Report of the 1994/95 Cruise of the Japanese Whale Research Programme Under Special Permit (JARPA) in the Antarctic Area V

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ABSTRACT

The eighth cruise of the Japanese whale research programme under special permit in the Antarctic (JARPA) was carried out in the Antarctic Area V from 3 December 1994 to 21 March 1995. The Research Fleet was organized by one research base vessel and three sighting/sampling vessels, one of which is solely dedicated to sighting surveys. The research conducted in both the entire research area and the Special Monitoring Zone (SMZ). The latter was conducted twice in the same stratum (60°S-69°S, 165°E-170°W) before and after the entire research. One dedicated sighting vessel (SV) which was exclusively engaged in whale sighting survey in all the research areas along the independent sighting track line. Two sighting/sampling vessels (SSVs) had two track lines for sightings with sampling activity. These three vessels surveyed a total distance of 14,038.6 n.miles. 823 primary (2,453 animals) and 266 secondary (566 animals) sightings of ordinary form minke schools were recorded. One whale was taken randomly from a primary sighted school of ordinary form minke whales. From 412 schools (965 animals) primarily sighted by the SSVs, 330 whales (200 males and 130 females) were sampled. The ratio of males was higher than females with the exception in the East-South stratum where female sex ratio was high. There were two peaks in the body length distributions of both sexes. Minke whales were the most dominant in all research areas. Blue, humpback, fin, and ziphiid whales increased markedly from the previous years. A school of the spectacled porpoise was found near pack ice (63°43.8'S, 134°34.1'E).

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INTRODUCTION

Japan has been conducting a research of whale resources every year in the Antarctic under the a long-term scientific programme of JARPA since 1987/88 season in compliance with Article VIII of the International Convention for the Regulation of Whaling. The Government of Japan submitted to the 46th IWC Scientific Committee the research plan in the 1994/95 season (SC/46/SH16). The Commission meeting was held at which Resolution on Special permit by Jäpan in the Southern Hemisphere (IWC/46/50) was adopted with some comments received from the members (IWC/46/4). In addition, two other resolutions and an amendment to the Schedule which are relevant to the Japanese research were adopted (IWC/46/53, IWC/46/57, IWC/46/58). Considering the adopted schedule amendment and the resolutions, the research plan in 1994/95 was amended in part. (The government of Japan 1994). On the basis of the reconsidered plan, the JARPA research was conducted in 1994/95.

RESEARCH METHODS

A meeting was held in Tokyo on November 1994 to finalize plans for the research cruise with the participation of scientists, researchers who would join the cruise and representatives of the ships' crews. Based on conclusions of the meeting, the survey was conducted and outline of cruise and research method employed is summarized below.

Research fleet

The research base vessel, *Nisshinmaru (NM*; 7,440GT) acted in general matters such as planning of the daily research strategy, setting cruise course, arrangements for SV and SSVs, conducting of oceanographical surveys. The measurements, collection of biological samples and processing of the whale carcasses took place on the deck of NM.

Three research vessels, *Kyomaru No.1 (K01*; 812.08GT), *Toshimaru No.25 (T25*; 739.92GT) and *Toshimaru No.18 (T18*; 758.33GT) engaged in the whale sightings and sampling of minke whales, the natural markings and collection of skin biopsy samples of blue, right and humpback whales. In addition, attachment of the satellite telemetry tag to minke whales, experiments of the distance and angle estimation, and the whale reaction monitoring is planned by three research vessels.

Research area divisions

The research area for sampling of minke whales covered the Area V, south of 60°S between 130°E and 170°W, including all regions of the Ross Sea south of 69°S (Fig. 1). The research in this season consisted of two surveys, those in the entire research area and the special monitoring zone (SMZ) in one part of the entire research area.
Sighting survey is also conducted in the area between 30°S and 60°S on the courses to and from the research area.

a)Entire research area
The research area is divided into the east and west sectors by line of 165°E, and then further is divided into north and south strata. For the West Sector, the North and South strata is separated by a line of 45 n.miles northward from the ice edge line. For the East Sector, The area between 60°S and 69°S is designed as the North strataum, and all the Ross sea region south of 69°S as the South strataum. Consequently, the entire research area is divided into four strata (Fig. 1).

b)Special monitoring zone (SMZ)
The area between 165°E and 170°W is designated as the special monitoring zone. The SMZ is the North strataum of the East Sector(Fig. 1). In case of the ice edge line is situated at north of 69°S, southern boundary of the SMZ is set on the ice edge line.

Sighting and sampling methods
a)Cruise track
In principle, the cruise track in the south strata was set according to that used in the 1991/92 research (Fujise *et al.*,1993a). In the north strata, a zigzag line that is used in the IWC/IDCR research was used both in the SMZ and the entire research area except for the West-South stratum. In this stratum, the track line was zigzagged from north to south at intervals of four degree's longitude.

b)Sighting method
The sighting method was basically in conformance with that is used in the IWC/IDCR research. The detailed information about this method is available in the previous cruise reports (Kato *et al.*, 1989, 1990: Fujise *et al.*, 1990, 1993a, 1993b: Kasamatsu *et al.*, 1993).

One SV is deployed on whole research area. Two SSVs had a main course and sub-course of track lines. The main course was the same as the course for the SV. The sub-course is drawn parallel to the main course which is 12 n.miles apart from it. Each SSV are deployed either a main course or sub-course, alternatively. The functions of these three vessels were switched from exclusive sighting to sighting/sampling or vice versa when the survey shifted from one stratum to another in order to assure the independent nature of the SV.

Whale schools (minke whales for sampling and blue, humpback and right whales for natural marking) are approached by the research vessels in a closing mode, only when the animals were primarily sighted with the range of 3 n. miles from the track line.

c)Sampling method
The sampling method was the same as in the 1992/93 research (Fujise *et al.* 1993a). One ordinary form minke whale was sampled randomly from a primarily sighted school. Dwarf form minke whales were found, but not sampled.

Biological research of sampled whales

Sampled whales are towed by sampling vessels to the research base vessel (*NM*) as quickly as possible to obtain a wide range of biological data and materials, including genetics, morphology, reproductive status, age, food and environmental chemistry. The measurement and collection of specimen are conducted according to the manual of biological research for the JARPA.

The trajectory of harpoons fired into the sampled animals are studied, and visual autopsies were carried out to improve the method of humane killing. Accompanying with the study of humane killing, blood sampling on the deck of the *NM* and *T18* is carried out for the analysis of serum chemistry.

Experiments

a)Distance and angle estimation experiment

This experiment was conducted to help adjustment and correction of sighting data for the abundance analysis by evaluating the accuracy of sighting distance and angle estimates. The method used was the same as that of the IWC/IDCR research. A buoy was set and then sighting staff on the moving vessel estimated the distance and angle from the vessel to the buoy. Radar is simultaneously used to detect the position of the buoy.

b)Reaction monitoring experiment

This experiment was planned in order to assess the effects on the behavior of whales by the sampling activity of the SSVs. It is designed to be conducted three times in two days in areas where the density of minke whales was high.

c)Experiment for the assessment of the effect on whales' behavior by the use of a sonic device

A sonic device is expected to use to the abundance estimation of krill in future. This experiment was planned in order to assess the effect of the device on the behavior of whales.

d)Natural marking

Blue, humpback and right whales were photographed by the SV for natural marking. The SV took photographs of these whales only when they were sighted within 3 n. miles from the track line.

e)Skin biopsy sampling

Blue, humpback and right whales which are sighted and photographed by SV is subjected to biopsy skin sampling.

f)Observation of the behavior of blue whales

The SV engaged in observing various behaviors of blue whales on the feeding grounds. Attention was paid to the diving time.

g)Observation of the behavior of beaked whales

Beaked whales such as Southern bottlenose whale, Arnoux's beaked whale and *Mesoplodon* species were paid close attention in order to assess the possibility of research take in future. They were observed for the species identification and survey of their reactions to approaching vessels.

h)Satellite telemetry tagging for minke whales
Attachment of a satellite telemetry tag to the whale body was tried on swimming minke whales.

i)Marine debris
The research fleet engaged in the survey of marine debris observation in the research area. When the stomach content of minke whale was examined, the presence of artificial materials was checked.

j)Oceanographical surveys
Oceanographical surveys with XBT were carried out on board of *NM* once a day at a discretionary point within the research area. In addition, *NM* was engaged in taking samples of air and sea water during the cruise as part of the Fisheries Agency's (Department of Research, Fishing Ground Environment Conservation Division) Global Environment Monitoring Scheme that utilizes fishing boats.

RESULTS

Sighting surveys
a)Survey period and main activities
Sighting and sampling activities were carried out in the Antarctic Area V for 109 days from 3 December 1994 to 21 March 1995. The following is the detailed description of the survey period in each stratum and allotment of duties of three sighting and sampling vessels. Research fleet encountered an obstructing vessel offshore Cape of Adare at 9 day February. An obstructing vessel declared oneself against sampling activity in the research area, and pursued to obstruct on research fleet. The research itinerary of East-South stratum and the third SMZ were changed a part to evade the obstructing vessel.

		K01	T25	T18
The first SMZ				
East-North Stratum	3 - 17 Dec. 1994	SSV	SSV	SV
The entire research area				
West-South Stratum	18 Dec. 1994 - 3 Jan. 1995	SV	SSV	SSV
West-North Stratum	4 - 19 Jan. 1995	SSV	SV	SSV
East-North Stratum (The second SMZ)	20 Jan. - 5 Feb. 1995	SV	SSV	SSV*
East-South Stratum	8 Feb. - 9 Feb. 1995	SSV	SSV	*
	15 Feb. -22 Feb. 1995	-	SV	-
	23 Feb. -28 Feb. 1995	SSV	SSV	**
	1 - 3 Mar. 1995	SSV	SV	SSV
	4 - 11 Mar. 1995	SSV	SSV	**
	11 - 14 Mar. 1995	SV	SV	SV
The third SMZ				
East-North Stratum	13 - 14 Feb. 1995	SSV	SV	SSV
	15 - 18 Feb. 1995	SSV	-	SSV
	15 - 21 Mar. 1995	SV	SV	SV

* : This vessel transported an injured person to Wellington during this research period.
**: This vessel was not able to conduct research due to the unexpected harassment from an obstructing vessel during the period of 23 February to 11 March.

Sampling activity was completed on 11 March 1995 in the East-South Stratum during the entire research period. The number of sampled animals was total of 330 minke whales. Following the completion of the sampling activities, three vessels engaged in sighting in the East-South Stratum until 14 March, and then moved to the North-East Stratum (the third SMZ). These vessels were also engaged in several experiments (attachment of satellite telemetry tag to minke whales by *KOI*, natural marking and Biopsy sampling, observation of whale behavior, *etc.*).

b)Cruise track
Fig.2 shows the main research courses in research areas. The ice edge within the West-South stratum was located near 63°S from 150°E to 165°E and it was remarkably norther than that in the 1992/93 research (Fujise *et al.*, 1993a). The research track-line was designed by the ice edge information from the US Navy-NOAA Joint Ice Center (JIC). According to the ice edge information, the south boundary in plan of the West-North Stratum between 150°E and 165°E situated more southward than the North boundary of the West-South Stratum. In case of the ice edge line situated north of 69°S, southern boundary of the SMZ was set on the ice edge line.

c)Searching effort
The searching distance (n. miles) of a SV and two SSVs in each research area is shown in Table 1. The total searching distance of the SV and SSVs was 14,038.6 n.miles. This is 546.3 n.miles longer than those in the 1992/93 (Fujise *et al.*, 1993b). This cruise was planned to increase the effort of SV in the entire research area by extending the research period from 66 days to 77 days and by shortening the minimum proceeding distance from the previous 140 n.miles to 120 n.miles. These amendments were expected to increase the sighting effort by 23%, as the total sighting distance will be increased from the previous 3,671 n.miles to 4,544 n.miles. However, total searching distance of the SV in the entire research area was 3,641.1 n.miles in practice by decrease research days by disturbance of an obstructing vessel.

d)Cetacean species sighted
Table 2 shows the number of schools and animals sighted by cetacean species.
Minke whales were the most dominant in all research areas. This accounted for 56.7% of total number of cetacean sighted. Sub-dominant species such as humpback, fin, sperm, and beaked whales accounted for 26.8% of total number of animals. Except sperm whales, the sightings of these sub-dominant species increased markedly than that of the previous researches (Kasamatsu *et al.*, 1993, Fujise *et al.*, 1993b). Compared with sub-

dominant species in the 1992/93 season, it was indicated those 1.0 times in sperm whales, 4.6 times in humpback whales, 5.5 times in the fin whales, and 1.3 times in beaked whales (Fujise *et al.*, 1993b). additionally, thirteen schools (20 individuals) of blue whales were primariiy sighted and four schools (seven individuals) were the secondarily sighted. The sightings in the present research recorded the highest numbers throughout previous researches.

e)Distribution of minke whales

The locations of minke whales which were primarily sighted are shown in Fig. 3. It is noted that minke whales were widely distributed within the entire research area. Except the east half of the West-South Stratum, the pattern of distribution of minke whales was not so different from that was observed in the previous surveys. In this east half of sub-area, 186 schools (772 animals) of minke whale were sighted in the 1992/93 research (Fujise *et al.*, 1993). However, there were not sighting records of minke whales from 160°E to 165°E in the present research. The ice edge within the West-South Stratum was located from 150°E to 165°E and it was remarkably northern than the case of the 1992/93 (Fujise *et al.*, 1993a). This phenomenon indicates that there are some yearly fluctuation in the distribution pattern of minke whale.

In the SMZ, there was no major difference in distribution pattern between different research periods.

Table 3 shows the density indices (DI) which is calculated as the number of minke whale schools primarily sighted per 100 n.miles searched and the mean school size (MSS). When the entire research area was examined, it was indicated that the DI was higher in the south strata than in the north strata and was higher in the east sectors than in the west sectors. However, considerable difference was not observed compared with previous survey, except the DI of the East-South Stratum in which the DI was remarkably high compared with those in previous survey. Mean School Size (MSS) of SV was higher than that of SSV. The combined MSS ranged from 2.96 to 3.51, except that of 1.72 in the East-North Stratum.

As for the DI in the SMZ, it was higher in the second period than other periods. The MSS was not observed large difference among research periods.

f)Distribution of other whales than minke whales

Figs. 4, 5 and 6 show the distribution of baleen, sperm and zhiphiid whales, respectively, which were the primarily sighted. Humpback and fin whales (Fig. 4) were widely distributed in the entire research area. However, those were not observed in south of 70°30'S in the East-South stratum. In addition, in West sector these whales were sighted more in the south stratum than in the north stratum. In East sector they were sighted more in the north stratum than in the south stratum. The pattern of distribution of those whales was considerably different in the previous surveys (Kasamatsu *et al.*, 1993, Fujise *et al.*, 1993a) As for blue whales (Fig. 4), the pattern of distribution was not considerably different from that was observed in the previous

surveys. However, sightings of blue whales concentrated in the West-South stratum.

Toothed whales such as sperm (Fig. 5) the Southern bottlenose and other beaked whales (Fig. 6) were similar to the pattern of distribution of the minke whales. However, they were not observed in south of 70°30'S in the East-South Stratum (Ross Sea).

As for the uncommon sightings of cetacean species in the Antarctic, a spectacled porpoise was observed near pack ice (63°43.8'S, 134°34.1'E).

Sampling

a)Sampling activities and samples

It was designed in principle that all minke whale schools which were primarily sighted within 3 n. miles on both sides of the track line were subjected to sampling. However, in order to avoid an excessive burden on the research base vessel and to balance the number of samples among different strata, samples were not taken from 26 schools in total. Sampling activities were completed in the East-South Stratum on 11 March 1995. Total of 330 minke whales was sampled. Fig. 7 shows the locations where the sampled whales were sighted. The number of samples in each stratum is as follows:

Survey	Stratum	Males	Females	Total
1st.SMZ	East-North	6	7	13
The entire research area				
	West-South	71	14	85
	West-North	42	13	55
	East-North*	43	14	57
	East-South	27	81	108
3rd.SMZ	East-North	11	1	12
Total		200	130	330

*:Second SMZ

b)Sampling efficiency

The sampling efficiency of minke whales in each stratum is shown in Table 4. A and B show the total number of schools and individuals which were primarily sighted by the SSVs, respectively. C and D show the number of animals tried for sampling and of samples actually collected, respectively.

The sampling efficiency I (D/B) shows the ratio of samples actually taken from the primary sightings. The value is small in the East Sector and the West-South Stratum where the mean school size is large. The sampling efficiency I was 0.33 in average, and this was higher than 0.29 in average for the entire research area in 1992/93 (Fujise *et al.*, 1993b). The sampling efficiency II (D/C) shows the ratio of samples actually collected from the targeted animals for sampling. This value indicates technical efficiency or success rates of sampling. In the East strata, value ranged from 0.81 to 0.86, while it was from 0.93 to 0.95 in

the West strata. During the term of research in the SMZ, value was relatively small ranged from 0.46 to 0.65, except 0.86 in the second SMZ. These low values were caused by the encounter of bad sea condition. The sampling efficiency II was 0.85 in average. This was almost the same as that of the 1992/93 (Fujise *et al.*, 1993b).

Out of targeted animals, 59 could not be taken. Sight was lost before estimation of body length in case of 10 animals, while sampling was intentionally canceled on 6 animals in order to avoid bad weather, an excessive burden on the base vessel and to balance the number of samples between different strata. Thirty-seven animals were missed, because they were swimming too fast or diving too long or too quick running. Remaining 6 animals were missed for technical reasons.

Biological data and sample collection

The number of samples on each research item of the biological investigation is shown in Table 5. All the sample whales were subjected to the biological investigation aboard the research base vessel. They were processed after the investigation was completed. Among 330 samples males were 200 and females were 130. In addition, 72 fetuses (including 2 pairs of twins) were collected from 70 pregnant females. As for in -vitro fertilization, 11 samples of live sperm, one sample of live oocyte, 8 serum samples from males, 2 fetal serum samples were collected. Blood samples were collected on the deck of the *NM* and *T18*. Those were immediately analyzed serum chemistry in the laboratory of the *NM*.

One of the objectives of the present research was to compare the biological data of ordinary form minke whales to that of dwarf form minke whales which were collected in the past. Thus, 3 males and 3 females were subjected to a detailed examination. The skulls of the ordinal form minke whales were taken for craniometric study.

Experiments

a)Distance and angle estimation experiment

Three sighting and sampling vessels carried out the distance and angle estimation experiment during the entire research period after rehearsed. *K01* conducted the experiment on 3 January 1995, *T25* and *T18* on 15 January, respectively. Six top men and seven persons on the upper bridge engaged in the experiment. They estimated distances and angles to the buoy from the positions of eight different combinations of distances and angles. A total of 168 different experiments were conducted by the three vessels with the participation of 312 crew members in the total number.

b)Reaction monitoring experiment

The experiment was planned to be conducted in the East-South Stratum, where a large number of minke whales were sighted in the 1992/93 (Fujise *et al.*, 1993b). However, the experiment was canceled by obstruction of research by a vessel.

c)Natural markings
11 blue whales from 7 schools (12 animals), 34 humpback whales from 22 schools (40 animals) were photographed (Table 6).

d)Biopsy sampling
17 skin biopsy samples were collected from 16 schools (31 animals) of the humpback whale and 4 samples were collected from 5 schools (9 animals) of the blue whale (Table 7).
Additionally, the biopsy skin samplings from the minke whale were attempted in the East-South Stratum during the entire research period after finishing the sampling activity. Taking the difficulty of biopsy in minke whales into account, large size schools were chosen, and consequently, 8 skin biopsy samples were collected from 11 schools (61 animals) of the ordinary minke whale (Table 7).

e)Observation of the behavior of blue whales
This experiment was conducted by the same guidelines as for the dive time experiment on IWC/IDCR, and two schools (5 animals) of the blue whale in the West-South Stratum were observed. All surfacing cues were counted in these cases.

In the first trial, one blue whale was observed for 39 minutes. Surfacing cues were counted 35 times for 17 minutes by the blow. A surfacing time during which a cue was supplied 29.1 second in the average. The diving time ranged from 1 to 6 minutes and 2.9 minutes in average. The traveling distance during the experimental period was 4.4 n.miles.

As for the second trial, four blue whales of one school were observed for 38 minutes. Surfacing cues were counted 134 times for 27 minutes by blow. A surfacing time during which a cue was supplied 12.1 second on the average. The diving time ranged from 1 to 2 minutes and 1.4 minutes in average. The traveling distance during the experimental time was 5.4 n.miles.

f)Observation of the behavior of beaked whales
Nineteen schools (51 animals) of beaked whales were sighted and approached for the observation of their behaviors. 13 schools (32 animals) of the southern bottlenose whale and 1 school (10 animals) of the Gray's beaked whale was identified. The remaining 5 schools (9 animals) were unidentified their species (Table 8).

The observation was carried out for 902 minutes in total. One session of the observation was from 30 to 58 minutes. The sights of 4 schools were lost within 30 minutes of observation. No cue was found after first cue in the case of 4 schools. Two schools were re-sighted once, while 9 schools were re-sighted twice to four times. The shortest approaching distances to these schools were 0.1 to 0.6 n.miles except a case of the southern bottlenose whale (available shooting distance of below 0.03 n. miles). The shortest distance was 0.15 n.miles on the gray's beaked whale and 0.5 to 1.0 n.miles the unidentified beaked whales.

The diving time ranged from 2 to 28 minutes and 11.6 minutes average, excluding case of long dives from 34 to 37 minutes (These indicates a possibility to be confused with other sight-

ings). The average diving time on 13 schools of the southern bottlenose whale was 10.0 minutes. A surfacing time during which a cue was supplied was 2.8 minutes on the average of all the schools under observation. It was 3.9 minutes in case of the southern bottlenose whale.

The traveling distances during one dive were 0.01 to 2.0 n. miles, averaging out at 0.65 n. miles.

During the experiment, 3 schools (11 animals) of the southern bottlenose whale approached accidentally to available shooting distance. Most of beaked whales seemed to difficult to catch as mentioned above.

g)Attachment of a satellite telemetry tag to minke whales

This experiment was planned to be carried out at the high density area of minke whale after sampling activity. However, there was no chance to conduct this experiment during the present research.

h)Assessment of the effect on behavior of whales by use of sonic device

This experiment was planned to be carried out, in addition to the reaction monitoring experiment in the areas where minke whales were expected to be abundant. However, there was no chance to conduct this experiment during the present research.

i)Marine debris and floating whale caracass

A marine debris recording was conducted concurrently during the present research (Table 9). Debris was not recorded from the stomach contents of the whales sampled.

A sperm whale carcass was seen floating at 65°19.9'S and 177°31.9'E on 8 December 1994. An Arnoux's beaked whale carcass was seen floating at 64°58.2'S and 143°42.5'E on 30 December 1994.

j)Oceanographical surveys

The XBT observation was made at 93 locations from 3 December 1994 to 21 March 1995 by the *NM* (Fig 8).

Meteorological data such as weather conditions, wind direction, wind speed, atmospheric pressure, surface water temperatures were recorded.

In addition, NM was engaged in taking 10 samples of both air and sea water and taking 8 samples of microsubstances in sea water by the use of a filter at discretionary points of the research area.

k)Products

After the biological survey was completed, whale products were produced according to the provisions of Article VIII of the convention. All of 330 whales sampled were processed to produce 1,340 tons of frozen products and 18 tons of whale oil (Table 10).

PRELIMINARY ANALYSIS OF SAMPLES TAKEN

Body length

Table 11 shows the mean body length and the range of body length by strata and by maturity.

Fig.10 compares this year's body length compositions with those in 1992/93. Although no major difference between the two researches, present research shows that both males and females less than 7m in length were collected more than previous research. As for the mean body length, both males and females were shorter than those of 1992/93 research (Fujise *et al.*, 1993b), resulting from a large number of immature whales. There were two peaks in the body length distribution with mean body length of 7.47m in males and 7.60 m in females (Table 11).

Maturity rates

On the female, the existence of corpus luteum or corpus albicans in the ovaries, the width of uterin horn and developmental levels of the mammary glands were examined, and then samples were categorized as follows: 1) immature, 2) ovulating (existence of corpus luteum and no existence of fetus), 3) resting (existence of corpus albicans, no existence of corpus luteum and no location), 4) pregnant, 5) lactation, 6) pregnant and lactation, 7) unidentified mature.

On the male, determination of maturity should be made by the histological observation of the testis and epididymis. However, such observation was not completed yet and thus samples were categorized as the mature male when either of the testis is larger than 400g (Ohsumi *et al.*, 1970: Kato, 1986). Table 12 shows the maturity status of the sampled whales. The ratio of samples categorized by their maturity status is as follows: mature male 78.5%, immature male 21.5%, pregnant female 52.3% (including simultaneous lactation), ovulating 0.8%, resting 13.8 % and immature female 33.1%.

In the entire research area, sex ratios of males, were from 75.4 to 83.5% except 25% in the East-South Stratum. The ratio of matured animal in the male ranged from 62.8 to 91.5%. As for the ratio of reproductive status of females, mature females were high in the south strata, and immature females were high in the north strata. In the East-South Stratum, mature females were high in ratios, and it was noted that resting females were 21%.

In comparison among three SMZ surveys, the ratio of males increased with the research season (the first: 46.2%, the second: 75.4%, the third: 91.7%). However, no significant changes of the maturity rate of the males were observed (the first: 66.7%, the second: 62.8%, the third: 62.8%). On the females, such comparisons were not done because of few samples.

Change in thickness of blubber

The seasonal change in average thickness of blubber (they were measured from the three points of the body) of mature whales was examined by the moving average as shown in Fig.10.

The average thickness of blubber was thin in the north strata. However, the average thickness increased as the research progressed. These results was almost the same as that in the 1993/94 research (broken lines in Fig. 10).

DISCUSSION

The ratio of males and immature whales in samples were larger than those in previous research. This was due mainly to increase search efforts in the north strata.
In the present survey, search efforts in the entire research area and the SMZ which was laid in the East-North Stratum were increased by extension of research days. The searching effort by the SSVs in the north strata was 1,000 n.miles longer than that (2321.4 n.miles) in 1992/93 (Fujise *et al.* 1993b). Accompanying with increase of searching effort in northern strata, sampling rates of immature whales and males were larger than previous research.

As sample size of immature whales were more than previous research, two peaks in the body length distribution become more clear than 1992/93 (Fig. 9).

As one of distinctive feature in the present research, it was noted that the pregnancy rate was low in the East-South Stratum. The ratio of pregnant females in this stratum was 60.5% and was the lowest among the previous researches (1990/91: 74.6%, 1992/93: 78.7%). On the other side, the ratio of resting stage females was 21% and was the highest in compared with the previous research (1990/91: 15.5%, 1992/93: 1.6%). These results indicate existence of the yearly fluctuation in pregnancy rate.

Fig. 7 shows the locations of the sampled whales by reproductive conditions. The feature of reproductive conditions changed at nearly 71°S and 72°S in the East-South Stratum. The ratios of Mature whales were more in south of this boundary than the north. Yearly change of pregnancy rate might be caused by the change in size, shape and position of open water in this stratum. On the other hand, the density of humpback, fin, sperm and Ziphiid whales become lower remarkably in the south of this boundary (Figs. 4, 5 and 6). Although the northern boundary of the East-South stratum has been set at 69°S till present research, this boundary should be re-examined in the future researches.

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Table 1. Searching distance (n.miles) by the 'sighting' vessel (SV) and 'sighting/sampling' vessels (SSVs) in each stratum of the research area.

	SV	SSVs	Combined
The first SMZ			
East-North	863.3	1,920.0	2,783.3
The entire research area			
West-South	886.5	1,583.9	2,470.4
West-North	1,166.8	2,060.1	3,226.9
East-North (The second SMZ)	983.5	1,567.0	2,550.5
East-South (Ross-Sea)	685.6	604.3	1,289.9
The third SMZ			
East-North	934.2	783.4	1,717.6
Total	5,519.9	8,518.7	14,038.6

Table 2a. Summary of sightings (no. schools/no. individuals) conducted by the 'sighting' vessel (SV) and the two 'sighting/sampling' vessels (SSVs) in the first and third special monitoring zone (SMZ) survey. The second SMZ is equal to the East-North stratum in the entire research survey.

	SV		SSVs		Total	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
The first SMZ						
Minke whale	13/ 16	3/ 3	19/ 20	3/ 3	32/ 36	6/ 6
Dwarf minke whale	1/ 1	0/ 0	0/ 0	2/ 2	1/ 1	2/ 2
Like minke	2/ 2	0/ 0	4/ 4	2/ 2	6/ 6	2/ 2
Blue whale	-	-	1/ 1	0/ 0	1/ 1	0/ 0
Fin whale	2/ 3	0/ 0	3/ 4	0/ 0	5/ 7	0/ 0
Humpback whale	10/ 14	3/ 7	22/ 35	2/ 5	32/ 49	5/ 12
Baleen whales	0/ 0	2/ 3	11/ 14	2/ 3	11/ 14	4/ 6
Sperm whale	9/ 9	3/ 3	11/ 11	2/ 3	20/ 20	5/ 6
S. bottlenose whale	2/ 3	0/ 0	8/ 19	1/ 2	10/ 22	1/ 2
Arnoux's beaked whale	-	-	1/ 10	0/ 0	1/ 10	0/ 0
Gray's beaked whale	1/ 10	0/ 0	-	-	1/ 10	0/ 0
Strap-toothed whale	-	-	1/ 1	0/ 0	1/ 1	0/ 0
Mesoplodon sp.	5/ 20	0/ 0	3/ 7	0/ 0	8/ 27	0/ 0
Ziphiid whales	1/ 2	0/ 0	15/ 27	0/ 0	16/ 29	0/ 0
Killer whale	3/ 33	2/ 13	5/ 18	1/ 6	8/ 51	3/ 19
Hourglass dolphin	-	-	1/ 8	0/ 0	1/ 8	0/ 0
Species unknown	5/ 15	3/ 4	15/ 16	2/ 2	20/ 31	5/ 6
Total	54/128	16/ 33	120/195	17/ 28	174/323	33/ 61

	SV		SSVs		Total	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
The third SMZ						
Minke whale	14/ 30	4/ 11	20/ 26	7/ 10	34/ 56	11/ 21
Like minke	-	-	1/ 1	1/ 1	1/ 1	1/ 1
Fin whale	7/ 23	1/ 4	8/ 20	2/ 6	15/ 43	3/ 10
Sei whale	2/ 5	0/ 0	-	-	2/ 5	0/ 0
Humpback whale	2/ 4	0/ 0	9/ 14	0/ 0	11/ 18	0/ 0
Baleen whales	0/ 0	3/ 4	7/ 8	6/ 7	7/ 8	9/ 11
Sperm whale	3/ 3	0/ 0	7/ 7	0/ 0	10/ 10	0/ 0
S. bottlenose whale	5/ 14	1/ 2	1/ 2	0/ 0	6/ 16	1/ 2
Arnoux's beaked whale	1/ 8	1/ 6	1/ 6	0/ 0	2/ 14	1/ 6
Ziphiid whales	8/ 13	0/ 0	9/ 14	0/ 0	17/ 27	0/ 0
Hourglass dolphin	4/ 18	0/ 0	0/ 0	2/ 5	4/ 18	2/ 5
Species unknown	3/ 4	0/ 0	6/ 6	0/ 0	9/ 10	0/ 0
Total	49/122	10/ 27	69/104	18/ 29	118/226	28/ 56

Table 2b. Summary of sightings (no. schools/no. individuals) conducted by the 'sighting' vessel (SV) and the two 'sighting/sampling' vessels (SSVs) in each stratum of the entire research survey. Enclosed parts of the table represent the second SMZ (East-North stratum).

Species	SV				SSVs			
	West Sector		East Sector		West Sector		East Sector	
	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondar
North stratum								
Minke whale	52/186	8/ 13	24/ 47	17/ 24	58/140	14/ 25	65/106	5/ 10
Dwarf minke whale	-	-	-	-	1/ 1	0/ 0	2/ 2	0/ 0
Like minke whale	6/ 6	1/ 1	1/ 1	3/ 4	6/ 6	1/ 1	2/ 2	0/ 0
Blue whale	-	-	-	-	-	-	-	-
Fin whale	4/ 11	0/ 0	15/ 40	5/ 23	4/ 12	2/ 3	11/ 31	3/ 4
Humpback whale	8/ 15	3/ 7	18/ 33	6/ 10	6/ 10	10/ 17	11/ 25	6/ 13
Baleen whales	2/ 2	1/ 2	0/ 0	19/ 33	4/ 7	0/ 0	10/ 18	4/ 5
Sperm whale	3/ 3	1/ 1	11/ 11	3/ 3	2/ 2	1/ 1	17/ 17	2/ 2
S. bottlenose whale	11/ 16	6/ 8	4/ 7	0/ 0	3/ 5	2/ 4	10/ 23	1/
Arnoux's beaked whale	-	-	-	-	-	-	1/ 15	
Mesoplodon spp.	-	-	1/ 4	0/ 0	1/ 15	1/ 2	1/ 2	0/ 0
Ziphiid whales	2/ 2	2/ 4	22/ 45	3/ 15	15/ 22	1/ 2	24/ 36	2/ 6
Killer whale	2/ 10	0/ 0	-	-	3/ 25	2/ 4	5/ 34	1/ 6
Long-finned pilot whale	0/ 0	1/ 10	-	-	1/ 5	0/ 0	-	-
Hourglass dolphin	1/ 5	1/ 3	1/ 1	0/ 0	1/ 5	0/ 0	2/ 9	3/ 12
Unidentified dolphins	-	-	6/ 29	0/ 0	-	-	2/ 7	0/ 0
Species unknown	1/ 1	0/ 0	13/ 22	0/ 0	13/ 13	0/ 0	23/ 35	1/ 1
South stratum								
Minke whale	97/334	74/131	211/875	61/161*	94/259	33/ 83	156/414	37/ 92
Dwarf minke whale	-	-	-	-	-	-	-	-
Like minke whale	3/ 3	3/ 6	3/ 3	4/ 7	7/ 9	4/ 9	6/ 6	1/ 1
Blue whale	5/ 9	2/ 3	2/ 3	1/ 2	4/ 6	1/ 2	1/ 1	0/ 0
Fin whale	4/ 18	1/ 2	9/ 46	3/ 6	7/ 35	2/ 15	-	-
Humpback whale	15/ 27	5/ 8	2/ 3	2/ 4*	27/ 44	4/ 7	3/ 6	1/ 2
Baleen whales	4/ 5	11/ 19	0/ 0	4/ 4*	16/ 39	1/ 1	1/ 2	2/ 2
Sperm whale	22/ 22	5/ 5	4/ 4	1/ 1*	41/ 43	5/ 8	3/ 3	1/ 1
S. bottlenose whale	10/ 19	1/ 1	2/ 6	0/ 0	18/ 32	3/ 6	-	-
Arnoux's beaked whale	-	-	1/ 8	0/ 0	-	-	0/ 0	1/ 3
Mesoplodon spp.	-	-	-	-	1/ 1	0/ 0	-	-
Ziphiid whales	38/ 57	6/ 12	1/ 1	0/ 0	31/ 38	0/ 0	2/ 6	0/ 0
Killer whale	2/ 13	0/ 0	8/ 57	4/ 31	6/ 76	0/ 0	1/ 15	1/ 5
Long-finned pilot whale	-	-	-	-	-	-	-	
Hourglass dolphin	-	-	0/ 0	1/ 3*	-	-	-	
Spectacled Porpoise	1/ 1	0/ 0	-	-	-	-	-	-
Unidentified dolphins	-	-	-	-	-	-	-	-
Species unknown	8/ 8	1/ 1	6/ 6	0/ 0	27/ 28	1/ 3	1/ 1	0/ 0

*: including secondary sightings in other area by the vessel watching the obstructing vessel

Table 2c. Total sightigs in all research area.

	SV		SSVs		Total	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
Minke whale	411/1488	167/343*	412/965	99/223	823/2453	266/566
Dwarf minke whale	1/ 1	0/ 0	3/ 3	2/ 2	4/ 4	2/ 2
Like minke whale	15/ 15	11/ 18	26/ 28	9/ 14	41/ 43	20/ 32
Blue whale	7/ 12	3/ 5	6/ 8	1/ 2	13/ 20	4/ 7
Fin whale	41/141	10/ 35	33/102	9/ 28	74/243	19/ 63
Sei whale	2/ 5	0/ 0	-	-	2/ 5	0/ 0
Humpback whale	55/ 96	19/ 36*	78/134	23/ 44	133/230	42/ 80
Baleen whales	6/ 7	40/ 65*	49/ 88	15/ 18	55/ 95	55/ 83
Sperm whale	52/ 52	13/ 13*	81/ 83	11/ 15	133/135	24/ 28
S. bottlenose whale	34/ 65	8/ 11	40/ 81	7/ 13	74/146	15/ 24
Arnoux's beaked whale	2/ 16	1/ 6	3/ 31	2/ 13	5/ 47	3/ 19
Gray's beaked whale	1/ 10	0/ 0	-	-	1/ 10	0/ 0
Strap-toothed whale	-	-	1/ 1	0/ 0	1/ 1	0/ 0
Mesoplodon spp.	6/ 24	0/ 0	6/ 25	1/ 2	12/ 49	1/ 2
Ziphiid whales	72/120	11/ 31	96/143	3/ 8	168/263	14/ 39
Killer whale	15/113	6/ 44	20/168	5/ 21	35/281	11/ 65
Long-finned pilot whale	0/ 0	1/ 10	1/ 5	0/ 0	1/ 5	1/ 10
Hourglass dolphin	6/ 24	2/ 6*	4/ 22	5/ 17	10/ 46	7/ 23
Spectacled Porpoise	1/ 1	0/ 0	-	-	1/ 1	0/ 0
Unidentified dolphins	6/ 29	0/ 0	2/ 7	0/ 0	8/ 36	0/ 0
Species unknown	36/ 56	4/ 5	85/ 99	4/ 6	121/155	8/ 11
	769/2275	296/628	946/1993	196/426	1715/4268	492/1054

*:including secondary sightings in other area by the vessel watching the obstructing vessel.

Table 3. Density indices (DI) and mean school size (MSS) of minke whale sighted primarily by the 'sighting' vessel (SV) and 'sighting/sampling' vessels (SSVs).

	SV				SSVs				Combined			
Stratum	Sch	Ind	DI	MSS	Sch	Ind	DI	MSS	Sch	Ind	DI	MSS
The first SMZ												
East-North	13	16	1.51	1.23	19	20	0.99	1.05	32	36	1.15	1.13
The entire research area												
West-South	97	334	10.94	3.44	94	259	5.93	2.76	191	593	7.73	3.10
West-North	52	186	4.46	3.58	58	140	2.82	2.41	110	326	3.41	2.96
East-North (The second SMZ)	24	47	2.44	1.96	65	106	4.15	1.63	89	153	3.49	1.72
East-South (Ross Sea)	211	875	30.78	4.15	156	414	25.81	2.65	367	1289	28.45	3.51
The third SMZ												
East-North	14	30	1.50	2.14	20	26	2.55	1.30	34	56	1.98	1.65
Total	411	1488	7.45	3.62	412	965	4.84	2.34	823	2453	5.86	2.98

Sch : number of minke whale schools sighted, Ind: number of minke whales sighted,
DI : density indices (the number of schools per 100 n.miles searching),
MSS : mean school size.

Table 4. Number of minke whales sighted (schools/individuals, A/B), targeted (C), sampled (D) and efficiencies of sampling. Efficiency I shows the ratio of samples actually taken from the primary sightings and II shows the ratio of samples actually collected from target animals.

Stratum	Sighted*	Targeted**	Sampled	Efficiency	
	A / B	C	D	I(D/B)	II(D/C)
The first SMZ					
East-North	19 / 20	19	13	0.65	0.68
The entire research area					
West-South	94 / 259	91	85	0.33	0.93
West-North	58 / 140	58	55	0.39	0.95
East-North (The second SMZ)	65 / 106	66	57	0.54	0.86
East-South (Ross Sea)	156 / 414	134	108	0.26	0.81
The third SMZ					
East-North	20 / 26	21	12	0.46	0.57
Combined	412 / 965	389	330	0.34	0.85

* : primary sightings of sighting and sampling vessels.
** : including secondary target in the same school.

Table 5. Summary of biological data and samples collected.

Data and samples	Number of whales		
	Male	Female	Total
-Data-			
Photographic record of external character*	200	130	330
Body length	200	130	330
External measurement	200	130	330
Body weight	200	130	330
Body weight by total weight of parts	39	19	58
Skull measurement (length and breadth)	190	121	311
Craniometric study	3	3	6
Standard measurement of blubber thickness (three points)	200	130	330
Detailed measurement of blubber thickness (fourteen points)	39	19	58
Measurement of mammary grand and observation of lactation status	—	130	130
Breadth measurement of uterine horn	—	130	130
Testis and epididymis weight	200	—	200
Stomach contents weight	198	129	327
Photographic record of fetus	(36)	(31)	(70)**
Fetal sex (identified by visual observation)	(36)	(31)	(67)**
Fetal length and weight	(36)	(31)	(68)**
External measurement of fetus	(36)	(31)	(68)**
Analysis of serum chemistry on board	60	25	85
-Sample-			
Diatom film	200	130	330
Serum sample for chemical analysis	195	127	322
Earplug for age determination	200	130	330
Earplug for chemical analysis (one of the pair)	4	4	8
Tympanic bulla for age determination	199	127	326
Largest baleen plate for age determination	39	42	81
Vertebral epiphysis sample	199	127	326
Ovary	—	130	130
Histological sample of endometrium	—	130	130
Histological sample of mammary grand	—	130	130
Milk sample for chemical analysis	—	2	2
Histological sample of testis	199	—	199
Histological sample of epididymis	200	—	200
Testis and epididymis smear for sperm detection	200	—	200
Urine sample for sperm detection	115	—	115
Blubber, muscle, liver, kidney and heart tissues for genetic study	200	130	330
Muscle, liver and kidney tissues for heavy metal analysis	200	130	330***
Blubber and liver tissues for organochlorine analysis	200	130	330***
Muscle, liver and blubber tissues for lipid analysis	39	19	58***
Stomach contents for the food and feeding study	84	77	161
External parasites	57	44	101
Internal parasites	25	8	33
Whole skeleton	1	3	4
Live sperm for in-vitro fertilization (IVF)	11	—	11
Live oocyte for in-vitro fertilization (IVF)	—	1	1
Serum sample for in-vitro fertilization (IVF)	8	—	8
Fetal serum sample for in-vitro fertilization (IVF)	1	1	2
Fetus	(1)	(0)	(3)**
Blubber, muscle, liver, kidney and heart tissues for genetic study (fetus)	(36)	(30)	(66)
Jaws of fetus for embryological study	(2)	(7)	(10)**
Histological sample for electron microscopic study	42	22	64

* : photos including (1) color pattern of dorsal side, (2) dorsal fin, and (3) pectoral fin (left or right).
** : including fetuses of sex unidentified.
***: including 24 samples of stomach contents.

Table 6. Summary of natural marking attempt during survey.

Vessel	Date	Sight No.	Position	Species	School size	Whale No.	Target	Oppotunity
K01	20/Dec.	8	62.288S 162.331E	Humpback	1	1	Right dorsal	Poor
K01	20/Dec.	8	62.288S 162.331E	Humpback	1	1	Fluke	Poor
K01	28/Dec.	5	64.426S 141.360E	Humpback	2	1	Right dorsal	Unidentified
K01	29/Dec.	8	64.093S 138.332E	Humpback	2	1	Right dorsal	Poor
K01	29/Dec.	8	64.093S 138.332E	Humpback	2	2	Other	Poor
K01	29/Dec.	10	63.573S 138.330E	Humpback	2	1	DM*	Unidentified
K01	29/Dec.	10	63.573S 138.330E	Humpback	2	1	Other	Unidentified
K01	15/Jan.	1	63.072S 153.382E	Humpback	3	1	Right dorsal	Poor
K01	15/Jan.	1	63.072S 153.382E	Humpback	3	2	DM	Poor
K01	15/Jan.	1	63.072S 153.382E	Humpback	3	3	Fluke	Poor
K01	24/Jan.	23	65.057S 173.418E	Humpback	2	1	Right dorsal	Poor
K01	24/Jan.	23	65.057S 173.418E	Humpback	2	2	Fluke	Poor
K01	25/Jan.	1	64.519S 173.545E	Humpback	2	1	Right dorsal	Poor
K01	25/Jan.	1	64.519S 173.545E	Humpback	2	2	Fluke	Poor
K01	30/Jan.	1	65.475S 177.212W	Humpback	2	1	Fluke	Poor
K01	2/Feb.	1	65.318S 172.135W	Humpback	2	1	Fluke	Good
K01	2/Feb.	1	65.318S 172.135W	Humpback	2	2	Fluke	Good
K01	14/Feb.	11	67.036S 171.588W	Humpback	1	1	Right dorsal	Good
K01	17/Mar.	1	67.556S 173.541W	Humpback	2	1	Right dorsal	Good
K01	17/Mar.	1	67.556S 173.541W	Humpback	2	1	Left dorsal	Good
K01	17/Mar.	1	67.556S 173.541W	Humpback	2	2	Right dorsal	Good
K01	17/Mar.	1	67.556S 173.541W	Humpback	2	2	Left dorsal	Good
K01	17/Mar.	1	67.556S 173.541W	Humpback	2	?	Fluke	Good
K01	22/Dec.	7	62.351S 154.331E	Blue	2	1	Right side	Poor
K01	22/Dec.	7	62.351S 154.331E	Blue	2	2	Left side	Poor
K01	27/Dec.	14	64.380S 142.225E	Blue	1	1	Left side	Poor
K01	27/Dec.	14	64.380S 142.225E	Blue	1	1	Right side	Poor
K01	29/Dec.	6	64.154S 138.291E	Blue	1	1	Left side	Good
K01	29/Dec.	6	64.154S 138.291E	Blue	1	1	Right side	Good
K01	29/Dec.	17	64.138S 136.387E	Blue	4	1	Right side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	1	Left side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	1	Other	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	2	Right side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	2	Left side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	2	Other	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	3	Right side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	3	Left side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	3	Other	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	4	Right side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	4	Left side	Poor
K01	29/Dec.	17	64.138S 136.387E	Blue	4	4	Other	Poor
T25	8/Jan.	7	63.478S 141.144E	Humpback	2	1	Right dorsal	Good
T25	8/Jan.	7	63.478S 141.144E	Humpback	2	2	Right dorsal	Good
T25	14/Jan.	3	62.331S 152.307E	Humpback	3	1	Left side	Good
T25	14/Jan.	3	62.331S 152.307E	Humpback	3	2	Right side	Good
T25	15/Jan.	1	63.045S 153.441E	Humpback	2	1	Fluke	Good
T25	16/Jan.	35	62.493S 155.548E	Humpback	2	1	Fluke	Poor
T25	13/Feb.	10	65.399S 170.255W	Humpback	2	1	Left dorsal	Poor
T25	13/Feb.	10	65.399S 170.255W	Humpback	2	2	Left dorsal	Poor
T25	3/Mar.	5	70.132S 173.536W	Humpback	1	1	Right dorsal	Poor
T25	1/Jan	4	64.105S 138.329E	Blue	1	1	Right dorsal	Poor
T25	15/Feb.	19	72.128S 179.343W	Blue	2	1	Right dorsal	Unidentified
T25	2/Mar.	22	70.289S 172.064W	Blue	1	1	Right dorsal	Poor
T18	8/Dec.	2	65.057S 176.415W	Humpback	2	1	Right dorsal	Poor
T18	8/Dec.	2	65.057S 176.415W	Humpback	2	2	Left dorsal	Poor
T18	13/Dec.	5	63.445S 173.232E	Humpback	1	1	Right dorsal	Poor
T18	13/Dec.	5	63.445S 173.232E	Humpback	1	1	Left dorsal	Poor
T18	13/Dec.	5	63.445S 173.232E	Humpback	1	1	Fluke	Poor
T18	14/Dec.	2	64.029S 171.566E	Humpback	1	1	Right dorsal	Unidentified
T18	14/Dec.	3	63.584S 171.512E	Humpback	2	1	Right dorsal	Good
T18	14/Dec.	3	63.584S 171.512E	Humpback	2	1	Left dorsal	Good
T18	14/Dec.	3	63.584S 171.512E	Humpback	2	2	Right dorsal	Good
T18	16/Dec.	3	62.013S 169.379E	Humpback	1	1	Right dorsal	Good
T18	16/Dec.	3	62.013S 169.379E	Humpback	1	1	Left dorsal	Good
T18	16/Dec.	3	62.013S 169.379E	Humpback	1	1	Fluke	Good

*DM: Other position which can identify individual

Table 7. Results of the biopsy experiment. "Position struck" refers to the position where the biopsy dart struck the whale.

Vessel	Date	Speceis	Sight. No.	School size	Whale No.	Position struck	Sample No.	Position
K01	27/Dec.	Blue	14	1	1	RC1	J94K01B001	64.380S 142.225E
K01	29/Dec.	Blue	6	1	1	LRC1	J94K01B002	64.154S 138.291E
K01	29/Dec	Humpback	8	2	1	LC1	J94K01H003	64.093S 138.332E
K01	29/Dec.	Humpback	8	2	2	LB1P	J94K01H004	64.093S 138.332E
K01	29/Dec.	Blue	17	4	1	LC1	J94K01B005	64.138S 136.387E
K01	29/Dec.	Blue	17	4	2	LC1	J94K01B006	64.138S 136.387E
K01	15/Jan.	Humpback	1	3	1	RC1	J94K01H007	63.072S 153.382E
K01	15/Jan.	Humpback	1	3	2	RC2	J94K01H008	63.072S 153.382E
K01	15/Jan.	Humpback	1	3	3	RC3	J94K01H009	63.072S 153.382E
K01	25/Jan.	Humpback	1	2	2	RC1	J94K01H011	64.519S 173.545E
K01	25/Jan.	Humpback	1	2	1	RD1	J94K01H010	64.519S 173.545E
K01	30/Jan.	Humpback	1	2	2	RC2	J94K01H013	65.475S 177.212W
K01	30/Jan.	Humpback	1	2	1	RC1	J94K01H012	65.475S 177.212W
K01	2/Feb.	Humpback	1	2	1	RC1	J94K01H014	65.318S 172.135W
T25	8/Jan.	Humpback	7	2	1	LB1P	J94T25H001	63.478S 141.144E
T25	14/Jan.	Humpback	3	3	2	RC1	J94T25H002	62.331S 152.307E
T25	16/Jan.	Humpback	35	2	1	LC1	J94T25H003	62.493S 155.548E
T25	13/Feb.	Humpback	10	2	1	LC1	J94T25H004	65.399S 170.255W
T25	13/Feb.	Humpback	10	2	2	RC1	J94T25H005	65.399S 170.255W
T25	2/Mar.	Minke	5	4	1	LC1	J94T25Mi006	71.216S 173.337W
T25	2/Mar.	Minke	23	8	1	RC1	J94T25Mi007	70.266S 172.249W
T25	13/Mar.	Minke	1	1	1	RC2	J94T25Mi008	71.304S 172.417E
T18	8/Dec.	Humpback	2	2	1	LA	J94T18H001	65.057S 176.415W
T18	16/Dec.	Humpback	2	1	1	LC1	J94T18H002	62.013S 169.379E
T18	11/Mar.	Minke	14	4	1	RC2	J94T18Mi001	69.160S 179.341E
T18	11/Mar.	Minke	16	6	1	RC2	J94T18Mi002	69.186S 179.291E
T18	11/Mar.	Minke	17	4	1	RC2	J94T18Mi003	69.192S 179.173E
T18	11/Mar.	Minke	22	13	1	LC2	J94T18Mi004	69.235S 178.519E
T18	13/Mar.	Minke	3	6	1	LD2	J94T18Mi005	70.222S 173.336E

Table 8. Summary of the preliminary survey on the behavior of ziphiid whales.

Species	School	Animals
S.bottlenose whale	13	32
Gray's beaked whale	1	10
Ziphiid whales	5	9
Total	19	51

Table 9. Observations of marine debris during the survey.

Object	Date	Position		Size
Metal can	16/Dec.	61.429S	169.184E	150-250 litres
Metal can	29/Dec.	64.139S	146.057E	150-250 litres
Plastic	29/Dec.	64.140S	146.099E	less than 1 square metre
Metal can	8/Jan.	63.285S	139.464E	150-250 litres
Metal can	12/Jan.	60.043S	147.235E	150-250 litres
Metal can	26/Jan.	62.428S	176.404E	50-150 litres
Metal can	19/Mar.	63.250S	170.241E	150-250 litres
Metal can	19/Mar.	63.005S	170.080E	150-250 litres

Table 10. Products from samples.

Items of products	Weight (kg)	Items of products	Weight (kg)
Frozen products			
Ordinal meat	317,295.0	Maxillary cartilage	2,125.0
Premium meat (Oniku)	930.0	Mandibular ligaments	4,095.0
Breast meat	436,245.0	Nasal plug	4,100.0
Meat pieces	110,520.0	Tendon	24,374.0
Meat inside ventral grooves	15.280.5	Heart	4,284.0
Blubber of ventral grooves	7,762.5	Tongue	28,613.0
Meat/blubber of ventral grooves	93,852.0	Diaphragm	7,605.0
Meat/blubber of ventral part	66,950.0	Stomach	3,549.0
Ordinal blubber	149,479.0	Intestine	5,400.0
Underside part of blubber	12,225.0	Pancreas	810.0
Lining of meat	12,950.0	Kidney	3,766.0
Tail flukes	20,600.0	Testes	168.0
Meat/connective tissue of lower jaw	4,335.0	Esophagus	325.0
		Liver	2,660.0
		Total	1,340,298.0
Others			
Oil*	18,000.0		

* : Oil was consumed as fuel of Nisshin-maru.

Table 11. Mean body length(m) by sex and maturity in each stratum.

Male

Stratum	Immature					Mature				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
The first SMZ										
East-North	5.85	0.51	5.33	6.36	2	8.24	0.50	7.66	8.96	4
The entire research area										
West-South	6.84	1.23	5.25	8.71	6	8.46	0.34	7.69	9.05	65
West-North	6.46	1.01	5.02	8.39	10	8.35	0.36	7.52	9.21	32
East-North (The second SMZ)	6.74	1.01	5.11	8.47	16	8.30	0.36	7.68	9.10	27
East-South (Ross Sea)	6.54	0.60	5.71	7.42	5	8.15	0.28	7.60	8.65	22
The third SMZ										
East-North	6.32	0.56	5.54	6.97	4	8.19	0.25	7.84	8.59	7
Total	6.58	0.98	5.02	8.71	43	8.35	0.36	7.52	9.21	157

Female

Stratum	Immature					Mature				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
The first SMZ										
East-North	5.43	0.23	5.17	5.75	6	8.61	——	8.61	8.61	1
The entire research area										
West-South	6.99	0.99	5.49	8.35	5	9.20	0.32	8.83	9.65	9
West-North	6.20	0.43	5.64	6.64	8	8.83	0.46	8.18	9.58	5
East-North (The second SMZ)	5.84	0.42	5.13	6.51	9	8.98	0.42	8.40	9.35	5
East-South (Ross Sea)	7.30	0.94	5.58	8.40	14	8.64	0.35	7.73	9.37	67
The third SMZ										
East-North	7.70	——	7.70	7.70	1	——	——	——	——	0
Total	6.50	1.01	5.13	8.40	43	8.73	0.40	7.73	9.65	87

Table 12. Reproductive status of samples in each stratum.

Stratum	Male		Female							M%*
	Imm.	Mat.	Imm.	Mat.						
				Preg.	Ovu.	Rest.	Lact.	P & L	Unk.	
The first SMZ										
East-North	2	4	6	1	0	0	0	0	0	46.2
	(33.3)	(66.7)	(85.7)	(14.3)						
The entire research area										
West-South	6	65	5	8	0	0	0	1	0	83.5
	(8.5)	(91.5)	(35.7)	(57.1)				(7.1)		
West-North	10	32	8	4	0	0	0	1	0	76.4
	(23.8)	(76.2)	(61.5)	(30.8)				(7.7)		
East-North	16	27	9	4	0	1	0	0	0	75.4
(The 2nd SMZ)	(37.2)	(62.8)	(64.3)	(28.6)		(7.1)				
East-South	5	22	14	49	1	17	0	0	0	25.0
(Ross Sea)	(18.5)	(81.5)	(17.3)	(60.5)	(1.2)	(21.0)				
The third SMZ										
East-North	4	7	1	0	0	0	0	0	0	91.7
	(36.4)	(63.6)	(100.0)							
Total	43	157	43	66	1	18	0	2	0	60.6
	(21.5)	(78.5)	(33.1)	(50.8)	(0.8)	(13.8)		(1.5)		

Explanation of abbreviations.
Imm.: immature, Mat.: mature, Preg.: pregnant, Ovu.: ovulating,
Rest.: resting, Lact.: lactating, P&L: pregnant and lactating,
Unk.: unknown.
* : percentage of males.

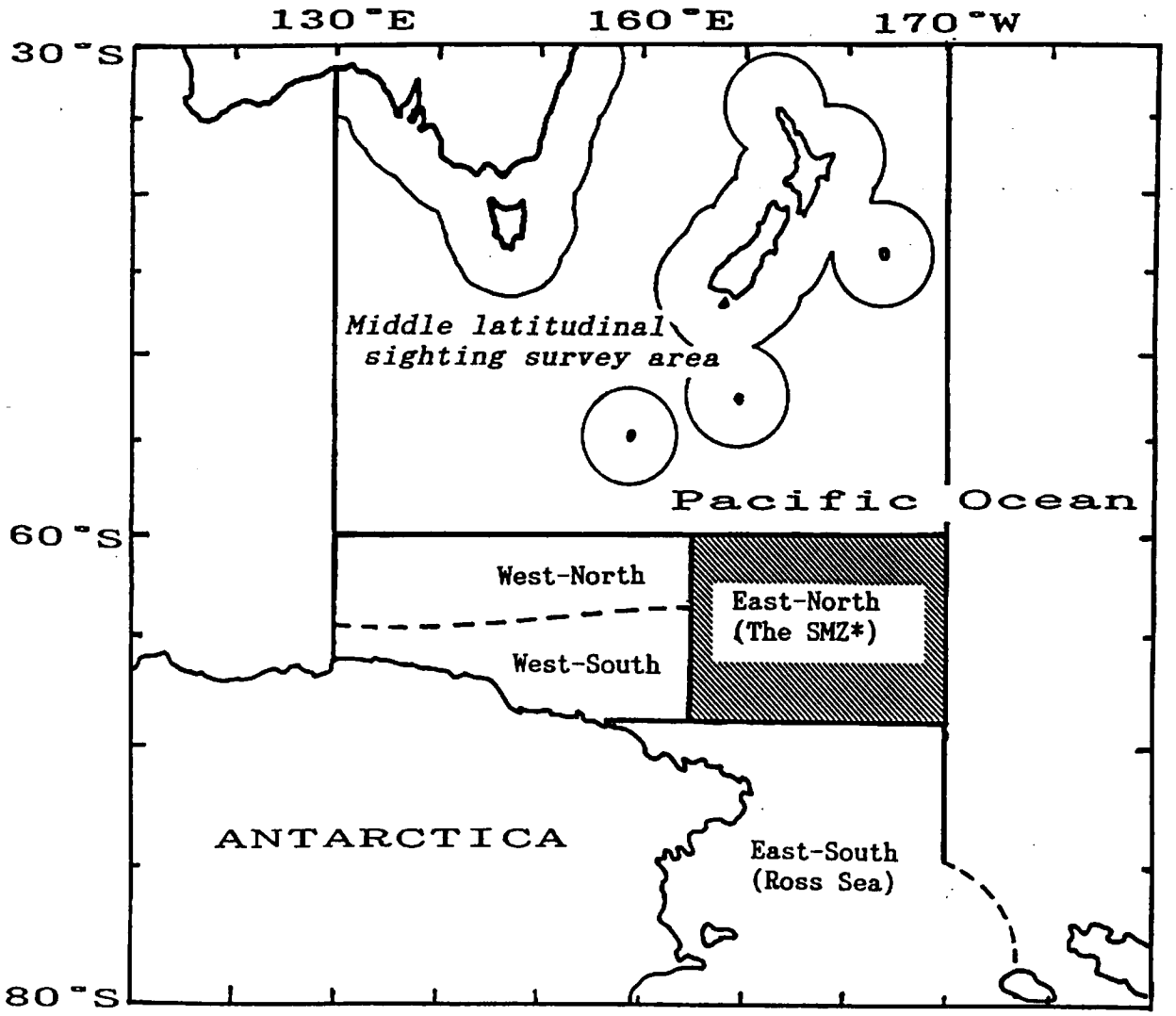

Fig. 1. Geographical location and the stratification of the research area in the JARPA in 1994/95.
* : Special monitoring zone (SMZ) to investigate the seasonal changes of the distribution and segregation of minke whales.

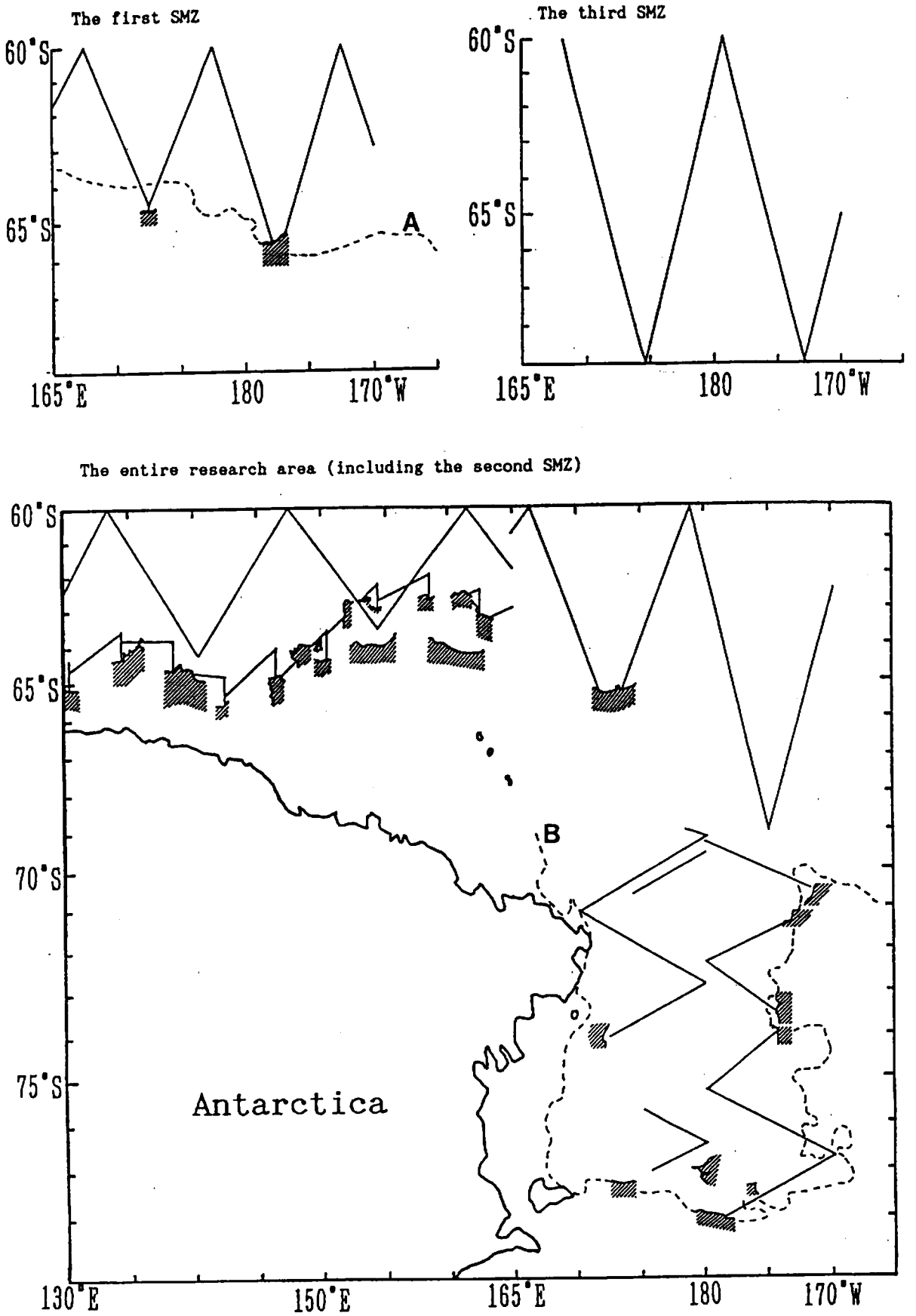

Fig. 2. Cruise tracks of the research vessels in the JARPA in 1994/95.
Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period). Bloken line indicates pack ice information from NAVY/NOAA JIC of A: Dec.9,1994 and B: Feb.24,1995 respectively.

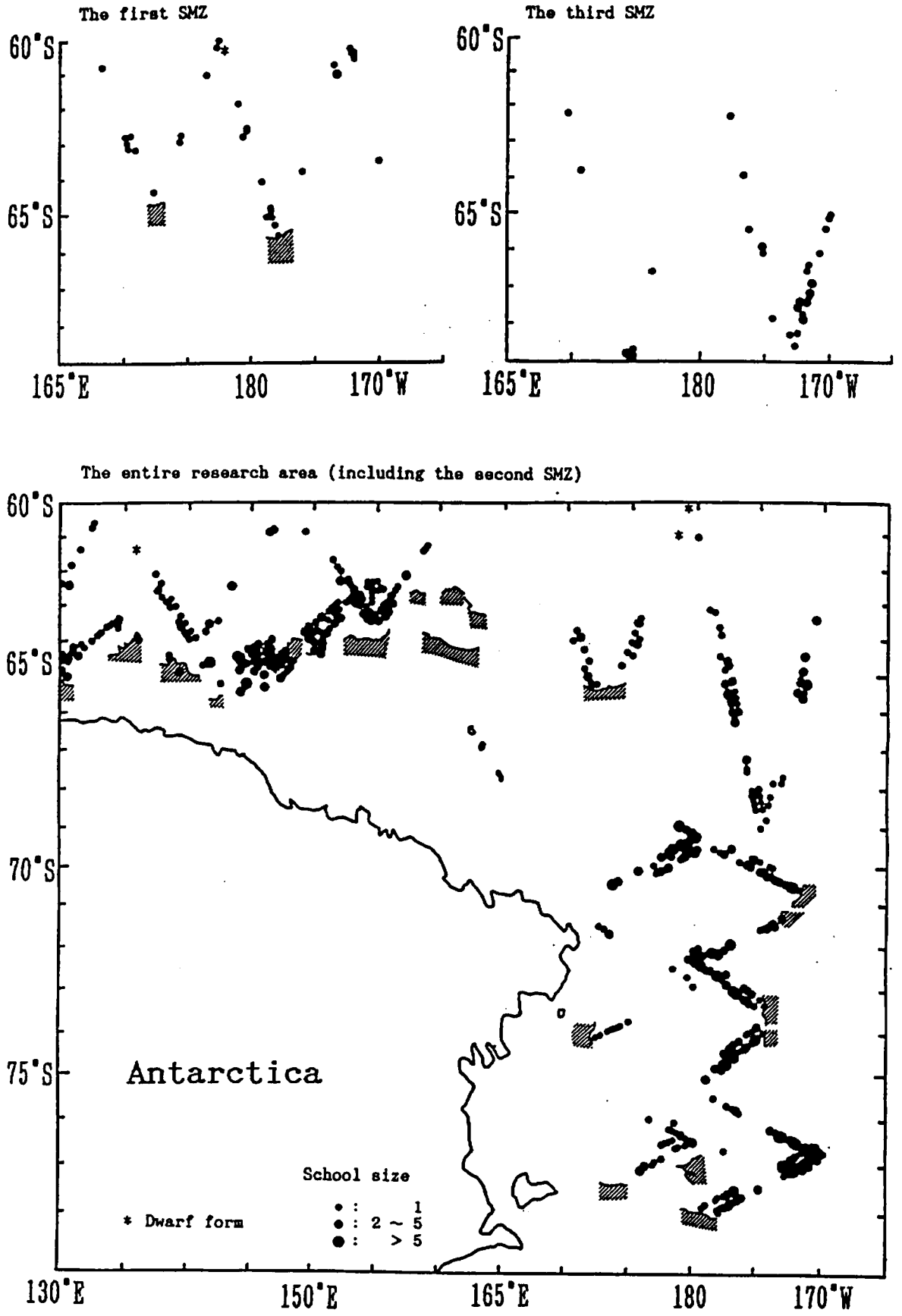

Fig. 3. Distribution of the primary minke whale sightings by three sampling and sighting vessels.
Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period).

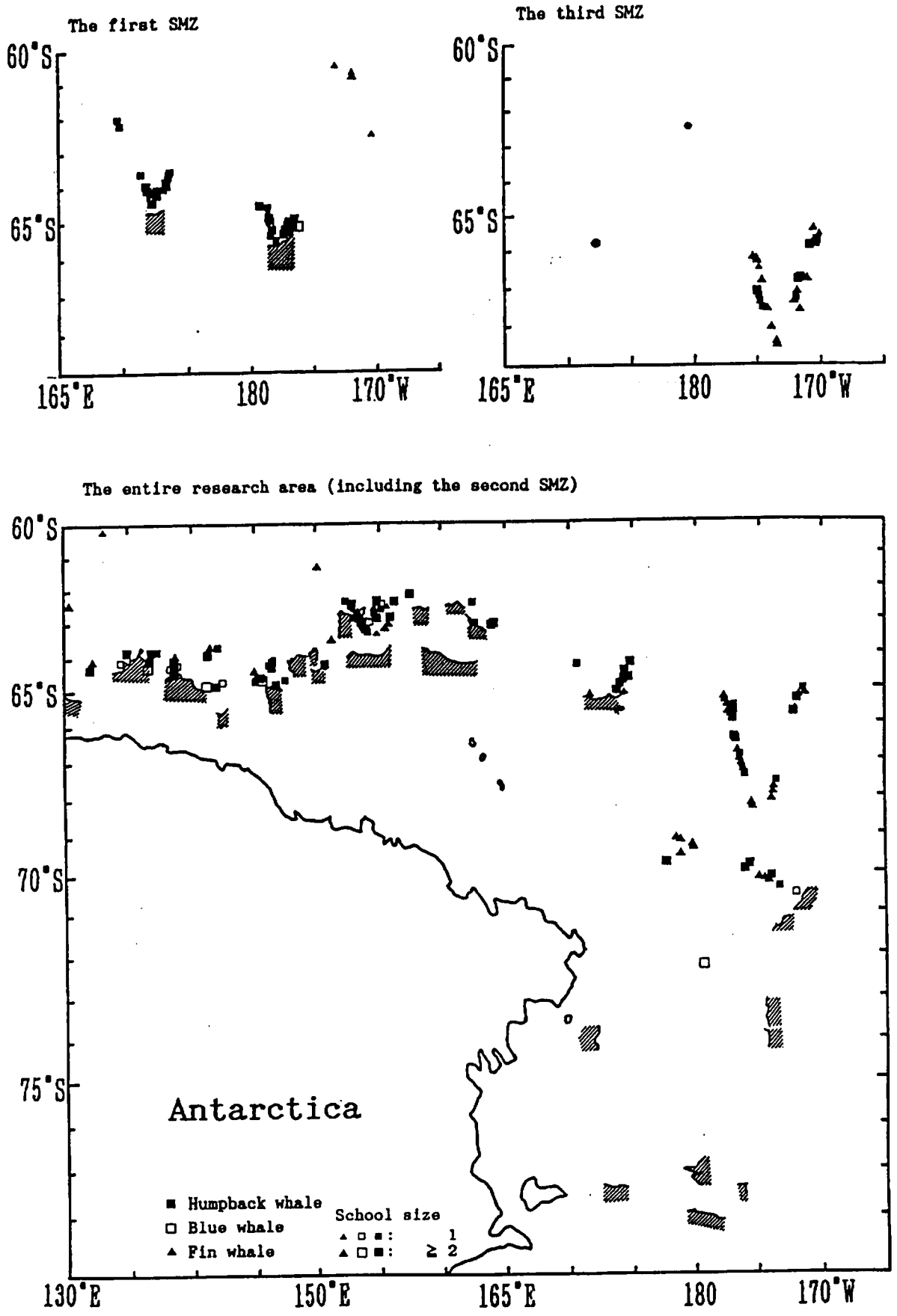

Fig. 4. Distribution of humpback, blue, fin, sei whales sighted by three sighting and sampling vessels.
Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period).

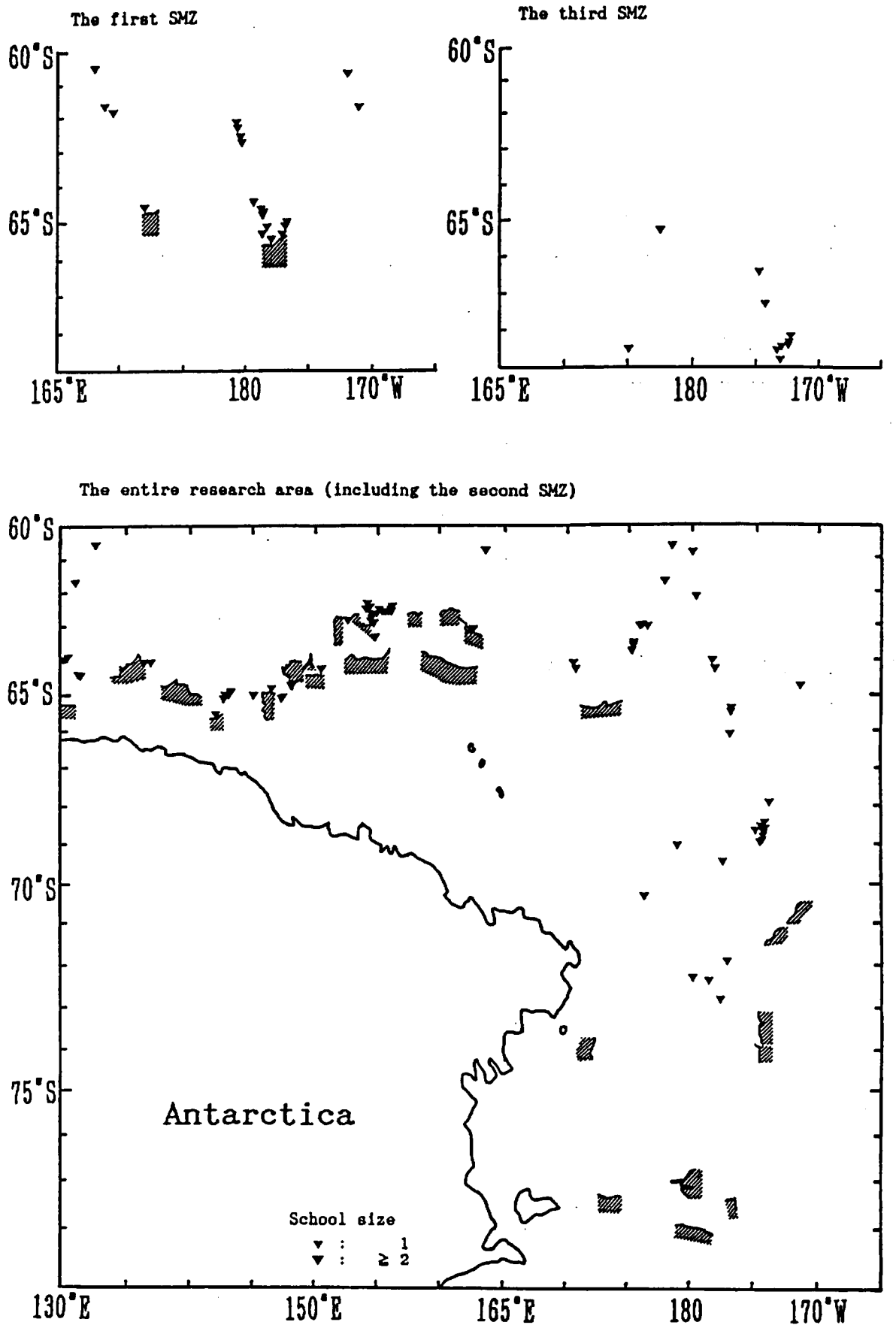

Fig. 5. Distribution of sperm whales sighted by three sighting and sampling vessels. Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period).

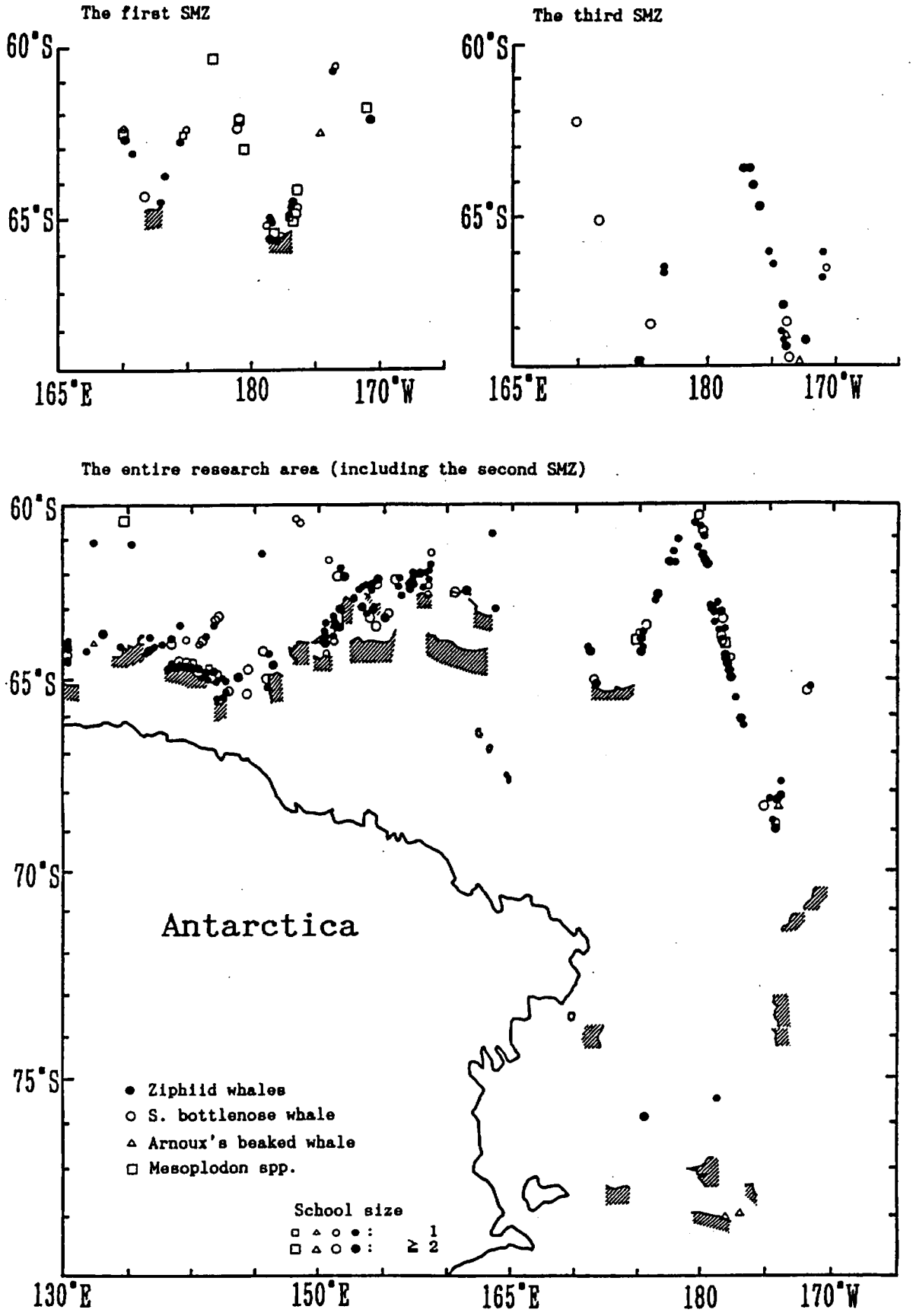

Fig. 6. Distribution of ziphiid whales sighted by three sighting and sampling vessels. Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period).

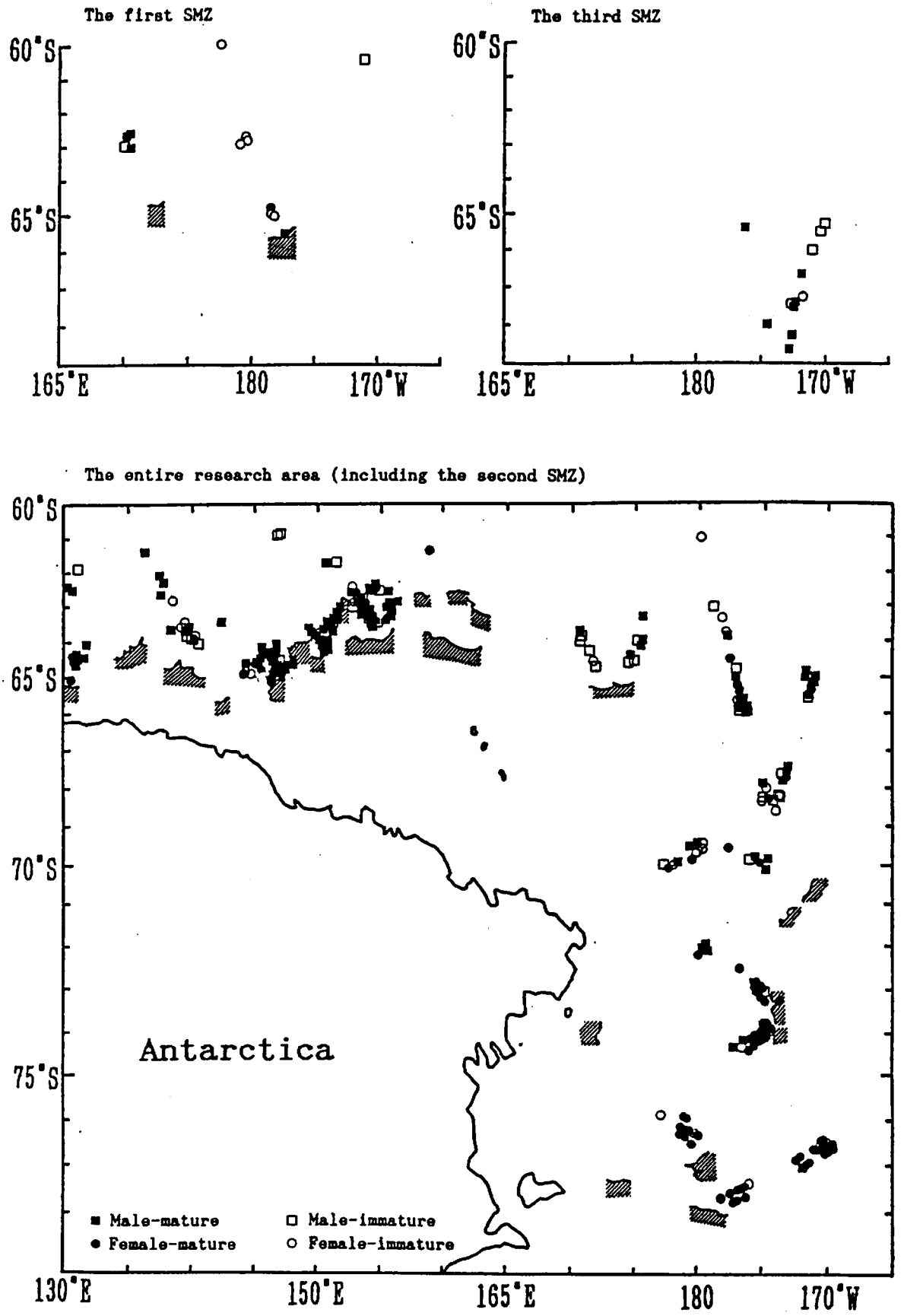

Fig. 7. Distribution of minke whales sampled based on their sighted position. Upper: the survey in the SMZ in the first and third period., lower: the survey in the entire research area (including the SMZ in the second period).

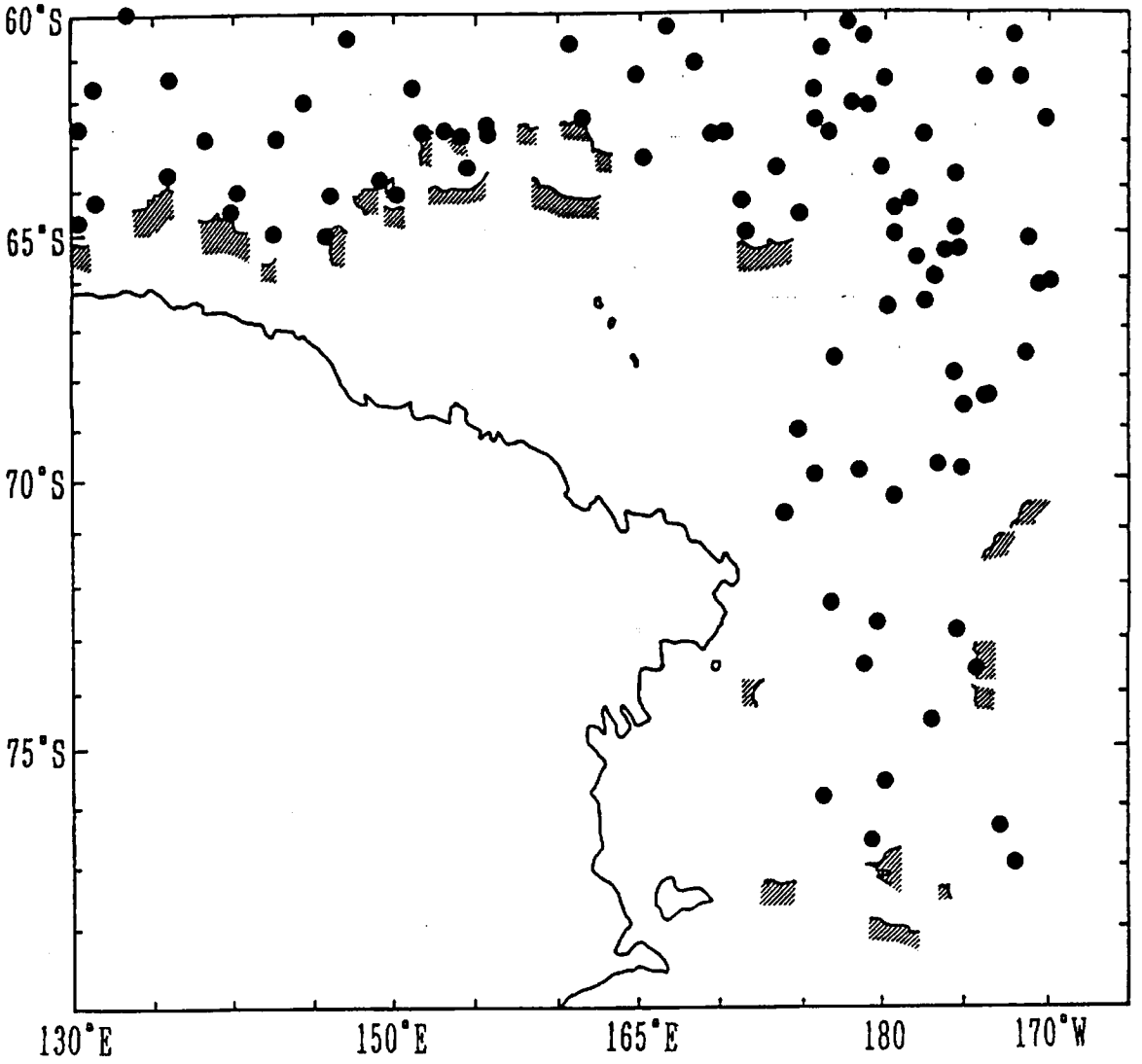

Fig. 8. Positions of the XBT survey.

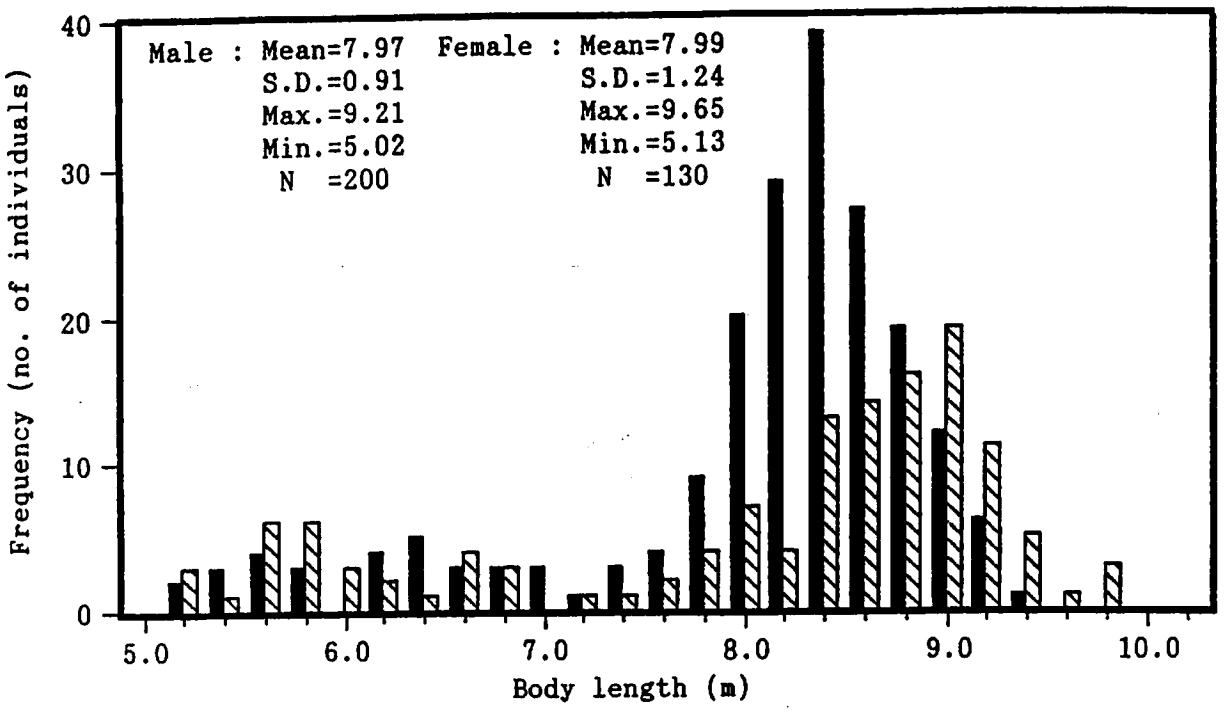

Fig.9a. Body length compositions (20cm intervals) of the samples taken in the present research. Solid and striped lines represent males and females, respectively.

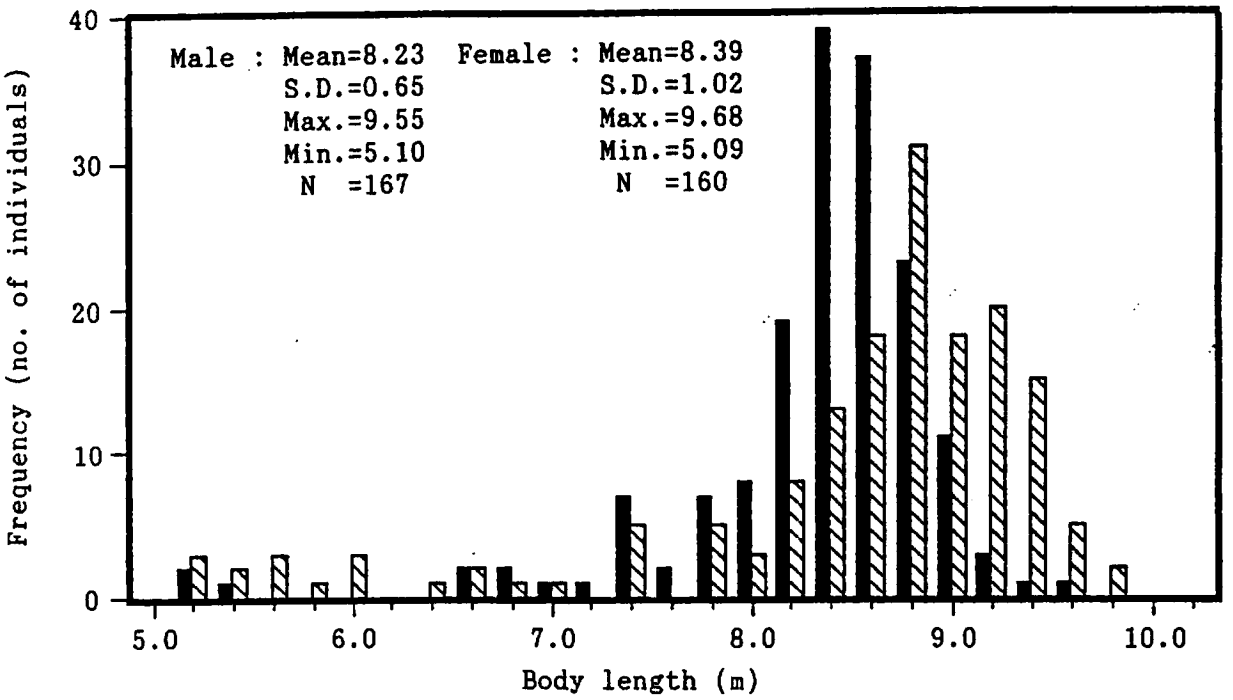

Fig.9b. Body length compositions (20cm intervals) of the samples taken in the 1992/93 JARPA. Solid and striped lines represent males and females, respectively.

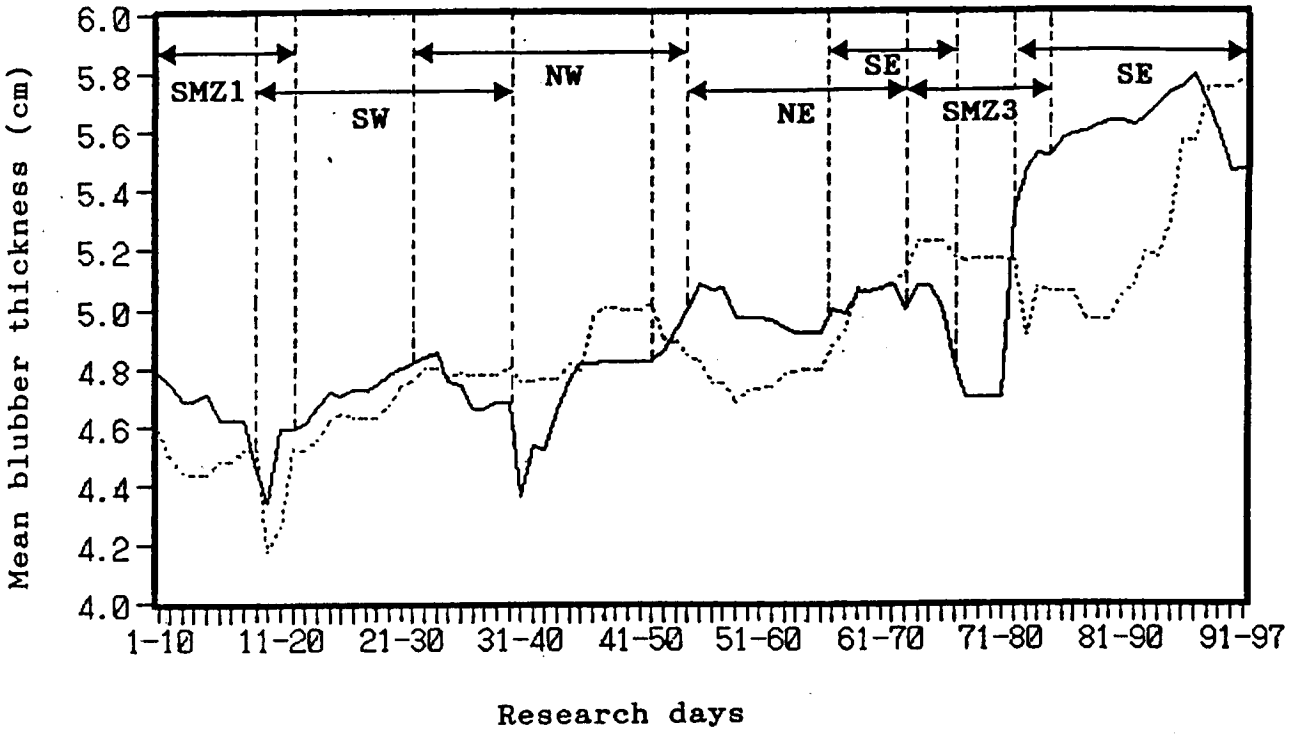

Fig.10. The moving average of mean blubber thickness (three left side points of the body at ear, navel and dorsal fin positions) of matured animals with every 10 research days. Solid and broken line represents 94/95 and 93/94 research, respectively. SMZ1: the first SMZ, SW: South-West stratum, NW: North-West stratum, NE: North-East stratum (the second SMZ), SE: South-East stratum (Ross Sea), SMZ3: the third SMZ.