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# Selenium In Tissues Of Woodchucks Inhabiting Fly Ash Landfills

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Millions of tons of fly ash are produced each year by coal-burning, electric power generating plants in the United States (BRACKETT 1970). A small percentage of the material produced is used as a base material in roadbeds and as an additive in concrete products. The bulk of the fly ash is disposed of in landfills.

Extremely high levels of selenium have been found in sweet clover found voluntarily growing on fly ash (GUTENMANN et al. 1976). When this clover was fed to guinea pigs, significantly higher concentrations of selenium were found in the animal tissues as compared to those fed control clover growing on soil (FURR et al. 1975). Aquatic species inhabiting a farm pond contaminated with fly ash showed markedly higher levels of selenium than control organisms (GUTENMANN et al. 1976). Cabbage grown on soil containing 10% by weight of fly ashes from several states absorbed selenium in direct proportion to the total selenium concentration in the respective fly ash (GUTENMANN et al. 1976).

## EXPERIMENTAL

A coal-burning electric power generating plant, Milliken Station, is located in Lansing, New York about 30 km north of Ithaca on the eastern shore of Cayuga Lake. Fly ash generated there is spread over a 6 hectare landfill site about 3 km east of the plant. The total selenium content of random samples of fly ash taken on the dump site ranged from 5 to 17 ppm. Woodchucks (Marmota monax) were live-trapped among vegetation growing on the landfill. During the same period, 25 woodchucks (control animals) were similarly trapped or shot in a number of location 8 to 30 km from the fly ash dump. Trapped animals were asphyxiated with carbon dioxide and all animals were subjected to routine necropsy examination. Liver and lung tissues were taken for the determination of selenium. The fluorimetric method of OLSEN (1969) was used for selenium analysis. The recovery of 1 ppm of selenium from liver and lung tissue was 90 and 92%, respectively. The method was sensitive to about 0.01 ppm of selenium on a dry weight basis.

## RESULTS AND DISCUSSION

The concentrations of selenium were consistently higher in the tissues of animals trapped on the fly ash dump than in the corresponding controls (Table 1). Although the average weights of the male animals exceeded that of the corresponding replicated

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TABLE 1

Liver and lung selenium concentrations in woodchucks (Marmota monax) collected from regionally low selenium soils (controls) and from a fly ash landfill.

| Location of capture | Maturity | Sex | No. of reps. | Weight (kg)[a] | Selenium (ppm dry weight) in: Liver[a] | Lung[a] |
|---|---|---|---|---|---|---|
| Fly ash | adult | M | 3 | 2707 ± 93 | 2.2 ± 1.3 | 1.4 ± 0.7 |
| Control | adult | M | 12 | 3381 ± 909 | 0.4 ± 0.2 | 0.4 ± 0.2 |
| Fly ash | adult | F | 3 | 2283 ± 241 | 10.7 ± 3.4 | 4.4 ± 0.6 |
| Control | adult | F | 10 | 2775 ± 537 | 0.4 ± 0.1 | 0.4 ± 0.1 |
| Fly ash | juvenile (10 w.o.)[b] | M | 1 | 1290 | 3.9 | 2.1 |
| Control | junveile (5 & 9 w.o.) | M | 2 | 913 ± 314 | 0.2 ± 0.1 | 0.2 ± 0.1 |
| Fly ash | juvenile (5 & 6 w.o.) | F | 2 | 685 ± 45 | 6.4 ± 3.8 | 2.8 ± 1.8 |
| Control | juvenile (5 w.o.) | F | 1 | 690 | 0.4 | 0.2 |

a average ± standard deviation
b 10 weeks old

females, the selenium concentration in the female organ tissues was most often higher than that of the corresponding males. Juvenile animals accumulated surprisingly high concentrations of tissue selenium by 10 weeks of age. No grossly visible lesions were found in any of the woodchucks.

Plant material such as sweet clover and winter wheat growing on the fly ash dump contained about 5 ppm dry weight of selenium (FURR et al. 1975). Selenium in plants is present as selenoamino acids such as selenomethionine (BUTLER and PETERSON 1967). These organic forms of the element are absorbed by foraging animals much more efficiently than inorganic forms of selenium (SMITH et al. 1938, EHLIN et al. 1967). Although a portion of the selenium in lung tissue could have resulted from inhalation of fly ash dust particles, SMITH et al. (1938) have shown that there is efficient transfer of selenium ingested in the organic form to lung.

Liver to lung selenium ratios seem to provide evidence of selenium deficiency in our control animals. The liver is one of the highest selenium tissues in the body while the lung is considered to be one of the lowest (DUDLEY 1936). Since the element normally appears to be stored in the liver, selenium expectedly would be mobilized from the liver to other tissues in selenium deficient animals. The ratio of liver to lung selenium was about unity in our control animals and about 2 in animals from the fly ash dump. Control animals apparently failed to accumulate selenium in their livers beyond what was needed in the lungs and presumably, other organs of the budy. In woodchucks from the fly ash dump, where dietary selenium levels were greater than for controls, livers disproportionately concentrated selenium. Thus the failure of control woodchucks to concentrate selenium in liver tissue indicates that these animals were borderline selenium deficient.

Selenium levels in our control animals appear to be compatible with the occurrence of regionally low selenium soils in the Northeastern United States.

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