

Dr. Mineshi Sakamoto

○アブストラクトデータ

Mercury speciation and selenium concentrations in tooth-whale meats consumed in Taiji Town, Japan

M Sakamoto, A Yasutake, T Iwasaki, G Yasunaga, Y Fujise, M Nakamura, M Marumoto, K Murata, HM Chan

Taiji is a whaling town in Wakayama Prefecture, Japan. The local residents who eat tooth whales are exposed to methylmercury (MeHg) and show high mercury concentrations in their hair or blood. In this study, we measured total mercury (T-Hg), MeHg and selenium (Se) in red meat of 4 species of tooth-whales, striped dolphin (n=29), short-finned pilot whale (n=30), risso's dolphin (n=31) and Bottlenose dolphin (n=31) which were caught in the sea near Taiji. The red meats of the former two species are commonly consumed by local residents. Median concentrations of T-Hg, MeHg, and Se were: striped dolphin (5.6 ppm for T-Hg, 2.3 ppm for MeHg, 2.8 ppm for Se), short-finned pilot whale (7.8 ppm for T-Hg, 4.2 ppm for MeHg, 2.7 ppm for Se), risso's dolphin (3.2 ppm for T-Hg, 2.6 ppm for MeHg, 1.3 ppm for Se), and bottlenose dolphin (30 ppm for T-Hg, 7.0 ppm for MeHg, 14.2 ppm for Se), respectively. T-Hg concentrations in bottlenose dolphin were 4 to 7 times higher than those in other species. MeHg concentrations in bottlenose dolphin were 1.5 to 4 times higher than those in other species. However, the percentage of MeHg (35%) was lower than in the other species. In all species, T-Hg concentrations were positively associated with MeHg concentrations. However, MeHg concentrations appeared to reach plateau beyond which the percentage of MeHg dramatically decreased with further increase in T-Hg concentrations. Similar to T-Hg, Se concentrations in bottlenose dolphin were 4 to 8 times higher than those in other species. Inorganic Hg (I-Hg) was calculated as T-Hg minus MeHg. The Se/I-Hg molar ratio decreased with the increase in T-Hg concentrations, and eventually reached to a constant ratio of 1 (Se:I-Hg=1:1). These results suggest that tooth whales, especially bottlenose dolphin, accumulate a high Hg concentration in the red meat, but they have a high demethylation ability to regulate the MeHg concentrations. This information on Hg and Se speciation will help to characterize the health risk associated with consumption of tooth-whale meat.

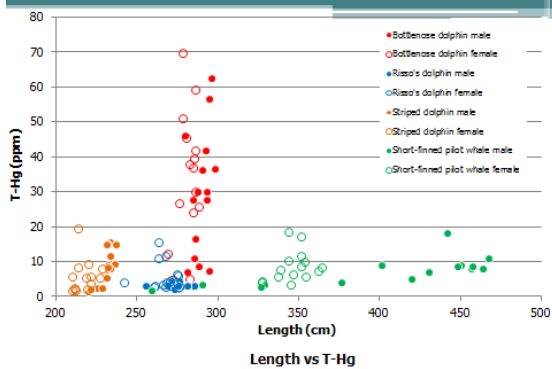
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Table 1. T-Hg, MeHg and Se concentrations in red meat of 4 species of tooth-whales

Species Means(SD)	T-Hg ppm	MeHg ppm	MeHg (%)	I-Hg ppm (T-Hg- MeHg)	Se ppm
Bottlenose dolphin n=31	31.0 (18.2)	7.21 (1.80)	35.4 (24.7)	23.8 (17.3)	14.6 (10.5)
Risso's dolphin n=31	4.31 (3.02)	2.60 (0.660)	70.9 (18.9)	1.70 (2.69)	1.74 (1.22)
Striped dolphin n=29	7.21 (5.02)	2.37 (0.697)	50.0 (29.3)	4.84 (4.75)	3.48 (2.89)
Short-finned pilot whale n=30	7.92 (4.29)	4.40 (1.79)	62.9 (21.9)	3.52 (3.37)	2.75 (1.57)



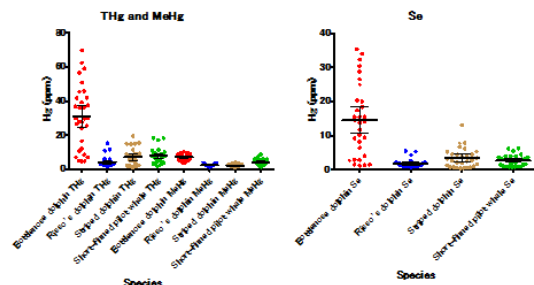
Background

- Taiji has been primarily known as a whaling town in Wakayama Prefecture, Japan. Japanese traditional whaling techniques were developed here in the 17th century, and the commercial hunting and catching of whales remains a major source of income for its residents to this day.
- The local resident who eat tooth whales are exposed to methylmercury (MeHg) and show high mercury (Hg) concentrations in their hair or blood.

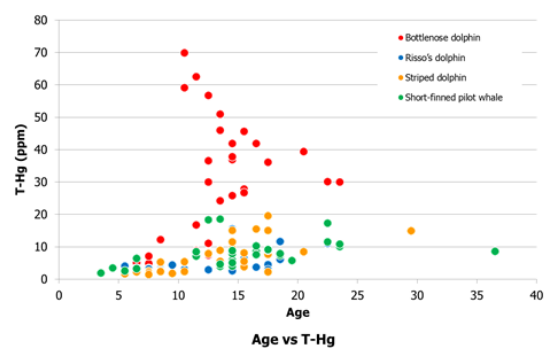


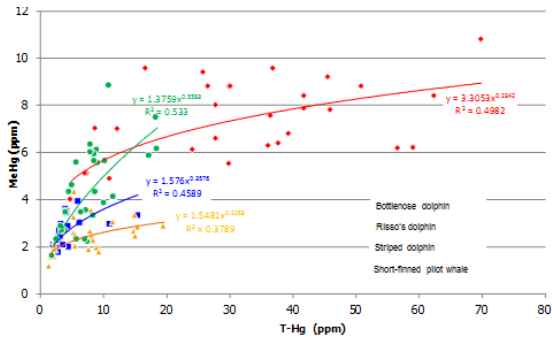
Materials and Methods

- Total mercury (T-Hg), MeHg and Se were measured in abdominal red meat of 4 species of tooth-whales, striped dolphin (n=29), short-finned pilot whale (n=30), risso's dolphin (n=31) and bottlenose dolphin (n=31). The red meats of the former two species are commonly consumed by local residents.
- T-Hg was determined by cold vapor atomic absorption spectrometry (CVAAS) and MeHg was determined by gas chromatography with electron capture detection (GC-ECD) according to the method of Akagi et al. Se was determined by ICP-MS. Inorganic Hg (I-Hg) was calculated as T-Hg minus MeHg.



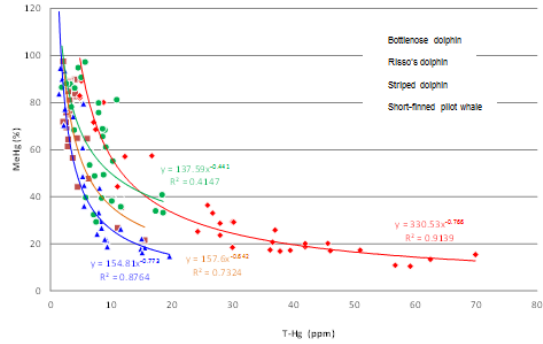
T-Hg, MeHg and Se concentrations in red meat of 4 species of tooth-whales





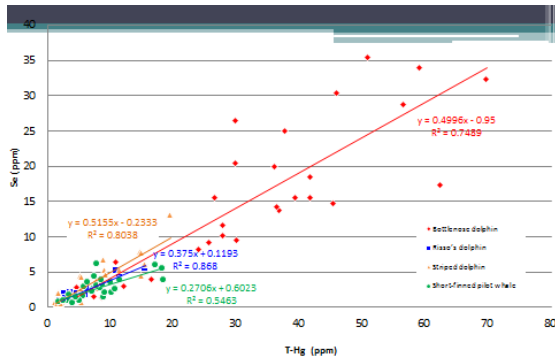
T-Hg vs. MeHg in tooth whales

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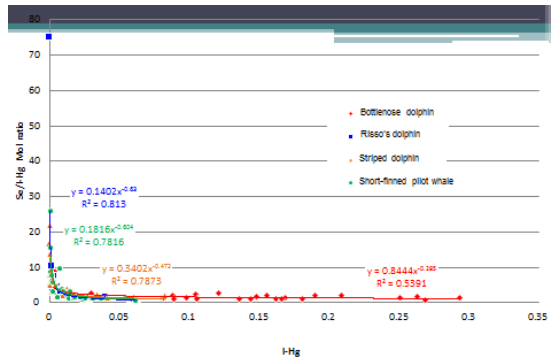


T-Hg vs. MeHg (%) in tooth whales

28



T-Hg vs Se in tooth whales



I-Hg vs. Se/I-Hg molar ratio

Results

- T-Hg in bottlenose dolphin were 4 to 7 times higher than those in other species. MeHg in bottlenose dolphin were 1.5 to 4 times higher than those in other species. However, the percentage of MeHg (35%) was lower than in the other species.
- Lengths of male whales were longer than those of female ones, while T-Hg concentrations were almost similar between sex among the species.

- T-Hg were positively associated with MeHg. However, MeHg appeared to reach plateau beyond which the percentage of MeHg dramatically decreased with further increase in T-Hg concentrations.
- Similar to T-Hg, Se concentrations in bottlenose dolphin were 4 to 8 times higher than those in other species.
- T-Hg and Se showed significant and strong positive correlations.

- The Se/I-Hg molar ratio decreased with the increase in I-Hg concentrations, and eventually reached to a constant ratio of 1 (Se:I-Hg=1:1), indicating inorganic Hg exist as mercuyselenide (HgSe), which is inert, in their meat.
- These results suggest that tooth whales, especially bottlenose dolphin, accumulate a high Hg concentration in the red meat, but they have a high demethylation ability to regulate the MeHg concentrations.

Electron Probe Microanalyzer (EPMA)

- A beam of accelerated electrons is focused on the surface of a specimen, and these energetic electrons produce characteristic X-rays of the specimen.
- The characteristic X-rays are detected at particular wavelengths, and their intensities are measured to determine concentrations.



EPMA Analysis

Material: Paraffin embedded Bottle nose dolphin's skeletal muscle slice (2 μm)

T-Hg	69.9 ppm
MeHg	10.8 ppm
I-Hg	59.1 ppm
Se	32.3 ppm

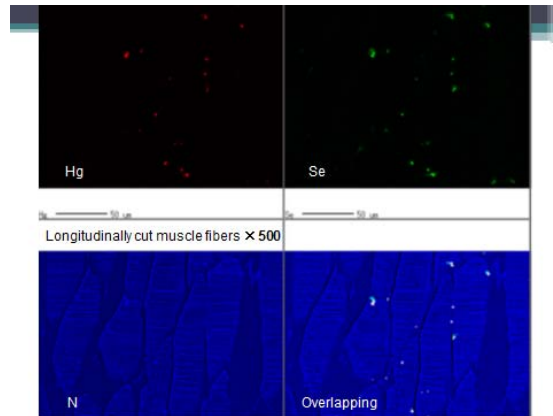
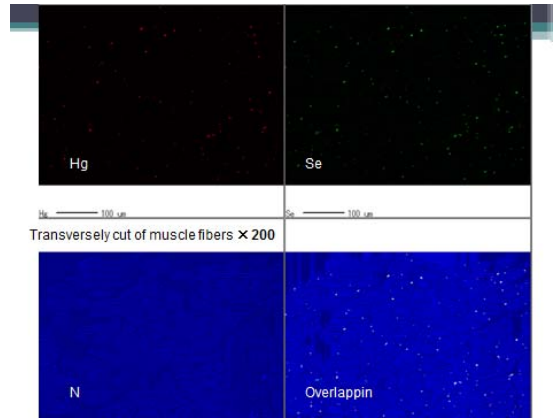
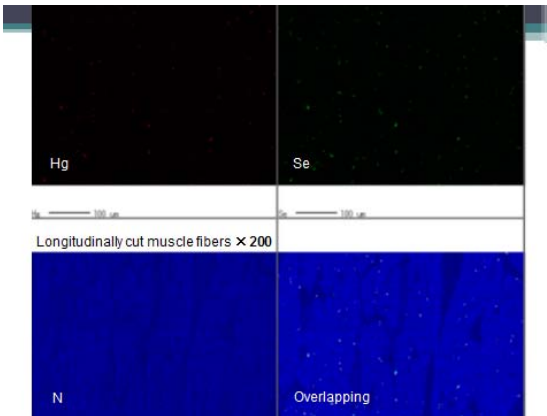
Analysis by Electron Probe Microanalyzer (EPMA):

The analyzed element: Hg, Se, N

Accelerating voltage: 15 kV

Irradiation current: 0.6 μA

Analyzed time: 11-13 hours



Result of Electron Probe Microanalyzer

- Hg and Se were detected in the same place, mainly near the endomysium, which ensheathes individual muscle fiber. The endomysium contains capillaries, lymphatics and nerves.
- The EPMA analysis also indicated that Hg and Se co-exist suggesting the form of HgSe.

Conclusion

- These results suggest that tooth whales, especially bottlenose dolphin, accumulate a high Hg concentration in the red meat, but they have a high demethylation ability to regulate the MeHg concentrations.
- The Se/I-Hg molar ratio rapidly decreased with the increase in I-Hg, and eventually reached to a constant ratio of 1 (Se:I-Hg = 1:1). EPMA analysis also indicated that Hg and Se co-exist, suggesting that I-Hg existed as mercury selenide (HgSe), which is inert, in their meat.

- The strong demethylation and forming HgSe may protect the life of the tooth whales.
- For human exposure, the high I-Hg in tooth whale meat will not be a serious threat to human who consume tooth whale meat. However, they still contain 2-7 ppm of MeHg. Pregnant women should avoid eating tooth whale meat as are advised in many countries

Selenomethionine Protects against Neuronal Degeneration by Methylmercury in the Developing Rat Cerebrum

Mineshi Sakamoto,^{1,*} Akira Yasutake,¹ Akiyoshi Kakita,² Masae Ryuufuku,³ Hing Man Chan,³ Megumi Yamamoto,¹ Sanae Oumi,⁴ Sayaka Kobayashi,¹ and Chiho Watanabe¹

¹National Institute for Minamata Disease, Minamata, Kumamoto 867-0008, Japan

²Brain Research Institute, Niigata University, Asahimachi, Niigata 951-8522, Japan

³University of Ottawa, Ottawa ON K1N 6N5, Canada

⁴University of Tokyo, Bunkyo-ku, Tokyo 113-8656, Japan

ABSTRACT: Although many experimental studies have shown that selenium protects against methylmercury (MeHg) toxicity at different end points, the direct interactive effects of selenium and MeHg on neurons in the brain remain unknown. Our goal is to confirm the protective effects of selenium against neuronal degeneration induced by MeHg in the developing postnatal rat brain using a postnatal rat model that is suitable for extrapolating the effects of MeHg to the fetal brain of humans. As an exposure source of selenium, we used selenomethionine (SeMet), a food-originated selenium. Weistar rats of postnatal days 14 were orally administered with vehicle (control), MeHg (8 mg Hg/kg/day), SeMet (2 mg Se/kg/day), or MeHg plus SeMet coexposure for 10 consecutive days. Neuronal degeneration and reactive astrocytosis were observed in the cerebral cortex of the MeHg group but the symptoms were prevented by coexposure to SeMet. These findings serve as a proof that dietary selenium can directly protect neurons against MeHg toxicity in the mammalian brain, especially in the developing cerebrum.

