Managing Colony Genetics by Grafting and Selecting for Queens With Shorter Development Times

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Two serious problems facing the beekeeping industry are the migration of Africanized honey bees into the U.S. and the spread of Varroa mites. Now more than ever beekeepers must manage the genetics of the bees in their colonies if they hope to deal with these problems.

THE STRONGEST tool that a beekeeper has for controlling colony genetics is the grafting needle. Colony characteristics that are favorable to a particular beekeeping operation or are adapted for a specific geographic area can be increased by grafting queens from colonies that possess the desired traits. By grafting their own queens, beekeepers can create lines of bees tailored for the conditions of their apiary sites and beekeeping practices.

A trait that may be an important component in solving Africanized bee and *Varroa* problems is queen development time. The first queen to emerge destroys the remaining queen cells and becomes the matriarch of the colony. The colony's behavior and attributes will reflect the genetic composition of the queen and the drones with whom she has mated. Queen development time could be partially responsible for Africanized traits being expressed by bees in geographical areas that previously were inhabited by European strains, if the development period for Africanized queens is shorter than that of European queens. In Africa, queens of *Apis mellifera scutellata* develop in 14-15 days while European queens require 14-17 days (Anderson, Buys, and Johansmeier 1973). If Africanized queens emerge first the colonies will express many traits associated with that line of bees. Queen development time apparently is an inherited trait. A line of honey bees (hereafter referred to as Lusby bees (LUS) that has been selected for shorter queen development time now has queens with an average development period of 14.1 days (with a range of 12.4-15.8 days). We conducted an experiment to determine the variability in queen development time using a closed population (CP) line of bees composed of stocks that can be purchased from commercial package and queen breeding operations throughout the U.S. (Page and Laidlaw 1982). Larvae from LUS bees were also grafted for comparison. Three CP colonies and two LUS colonies were used for grafting. The resulting queens will hereafter be referred to as CP 1, 2, or 3 or LUS 1 or 2 queens. In this experiment, only 12-24 hour old larvae were grafted (age was determined by size of the larvae). The grafting technique was similar to the procedure outlined by Laidlaw (1981) in which larvae were placed in a drop of royal jelly at the bottom of queen cups. The grafted larvae were then placed in starter-finisher hives containing the same line of bees from which the larvae were grafted. Five days after grafting, the capped cells were placed in individual plastic vials and put in an incubator set at 34.5°C (94° F) and 78% relative humidity (Fig. 1). The incubator was checked every 4-5 hours for newly emerged queens.

The emergence times for CP and LUS queens are shown in Table 1. LUS queens emerged 9.5-10.6 days after grafting (13.5-14.6 days total development time), while CP queens emerged 10.4-11.0 days after grafting (14.4-15.0 days total development time). LUS 2 queens had the shortest average development time. The average development time of LUS 1 queens was not significantly different from those of any of the CP queens.

Differences among colonies concerning queen development times are revealed in greater detail by examining the percentage of queens from each colony emerging over time (Fig. 2). Almost 20% of LUS 2 queens had 12-13

Table 1. Total development times (egg to adult) of grafted queens from two different strains of honey bees.

Strain	Colony Number	No. of queens	Queen emergence times (days) after grafting
Lusby	1	17	14.6 ac
	2	63	13.5 b
Closed Population	1	28	15.0 a
	2	19	14.4 c
	3	23	14.8 ac

Means followed by the same letter are not significantly different at the 0.05 level as determined by Scheffe's S test.

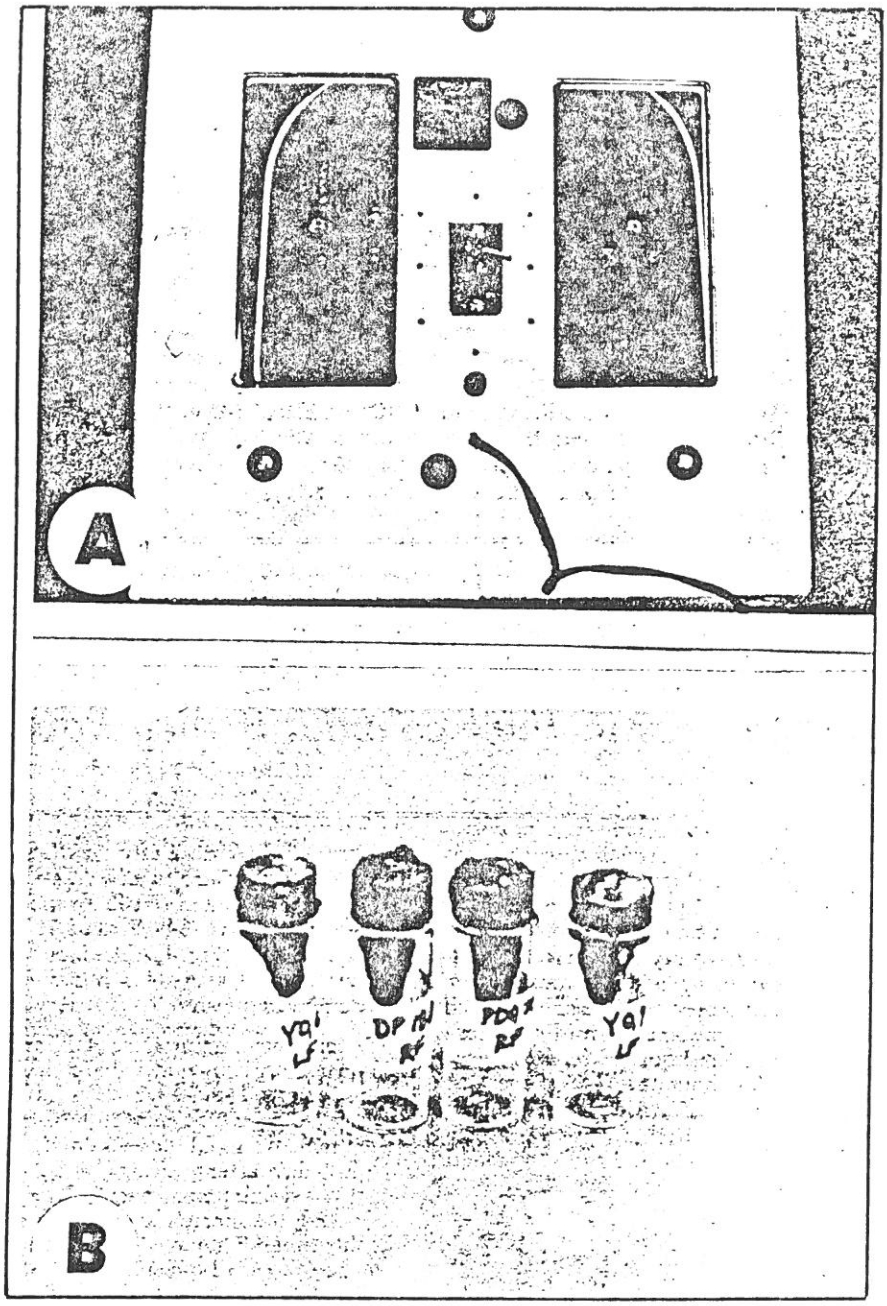

Figure 1. A) The incubator used to house capped queen cells until they emerged, and B) vials in which capped queen cells were placed before putting them into the incubator.

day total development times and emerged before other LUS or CP queens. CP 2 had some queens with 13-14 day development times as did both LUS colonies. Most of CP and LUS 1 queens had 14-15 day development times. A relatively small percentage of LUS 1 and CP 2 queens had 15-16 day development times, while almost 60% of CP 1 queens and 20% of CP 3 queens emerged at this time.

Grafting queens and documenting their development time using an incubator is a simple procedure that can be done by any beekeeper. The first step is to determine the range of queen development times in existing stocks, particularly those with other attributes that need to be perpetuated. To do this, graft larvae of the same age. When the cells are sealed, place them in individual plastic or glass vials, and transfer them to an incubator. We use a plastic foam Little Giant poultry incubator, Miller Mfg. Co. Inc., St. Paul, Minn., that costs about $30.00. Check the incubator every 4-6 hours to determine emergence times. Label the vials with the time that the queen emerged, and estimate the total development time. To apply selective pressure for shorter queen development time, introduce only those queens which emerge 9-10 days after grafting. By repeating this process with the offspring of these queens, the frequency of shorter queen development time can be increased in the next generation. Once this trait is established in a colony, it will be retained even if the colony requeens itself (assuming that larvae of nearly the same age are selected by the bees to be reared into queens).

Additional studies are currently being conducted using the grafting and selection techniques described here to determine whether queens with shorter development times produce workers with this trait. We are testing factors that could influence development rates. One such factor is temperature which in many insect species strongly influences development rates. In honey bee colonies workers control temperature particularly in the brood nest, and thus may be influencing development rates through temperature regulation.

Shorter development times may be associated with smaller body size. We are examining the size and weight of queens (and possibly workers) with the shortest and longest development times to determine if they differ. If, indeed, queens with shorter development times produce offspring with this trait, they may show resistance to *Varroa* mite infestations since fewer female *Varroa* mites will have the opportunity to develop before the adult worker or drone emerges (Camazine 1988).

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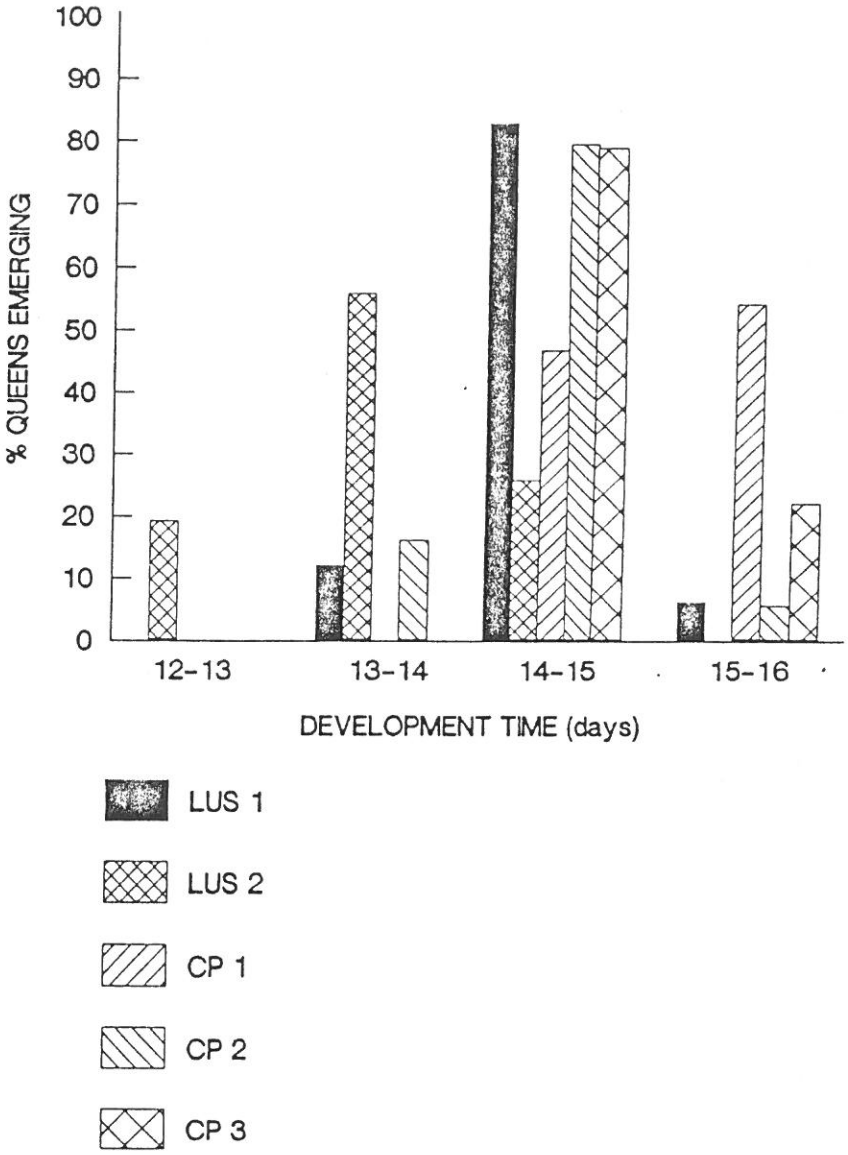

Figure 2. The percentage of queens emerging from each test colony over time.