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RESULTS OF THE TRANSPACIFIC DALL'S PORPOISE RESEARCH CRUISE

BY THE HOYOMARU NO.12 IN 1986

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ABSTRACT

During the transpacific cruise conducted in August through October in 1986, 1311 Dall's porpoises in 335 schools were sighted, and 40 dalli-type Dall's porpoises were captured by hand harpoons. Although no distinct density change was detected, cow-calf pairs were found in three apparently isolated areas; 1) west of 164°E, 2) south of Aleutian Islands between 167°W to 180°, 3) the Gulf of Alaska between 140°W to 153°W.

The male catch predominated over females as in the previous cruises. Sixteen of the 27 males (59.3%) and 7 of the 13 females (53.8%) were sexually mature. All the seven mature females were non-lactating with a corpus luteum. Six of them were found with small fetuses (8-33 mm in length). Mature males in the Gulf of Alaskan area measured 168 to 183 cm (8 individuals) and those west of it 182 to 198 cm (8 individuals), but females showed no geographical size variation.

INTRODUCTION

Dall's porpoise Phocoenoides dalli is known to be distributed in the northern North Pacific and its adjacent waters (Bering Sea, Sea of Japan and Okhotsk Sea) (Leatherwood and Reeves, 1983). Life history of the species has been actively investigated by the Japanese and U.S. scientists in recent years. But the materials used in the past analyses were limited to those collected in the western part of the northern North Pacific and the Bering Sea. In order to obtain the information on Dall's porpoise in the eastern North Pacific, a transpacific cruise by the research

vessel Hoyomaru No.12 was conducted by the Fisheries Agency of Japan. The present paper reports the results of the cruise and the analysis of biological samples collected from captured Dall's porpoises.

MATERIALS AND METHODS

1. Outline of the cruise and research items

The Hoyomaru No.12 (42 m in length, 299 gross tons) was chartered by the Fisheries Agency of Japan for the research cruise in 1986. Researchers on board were M. Yoshioka, M. Ogura and C. Shikano.

The vessels started from Kesenuma on August 9 (Time is shown by Japan Standard Time, JST in this paper.), and arrived in Seattle on September 2 (eastbound cruise). After supply, she left Seattle on September 7, and returned to Kesenuma on October 5 (westbound cruise). The research periods were 23 days in the eastbound cruise, 28 days in the westbound and 51 days in total. The research area was the northern North Pacific between latitudes of 37° and 55°N. Research activity was conducted outside the FCZ of the U.S.S.R., the U.S.A. or Canada, but the vessel cruised the FCZ of the U.S.A. on the way to and from Seattle (September 1-2 and 7-8). The track line is shown in Fig.1. On September 23-24 and 29-30, the vessel was forced to change the prefixed track line southward due to avoiding a developed low atmospheric pressure or a typhoon.

Research items on board were as follows:

(1) sighting observations on marine mammals (eastbound and

westbound cruises),

(2) capture of Dall's porpoises by electric hand-held harpoons and collection of biological samples from captured porpoises (westbound cruise),

(3) oceanographic observations (eastbound and westbound cruises).

No research activity was made on October 1 due to rough weather.

Method of sighting

Sightings of marine mammals were conducted from the upper wheel deck from sunrise to sunset. When sea condition was unfavorable (wind force more than 5 or 6 in Beaufort scale, heavy rain or poor visibility less than 50 m due to dense fog), sighting operations were conducted from the bridge or interrupted.

Three researchers and 4 to 8 crew engaged in sighting. When the captured porpoises were dissected on board, at least one of 3 researchers and several crew continued sightings. Since 6 of all 16 crew had experience on skip jack fishing vessels or had participated in the previous Dall's porpoise research cruises on board of the Hoyomaru, they were accustomed to sighting operations.

The observation range was 180° in the direction of travel (90° port and starboard). When small cetaceans were sighted, we recorded species, number of individuals, time, position (obtained by Loran C), angle from bow, initial sighting distance, visibility, sea state, weather, surface water temperature and behavior of the animals. Most of the small cetaceans sighted were chased for species identification, school structure and

behavior information (closing mode), but some schools were passed without changing prefixed track line and detailed observation was not made (passing mode). During chasing a school of small cetaceans, some other marine mammal schools were sighted. These were recorded as secondary sightings.

Capture and shipboard processing of porpoises

Porpoises were chased as long as possible to wait their bow wave riding and obtain chance for harpooning. Forty Dall's porpoises (all dalli-type), 3 common dolphins, Delphinus delphis and one spotted dolphin, Stenella attenuata were captured. The latter two species were caught in the Japanese coastal waters west of 160°E longitude.

Porpoise samples were photographed and measured for body weight and external proportion. Biological samples as follows were collected in the same method as in the past cruises (Kasuya and Jones, 1984) to study life history and stock identity:

(formalin fixed samples) teeth, gonad, uterus, mammary gland;

(frozen samples) blubber, kidney, liver, skeletal muscle, cardiac muscle, spleen, whole stomach, skeleton, serum, brain, pancreas.

Since skeletal and biochemical samples of them were distributed to scientists concerned, the results of their analyses will be reported separately. Blubber samples for parasite analysis were also collected from 38 Dall's porpoises for National Marine Mammal Laboratory of NMFS, NOAA.

Oceanographic observations

Atmospheric temperature, surface water temperature, weather,

wind direction, wind force and atmospheric pressure were recorded every one hour during cruising.

The vertical water temperature profile of 250 m was measured by DBT at 57 stations. Plankton and larvae of fishes were also collected by towing a fingerings net for 10 minutes one hour after sunset at 37 stations.

2. Laboratory procedures

Gonads were weighed after fixation. Male sexual maturity was provisionally determined by the weight criteria (left testis > 40 g : mature, < 40 g : immature) of Kasuya and Jones (1984).

The ovarian corpora were counted, and females with at least one corpus luteum (CL) or corpus albicans (CA) were regarded as sexually mature. In the case when CL was found in the ovary, its mean diameter was obtained as the cube root of the product of three diameters and the uterus was opened carefully to examine small embryo or fetus.

RESULTS

1. Marine mammal species sighted

We surveyed 5663 nautical miles (nm) in 541 hours (2983 nm, 281 hours in the eastbound cruise and 2680 nm, 260 hours in the westbound). Of these, 310 nm (33 hours) were surveyed only from the bridge due to bad weather. And we made primary sightings of 1227 Dall's porpoises in 315 schools (697 individuals in 202 schools in the eastbound cruise and 530 individuals in 113 schools in the westbound) and secondary sightings of 84

individuals in 20 schools (30 porpoises in 9 schools in the eastbound cruise and 54 porpoises in 11 schools in the westbound). Three schools of the Dall's porpoise found at the backward position of the vessel in the westbound cruise were also included in the secondary sightings. A total of the primary and secondary sightings was 1311 animals in 335 schools (Table 1).

In addition to the Dall's porpoise, our sighting of marine mammals included northern fur seals, Pacific white-sided dolphins, common dolphins, spotted dolphins, bottlenosed dolphins, northern right whale dolphins, short-finned pilot whales, killer whales, Baird's beaked whales, sperm whales and fin whales (Table 2). Saddle mark of the short-finned pilot whales found in the U.S. coastal waters resembled that of pilot whales in the northern Japan described by Kasuya, Miyashita and Kasamatsu (1986), but further identification requires additional information (Kasuya, pers. comm.).

2. Density distribution of Dall's porpoises

During the eastbound and westbound cruise, Dall's porpoises were sighted daily except for August 11, September 9, 20, 23, 30 and October 2-5, when we encountered no porpoises in spite of the sighting effort. The number of porpoises of primary sightings per 100 nm (Fig.1) did not show distinct change, but the density tended to decline at 175°E to 160°W in the south of Aleutian Islands. The southern limit of the Dall's porpoise sightings was in 40°00'N latitude, between longitudes 145°E and 126°W, where the vessel surveyed as south as 37°24'N.

Most of the truei-type sightings (20/22) were limited to the Japanese coastal waters surveyed in the first day of the research (August 10), but two truei-type animals were also sighted with dalli-type animals in 43°31'N, 168°28'E and 47°32'N, 172°40'E, respectively.

Table 3 shows relationship between surface water temperature and number of porpoises sighted. Most of the Dall's porpoises (93 %) were sighted in the surface water temperature below 16°C. Truei-type animals were sighted in the waters above 18°C. The lowest surface water temperature recorded during the cruise was 11.0°C, and the lower temperature limit of the Dall's porpoise was not confirmed.

3. Dall's porpoise response to the vessel

Percentages of Dall's porpoises that rode vessel's bow wave in the daily number of sightings of the species which were closed or intensively chased varied by area (Table 4).

In the eastbound cruise, Dall's porpoises hardly rode the ships wave in the area of approximately 180° to 155°W (August 16-22), compared with these in the Japanese coastal and the Gulf of Alaskan waters. During the westbound cruise, we cruised the south of the area surveyed in the eastbound cruise and found less distinct latitudinal difference in the bow wave riding behavior. However, the proportion of the porpoises that rode the bow wave was slightly low in 158°W to 170°W, where it was more difficult to capture porpoises, compared with the west and east of the longitudes. In the waters west of 175°W porpoises actively

approached the vessel and rode the bow wave.

In the eastbound and westbound cruise, a total of 322 porpoises were not chased, but 49 individuals of them (15.2 %) approached the vessel and rode the ships wave. The proportion of porpoises that rode ships wave in the total sightings largely changed daily ranging from 0 to 100 %.

At least 7 schools were taken to be those chasing fish for feeding. Because some fish jumped out of water in front of the porpoises while the vessel approached the porpoise school. These porpoises were swimming at high speed, changing directions frequently, and rarely attracted to the vessel. Using these behaviors as an index, a total of 27 schools were considered as those chasing fish. Such feeding schools tended to occur within 5 hours after sunrise (62.9%). Ridgway (1966) observed that the captive Dall's porpoise seemed to be hungrier and to be more responsive to training at night or in the morning. The present observation in the wild is consistent with this.

4. Occurrence of cow-calf pairs

Cow-calf pairs of Dall's porpoise were identified as two porpoises which swam side by side and which surfaced making spray of different size or revealing actual difference in body length. Twenty cow-calf pairs were sighted during the 50 days' survey (Table 4). None of those pairs except one pair sighted on August 10 were identified as truei-type porpoises. Five pairs sighted on August 25 and 3 on September 22 formed combination of 3, 2 and 3 cow-calf pairs, respectively. Cow-calf pairs avoided

approaching vessel as reported by Kasuya and Jones (1984) and Miyazaki, Fujise, Komuro and Taketomi (1984). In contrast to 16 cow-calf pairs sighted in the eastbound cruise, only 4 pairs were found in the westbound cruise which cruised southern waters.

Figure 2 shows the percentage of porpoises constituting cow-calf pairs in the daily number of individuals sighted in the present cruise. The cow-calf pairs were found in three apparently isolated areas, i.e., west of 164°E longitude (5 pairs), south of Aleutian Islands between 167°W to 180° (7 pairs), and the Gulf of Alaska between 140°W to 153°W (8 pairs).

5. Composition of the Dall's porpoise specimens

Sex ratio and body length frequency

The catch of Dall's porpoises consisted of 27 males and 13 females (all dalli-type)(Table 5 and Fig.3), and predominance of males (=2.1 male/female) was statistically significant (Chi-square test, $p < 0.05$).

Table 6 shows body length and maturity of the porpoises. Body lengths of males ranged from 161 to 198 cm, and those of females from 154 to 182 cm. No individuals exceeded 200 cm in body length, which is different from the catch in the former cruises of the same vessel (1982-1985)(Miyazaki et al., 1984; Kasuya and Shiraga, 1985; Yoshioka, 1986). All the porpoises exceeding 190 cm (all mature males) were caught in the west of 179°E longitude.

Male sexual maturity

Of 27 males 16 (59.3 %) were sexually mature. Body lengths of mature males ranged from 175 to 198 cm, and those of immature from 161 to 177 cm.

Each half of the mature males were caught in two geographical areas of the Gulf of Alaska east of 157°W longitude and northwestern North Pacific west of 179°E. The mean body length and the mean left testis weight of the mature males were 176.3 cm (range: 168-183 cm) and 76.5 g (range: 40-110 g)(n=8) in the Gulf of Alaskan area, and 193.3 cm (range: 182-198cm) and 133.0 g (range: 92-173 g)(n=8) in the northwestern North Pacific area, respectively. Both the mean lengths and the mean testis weights were significantly different between the two areas (t-test, $p < 0.01$).

Female sexual maturity and reproductive status

In females, 7 of 13 animals (53.8 %) were sexually mature. The body length ranges of mature and immature animals overlapped almost completely (Table 6). Geographical size variation was not recognized in the females. The smallest mature one was 157 cm in body length, which was pregnant at her first ovulation.

Table 7 shows reproductive status of the females. All the mature females had a CL in the left ovary. Six individuals out of the 7 mature animals had only CLs but no CA, and remaining female had a CL and a CA. The proportion of females having only one corpus (85.7 %) was also as high in the present samples as in the past ones (Kasuya and Shiraga, 1985; Yoshioka, 1986). Mean body length of females at their first ovulation was 172.8 cm

(n=6).

Six of the 7 mature females were in their early pregnancy having small fetuses ranging 8 to 33 mm in length (September 12-28). The remaining one had CL of ovulation. Twin fetuses were found in the left uterine horn of one female (Field No.36). The female in the second ovulation had 8 mm fetus and a CA with 8 mm in the mean diameter, but was not lactating. Since she had stretch mark on the surface of the uteri, it is probable that she became pregnant in this season after parturition in the previous year or in this year.

Mean CL diameter of females in their early pregnancy was 22.6 mm (SD=2.5, n=6), which was significantly larger than the mean diameter of CLs in non-pregnant (ovulated) animals (16.5 mm, SD=2.9, n=8, samples in 1985 cruise of Yoshioka (1986) included) (t-test, $p < 0.05$).

Ovarian follicles of the pregnant females measured less than 5 mm in the largest diameter. One ovulated and two immature females had developing follicles ranging from 7 to 10 mm in diameter. These animals will ovulate shortly in the season. The 4 remaining immature females had no larger follicles than 5 mm in diameter.

Above ovarian status and fetal size suggest that estrus season begins in August at least in any part of the research area.

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Table 1. Daily sightings of Dall's porpoises during the *Boyowaru No.12* cruise in 1988.

Date (JST)	Moon position (JST)	Distance surveyed (nm)	No. of schools	No. of porpoises				Surface water temp. (°C)
				PD*	PT	PX	total	
Aug.08 (Lv. Kesennuma)								
10	40°03'N, 146°48'E	125	10	1	18	11	30	18.1-21.9
11	41°37'N, 151°55'E	147	0	0	0	0	0	18.4-20.2
12	43°43'N, 157°15'E	123	21	38	0	23	61	14.3-18.1
13	45°07'N, 162°55'E	152	24	61	0	25	86	12.6-14.3
14	46°35'N, 168°50'E	152	17	12	0	34	46	11.2-12.1
15	48°00'N, 174°57'E	141	5	3	1	9	13	11.2-11.5
16	47°40'N, 178°49'W	144	12	16	0	23	39	11.3-12.0
17	47°50'N, 175°18'W	136	12	25	0	9	34	11.5-11.9
18	47°58'N, 171°18'W	148	5	5	0	8	13	11.0-11.5
19	48°27'N, 167°49'W	136	3	5	0	6	11	11.0-11.3
20	49°45'N, 161°49'W	134	10	7	0	20	27	11.1-11.9
21	50°28'N, 159°00'W	124	3	5	0	3	8	11.5-11.9
22	51°28'N, 156°16'W	113	3	4	0	4	8	11.4-11.8
23	52°28'N, 153°33'W	114	15	55	0	9	64	11.4-11.6
24	53°23'N, 150°12'W	134	8	25	0	10	35	11.5-11.8
25	54°30'N, 146°36'W	140	5	25	0	10	35	11.4-12.1
26	54°19'N, 144°23'W	73	7	9	0	17	28	12.0-12.2
27	52°20'N, 141°52'W	115	5	9	0	7	18	12.5-13.7
28	50°26'N, 140°22'W	127	19	55	0	22	77	13.7-14.9
29	49°59'N, 137°23'W	119	6	18	0	11	27	14.7-16.1
30	48°58'N, 134°50'W	123	8	20	0	6	26	15.3-16.9
31	47°39'N, 132°07'W	133	2	7	0	1	8	16.7-17.7
Sep.01	47°09'N, 127°04'W	132	2	5	0	2	7	16.6-17.2
02	(Ar. Seattle)							
total(eastbound)		2983	202	408	19	270	637	
Sep.07 (Lv. Seattle)								
08	46°12'N, 129°27'W	136	2	7	0	2	9	16.0-17.4
08	45°09'N, 134°14'W	121	0	0	0	0	0	17.6-18.6
10	47°13'N, 137°48'W	114	3	7	0	2	9	17.0-18.2
11	49°03'N, 141°51'W	120	3	6	0	13	19	14.4-16.1
12	49°49'N, 144°13'W	113	4	12	0	1	13	13.5-14.2
13	50°47'N, 145°57'W	81	9	33	0	19	52	12.8-13.5
14	51°52'N, 146°56'W	75	17	71	0	29	100	12.4-13.1
15	50°54'N, 148°45'W	95	9	35	0	9	44	12.3-12.6
16	48°16'N, 152°08'W	92	11	38	0	10	48	12.9-13.4
17	46°43'N, 154°10'W	120	3	7	0	5	12	13.2-14.1
18	45°06'N, 156°43'W	97	6	22	0	4	26	14.9-16.1
19	46°31'N, 158°14'W	107	10	30	0	11	41	13.8-14.7
20	46°15'N, 159°56'W	25	0	0	0	0	0	13.7-13.9
21	46°11'N, 162°53'W	108	6	25	0	5	30	12.7-13.2
22	47°23'N, 167°34'W	117	5	10	0	16	26	11.9-12.5
23	47°41'N, 173°42'W	28	0	0	0	0	0	11.6-11.7
24	44°29'N, 174°47'W	114	1	5	0	0	5	12.5-13.5
25	42°13'N, 178°27'W	107	3	7	0	2	9	14.1-17.0
26	42°13'N, 177°04'E	108	1	3	0	0	3	15.4-15.6
27	43°21'N, 172°13'E	105	5	9	0	8	17	13.8-16.3
28	43°35'N, 167°47'E	78	12	33	1	22	56	13.4-14.0
29	42°46'N, 163°10'E	120	3	8	0	3	11	15.4-15.9
30	38°32'N, 162°45'E	75	0	0	0	0	0	18.1-20.5
Oct.01	37°27'N, 162°14'E	0	-	-	-	-	-	-
02	38°08'N, 158°48'E	108	0	0	0	0	0	15.0-19.9
03	38°55'N, 153°47'E	113	0	0	0	0	0	18.5-22.4
04	38°51'N, 148°24'E	134	0	0	0	0	0	17.1-21.9
05	38°56'N, 142°55'E	69	0	0	0	0	0	18.6-24.0
06	(Ar. Kesennuma)							
total (westbound)		2580	113	368	1	161	530	
TOTAL		5663	315	776	20	431	1227	

Excludes secondary sightings.

* PD: dalli-type, PT: truei-type, PX: type unidentified.

Table 2. Daily sightings of marine mammals other than Dall's porpoise during the *Toyomaru No. 12* cruise in 1988.

species*	CU	LO	OO	SA	TT	LB	GM	OO	BB	PC	BP	UD	UX	UW	UZ
Aug.10	-	-	-	-	53	-	50	3	-	-	-	-	9	3	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-
12	2	4	-	-	-	-	-	-	-	-	-	-	4	-	-
13	6	-	-	-	-	-	-	5	-	-	-	-	6	-	-
14	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
15	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
16	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
17	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
18	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-
20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4
27	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	30	-	-	-	8	35	-	-	-	-	4	-	-	-
Sep.01	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3
total	15	34	-	-	53	17	95	8	2	-	1	6	23	16	16
Sep.08	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-
09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	1	-	6	-
12	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	2	-	-	-	-	-	-	-	-	-	2	-	1	1	-
16	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	4	-	-	-	2	-	-
19	3	-	-	-	-	-	-	-	-	-	-	-	-	5	-
20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-
28	1	-	-	-	-	-	-	-	-	1	-	-	1	1	-
29	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
30	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-
Oct.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02	-	-	6	-	-	-	-	-	-	-	34	-	-	-	-
03	-	-	39	-	-	-	-	-	-	-	-	-	-	-	-
04	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-
05	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-
total	33	30	45	8	-	-	-	-	-	4	1	36	6	9	17
TOTAL	48	64	45	8	53	17	95	8	2	4	2	42	29	25	33

* CU: *Callorhinus ursinus*, LO: *Lagenorhynchus obliquidens*, OO: *Delphinus delphis*, SA: *Stenella attenuata*, TT: *Tursiops truncatus*, LB: *Lissodelphis borealis*, GM: *Globicephala macrorhynchus*, OO: *Orcinus orca*, BB: *Berardius bairdii*, PC: *Physeter catodon*, BP: *Balainoptera physalus*, UD: unidentified dolphin or porpoise, UX: unidentified small whale, UW: unidentified whale, UZ: unidentified large whale.

Table 3. Relationship between surface water temperature and number of Dall's porpoises sighted in the *Hoyomaru No.12* cruise in 1986.

Water temp. (°C)	Temp.* frequency (days)	Eastbound Cruise				Westbound Cruise				Total(%)
		PD	PT	PX	Total(%)	PD	PT	PX	Total(%)	
≤10.9	0	-	-	-	-(-)	-	-	-	-(-)	-(-)
11.0-11.9	11	198	1	148	347(47.7)	2	0	2	4(0.7)	351(26.8)
12.0-12.9	4	17	0	27	44(6.1)	132	0	60	192(32.9)	236(18.0)
13.0-13.9	10	73	0	29	102(14.0)	162	1	60	223(38.2)	325(24.8)
14.0-14.9	7	59	0	17	76(10.5)	65	0	27	92(15.7)	168(12.8)
15.0-15.9	5	58	0	33	91(12.5)	33	0	10	43(7.3)	134(10.2)
16.0-16.9	3	16	0	9	25(3.4)	12	0	9	21(3.6)	46(3.5)
17.0-17.9	4	7	0	3	10(1.4)	3	0	2	5(0.9)	15(1.2)
18.0-18.9	1	0	3	3	6(0.8)	4	0	0	4(0.7)	10(0.8)
19.0-19.9	3	0	16	8	24(3.3)	0	0	0	0(0)	24(1.8)
20.0-20.9	0	1	1	0	2(0.3)	0	0	0	0(0)	2(0.1)
21.0-21.9	2	0	0	0	0(0)	0	0	0	0(0)	0(0)
22.0≤	0	-	-	-	-(-)	-	-	-	-(-)	-(-)
Total	50	429	21	277	727(100)	413	1	170	584(100)	1311(100)

*: Temperature frequency at noon position (days).
 Includes secondary sightings.
 PD: *dalli*-type, PT: *truei*-type, PX: unidentified.

Table 4. Daily sightings of Dall's porpoises during the *Hooyamur No.12* cruise in 1986.

Date	No. of schools	No. of porpoises (A)	No. of cow-calf pairs (B)	Porpoises chased		Porpoises only sighted	
				No. (C)	mode bow wave (D)	No. (E)	mode bow wave (F)
Aug.10	11	32	1(6) ^{x1}	23(88) ^{x2}	11(39) ^{x3}	4(12) ^{x4}	0(0) ^{x5}
11	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
12	23	69	3(9)	32(46)	17(53)	37(54)	9(24)
13	24	86	1(2)	0(0)	-(-)	86(100)	12(14)
14	17	46	0(0)	0(0)	-(-)	46(100)	6(13)
15	5	13	0(0)	0(0)	-(-)	13(100)	4(31)
16	12	39	1(5)	25(64)	0(0)	14(36)	0(0)
17	12	34	2(12)	23(68)	0(0)	11(32)	0(0)
18	5	13	1(15)	10(77)	0(0)	3(23)	0(0)
19	3	11	0(0)	6(55)	0(0)	5(45)	5(100)
20	10	27	0(0)	9(30)	0(0)	19(70)	0(0)
21	4	11	0(0)	11(100)	1(9)	0(0)	-(-)
22	3	8	0(0)	0(0)	-(-)	8(100)	0(0)
23	18	77	0(0)	68(88)	26(38)	9(12)	0(0)
24	8	35	1(6)	23(66)	3(39)	12(34)	3(25)
25	5	35	5(29)	35(100)	11(31)	0(0)	-(-)
26	7	26	0(0)	14(54)	3(21)	12(46)	0(0)
27	5	16	0(0)	10(63)	6(60)	6(37)	1(17)
28	19	77	1(3)	65(84)	39(60)	12(16)	7(58)
29	7	29	0(0)	29(100)	13(45)	0(0)	-(-)
30	8	26	0(0)	24(92)	11(46)	2(8)	0(0)
31	2	8	0(0)	8(100)	3(38)	0(0)	-(-)
Sep.01	3	9	0(0)	7(78)	5(71)	2(22)	2(100)
total	211	727	16(4)	426(59)	155(36)	301(41)	49(16)
Sep.08	2	9	0(0)	0(0)	-(-)	9(100)	0(0)
09	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
10	3	9	0(0)	9(100)	3(33)	0(0)	-(-)
11	3	19	0(0)	19(100)	1(5)	0(0)	-(-)
12	4	13	0(0)	13(100)	6(46)	0(0)	-(-)
13	9	52	0(0)	52(100)	17(33)	0(0)	-(-)
14	20	116	1(2)	113(97)	28(25)	3(3)	0(0)
15	11	52	0(0)	52(100)	16(31)	0(0)	-(-)
16	12	55	0(0)	55(100)	11(20)	0(0)	-(-)
17	3	12	0(0)	12(100)	3(25)	0(0)	-(-)
18	6	26	0(0)	26(100)	9(35)	0(0)	-(-)
19	10	41	0(0)	41(100)	5(12)	0(0)	-(-)
20	0	0	0(0)	-(-)	-(-)	-(-)	-(-)
21	6	30	0(0)	30(100)	7(23)	0(0)	-(-)
22	5	26	3(23)	26(100)	3(12)	0(0)	-(-)
23	0	0	0(0)	-(-)	-(-)	-(-)	-(-)
24	1	5	0(0)	5(100)	5(100)	0(0)	-(-)
25	3	9	0(0)	9(100)	7(78)	0(0)	-(-)
26	1	3	0(0)	3(100)	3(100)	0(0)	-(-)
27	5	17	0(0)	17(100)	9(53)	0(0)	-(-)
28	17	79	0(0)	70(89)	26(37)	9(11)	0(0)
29	3	11	0(0)	11(100)	5(45)	0(0)	-(-)
30	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
Oct.01	-	-	-(-)	-(-)	-(-)	-(-)	-(-)
02	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
03	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
04	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
05	0	0	-(-)	-(-)	-(-)	-(-)	-(-)
total	124	584	4(1)	563(96)	164(29)	21(4)	0(0)
TOTAL	335	1311	20(3)	989(75)	319(32)	322(25)	49(15)

Includes secondary sightings of 84 individuals in 20 schools.

Figures in the parenthesis are percentage.

x1=8x2/A, x2=C/A, x3=D/C, x4=E/A, x5=F/E.

Table 5. Dall's porpoises taken by the *Hoyomaru No.12* cruise in 1986.

Field No.	Sex	Body length (cm)	Body weight (kg)	Catch position		Sexual ^{*1} cond.	GW ^{*2} (g)	
				latitude	longitude		L	R
01	M	162	78	52°45'N	152°30'W	Im	8	9
03	M	176	100	49°12'N	142°20'W	M	40	32
05	M	178	99	50°19'N	145°32'W	M	67	59
06	M	174	92	50°28'N	145°43'W	Im	20	20
07	M	164	93	50°47'N	145°57'W	Im	16	15
08	M	168	80	51°05'N	146°07'W	Im	9	9
09	M	177	92	51°18'N	146°16'W	Im	24	22
10	M	175	106	51°24'N	146°21'W	M	59	58
11	M	177	107	51°40'N	146°34'W	M	110	102
13	M	175	111	51°51'N	146°50'W	M	61	65
14	M	178	102	51°55'N	146°55'W	M	108	98
16	M	177	97	51°27'N	147°54'W	Im	33	30
18	M	183	112.5	48°41'N	152°05'W	M	103	92
19	M	174	90	48°24'N	152°19'W	Im	9	9
20	M	161	77	45°05'N	156°40'W	Im	7	7
21	M	168	94	45°15'N	156°53'W	M	64	65
24	M	171	87	46°27'N	162°19'W	Im	12	10
28	M	172	107	45°51'N	174°35'W	Im	33	33
29	M	165	91.5	42°40'N	177°07'W	Im	13	13
30	M	195	140	42°16'N	178°10'E	M	101	95
31	M	196	152	43°11'N	173°41'E	M	136	131
32	M	196	144	43°22'N	172°13'E	M	155	141
33	M	198	153	43°20'N	171°55'E	M	129	127
34	M	198	157	43°30'N	168°49'E	M	173	170
38	M	190	117	43°33'N	167°41'E	M	128	124
39	M	182	129	43°32'N	167°40'E	M	92	95
40	M	191	137	43°24'N	163°47'E	M	152	137

02	F	181	87	54°16'N	147°16'W	Im	5.6	1.8
04	F	182	93	49°24'N	142°53'W	P	9.0	1.9
12	F	178	99	51°44'N	146°44'W	O	4.6	1.8
15	F	174	91	51°59'N	147°02'W	P	10.7	1.1
17	F	154	62	50°54'N	148°45'W	Im	1.2	0.9
22	F	175	96	45°45'N	157°27'W	P	14.2	2.6
23	F	160	77	46°21'N	158°07'W	P	7.4	0.7
25	F	166	81	46°12'N	162°53'W	Im	4.5	3.0
26	F	171	90	46°12'N	162°53'W	P	9.1	1.3
27	F	173	86	47°18'N	166°30'W	Im	3.4	1.7
35	F	161	77	43°36'N	167°50'E	Im	1.1	0.6
36	F	157	84	43°36'N	167°50'E	P	9.4	1.1
37	F	173	91	43°36'N	167°50'E	Im	3.9	1.3

All porpoises were *dalli*-type.

*1: Sexual condition; Im: immature, M: mature, P: pregnant, O: ovulated.

*2: Gonad weight (testis or ovary).

Table 6. Body length frequency of Dall's porpoises taken by the *Hoyomaru No.12* cruise in 1986.

Body length (cm)	Male			Female			
	immature	mature	total	immature	pregnant	ovulated	total
150-155	-	-	-	1	-	-	1
155-160	-	-	-	-	1	-	1
160-165	3	-	3	1	1	-	2
165-170	2	1	3	2	-	-	2
170-175	4	-	4	1	2	-	3
175-180	2	6	8	-	1	1	2
180-185	-	2	2	1	1	-	2
185-190	-	-	-	-	-	-	-
190-195	-	2	2	-	-	-	-
195-200	-	5	5	-	-	-	-
total	11	16	27	6	6	1	13

Table 7. Female reproductive status of Dall's porpoises taken by the *Hoyomaru No.12* cruise in 1986.

Field No.	Body length (cm)	Sexual condition	No. of		Diameter of CL (mm)	Fetal length (mm)	Remarks
			CL*1	CA*2			
2	181	Immature	0	0	-	-	follicle(9mm ϕ)
4	182	Pregnant	1	0	19.5	8	
12	178	Ovulated	1	0	12.2	-	follicle(7mm ϕ)
15	174	Pregnant	1	0	24.6	20	
17	154	Immature	0	0	-	-	
22	175	Pregnant	1	0	26.1	19	
23	160	Pregnant	1	1	20.5	8	8mm ϕ CA, non-lactating
25	166	Immature	0	0	-	-	
26	171	Pregnant	1	0	21.6	23	
27	173	Immature	0	0	-	-	
35	161	Immature	0	0	-	-	
36	157	Pregnant	1	0	23.3	30,33	twin fetuses
37	173	Immature	0	0	-	-	follicle(10mm ϕ)

*1: Corpus luteum, *2: Corpus albicans.

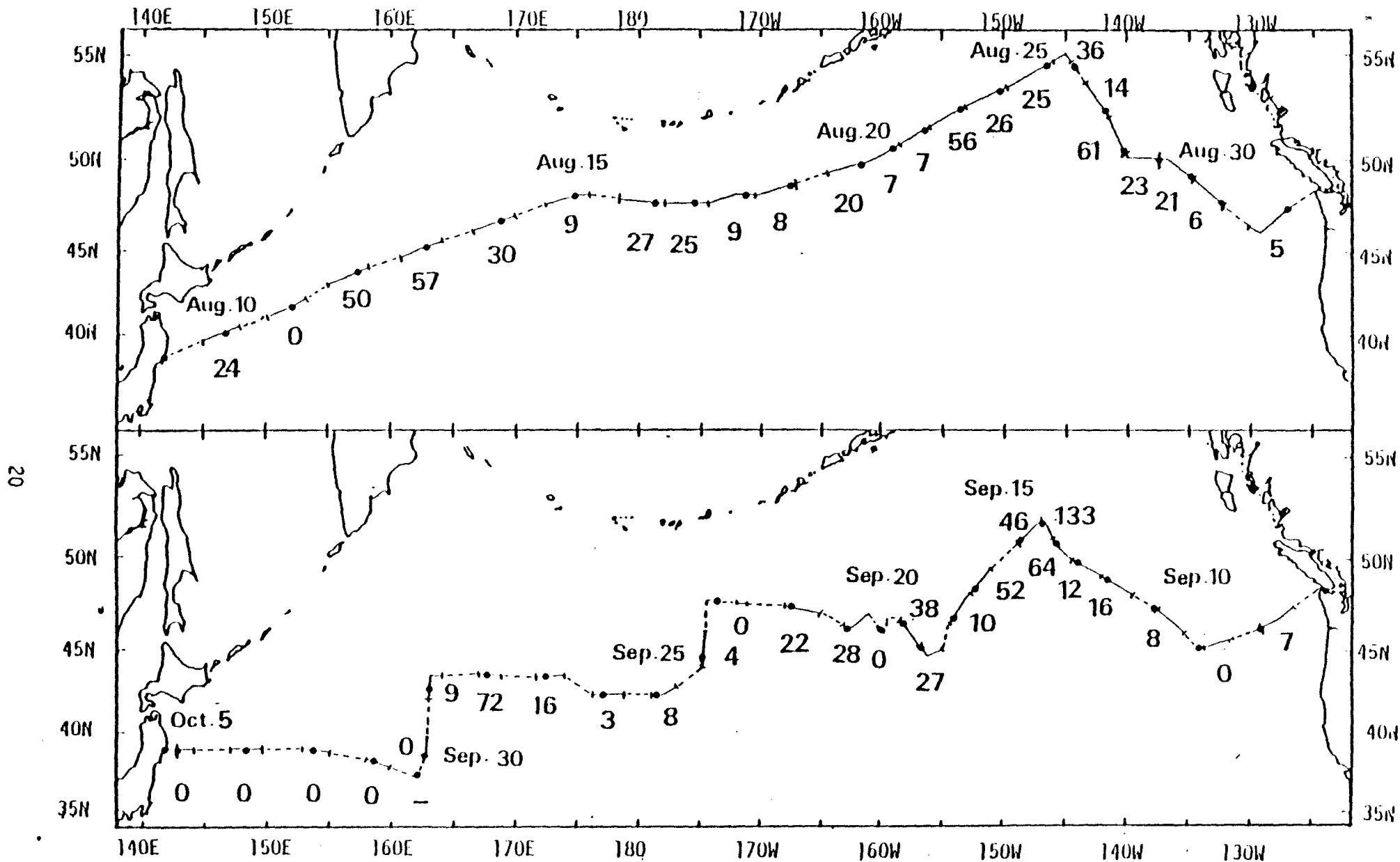


Fig. 1 Track line and density of Dall's porpoise (number of individuals of primary sighting per 100 nautical miles) during the Hoyomaru No. 12 cruise in 1986. Solid line indicates track line surveyed, dotted line track line not surveyed. Closed circle shows noon position (J.S.T.).

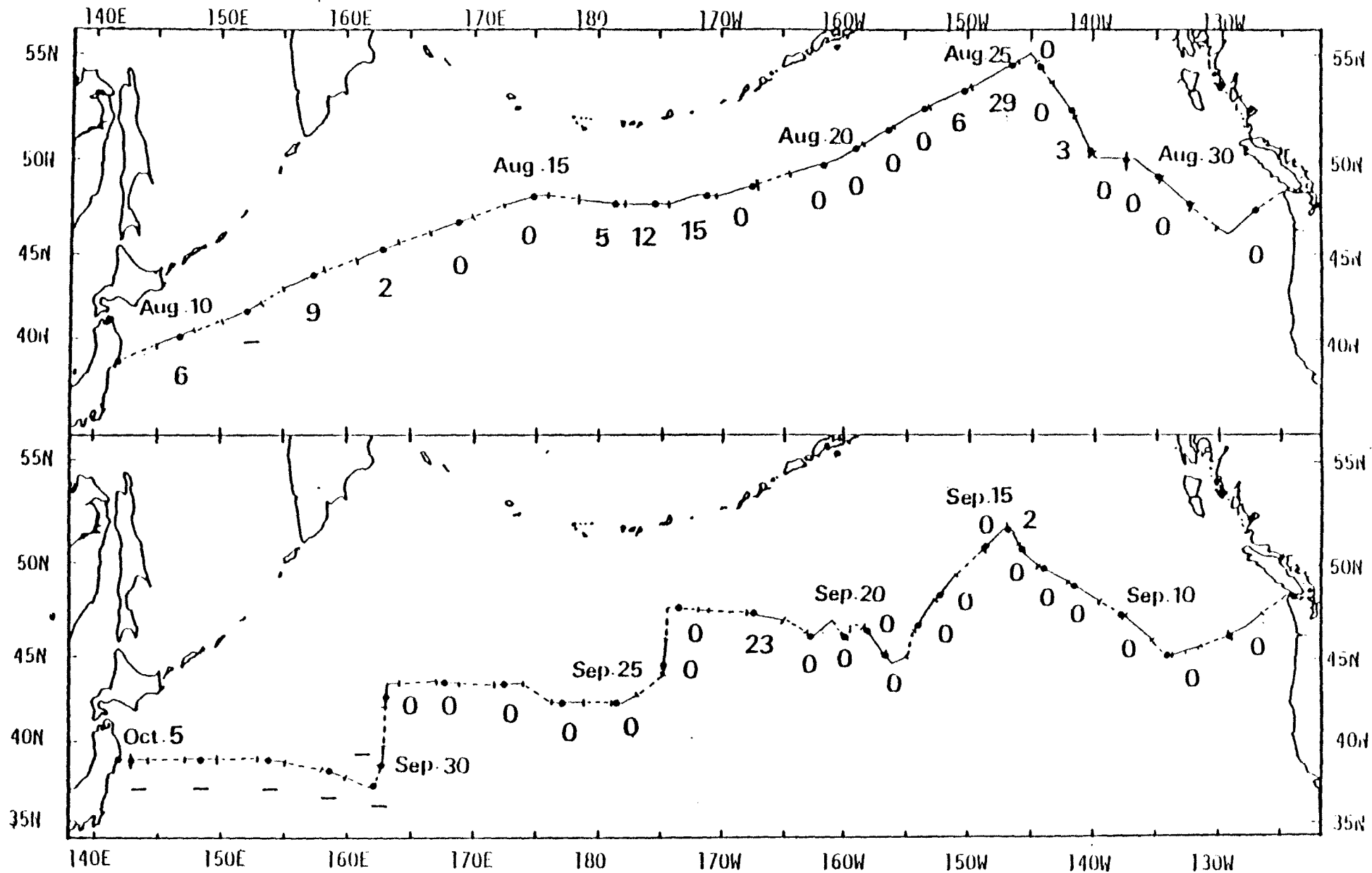


Fig.2 Frequency of cow-calf pairs of the Dall's porpoise shown by percentage of individuals constituting such pairs in the daily number of animals sighted during the Hoyomaru No.12 cruise in 1986. Solid line indicates track line surveyed, dotted line track line not surveyed. Closed circle indicates noon position (J.S.T.).

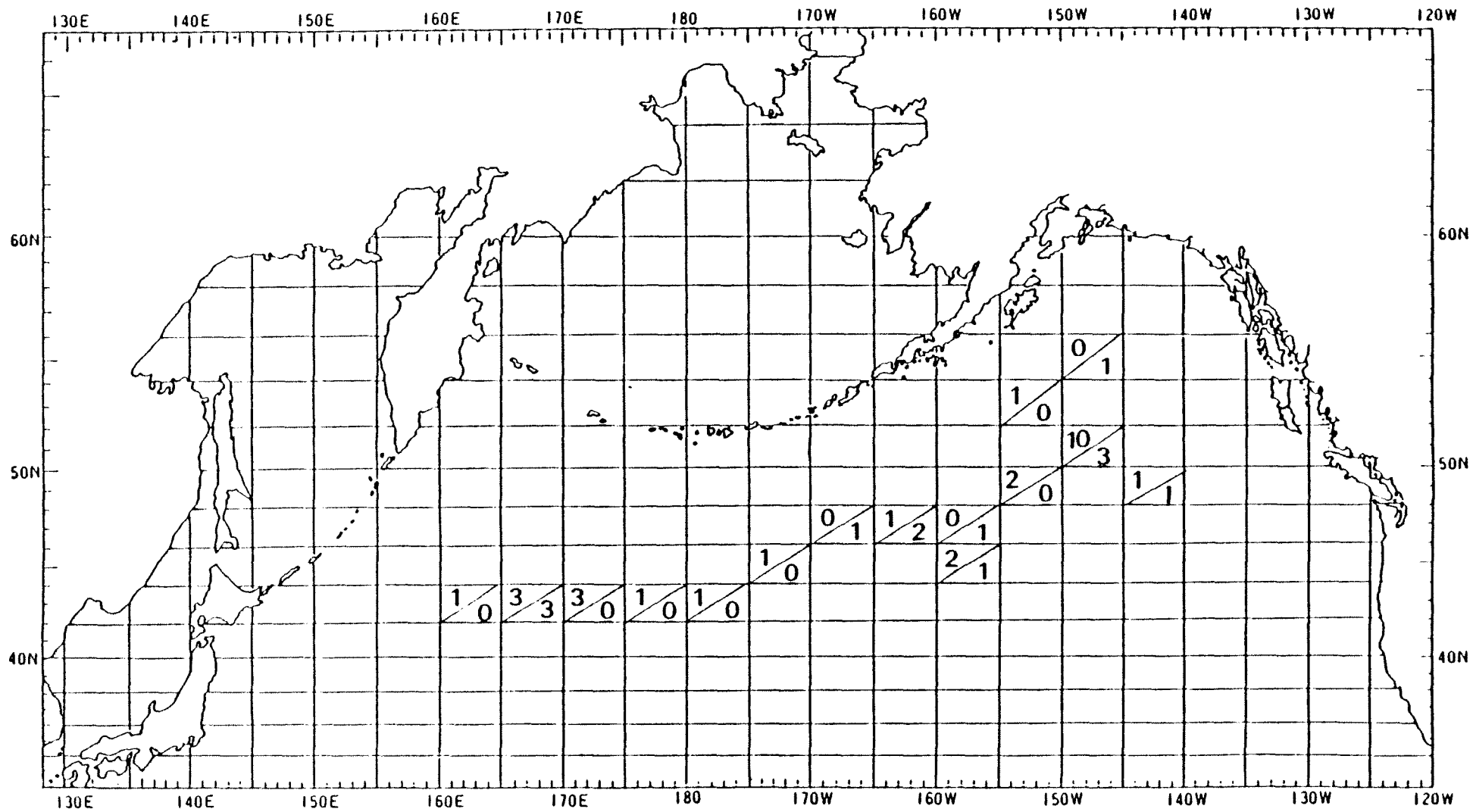


Fig. 3. Catch position of Dall's porpoises taken by the Hoyomaru No.12 cruise in 1986. Numbers of males/females are indicated by 2° x 5° area.

