Eva Crane Trust

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TITLE: Bees, honey and pollen as indicators of metals in the environment

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On the scientific front

Bees, honey and pollen as indicators of metals in the environment

It was proved at least as early as 1935 that bees could be killed by the effluent from smelters built in their foraging area[7]. A high arsenic content was found in the honeybees and in pollen they collected. There has been quite a spate of publications recently on wider relationships between bees and trace metals in their environment, and six papers published in 1982 and 1983 are commented on here.

The mineral content of bees, honey, or bee-collected pollen, is now recognized as a useful indicator of the presence of specific minerals within their forage area. High levels of some of the metals are undesirable because of their known or likely toxicity; alternatively some metals may be desirable to the investigator because, if the sources of the minerals can be located, they could perhaps be profitably mined, the bees having been used as preliminary 'prospectors'.

The argument runs like this. Honeybees forage on plants growing in a relatively large area (7 km^2 if they fly up to 1·5 km from the hive). They effectively sample this area for trace elements in the forage plants, and hence in the soil and atmosphere of the area[8]. Lead is one environmental pollutant that has been investigated[6]. Two sites in the USA were used, with similar flora; one was on a busy highway and the other 850 m away from it. The average lead content of flowers on the two sites was 13·6 and 0·2 ppm, respectively, and of honeybees foraging on them, 28·1 and 1·4 ppm, respectively. The difference between the two sites for both flowers and bees was highly significant ($P<0{\cdot}005$). In West Berlin[4], with 2600 honeybee colonies in an urban environment, honey is being assessed for its usefulness as an indicator for various heavy metals. Lead concentrations varied between 0·02 and 1·8 ppm honey (average 0·18). Cadmium is now under investigation, and work on other metals will follow.

Results obtained by a Dutch government analyst[3] show wide variations in the lead and cadmium contents of honeys, according to plant source and country or region of origin and whether the honey was derived from nectar or honeydew. It seems clear that, in order to detect contamination, a suspect honey must be compared with honey from the same plant species and growing under similar conditions. The total ash content of honeys varies according to plant source, normally being lowest for light-coloured honeys and highest for dark (including honeydew) honeys. The average lead and cadmium contents of 15 samples of flower honeys and of 6 samples of honeydew honeys, all Dutch, were: lead 0·31, 0·89 ppm; cadmium 0·014, 0·018 ppm, respectively. Samples of 13 honeys imported from 8 countries had average contents of 0·30 and 0·009 ppm of lead and cadmium, respectively. The lowest was lime honey from the USSR (0·06, < 0·001). Of two samples of citrus honey from California, one contained 0·26 and 0·001 ppm lead and cadmium, respectively, and the other 0·76 and 0·016 ppm; it would be interesting to know just where the two samples were produced. The author states that none of the amounts of lead or cadmium found would approach values that could cause a health hazard.

For some years honeybees have served as monitors of environmental pollution—'biomagnifiers of contaminants in the air, water, soil or plants'—round Los Alamos National Laboratory in New Mexico, USA[8]. The network of hives maintained round the Laboratory is used to provide a constant monitoring system that requires very little maintenance, and which may provide information concerning food chain pathways of various pollutants. Details of this and other work are available[8]. Elements under investigation have included copper, zinc, phosphorus (bees, honey and pollen), fluorine (foraging bees, hive bees and brood), and arsenic (bees). Radioactive elements recovered from bees include tritium (^{3}H), caesium (^{137}Cs) and plutonium. Tritium and caesium were also transferred to honey, but in lower concentrations. When uranium was included in syrup fed to bees, the highest concentration was in the bees themselves; comb, larvae and honey contained smaller amounts. In 1980 honey samples from areas potentially contaminated from the Los Alamos Laboratory showed no detectable levels of mercury or plutonium, and only very low levels of beryllium (^{7}Be), caesium (^{137}Cs), tritium and sodium (^{22}Na).

As well as being monitored because they are pollutants, trace elements are also deliberately sought for, and bees are being used experimentally as indicators of the presence of heavy metals that might be mined or otherwise exploited. In experiments in England, honeybee pollen loads reflected the environmental soil content of manganese, zinc, copper and lead[2], but not of iron or magnesium. Two large mining companies in

British Columbia have already taken part in experiments with bees to sample the pollen in areas of interest[5].

These probings into the amounts of trace metals in honey and pollen should give beekeepers pause for thought if they are accustomed to quoting the mineral content of these food products as nutritionally beneficial.

Metals essential in the human diet are: sodium, potassium, calcium, magnesium, iron and zinc, also copper, chromium, selenium, molybdenum, manganese and cobalt in smaller amounts. The amounts of any of these in honey are so small that even 100 g eaten daily would not contribute appreciably to dietary requirements[1]; iron comes closest to doing so—100 g of dark honey contains about 5% of the daily requirement, light honey much less. An environment rich in one or more of these metals is unlikely to enhance the content in honey by an amount large enough to alter the picture. The same is probably true of pollen but, although it is likely to have a higher concentration of the minerals than honey, the human daily intake would be much less. With regard to metals mentioned above that are not essential in the human diet, some are actually toxic (lead and arsenic, for instance), and some others are radioactive. The following metals normally occur in the human diet, usually in even smaller amounts than metals that are essential: lithium, rubidium, silver, strontium, barium, beryllium, cadmium, aluminium, tin, lead, vanadium, arsenic and nickel. The amounts of these that would normally be eaten in honey are so small that they could be ignored. Nevertheless, beekeepers should be aware of the possible increase in amounts of undesirable elements, especially in industrialized areas of the world. Beekeepers in areas free from such environmental pollution may appreciate their honeys accordingly.

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