

Selenium in Pollen Gathered by Bees Foraging on Fly Ash-Grown Plants

David De Jong,¹ Roger A. Morse,¹
Walter H. Gutenmann² and Donald J. Lisk²
*New York State College of Agriculture and Life Sciences
Cornell University
Ithaca, N. Y. 14853*

Fly ash is the material collected in the stacks of coal burning electric power-generating plants by electrostatic precipitators. About 26 million metric tons of fly ash was estimated to have been produced in 1975 (BRACKETT, 1970). Aside from a small percentage of the material which is used as a base material for roads and in concrete, the bulk of it is deposited in landfills. It was first reported by Gutenmann et al. (1976) that sweet clover, found voluntarily growing on a fly ash landfill site contained up to 200 ppm of selenium. Fly ashes from 21 states were found to contain the element. Cabbage grown on each of these fly ashes added (7% w/w) to soil was shown to absorb selenium in proportion to its concentration in the particular ash (GUTENMANN et al., 1976). The percentage of fly ash in soil was also shown to dictate the extent of selenium absorption by a variety of plants (FURR et al., 1976). In the work reported, pollen collected by honey bees foraging on plants growing on a fly ash landfill was analyzed for selenium and compared with that collected by bees from the same plants growing on soil.

EXPERIMENTAL

In October, 1976 pollen was collected directly from the rear legs of honey bees that were foraging on New England asters (*Aster novae-angliae*) growing voluntarily on two sites in New York. One site was on fly ash which had been dumped up to 23 meters deep over a two-acre area in Endwell, New York. The control site was on soil in a field near Ithaca, New York. Total selenium was determined in the pollen samples by the fluorometric method of Olsen (1969).

¹Department of Entomology

²Pesticide Residue Laboratory, Department of Food Science

RESULTS AND DISCUSSION

The results of analysis are listed in Table 1. The high concentration of selenium in the pollen produced by asters grown in a fly ash dump is in sharp contrast to the negligible concentrations of the element found in the contents of honey stomachs of bees found foraging on seleniferous clover growing on this same fly ash site (GUTENMANN et al., 1976). These findings are understandable since the pollen is high in protein with which selenium is known to be associated as selenoaminoacids whereas the honey stomach contents is essentially comprised of carbohydrates.

Practically this finding may have significance. Normally honey contains very little pollen so that its content of selenium from such pollen would expectedly be negligible. Royal jelly, however, which is normally used for nurturing bees and is used by some persons as a food or medicinal contains pollen and would thus undoubtedly be high in selenium if pollen from seleniferous plants were involved. This could be significant since vast areas in the Western United States contain soils which are natively high in selenium and produce highly seleniferous vegetation (ROSENFELD and BEATH, 1964). These findings pose no threat to bees or beekeeping in the Eastern United States where deposits of fly ash are limited. In the Western United States, however, there are vast areas where soils are naturally high in selenium and seleniferous vegetation abounds (ROSENFELD and BEATH, 1964). Bees from a colony commonly forage over about four square miles. Pollens collected in such an area is fed upon communally within the hive insuring some mixing. Little pollen is contained in honey and thus honey produced anywhere would be expected to have a very low selenium content. However, pollen is collected from bee hives in some parts of the world and used as a human food supplement. To a much lesser extent, the pharyngeal gland secretion of honey bees, royal jelly, used under normal circumstances as honey bee larval food, is likewise consumed as human food. Plants growing on seleniferous soils or fly ash might therefore produce pollen containing elevated concentrations of selenium to contaminate the resultant royal jelly. The susceptibility of insects to toxicity from selenium compounds varies over an extreme range (ROSENFELD and BEATH, 1964). The effect on bees, if any, of foraging on seleniferous plants is as yet unknown.

SUMMARY

Pollen collected from the rear legs of honey bees found foraging on asters voluntarily growing on a fly ash dump in Endwell, New York, was found to contain a high concentration of selenium. Pollen from bees foraging on asters growing on field soil contained no detectable selenium.

Table 1.
Selenium in pollen collected by bees foraging on asters
growing on fly ash versus soil.

Asters growing on:	Selenium, ppm, fresh wt.
fly ash	14.1
soil (control)	< 0.1

REFERENCES

- BRACKETT, C. E.: "Production and utilization of ash in the United States" (Information Circular 8488, U. S. Bureau of Mines, Washington, D. C., pp. 11-16) (1970).
- FURR, A. K., W. C. KELLY, C. A. BACHE, W. H. GUTENMANN, and D. J. LISK: J. Agric. Food Chem. 24, 885 (1976).
- GUTENMANN, W. H., C. A. BACHE, W. D. YOUNGS, and D. J. LISK: Science 191, 966 (1976).
- OLSEN, O. E.: J. Assoc. Off. Anal. Chem. 52, 627 (1969).
- ROSENFELD, I. and O. A. BEATH: Selenium - Geobotany, Biochemistry, Toxicity, and Nutrition. Academic Press, New York (1964).