Heavy Metal Concentrations in Minke Whales from the Pacific Coast of Japan and an Offshore Area in the Western North Pacific

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ABSTRACT

A preliminary comparison in the accumulation levels of heavy metals (Cd and Hg) in minke whales from the Pacific coast of Japan (sub-area 7) and an offshore area of the western North Pacific (sub-area 9), was carried out in order to investigate possible geographical differences in the accumulation levels. With this objective, we examined samples of minke whales from the 1994 and 1995 JARPN surveys (sub-area 9) and from the small-type coastal whaling in 1987 (sub-area 7). Although relatively higher concentrations of Cd and Hg were found in whales from sub-area 9, such apparent differences could be explained by the length-related (possibly age-related) accumulation characteristics of these pollutants. Further analyses involving more samples from the coastal sub-area, especially mature animals, are need in order to corroborate whether the differences in the levels of heavy metals reported here can be interpreted as the length-related accumulation within a stock.

INTRODUCTION

Recently, considerable discussion has been arising with regard the use of pollutants as indicator of stock. In the western North Pacific, the Japanese Government began a research program in order to elucidate the stock identity of the minke whale (Government of Japan, 1994; 1995). As the stock identity issue should be treated under a multi-approaches perspective (see Donovan, 1991), the research program combine studies on genetics, morphology/morphometric, ecological markers and differences in the level of chemical pollutants. The latter approach is considered particularly useful for elucidating stock and sub-stock structure in the western North Pacific minke whale.

Last year we began a comparative study on the differences in the levels of heavy metal between coastal and offshore minke whales in the western North Pacific (Fujise, 1995). In that study, we used 21 offshore minke whales in sub-area 9, taken during the first JARPN survey (Fujise *et al.*, 1995). The comparative study has been expanded for analyzing an additional 100 samples from sub-area 9 sampled during the second JARPN survey in that sub-area (Fujise *et al.*, 1996).

This report shows the results of a comparative analysis in the level of accumulation of heavy metals such as cadmium (Cd) and mercury (Hg) , between offshore samples from sub-area 9

and coastal samples from sub-area 7 available from past whaling operations in that sub-area.

MATERIALS AND METHODS

Samples

Samples used in the present study were 121 minke whales (109 males, 12 females) from sub-area 9 sampled during the 1994 and 1995 JARPN surveys in that sub-area. For comparison purposes, we examined 38 minke whales (23 males, 15 females) from sub-area 7 available from a 1987 operation of the small-type coastal whaling in Ayukawa .

Analysis of heavy metals

The accumulation levels of heavy metals Cd and Hg were examined from three different tissues: muscle, liver and kidney following the method described by Honda (1985). The level of accumulation of these metals were related in each sub-area to the sex and body length of the samples.

RESULTS AND DISCUSSION

Table 1 shows the level of concentrations of heavy metals (Cd and Hg) in minke whales from sub-areas 7 and 9, by sex, tissue and survey (sub-area 9).

Cd

In sub-area 9, the mean hepatic concentrations in male was 3.08ppm (range: 1.40-7.22) in the 1994 JARPN and 3.20ppm (range: 0.37-8.52) in the 1995 JARPN. The concentrations in kidney were 9.43ppm (range: 3.39-15.27) and 8.05ppm (1.47-32.80) in the 1994 and 1995 surveys, respectively. The accumulation levels of Cd found in males from sub-area 9 are considerably higher than those found in male individuals from sub-area 7. In this sub-area the values were 0.45ppm in liver (range: 0.04-1.15) and 2.08ppm in kidney (range: 0.23-5.29). In the case of muscle tissues, in most of them, the level of this metal was very small (0.02ppm) or not detected (<0.02ppm).

Hg

Hg concentration in liver of male was higher in sub-area 9 (mean 1.15ppm in 1994 and 0.95 in 1995) than in sub-area 7 (mean 0.34ppm), showing a similar trend as that observed for Cd. The levels of accumulations in kidney were also higher in sub-area 9 (mean 1.45ppm in 1994, 1.36ppm in 1995) than in sub-area 7 (0.13). In case of muscle tissue, it also showed a similar pattern as those in liver and kidney for Hg, although the level was considerably lower than those in liver and kidney.

The number of females examined is small. However, a similar trend as found in males is observed, e.g. higher concentration in sub-area 9.

It has been suggested that the level of accumulation in heavy metals such as Cd and Hg are related to the age of the individuals (Honda, 1985; Honda *et al.*, 1987, Yamamoto, 1988). The levels tend to be higher in older animals. According to this information, comparison in the level

of accumulation of heavy metals between sub-areas should be examined by age class. As age data are not available, we have related the accumulation level of pollutants to the body length of the individuals. Fig. 1 shows Cd concentrations in liver and kidney and its relations with the body length, and Fig. 2 shows the Hg concentrations in muscle, liver and kidney related to body length. In both cases, the accumulation level increased with the growth of body size. Then, differences between sub-areas identified from the mean values, could be a reflect of differences in body size between coastal and offshore individuals. In other words, the differences are due to the fact that most of animals sampled in sub-area 9 were larger than those sampled in sub-area 7.

On the other hand, hepatic Cd concentration of smaller (probably immature) females in sub-area 9 tend to be somewhat higher than those in sub-area 7 (Fig. 1), although hepatic Hg concentration in females were similar to those in males. It is known that Hg is bioconcentrated in animals of high trophic level through the food chain, but Cd has a species-specific accumulation characteristics, e.g. the concentration is higher in zooplanktons and squids than in other fishes (Honda, 1985; Fujise, 1987). The high Cd levels found in immature female in sub-area 9 could be explained by the intake of prey species such as zooplanktons and squids. However, it have been reported that the biological half life of Hg was considerably longer than that of Cd in marine mammals (Honda, 1985). This suggest that the immature females in both sub-areas have a similar feeding habitat in view of long term period. As a result, the differences in Cd levels observed in immature females, are not a reflect of stock or sub-stock differentiation.

From these considerations, it is not possible to draw a definitive conclusion on the differences in the accumulation levels of Cd and Hg observed between sub-areas, because the of possibility of age or length related accumulation level. Another possibility is that the differences found could reflect differences in the amount of pollutants in different years, because whales from the coastal and offshore sub-areas were taken in different years (1987 against 1994, 1995).

Further analyses involving more samples from the coastal sub-area, especially mature animals, are needed in order to corroborate whether the differences in the levels of heavy metals reported here can be interpreted as the age-related accumulation within a stock.

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Table 1. Comparison of body length, blubber thickness and cadmium and mercury concentrations (μg/g wet weight) in muscle, liver and kidney of minke whales from sub-areas 7 and 9

	Sub-area		Body length (m)	Blubber thickness (cm)	Muscle Cd (ppm)	Muscle Hg (ppm)	Liver Cd (ppm)	Liver Hg (ppm)	Kidney Cd (ppm)	Kidney Hg (ppm)
Male	7	Mean	6.0	2.9	0.01	0.07	0.45	0.34	2.08	0.13
		S.D.	0.6	0.4	0.01	0.04	0.32	0.18	1.19	0.12
		Min.	4.7	2.0	0.00	0.01	0.04	0.05	0.23	0.03
		Max.	7.3	3.5	0.03	0.17	1.15	0.96	5.29	0.49
		n	23	21	23	23	23	23	19	20
	9 (1994)	Mean	7.4	3.5	<0.02	0.34	3.08	1.15	9.43	1.45
		S.D.	0.4	0.7	-	0.18	1.59	0.85	3.40	0.91
		Min.	6.1	2.4	<0.02	0.10	1.40	0.27	3.39	0.25
		Max.	8.1	4.8	<0.02	0.87	7.22	3.19	15.27	3.23
		n	18	18	18	18	18	18	18	18
	9 (1995)	Mean	7.4	3.0	<0.02	0.27	3.20	0.95	8.05	1.36
		S.D.	0.5	0.5	-	0.06	1.73	0.53	4.93	0.72
		Min.	4.5	2.2	<0.02	0.04	0.37	0.13	1.47	0.12
		Max.	8.4	4.4	0.02	0.44	8.52	4.20	32.80	4.27
		n	91	91	91	91	91	91	91	91
	9 (combined)	Mean	7.4	3.1	<0.02	0.28	3.18	0.98	8.28	1.38
		S.D.	0.5	0.6	-	0.10	1.70	0.59	4.73	0.75
		Min.	4.5	2.2	<0.02	0.04	0.37	0.13	1.47	0.12
		Max.	8.4	4.8	0.02	0.87	8.52	4.20	32.80	4.27
		n	109	109	109	109	109	109	109	109
Female	7	Mean	5.6	2.9	0.01	0.07	0.46	0.27	2.35	0.09
		S.D.	0.5	0.4	0.01	0.04	0.34	0.13	1.18	0.04
		Min.	4.1	2.3	0.00	0.00	0.13	0.03	1.14	0.03
		Max.	6.4	4.2	0.04	0.15	1.26	0.50	5.18	0.18
		n	15	15	13	15	14	15	12	12
	9 (1994)	Mean	6.5	3.3	<0.02	0.19	1.95	0.43	9.80	0.45
		S.D.	1.5	0.4	-	0.14	0.35	0.34	3.36	0.37
		Min.	4.8	2.9	<0.02	0.03	1.55	0.04	6.25	0.03
		Max.	7.6	3.6	<0.02	0.31	2.20	0.66	12.93	0.73
		n	3	3	3	3	3	3	3	3
	9 (1995)	Mean	7.6	3.5	<0.02	0.24	4.60	0.85	8.01	0.90
		S.D.	0.8	0.7	-	0.08	2.39	0.47	4.12	0.55
		Min.	5.7	2.5	<0.02	0.07	1.51	0.14	3.20	0.12
		Max.	8.2	4.3	<0.02	0.34	8.04	1.50	14.82	2.06
		n	9	9	9	9	9	9	9	9
	9 (combined)	Mean	7.3	3.4	<0.02	0.23	3.93	0.74	8.46	0.79
		S.D.	1.1	0.6	-	0.09	2.37	0.47	3.88	0.53
		Min.	4.8	2.5	<0.02	0.03	1.51	0.04	3.20	0.03
		Max.	8.2	4.3	<0.02	0.34	8.04	1.50	14.82	2.06
		n	12	12	12	12	12	12	12	12

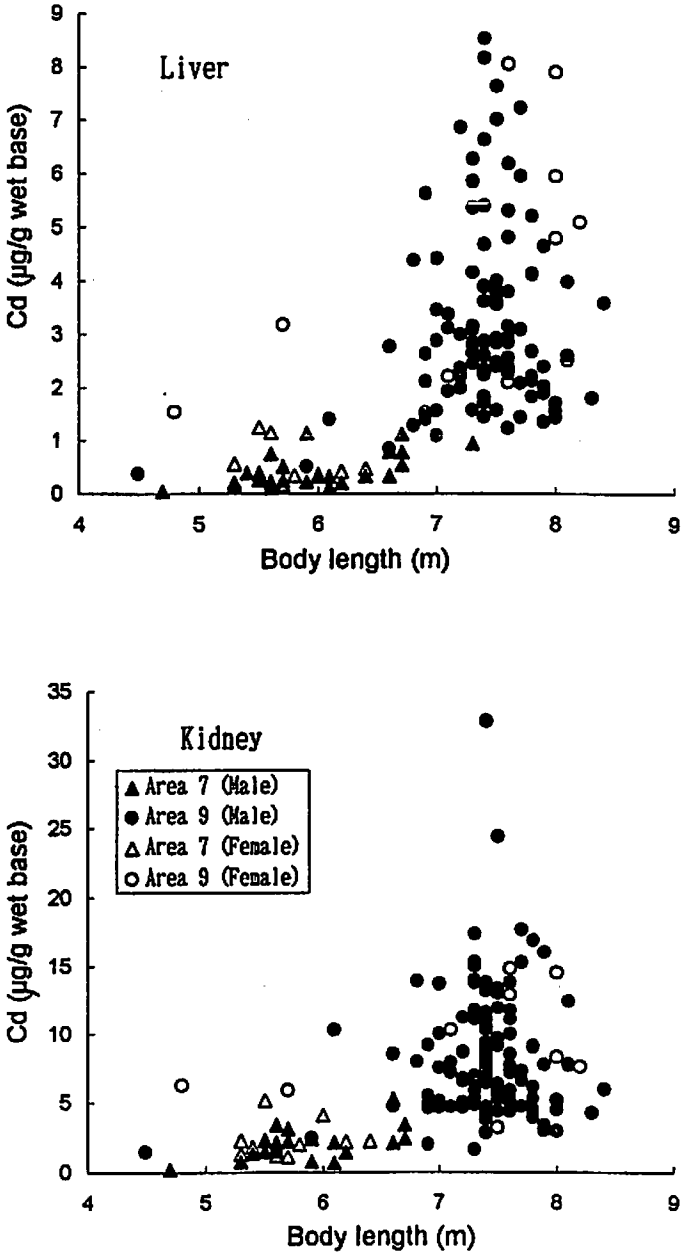

Fig. 1. Relationships between body length and Cd concentration in liver and kidney of minke whales taken in sub-areas 7 and 9, in the western North Pacific.

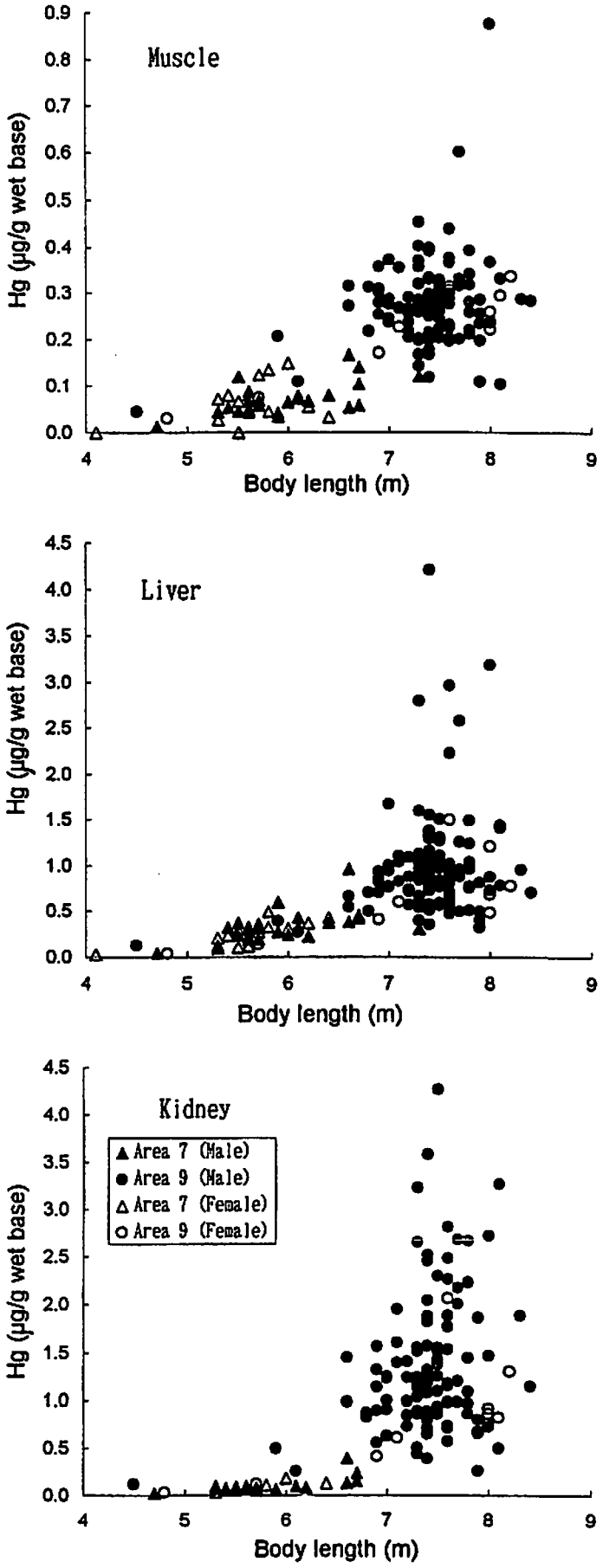

Fig. 2. Relationships between body length and Hg concentration in muscle, liver and kidney of minke whales taken in sub-areas 7 and 9, in the western North Pacific.