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THE DEVELOPMENT OF THE ALFALFA POLLEN-COLLECTING (APC) HONEY BEE*

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Alfalfa flowers of commercial varieties, which have very limited self fertility, must be "tripped" before the pollen can germinate on the stigma. Therefore, though automatic tripping sometimes occurs by such agencies as wind and tripping machines, little seed is obtained unless insects (primarily honey bees and several species of wild bees) provide large-scale cross pollination. However, honey bees are known to visit alfalfa more frequently for nectar than for pollen, and when they visit it for nectar, they pollinate only a small percentage of the flowers because of the tripping mechanism of the alfalfa flower. When the sexual column of the alfalfa flower, which is tightly enclosed by the petals, is suddenly released (tripped), it strikes the bee's head and leaves a mass of sticky pollen. When the bee visits another alfalfa blossom, the process is repeated and cross pollination results. The bee learns that it can obtain nectar more rapidly by avoiding the tripping mechanism. Thus, nectar-seeking bees slip their tongues in from the side, unlike pollen-collecting bees, which trip nearly every flower they visit and are therefore much more valuable to the grower of alfalfa seed.

In 1947, I observed that pollen traps on some colonies yielded more pollen than others and that not all traps at a given location yielded the same kinds of pollen, even on the same day. Apparently, foraging bees from different colonies become oriented to different areas where different plants grow. In addition, I found that greatly varying percentages of alfalfa pollen were brought to hives that were side by side in an apiary. Percival (1947) concluded that any plant offering a fair amount of pollen per flower-form will be worked for pollen by the honey bee. Pollen samples collected from three locations near Delta, Utah in 1947 suggested that the closer the trap colony was to alfalfa, the greater the amount of alfalfa pollen collected (unpublished report, with F. E. Todd). In this study, the traps on colonies 0 and 1/8 mile from alfalfa fields in the same locality collected 78 and 61%, respectively, of their pollen from alfalfa, but the colony 1/4 mile from the fields collected only 34% from alfalfa.

In August 1948, my colleague and I (unpublished report, with F. E. Todd) placed pollen traps on four hives in a field of flowering alfalfa at Petersboro, Utah, collected the pollen daily, and weighed and sorted it by plant source. Colony 1 collected the most pollen (2062 grams) and the highest (12) percentage of alfalfa pollen; colony 2 collected the least pollen (1221 grams) but the second highest percentage (8%) of alfalfa pollen; colonies 3 and 4 collected 1856 and 1698 grams of pollen, 2 and 1 percent, respectively (Table 1). In all four Petersboro colonies, gum plant was the predominant source of pollen, and alfalfa, burdock, corn, and Iva were of secondary importance. These data therefore suggested a relationship between colony location and collection of pollen from alfalfa and also the possibility of a genetic basis for colony differences.

Because of these observations, Bohart et al. in 1950 recommended that colonies be placed in or close to the alfalfa field. Then in 1955, Bohart et al. suggested that colonies should be placed adjacent to fields with fewer than 10

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acres or within larger fields (in groups of 12 colonies about 1/10 mile apart). Carlson et al. (1950) reported that plant breeders had succeeded in developing cold and wilt resistant varieties of alfalfa and that seed production could be improved by breeding the crop to fit the bees. In 1953, Pedersen showed that the flowers of certain alfalfa plants were more attractive than others to honey bees and reported significant correlations between visitations by honey bees and production of nectar and between production of nectar and seed yield. Finally, Pedersen and Nye (1962) showed that Uinta, a variety of alfalfa that was highly attractive to bees, yielded an average 859 pounds of seed per acre over 4 years compared with 510 pounds for Ranger and 380 pounds for Lahonton. Therefore, a bee breeding program was begun at the Wild Bee Pollination Investigations Laboratory at Logan, Utah in 1962 in cooperation with Otto Mackensen of the Bee Breeding Investigations Laboratory at Baton Rouge, Louisiana, to determine whether the tendency to collect alfalfa pollen is inherited and to develop a strain of bees that would collect a high percentage of alfalfa pollen. The breeding was done at Baton Rouge and the testing at Logan. All matings were achieved by instrumental insemination.

In 1962, I tested 356 colonies from various sources and selected three for further breeding that had collected a high percentage of alfalfa pollen and three that had collected a low percentage. In 1963, daughters of the queens heading these colonies were mated to their brothers, and colonies headed by new queens were tested. The colonies headed by sister queens were more similar in the proportion of alfalfa pollen collected than the colonies headed by unrelated sister queens (Nye and Mackensen, 1965). Since the closer the relationship the greater the similarity, heritability was indicated.

The steady progress made since 1963 in separating inbred lines that rank high and low as collectors of alfalfa pollen and the complete separation of the two lines has now proved beyond doubt that the tendency to collect alfalfa pollen is heritable (Mackensen and Nye, 1966, 1969; Nye and Mackensen, 1968). Therefore, in 1967, colonies of the high and low alfalfa pollen-collecting lines were compared with colonies of commercial line "B" at Howell, Utah. The high APC line collected 88 percent of its pollen from alfalfa; the low APC line collected less than 0.1 percent alfalfa pollen; and commercial line B collected 26 percent alfalfa pollen (Table 2). Since then, Mackensen and I have been devoting ourselves mainly to a study of the genetic and other scientific aspects of this discovery. However commercial breeders have been quick to realize the economic value of the tailor-made honey bees for alfalfa pollination.

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Table 1. Type, amount, and percentage of pollen collected by traps from four colonies. August, 1948, Petersboro, Utah.

Plants	Trap 1		Trap 2		Trap 3		Trap 4	
	Wt. of pollen (g)	% of collection	Wt. of pollen (g)	% of collection	Wt. of pollen (g)	% of collection	Wt. of pollen (g)	% of collection
Alfalfa	247	12	94	8	40	2	12	1
Burdock	187	9	183	15	21	1	14	1
Corn	120	6	250	20	134	7	2	0
Gum plant	934	45	393	32	1363	73	1454	86
Iva	202	10	59	5	118	6	94	6
Mustard	53	3	56	5	7	1	2	0
Rag weed	112	5	2	0	11	1	9	1
Russian thistle	90	4	22	2	40	2	12	1
Miscellaneous	117	6	162	13	122	7	99	6
Total	2062		1221		1856		1698	

Table 2. Type and percentage of pollen collected from colonies representing three lines of alfalfa pollen collectors (APC). Howell, Utah, 1967.

	Percentage of pollen collected by indicated line		
	High APC	Commercial line B	Low APC
Alfalfa	88	26	0.06
Chicory	2	1	3
Gum plant	1	44	30
Haplopappus	1	15	8
Mustard	5	3	2
Russian thistle	1	4	18
Miscellaneous	2	7	38