FIELD BREEDING BASICS FOR HONEYBEES USING COLONY THERMODYNAMICS WITHIN THE TRANSITION ZONES

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Honeybees can be controlled by working in harmony with their natural instincts. How honeybees behave, both individually and as a whole colony working-unit, depends upon the field temperatures and the weather conditions. Colony thermodynamics, which means working with Nature's natural temperature rhythms and climate as relates to honeybees, controls the behaviour of the colonies relative to brood rearing, swarming, honey gathering, wax production, queen rearing etc. all around the year. Beekeepers can create an environment for their colonies to build-up strong populations for breeding and honey gathering etc., by working with colony thermodynamics and larning to remove adverse hive conditions through sound field management practices.

The queen is the heart of each colony. However, the life of each colony depends upon temperature. In cold weather, the honeybee activity slows-up and finally completely stops each winter. If the winter cold is too severe, the colony may die from cold or starvation. In warm weather, the honeybee activity increases up a certain point and then colonies may die from heat. It does not take a very high temperature to kill an entire colony.

To manage honeybees successfully means, therefore, controlling their behaviour with sound field management on a year-round program. Honeybees always react in the same way to the same conditions relative to temperature and climate. If beekeepers learn to understand how these conditions work relative to honeybees, then they can anticipate and control their behaviours within the framework of a sound year-round management program.

Queen breeding should rank as the most important activity in a sound program of honeybee management. Queen breeding is simply an increase in the number of queens a beekeeper manages, thus increasing colony numbers. Yet, it is not merely a question of reproduction. Breeding implies an improvement of the honeybee's performance capabilities by the augmentation of the best attributes and the elimination of negative attributes, the final result being the production of colonies which are uniform in all aspects and have above average production performances.

The major limiting factor of the start of queen breeding is the rearing of sufficient drones and nurse bees. Insufficient numbers of either will doom most operations attempting requeening to unsatisfactory results (the exception being breeding to raise the incidence of the lytoky). Beekeepers using colony thermodynamics relative to the local area breeding cycles within the framework of year-round field management, geared to Nature's natural temperature rhythms and climate, can greatly improve overall colony performances in a period of 3-5 years. Beekeepers need to learn that queen breeding is progressive and retrogressive in results and can even hold status-quo, as in the case of cloning.

Beekeepers should know both the mainflow-breeding and stress-breeding times of the year in their local areas. Mainflow-breeding mainly hybridizes and/or breeds honeybees forward progressively, while stress-breeding when used at either the beginning or the end of selected breeding cycles can retrogress bee stocks, like separating oil from water, so that they may be re-hybridized again and again to re-infuse hybrid-vigor for increased colony production standards.

Basic colony thermodynamics for bee breeding

1. A cold-blooded animal is one that has a body temperature below 80 degrees F., and that takes on the temperature of the air, water, or other element in which it lives. One bee or a few bees do take on the temperature of the air around them and cannot protect themselves against the loss of heat or cold.

2. A warm-blooded animal is one having a relatively high and constant body temperature relatively independent of the surrounding environment. The bee cluster can keep itself warm against a temperature of 100 degrees F below zero or cool against a temperature of over 135 degrees F by metabolic activity mimicing warm-bloodedness by working together as a whole harmonious unit to provide an optimum and constant body temperature relatively independent of the harsh surrounding conditions of temperature and humidity.

3. With an internal ambient temperature of approximately 106 degrees F both bees and brood die without some measures of heat regulation.

4. When the ambient temperature inside the hive drops to 45 degrees F, bees normally cease work, cluster loosely, and maintain the cluster temperature at 57-58 degrees F.

5. The cluster is mostly nearly dormant at 57-58 degrees F which still allows the bees to be able to break cluster and move to a new store of honey when all within the cluster has been consumed.

6. Honeybee clusters generate 12-13 degrees F heat by their normal and natural bodily metabolism or activity incidential to living.

7. The brood rearing temperature is approximately 93 degrees F to stimulate both the queen to lay eggs and the worker bees to feed and care for larvae.

8. Once the brood rearing has begun, bees must generate whatever heat it takes to maintain the brood nest temperature at approximately 93 degrees F until the brood emerges.

9. If the temperature of the outside air rises to 90 degrees F or higher, bees normally carry water into the hive, evaporating it by forced air circulation and thus removing the excess heat from the hive (Evaporation of water cools the hive because the specific heat of water is more than 4 times that of air.).

10. Pure hybridization occurs where hot-weather bees and coldweather bees come together naturally by either latitude or altitude with a mean monthly temperature of 75 degrees F.

11. As the inside ambient temperature approaches and/or exceeds both 45 degrees F and 106 degrees F small black bees approach the breeding condition of thelytoky (Have not been able to accomplish with either yellow-mix or large dark castes).

12. Humidity in the brood chamber should be about 60% relative humidity, while in the supers where the honey is being ripened it should be 10% relative humidity.

Other basic guidelines for bee breeding

1. Dark (brown/black) cold-weather bees exist naturally below 30 degrees latitude where higher altitudes permit.

2. Yellow hot-weather bees exist naturally above 30 degrees latitude where warm thermal areas permit.

3. Small caste races/strains of hot weather bees exist at the Equator and large caste races/strains of cold-weather bees exist as they approach the poles.

4. As all races/strains of bees advance towards temperature transition-zones at near 30 degrees latitude, hot-weather bees hybridize more, while cold-weather bees hybridize less.

5. Nature breeds constantly when all optimum basic evolutionary needs are met i.e. water, food, shelter, and temperature.

6. Mongrel hybridization is not an evolutionary progression for it separates when artificial stimuli are removed i.e. inappropriate artificial comb size, surrogate geographic areas, and forced climatic breeding.

7. Nature breeds evolutionary change that is progressive, retrogressive, or cloned, when race/strain survivability is at stake.

8. Each race/strain of honeybees has its own separate breeding cycle in Nature providing, an evolution separate from all others, enabling it to exist.

9. Large caste bees on a natural system equate with: 1) fewer bees per brood comb, 2) slower developmental time, and 3) slower mating flight.

10. Small caste bees on a natural system equate with: 1) more bees per brood comb, 2) faster developmental time, and 3) faster mating flight.

11. Drones take mating flights on days when bees are able to break cluster and fly outside.

In queen rearing, not the outside air temperature itself is the focal point which beekeepers must consider, but the temperature of the skin surface of the artificially boxed hive where exposed to the sun or the chill-factor of cold winds, which may reach 135 degrees F or 100 degrees F below zero, or even more depending upon latitude and time of the year. This heat or cold passes through the wall/entrance of the hive to its interior, thus increasing or decreasing it to far above or below the outside temperature. Beekeepers seriously breeding bees can help colonies thermoregulate by maintaining tight and painted equipment, and leaving full frames of honey surrounding the brood nests to act as insulation against extremes of cold and heat.

By natural metabolic cluster reactions, honeybees thermodynamically overcome these effects of unfavorable weather conditions within the hive during cold winters and hot summers. However, to bees, the temperature of the skin surface of the artificial box is a trigger mechanism to which they must react, to average the maximum and minimum temperatures of each day. Day in and day out, bees must manipulate natural weather conditions to approach and provide optimum mean temperature conditions for brood rearing and colony survival. An ambient temperature lower than about 80 degrees F inside the colony results in one of two things. Either the brood rearing within the colony decreases and cuts back or, is seasonal conditions cause the bee to react favorably (fresh pollen and/or nectar coming in), the bees will increase their metabolic activity and produce the necessary heat to offset any short-term decrease in temperature, adding a minimum of 12-13 degrees F of their own body heat to raise brood, if there is a supply of pollen and reserve honey stored. As soon as the brood rearing temperature of 93 degrees F is reached, the queen begins to lay eggs and the brood is reared and cared for by the colony.

In spring, when most beekeepers think of rearing queens, they think of progressive breeding techniques, waiting until colonies produce sufficient drones and nurse bees before beginning the queen rearing. Many wrongly believe that hybridization is progressive breeding. It is not! In today's world, hybridization is for the most part mongrel breeding that produces only a short burst of hybrid vigor and then quickly falls apart with each succeeding generation. For most beekeepers, there should be not breeding from hybrids since it is beyond most beekeepers to control it. The final result is nearly always total mongrelization of local area bee stocks and an uncontrolled mixture of overly aggressive bees which makes beekeeping more and more impossible in today's urbanizing world. In a long-term stock improvement program, artificial insemination and various closed-population breeding methods should be avoided, as they lead to severe inbreeding, resulting in poor brood patterns, poor product averages, weak winter cluster carry-over, and colony collapse over a period of 20-30 years.

Nature breeds evolutionary changes that are progressive, retrogressive, or cloned, when race/strain survivability is at stake. To accomplish either of the three, beekeepers must remember that all breeding begins with the selection of notable stock of above average overall colony performance. Beekeepers should look for and select honeybee breeder colonies based on a whole-bee theory of field characteristics. To do anything else will, in the long-term, doom the breeding program to problems and necessitate retrogression before being able to proceed further.

Progressive breeding

Is the production of uniform progeny within the framework of a fully naturalized breeding program which will true breed and the results of which can only be obtained from uniformly bred colonies. Permanent results can only be achieved by the use of naturally occurring races/strains of honeybees. Since a bee by any other name is still a bee, then beekeepers must use individual or combinations of large or small caste races/strains of hot or cold-weather bees to accomplish this. Artificial hybrids may then be created by mimicing natural hybridization, when two of these races/strains are assimilated. Nature does not produce complex mongrels. Nature transitions in and out from one race/strain to another, with a brief transition-zone between, that is a mixture of each, while always maintaining compatibility to localized geography and climatic thermodynamics.

Retrogressive breeding

Is the reversal of either natural or artificial hybridized combinations of large or small caste races/strains of hot or cold-weather bees, resulting in the production of uniform progeny within the framework of a fully naturalized breeding program, which will then result in each separation achieved, breeding true to their own hot or cold-weather characteristics and large or small caste delineations. Results can only be achieved by the use of stress-breeding at either the beginning or the end of the selected race/strain breeding cycles where no overlap occurs, one projected breeder-cycle to the others (s). Artificial races/strains can then be created by mimicking natural races/strains where complex mongrelization has taken place, to gain uniformity of characteristics then necessary for the advancement of desirable traits i.e. gentleness and production.

Cloning (Thelytoky)

Is the holding constant of race/strain genetics from one generation to the next naturally or by artificially increasing the propensity of worker bees to lay viable brood, to raise queens as an alternate survival system to supplement normal queen mating in case the virgin queen is lost during the mating flight. Results can only be achieved by using severe stress-breeding, by using the temperature outside, the beginning or the end of selected race/strain breeding cycles where no overlap occurs, one projected breeder cycle to the other (s). It is a short-duration phenomenon initiated by extreme stress to allow perpetuation of species, until the first available normal mating can be accomplished, to allow, the colony to permanently requeen itself in the normal manner of mating.

Projecting breeding cycles

Beekeepers should remember when projecting breeding cycles that the colour of the exoskeleton is only of significance as a distinguishing character for the purpose of racial analysis where there is the possibility of darker races/strains of honeybees crossing with yellow races/strains of honeybees. In these instances, because the yellow rings of the tergits are so conspicuous, they can be quickly eliminated one from the other. It is because of this that beekeepers from time immemorial have given significance to the colouration of the tergits of the abdomens of honeybees.

Only when more than one race/strain of bees are in given area do beekeepers need to project breeding cycles to find the best times the drones of their bees have the breeding advantage to maintain racially segregated stock. To project the number of breeding cycle graphs required, beekeepers should first survey colonies in their area that are both domestic and feral (Note – Colonies on oversized artificial brood foundations do not fully correlate with naturally occurring breeding cycles, necessitating that differences be taken into account or excluded from survey). Survey information should include:

1. The number and type of race/strain bees perceived present in the area.
2. Being specific, the approximate dates the worker bees first begin to either raise or eliminate drones from their colonies.
3. Being specific, the weeks/months drones are totally absent from all colonies. (Note – If a few drones are present so note, and under what circumstances i.e. laying worker, extra strong hive, etc.)

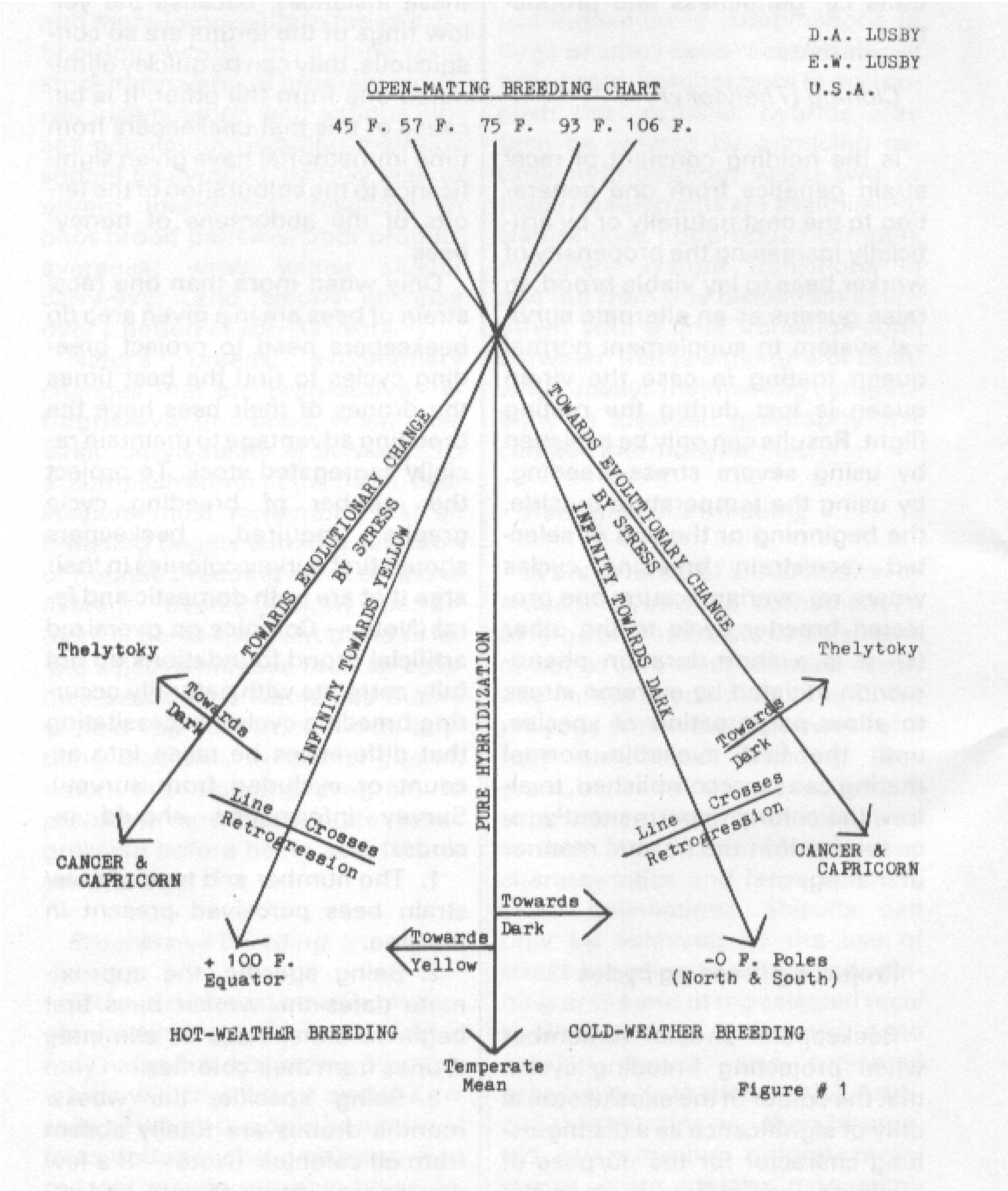

Figure 1

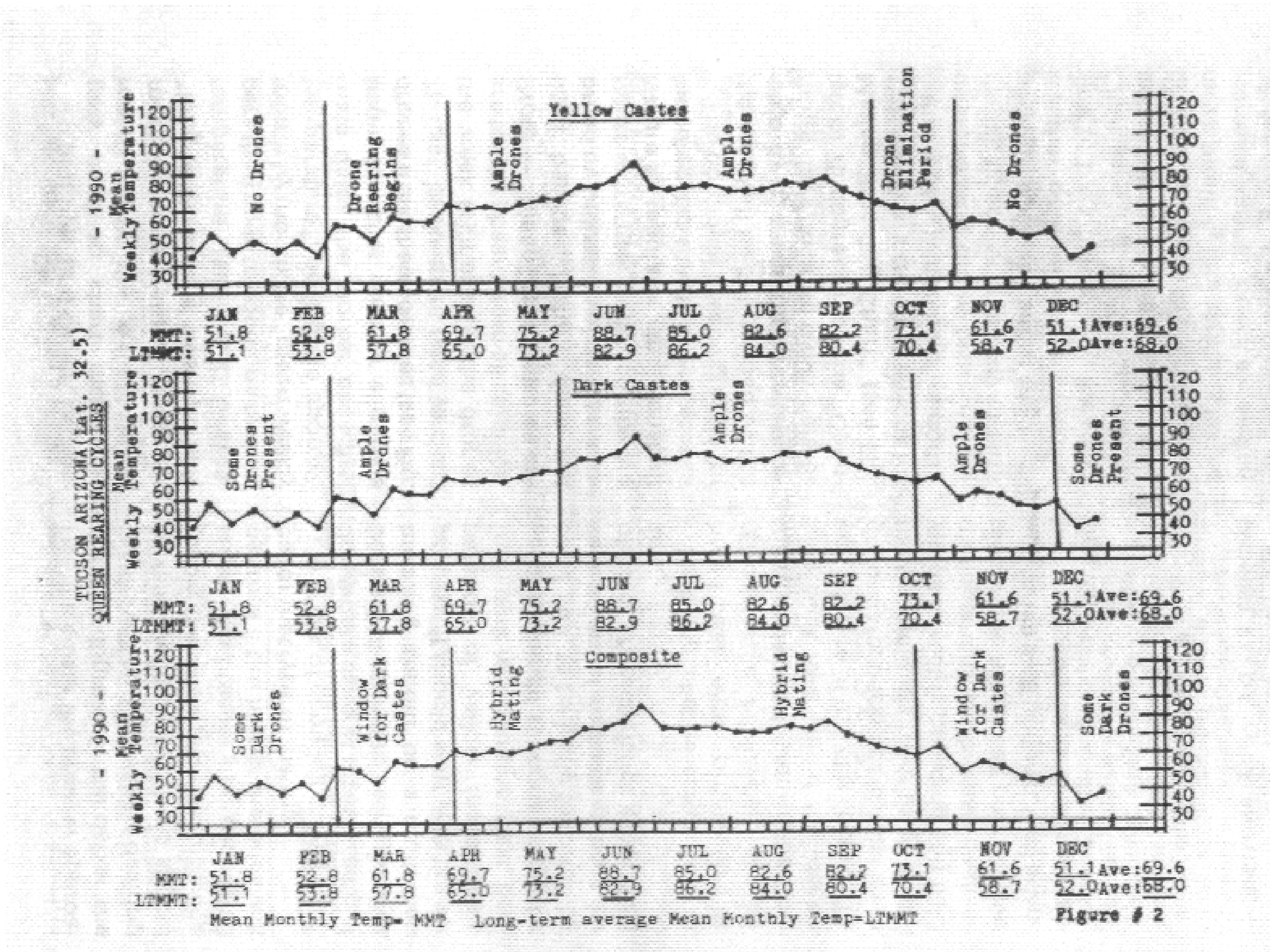

Figure 2

To plot breeding cycles, beekeepers need to chart month by month, both the actual “mean monthly temperature” and the “long term average mean monthly temperature” (see Fig. 2). Beekeepers then need to additionally chart month by month the “mean weekly temperature”, noting the approximate dates the worker bees first begin to either raise or eliminate drones from their colonies (see Fig. 2). Last, beekeepers need to chart the week (s)/months(s) the drones are totally absent from all colonies. (Note – “Mean” temperatures are used because Nature does not breed by utilization of daily temperature extremes. Honey combs are Nature’s regulator for constant breeding transition).

The dominate breeding cycle for the area will be determined by the majority of mean monthly temperature days favoring either right or left of 75 degrees F on the “Open-Mating Breeding Chart” (see Fig. 1). Beekeepers should then look for either open windows-of-opportunity showing drone breeding advantage, and/or majority-of-temperature dates, to either the cold-weather or hot-weather breeding side of the Open-mating Breeding Chart (see Fig. 1). Consequently, for raising dark bees, the closer the breeder can come to the maximum mean monthly temperature, for the warmest month never exceeding 75 degrees F, the better the results will advantage dark drones. Further, the closer the breeder approaches 57 degrees F, the darker the results will be. Beekeepers desiring to raise yellow caste bees should follow the same process, only, the closer the breeder approaches 93 degrees F the higher the odds will be for that type of mating.

In areas of complex mongrelization where several races/strains of bees are determined, retrogressive breeding should be a multi-step process. It should start with the separation of yellow races/strains from dark races/strains. Next, beekeepers should separate colour by caste size, to be lastly followed by separation of remaining bees by physical characteristics other than size.

By being able to select how to breed bees, either progressive or retrogressive, beekeepers can initiate methods to return beekeeping back to a sound foundation and a future in the 21st century. To go forward, beekeepers must learn they sometimes have to go backwards to rectify breeding and field management problems. Beekeeping in the future can only survive and thrive with uniform, well adapted, peaceable bees in our urbanizing world.

REFERENCES

SECHRIST, E.L., D.F. McFARLAND (1946) – *Scientific Beekeeping*, Earthmaster Publications, Roscoe, California, U.S.A.
RUTTNER, F. (1988) – Breeding Techniques and Selection for Breeding of the Honeybee, Published by the British Isles Bee Breeders Associations by arrangement with Ehrenwirth verlag, Munich
DEGRANDI-HOFFMAN, G., E.H. ERICKSON Jr., D. LUSBY, E. LUSBY (1991) – Thelytoky in a strain of U.S. honeybees, *Bee Science*, Vol No. 3, Pg. 166-171