Cruise Report of the Japanese Whale Research Program Under a Special Permit for North Pacific Minke Whales in 1995 with the result of a preliminary analysis of data collected

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ABSTRACT

The 1995 Japanese Whale Research Program Under Special Permit in the Northwestern Part of the North Pacific (JARPN) was conducted in a part of sub-area 9 established by the IWC/SC as a feasibility study using three sighting/sampling vessels and one research base. A total of 11,843.9 n.miles were searched, resulting in sighting of 144 schools/151 animals (primary sighting: 90 schools/91 animals, secondary sighting: 54 schools/60 animals) of minke whales. Also sighted during the research periods were blue whales (12 schools/24 animals), fin whales (18 schools/24 animals), sei whales (18 schools/25 animals), humpback whales (23 schools/40 animals), sperm whales (283 schools/319 animals) and right whales (2 schools/2 animals). Sampling activities were conducted on 131 schools/138 animals minke whales, resulting in the catch of 100 minke whales (91 male animals, 9 female animals). The collected samples were predominantly large males, and seven out of nine females samples had fetus. From the body length of the fetus, it was found that the conception period of those pregnant animals coincided roughly with that of the Okhotsk Sea-West Pacific stock ('O'stock). Furthermore, these minke whales widely consumed zooplankton and pelagic fish species. The most frequent species found in stomach of minke whale was the Pacific saury (*Cololabis saira*). Furthermore, the parasite *Anisakis simplex* was detected from the stomach and *Bolbosome* sp. from intestine of all the whales sampled.

INTRODUCTION

The Japanese Whale Research Program Under the Special Permit in the Northwestern Part of the North Pacific (JARPN) was designed by the Government of Japan with the aim to elucidate

the stock structure of minke whales distributed in the area surrounding Japan, in preparation for the future implementation of the Revised Management Procedure (RMP) developed by the International Whaling Commission/Scientific Committee (IWC/SC). A research plan was submitted to the IWC/SC in 1994 (The Government of Japan, 1994). In 1994, the first year of the program, a feasibility study was conducted from 6 July to 7 September in a part of sub-area 9 (north of 35°N, 157-170°E) established by the IWC, but, due to adverse weather conditions, no adequate research activities were conducted, with the result of sampling of only 21 whales (Fujise *et al.*, 1995). Samples and data collected in this research were analyzed extensively by experts after the cruise. The results suggested that minke whales distributed in sub-area 9 have a similar breeding cycle with those in the Pacific coast of Japan. No substantial difference in genetics (isozyme and mtDNA), morphology, and accumulations of heavy metals and organochlorines between sub-area 9 and Pacific coast of Japan, were detected (Goto and Pastene, 1995; Fujise and Kato, 1995; Fujise, 1995; Fujise *et al.*, 1995; Kuramochi *et al.*, 1995). However, because of small sample size for sub-area 9, no decisive conclusion was reached. For this reason, the Government of Japan decided to continue the feasibility study in the same area and submitted to the IWC/SC a research plan in 1995 (The Government of Japan, 1995).

This report outlines the 2nd cruise of JARPN in sub-area 9 conducted from 13 June to 22 August in 1995 and presents some results of preliminary analysis.

RESEARCH METHODS

1. Research area

Research area was a part of sub-area 9 established by the IWC: north of 40°N, 157-170°E (excluding the exclusive 200 n.miles zones of the United States and Russia) (Fig. 1). In the first period the entire research area was surveyed, and in the second and third periods, the survey conducted in the western and eastern parts of the research area, respectively.

2. Research vessels

Nisshin Maru (7,440GT) was used as a research base, which commanded the research and engaged in biological examination of collected samples and of by-products. Furthermore, it engaged oceanographic observation using XBT and collection of information on sea and weather conditions. Sighting surveys and sampling of minke whales were conducted by three sighting/sampling vessels: *Kyo Maru No.1* (*K01*: 812.08GT), *Toshi Maru No. 25* (*T25*: 739.92GT) and *Toshi Maru No. 18* (*T18*: 758.33GT). One of three vessels was added newly in this cruise. The sighting/sampling vessels also conducted various experiments and observations, such as photographing of natural marks, biopsy sampling, observation of behavior patterns of large whales, angle and distance experiment.

3. Cruise trackline

The research was carried out in three periods, with different methods of establishing research courses used for each period. In the first period (13-30 June, 1995), the trackline was established, as in 1994, through the billiard method by means of fixed angle of reflection using the line transect method. In the second and third periods (1 July-6 August and 7-22 August, 1995, respectively), sub-areas were established in parts of the research area, in which zigzag research course was established on an arbitrary basis, taking into consideration the sighting of minke whales and sea weather condition observations in the first period. Furthermore, during

the survey in the second and third periods; separate courses attaching emphasis on the east-west direction were introduced, and research was conducted as "special monitoring survey."

The cruise track (main course) for each period and the noon positions of the research base are shown in Fig. 2. The way points (WP) and passing date in the research course are shown in Table 1. The research course consisted of three tracks, one main track established as in the above procedure and two parallel sub-tracks established 6 n.miles apart on both sides. In the special monitoring survey conducted in the second and third periods, the distance between the tracks was set at 4 n.miles considering efficiency of sampling. Three sighting/sampling vessels (*K01*, *T25* and *T18*) were allocated for sighting and sampling activities, with vessels changed each research day.

4. Sighting surveys

Searching was conducted under the similar research conditions as in the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise (visibility of 2 n.miles or more and wind velocity 4 or below). Moreover, even when survey conditions were not met, similar searching was carried out under the sea conditions in which collection of whale samples was possible. In this case, an independent research mode (hereinafter referred to as BS mode) was used for data recording in order to distinguish from ordinary sighting surveys (BC mode). Closing was made targeting at minke whales or schools which looked like minke whales. Furthermore, closing was made as much as possible to large whales such as blue, humpback and right whales in order to identify whale species and their school size and conduct the some experiments.

5. Sampling of minke whales

Sampling activities were conducted with the aim to take of 100 minke whales, and were conducted in principle for all the minke whales found during the sighting surveys. Furthermore, sampling effort was conducted whenever it was judged that sampling and biological research were possible even outside the above designated time range, if collection of whale samples was possible. When the schools targeted for sampling were 2 animals or more, numbering was made to all the minke whales in the school, and sampling was made by setting sampling order randomly in accordance with the table of random numbers (Kato *et al.*, 1989). Based on the results of the 1994 research that demonstrated the difficulty to sample targeted whale because minke whales distributed in this area dived for a long time and exhibit a quick mobile behavior (Fujise *et al.*, 1995), the sampling was made in cooperation with three sighting/sampling vessels in this survey.

6. Experiments, observation and oceanographical surveys

On board the sighting/sampling vessels, experiments were conducted on the estimation of distance angle for examination of the precision of sighting data. Also conducted were biopsy sampling experiments on minke whales as well as experiments to install satellite tagging. With respect to blue, humpback and right whales, photographing of natural marks was conducted, and with respect to large whale species, observation of behavior patterns were made. On board the research base, oceanographic observation by means of XBT and marine debris survey were conducted.

NARRATIVE OF THE RESEARCH

1. First period (13-30 June, 1995)

The research starting point, direction from the starting points, and fixed reflexive angle were

selected randomly. As a result, it was decided to start the research course at 59 degrees from 40°N, 160°23'E (WP1). A 65 degrees angle was selected as the fixed reflexive angle, and in case the reflexive angle is established on both sides at the way point on the boundary, it was selected randomly on each occasion. The first period survey was started at noon, 13 June at the starting point (WP1), and was completed at the ending point (41°38'N, 158°24'E) on 30 June.

2. Second period (1 July - 6 August, 1995)
As many minke whales were found in the southwestern part of the research area (42-43°N, 157-160°E) in the first period, sub-areas were established in the western part (157-163°E) in the second period, and research course was established with emphasis on the longitudinal zones. The method of establishment was as follows:

A. Sub-areas were further divided into zones of two latitudinal degrees.
B. Zigzag research courses were established at an interval of 2 degrees in each longitudinal zone.
C. Research was conducted from the longitudinal zone on the southern side toward the east-west direction, and upon completing it, research on the northern longitudinal zone was made.

However, as the front line extending from low atmospheric pressure lay in east-west direction in the research area, and there was concern that there may be longitudinal zones in which research cannot be implemented under the present research course, the research course was modified on 5 July as follows:

A. Sub-areas were divided into longitudinal zones of 2 degrees on east and west.
B. Zigzag research course was established with an interval of 2 degrees in each longitudinal zone.
C. Research was conducted in the north-south direction along the research course, and upon completion of research of a longitudinal zone, the adjoining longitudinal zone was surveyed.
D. Special monitoring survey was conducted by establishing a separate research course in the east-west direction in accordance with the sea climate information (i.e. concerning gas information and weather charts) as well as the sighting situation of minke whales.

In the second period survey, "sub-area" research was started at the course angle of 159 degrees from WP201 (42°N, 157°E) at 06: 00 on 1 July. The special monitoring survey (SMS) was conducted in each longitudinal zone of 41°N (SMS-A), 42°N (SMS-B), 44°N (SMS-E), 46°N (SMS-C and SMS-D) during the "sub-area" research. The research in the second period was completed at 13:58 on 6 August, when the ending point of the research WP209 (42°N, 161°E) was reached.

3. Third period (7-22 August, 1995)
Research was conducted by establishing a sub-area in the eastern part of the research area (164-169°E). The research course was established in the same way as for the second period. The research in the third period was started at 06:00 on 7 August at the 36 degree course from WP301 (42°N, 166°E). The special monitoring survey was conducted at the 45°N zone (SMS-F) and 47°N zone (SMS-G). The sampling activity was terminated on 15 August because the number of whales sampled reached 100, and only sighting surveys was conducted thereafter.

From 17 August and thereafter, three sighting/sampling vessels were allocated for sighting surveys in the remaining research course and newly added course. The research in the area was completed on 22 August when the ending point (42°N, 160°E) was reached.

RESULTS

1. Searching distance

The research days for the first, second and third periods were 18, 37 and 16 days, respectively. The total searching distance was 11, 843.9 n.miles (first period: 3,790.9 n.miles, second period: 4,637.3 n.miles, and third period: 3,415.7 n.miles), and 81.8% of the distance were made by BC mode survey.

The searching distance for each period under BC mode survey by one degree is shown in Table 2, and that under BS mode shown in Table 3. In the first period, effort was distributed almost evenly on the research course both under BC and BS modes, without any conspicuous bias, but there were greater efforts at 159°E, where south-north research was made. In the second period, larger efforts were made at 158-160°E and 40°N, 43°N and 45°N, where special monitoring survey was conducted. In the third period, efforts concentrated on 44°N and 166°E. Furthermore, only 11.1 n.miles were covered in the search under BS mode in the third period because no BS mode research was conducted after sampling activities were completed.

2. Distribution of minke whales sighted

Fig. 3 shows the distribution of minke whales and "like minke whales." sighted during the survey. Table 4 shows the whale species sighted during the survey by survey mode and period. Minke whale sighted in the first period were 17 schools/18 animals (primary: 13 schools/13 animals, secondary: 4/5), of which 14 schools (15 animals) were concentrated in the area of 40-42°N, 157-160°E. In the area north of 42°N, although 1,780.3 n.miles were searched under BC mode, only 3 schools (3 animals) of minke whales were found. "Like minke whales" (for which no confirmation was made) were 6 schools/6 animals. In the second period, 96 schools/101 animals were found (primary: 57/57, secondary: 39/44), and the number of "like minke whales" was 6 animals. Minke whales were sighted between 40°N and 46°N, showing a trend that they are distributed northward than in the first period. Minke whales sighted in the third period were 31 schools/32 animals (primary: 20/21, secondary: 11/11), and many were found in 45°N zone and 47°N zone where the special monitoring survey was conducted and 164-166°E.

Tables 5 and 6 show the number of schools of minke whale sighted as primary sighting by searching mode by one degree in the research area. Tables 7 and 8 show the density index (DI: the number of schools found per 100 n.miles searched) by one degree. The primary sighting of minke whales in the first period were made under BC mode for all the 12 schools, except one. The DI for the entire research area in the first period was 0.41 under BC mode and 0.11 under BS mode. High density areas (DI under BC mode: 2.02-3.82) have been formed in the south-western part of the research area (40-41°N, 157°E). In the second period, a total of 48 schools of minke whales were found under BC mode, and the DI was the highest in 45°N zone (2.16-4.10). Furthermore, although 10 schools were found through BS mode, there was no area with a particular high density index. The DI for the entire area in the second period were 1.45 and 0.79 under BC and BS modes, respectively. In the third period, 20 schools of minke whales

were found under BC mode, but no sighting was made through BS mode. The DI was relatively high in the 47°N zone (2.00-6.71), with the DI for the entire research area standing at 0.59. These DI were higher than those in the corresponding period of 1994 (5 July - 6 August, BC mode: 0.82, BS mode: 0.29). The seasonal changes which indicated the highest DI in July (second period) were the same as indicated in the past whale searching boats in the past (June: 0.04, July: 0.30, August: 0.12).

3. Distribution of other whale species sighted

Table 4 shows the number of schools and animals of whales found by searching mode, period and category sighting. Fig. 4 shows the sighting location of large baleen whales in each period. In the first period, large number of large baleen whales were observed in area around WP3 (46-48°N, 160-161°E), with 5 blue, 19 fin, and 12 humpback whales found as primary sightings under BC mode. On the other hand, sperm whales were found around WP2 (44-46°N, 168-170°E), with 69 schools/78 animals primary sightings.

In the second period, 96 sperm, 14 sei, 15 blue and 3 humpback whales were sighted, but there was no such high-density area as that found in the first period . However, there was a tendency for blue, fin and humpback whales to be sighted in the area north of 44°N, and sei whales were found on the southern part of research area. Largest number of *dalli*-type Dall's porpoises (102 schools/458 animals) were found in this period. Pacific white-sided dolphins and northern right whale dolphins were found in the numbers of 11 schools (853 animals) and 6 schools (281 animals), respectively.

In the third period survey, large number of sperm whales (126 schools/140 animals) were sighted, followed by humpback (10/14) and sei whales (6/11). As in the second period, *dalli*-type Dall's porpoises were found more frequently than other dolphins sp. (44 schools/157 animals). Pacific white-sided dolphins and northern right whale dolphins were also found (7 schools 1,180 animals and 10 schools 990 animals , respectively). In this period, a tendency was observed that humpback whales were distributed in the northern part of the research area, and sei and fin whales in the southern part. But no clear tendency of distribution was observed in the blue whales.

4. Sampling of minke whales

A total of 144 schools (151 animals) of minke whales were found throughout the research period, of which sampling was targeted at 131 schools (138 animals), resulting in the catch of 100 minke whales. Table 9 shows the number of minke whales sighted and sampled in each period. There were 38 individuals for which chasing was made for sampling but no catch was made, and the reason for the failure are listed in Table 10. Fig. 5 shows the geographical location of sampled whales.

In the first period, 17 schools/18 animals of minke whales were sighted and targeted (primary: 13 schools/13 animals, secondary: 4 schools/5 animals), resulting in the catch of 14 animals. With respect to the 4 animals that could not be sampled, in two cases the sighting of whales was lost during confirmation, making chasing not possible, and in the another 2 cases, whales were not found in the course of chasing because of long diving and/or quick mobile behaviors.

In the second period, 96 schools/101 animals of minke whales were found, of which sampling was made for 89 schools/94 animals, resulting in the catch of 65 animals. The 29

animals that could not be caught by lost before chasing (15), lost during chasing because of long diving (6), quick mobile behavior (3), deterioration of sea conditions (2) and technical reasons (3).

In the third period, 31 schools/32 animals of minke whales were found, of which sampling activities were directed toward 25 schools/26 animals, resulting in the catch of 21 animals. The 5 animals that could not be caught by lost during chasing because of long diving (2) and quick mobile behavior (3).

Technical sampling efficiency (the rate of sampling of targeted individuals) was 0.78 for the first period, 0.69 for the second and 0.81 for the third, with the rate for the entire research standing at 0.72, which was somewhat lower than the research in the Antarctic (0.85: Nishiwaki *et al.*, 1995). Furthermore, the true sampling efficiency (the percentage of sampled individuals in all the sighted individuals) was 0.78, 0.64, 0.66, respectively, with that for the entire period standing at 0.66.

5. Experiments and oceanographical observations

5.1. *Recording of natural marks*

Photographing of natural marking was made in the range of 3 n.miles in perpendicular distance of trackline, and was implemented to target the blue, humpback and right whales, which were sighted as primary sighting, with due consideration to the research itinerary. Photographing of natural marks was conducted on 7 schools/19 animals of blue whales, 3 schools/5 animals of humpback whales and one right whale.

5.2. *Biopsy sampling experiment*

A total of 7 schools/7 animals of minke whales were targeted for biopsy sampling experiment. Collection of skin biopsy samples was successful for the 3 animals. The time employed for the sampling of individual skin biopsies, ranged from 11 min. to 75 min. It was able to close up to 20 m to the whales getting only one chance of shooting. With respect to the other 4 animals, sample collection was unsuccessful up to one and half hours chasing, with several trials of shooting.

5.3. *Experiment to estimate distance angle*

The experiment was made using the same procedure as in the sighting survey in the North Pacific, and the full-scale experiment was conducted on 30 July after a rehearsal of the experiment on 13 June. However, visibility deteriorated in the course of the experiment, preventing to complete the experiment. Therefore, the remaining part of the experiment was carried out on 4 August. A total of 143 trials were made.

5.4. *Observation of behavior in large whale species*

In the feasibility study in 1994, many large whales such as blue and fin whales were found in the eastern part of the area (Fujise *et al.*, 1995). Therefore, in the case of large whales species such as blue , fin and sperm whales were found, research schedule was adjusted to conduct observation on whale behavior patterns and record their swimming direction, diving time and feeding activities. However, this observation could not conducted because most of whales reacted to the vessels before observation was made. On 18 July, behavior patterns of 3 blue whales in a school, which were found in the primary sighting, were observed for 36 minutes. After the completion of observation, closing was made for the purpose of estimating body length and natural marking photographs were taken. Similar experiments were made on 2

schools/2 animals of sperm whales on 20 August.

5.5. *Experiment to attach satellite marking*
Experiments were made on attaching satellite marking now being performed in the Antarctic on minke whales (Nishiwaki *et al.*, 1995). In the 1995 JARPN survey, it was planned to attach the marking only on one whale in the first half of the research period as a preliminary experiment, with the intention to collect information such as swimming direction and speed. However, experiment were delayed until 23 July because it took time to prepare the device and it was difficult to close up to the sighted schools. Attempt was made for 90 minutes to attach the device on one minke whale. One shooting was made but the attachment failed because the wire connecting the device was broken. Later, a similar attempt was made for 25 minutes to attach the device but did not succeed because there was no chance of shooting.

5.6. *XBT observation*
XBT oceanographic observation and ocean climate observation were conducted at a total of 58 points from 13 June to 17 August on board the research base.

5.7. *Observation of marine debris*
Observation of marine debris was conducted on the bridge of research base for three days (10-12 June) and five days (17-21 August), during the going and return cruises. Observation totaled 104 hours and 30 minutes.

Furthermore, when the debris were found in the stomach contents of the sampled minke whales, they were collected and photographed. During the research period, one or more marine debris were observed in the stomach contents of 10 animals, most of which were plastic covers or their fragments (9 animals), brown-colored glass bottles (1), empty cans (1) and vinyl fragments (1), etc.

6. *Biological research*
Minke whales sampled were retrieved onto the research base and biological researches (measurements and sample collections) were conducted. Table 11 shows major biological research items and the number of animals examined. Items on related to the elucidation of stock structure, such as genetics, morphology, morphometry, osteology, ecology, parasite, pollution and other related items now being surveyed in the Antarctic, were made. In the 1994 research, the presence of *Anisakis* sp. and many other parasites were identified in the North Pacific minke whales and it was expected that the research on parasites would contribute significantly to the elucidation of stock structure of minke whales -- which is the major objective of the present research. Therefore, an parasitologist got on board the fleet in the 1995 research

7. *Products*
After biological sampling was completed, all the whales were processed according to the provisions of Convention, Article VIII. Total production from all of the sampled whales was 316t (Table 12).

8. *Preliminary analysis of biological information*
Data and samples collected during the 1995 surveys are being or were analyzed by experts in each field after the fleet returned to Japan. Preliminary results of biological survey data are presented in this report.

8.1. *Sex ratio and body length*
Values of body length of the sampled individuals are shown in Table 13. Out of 100 minke whales caught, female was only 9 as compared with 91 males. Sex ratio was marked biased toward male in all research periods (first period: 100%, second period: 90.8%, third period: 85.7%). This is result the same as that obtained in 1994.

The average body length of 91 males sampled was 7.38 +/- 0.48m, which indicated no significant changes from that for male in 1994 (7.39 +/- 0.42m). On the other hand, the average body length for female was 7.54 +/- 0.75m, which was larger by 1.1m than in 1994.

8.2. *Blubber thickness and the body girth length*
Table 14 shows the blubber thickness measured below dorsal fin. The average thickness of male blubber was 3.0 +/- 0.5cm (range: 2.2-4.4cm), slightly thinner than that of 1994 (3.5 +/- 0.7cm, range: 2.4-4.8cm, n=18). Notably, it tended to be thinnest for the individuals collected in the first period and second period. On the other hand, the average blubber thickness of female blubber was 3.5 +/- 0.6cm, more or less unchanged from the previous year's values (3.3 +/- 0.3cm in the 1994 research).

Body girth length is shown in Table 15. Here, body girth length means the length of girth radius at the navel. The average body girth length for male was 186+/- 13cm (range: 130 - 216cm), smaller by 13cm than in 1994. The average body girth length for female was 206+/-6 cm (range:190-222cm), larger by 32cm than in the previous year.

8.3. *Fetus size (conception date)*
Seven out of nine females sampled were mature individuals and had fetus. The list of fetuses is shown in Table 16. The body length of the seven fetuses was in the range of 50 to 80 cm, excluding on very small fetus with the length of 9.33cm. The relations between the sampling date and the body length of the fetuses are shown in Fig. 6. All fetuses were considered to have been conceived at roughly the same time as the Okhotsk-Western North Pacific stock ('O' stock).

8.4. *Anomaly in tissues of sampled whales*
Anomaly was found in both (right and left) or either one the reproductive glands (testes and epididymes) in 21 of 91 male whales sampled (Table 17). These showed transformation in part of or entire tissue, and milk-white color purulent matters or those turned into lime were found. The emergence rates in the second and third period were 6.8%, 5.6% for those in which anomalies found on both testes, and when combined with those in which anomalies were found in only one (16.9% and 27.8%, respectively), the emergency rate exceeded 20%. In the 1994 JARPN survey, anomaly was found in only one individual (5.6%) of the 18 male individuals samples. These reproductive glands were preserved in 10% formalin solution for closer examination in later days.

Furthermore, anomalies were detected in whale baleen plates in 3 individuals sampled. Two of them (Nos. 22, 30) had numberless small holes at about 10cm from the gum layer, and in the other individuals (No. 50), part of baleen dropped because of decay of gums, apparently not functioning as baleen.

8.5. *Feeding habit*

Table 18 shows the stomach contents based on conventional classification of the first stomach for 93 individuals, excluding 7 whose first stomach had been destroyed by the harpoon. Throughout the research period, the relative richness of the first stomach was 1 (small quantity: less than 24%) to 2 (to some degree: 49-25%) for many individuals. In the first period, there was no single individual whose stomach was full (4: 100-75%) while in the second period, 16 individuals (25.7%) showed the index of 3 (large: 74-50%) or over. In the third period, majority showed index 1-2, as in the first period, although there were some individuals with full stomach.

Animal plankton such as krill (*Euphausia pacifica*) and pelagic fishes such as Pacific saury (*Cololabis saira*), Japanese anchovy (*Engraulis japonicus*), Japanese sardine (*Sardinops sagaxmelanosticta*), and Pacific pomfret (*Brama japonica*) were identified from observation of stomach contents at the time of biological research. These prey species had been identified also in the 1994 survey. Besides theses species copepods, and other species of fish such as barracuda and pink salmon (*Oncorhynchus gorbuscha*) were newly confirmed (Table 19). Furthermore, Pacific saury was largest in quantity in the prey species confirmed from the stomach contents of sampled minke whales. It was therefore believed that Pacific saury is a major prey species for minke whales in this area.

8.6. *Parasites*

The location examined for parasitological survey were mainly body surface, blubber, stomach, intestines (mainly small intestine), lung (mainly trachea), liver (mainly liver pipe), pancreas (mainly pancreas pipe), kidney (mainly main and urinal route). The locations other than these were examined whenever anomalies were found during the flensing or other sampling activities. The parasites collected are preserved in appropriate ways and will be examined in detail in later days.

Table 20 shows the list of parasites collected from each part of minke whales, and Table 21 shows the parasiting rate. *Anisakis simplex* in the stomach and *Bolbosome* sp. in the small intestine were found in all minke whales sampled. Furthermore, *Trematodae* which were believed to have parasited on liver were also detected from pancreas. Moreover, *Nematodes* were found at the tip of the small intestine (ileo-cecal part), and identified as larvae of *Anisakis simplex* as a result of microscopic observation in later days. Furthermore, in one individual collected in the third period, a large number of whale lice were found all over the stomach.

DISCUSSIONS

During the research on minke whales in sub-area 9 conducted in 1994, only 21 samples were collected because of poor visibility due to fog and adverse weather condition due to low atmospheric pressures. For this reason, the present research was conducted in sub-area 9 again as the continuation of the 1994 feasibility research, from 13 June to 22 August. The objection to choice the same sub-area was to increase sample size and discuss whether there exist annual fluctuations. Drastically different from 1994, the inflow of warm atmosphere was hampered because of the stay of the front line on the southern part of the research area in 1995. As a result, research was conducted under more favorable weather conditions, resulting in the catch of the targeted number of 100 minke whales. In this report, the characteristics of minke whales distribution in the area are discussed in a comparative point of view with the results of the

1994 research.

Fig. 7 shows the perpendicular distance distribution of minke whales based on sighting angle and distance by searching mode. This figure also shows the cue for sighting. Thanks to favorable weather, 82% of the total searching distance was surveyed by normal survey mode (BC mode). However, the sighting distance of minke whales was largely limited to the range of 1.5 n.miles horizontally as same as in 1994, and the cue was mainly whale body. Furthermore, sighting of 1.5 n.miles or longer was confined to other cue such as jumping. The results coincided with the report of Buckland *et al.* (1992) and may be regarded as the sighting characteristic of minke whales in the North Pacific.

The relationship between sea surface temperature and number of schools of minke whale sighted, is shown in Fig. 8, by research period. Seawater temperature in the first period (June) stayed in the range of 5 to 12°C, and minke whales were found in the southern side of the area, with the most frequent seawater temperature at time of sighting being 12°C. In the second period (early July to early August), the seawater temperature was predominantly 10 to 20°C in the research area. Sightings during this period concentrated in the temperature zone peaking at 13°C. Further, in the third period (mid-August), minke whales were sighted in the water temperature zone of 14-15°C, and the water temperature in which minke whales were found varied in June - August. However, there was no significant changes in the composition of the stomach contents, with Pacific saury being the main feed organism in every period. Comparative examination of the distribution of Pacific saury and minke whales might be necessary. Furthermore, it is should be noted that one of these prey species was pink salmon.

Fig. 9 shows the relationship between estimated body length at the time of sighting of sampled individuals and their actually measured values. Although there are variations between estimated body length and actually measured values, there exist positive correlation and it is possible to estimate roughly the actual size of whale body through estimates of body length. Comparative studies were made on body length composition of the sighted whales and collected whales using the estimated length of minke whales sighted during the sighting surveys (Fig. 10). Although this figure does not include the individuals whose body length could not be estimated, no significant differences are observed in body length composition of sighted whales and sampled whales, maybe suggesting that individuals collected represent the whales distributed in the area. Fig. 11 shows the body length composition of collected samples. This figure also shows the body length composition of whales caught by small-type whaling in the Japanese coastal area and also body length composition obtained in the 1994 research. Body length composition of minke whales in the offshore part of sub-area 9 which was conducted the JARPN surveys in 1995 shows the unimodal distribution with the peak body length of 7.4m for male. This seems to coincide with the peak for large individuals in the Eastern Hokkaido and the area off Sanriku. However, only a small number of small individuals as recognized in the coastal areas have emerged. Furthermore, based on the research on caught individuals, it is considered that a majority of large individuals are mature males and the distribution of immature individuals and mature females was scarce. This may suggest the segregation according to the growth stage in the coastal area and offshore area of Japan. Furthermore, although no sufficient number of samples were obtained to make comparison about female, it is considered from two years of research that females distributed in offshore areas show wide range of body length from 4.8m to 8.2m, and when considered together with male composition, it may be close to body length composition in eastern Hokkaido.

In the 1994 research, *Anisakis simplex* in the stomach and *Bolbosome* sp. in small intestine were detected as internal parasites, but, as parasite experts were onboard the research vessel in 1995, the presence of Cestoda (species unidentified) in 16.0% of minke whales sampled, besides *Anisakis simplex* and *Bolbosome* sp . was identified. Detailed data have not been clarified as regard the number of parasites and parasiting rates, but the presence of 2-3 species of cestoda have been reported in minke whales in the Japanese coastal areas. We have to look toward future analysis for conclusive remark but assumption that the ground for the minke whales in the coastal and offshore areas of Japan differ in terms of stock does not enjoy a strong support, even from the viewpoint of parasite studies.

Furthermore, there have been reports that, based on the research and studies to date, minke whales in the offshore area have the same mtDNA haplotype composition and isozyme composition as that of the Okhotsk Sea-West Pacific stock, mature females have the same conception period with the stock, and that no visible differences were observed in terms of external morphology and accumulation of pollutants. However, three is no adequate sample size for the coastal area which can be adequately compared, except for some studies. Therefore, it is much desired that analysis of data and samples collected in the present research will be made. At the same time, it is much desired that this type of detailed research will be conducted in the Pacific coastal areas of Japan and their results is fully compared and examined.

ACKNOWLEDGMENTS

The authors present profound appreciation to Dr. Hiroshi Hatanaka, Director-general of the National Research Institute of Far Seas Fisheries, for his guidance in the design and implementation of this research. We are also deeply indebted to the support, cooperation and guidance of Mr. Masayuki Komatsu of the Whaling Section and other officials of the Fisheries Agency, the Government of Japan. In actual implementation, we owed greatly to the guidance and support from Dr. Fukuzo Nagasaki, former Director-general, and Dr. Seiji Ohsumi, Director-general of the Institute of Cetacean Research. We express warm appreciation to all the crew and the staff of the Institute of Cetacean Research and other related institutions who participated in the research. We also thank Dr. Luis A. Pastene for valuable suggestion for preparing of this manuscript. The present covered in this report was funded under the subsidy of the Ministry of Agriculture, Forestry and Fisheries, Government of Japan.

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Table 1. Summary of cruise track of the JARPN survey in 1995

Stratum	Way point		Course direction	Distance (n. miles)	Date
First period	WP1	40°00'N, 160°23'E	59	500.5	6 June
6-30 June	WP2	44°18'N, 170°00'E	304	457.8	17 June
	WP3	48°34'N, 160°51'E	189	520.4	22 June
	WP4	40°00'N, 158°57'E	304	107.5	28 June
	WP5	41°00'N, 157°00'E	59	73.8	29 June
	WP6	41°38'N, 158°24'E			30 June
Second Period	WP201	42°00'N, 157°00'E	159	128.2	1 July
1 July-	WP202	40°00'N, 158°00'E	21	128.2	3 July
6 August	WP203	42°00'N, 159°00'E	323	148.8	9 July
	WP204	44°00'N, 157°00'E	35	147.1	16 July
	WP205	46°00'N, 159°00'E	19	126.9	19 July
	WP206	48°00'N, 160°00'E	161	126.9	20 July
	WP207	46°00'N, 161°00'E	215	147.1	21 July
	WP208	44°00'N, 159°00'E			28 July
SMS-A	WP-A1	40°40'N, 159°00'E	270	57.1	6 July
6-8 July	WP-A2	40°40'N, 157°45'E	360	10	6 July
	WP-A3	40°50'N, 157°45'E	90	56.9	6 July
	WP-A4	40°50'N, 158°18'E			
	WP-A5	40°40'N, 159°00'E	90	53.3	7 July
	WP-A6	40°40'N, 160°10'E	360	15	7 July
	WP-A7	40°55'N, 160°10'E	270	53.1	7 July
	WP-A8	40°55'N, 158°28'E			8 July
SMS-B	WP-B1	42°05'N, 158°35'E	270	59.6	10 July
10-15 July	WP-B2	42°05'N, 157°15'E	180	15	10 July
	WP-B3	41°50'N, 157°15'E	90	190.6	11 July
	WP-B4	41°50'N, 161°30'E	360	15	12 July
	WP-B5	42°05'N, 161°30'E	270	108	13 July
	WP-B6	42°05'N, 159°05'E	180	65	13 July
	WP-B7	41°00'N, 159°05'E	270	15.1	14 July
	WP-B8	41°00'N, 158°45'E	360	60	14 July
	WP-B9	42°00'N, 158°45'E			15 July
SMS-C	WP-C1	45°00'N, 158°20'E	90	17.7	17 July
17 July	WP-C2	45°00'N, 158°45'E	360	15	17 July
	WP-C3	45°05'N, 157°50'E			
SMS-D	WP-D1	45°20'N, 160°00'E	270	91.7	22 July
22-27 July	WP-D2	45°20'N, 157°50'E	180	15	22 July
	WP-D3	45°05'N, 157°50'E	90	163	23 July
	WP-D4	45°05'N, 161°40'E	360	15	26 July
	WP-D5	45°20'N, 161°40'E	270	56.4	26 July
	WP-D6	45°20'N, 160°20'E			27 July
SMS-E	WP-E1	44°00'N, 159°20'E	90	101	29 July
29 July -	WP-E2	44°00'N, 161°40'E	180	15	1 August
5 August	WP-E3	43°45'N, 161°40'E	270	159.5	2 August
	WP-E4	43°45'N, 158°00'E	360	15	3 August
	WP-E5	44°00'N, 158°00'E	90	43.3	5 August
	WP-E6	44°00'N, 159°00'E			5 August

SMS: Special monitaring survey

Table 1. (continued)

Stratum	Way point		Course direction	Distance (n. miles)	Date
Third period	WP301	42°00'N, 166°00'E	36	148.8	7 August
8-16 August	WP302	44°00'N, 168°00'E	324	147.1	8 August
	WP303	46°00'N, 166°00'E	34	71.3	9 August
	WP304	46°59'N, 166°58'E	326	143.8	16 August
SMS-F	WP-F1	45°00'N, 166°40'E	270	113.5	9 August
9-13 August	WP-F2	45°00'N, 164°00'E	180	15	10 August
	WP-F3	44°45'N, 164°00'E	90	213.8	10 August
	WP-F4	44°45'N, 169°00'E	360	15	12 August
	WP-F5	45°00'N, 169°00'E	270	78.1	12 August
	WP-F6	45°00'N, 167°10'E			13 August
SMS-G	WP-G1	47°00'N, 166°40'E	270	89	14 August
14-16 August	WP-G2	47°00'N, 164°30'E	180	15	15 August
	WP-G3	46°45'N, 164°30'E	90	75.6	16 August
	WP-G4	46°45'N, 166°20'E			16 August
SS-K01	WP401	49°00'N, 167°00'E	326	71.6	17 August
17-22 August	WP402	50°00'N, 166°00'E	319	59.1	18 August
	WP403	50°45'N, 165°00'E	220	59.1	18 August
	WP404	50°00'N, 164°00'E	146	143.8	19 August
	WP405	48°00'N, 166°00'E	214	145.5	20 August
	WP406	46°00'N, 164°00'E			21 August
SS-T25	WP501	46°59'N, 166°58'E	34	74.1	17 August
17-22 August	WP502	48°00'N, 168°00'E	326	72.1	17 August
	WP503	49°00'N, 167°00'E	270	158	17 August
	WP504	49°00'N, 163°00'E	146	72.1	19 August
	WP505	48°00'N, 164°00'E	214	145.5	19 August
	WP506	46°00'N, 162°00'E	144	147.1	20 August
	WP507	44°00'N, 164°00'E	216	148.8	21 August
	WP508	42°00'N, 162°00'E			22 August
SS-T18	WP601	46°45'N, 166°20'E	90	110	17 August
17-22 August	WP602	46°45'N, 169°00'E	360	15	17 August
	WP603	47°00'N, 169°00'E	282	291	17 August
	WP604	48°00'N, 162°00'E	214	145.5	18 August
	WP605	46°00'N, 160°00'E	144	147.1	20 August
	WP606	44°00'N, 162°00'E	216	148.8	21 August
	WP607	42°00'N, 160°00'E			22 August

SMS: Special monitaring survey, SS: Sighting survey by single vessel

Table 2. Searching distances (n.miles) of BC mode survey by one degree and research period

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.0
50°N														0.0
49°N														0.0
48°N				71.2	124.5									195.7
47°N				117.8		8.0	32.0	17.9						175.7
46°N				64.1				2.2						66.3
45°N										25.0	135.5	82.8		243.3
44°N			88.2	20.5								46.8	247.2	402.7
43°N			174.9							11.6	106.4	147.9	46.6	487.4
42°N			179.5					1.4	11.2	3.7	13.4			209.2
41°N	131.0	50.7	158.5			25.3	41.8	89.5						496.8
40°N	148.8	212.7	112.5	69.4	41.2	45.4								630.0
Total	279.8	263.4	713.6	343.0	165.7	78.7	73.8	111.0	11.2	40.3	255.3	277.5	293.8	2,907.1

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.0
50°N														0.0
49°N														0.0
48°N														0.0
47°N			28.2	35.5										63.7
46°N		10.0	125.3	52.6	9.1									197.0
45°N	73.7	219.3	211.8	288.2	92.5									885.5
44°N		72.1	82.5	81.8	34.7									271.1
43°N	9.4	95.3	245.7	120.2	129.2									599.8
42°N	44.0	13.9	10.7	195.9	13.0									277.5
41°N	63.3	157.9	145.6		0.9									367.7
40°N	158.6	262.2	205.1	86.3										712.2
Total	349.0	830.7	1,054.9	860.5	279.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,374.5

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														
50°N								14.1	33.3					47.4
49°N								29.5						29.5
48°N							7.1		29.3					36.4
47°N							20.2	29.8	99.8	22.7				172.5
46°N				47.8		63.0		143.6	151.9	257.2	3.1			666.6
45°N				72.8	0.5	73.3	0.3	77.3	83.8	240.5	58.5	53.1	13.3	673.4
44°N					72.5		50.9	190.6	130.6	167.2	331.8	165.4	30.6	1,139.6
43°N				0.5	21.2					13.2	183.7			218.6
42°N				161.4	55.8	7.6			6.5	178.3	11.0			420.6
41°N														0.0
40°N														0.0
Total	0.0	0.0	0.0	282.5	150.0	143.9	78.5	484.9	535.2	879.1	588.1	218.5	43.9	3,404.6

Table 3. Searching distances (n. miles) of BS mode survey by one degree and research period

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.0
50°N														0.0
49°N														0.0
48°N				20.2	4.1									24.3
47°N				36.0		31.1	35.1	7.6						109.8
46°N								62.0	31.7					93.7
45°N			30.7	40.0						12.0				82.7
44°N			40.3	21.9										62.2
43°N											5.2			5.2
42°N			2.4					35.0	79.2	120.9	1.8			239.3
41°N			15.4			43.7	64.2	29.6	2.1					155.0
40°N				19.8	47.6	44.2								111.6
Total	0.0	0.0	88.8	137.9	51.7	119.0	99.3	134.2	113.0	132.9	7.0	0.0	0.0	883.8

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.0
50°N														0.0
49°N														0.0
48°N														0.0
47°N			56.1	79.0										135.1
46°N		13.0	30.2	80.7										123.9
45°N		79.7	15.1	0.9	55.1									150.8
44°N	34.3	8.8	73.6	0.0	17.4									134.1
43°N	36.3	85.2	71.8	45.3	14.0									252.6
42°N	33.5	150.1	1.3	2.7	13.5									201.1
41°N	114.3	58.3	11.1											183.7
40°N	19.9	35.2	26.4											81.5
Total	238.3	430.3	285.6	208.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,262.8

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.0
50°N														0.0
49°N														0.0
48°N														0.0
47°N														0.0
46°N														0.0
45°N														0.0
44°N											10.9			10.9
43°N											0.2			0.2
42°N														0.0
41°N														0.0
40°N														0.0
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	11.1

	Searching mode *					
	BC mode		BS mode		OE	
	Primary	Secondary.	Primary	Secondary.	Secondary	
First period						
Minke whale	12 / 12	2 / 3	1 / 1	-	2 / 2	**
Like minke whale	3 / 3	2 / 2	-	1 / 1	-	
Blue whale	2 / 5	-	-	-	-	
Fin whale	9 / 12	-	-	-	-	
Humpback whale	9 / 19	1 / 4	-	-	-	
Right whale	-	-	-	-	1 / 1	
Sperm whale	55 / 64	2 / 2	14 / 14	1 / 1	2 / 2	
Killer whale	11 / 38	2 / 12	3 / 6	-	-	
Cuvier's beaked whale	2 / 3	-	-	-	-	
Unidentified Mesoplodon	15 / 39	-	1 / 2	-	1 / 3	
Unidentified Ziphiidae	13 / 23	-	3 / 7	-	1 / 1	
Dall's porpoise						
dalli type	61 / 284	3 / 16	12 / 77	1 / 6	4 / 19	
Unidentified type	33 / 191	2 / 30	5 / 22	-	1 / 2	
Pacific white-sided dolphin	2 / 140	-	-	-	-	
Right whale dolphin	3 / 70	-	-	-	-	
Unidentified large cetacean	3 / 3	5 / 13	1 / 1	-	-	
Unidentified small cetacean	120 / 825	10 / 49	5 / 45	4 / 17	4 / 18	
Unidentified cetacean	20 / 24	4 / 5	3 / 3	-	1 / 1	
Second period						
Minke whale	48 / 48	19 / 19	9 / 9	2 / 2	18 / 23	**
Like minke whale	1 / 1	2 / 2	-	1 / 1	2 / 2	
Blue whale	4 / 12	1 / 1	1 / 1	-	1 / 1	
Fin whale	5 / 8	-	-	-	-	
Sei whale	6 / 7	2 / 2	1 / 1	-	3 / 4	
Humpback whale	1 / 1	-	2 / 2	-	-	
Sperm whale	51 / 64	14 / 14	7 / 7	-	11 / 11	
Killer whale	9 / 33	1 / 5	2 / 6	-	-	
Cuvier's beaked whale	1 / 2	-	-	-	1 / 3	
Unidentified Mesoplodon	2 / 5	1 / 4	2 / 4	-	1 / 1	
Unidentified Ziphiidae	35 / 81	10 / 26	7 / 11	-	-	
Dall's porpoise						
dalli type	54 / 235	7 / 29	16 / 66	3 / 19	22 / 109	
Unidentified type	39 / 200	7 / 24	19 / 83	-	10 / 27	
Pacific white-sided dolphin	5 / 180	1 / 400	3 / 240	-	2 / 33	
Right whale dolphin	3 / 170	-	3 / 111	-	-	
Unidentified large cetacean	10 / 11	1 / 1	1 / 1	-	2 / 2	
Unidentified small cetacean	136 / 1,250	15 / 71	18 / 69	9 / 50	9 / 65	
Unidentified cetacean	36 / 38	12 / 13	13 / 13	3 / 3	3 / 3	
Third period						
Minke whale	20 / 21	7 / 7	-	-	4 / 4	**
Like minke whale	-	-	-	-	1 / 1	
Blue whale	-	-	-	-	3 / 4	
Fin whale	4 / 4	-	-	-	-	
Sei whale	5 / 9	-	-	-	1 / 2	
Humpback whale	8 / 11	1 / 1	-	-	1 / 2	
Right whale	1 / 1	-	-	-	-	
Sperm whale	116 / 129	6 / 6	-	-	4 / 5	
Killer whale	17 / 80	2 / 14	-	-	-	
Cuvier's beaked whale	-	-	-	-	-	
Unidentified Mesoplodon	3 / 8	-	-	-	-	
Unidentified Ziphiidae	48 / 89	4 / 7	-	-	2 / 2	
Dall's porpoise						
dalli type	36 / 134	5 / 15	-	-	3 / 8	
black type	1 / 1	-	-	-	-	
Unidentified type	54 / 219	3 / 19	-	-	2 / 6	
Pacific white-sided dolphin	6 / 930	-	-	-	1 / 250	
Right whale dolphin	9 / 940	-	-	-	1 / 50	
Risso's dolphin	1 / 8	-	-	-	-	
Unidentified large cetacean	6 / 7	1 / 1	-	-	1 / 1	
Unidentified small cetacean	105 / 1,372	8 / 83	-	-	2 / 6	
Unidentified cetacean	26 / 26	8 / 8	-	-	1 / 1	

*: See text

**: including secondary sightings (1/1 in the first period, 10/14 in the second period and 3/3 in the third period) by the research base.

Table 5. Distribution of primary sighting of minke whale by BC mode searching by one degree

A. School base

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N				0	0	0								0
47°N				1			0	0						1
46°N				0				0						0
45°N										0	0	0		0
44°N			0	0								0	1	1
43°N			0							0	0	0	0	0
42°N			0					0	0	0	0			0
41°N	5	0	1			0	0	0						6
40°N	3	1	0	0	0	0								4
Total	8	1	1	1	0	0	0	0	0	0	0	0	1	12

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N	2	9	6	7	2									26
44°N				1										1
43°N			1	3										4
42°N	3													3
41°N		3	1											4
40°N	2	4	2	2										10
Total	7	16	10	13	2	0	0	0	0	0	0	0	0	48

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N								0	0					0
49°N								0						0
48°N							0		0					0
47°N							0	2	2	1				5
46°N				0		0		2	1	1	0			4
45°N				0	0	0	0	2	0	1	0	0	0	3
44°N					0		0	2	1	0	1	1	0	5
43°N				0	0					0	0			0
42°N				0	1	0			0	2	0			3
41°N														0
40°N														0
Total	0	0	0	0	1	0	0	8	4	5	1	1	0	20

B. individual base

First period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N				1										1
46°N														0
45°N														0
44°N													1	1
43°N														0
42°N														0
41°N	5		1											6
40°N	3	1												4
Total	8	1	1	1	0	0	0	0	0	0	0	0	1	12

Second period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N	2	9	6	7	2									26
44°N				1										1
43°N			1	3										4
42°N	3													3
41°N		3	1											4
40°N	2	4	2	2										10
Total	7	16	10	13	2	0	0	0	0	0	0	0	0	48

Third period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N								0	0					0
49°N								0						0
48°N							0		0					0
47°N							0	2	2	1				5
46°N				0		0		2	1	1	0			4
45°N				0	0	0	0	2	0	1	0	0	0	3
44°N					0		0	2	1	0	1	2	0	6
43°N				0	0					0	0			0
42°N				0	1	0			0	2	0			3
41°N														0
40°N														0
Total	0	0	0	0	1	0	0	8	4	5	1	2	0	21

Table 6. Distribution of primary sighting of minke whale by BS mode searching by one degree

A. School base

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N				0	0									0
47°N				0		0	0	0						0
46°N								0	0					0
45°N			0	0						0				0
44°N			0	0										0
43°N											0			0
42°N			0					0	0	0	0			0
41°N			1			0	0	0	0					1
40°N				0	0	0								0
Total	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N														0
44°N			1											1
43°N	2			1	1									4
42°N	2													2
41°N	1													1
40°N		1												1
Total	5	1	1	1	1	0	0	0	0	0	0	0	0	9

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N														0
44°N											0			0
43°N											0			0
42°N														0
41°N														0
40°N														0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

B. individual base

First period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N														0
44°N														0
43°N														0
42°N														0
41°N			1											1
40°N														0
Total	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Second period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N														0
44°N			1											1
43°N	2			1	1									4
42°N	2													2
41°N	1													1
40°N		1												1
Total	5	1	1	1	1	0	0	0	0	0	0	0	0	9

Third period

	Longitude													
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0
50°N														0
49°N														0
48°N														0
47°N														0
46°N														0
45°N														0
44°N											0			0
43°N											0			0
42°N														0
41°N														0
40°N														0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7. Density indicies (no. of schools/100 n. miles) of minke whales by BC mode searching by one degree.

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.00
50°N														0.00
49°N														0.00
48°N				0.00	0.00									0.00
47°N				0.85		0.00	0.00	0.00						0.57
46°N				0.00				0.00						0.00
45°N										0.00	0.00	0.00		0.00
44°N			0.00	0.00								0.00	0.40	0.25
43°N			0.00							0.00	0.00	0.00	0.00	0.00
42°N			0.00					0.00	0.00	0.00	0.00			0.00
41°N	3.82	0.00	0.63			0.00	0.00	0.00						1.21
40°N	2.02	0.47	0.00	0.00	0.00	0.00								0.63
Total	2.86	0.38	0.14	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.41

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.00
50°N														0.00
49°N														0.00
48°N														0.00
47°N			0.00	0.00										0.00
46°N		0.00	0.00	0.00	0.00									0.00
45°N	2.71	4.10	2.83	2.43	2.16									2.94
44°N		0.00	0.00	1.22	0.00									0.37
43°N	0.00	0.00	0.41	2.50	0.00									0.67
42°N	6.82	0.00	0.00	0.00	0.00									1.08
41°N	0.00	2.53	0.69		0.00									1.36
40°N	1.26	1.53	0.98	2.32										1.40
Total	2.01	2.05	0.95	1.51	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.45

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.00
50°N								0.00	0.00					0.00
49°N								0.00						0.00
48°N							0.00		0.00					0.00
47°N							0.00	6.71	2.00	4.41				2.90
46°N				0.00		0.00		1.39	0.66	0.39	0.00			0.60
45°N				0.00	0.00	0.00	0.00	2.59	0.00	0.42	0.00	0.00	0.00	0.45
44°N					0.00		0.00	1.05	0.77	0.00	0.30	0.60	0.00	0.44
43°N				0.00	0.00					0.00	0.00			0.00
42°N				0.00	1.79	0.00			0.00	1.12	0.00			0.71
41°N														0.00
40°N														0.00
Total	0.00	0.00	0.00	0.00	0.67	0.00	0.00	1.65	0.75	0.57	0.17	0.46	0.00	0.59

Table 8. Density indicies (no. of schools/100 n. miles) of minke whales by BS mode searching by one degree.

First period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.00
50°N														0.00
49°N														0.00
48°N				0.00	0.00									0.00
47°N				0.00		0.00	0.00	0.00						0.00
46°N								0.00	0.00					0.00
45°N			0.00	0.00						0.00				0.00
44°N			0.00	0.00										0.00
43°N											0.00			0.00
42°N			0.00					0.00	0.00	0.00	0.00			0.00
41°N			6.49			0.00	0.00	0.00	0.00					0.65
40°N				0.00	0.00	0.00								0.00
Total	0.00	0.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Second period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														0.00
50°N														0.00
49°N														0.00
48°N														0.00
47°N			0.00	0.00										0.00
46°N		0.00	0.00	0.00										0.00
45°N		0.00	0.00	0.00	0.00									0.00
44°N	0.00	0.00	1.36		0.00									0.75
43°N	5.51	0.00	0.00	2.21	7.14									1.58
42°N	5.97	0.00	0.00	0.00	0.00									0.99
41°N	0.87	0.00	0.00											0.54
40°N	0.00	5.68	0.00											2.45
Total	2.10	0.46	0.35	0.48	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79

Third period

	Longitude												
	157°E	158°E	159°E	160°E	161°E	162°E	163°E	164°E	165°E	166°E	167°E	168°E	169°E	Total
51°N														
50°N														0.00
49°N														0.00
48°N														0.00
47°N														0.00
46°N														0.00
45°N														0.00
44°N											0.00			0.00
43°N											0.00			0.00
42°N														0.00
41°N														0.00
40°N														0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 9. Numbers of minke whales sighted and sampled by the sighting/sighting vessels and their sampling efficiencies

Period	Sighted		Targeted		Sampled	Sampling efficiencies	
	Sch. (A)	Ind. (B)	Sch. (C)	Ind. (D)	Ind. (E)	Technical (F/D)	True (F/B)
First	17	18	17	18	14	0.78	0.78
Second	96	101	89	94	65	0.69	0.64
Third	31	32	25	26	21	0.81	0.66
Total	144	151	131	138	100	0.72	0.66

Table 10. Cause of failure to collect samples targeted by research period. A: long diving; B: quick/mobile behavior; C: rough sea condition; D: technical problems; E: missing of the targeted animal before chasing; F: other

Period	Reason why whales could not be sampled						Total
	A	B	C	D	E	F	
First	1	1	0	0	1	1	4
Second	6	3	2	3	15	0	29
Third	2	3	0	0	0	0	5
Combined	9	7	2	3	16	1	38

Table 11. Summary of biological data and samples collected

Samples and data	Number of whales		
	Male	Female	Total
Body length and sex	91	9	100
External body proportion	91	9	100
Photographic record and external character	91	9	100
Diatom film record and sampling	91	9	100
Standard measurements of blubber thickness (three points)	91	9	100
Detailed measurements of blubber thickness	26	3	29
Body weight	91	9	100
Body weight by parts	26	3	29
Blubber, muscle, liver and heart tissues for DNA study	91	9	100
Muscle, liver and heart tissues for isozyme analysis	91	9	100
Muscle, liver and kidney tissues for heavy metal analysis	91	9	100
Blubber, muscle, liver and kidney tissues for organochlorine analysis	91	9	100
Tissues for lipid analysis	26	3	29
Muscle, liver, limpa and intestine tissue for bacteria study	26	3	29
Mammary grand; lactation status, measurements and histological sample	-	9	9
Ovary collection	-	9	9
Uterine horn; measurement and endometrium sample	-	9	9
Uterine mucus for sperm detection	-	9	9
Photographic record of fetus	-	-	7
Fetal sex (identified by visual observation)	(2)	(5)	(7)
Fetal length and weight	(2)	(5)	(7)
External measurements of fetus	(2)	(4)	(6)
Collection of fetus	(2)	(5)	(7)
Testis and epididymis; weight and histlogical sample	91	-	91
Smear samples from testis and epididymis tissues	91	-	91
Urine sample for sperm detection	77	-	77
Urine sample for physiological study	85	8	93
Serum sample for physiological study	91	9	100
Stomach content, conventional record	91	9	100
Weight of stomach content in each compartment	91	9	100
Collection of stomach contents for the food and feeding study	90	8	98
Collection of stomach contents for organochlorine analysis			
Collection of stomach contents for heavy metal analysis	15	2	17
Collection of stomach contents for lipid analysis	10	1	11
Collection of external parasites	23	3	26
Collection of parasites from 1st stomach	1	0	1
Collection of parasites from 2nd stomach	90	7	97
Collection of parasites from 3rd stomach	42	5	47
Collection of parasites from 4th stomach	12	2	14
Collection of parasites from intestine	20	3	23
Collection of parasites from liver	8	1	9
Earplug for age determination	91	9	100
Tympanic bulla for age determination	91	9	100
Largest baleen plate for stock identification	91	9	100
Vertebral ephiphyses sample	91	9	100
Skull measurement (length and breadth)	91	9	100
Detailed measurement of skull	2	3	5
Detailed measurement of skull and skeleton	0	1	1
Collection of skull	0	1	1

Table 12. Products amassed at the research base in the 1995 JARPN survey.

Name of product	Amount (kg)	Name of product	Amount (kg)
O-niku*	135	Throat mottled meat	1,769
O-niku* (regular)	450	Bacon (grade 1)	11,988
Ventral blubber (neck)	75	Bacon (grade 2)	14
Jaw skin (mottled)	345	Bacon (small pieces)	4,050
Jaw skin (regular)	255	Ventral blubber	1,134
Red meat (premium)	1,215	Blubber (premium)	0
Red meat (grade 1)	64,140	Blubber (grade 1)	19,630
Red meat (grade 2)	8,760	Kidney	742
Red meat (regular)	1,965	Heart	1,008
Small pieces (grade 1)	12,510	Pancreas	189
Small pieces (grade 2)	6,930	Esophagus	169
Small pieces (regular)	11,910	Mandibular ligaments (hard)	429
Breast meat (grade 1)	14,205	Mandibular ligaments (soft)	247
Breast meat (grade 2)	32,820	Tongue (mottled)	507
Breast meat (grade 3)	61,335	Tongue	3,705
Breast meat (regular)	870	Tongue (regular)	0
Diaphragm	1,320	First stomach	468
Blubber (regular)	13,125	Intestine	0
Posterior ventral blubber	15,300	Underside of blubber	4,325
Nasal plug	700	Lining of meat	3,225
Tail flukes (premium)	4,475	Testis	72
Tail flukes (regular)	775	Caudal tendon	840
Maxillary cartilage	300	Tendon	7,770

*: Muscles associated with caudal vertebra.

Table1 3. Mean body length of minke whales taken in the JARPN surveys in 1994 and 1995

	Male				Female			
	Mean	S.D.	Range	n	Mean	S.D.	Range	n
1994 survey								
First (5 July-6 Aug.)	7.42	± 0.19	(7.21 - 7.70)	6	5.93		(4.79 - 7.07)	2
Second (7 Aug.-7 Sept.)	7.37	± 0.50	(6.12 - 8.09)	12	7.55			1
Total	7.39	± 0.42	(6.12 - 8.09)	18	6.47	± 1.20	(4.79 - 7.55)	3
1995 survey								
First (13-30 June)	7.25	± 0.56	(5.91 - 7.95)	14				0
Second (1 July-6 Aug.)	7.47	± 0.34	(6.59 - 8.40)	59	7.88	± 0.26	(7.45 - 8.18)	6
Third (7-15 Aug.)	7.21	± 0.68	(4.54 - 7.66)	18	6.87	± 0.93	(5.73 - 8.01)	3
Total	7.38	± 0.48	(4.54 - 8.40)	91	7.54	± 0.75	(5.73 - 8.18)	9

Table1 4. Mean blubber thichness (cm) of minke whales taken in the JARPN surveys in 1994 and 1995

	Male				Female			
	Mean	S.D.	Range	n	Mean	S.D.	Range	n
1994 survey								
First	3.5	± 0.9	(2.7 - 4.8)	6	3.1		(2.9 - 3.3)	2
Second	3.5	± 0.5	(2.4 - 4.3)	12	3.6			1
Total	3.5	± 0.7	(2.4 - 4.8)	18	3.3	± 0.3	(2.9 - 3.6)	3
1995 survey								
First	2.9	± 0.5	(2.3 - 4.4)	14				0
Second	2.9	± 0.4	(2.2 - 4.1)	59	3.6	± 0.6	(2.9 - 4.3)	6
Third	3.4	± 0.5	(2.4 - 4.4)	18	3.2	± 0.7	(2.5 - 4.1)	3
Total	3.0	± 0.5	(2.2 - 4.4)	91	3.5	± 0.6	(2.5 - 4.3)	9

Table1 5. Mean half of girth (cm) at umbilicus of minke whales taken in the JARPN survey in 1944 and 1995

	Male				Female			
	Mean	S.D.	Range	n	Mean	S.D.	Range	n
1994 survey								
First	198	± 9	(183 - 209)	6	162		(131 - 193)	2
Second	199	± 17	(174 - 232)	12	199			1
Total	199	± 15	(174 - 232)	18	174	± 31	(131 - 199)	3
1995 survey								
First	182	± 13	(159 - 200)	14				0
Second	186	± 11	(166 - 216)	58	209	± 7	(203 - 222)	5
Third	186	± 17	(130 - 206)	17	197	± 7	(190 - 203)	2
Total	186	± 13	(130 - 216)	89	206	± 9	(190 - 222)	7

Table1 6. Summary of pregnant females and her fetus collected in this survey

Sampling Date	Sample No.	Body length (m)	Blubber thickness (cm)	Fetus		
				Length (cm)	Weight (kg)	Sex
6 July	18	8.02	4.2	61.4	3.0	M
22 July	48	7.60	3.4	9.3	0.02	F
23 July	57	7.45	4.3	79.7	6.33	F
24 July	58	8.05	2.9	55.6	2.62	F
25 July	71	7.95	3.0	49.6	1.8	F
1 August	76	8.18	3.9	76.8	6.3	F
9 August	86	8.01	3.0	73.8	5.8	M

Table 17. Number of male whales observed abnormal in his gonadal tissues

Survey and research period	n	Normal	Abnormal			
			Both side	(%)	One side	(%)
1994 survey						
First (5 July-6 Aug.)	6	5	0	(0.0)	1	(16.7)
Second (7 Aug.-7 Sept.)	12	12	0	(0.0)	0	(0.0)
Total	18	17	0	(0.0)	1	(5.6)
1995 survey						
First (13-30 June)	14	13	0	(0.0)	1	(7.1)
Second (1 July-6 Aug.)	59	45	4	(6.8)	10	(16.9)
Third (7-15 Aug.)	18	12	1	(5.6)	5	(27.8)
Total	91	70	5	(5.5)	16	(17.6)

Table 18. Composition of relative richness of stomach contents based on conventional classification by the research period

Period	Relative richness (%)					
	Empty	< 25%	25-49%	50-74%	75-100%	Total
First	0 (0.0%)	10 (71.4%)	4 (28.6%)	0 (0.0%)	0 (0.0%)	14
Second	5 (7.9%)	24 (38.1%)	18 (28.6%)	15 (23.8%)	1 (1.6%)	63
Third	0 (0.0%)	8 (50.0%)	6 (37.5%)	1 (6.3%)	1 (6.3%)	16

Table19. Food species of minke whale and their frequency of occurence by survey period

Food species		First		Second		Third		Total	
		n	(%)	n	(%)	n	(%)	n	(%)
Euphausiacea	Euphausiids	1	(7.1)	10	(14.7)	1	(5.6)	12	(12.0)
Copepoda	copepods	0	(0.0)	2	(2.9)	2	(11.1)	4	(4.0)
Salmonids	Pink salmon (*Oncorhynchus gorbuscha*)	2	(14.3)	7	(10.3)	0	(0.0)	9	(9.0)
	Unidentified	1	(7.1)	0	(0.0)	1	(5.6)	2	(2.0)
Sauries	Pacific saury (*Cololabis saira*)	4	(28.6)	58	(85.3)	13	(72.2)	75	(75.0)
Anchovies	Japanese anchovy (*Engraulis japonicus*)	3	(21.4)	4	(5.9)	1	(5.6)	8	(8.0)
Herrings	Japanese sardine (*Sardinops melanostictus*)	1	(7.1)	0	(0.0)	0	(0.0)	1	(1.0)
	Unidentified	4	(28.6)	3	(4.4)	0	(0.0)	7	(7.0)
Barracudas	Unidentified	0	(0.0)	1	(1.5)	0	(0.0)	1	(1.0)
Pomfrets	Pacific pomfret (*Brama japonica*)	0	(0.0)	1	(1.5)	3	(16.7)	4	(4.0)
Daggertooths	Daggertooth (*Anotopterus pharao*)	1	(7.1)	0	(0.0)	0	(0.0)	1	(1.0)
Other fishes	Unidenfitied	0	(0.0)	1	(1.5)	2	(11.1)	3	(3.0)

Table 2 0. List of parasites in minke whales observed

Position	Parasite
Skin	Pennella (Crustacea, Copepoda)
	Lepas (Crustacea, Cirripadia)
	Cyamus (Crustacea, Amphipoda)
Blubber	- (part of pennella)
Stomach	Nematode (*Anisakis simplex*)
Small intestine	Acanthocephala (genus: *Bolbosoma*)
	Cestoda (at least 3 species in *Pseudophyllidea* and *Cyclophyllidea*)
Lung	-
Liver	Trematoda (*Lecithodesmus*)
Pancreas	Trematoda (*Lecithodesmus*)
Kidney	-

Table 2 1. Observation rate of parasitic worm in minke whale taken in the JARPN survey in 1995

Parasitic worm	Body part	First		Second		Third		Total	
		Infected/ exmained	%	Infected/ exmained	%	Infected/ exmained	%	Infected/ exmained	%
External parasite									
Pennella	Skin	12 / 14	92.9	48 / 65	73.8	18 / 21	85.7	78 / 100	78.0
Cirripadia	Skin	0 / 14	0.0	4 / 65	6.2	0 / 21	0.0	4 / 100	4.0
Cyamus	Skin	0 / 14	0.0	3 / 65	4.6	1 / 21	4.8	4 / 100	4.0
Internal parasite									
Nematode	Stomach	14 / 14	100.0	65 / 65	100.0	21 / 21	100.0	100 / 100	100.0
Nematode	Intestine (ileo-cecal part)	- - -	–	10 / 45	22.2	1 / 21	4.8	11 / 66	16.7
Acanthocephala	Small intestine	14 / 14	100.0	65 / 65	100.0	21 / 21	100.0	100 / 100	100.0
Cestoda		3 / 14	21.4	7 / 65	10.8	6 / 21	28.6	16 / 100	16.0
Trematoda	Liver	3 / 14	21.4	31 / 65	47.7	3 / 21	14.3	37 / 100	37.0
Trematoda	Pancreas	0 / 14	0.0	1 / 65	1.5	0 / 21	0.0	1 / 100	1.0

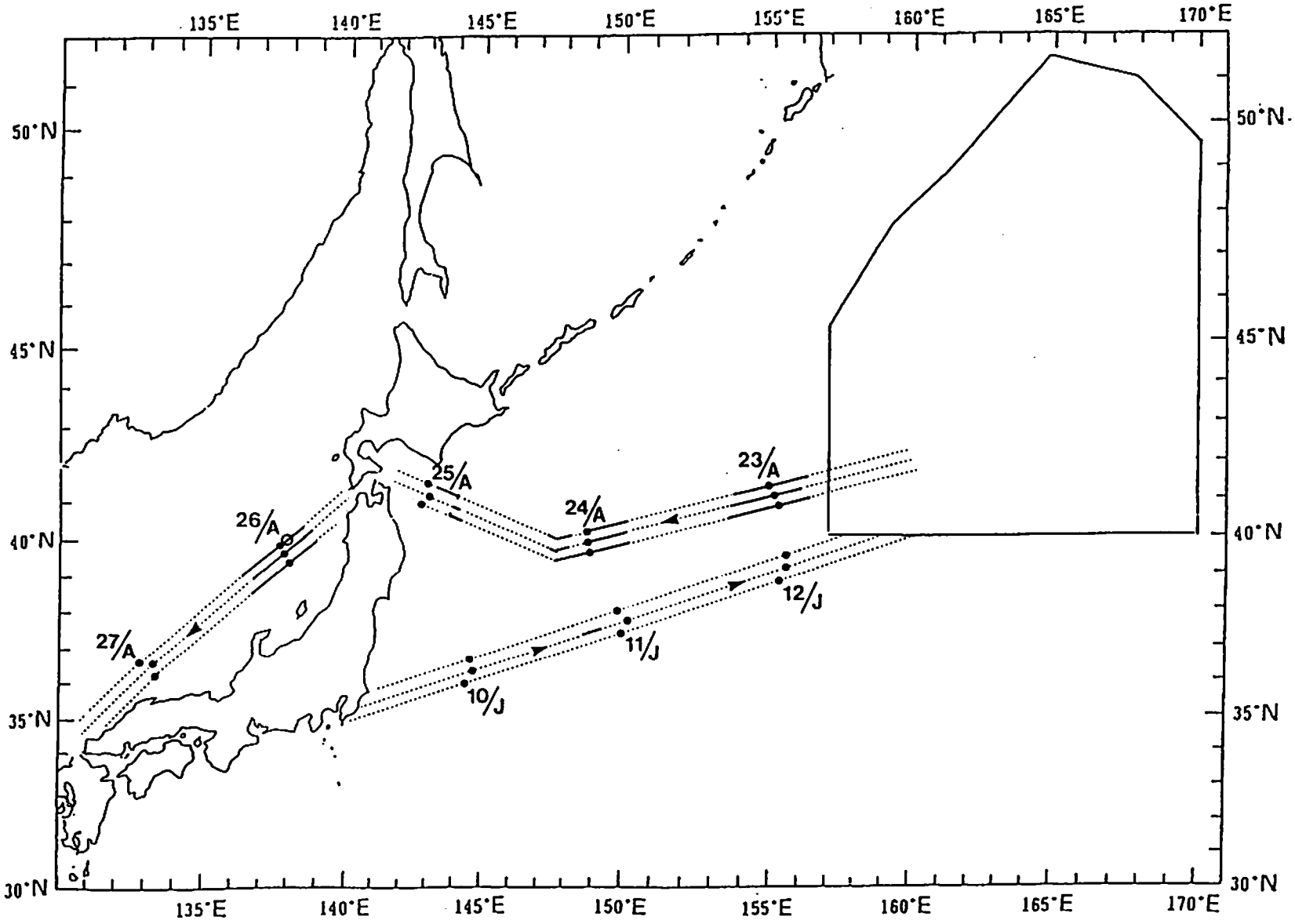

Fig. 1. Geographic location of research area and cruise tracks of sighting survey associated with the 1995 JARPN survey. Closed circles represent the noon positions of three sampling/sighting vessels, solid line indicate the survey conducted, and open circle sighting of minke whale.

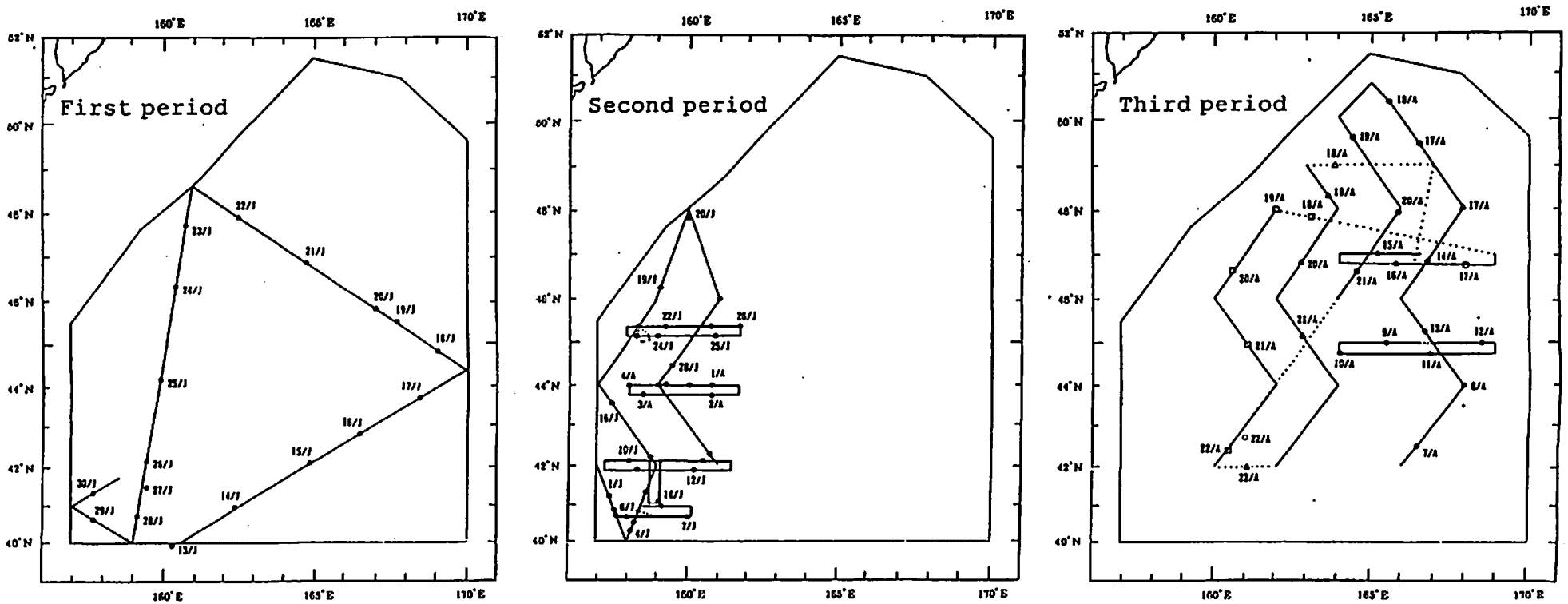

Fig. 2. Cruise track indicating the noon position of the research base (NM: ●) for the JARPN survey in 1995. Figure also shows the noon positions of three sighting/sampling vessels (K01: ○, T25: △, T18: □) after the sampling activities were completed (from 17 August to 22 August).

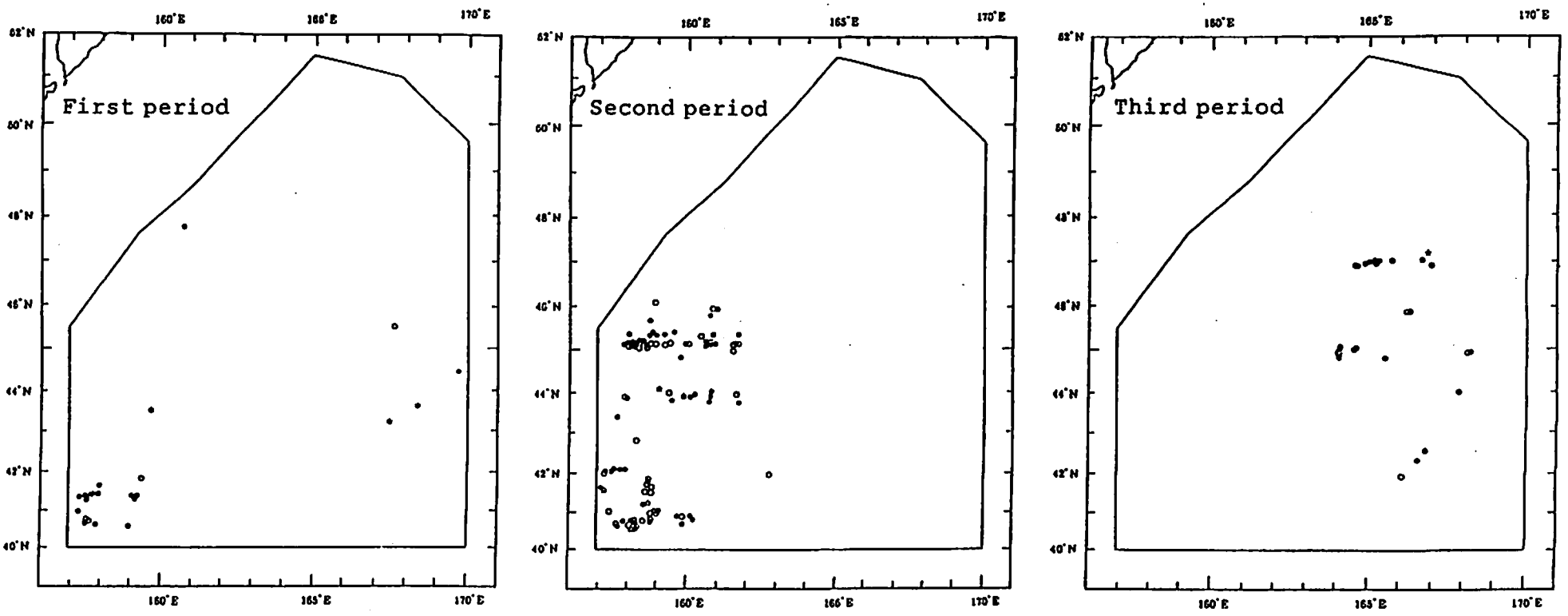

Fig. 3. Distribution of minke whales sighted by three sampling/sighting vessels during the 1995 JARPN. Confirmed minke whale: ● primary, ○ secondary; like minke whale: ✻ primary, ☆ secondary.

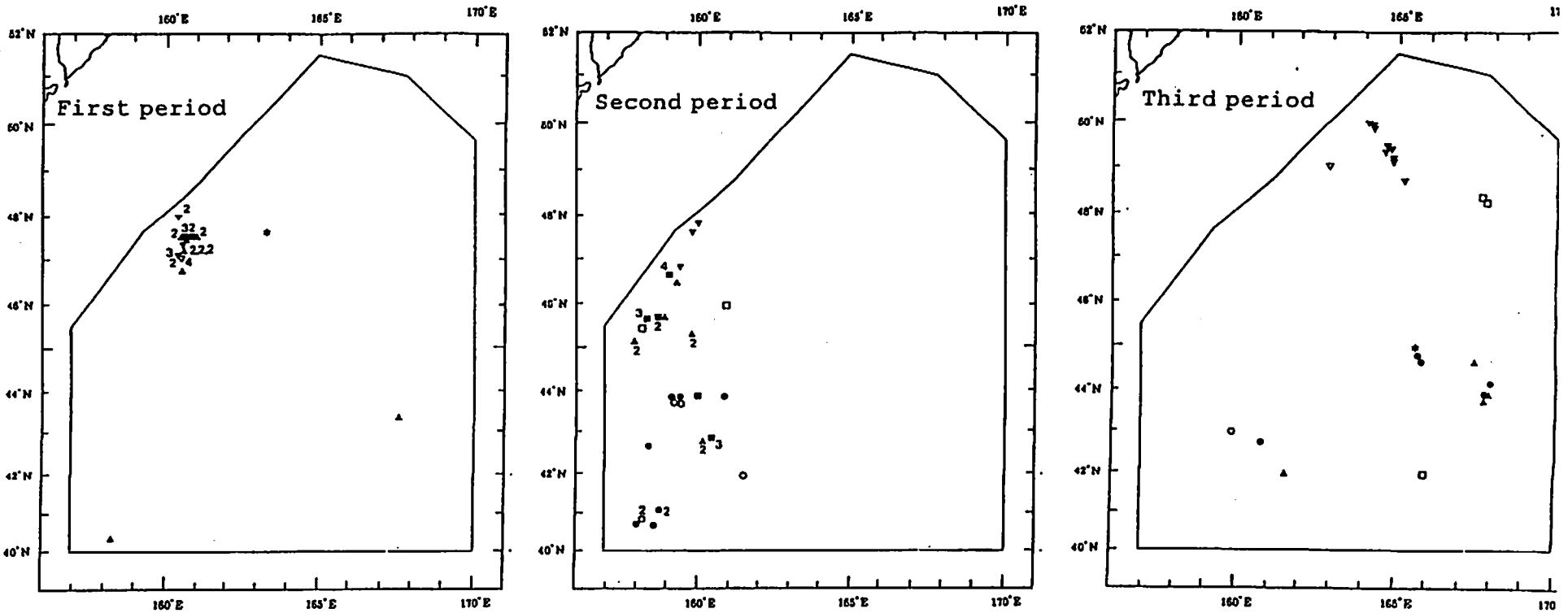

Fig. 4. Distribution of blue, fin, humpback, sei and right whales sighted by three sighting/sampling vessels. Numeral in figure indicates the school size.
Blue whale: ■ primary, □ secondary; Fin whale: ▲ primary, △ secondary; Humpback whale: ▼ primary, ▽ secondary; Sei whale: ● primary, ○ secondary; Right whale: ✻ primary.

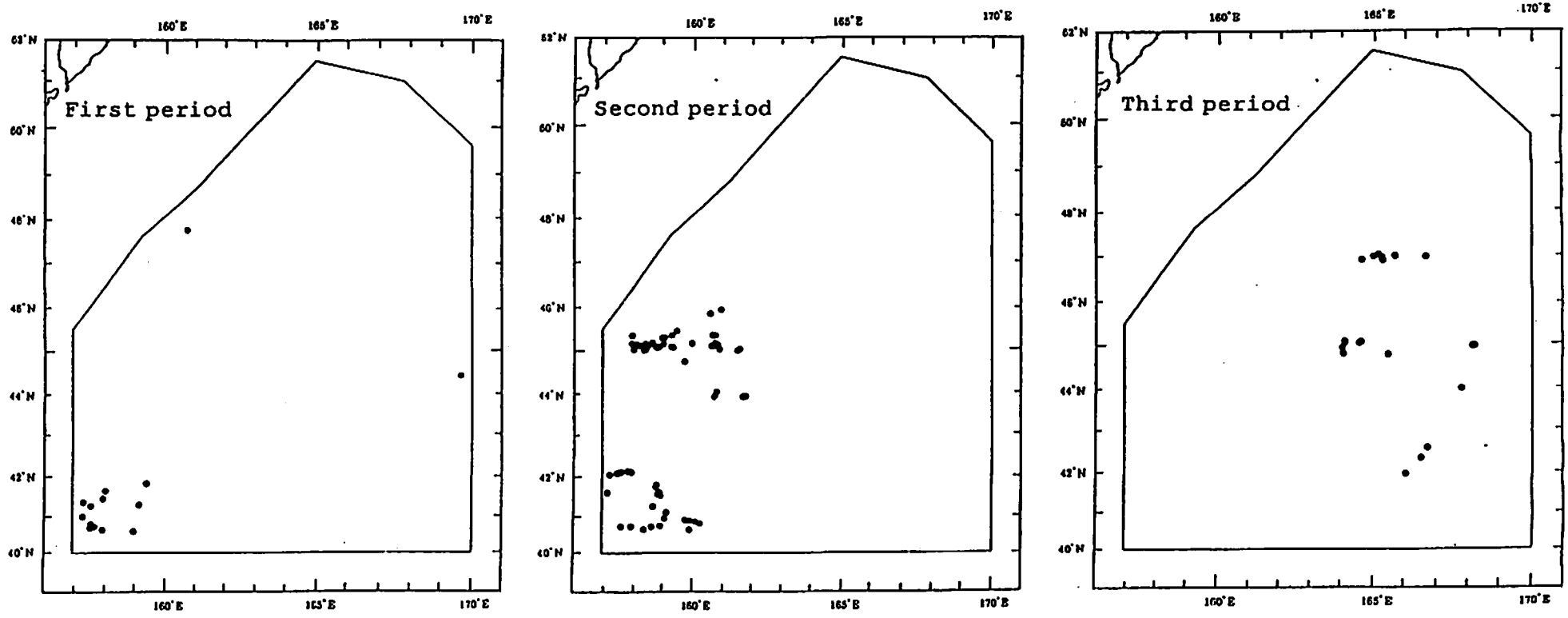

Fig. 5. Distribution of minke whales sampled during the 1995 JARPN, based on their sighting position.

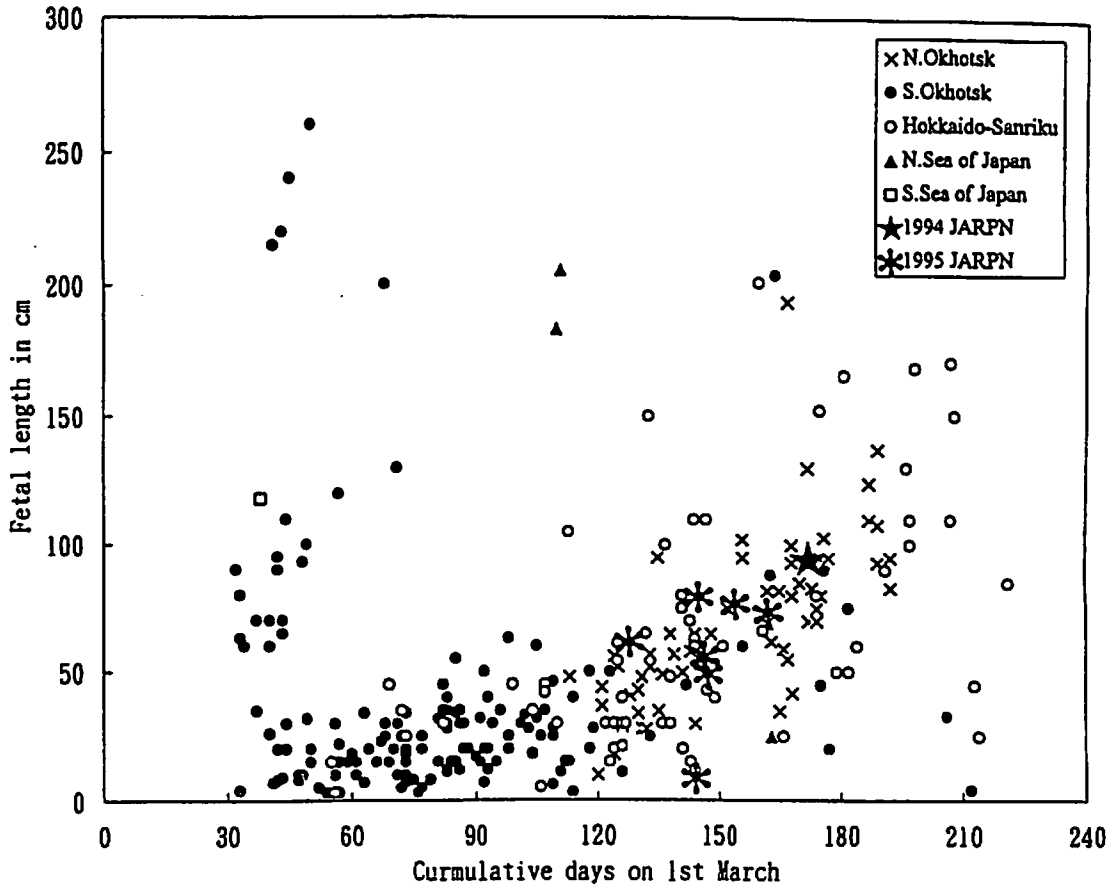

Fig. 6. Relationship between length of fetuses and collection date in minke whales from coastal water around Japan (Kato *et al.*, 1993) and from subarea 9 where conducted the JARPN surveys in 1994 and 1995.

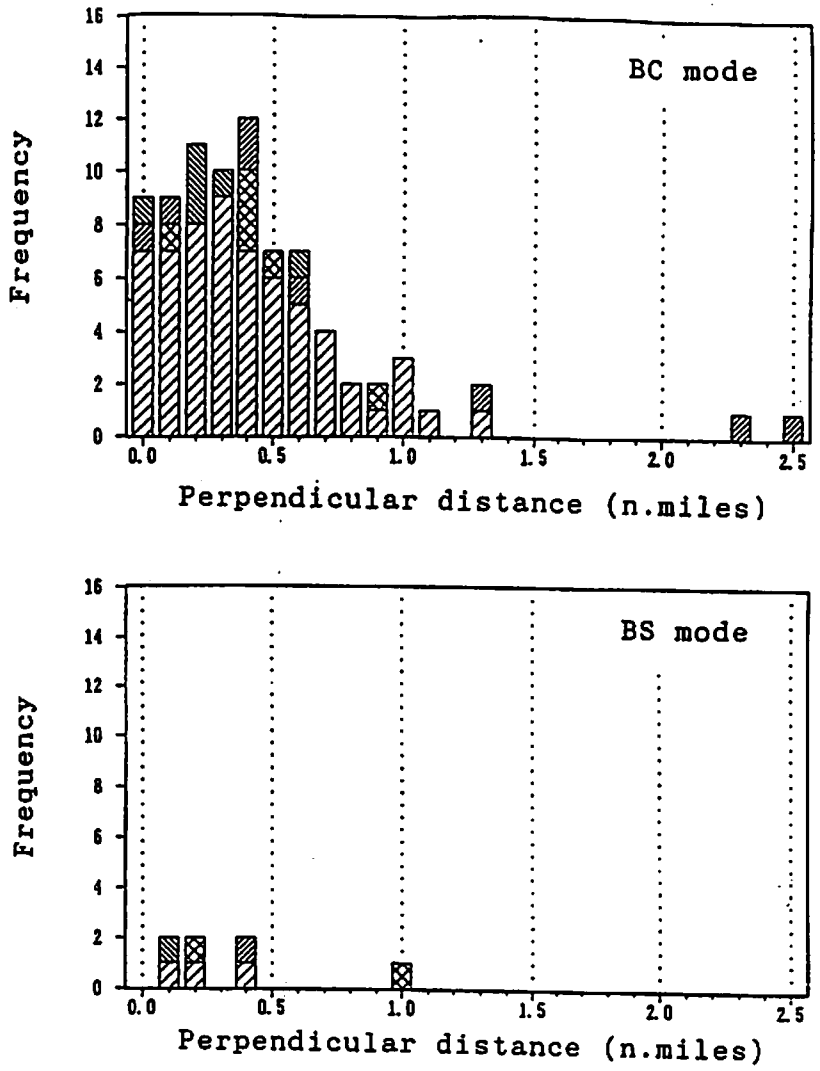

Fig. 7. Distribution of perpendicular distance for minke whale sighting under BC and BS mode surveys. Body: ▨, blows: ▩, jump: ▨, ring: ▧.

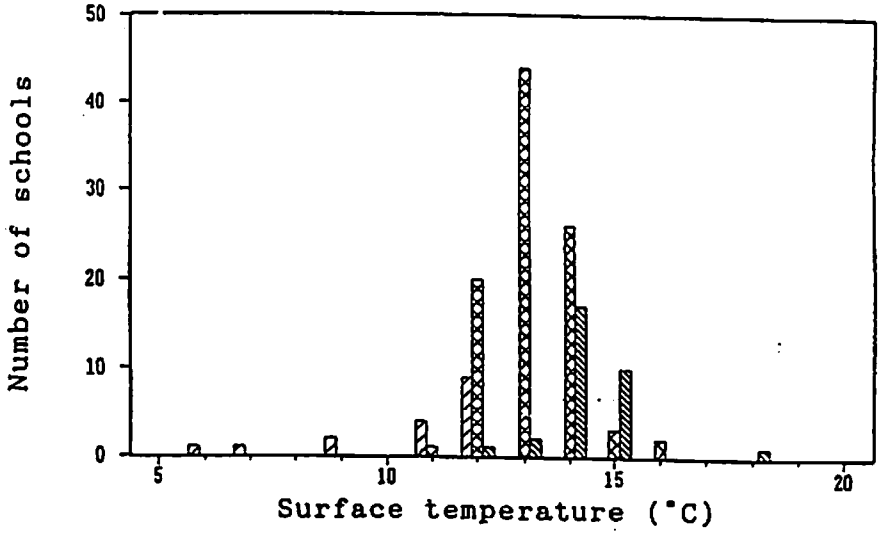

Fig. 8. Frequency distribution of sea surface temperature where minke whale sighted. First period: ▨, second period: ▩, third period: ▧.

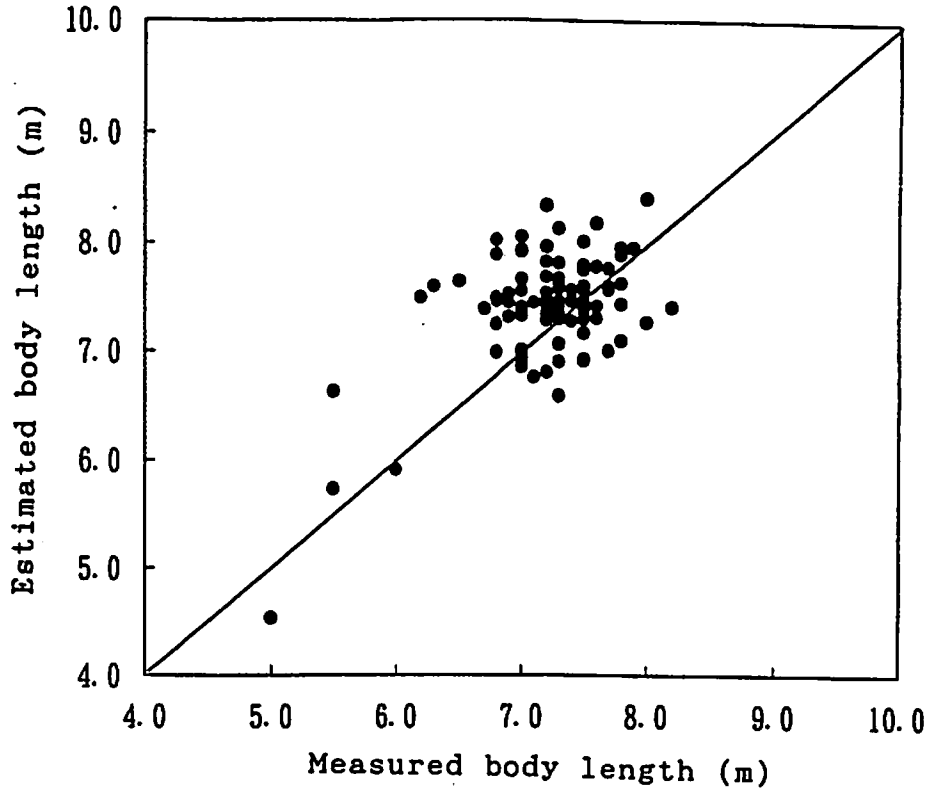

Fig. 9. Relationship between estimated body length (made by eye before sampling) and measured body length of minke whale in the 1995 JARPN survey.

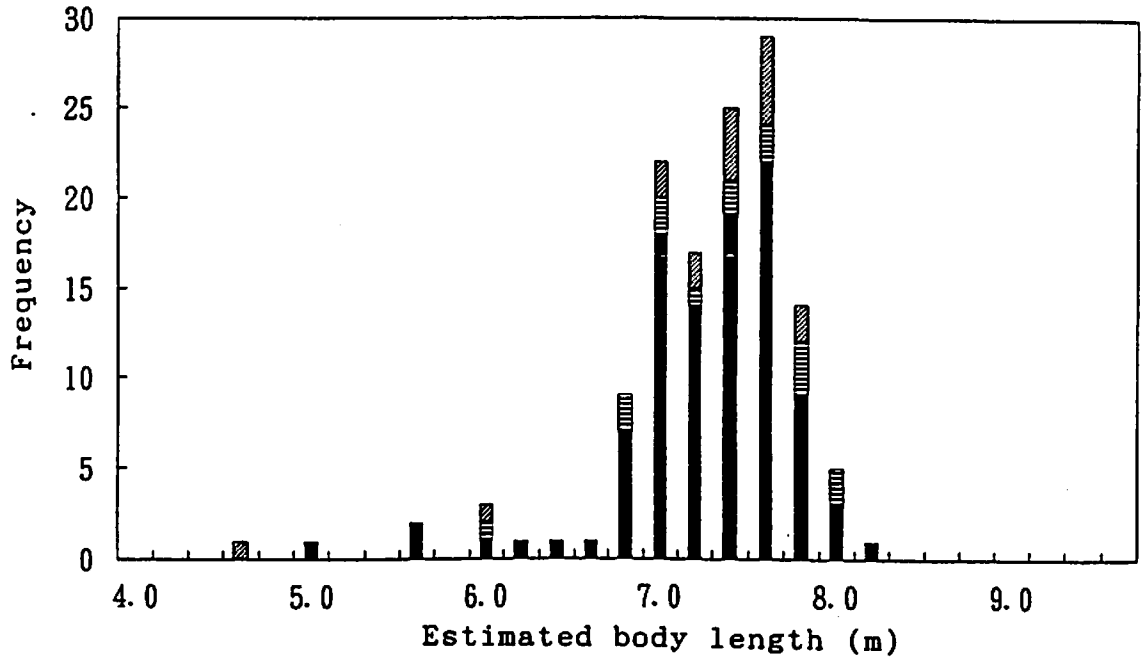

Fig. 10. Comparison of estimated body length composition among sampling event. ■ : Sampled whales, ▤ : Chasing and missing of the targeted whales, ▨ :Missing of the targeted whales before chasing.

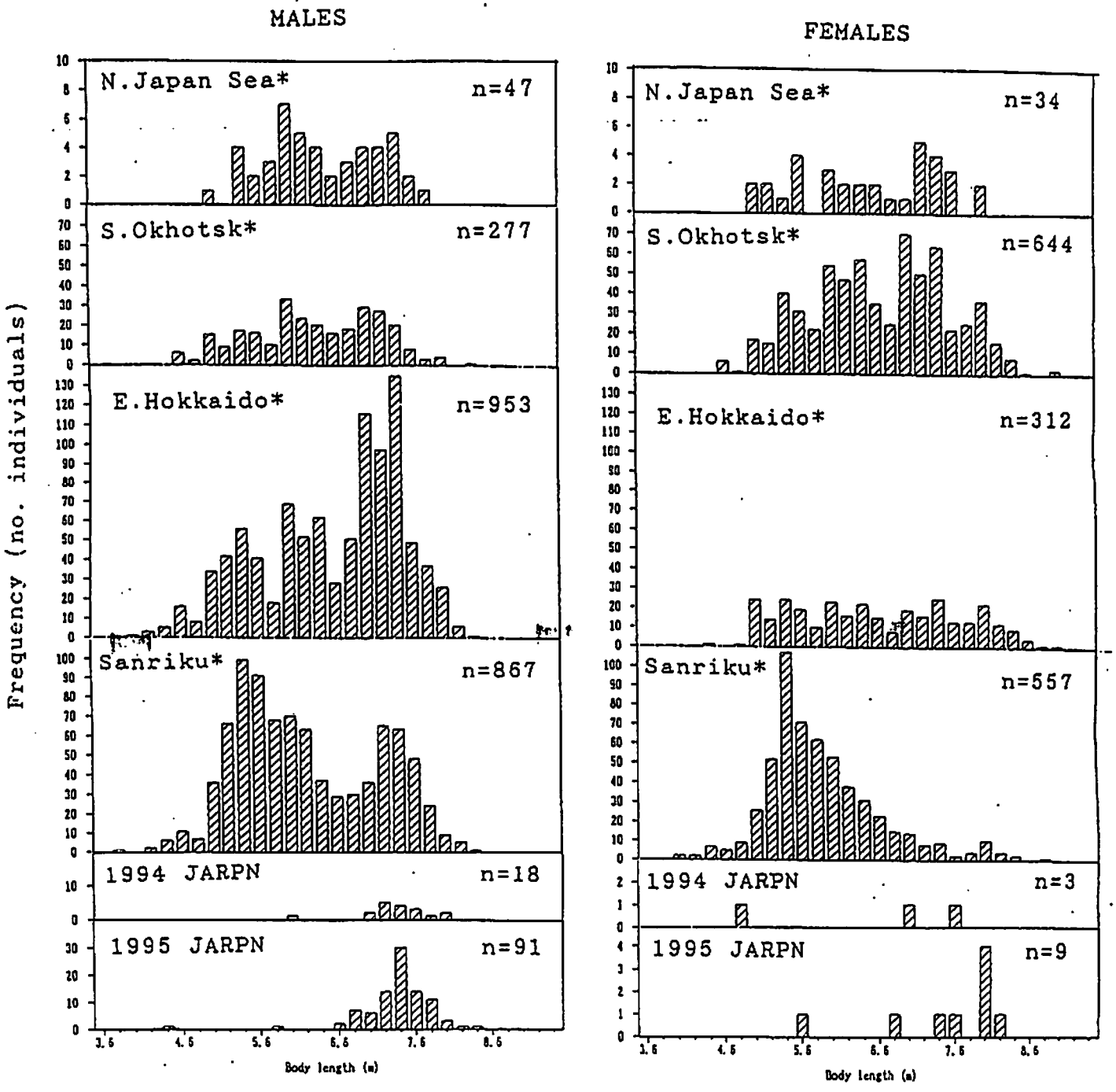

Fig. 11. Body length distribution of minke whales captured from 1977 to 1987, in four Japanese coastal whaling grounds. The length distribution of whales sampled in sub-area 9 by the JARPN survey in 1994 and 1995 are also shown. * After Kato (1992).