Dr. Tokutaka. Ikemoto

○アブストラクトデータ

Presence of mercury selenide in various tissues of marine mammals

Tokutaka Ikemoto[1], Takashi Kunito[2], Akiko Hokura[3], Izumi Nakai[4], Shinsuke Tanabe[5]

[1] Thermo Fisher Scientific K.K.
[2] Department of Environmental Sciences, Faculty of Science, Shinshu University
[3] Department of Green and Sustainable Chemistry, School of Engineering, Tokyo Denki University
[4] Department of Applied Chemistry, Tokyo University of Science
[5] Center for Marine Environmental Studies (CMES), Ehime University

Marine mammals accumulate mercury in their tissues at high concentration and detoxify by forming mercury selenide (HgSe, tiemannite) mainly in the liver. We investigated the possibility of formation of HgSe in various tissues (liver, kidney, lung, spleen, pancreas, muscle and brain) other than the liver of the striped dolphin (*Stenella coeruleoalba*). We applied a combination method of micro-X-ray fluorescence (μ-XRF) imaging and micro-X-ray diffraction (μ-XRD) using a synchrotron radiation X-ray microbeam to analyze the tissue samples directly with minimal sample preparation. By this method, many accumulation points for Hg and Se on a micron scale were found in thin sections of the spleen and liver tissue and consequently, the XRF spectra and the XRD pattern of the hot spots confirmed the presence of tiemannite, HgSe. On the other hand, the insoluble fractions after enzyme digestion of the nuclear and mitochondrial fractions of all tissues were subjected to X-ray absorption fine structure (XAFS) analysis. XAFS analysis confirmed the presence of HgSe in all the tissues examined (liver, kidney, lung, spleen, pancreas, muscle and brain) of the striped dolphin. The presence of HgSe in all the tissues examined suggests that Se would be involved in the detoxification process of Hg in various tissues other than the liver. This contribution seems to be large especially in the liver and spleen but relatively small in the kidney, pancreas and brain, because the proportion of insoluble fraction containing HgSe was lower in these tissues (25-46%).

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○発表データ

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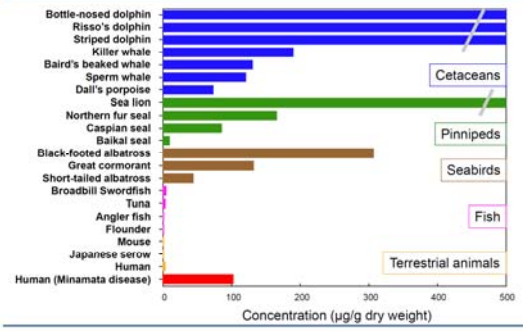
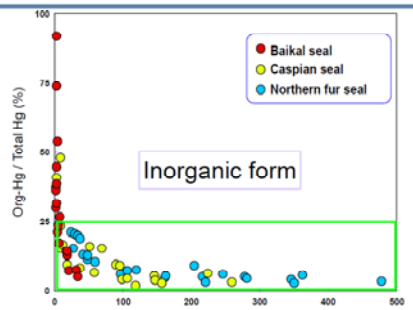
Background: Hg concentration in liver of wildlife



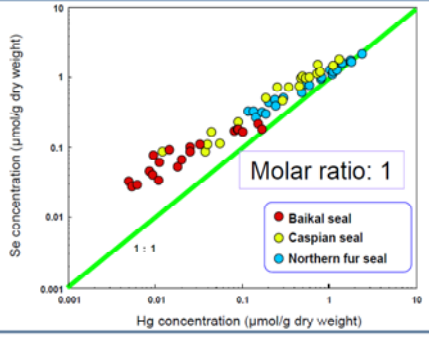
2

Background: Percentage of Org-Hg to total Hg in the liver



3

Background: Relationship between Hg and Se concentrations

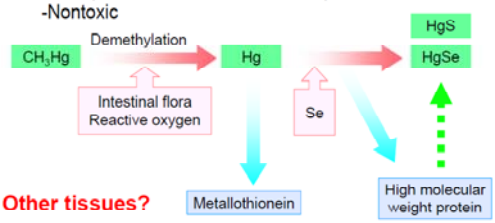


4

Background: HgSe(tiemannite)

This equimolar ratio may be due to the presence of mercury selenide (HgSe, tiemannite)

HgSe
-Final product of the detoxification process
-Nontoxic



5

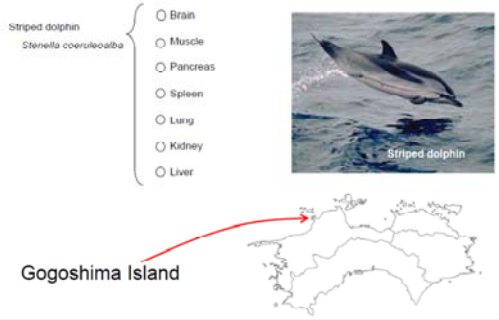
Objectives

The goal of the present study is to clarify the detoxification mechanism of Hg by combining with Se in the striped dolphin.

1. We explored HgSe granuls in various tissues and tried to identify their chemical form non-destructively by utilizing a combined analytical system, SR-μ-XRF-XRD.
2. The local structure of Hg was examined by analyzing XAFS data for various tissues of striped dolphin to determine whether Hg is detoxified by forming HgSe in tissues other than the liver.

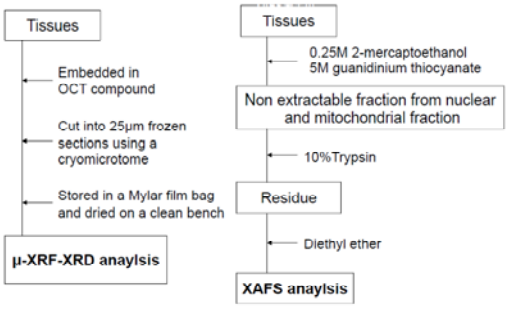
6

Samples



7

Sample preparation



8

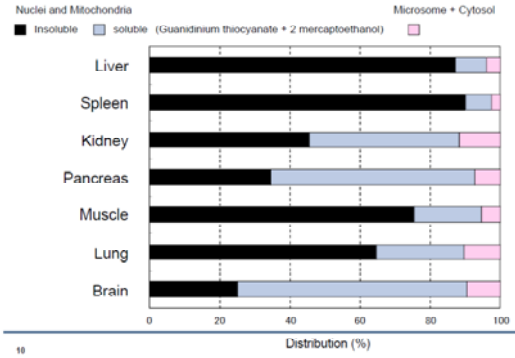
Results: Molar ratio of Hg to Se in various tissues

Species	Tissues	Fraction	Hg (ppm)	Hg (mol)	Se (ppm)	Se (mol)	Molar ratio
Striped dolphin *Stenella coeruleoalba*	Brain	Whole	33	0.16	17	0.22	Hg : Se = 1 : 1.3
		NE in NM	270	1.4	190	2.4	Hg : Se = 1 : 1.8
	Muscle	Whole	50	0.25	19	0.24	Hg : Se = 1 : 0.97
		NE in NM	670	3.3	370	4.7	Hg : Se = 1 : 1.4
	Spleen	Whole	96	0.48	55	0.70	Hg : Se = 1 : 1.5
		NE in NM	2400	12	990	13	Hg : Se = 1 : 1.1
	Pancreas	Whole	240	1.2	95	1.2	Hg : Se = 1 : 1.0
		NE in NM	1000	9.0	950	12	Hg : Se = 1 : 1.3
	Lung	Whole	51	0.25	31	0.39	Hg : Se = 1 : 1.5
		NE in NM	130	0.65	62	0.78	Hg : Se = 1 : 1.2
	Kidney	Whole	55	0.27	35	0.44	Hg : Se = 1 : 1.6
		NE in NM	160	0.80	110	1.4	Hg : Se = 1 : 1.8
	Liver	Whole	1000	5.0	390	4.9	Hg : Se = 1 : 0.98
		NE in NM	9100	45	3700	47	Hg : Se = 1 : 1.0

HgSe may exist in the various tissues

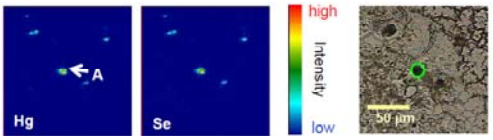
9

Results: Distribution of Hg in subcellular fractions

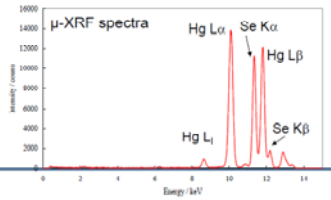


10

Results: μ-XRF imaging (Liver)

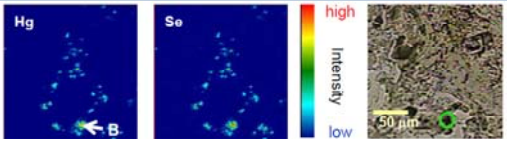


2D elemental map Micrograph

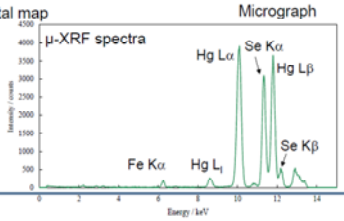


11

Results: μ-XRF imaging (Spleen)

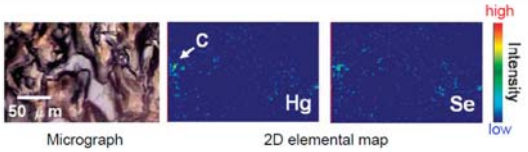


2D elemental map Micrograph



12

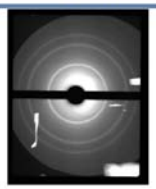
Results: μ-XRF imaging (Muscle)



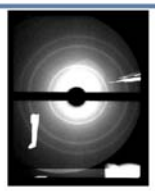
Micrograph 2D elemental map

13

Results: μ-XRD



μ-XRD pattern (Liver)

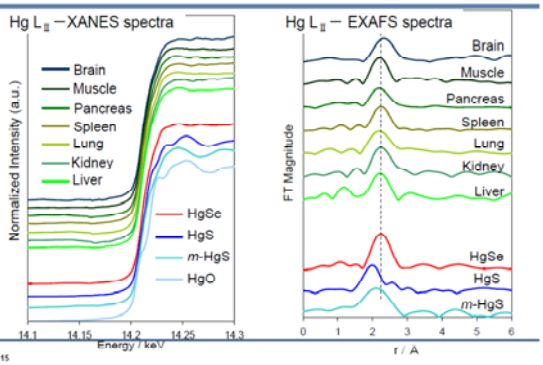


μ-XRD pattern (Spleen)

Liver		Spleen		tiemannite (HgSe)*		
d / Å	Int	d / Å	Int	d/ Å	Int	hkl
3.46	100	3.51	100	3.51	100	111
3.02	19			3.04	16	200
2.13	54	2.14	46	2.15	50	220
1.82	28	1.83	31	1.84	30	311

14

Results: XAFS spectra



15

Conclusions

1. Non-destructive SR-μ-XRF-XRD measurement provided direct evidence of the presence of mercury selenide in the liver and the spleen.
2. The presence of mercury selenide in the liver , muscle, kidney, brain, lung, pancreas, and spleen was supported by XAFS analysis.

The results of the present study reinforce the importance of the detoxification role of Se in tissues other than the liver of marine mammals

16