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Abstract

Total mercury content in nanoplankton and fishes was determined by cold vapor atomic absorption spectrometory using porous gold as a collector. The contents and distributions of mercury in these biological samples were investigated.

Biological samples were taken from the East China Sea and Kagoshima Bay. Levels of total mercury of nanoplankton determined were found to be in the range of $0.01 \sim 4.0_2$ ng/l (mean 0.03_8 ng/l) for 10 samples taken from the East China Sea and 3.8_3, $13._6$ ng/l for two samples taken from Kagoshima Bay.

The ranges of total mercury content in fishes and their stomach contents were $310 \sim 2650$ μg/kg (wet basis), $60 \sim 680$ μg/kg (wet basis), respectively, and their arithmetic means were 1050 μg/kg, 235 μg/kg, and their geometric means were 897 μg/kg, 180 μg/kg, respectively. A high degree of positive correlation (correlation coefficient: 0.97) was found between mercury content of fish meat and stomach contents in fishes of Kagoshima Bay.

Key words: Mercury, Nanoplankton, Fishes, Mercury concentration

Introduction

Mercury polluted fishes were found in Ushine district of Kagoshima Bay in November, 1973. The cause of the pollution had been widely investigated.

There have been many reports concerning the mercury polluted fishes[1)-11)] and mercury content of biological samples[12)-14)].

It was necessary to investigate the concentration mechanism of mercury containing biological samples.

A purpose of this research was to clear concentration mechanism of mercury polluted fishes. Firstly we have been investigated determination method for mercury in sea water samples[15)-17)] and sediments[3),18)]. These methods were applied to biological samples.

Nanoplankton was taken up as the low degree organism of food chain and fishes were taken up as high order. Furthermore, behavior of mercury was examined in a food chain of Kagoshima Bay.

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This paper describes the results of total mercury content in nanoplankton and fishes taken from the East China Sea and Kagoshima Bay.

Experimental

Reagents and Apparatus.

All reagents were analytical special grade of marketing and several reagents were

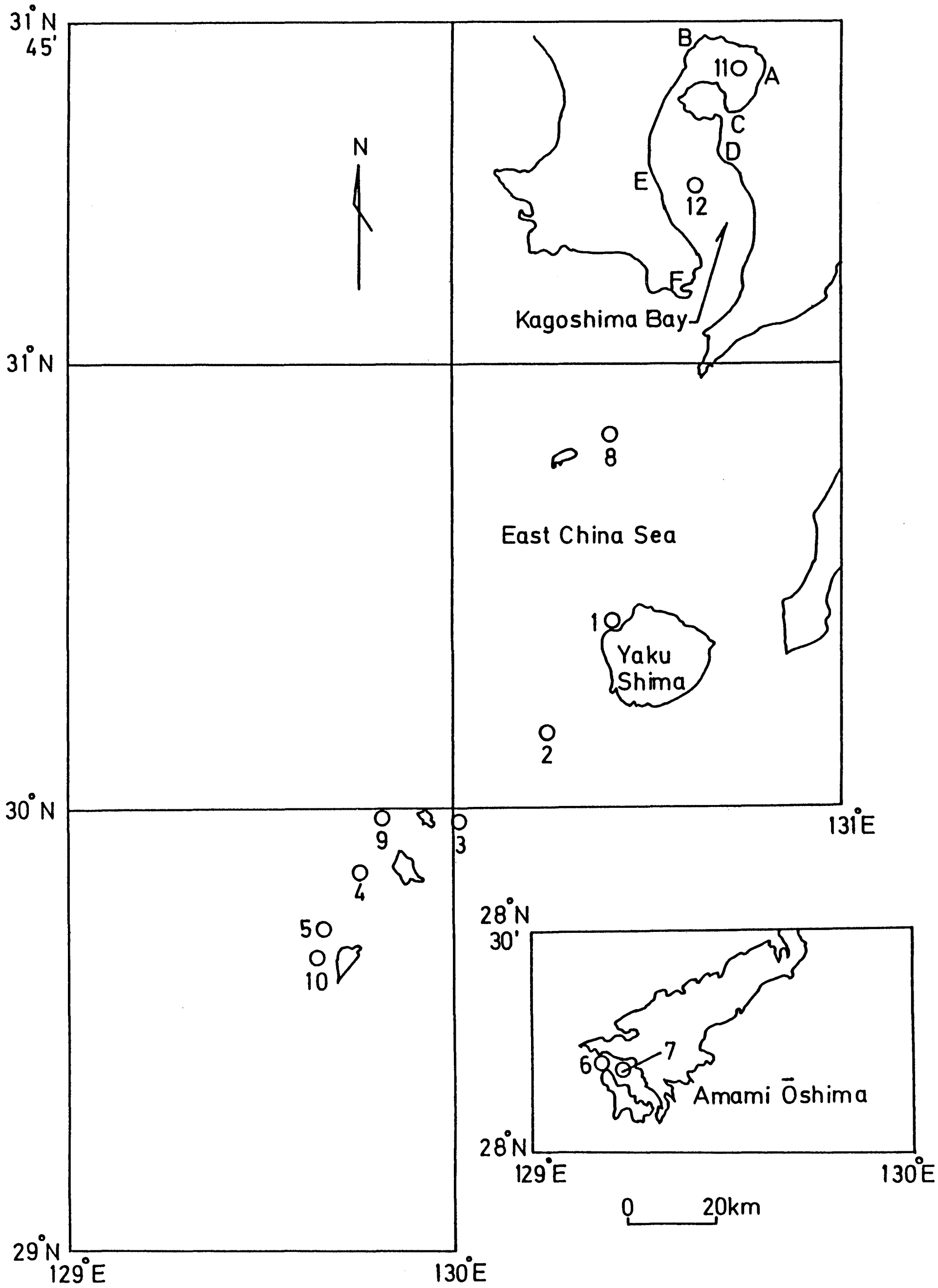

Fig. 1 Sampling stations of biological samples in East China Sea and Kagoshima Bay.
A: Fukuyama, B: Kajiki, C: Ushine, D: Tarumizu,
E: Hirakawa, F: Yamagawa

prepared in mercury free by heating.

Porous Gold Collector. Trapping agents coated with porous gold (sintered chloroauric acid on the surface of chromosorb) was used.

Apparatus. The apparatus used Rigaku Mercury SP (Nihon Instruments).

Sampling of Biological Sample and Preservation.

Sampling stations of biological samples in the East China Sea and Kagoshima Bay are shown in Fig. 1; the station numbers are tabulated in Table 1.

Nanoplankton is a general term of extremely feeble plankton of the self exercise capability. A plankton is classified into a plant plankton and an animal plankton. Minute plant plankton (nanoplankton) comprises appreciable portion of carbonic acid assimilation. There is not obvious prescription regarding size of nanoplankton. Generally speaking, the size is from 5 to 60 μm. When the mercury content in ocean biological material is made a problem in low degree of food chain, mercury content of nanoplankton need to be known. This is the first step to clarify the mercury concentration mechanism to living body.

Water samples (from 20 to 100 liters) used for mercury determination were kept in polyethylene bottle, which were exuded beforehand by approximately 3 mol/l nitric acid for two weeks and then washed thoroughly with water.

Nanoplankton was collected concomitantly using a plankton net (60 μm) and millipore filter (8 μm). After that, nanoplankton sample inserted in freezer and was preserved. The sample that was collected in this way is containing the particle (Detritus) that life activity lost, inorganic floatting particle and nanoplankton. We can not to only separate nanoplankton out of these samples. It is very difficult to obtain reliable mercury content for nanoplankton. Accordingly, total mercury content that combined this 3

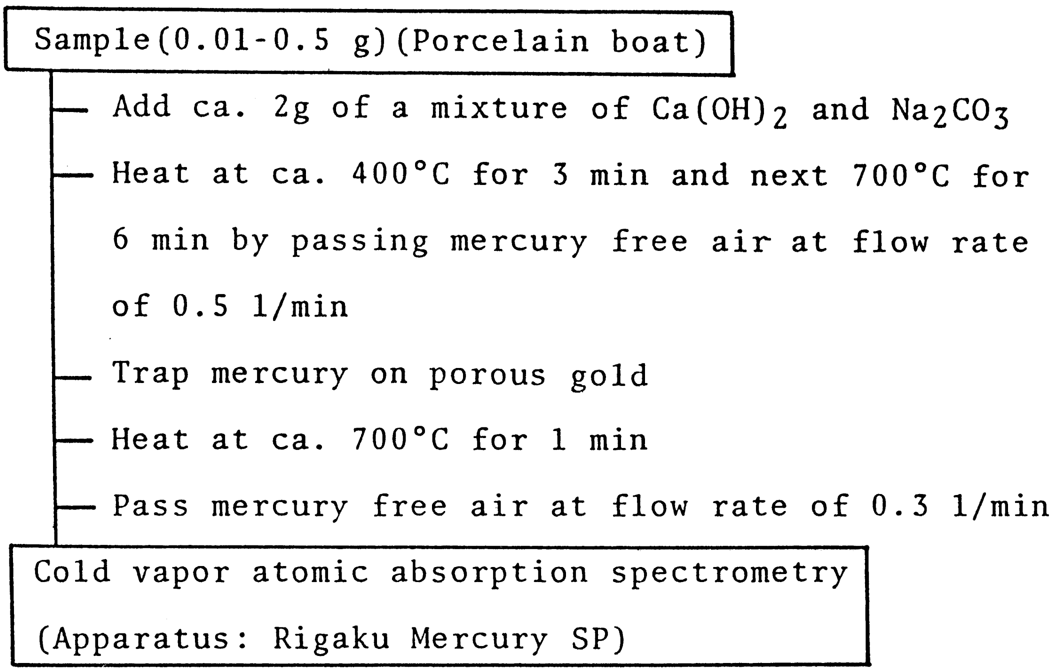

Fig. 2 Analytical procedure of total mercury in biological samples.

parts is upper bound of the mercury for nanoplankton.

Determination of Total Mercury in Nanoplankton and Fishes.

After frozen preservation samples were defreezied and were used. Total mercury was determined by using cold vapor atomic absorption, following to heating evaporation by combustion of samples and concentration by gold amalgamation of mercury. The procedure for determination of total mercury in biological samples is shown in Fig. 2. Mercury content in sample converts to mercury content of water sample that it collected because the weight of sample is small for nanoplankton. The method that this is substituted is not found antil the present. The content of total mercury in fishes and their stomach contents is shown by wet basis.

Results and Discussion

Total Mercury Content in Nanoplankton.

The analytical results of mercury content of nanoplankton in the East China Sea and

Table 1 Total mercury content and number of nanoplankton in the East China Sea and Kagoshima Bay.

Sampling location (No.)	Data	Hg (ng/l)	Cells/l*	Remarks
1. 30°24.4′N 130°25.2′E	Jul. 26. '79	0.02	2.00×10^6	East China Sea
2. 30°08.4′N 130°10.5′E	〃 27. 〃	0.01	0.12 〃	〃
3. 29°56.9′N 130°02.5′E	〃 28. 〃	0.03	0.77 〃	〃
4. 29°51.5′N 129°45.6′E	〃 29. 〃	0.05	0.58 〃	〃
5. 29°43.8′N 129°39.8′E	〃 30. 〃	0.09	1.70 〃	〃
6. 28°12.6′N 129°10.8′E	Aug. 1. 〃	0.08	1.26 〃	〃
7. 28°10.4′N 129°14.4′E	〃 2. 〃	0.05	1.95 〃	〃
8. 30°47.3′N 130°23.9′E	Oct. 9. 〃	0.03	4.02 〃	〃
9. 29°57.2′N 129°49.0′E	〃 10. 〃	0.01	1.10 〃	〃
10. 29°37.8′N 129°37.7′E	〃 11. 〃	0.01	2.59 〃	〃
11. 31°39.8′N 130°45.6′E	〃 5. 〃	0.15	13.6 〃	Kagoshima Bay
12. 31°24.4′N 130°38.7′E	〃 7. 〃	0.01	3.83 〃	〃

*After Ichikawa (1980)

Kagoshima Bay are shown in Table 1.

Mean total mercury content of nanoplankton was 0.03_8 ng/l for 10 samples taken from the East China Sea and 0.15 ng/l for one sample taken from Northern Kagoshima Bay, respectively. These value are 1/20 ~ 1/100 of total mercury content of the open sea. The number of nanoplankton was 13.6×10^6 Cells/l in one sample taken from Northern Kagoshima Bay and it was higher number about 1 order than open sea water[19]. Accordingly, nanoplankton of Northern Kagoshima Bay is not especially concentrated with mercury.

The number of nanoplankton fluctuates seasonally and then continual research is necessary.

Total Mercury Content in Fishes.

Total mercury content in fishes of Kagoshima Bay was determined using cold vapor atomic absorption method, following to heating evaporation by combustion of samples and concentration by gold amalgamation of mercury.

A part of analytical results are shown in Table 2.

Identification of stomach contents of fishes was obtained by cooperation of professor Saisyo of Kagoshima Univ.

Average total mercury content of fishes of Kagoshima Bay was 897 μg/kg. Also, average total mercury content of stomach contents was 180 μg/kg. Fig. 3 shows the relationship between the mercury content of fishes meat and stomach contents in fishes of Kagoshima Bay. A high degree of positive correlation (correlation coefficient: 0.97) was found between mercury content of fish meat and stomach contents in fishes of Kagoshima Bay. Also, correlation coefficients between body length, weight and mercury content in fishes were 0.51, 0.55, respectively.

Table 2 Total mercury content of fishes in Kagoshima Bay.

No.	Sampling station	Data	Type of fish	body length (cm)	Weight (g)	He content of fish meat (μg/kg)	Stomach contents	Hg content of stomach contents (μg/kg)
1	Ushine oki	Nov. 18. '77	Maanago	64	460	1160	None	—
2	Ushine oki	Nov. 18. '77	Maanago	47	150	1100	None	—
3	Kajiki oki	Nov. 25. '77	Maanago	64	470	1560	None	—
4	Yamagawa oki	Oct. 13. '78	Itachiuo	28	409	460	White meat piece	92
5	Yamagawa oki	Oct. 17. '78	Amadai	31	431	1310	Shiroganegokai	310
6	Tarumizu oki	Oct. 31. '78	Sabafugu	18	132	310	Meat piece	60
7	Kajiki oki	Nov. 07. '78	Maanago	67	450	2650	Okinosujiebi	680
8	Hirakawa oki	Nov. 01. '78	Sabafugu	19	118	770	Meat piece	150
9	Hirakawa oki	Nov. 01. '78	Yagataisaki	28	459	1310	Scales	370
10	Fukuyama oki	Aug. 08. '79	Maanago	48	200	650	Meat piece	181
11	Fukuyama oki	Aug. 08. '79	Maanago	75	510	900	Kouika	101
12	Fukuyama oki	Aug. 08. '79	Maanago	45	140	467	Sunahorimusi	169

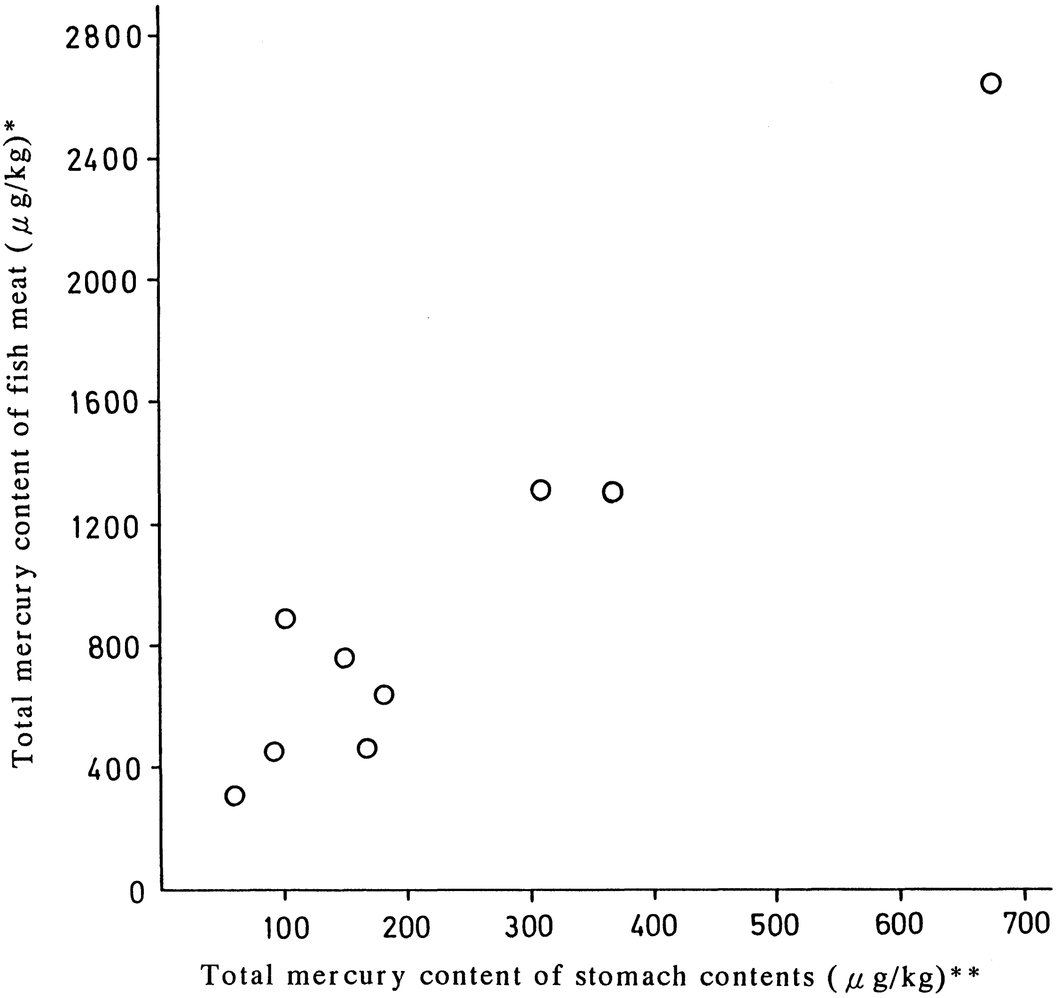

Fig. 3 Relation between total mercury content of fish meat and stomach contents.
*, **: Wet basis

Fig. 4 shows concentration range and mean value of total mercury in fishes and their stomach contents. Total mercury content is high in order of Kisu (Sillago sihama), Ebi (Penaeidae), Sabafugu (Legocephalus lunaris spadiceus), Nutaunagi (Eptatretus burgeri) and Maanago (Conger myriaster).

Horibe[20] has been reported that there was high correlation between fishes and organic mercury concentration of Sagami Bay. Mercury in a living body is not concentrated by only food chain but unique physiological action may be related to mercury concentration mechanism.

Conclusion

In this study, total mercury in nanoplankton, fishes and their stomach contents were determined by cold vapor atomic absorption spectrometry using porous gold cellector.

Mean total mercury content of nanoplankton was 0.03_8 ng/l for 10 samples taken

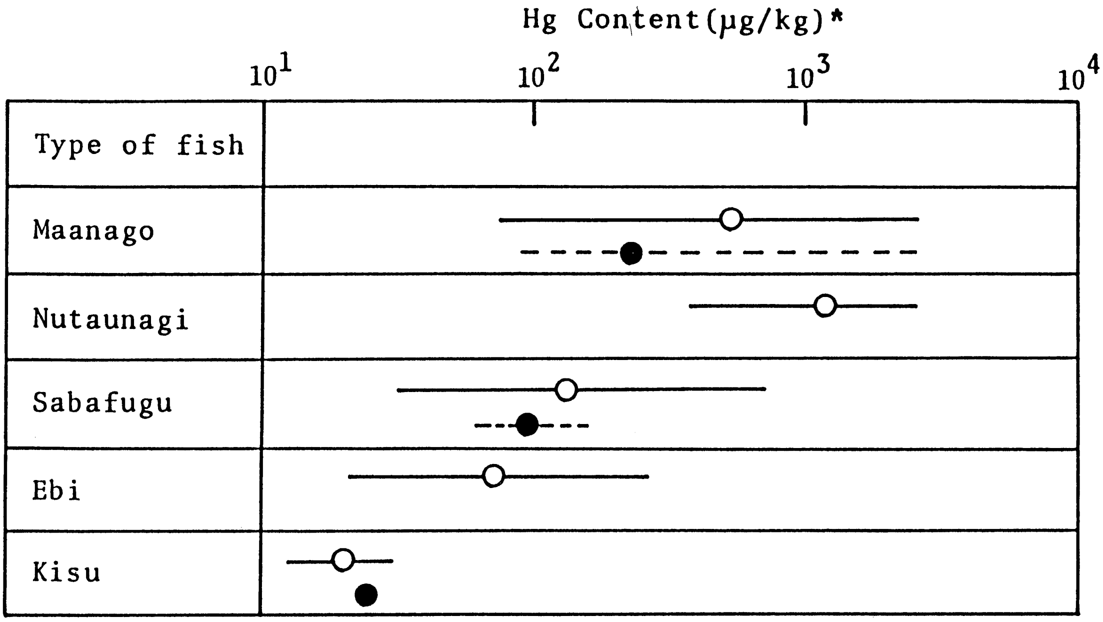

Fig. 4 Range of total mercury content in fishes.
——: Fish meat, - - - -: Stomach contents,
○, ●: Mean value, *: Wet basis

from the East China Sea and 0.01～0.15 ng/l for sample taken from Northern Kagoshima Bay, respectively. These value are 1/20～1/100 of total mercury content of the open sea.

Fish samples were taken from Kagoshima Bay. The ranges of total mercury contents in fishes and their stomach cotents were 310～2650 μg/kg (wet basis), 60～680 μg/kg (wet basis), respectively, and their arithmetic means were 1050 μg/kg, 235 μg/kg, and their geometric means were 897 μg/kg, 180 μg/kg, respectively.

A high degree of positive correlation (correlation coefficient: 0.97) was found between mercury content of fish meat and stomach contents in fishes of Kagoshima Bay.

Mercury concentration mechanism of mercury pollution fishes of Kagoshima Bay has not been clarified yet. A food chain is not denied completely. Continuous survey containing water quality, sediments, organism and volcanic activity is necessary.

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