
A solid line is estimated southern boundary of the ACC.

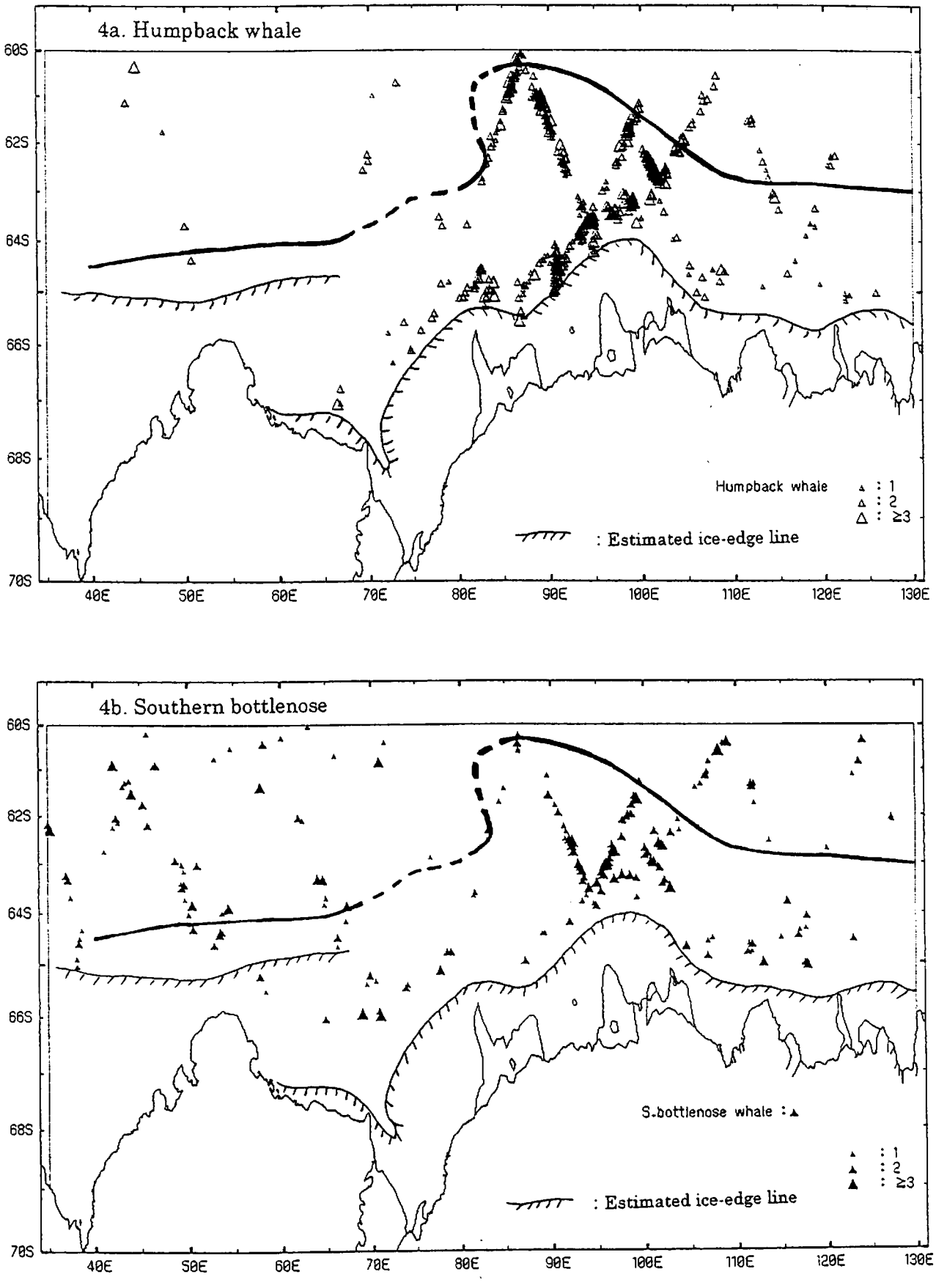
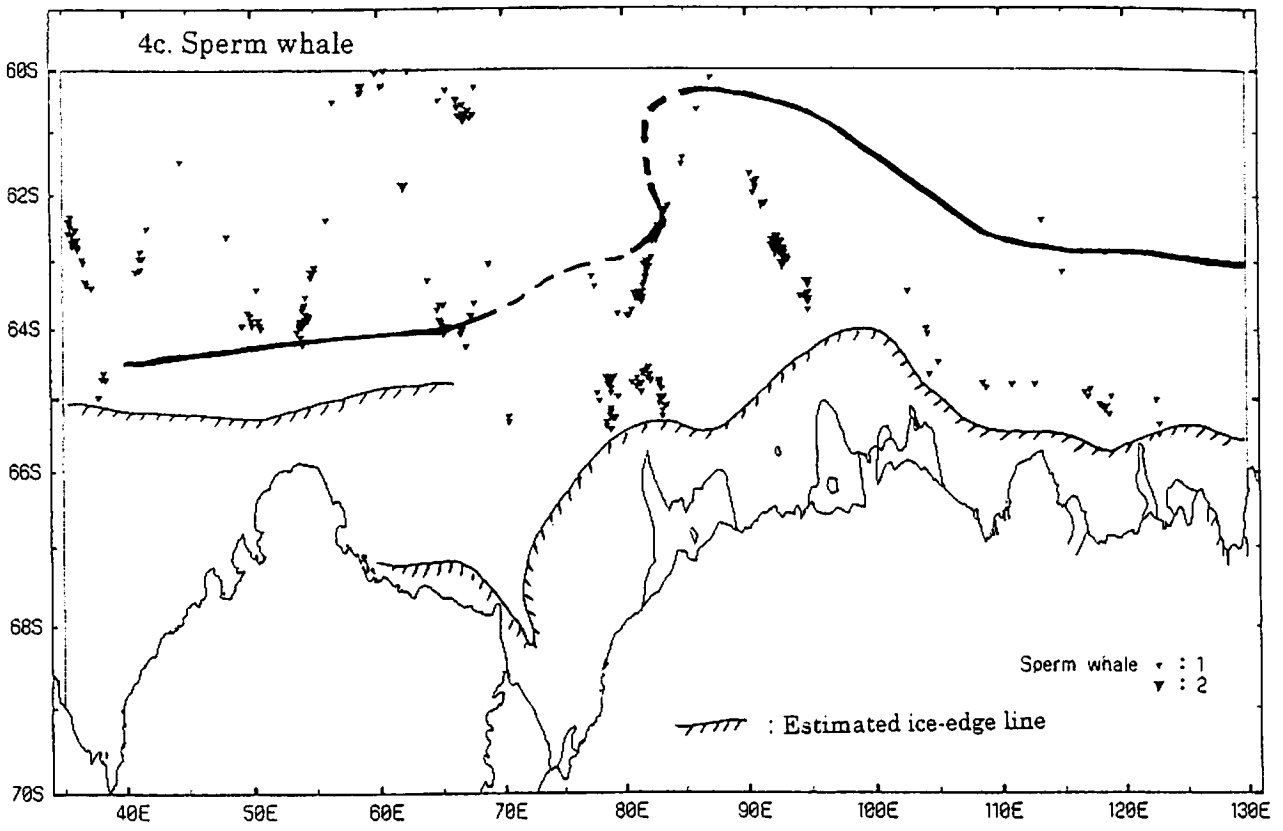



Fig.4 Sighting positions of whales in 1997/98 JARPA.
A solid line is estimated southern boundary of the ACC.



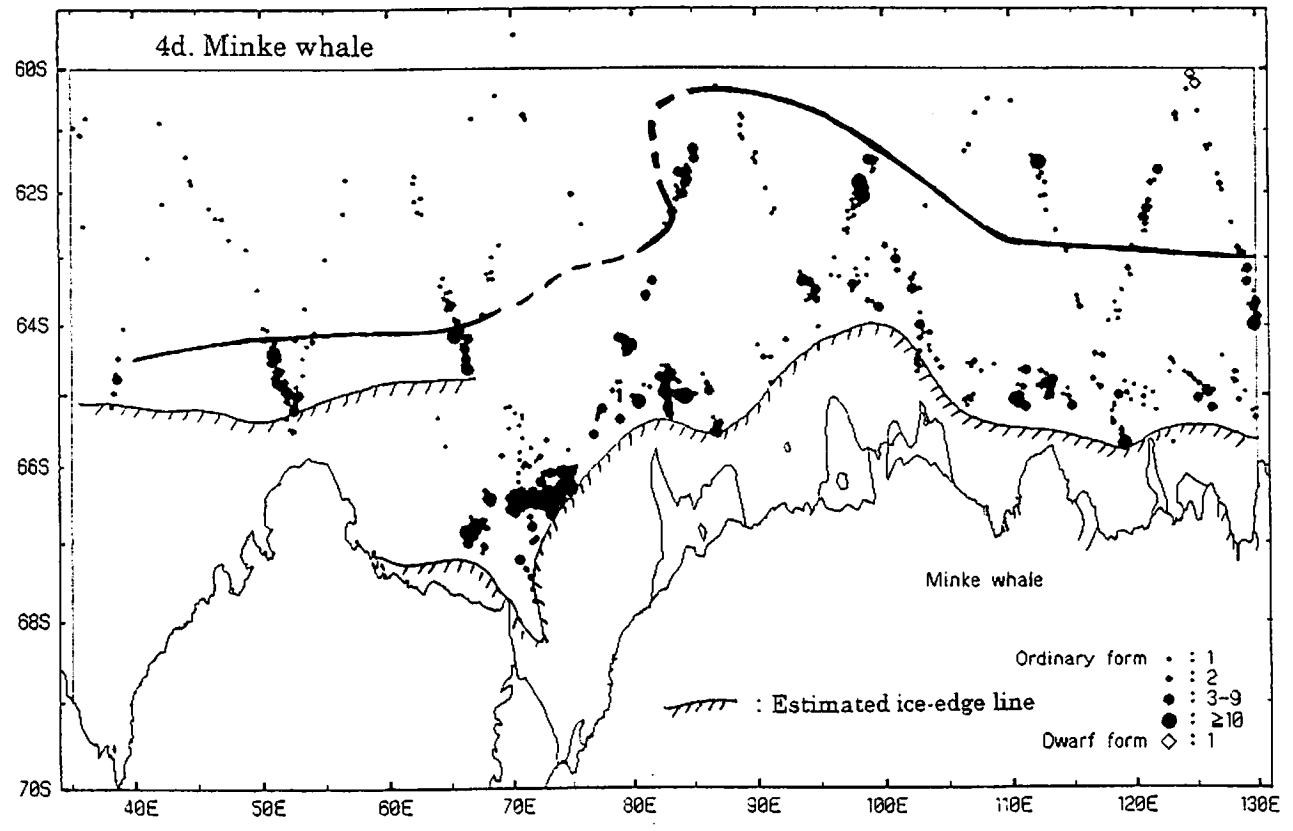




Fig.4. (Continued)