Principles of Bee Breeding

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Why Breed Bees?

• Increase honey production
• Improve overwintering ability
• Decrease defensive behavior
• Reduce swarming
• Reduce or increase use of propolis
• Change color
• Improve queen characters
• Decrease incidence of diseases
• Other personal reasons
Breeding versus Queen Rearing
Most important part of a breeding program
Principles of Queen Rearing

• Provide lots of nurse bees

• Provide lots of drones
Honey bee gender and caste
Workers
fed low sugar
restrict food
increase sugar
starve

Queens
fed high sugar food
Leimar et al. 2012

Graph showing the log JH titer and ecdysteroids over age (days) from L1 to PPW.
Programmed cell death in ovaries

queen

juvenile hormone

worker

egg  L5  pupa  egg  L5  pupa

queen worker juveniles egg L5 pupa

queen worker juveniles egg L5 pupa
In vitro rearing
Wild type bees

Body mass (mg)

Starved L5

95% ellipse

R² = 0.16****

Ovarioles

Control

12 hours

15 hours

18 hours

Kaftanoglu and Page unpublished data
Mating behavior
(polyandry)
polyandry produces genetic diversity
Division of labor
Genetic diversity affects division of labor
Genetic diversity is important:

- fly > 5 km to avoid inbreeding
- mate with large number of males
- have mechanisms to insure sperm mixing
- have highest recombination rate (20X humans)
- affects distribution of thresholds and division of labor
Early Breeding

• Mendel tried to select better bees
• He could not control matings
• Not until 1940’s could we control matings with development of II
Fundamental Principle of Breeding

Offspring resemble their parents

(requires genetic variation)
Genetic Variation

• Colony level

• Individual level
Genetic variation for colony traits

- Number of workers
- Worker comb
- Drone comb
- Total brood
- Propolis
- Undertaking
- Stored pollen
- Hygienic behavior
- Sugar solution storage
- Tracheal mite resistance
Individual Genetic Variation

Retinue behavior
Fanning
Nectar load size
Pollen load size
Concentration of nectar
Water foraging
Food sharing
Guarding
Scouting food
Scouting nest sites
Pollen dance attendance
Light sensitivity
Walking activity
Life span
Age of foraging
Grooming
Ovary size
Stinging
Sensitivity to sugar
Learning
Dancing for pollen
Response to brood
Response to stored pollen
Undertaking
Body color
Queen development
Nursing behavior
Body weight
Others...
Mechanism of Breeding

- Select parents based on some trait
- Raise queens and drones
- Control mating
Steps in Breeding

- Decide on a trait (phenotype)
- Develop an assay
- Measure the foundation population
- Select parents
- Control mating using a design
- Evaluate, document, and verify
- Select parents
The Phenotype

HONEY

POLLEN

BROOD
The Assay
The Population
Mating Design

Queens → H1 → H2 → H3 → H4 → H5

Drones → H6 → H7 → H8 → H9 → H10

Sublines Generation 1

High Strain

Mating Control
Evaluate
Verify Selection Results

Generation 4

Pollen area

High
Commercial
Low
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