Honey Bees:(1) Preference for and Nutritive Value of Pollen from Five Plant Sources(2,3)

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ABSTRACT
Caged colonies of *Apis mellifera* L. fed diets of bee-gathered pollen from each of 5 plant sources were able to rear brood for as long as 45 days. The number of bees reared depended more on the amount of food consumed (preference) than on the nutritive value (number of bees reared per gram of pollen consumed).

Pollen is the primary source of protein, fats, vitamins, and minerals in the diet of the honey bee, *Apis mellifera* L., and provides all the nutritive elements necessary for life when it is ingested along with nectar and water. However, in any study concerning the nutrition of honey bees, the interaction between larval and adult honey bees is a prime consideration because newly emerged adults must consume pollen during the 1st 10 days after emergence. Without this initial pollen, the brood rearing ability of these bees is drastically impaired (Haydak 1934, 1935, 1937) since the glands responsible for producing the food fed by nurse bees to the larval honey bees remain underdeveloped and nonfunctional.

Haydak (1935, 1949) and Back (1956) found that honey bees maintained on marginal or submarginal (in nutritive value) diets could begin to rear brood, but this ability rapidly diminished with time as some essential nutritive factors present in the newly emerged honey bees were exhausted and not adequately replenished by the food source (Hagedorn and Moeller 1968). Therefore, normal brood rearing can occur only when the diet consumed by the nurse bees is sufficient in essential nutrients. However, diets consisting of the pollen from different plant sources may have different nutritional value for the honey bee (Todd and Bretherick 1942, Auclair and Jamieson 1948, Weaver and Kuiken 1951). Investigators have therefore attempted to discover the differences in the nutritive value of pollen from various plant species (Maurizio 1950, Wahl 1954, 1963). The experiments reported here were made in 1973 in an effort to add to the information obtained in the previous studies.

MATERIALS AND METHODS. - Characteristically, honey bees gather mixtures of pollens from many sources but when one source becomes especially abundant , they may gather from that source almost exclusively. By watching for such periods, which may last for only 1 or 2 days, we were able to define the sources and to obtain pure pollen. The pollen used in our experiments was trapped (Schaefer and Farrar 1946) and frozen during spring and summer of 1971 and 1972 as it was collected by bees from 5 groups of plants (willow, *Salix* sp.; sweet clover, *Melilotus* sp.; boxelder, *Acer negundo* L.; blackberry, *Rubus allegheniensis* Porter; and fruit bloom, *Prunus* sp. and *Pyrus* sp.). The control diet was made of pollen, collected in 1972, from mixed sources. Before the test, 1/2-lb (227 g) cakes of each pollen type and of the mixed pollen (control) were prepared by combining the pollen (34.4%) with sugar (60.0%) and water (5.6%). The cakes were kept frozen until fed to the bees.

In the summer of 1973, twenty-four 2-lb (ca. 7000 bees) packages of bees (provided with a

hybrid laying queen of genetically uniform stock) were hived in single-story 12-frame hives that contained no pollen or honey. Thus, no food remained in the combs. The 24 colonies were randomly located in one of six 10x10-ft Saran screen cages 7 ft high, 4 hives/cage. The separate groups of 4 cages each received one of the experimental diets (pollen cakes) plus 5-lb cans of 67% sugar syrup containing 5 g of fumagillin/gal of syrup for control of nosema as needed. Syrup feeding was discontinued when an excess had been stored by the colony. A pan containing water and a sponge also was provided in each cage.

As bees for this test were obtained, they were of various ages representative of the normal colonies from which they were taken. They were uniformly mixed and 2-lb packages prepared from them. Thus, every unit had bees of the same ages and condition, numbers, and stock.

The area of sealed brood in each colony was determined as described by Moeller (1961) on the 20th, 31st, and 45th day after installation of the bees, times that coincided with the emergence of new adults. (Colonies maintained on the fruit bloom pollen diet were terminated following the 2nd sealed brood count due to an insufficient amount of pollen diet.) Also, after the 3rd and final brood count, any remaining cake was removed from the colonies and weighed to the nearest 0.1 g. Then the total amount of pollen consumed by the bees maintained on each of the pollen diets was calculated based on the pollen content of the cake. In addition, the cells of sealed brood were calculated from each count of square-inch brood area.

The number of cells of brood reared per gram of pollen consumed was then obtained by calculating the number of cells of sealed brood produced for the total 45-day test period and dividing this by the amount of pollen consumed during the test period.

Comparisons were made between all treatments for the 3 factors by using a completely randomized design (Steel and Torrie 1960). Analyses also were conducted on the total amount of sealed brood produced by bees maintained on each diet and on the brood production efficiency of the diets. When significant dlifferences were found in the F values of the analysis of variance, comparisons between the means were made by using the Waller-Duncan multiple comparison procedure (1969).

RESULTS. - Table 1 summarizes statistical analyses. All values are the mean of 4 replicates. Plainly, more bees were reared by honey bees maintained on sweet clover pollen than were reared by bees maintained on any other pollen. However, fruit bloom was not significantly different from clover to the extent that data could be obtained for fruit bloom. Values for cells of sealed brood reared per gram of pollen consumed figures indicate the relative nutritive value of each pollen diet. Diets high in efficiency were fiuit bloom, boxelder, and the mixed pollens.

The calculated amounts of pollen consumed per day indicate preference for a particular pollen diet because of the uniformity of test colony conditions. The most preferred of the diets tested was sweet clover pollen followed by fruit bloom pollen and mixed pollen.

The bees were able to rear brood throughout the 45-day test period while they were maintained on each of the test diets. However, the dlifferences in the amounts of brood reared and in the efficiency of the diets were large. For example, bees maintained on fruit bloom and boxelder pollen were able to rear more bees per gram of pollen consumed than bees maintained on the other diets; however, the colonies maintained on fruit bloom and boxelder pollen did not produce the most bees. Instead, the colonies that consumed more pollen were able to rear more bees. Preference is therefore of greater importance in building

colony populations than is nutritive value provided, of course, that the diet does not lack any important nutrients. Continued investigations into the nature of preference would be useful in developing a diet that was both nutritious and preferred by the honey bees.

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