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BREEDING BEES TO THE CROP

WILLIAM P. NYE and OTTO MACKENSEN

It is well known that honey bees visit blooming alfalfa (lucerne) more frequently for nectar than for pollen, and that when they collect the nectar, they pollinate only a small percentage of the flowers.

This behavior is the result of peculiarities of the alfalfa flower. It is largely self sterile and must be fertilized by pollen from other alfalfa plants. The anthers and stigma (the male and female parts) form a sexual column that is tightly enclosed by the petals. This column is suddenly released (or tripped) and strikes the bee on its head, leaving behind a mass of sticky pollen. When the bee visits another alfalfa blossom, the process is repeated and pollination results.

POLLEN COLLECTION

Perhaps honey bees find the action of the tripping mechanism disagreeable as many people have stated, but, more likely, they merely learn that they can obtain the nectar more rapidly without tripping the flower. At any rate, when seeking nectar, they soon learn to slip their tongues in from the side and avoid tripping the flower. Pollen collecting bees, however, trip nearly every flower, and hence are much more valuable to the alfalfa seed grower. Honey bees collect pollen and store it in the hives for food. When eaten by nurse bees, it supplies the basic ingredients for the production of the glandular substances used for rearing brood. Some of the pollen is also fed directly to the larval bees as they get older.

Since each species of plant has a distinctive type of pollen, beekeepers can tell what sources their bees are using by examining the pollen brought to the hives. They obtain this pollen by using traps which are essentially wire grids placed over the hive entrance. The screen allows the bees to enter but scrapes the pollen pellets from their hind legs.

Many beekeepers have observed that traps in some colonies yield more pollen than others and that not all traps at a location yield the same kinds of pollen even on the same day. It was thought that the foraging bees from different colonies become oriented to different areas where different plants grow. There was some scientific evidence to support this. It has also been observed that sharply different percentages of alfalfa pollen are often brought into hives placed side by side in an apiary. Although this indicated to us the possibility that a genetic basis for such differences exists, no effort was made to prove it until 1962. In that year 356 colonies from three sources were tested at Logan, Utah. Not enough pollen traps were available, so we modified a vacuum cleaner to pick up pollen-laden bees at the hive entrance and pull them into a killing bottle. From these, the percent that carried alfalfa pollen was determined. This worked well for a quick test of a large number of colonies.

Figure 1. Colony of honey bees on pollen trap. Note pollen in tray.

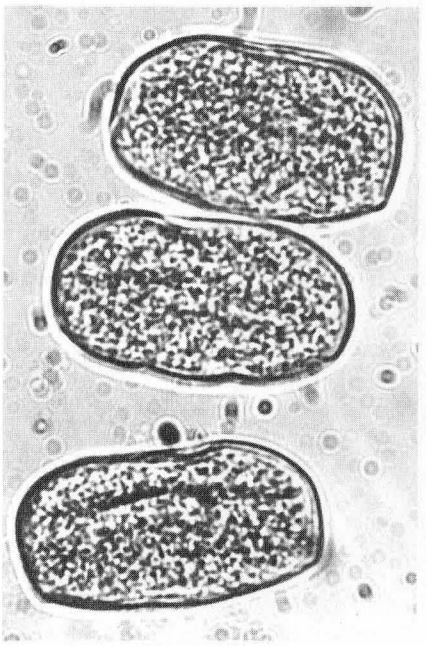

Figure 2. Alfalfa pollen grains. (unexpanded)

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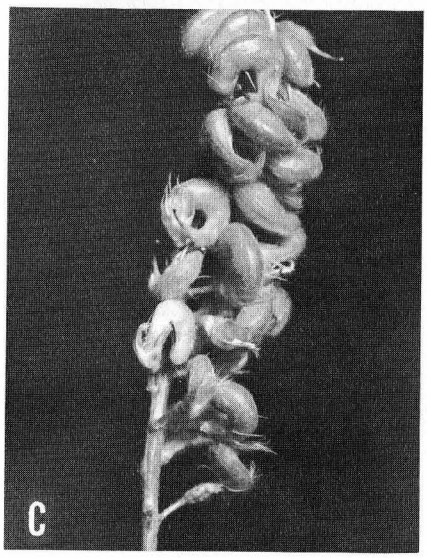

Figure 3. Photographs A to C show progress of a raceme pollinated by bees.

SELECTION FOR COLLECTION

Three high and three low alfalfa pollen collecting colonies were selected for the establishment of high and low preference lines. In 1963 virgin queens and drones reared from each of these selected colonies were mated to form six mating groups of sister queens. The tests showed that there was a greater similarity between colonies within mating groups than between less related colonies. This result indicated that the tendency to collect alfalfa pollen was an inherited characteristc and encouraged us to continue.

In bee breeding, the development of superior types is dependent on controlled mating of the queen. Ordinarily she mates with any drone that she encounters on her mating flight. An effective breeding program cannot be left to happenstance, so artificial insemination was used at Baton Rouge, Louisiana.

The breeding was done at the Baton Rouge laboratory because the season there is early enough for queens to be reared, mated and shipped to Logan in time to have worker progeny when alfalfa blooms. At Logan, the test colonies were placed in alfalfa fields grown for seed (alfalfa is not grown in the Baton Rouge area). In this way one generation a year was bred and tested.

LOW AND HIGH LINES

By the fifth generation, tested in 1966, the "low" and "high" lines had reached extreme levels of alfalfa preference. In that year the test colonies were placed first at Howell, Utah, on first crop alfalfa seed where other sources of pollen were scarce. Later they were moved to a second crop alfalfa field at Fielding, Utah, where other sources of pollen were plentiful and more comparable to those of previous years.

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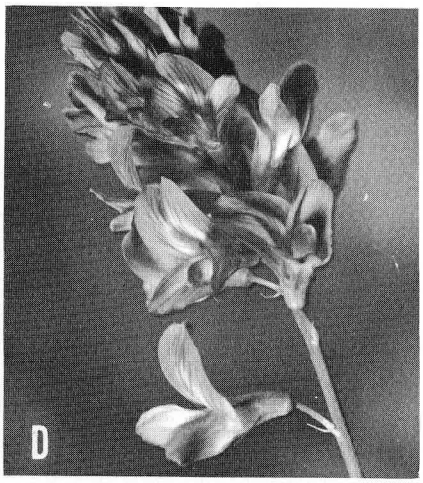
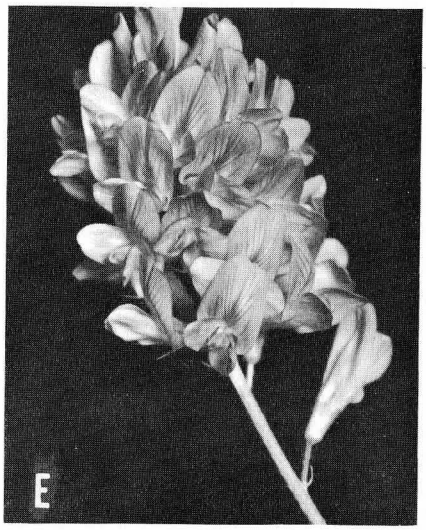




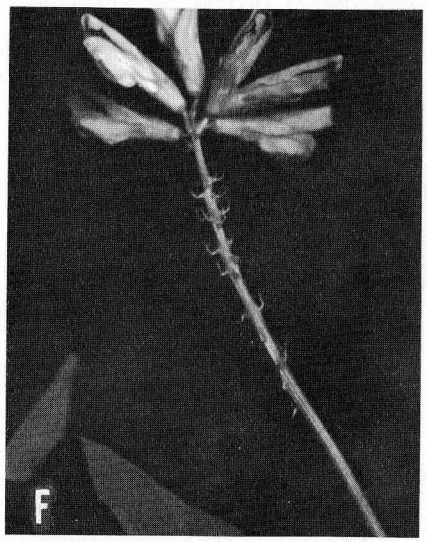


Figure 4. Photographs D to F show what occurs when racemes are protected from bee — the flowers are not pollinated.

The percentage of alfalfa pollen collectors for the two locations combined were 85 for the high and 18 for the low preference lines. In 1963, early in the program, the best colonies had collected an average of only 40 percent alfalfa pollen.

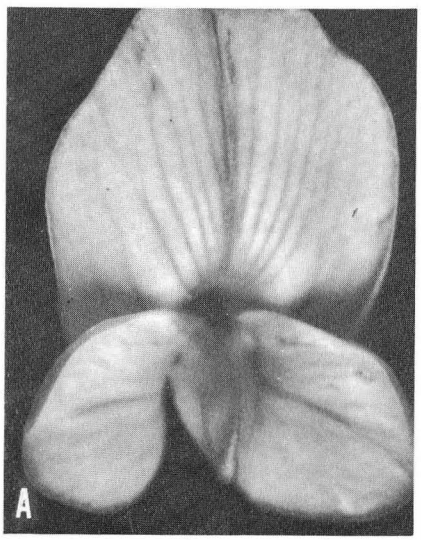
At Howell, the high preference line colonies collected their pollen almost exclusively from alfalfa; the low preference line colonies collected about half of their pollen from other sources in spite of their scarcity. Thus the high line colonies had a greater number of pollen collectors returning to the hives than did the low line colonies. At Fielding, where other pollen sources were relatively abundant, the low-line colonies almost ignored alfalfa. Probably as a consequence, the low-line colonies had a greater number of pollen collectors at Fielding than did those of the high line.

These results, together with those from backcrosses of the hybrid to the inbred lines, in which a lot of breeding and technical study was involved, confirmed that alfalfa pollen collection was an inherited trait and dependent on many genes. Thus efforts to develop still better strains for alfalfa pollination could be fruitful.

As the pollen preference study proceeded, a number of problems developed. Inbreeding and selection for one quality caused some of the other desirable qualities to gradually disappear. Bees of the "high" line lost viability and vigor, and became restless and difficult to handle. Therefore, we had to breed out those bad qualities as we continued to select for alfalfa pollen preference. The present new bee strains appear identical to the ordinary bees, they are a little more nervous and aren't quite as prolific, but we don't think this is too serious at this stage of research.

ADVANTAGES

Alfalfa seed growers have long used alkali bees, *Noma melander* Cockerell, and alfalfa leaf-cutter bees, Megahile rotundata (Fab), (both pollen-collecting species) as pollinators. However, their management has entailed expenses that could be lowered appreciably if pollen-collecting honey bees were available. While we have mainly pursued the genetic and other scientific aspects, commercial breeders have been quick to realize the economic value of tailor-made honey bees for alfalfa pollination. For example, G. H. Cale, Jr., of Dadant and Sons, Hamilton, Illinois, and Charles B. Reed, President of Valley Pollination Service, Bakersfield, California, already have started work on selective breeding for alfalfa pollen collection based on our findings.



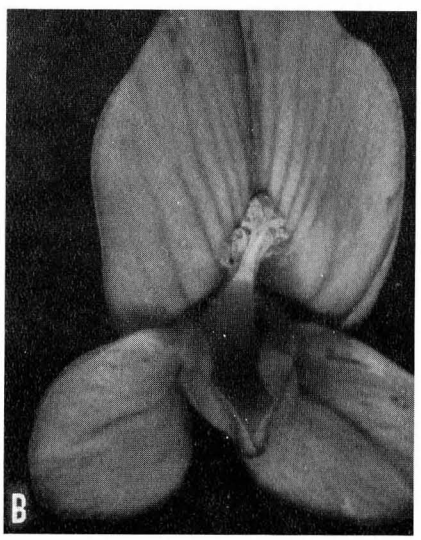


Figure 5. A shows untripped alfalfa flower while B shows a blossom that has been tripped.

About 90 crops grown in the United States are dependent on bees for pollination. To develop special pollinating strains for each of these is not practical. But a few crops are important enough and have a sufficiently difficult pollination problem to make the development of a practical strain worthwhile.

One such crop is red clover. There has been a lot of talk about the depth of the corolla tube of red clover. When honey bees are numerous on red clover, the seed yields are good. Our alfalfa experiment suggests that when bees are placed on red clover some of them will probably show a preference for its pollen. Beekeepers may have been led astray by too many references to the length of the corolla tube compared to that of the honey bee's tongue. Tube length is a factor only in nectar collection. The honey bee easily reaches red clover pollen when it wants to. Flowers of red clover are also self-sterile and require cross - pollination. Nectar - seeking bees have formerly been considered for red clover pollination but pollen seeking bees would be much better. If, as we suspect, the trait is present in certain colonies it need only to be ferreted out to develop a tailor-made honey bee for pollinating red clover.

RESEARCH CONTINUES

There is no clear evidence now that bees inherit a preference for any other pollen except alfalfa. Yet when pollen traps were placed on colonies in New Jersey cranberry bogs in 1966, one colony consistently collected almost pure cranberry pollen while others around it collected only a very small percentage of cranberry pollen. Selective breeding is being conducted among the descendents of this queen to determine if inheritance is involved. There is evidence that cotton benefits from honey bee visitation and a selective breeding program has been initiated. Laboratories of the Apiculture Research Branch in Beltsville, Maryland; Madison, Wiscon-

(Continued on page 60)

BREEDING BEES

(Continued from page 48)
sin; and Tucson, Arizona, are involved in these programs.

Positive results in these new programs would show that preference of individual lines for specific sources of pollen may not be unusual, and that it should be possible to "tailor-make" honey bees for the pollination of many kinds of crops.

Figure 6. Nectar collecting honey bee working a flower from the side to avoid tripping the flower.