Bull. Fac. Fish. Hokkaido Univ.
29(1), 70–74. 1978.

# Concentration of Mercury in Marine Animals

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## Abstract

About 200 marine animals were divided on the basis of food habit. The concentrations of mercury in them were measured and the mechanism of mercury accumulation was examined. Based on the results, it is likely that mercury accumulation in marine animals depends on food chain amplification.

## Introduction

The concentration of elements by marine animals is a reflection of the concentration in sea water[1)] whether the accumulation is by a food chain or some other mechanism. Even in the same species of fish the mercury concentration in each fish changes as the mercury concentration changes in sea water. The mechanism of accumulation of mercury is only considered with the assumption that the mercury concentration in the oceans is uniform.

Although many measurements of the mercury concentration in sea water have been made in open ocean water, the reported values scatter very widely because the samples were stored in polyethylene bottles after acidification. Matsunaga[2)] found that nanogram amounts of mercury were released by polyethylene bottles during storage, which increased the initial mercury level by a factor of 2–100 times, even if the container has been acid rinsed. When sea water samples with a salinity more than 30‰ were stored in all glass containers, and acidified with concentrated sulfuric acid, no contamination or reduction of mercury levels was observed. By using glass bottles, the correct mercury concentrations in natural waters have been reported[3–6)], especially the mercury concentration in sea water[3,4)] had a constant value of 5 ng/l regardless of depth. Thus, by comparing the mercury levels in marine animals living in uncontaminated sea water, the mechanism of mercury accumulation can be examined. Laboratory experiment suggested that a food chain mechanism was dominant[7)].

Generally three accumulation mechanisms were considered.

1) Direct accumulation from sea water through epithelial tissue
2) Direct accumulation through branchial respiration
3) Indirect accumulation from food

Since epithelial tissue per unit area in contact with water is constant regardless of size, mercury levels in fishes will be higher as years go by and also they will become equivalent in the same age, even if species are different. But, even in the same age they scatter very widely. In the second mechanism, no relation between mercury concentrations in marine animals and their branchial respiration

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has been found. From this, the third mechanism appears to be dominant.

Knauel and Martin[8] have reported that the mercury concentration in phytoplankton, on dry weight basis, was 2 times higher than in zooplankton and pilchard, and concluded that the mechanism was not caused by food chain amplification. But, it is premature to conclude the mechanism with measurements of mercury in only three marine animals.

## Materials and methods

About two hundred marine animals were collected at uncontaminated sea areas and muscles of the fish and surf clam and adductor muscles of the scallop were used for the determination of total mercury.

The outline of analytical procedure is as follows[9]: about 0.2 g of a sample in air dry weight from each specimen was burned in a quartz tube and the combustion gas was absorbed into potassium permanganate in 1 N sulfuric acid solution. Excess oxidizer was reduced with a hydroxylamine solution and by adding stannous chloride, produced metalic mercury vapour was concentrated on gold particles by passing nitrogen gas. The particles were heated in a furnace and the vaporized mercury was determined with an atomic absorption spectrophotometer.

## Results and discussion

The analytical results of mercury concentrations in marine animals and their food habits[10–12] are shown in Table 1. As a rule, the mercury levels in fishes increase with growth, that is, with age[13–21]. However, the rate of the increase of mercury in fishes after becoming adults is not so large that it is possible to discuss the mechanism using mercury levels in fishes measured in this study.

As shown in Table 1, fish in the first group, which feed on fishes, had the highest mercury levels. Although fish in the second group seemed to have the same food habit as those in the thrid group, the composition of muscle protein in the second group living in deep water differed from that in the third group living in shallow water[22] and mercury levels also differed. On this basis, they were classified into two groups. Fish in the fourth group had low mercury concentrations close to the values in zooplankton[8], and shell fish in the fifth group had the lowest mercury levels.

Judging from these results, higher predators had higher mercury levels and it is likely that the mercury accumulation in marine animals depends on food chain amplification. However, there are unsolved problems, e.g. mercury concentration in Japanese rockfish differs between species.

The origin of methyl mercury found in marine animals will be in sea water because methyl mercury is found in marine or river sediments[23].

## Acknowledgement

I thank Profs. M. Nishimura and S. Fukase for their advice, and Dr. K. Amaoka for identification of fish.

Bull. Fac. Fish. Hokkaido Univ. 29(1), 1978.

Table 1. *Concentrations of total mercury in marine animals and their food habit*

| Sample name | Body length (cm) | Number of samples | Total Hg (ppm, dry weight) | Food habit |
|---|---|---|---|---|
| Tuna | | 8 | 1.5 ±0.4 | 1) |
| Skipjack, *Katsuwonus pelamis* | | 4 | 0.85±0.23 | Fish and squid |
| Yellowtaill, *Seriole quinqueradiate* | | 5 | 0.19±0.14 | |
| | | | | |
| Pacific ocean perch, *Sebastodes alutus* | 30-40 | 20 | 0.60±0.21 | 2) |
| Japanese rockfish | | | | Shrimp, polycaeta and |
| *Sebastes baramenuke* | 50-55 | 13 | 0.62±0.26 | euphausia living in |
| *Sebastes flameus* | 40-50 | 12 | 1.4 ±0.4 | depth below 300 m |
| *Sebastes iracundus* | 40-70 | 15 | 1.6 ±0.4 | |
| Channel rockfish, *Sebastobus macrochir* | 30-35 | 10 | 0.36±0.1 | |
| | | | | |
| Common sea bass, *Lateolabrax japonicus* | 60-65 | 2 | 0.91±0.26 | 3) |
| Flounder, *Limand herzenstein* | 23-30 | 20 | 0.21±0.05 | Shrimp, shell, |
| Black rockfish, *Sebastes inermis* | 20-30 | 5 | 0.33±0.12 | euphausia, copepoda |
| Red sea bream snapper, *Pagrus major* | 23-26 | 5 | 0.25±0.01 | and polycaeta in |
| Squid, *Todarodes pacificus* | | 14 | 0.08±0.02 | shallow layer |
| | | | | |
| Red salmon, *Oncorhynhus nerka* | 55-60 | 5 | 0.15±0.01 | 4) |
| Alask pollock, *Theragra chalcogramma* | 53-57 | 5 | 0.16±0.13 | Euphausia and other |
| Pilchard, *Sardinops melanosticta* | | | | zooplankton and |
| *Engranulis japonica* | 10-15 | 20 | 0.14±0.05 | phytoplankton |
| Saury, *Cololabis saira* | 25-30 | 8 | 0.13±0.02 | |
| | | | | |
| Surf clam, *Spisula (Pseudocardium) sachalinensis* | | 28 | 0.07±0.02 | 5) Diatom and dead |
| Scallop, *Patinopecten (Mizuhopecten) yessoensis* | | 25 | 0.04±0.01 | organisms |

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