TRANSLATION

Results of heavy metal analysis of sea surface water, walleye pollock (*Theragra chalcogramma*) and northern fur seals (*Callorhinus ursinus*)

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ABSTRACT

The concentrations were analyzed of Hg, Cu, Cd, Zn, and Pb in sea surface water, walleye pollock, and northern fur seals sampled in the eastern Bering Sea, western Gulf of Alaska, and offshore area of northern Japan in the Pacific during 1983 to 1986. Cu and Zn in surface water showed higher concentrations in offshore areas of northern Japan compared to those in the eastern Bering Sea. In contrast, Pb showed high concentration in the eastern Bering Sea compared to that in offshore areas of northern Japan. However the average concentration value of each heavy metal in each area was within the range reported in the past. Cd and Zn of pollock sampled in the offshore areas of Aleutian Islands showed higher concentration than in northern Japan offshore areas. In contrast, Hg, Cu, and Pb showed higher concentrations in northern Japan offshore areas than in Aleutian Islands offshore areas. Hg, Zn, and Cd in livers and hairs on heads of northern fur seals showed higher concentrations than in muscles, hearts, and lungs. Hairs, which can be obtained without killing, are recognized as an effective index of heavy metal pollution of northern fur seals.
1. **Introduction**

In order to know the chemical pollution of northern fur seals (hereinafter referred to as fur seals), heavy metal analyses of sea surface water, pollock (food of fur seals), and fur seals were conducted.

2. **Materials and Methods**

   1) **Sea Surface Water**

   Sampling was conducted at 99 stations of the eastern Bering Sea and western Gulf of Alaska during July to August of 1984 and 1985 and in offshore Pacific areas of northern Japan during November to December, 1983 and during January to February, 1986 (Fig. 1). Five 2 liter vinyl chloride bottles were used at each stations. Waters were filtered using filter paper (paper size 4µm) and analyzed.

   Mercury (Hg) in the waters was concentrated by solvent extraction method and analyzed by dithizone colour absorptiometric method (Ota 1978; Seto and Yamazaki 1974: Hamaguchi et al. 1961). Copper (Cu), Zinc (Zn), Cadmium (Cd), and Lead (Pb) were analyzed by APDC-MIBK extraction method (Ishihara 1979, Yamamoto et al. 1971). Water in each bottle was analyzed three times. When the variances of the three values were within ±10% of the average, the average value was determined as a heavy metal content of that water. When the variance were over ±10%, the values of the bottle were abandoned.

   2) **Pollock**

   Heavy metal contents of pollock, which are food of fur seals, were analyzed. Pollock were sampled in offshore areas of the Aleutian Islands during September to October, 1983 and July to August, 1984 and offshore areas of northern Japan during February, 1986 (Table 1). Pollock sampled in 1983 were frozen and pollock in 1984 and 1986 were soaked in 10% formalin. Because it was difficult to do analysis separately for each internal organ, all internal organs were made uniform and analyzed.

   Hg in fish was first processed by Kanagawa method and analyzed by reduction gasification method (Kanno and Fukui 1978). Cu, Zn, Cd, and Pb were heated and melted in 8N KOH, made to a uniform solution, and analyzed by using an atomic absorption spectrophotometer. Content values were determined in the same manner as for sea surface water.

   3) **Fur Seals**

   Ten fur seals caught in offshore areas of northern Japan during 1985 to 1987 and 3 caught at St. Paul Island of the Pribilof Islands in August, 1985 were analyzed. Table 2 shows the age and sex data for the fur seals. Fur seals from the Pribilof Islands were provided by the United States as
Frozen samples and fur seals sampled in offshore areas of northern Japan were preserved in 10% formalin and provided by the National Research Institute of Far Seas Fisheries.

In 1985, to determine the organ which had the greatest concentration of heavy metals, heart, lung, stomach, liver, kidney, muscle, hair, and skin were analyzed. Subsequently, liver, hair, and muscle (only in 1986) were analyzed in 1986 and 1987. Instead of muscles, fat tissues were analyzed in 1987, because muscles were not sampled in that year. Muscle was brachial muscle, skin was sampled from the root part of brachium, and hair was from the head. The same methods as for pollock were used for analyses. Content values were determined the same way as for sea water and pollock.

Heavy metal concentrations in formalin used for preserving pollock and fur seals were under 1/50 of those in the sea surface water sampled. This indicates that the results were not influenced by heavy metals in formalin.

3. Results and Considerations

1) Sea Surface Water

The concentrations of Hg and Cu in water of the eastern Bering Sea, western Gulf of Alaska, and the areas offshore of northern Japan were almost equal or within the range of standard sea water. In contrast, the concentrations of Zn, Cd, and Pb were higher than those of standard sea water. The average concentration of Hg, Cu, Zn, Cd, and Pb sampled in each area was within the range of concentrations reported in the past.

By area, the concentrations of Cu and Zn in offshore areas of northern Japan were higher than those in the eastern Bering Sea. The concentration of Pb showed lower value than that in the eastern Bering Sea. The concentrations of Hg and Cd were almost same for both areas (Table 3).

2) Pollock

The average concentrations of Zn and Cd in offshore areas of the Aleutian Islands were higher than those in offshore areas of northern Japan. In contrast, the concentrations of Hg, Cu, and Pb in the offshore areas of northern Japan were higher than off the Aleutian Islands (Table 4).

3) Fur Seals

In 1985, 3 females were analyzed. Concentrations of Zn in hairs and livers ranged from 53.35 to 84.14 ppm and were higher than in other organs, i.e. muscle 30.44 to 37.46 ppm, kidney 36.45 to 48.09 ppm. The same tendency was observed for Hg. Cd showed highest values in hairs (0.81 to 1.01 ppm) (Table 5).
In 1986, 1 male and 2 females were analyzed. Concentrations of Zn in hairs were 3 to 17 times as high as in livers and muscles, but the cause is unknown. Cd in livers ranged from 1.23 to 2.42 ppm (Table 6).

In 1987, 2 males and 2 females were analyzed. Large differences were not observed for concentrations of Zn in livers and hairs compared to that in 1985 and 1986. However, the concentrations of Cu, Cd, Pb, and Hg were generally higher than in previous years. Cd in hairs and livers ranged from 2.16 to 2.83 ppm and from 2.36 to 2.50 ppm, respectively (Table 7).

Two males and one female sampled at the Pribilof Islands were analyzed. The concentrations of Zn in hairs was 3 to 5 times as high as in livers and muscles. The concentrations of Cd in livers ranged from 1.46 to 4.46 ppm (Table 8).

Concentration of each heavy metal varied by organs, years sampled, age, and condition of maturity. However, in general, concentrations of each heavy metal in hairs were equal or slightly higher than in livers and muscles. Mercury poisoning in men was characterized by substantial accumulation of Hg in hairs (Abe 1975; Nakao 1975). Hairs, which can be obtained without killing, are recognized as an effective index of heavy metal pollution of fur seals.

4. Acknowledgements

We would like to express our appreciation to the Marine Mammal Laboratory of the United States which provided us the fur seals sampled at Pribilof Islands.

References, Tables 1 to 8, and Fig. 1 are in English in the Japanese document.