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Mercury Content in Museum and Recent Specimens of Chiroptera in Japan

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The primary factor of environmental mercury contamination on land is the use in virtually every country of organomercurial fungicides on seeds. Mercury content in wild land animals has not been adequately measured in relation to pesticides use. Starting about 1953, organomercury compounds had been used widely and repeatedly in Japan until 1968 when the use of organomercuries as fungicides was forbidden by law.

Therefore, to detect the effects of pesticide-use on wildlife, mercury content in insectivorous Chiroptera, bats, was compared among the specimens collected before, during and after the use of organomercuries in dusting.

MATERIALS AND METHODS

Japanese insectivorous Chiroptera, Rhinolophus cornutus cornutus (Rh. c c), Rhinolophus ferrum-equinum nippon (Rh. f n), Vespertilio superans (Ve. su), Pipistrellus abramus (Pi. a) and Miniopterus schreibersi fuliginosus (Mi. s f) were used. Collection sites, locations, dates, species and number of collected specimens are shown in Fig. 1 and TABLE I. Rh. c c collected in Subashiri in 1890 were preserved in alcohol in the National Science Museum, Tokyo. All bats collected in 1965-1971 had been kept frozen in our laboratory. Bats collected in Bato in 1975 were kept under refrigeration until being used. Brains of the bats from 1890 and the kidneys of selected bats from 1965-1971 had already been removed for other purposes. 1890 was before, 1965-1967 during and 1970-1975 after the use of mercury fungicides.

Measurement of total mercury content in specimens was carried out by atomic absorption analysis in the same manner as described in our previous paper (NAKAMURA et al, in press).

RESULTS

The mercury content of the Chiroptera specimen is shown in TABLE II - IV according to species.

In Rh. c c, the mercury content of bats collected in 1967 at two collection sites differed from each other. Mercury content

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TABLE I

Location of Bat Collection in Japan (1890-1975).

Collection site	Date	Location	Bat species (No. of bats)
Shojyo (A)*	1966	Dwelling	Ve. su (2)
Bato (B)	1975	Old mine	Rh. c c (7)
Kawagoe (C)	1965	Dwelling	Pi. a (2)
Mine (D)	1967	Quarry	Rh. c c (12), Rh. f n (3) Mi. s f (5)
Numazu (E)	1970	Quarry	Mi. s f (6)
Subashiri (F)	1890	Cave	Rh. c c (6)
Ise (G)	1971	Cave	Rh. f n (5)
Nagashima (H)	1967	Cave	Rh. f n (9)
Owase (I)	1967	Old tunnel	Rh. c c (11)
Hiramatsu (J)	1967	Old mine	Rh. f n (2)

* Capitals in parentheses refer to collection sites shown in Figure 1.

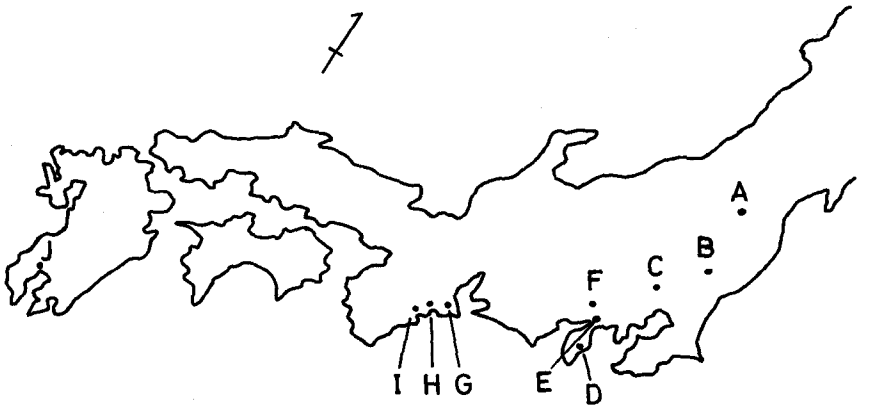

Figure 1. Distribution of sites of bat collection in Japan. See above TABLE for description of indicated sites where bats were collected.

of bats collected in Owase was higher than that in Mine. The mercury content of bats in Bato in 1975 was near the same range as that of bats in Mine in 1967 but lower than that of bats in Owase in 1967 except in respect to the hair. Bats collected in 1890 and preserved in the museum showed the lowest mercury content, especially in kidneys and livers. In Rh. f n, the mercury content of specimens collected at three sites in 1967 was near the same range. The content of specimens collected in Ise in 1971 was in the same range as that of those collected in 1967. In Mi. s f, mercury content of specimens collected in 1970 was lower than that of those in 1967 except that found in the hair. Content

TABLE II

Total Mercury Content in Rhinolophus cornutus cornutus (ppm).

Date & Site	Kidney	Liver	Brain	Muscle	Hair
1890					
Subashiri	0.11±0.05	0.19±0.03		0.25±0.04	2.63±0.36
1967					
Mine		0.70±0.22	0.14±0.05	0.32±0.11	3.49±1.26
Owase	0.84±0.27	1.15±0.32	0.30±0.08	0.61±0.15	5.00±2.15
1975					
Bato	0.63±0.20	0.87±0.23	0.22±0.04	0.40±0.18	6.34±4.30

TABLE III

Total Mercury Content in Rhinolophus ferrum-equinum nippon (ppm).

Date & Site	Kidney	Liver	Brain	Muscle	Hair
1967					
Hiramatsu		0.85±0.32	0.35±0.07	0.46±0.13	7.64±3.43
Mine		0.82±0.21	0.20±0.07	0.57±0.10	5.12±0.82
Nagashima	0.99±0.50	0.77±0.22	0.35±0.14	0.64±0.18	5.13±1.67
1971					
Ise		0.78±0.35	0.25±0.15	0.42±0.06	6.79±1.97

TABLE IV

Total Mercury Content in Miniopterus schreibersi fuliginosus (ppm).

Date & Site	Kidney	Liver	Brain	Muscle	Hair
1967					
Mine		0.69±0.10	0.10±0.02	0.19±0.03	10.5±0.9
1970					
Numazu	0.51±0.21	0.35±0.10	0.05±0.02	0.08±0.02	10.2±1.7

within the hair was not different.

The mercury content of bats of other species is shown in TABLE V. Pi. a and Ve. su were collected during dusting period. In both Pi. a and Ve. su, the mercury content in hair was remarkably higher than that of other bat species collected during the same dusting period. Other tissues, especially liver also showed higher mercury content.

TABLE V

Total Mercury Content in Pipistrellus abramus and Vespertilio superans (ppm).

Date	Species	Liver	Brain	Muscle	Hair
1965	Pi. a	2.36±0.17	0.39±0.06	0.61±0.01	33.0±6.3
1966	Ve. su	2.77±0.27	0.59	1.06±0.10	33.7±4.2

TABLE VI

Total Mercury Content in Rhinolophus cornutus cornutus, Rhinolophus ferrum-equinum nippon and Miniopterus schreibersi fuliginosus (ppm).

Date	Kidney	Liver	Brain	Muscle	Hair
Before dusting	0.11	0.19		0.25	2.63
During dusting	0.84*— 0.99	0.69— 1.15	0.10— 0.35	0.19— 0.64	3.49— 10.5
After dusting	0.51— 0.63	0.35— 0.87	0.05— 0.25	0.08— 0.42	6.34— 10.2

* Figures show the maximum and minimum values of mean mercury content indicated on TABLE II—IV according to bats species, collection site and date.

Values in TABLE II—IV are summarized in TABLE VI according to the time of collection without distinction of species or location. In general, mercury content of specimens in 1890 was lower than that of specimens collected during or after dusting period. On the other hand, mercury content in bats during and after dusting period were almost in the same range.

DISCUSSION

MILLER et al (1972) measured mercury content of tuna specimens preserved for 62—93 years in museums and that of swordfish preserved for 25 years, and noted that there were no significant differences in mercury concentration between the museum samples and the tuna recently caught. Man-made pollution may not have caused an increase in mercury concentration in ocean fish due to the vastness of the sea. Mercury dusted over fields, must have been dispersed and diluted less than the mercury poured into the ocean.

There are many reports in Japan, on increased soil and rice mercury content after mercurial pesticide dusting (FUKUNAGA et al

1972; ISHIKURA 1972). Mercury content in the hair of Japanese, who live on rice is greater than that of inhabitants of other countries (HOSHINO et al 1966). Mercury has been shown to accumulate in the larvae of butterflies on which insectivorous bats feed, which have fed on mercurial pesticide-absorbing plants (YAMADA 1970).

Bats used in this investigation varied in species and location. Ecological difference by species may influence mercury content. However, prominent differences of mercury content by species was not observed among Rh. c c, Rh. f n and Mi. s f. Environmental factors near the collecting location also may influence mercury content in specimens. As shown in TABLE V. the mercury content of Pi. a and Ve. su was higher than that of the other species collected during mercury dusting period. This may be due to a difference of habitat rather than an inherent specific difference. Locations at which specimens in our studies were collected were in the vicinities of farms. It is reported that the range of bats is about 20 - 30 kilometers (KURAMOTO et al 1973). Therefore, bats in our study could have been affected by the use of pesticides on the above-farms. However, Pi. a and Ve. su inhabit dwellings in towns in midsts of farms, while Rh. c c, Rh. f n and Mi. s f inhabit mountain areas near farms. Consequently, Pi. a and Ve. su may have had more chances to feed on insects containing mercury pesticides than the other bats. This may be the reason why the mercury content of these bats was higher than the other bats.

Mercury content of bats collected before mercury dusting period was lower than that of bats collected during or after. Preservation technique of the museum aside from effects of mercury dusting may have contributed to the lower content of mercury in bats collected in 1890. The mercury content of museum preservative solutions was below detectable levels (less than 0.5 ng/50ul). However, a possibility that the mercury had eluted into the preservative alcohol, being subsequently replaced during the long preservation period, cannot be excluded.

The reasons why the mercury content in specimens did not decrease after mercury dusting period may be due to lingering mercury residue in the fields. Less possible explanation may be that bats which had accumulated mercury had survived for years and to be collected after the dusting period.

SUMMARY

The mercury content of insectivorous Chiroptera caught in 1890, when mercurial pesticides had not yet been in use, and preserved in a museum in alcohol were compared with those caught in 1965 - 1967 or 1970 - 1975, during and after the use of mercurial pesticides, and kept frozen. The mercury content of the Chiroptera caught in 1890 was lower than that of those caught during or after the use of mercurial pesticides. Difference in mercury con-

tent between bats caught during and after use was not significant.

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