

Symposium Production Of Live Material



Developments and Changes In the Queen & Package Bee Industry

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Queen & Package Bee Industry



Specialized Business

Major Supplier of Queens & Bees to
Re-Stock the Commercial Industry,
Sideliners & Hobbyists



Economic Value Pollination Services Of Crops That Feed The World

Estimated Global Insect Pollination Value
€157 Billion, USD \$ 217 Billion



U.S. Almond Crop
Requires 1.4 million
colonies
Of the 2.6 million in the U.S.





And...

Numerous Honey Bee Products



Since Varroa... Increased Production
Demands and “Quick Fix”
Treatments



Queen & Package Bee Industry

Also Responsible for ...

Selection & Maintenance of Genetic Material



Selective Breeding

Historical Focus

Productivity

Temperament

Reduce Swarming

Overwintering

Current

Resistance to Varroa

Local Adaptation



Modern Beekeeping



Loss of Native Populations

Loss of Habitat

Intensive Agricultural Practices

Nearly the Entire Populations in Europe
& North America are Managed

Reduced Genetic Diversity

Chemical Treatments Routine



Queen Quality



Drone Production



Need To Minimize:

Varroa Infestations
Pathogen Loads
Chemical Residues

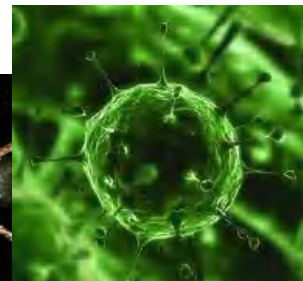
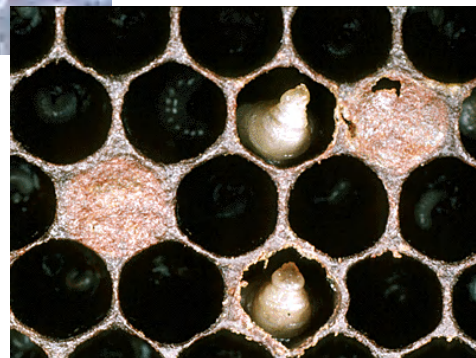
Impact:

Reduce Longevity
Reduce Mating Success
Reduce Sperm Development



Increasing Challenges...

The Worldwide Spread of Pests, Parasites & Pathogens



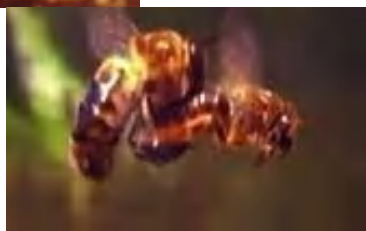
Multiple Resident Pathogens Co-Exist In Colonies

More Pathogenic In Association with:

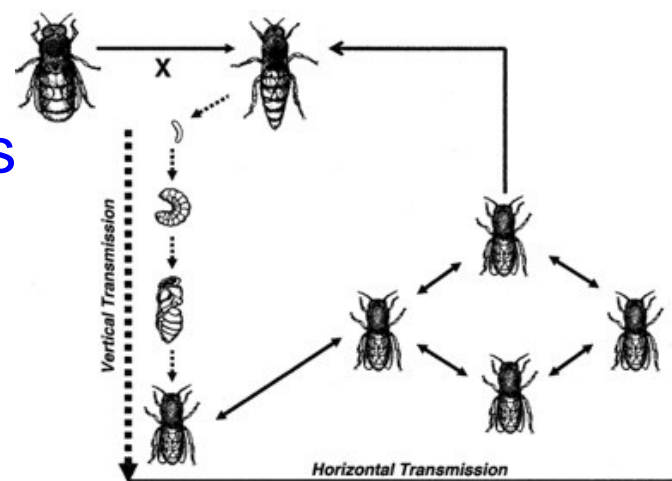
Varroa, Nosema, Malnutrition & Chemical Residues

Varying Tolerance / Susceptibility Among Colonies

Changing Combinations of Pathogens & Conditions



Transmitted Vertically
Between Generations
Transmitted Horizontally
Between Individuals



Increasing Challenges...

Malnutrition-

Lack of Adequate and Diverse Forage

Monoculture Crops

Habitat Degradation

Climate Change



Increasing Challenges...

Accumulation of Miticide & Pesticide Residues in Beeswax



Sub-lethal Effects:

Queen Effects

Mating

Signaling

Egg production/laying

Pre-mature supersedure

Brood / Nutritional Effects

Inhibits bee bread

microorganisms

Delayed development

Growth abnormalities

Reduced longevity

Increased morality

Neurological Effects

Impaired visual sensory

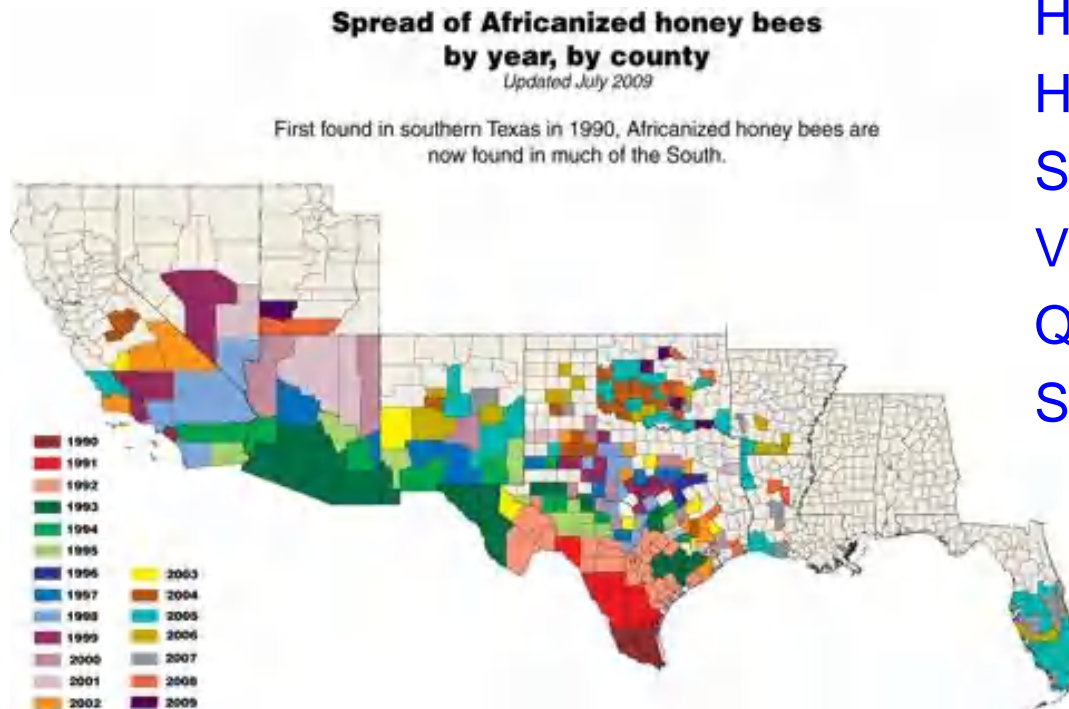
Reduced memory & learning
performance

Communication difficulties

Impact of the Africanized Bee

Genetic Dominance In The Process Of Africanization

Resistant to Pests & Disease
Faster Development Times
Higher Swarming Rates
Higher Drone Production
Sperm Competition Advantage
Virgins Better Fighters
Queens More Attractive
Social Parasites



Selective Breeding

Tendency to Reduce Genetic Diversity
Desire for Uniformity



Cost / Benefit

Selection for Resistance / Productivity



Resistant Strains

Less Productive

Reduced Brood

Production

High Swarming Tendency

Un-Selected

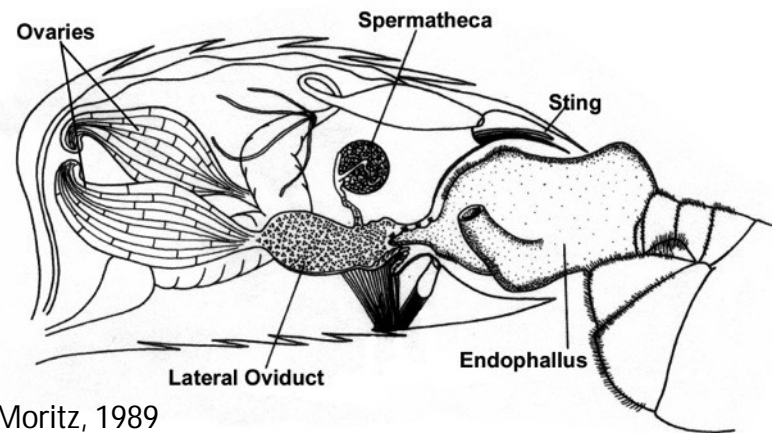
Increased Costs

Increased Labor

Chemical Residues

Honey Bee Mating

Favors Intra-Colony Diversity



Moritz, 1989



K. Lorenzen

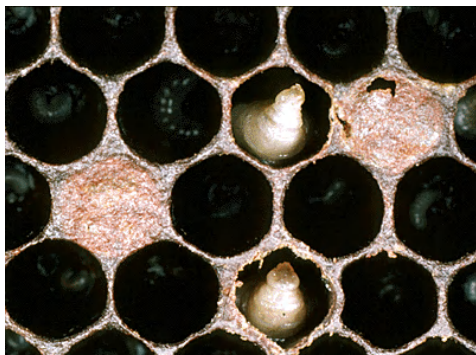
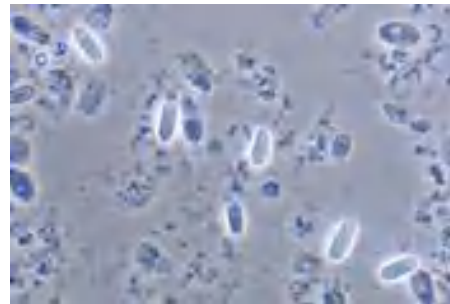
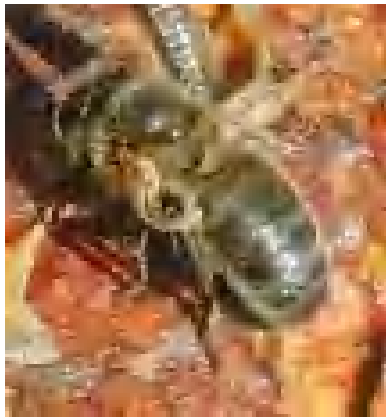
A Diverse Workforce Increases Colony Fitness



Duong & Schneider, 2008
Mattila & Seeley, 2007
Jones, et.al., 2004
Page et al, 1995
Oldroyd, et.al., 1992,

A Diverse Workforce

Reduces Prevalence, Severity of Disease & Pests



Tarpy & Seeley, 2007,
Seeley & Tarpy, 2007
Tarpy, 2003,
Fuchs & Schade. 1994

Stock Improvement

Controlled Mating

Isolation

Instrumental

Insemination

Selection Methods

Simple, Practical,
Effective Measurement
of Heritable Traits

Breeding System

Avoid Inbreeding

Maintain Selection Pressure
Over Time





Controlled Mating

Drone Saturation

Isolated Mating Stations

Instrumental Insemination



Instrumental Insemination

Under Utilized

No Standardized Equipment
Few Training Programs

Perception

Instrumentally Inseminated
Queens are Inferior

Numerous Studies Show

Performance Depends upon
Queen Care and Techniques



Factors Affecting Queen Performance Of Instrumentally Inseminated Queens

Rearing Conditions
Age of Insemination
Semen Quality
Semen Dosage
Insemination Techniques
Queen Introduction
Banking Practices
Pathogen Load
Chemical Residues



Selection Methods

Simple & Practical

Evaluate Several Traits
in Numerous Colonies

Effective Measurement of
Heritable Traits

Influenced by
Environmental Factors



Requires Evaluation of a Suite of Traits

Productivity



Brood Viability



Over-Wintering



Temperament



And..

Selection For Specific Traits of Resistance/Tolerance



Such as..

Hygienic Behavior

Liquid N₂ Frozen Brood Assay



Photos by Kathy Garvey



Co-Evolution Is Essential In Selection For Resistance

Host-Parasite Association

Fundamental Criterion for Selection

Requires

Diverse Population

Selection Pressure

Selection Methodology

Simple

Reliable

Standardized



Mechanisms of Resistance Involve Behavioral, Physiological & Beekeeper Management

Olfactory Sensitivity - Detection & Removal

Hygienic & Grooming Behavior

Development Time

Post-capping Stage

Duration & Breaks In the Brood Cycle

Re-Queening

Dividing Colonies

Inhibition of Varroa Reproduction

Cuticular Hydrocarbons



Resistance Mechanisms

Variable Among Colonies

Indicates Potential

Highly Complex

Partially Understood

Constantly Changing

Dependent Upon

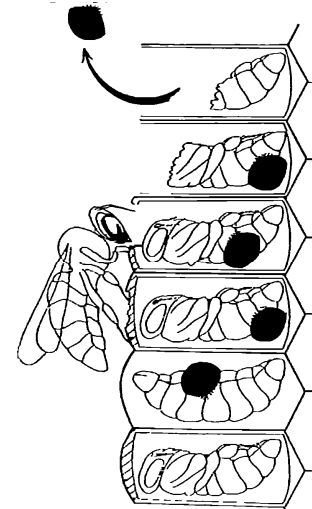
Environmental Conditions

Management Practices

Variation in Virulence of Varroa

Variation in Susceptibility

Combination of Associated
Pathogens



Drawings By O.
Boecking



Epigenetics

Biological Response To Environmental Stressors

Chemical modification of the genome changes gene expression

No change in the DNA sequence

The environment affects an organism's genetics

Passed to future generations

Epigenetic activity includes

Nutrition, social interactions, environmental changes, exposure to toxins, pests and other mechanisms



What It Takes ...

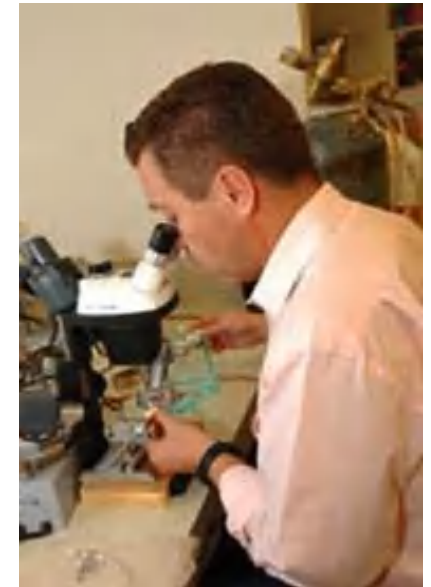
Collaborative Efforts of Research and Industry

PROAPI – Argentina
COLOSS - Europe



Technology Transfer...

Skills To Promote Stock Improvement



Strategies?

Producer Efforts

- Enhance Natural Selection Mechanisms
- Increase Intra - Colony Diversity
- Exclude Highly Susceptible Colonies
- Change Management Techniques

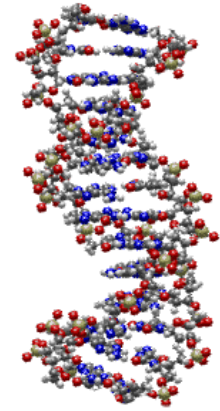
Research Efforts

- Develop Methodology for Selection & Breeding
- Identify Genetic Markers for Resistant Traits
- Explore Interrelationships of Pests & Diseases
- Apply Molecular Technologies



Future possibilities...

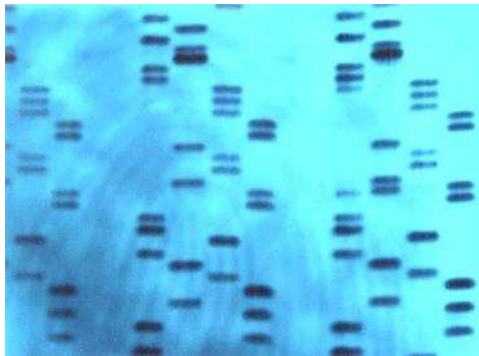
Marker Assisted Selection



1. Sample

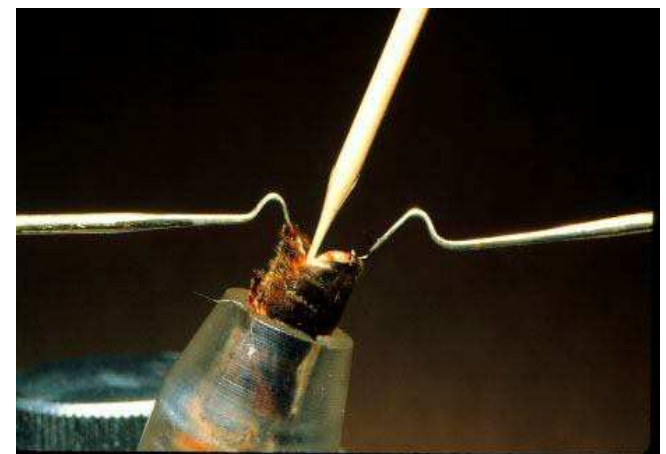


2. Identify



DNA Fingerprinting

3. Add to Selection
Criteria

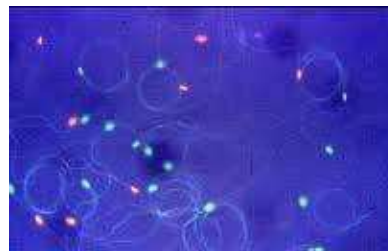


Future possibilities...

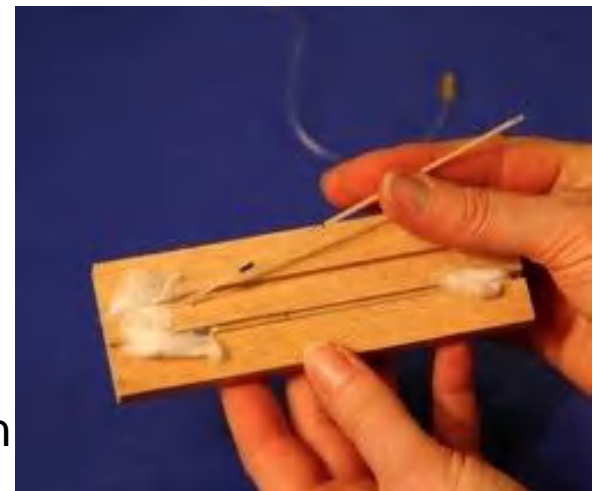
Honey Bee Germplasm Repository

Preserve Biodiversity
Stock for Re-Selection Program

Develop Regulations &
Protocol For Safe International
Transport



Honey bee semen



Thank you, Questions?

