

Quantity and Seasonal Variation of Pollen Types Collected by Honey Bees at Two Localities on the Island of Hawaii

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ABSTRACT. Monthly pollen pellet samples were collected from honey bee hives located at Hakalau and Volcano, Hawaii island, along with rainfall data for each site. The total amount of pollen collected at Hakalau ranged from a low of 61.0 g in December 1986 to a high of 469.4 g in October 1987. At Volcano, the largest amount of pollen was collected in September 1987 (711.5 g), and the least in May 1987 (33.0 g).

There appeared to be no relationship between rainfall and the amounts of pollen collected. Many pollen types were collected seasonally while other types were collected year round. The monthly pollen samples were usually a composite of many pollen types, including 1-4 dominant types.

Pollen has been identified as the major source of protein for the western honey bee, *Apis mellifera* L. (Hymenoptera: Apidae) (McCaughey et al. 1980). The need for pollen has been found to be important for both larval (brood) and adult development (Campana and Moeller 1977). Upon emergence, adult worker bees must consume pollen within 10 days to stimulate the development of the mandibular and hypopharyngeal glands responsible for the production of "royal jelly". Royal jelly is a creamy white substance which is fed to very young larvae. Thus, without the initial consumption of pollen, the brood rearing capabilities of worker (nurse) bees and brood production are reduced (Haydak 1935). In addition, the completion of brood development is dependent on pollen which is fed in an unaltered form to older larvae by nurse bees.

Honey bees usually gather pollen from a single plant source while foraging, which results in homogenous pollen pellets that are stored in the hive for use. Campana and Moeller (1977) and Herbert et al. (1970) showed that the number of honey bees produced in a colony varied, based on the pollen source provided, and concluded that the pollens of different plants have different nutritive values. Thus, the collection and subsequent use of several pollen types would be advantageous to the hive to insure that the essential dietary requirements of newly emerged adults and the brood are met.

Adams et al. (1978) found that honey bees from a single hive in southern Ontario collected 46 pollen types in a year, and that there was a seasonal foraging pattern based on pollen availability. In a similar study, Arita et al. (1989) identified the pollen types collected by honey bees from single hives located at three sites on Hawaii island. Results of that study showed that there were locality differences in the types of pollen collected, which may

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also be reflected in the amounts of pollen collected, and in the seasonal availability of the different pollen types. The study reported here investigated differences in pollen collections at two sites on the island of Hawaii relative to the above mentioned parameters, as well as the relationship between rainfall and the amount of pollen collected, previously observed by Moniz et al. (1988).

MATERIALS AND METHODS

Pollen Collection. Pollen was collected with the use of a pollen trap (Walter T. Kelly Co.) that was placed onto a two-story hive (see Moniz et al. 1989 for diagram) located at Hakalau (elevation 200 ft) and a similar hive at Volcano (elevation 4,000 ft), Hawaii. The standard entrance to the hive, located between the lower hive body and the bottom board, was sealed off with #3 mesh hardware cloth. After sealing the entrance, another opening was made by placing two separation boards between the first and second hive bodies. The separation boards were set into place 24 h prior to the placement of the pollen trap.

The pollen trap consisted of an entry port lined with #5 mesh hardware cloth. The hardware cloth prevented returning foragers from entering the hive with full pollen loads. Only after a majority of the pollen pellets had been scraped from the corbiculae (pollen baskets) by the screen, could bees proceed through the pollen trap into the hive. The dislodged pollen pellets fell through the hardware cloth into a collecting tray located beneath the entry port.

From November 1986 to October 1987, monthly pollen samples were collected from the two sites. The pollen trap was placed on a hive at each locality for 10 consecutive days each month. All pollen collected during that period constituted that month's sample. Continuous use of the pollen trap was not possible because of the need for pollen by the colony. Rainfall data were taken at each site during the experimental period with a calibrated rain gauge.

Separation of Pollen Pellets. Total monthly pollen pellet samples from each locality were weighed. Each sample was then separated by pellet color. Color groups were further separated into pollen types, based on the structure of individual pollen grains.

Identification of Pollen Pellets. A total of 73 pollen pellet types, representing 30 plant families were collected by honey bees at the 2 locations. Refer to Arita et al. (1989) for identification of the pollen types collected.

RESULTS AND DISCUSSION

Table 1 summarizes total pollen (g), rainfall (cm), and number of pollen types (floral sources) collected at each locality.

At Hakalau, the total amount of pollen collected ranged from a low of 61.0 g in December 1986 to a high of 469.4 g in October 1987. Large amounts of pollen were also collected in November 1986 and February 1987 (425.6 g and 377.4 g respectively).

TABLE 1. Monthly amounts of pollen, rainfall, and number of pollen types collected from Hakalau and Volcano, Hawaii.

	HAKALAU			VOLCANO		
	Total Pollen Collected (g)	Rainfall (cm)	#Pollen Types	Total Pollen Collected (g)	Rainfall (cm)	#Pollen Types
Nov. 1986	425.6	18.2	11	52.2	3.3	12
Dec. 1986	61.0	24.2	11	135.3	1.0	10
Jan. 1987	141.8	4.5	15	229.4	0.1	19
Feb. 1987	377.4	7.3	14	140.0	0.0	4
Mar. 1987	183.6	13.9	12	25.8	1.3	11
Apr. 1987	232.8	14.6	13	33.0	1.1	7
May 1987	187.2	10.5	13	45.5	2.2	11
June 1987	220.3	11.3	14	170.8	0.7	15
July 1987	235.5	3.0	14	134.4	9.6	12
Aug. 1987	144.6	3.0	10	226.1	1.3	12
Sep. 1987	240.3	5.1	10	711.5	3.1	7
Oct. 1987	469.4	0.4	3	141.2	2.1	6

The number of pollen types collected at Hakalau was usually between 10-15, with the exception of October 1987 when only 3 types were found. However, although a large number of pollen types were found in the samples, only about 3 or 4 types were present in large quantities. For example, in January 1987 there were 15 pollen types collected with a total combined weight of 141.8 g. Of these, 3 types weighed 49.8 g, 42.7 g, and 28.5 g respectively, which totaled 85.3% of the month's pollen collection. In addition, floral sources that bees utilized in large quantities changed during the year.

In Table 2, the monthly percentages for two floral sources (amount of each pollen type collected relative to the total) from Hakalau are presented. The pollen from an undetermined plant in the family Urticaceae was collected in small quantities from February 1987 to June 1987, but was present in substantial amounts in July, August, and September 1987. During the other months, no pollen from this source was collected.

Another pollen from a plant in the family Malvaceae was collected for 5 months in the Hakalau area. As with the pollen from the family Urticaceae, this pollen type appeared to be seasonal. However, the pollen from the Malvaceae was collected in lesser amounts, which may be indicative of the quantity available in the immediate vicinity of the hive.

The monthly weights of pollen collected at Volcano fluctuated from a high of 711.5 g in September 1987, to a low of 25.8 g in March 1987. The number of pollen types also changed, ranging from 6 to 19 types. However, in contrast to the Hakalau site, the pollen types collected each month at Volcano were predominantly from 1 or 2 floral sources.

TABLE 2. Monthly percentages of selected pollen types from Hakalau and Volcano, Hawaii (% = percent of the total monthly collection).

	HAKALAU		VOLCANO	
	Malvaceae	Urticaceae	Solanaceae	Urticaceae
Nov. 1986	0.2%	0	15.4%	77.5%
Dec. 1986	14.3%	0	6.9%	0
Jan. 1987	1.8%	0	0.2%	0
Feb. 1987	11.8%	13.3%	0.6%	0
Mar. 1987	17.6%	1.0%	25.5%	0
Apr. 1987	0	0.5%	0.3%	0
May 1987	0	1.1%	19.5%	0
June 1987	0	3.5%	4.3%	0
July 1987	0	36.9%	0.7%	0
Aug. 1987	0	73.4%	3.2%	81.2%
Sep. 1987	0	76.2%	7.1%	89.6%
Oct. 1987	0	0	8.9%	87.7%

At Volcano, like the Hakalau location, a few pollen types were collected in large amounts during only certain periods of the year (Table 2). An Urticaceae pollen type was collected in large amounts in November 1986 and then again in August, September, and October 1987. This pollen made up between 77.5% and 89.6% of the total pollen collected during those months. However, though some pollens were collected seasonally, others were found in small quantities year round, such as the pollen from a plant of the family Solanaceae.

In comparing the amounts of pollen collected at the two sites, it appeared that there were definitely peak months when pollen was collected in large quantities, although the peak months were different at Hakalau and Volcano. Interestingly, the peak months were October and November at the Hakalau site and September at the Volcano site. This is in contrast to temperate regions where large amounts of pollen are collected during the spring; the season usually associated with colony build-up.

There were also differences in the amounts of rainfall measured at the two sites. However, unlike the study conducted by Moniz et al. 1988, there appeared to be no relationship between rainfall and monthly pollen collections at either site.

Our data provide evidence that honey bees are foraging for pollen based on the availability of pollen sources, as had been suggested by Adams et al. (1978), since almost all of the monthly samples were predominantly from only a few pollen types. However, the collection of many different pollen types throughout the year indicates that colonies may need different kinds of pollen to fulfill their nutritional needs.

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