Comb Honey III:
The Swarm Syndrome in Perspective
Part III of Three Parts[1]

By JOHN A. HOGG[2]

FOREWORD:

Dr. C.C. Miller, a noted comb honey producer and author at the turn of the century, wrote in his book FIFTY YEARS AMONG THE BEES[3] that -***"If I were to meet a man perfect in the entire science and art of beekeeping, and were allowed from him an answer to just one question, I would ask for the best and easiest way to prevent swarming."***

Nearly a century later, we now have several schemes in use by the beekeeping community that are effective in the prevention and/or intervention of swarms.

Still, the scientific community has not yet claimed discovery of all of the underlying mechanisms responsible for the swarm syndrome. Mark Winston in his book entitled THE BIOLOGY OF THE HONEY BEE[4], a comprehensive review and analysis of the state of the art in honey bee biology, predicts that ***"A full understanding of swarming should be within our grasp"*** and notes that ***"swarm prevention is probably the major management problem confronting beekeepers worldwide."***

There appears to be no lack of consensus in the scientific community that a reduction of queen substance (QS) distribution is a key factor on the critical path to swarming; but just how queen pheromone distribution is reduced and whether the reduction alone is the stimulus for queen cell construction are controversial.

It was G. Collin Butler et al[5a,5b], in a race with two other research teams[5c,5d] in the 1950s, who pioneered the discovery of the queen substance (isolation, identification and synthesis also) and its inhibiting influence on honey bee worker behavior and physiology. Butler was the first also to propose the ***breakdown in queen substance distribution*** as a "working hypothesis" to explain the cause of swarming.

It is the author's belief that the state of our knowledge, viewed holistically from the perspectives of both the scientific and beekeeping communities, following Butler's lead, integrated with other hypotheses and experience with the Juniper Hill plan for comb honey, makes it possible to reconstruct a model of the swarming process which explains how the reduction in queen pheromone distribution and the start of swarm cells, is brought about naturally; and to conclude that "congestion in the brood nest", a widely embraced theory is not *per se* that factor, a notion that is likely to be regarded as heresy in the scientific and beekeeping communities.

Such a model, expressed in the form of a thesis with corollaries to be argued, will be seen to make assumptions which would require (even inspire) further research, yet hopefully enable the beekeeping community to better interpret the signs and symptoms of the swarm syndrome and make better hive management decisions.

I. THE SWARM SYNDROME; EVOLUTION OF THE UNDERLYING THEORY.

The sense that a preponderance of young bees is somehow a key factor in triggering the swarm has been consistently expressed in the literature on swarming for more than a century. But theoretical explanations for just how a preponderance of young bees, and other factors, cause the swarm have varied and evolved over this time as experimental evidence brings us closer to a full understanding of the cause of swarming.

The evolution of theory can be seen in the various hypotheses, briefly stated as follows with commentary and in somewhat chronological order, each of which implies a key role for the house-age bee population.

A. Brood Food Hypothesis. F. Gersting (1891)[6] argued that a surplus of young nurse bees produce excess brood food, which in turn somehow stimulates queen cell construction; widely believed for a long period, this theory now appears to be essentially obsolete.

B. The Brood Nest Congestion Hypothesis. George S. Demuth (1921)[7], preceded by F. Huber (1792)[8], proposed that overcrowding of the brood nest by young bees and limited room for the queen to lay is the trigger for queen cell construction; this theory is widely embraced, at least as one of the factors underlying the swarm syndrome, while several "open brood nest" management schemes, designed to relieve this "congestion," are widely and successfully practiced.

The present thesis will argue that the reasons given for the success of "open brood nest" management methods is a myth, a correct remedy for the wrong reason; i.e. that it is not congestion *per se* which triggers the start of queen cells, even though increased bee density in brood frames may be observed prior to the swarm. Heresy?

C. House Age Bee Employment. L. E. Snelgrove[9], in his book SWARMING, ITS CONTROL AND PREVENTION (1934 revised 1955) implies that it is an imbalance between house-age bee work force vs. work load that is responsible for the swarm by the statement that ***"It is logical to conclude that if we can so manage our bees that the nurses, wax secretors and nectar invecters . . . are kept fully employed we shall have no swarms";*** whereas this is more a statement of strategy than hypothesis, it is a sound objective which highlights the role of supernumerary house-age bees and serves to focus attention on their "employment" in swarm control management.

D. The "Queen Pheromone Distribution" Hypothesis. G. Colin Butler[5a] in his book THE WORLD OF THE HONEYBEE (1954 revised 1962) proposed that the inhibiting influence of queen pheromone on workers, e.g. the inhibition of queen cell construction, is reduced by a breakdown in its normal distribution for reasons yet to be identified; widely embraced as at least one factor in the initiation of queen cell construction, there appears to be little follow-up research on how a breakdown of pheromone distribution is imposed. It has been shown that the production of pheromones by the queen is not reduced; and the argument has been made that congestion in the brood area *per se* interferes with distribution.

E. A "Multifactorial" Hypothesis. Mark Winston[4] in his book THE BIOLOGY OF THE HONEYBEE (1987), a remarkably thorough review and analysis of the state of the art, which includes reproductive colonization (swarming), summarizes a multifactorial hypothesis, first stated by Winston et al[10] in 1980, as follows: ***"Queen rearing coincides with a short "window" in time during which colony conditions are most favorable for swarm production, and most of these colony characteristics must be at or near their threshold levels for queen rearing to begin. The relationship between colony conditions and queen rearing can be summarized as follows: Queen rearing is initiated due to intrinsic (demographic) and extrinsic (resource abundance) factors inducing workers to begin rearing new queens at a time when conditions are favorable for swarm production. The primary stimuli, none of which would initiate queen rearing independently of others, include (1) colony size, (2) brood nest congestion, (3) worker age distribution, and (4) reduced transmission of queen substances. Resource abundance influences the first three factors and also may be a primary stimulus for queen rearing."***

These authors do not identify specific mechanisms for the reduction of queen pheromone distribution and/or the initiation of queen cell construction when these "thresholds" are reached, except possibly as direct stimuli. Note, however, that this hypothesis does embrace congestion in the brood nest as one of the factors.

Winston states (in part) that ***"Future areas of honeybee research will certainly include . . . manipulations designed to test a multifactorial origin for the initiation of queen rearing. With this approach, a full understanding of swarming should be within our grasp."***

It should be noted that the foregoing multifactorial hypothesis, an advance model, is based on well controlled experiments in unmanaged fixed-cavity hives to better simulate the natural (feral) condition, starting with new swarms on frames with starter foundation only. Conducted only in periods of nectar abundance, these were not over-wintered hives.

Because of the "fixed variable" experimental design, those "permutations and combinations" with other variables that could lead to reduced QS distribution and the start of queen cells, such as those experienced by the beekeeping community in managed colonies over-wintered in cold weather climates, would not be revealed.

Importantly, the swarm prone African bee was included in these experiments, showing that they swarm at a much smaller "active nest" size than European bees. It is possible that this is due to poor comb building habit.

Brother Adam[11], in his book entitled BREEDING THE HONEYBEE etc. on several occasions correlates the inclination to swarm with lack of comb building ability; e.g. with reference to some crosses made with Buckfast bees ***"(they) will manifest a fabulous comb building ability. They will draw out foundation to perfection and at superlative speed, which is an essential concomitant of outstanding honey gathering ability and an absence of swarming."*** From this one might predict that the African bee could be an outstanding extracted honey producer, yet be poor at comb honey production.

F. The "Replete" Hypothesis: Bernard Möbus (1987)[12]. In a scholarly perspective on the subject of swarming - unmatched in my view - introduced the concept that house-age bees, the receivers and processors of incoming nectar, become contingency living storage cells (repletes) whenever comb storage space becomes unavailable; thus engorged, such bees are functionally out of the loop of queen pheromone distribution *via* social food exchange (trophalaxis) - congregating at the fringes of brood or the top bars of supers and undergoing "physiological" changes which "preprogram" them to orchestrate the swarm.

Möbus also postulates that the replete role also accounts for the necessary honey engorgement when the swarm issues, citing the work of Coombs[13]; engorgement is uniformly distributed by trophalaxis in a natural way which happens to serve this further purpose, rather than by an act of "foresight".

In question may be the argument that "repletes" become the swarm bees because full stomachs "block the daily dose of pheromones", since queen pheromone when fed in 5-10% sugar solution has been shown not to inhibit ovarian development. It seems more likely that overall task oriented circulation as repletes has simply been greatly curtailed, limiting queen pheromone exchange to bodily contact, associated with food exchange activity until they become fully engorged and inactive, no longer accepting fresh loads of nectar.

The Möbus scenario appears to reject the brood nest congestion hypothesis, except to propose that tightly spaced brood combs may result in "poor ventilation" causing the bees to abscond i.e. not true reproductive swarming.

These two papers by Bernard Möbus (*ABJ*, April & May of 1986) present a stimulating and enlightening narrative on the subject of swarming well worth careful study.

II. A "UNIFIED" THESIS OF UNDERLYING THEORY

All of the foregoing hypotheses are relevant, but from different perspectives. Together they constitute a basis for a unified view which we will see requires more than one mechanism for bringing about a common condition, the isolation and idling of house-age bees.

Following is such a thesis, with corollaries, which will be seen to leave no place for congestion *per se* in the brood nest as a stimulus for queen cell construction or as the direct cause of reduced pheromone distribution. That single condition which replaces it is the isolation and idling of supernumerary house-age bees temporarily away from the queen and brood nest, brought about naturally in order to regulate the degree of congestion in the brood nest proper.

THESIS: ***Throughout the brood rearing and food storage phases of colony expansion, the principal factor which is responsible for the initiation and continuation of the sequence of events leading to the swarm is a breakdown in the distribution of queen pheromones; various seasonally unique environmental and demographic factors, and/or space limitations, impose imbalances in the house-age bee population vs. their work load, which in turn automatically segregate and idle a "supernumerary" population of house bees at the periphery of the active work zones, brood or honey combs, - out of the loop of normal queen pheromone distribution by task oriented bees circulating in and out of the brood nest.***

COROLLARY I. ***Two distinct natural mechanisms, alone or in combination, are responsible for the isolation and idling of supernumerary house-age bees - depending on whether the work load imbalance arises due to changes in the brood care zone or in the honey processing/storage zone.***

A. During the spring buildup when brood rearing is dominant, task imbalance arises when a virtual explosion in the house bee population outpaces the need for their brood care employment; such "supernumerary" house bees become segregated and idled automatically at the periphery of brood by natural mechanisms for the auto-regulation of the brood nest environment, thus maintaining an acceptable level of "congestion" inside the brood nest with respect to temperature, ventilation, etc.

B. During the honey flow(s) when food storage is dominant and house-age bees are fully employed in the periphery of the hive as nectar receivers, processors and comb builders, as well as in the brood nest, it is a nectar storage or comb building space limitation, real or perceived,

that idles such house bees. Already segregated on storage combs, away from the brood nest, house bees now with no options store nectar in their stomachs on a contingency basis as "repletes"; the task oriented circulation of both house bees and foragers distributing pheromones between the brood and storage areas is automatically reduced.

An appealing notion is that the replete role is a key factor in the evolutionary design of reproductive colonization, by giving replete storage automatic priority over new comb construction for that purpose. In fact, the building of new comb is tightly linked to the ongoing role of comb builders as temporary repletes (see Butler's account in Comb Honey II.[1b]); absent a place for comb construction or given self imposed limits to nest expansion (perceived limits), the repletes then become segregated and idled naturally as the only alternative.

C. Throughout the season similar imbalances in work load may be imposed by intermittent flows, or intermittency by periods of confinement due to inclement weather, to trigger the start of queen cells.

Intermittency in foraging, especially when due to inclement weather, translates to intermittency in the employment of house-age bees by idling and isolating active nectar processing, compounded by an increase in the number of unemployed house bees as they hatch during the break. G. H. Cale et al[14a], in THE HIVE AND THE HONEYBEE (1949 edition), in a discussion of swarming due to intermittency, point out that ***"to control its effect, a thin syrup may be fed to the colonies. This feeding has the effect of an uninterrupted flow, restoring the balance of the colony and tending to avoid swarming"*** - giving tacit support to the concept of work load imbalance as a causative factor.

COROLLARY 2.***In response to reduced queen pheromone inhibition, idled and displaced house-age bees initiate queen cell construction at the periphery of the active brood nest. The causal work load imbalance, in the absence of spontaneous or managed reversal, becomes enhanced auto-catalytically by negative feed back cues which regulate colony activity; "swarm fever", an innate colonization behavior imperative, develops when the number of Queen Substance liberated house-age bees, vs. inhibited house-age bees, reaches a critical mass and prevails in orchestrating the swarm. Only re-exposure of such bees to queen pheromones brings about a reversal of the swarm syndrome.***

It is helpful to view "swarm fever" as the manifestation of a temporary reassignment of female worker bees, a *feminine oligarchy*, to the reproductive role of colonization, which starts when liberated from the inhibiting influence of queen pheromone in a *"feminine monarkie,"* (as Charles Butler[15] called it in 1607) and ends upon re-exposure to these pheromones - naturally or as managed by the beekeeper.

The location of swarm cells on the fringes of brood seems to support the isolation concept. Möbus[12] notes that ***"there is nothing strategic about the location of swarm cells at the fringes, just as there is nothing strategic about the location of supersedure cells centrally."*** This is where such bees are located in each case, building cells for the same reason, reduced QS - although there appear to be other reasons for supersedure cells as well which have to do with the quality of the queen.

In particular, the foregoing is useful in helping to understand the spontaneous on/off nature of the appearance of swarm cells and to manage bees with the notion of QS exposure or re-exposure in mind as the ultimate strategy in swarm control.

COROLLARY 3.***The consummation of the swarm syndrome, the issue of the swarm per se, is conditional in two respects: 1) There must be a replacement gyne (virgin, cell or worker larvae) and 2) A honey flow. The absence of a replacement gyne will prevent the swarm; the absence of a honeyflow may only delay it.***

Proof for the requirement of a replacement gyne comes from the success of the Killion comb honey experience in which swarming has been controlled in thousands of colonies which had been forced to the swarming state and then prevented by the careful elimination of all swarm cells. (See Comb Honey I[1a]); literature reports of reproductive swarming in the absence of queen cells are most certainly instances where the presence of a queen cell was overlooked, or the colony was not hopelessly gyneless by virtue of the presence of worker larvae (or eggs).

Fig. 1. Swarm returning to a naturally swarmed hive with a clipped queen.

The author had the good fortune to exploit this fact opportunistically in a double story hive with clipped queen which had been managed for comb honey only by adding two Halfcomb supers which had become nearly full. During the July flow it swarmed out and returned (see Fig. 1). The clipped queen, found in the grass, was cage-stored elsewhere - nothing else for ten days, when each brood frame, free of bees, was carefully examined. All cells except one were removed, care being taken to look for those nearly obscure rudimentary cells sometimes found embedded in brood.

The result was a naturally swarmed hive without loss of bees, the "ideal" brood break and new young queen, which went on to produce a total of six well-filled supers of Halfcomb cassettes.

The perception that a honey flow is essential at the time of the swarm has strong empirically-derived support from the beekeeping community. The honey flow (nectar abundance) appears to play quite a different role at the beginning of the swarm syndrome (the start of queen cells) than at its consummation (the swarm). The latter role may be to signal the availability of an immediate food resource to assure that swarming will be successful by supplementing the honey provisions already stored up by engorgement. But at the outset of the swarm syndrome (see Corollary I-B), engorgement may have also served as a factor in the isolation and segregation from brood.

The seemingly paradoxical relationship of honey flows vs. swarming is nicely summed up by Butler[5a] commenting on the sense of many beekeepers on the case of intermittent nectar flows, ***"The sudden onset of a period of bad weather, during which the bees are confined to the hive, immediately after a period during which foraging has been good, often appears to be associated with swarming. At other times the reverse seems to be true, and colonies will start queen cells immediately when good foraging conditions return after a period of bad weather and confinement to the hive. But should the weather become poor again, they will tear the queen cells down. As we shall see presently; both of these apparently contradictory conditions, first confinement of the field bees to the hive by bad weather and, secondly a rapid increase in the quantity of food stored within the hive as a result of good foraging conditions, can result in over-crowding of the occupied, and immediately occupiable, combs in the hive and trigger off this swarming impulse."***

Again, overcrowding is invoked to explain the start of the "swarm impulse", but I prefer the implication of G. H. Cale[14a] that it is colony imbalance (work load vs work force) that is responsible. (See quote following Corollary IC.)

III. STRATEGIES FOR SWARM PREVENTION AND INTERVENTION IN RELATION TO THEORY:

The majority of procedures described for the prevention or intervention of swarming can be lumped into one of the following broad strategic categories:

A. Open Brood Nest Management. By way of defining "open brood nest management," according to Sechrist[16], "Honey Getting" *ABJ* 1944 pg. 60, the objective is to "***......maintain a brood nest of ample proportions with enough clear, usable worker cells to permit the queen to lay freely......***".

The three most commonly advocated "open brood nest" management procedures, excepting all forms of hive splitting or equalization which often accomplish the same end, are described below. It will be seen that additional comb space in each case is provided inside or close to the brood nest proper, accessible to the queen for laying and also to the bees for food storage. Most important, in accord with this "unified" theory, cluster space is restored inside or close to brood, canceling the need for displacement, or allowing displaced house-age bees to return and become re-exposed to QS (swarm intervention). The bees couldn't care less about the egg laying rate of the queen *per se*, but uninhibited egg laying helps to restore the brood care work load imbalance, or to prevent it in the first place (swarm prevention).

1. Reversal of Hive Bodies. When overwintered colonies in double brood chamber hives contain 5-6 frames of brood or more, typically located entirely, or nearly so in the top hive body as shown in Fig.2, the hive bodies are reversed (Fig. 3).

Prior to the reversal (Fig. 2), the normal thermally supported upward progression of the cluster is blocked; the expansion of brood sideways and downward is discouraged, especially in cold climates, where brood mortality is also common due to cluster contraction in severe freezes. Hence the brood care work load lags the production of new workers, displacing them to the periphery of brood (in accord with Corollary IB).

After reversal the queen and her court can expand upward into an "open" brood nest, thermally supported by the warmth from brood below and restoring the brood care work load, thus avoiding the isolation and idling of workers, or reversing such by enabling re-exposure to QS if it had already occurred. Additionally, accessible storage comb space for any surplus nectar that might arise from early flows is now provided, thus eliminating the possibility of forced "replete" storage. Vertical partitioning of brood is undesirable and can be avoided if the arrangement of Fig. 4 below is used.

2. "Decongestion" of Brood Nest with Empty Combs. The practice of inserting of

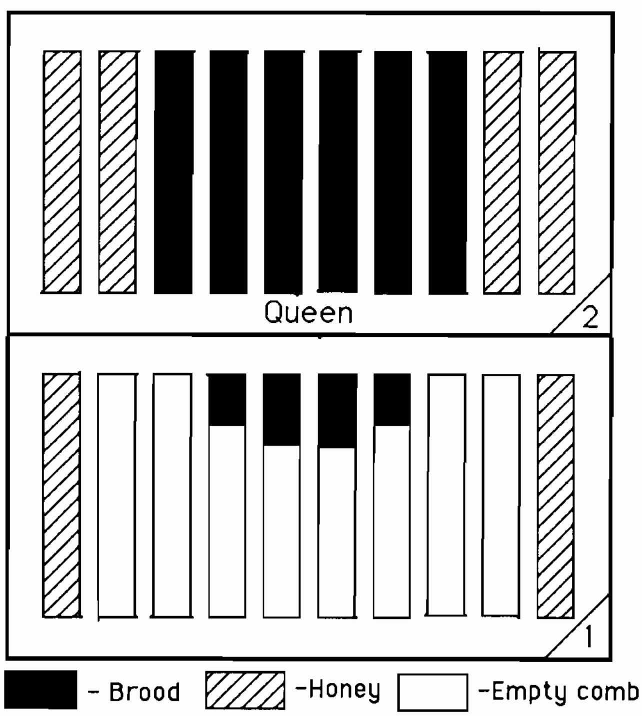

Fig. 2: Typical configuration of an overwintered colony in early spring.

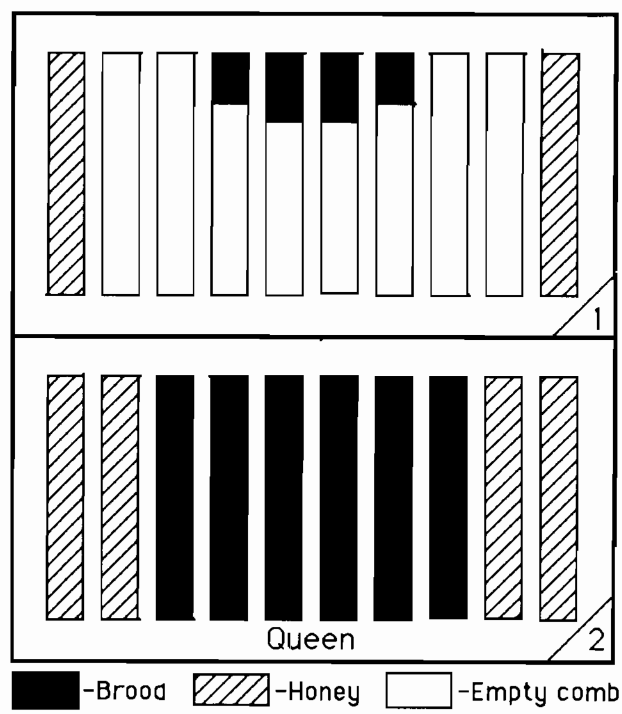

Fig. 3: Configuration of an overwintered colony after reversal of hive bodies.

frames of empty comb inside the brood nest proper takes several forms, ranging from the exchange of frames of brood for empty combs to the spreading of brood frames alternated with empty comb [illustrated below by the latter].

Such use of empty combs is highly effective, and viewed as only practical for swarm control before and up to the beginning of surplus honey production, after which supering becomes the name of the game.

The spreading of brood frames by alternating with empty combs is illustrated by Fig. 4, derived from Fig. 2 by rearrangement of only those frames already present - a distinct advantage.

Combs with foundation may be used instead of drawn comb after the flow starts, but in the absence of a flow this serves only to partition the brood horizontally - as would the use of two or more drawn combs together.

Now, as new brood hatches, cluster space interfacing with brood has been greatly expanded, canceling the need for nurse bee displacement to the periphery of brood; or, if already displaced, allowing cluster space for their return to interface with brood where they are re-exposed to QS.

The success of the Aspinwall hive as a "non-swarming" hive appears to be due to this same principle by virtue of interspersing the brood frames with cluster frames seen in Fig.5. According to E.R.Root[17] ABC-XYZ OF BEEKEEPING, 1935 edition, pg. 698, **"The author used several of these hives with colonies of Carniolans (excessive swarmers) in the production of comb honey. Not one of them swarmed after being put in these hives and what is more, produced over 100 pounds of comb honey each."**

B. OPEN FOOD STORAGE MANAGEMENT. The strategy of managing nectar storage space for swarm prevention, as well as in honey getting, may be given the broad title of Open Storage Space Management - another way of expressing the time honored strategy of swarm control by timely and adequate "supering" in a honey flow. But, since the use of comb at the interface for food or for brood is continuously competitive and shifting, the choice going to the bees; the beekeeper must think in terms of managing both an open brood nest and open storage space as interactive strategies.

It was the recognition that these two major in-hive work load categories, brood and food, are each dominant in its turn seasonally and therefore subject to different work load imbalances, that led to the formulation of two distinct mechanisms for reduced QS distribution, as proposed earlier in Corollary I, A & B.

Open storage space management for food as it relates to swarming is discussed here.

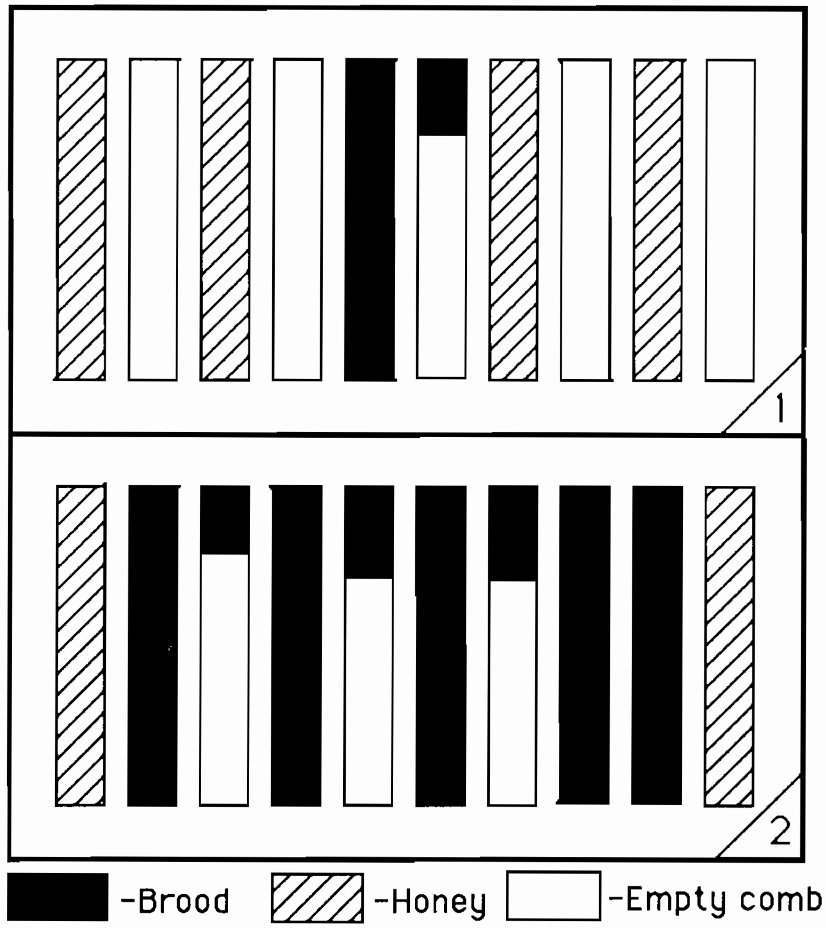

Fig. 4: Configuration of overwintered colony after "decongestion" by frame rearrangement.

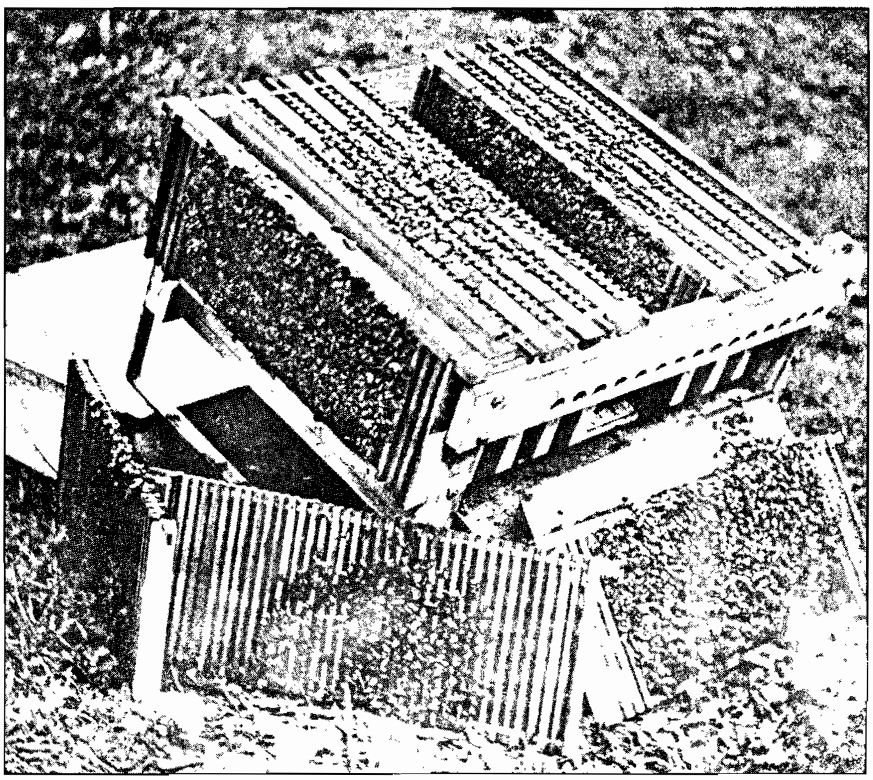

Fig. 5: Aspinwall hive with slatted dividers, to provide room between slats for the bees to cluster.

1. Supering: Basically "open storage space management" by supering is viewed as managing supers in such a way that no nectar storage space limit is perceived or reached, thus allowing house-age bees to keep fully employed in processing incoming nectar.

Please refer to the previous paper "Comb Honey II, Supering[1h]" where the subject of supering has already been discussed.

2. The DeMaree: The basic DeMaree, the separation of the queen from her brood by an excluder, is practiced with a variety of modifications for swarm control, differing largely in the number and location of extracting supers used, the presence or absence of swarm cells at the start, and the attention given (or not) to the inevitable supersedure cells in the queenless hive body the latter being influenced by distance from the queen. For example, a modification used by G.H.Cale[14h] THE HIVE AND THE HONEYBEE (1975) pg.380 is shown in Fig. 6.

Exception is taken here to the popular perception of the DeMaree as open brood nest management. Instead it is best explained as an example of open food storage space management.

Whereas the underlying principle of the DeMaree is generally seen to be relief of congestion in the brood nest, it is at the same time also viewed as the simulation of a swarmed hive without loss of bees, as noted by E.R. Root[18] in ABC/XYZ OF BEEKEEPING (1935): ***"In all of these plans it will be seen that the congestion of the brood-nest was relieved, (1) by putting the queen in new quarters where she would have plenty of room; (2) placing the emerging brood in the upper story away from the brood-nest proper, and (3) giving room for the flying or field bees to store their honey. With all the sealed brood upstairs, the emerging brood would gradually make room for the storage of honey. . . . This is exactly what takes place when a colony swarms, with this advantage: the parent colony and the swarm are together."***

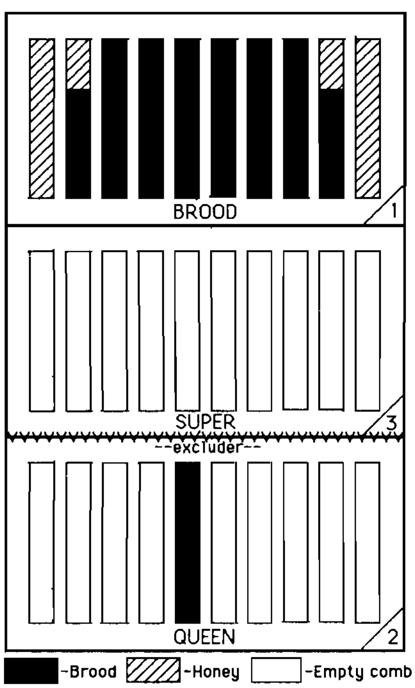

Fig. 6: A DeMaree'd hive for extract production at beginning of the swarm season (after Cale [14h]).

However, note the reference to the generous use of empty comb for nectar storage, (seen also Fig. 5) and the gradual provision of further storage cells vacated by emerging brood above.

It is the author's belief that the principal reason for the DeMaree's value in swarm prevention or intervention is due to such nectar storage space management. Conducted when the honey flows start, as generally recommended, synonymous with the swarming season, the full employment of house-age bees in processing and storing nectar is assured. The scenario of Corollary I-B is avoided; having access through the excluder, they circulate below into the relocated active brood nest (the "dance floor" of von Frisch) to receive nectar while foragers circulate above to recruit nectar processors etc. QS distribution is sustained.

In the absence of a honey flow, in accord with Corollary IA, it can be argued that in fact the DeMaree might induce swarming. The nurse bees would at first be segregated above to care for brood, away from the queen with little or no nectar processing duties, and then move down gradually over the next 8 days to care for the new brood when the brood above becomes sealed.

The new brood nest below is now consolidated on fewer frames; hence there is insufficient cluster space to accommodate the supernumerary population of continuously emerging young bees. They remain displaced and further idled by the lack of alternative employment as food handlers.

Experiences with the Juniper Hill plan in early 1997, when the expected flows were delayed or denied by record poor weather, have provided surprising evidence that a DeMareed hive in the absence of nectar intake may induce swarming. These unexpected results will be described below (Section IV) in context with the Juniper Hill plan, revisited.

C. Simulation of the Swarmed Hive Without Loss of Bees (Renewal). In its simplest form, this strategy is achieved by removing the queen and destroying all but one queen cell in 9-10 days (no later), or all cells if a virgin had already hatched from a swarm cell present at the start.

In about 2-3 weeks, after a brood break approximating that of a naturally swarmed hive, most brood has hatched and egg laying by the new queen is resumed; the renewed colony, still with all its bees, works with the vigor of a new swarm.

The peak of potentially "supernumerary" house bees down the road has been blunted, extending swarm control, at which time progeny from the new queen is more rapidly recruited for foraging, avoiding a foraging hiatus. Thus, a good balance in work load is achieved, allowing the comb honey producer to "crowd" the comb supers somewhat without inducing swarming; supers are thus better filled and finished before the next comb supers are added.

This strategy is dependent on the absolute certainty that all but one replacement gyne is eliminated to offset the issue of a swarm (Corollary 3) until re-exposure to the pheromones of the new queen occurs. Its swarm control value extends for at least 5-6 weeks from the start.

Note the Killion version of this strategy (see Comb Honey II[1h]) and also the opportunistic application of this strategy in a naturally swarmed out hive (Fig. 1) as mentioned following Corollary 2. The Juniper Hill plan also makes use of and benefits by the brood break, but conducted in an entirely different way.

IV. THE JUNIPER HILL PLAN AND THE SPECIAL CASE OF THE DEMAREE.

A "basic" DeMaree is the first step, stage 1 of the Juniper Hill plan, reproduced here in Fig.7. (from Fig. 4-II of "Comb Honey I[1a]", *ABJ*, Jan.1997).

The principal reason, beyond its swarm control value in a honey flow, for using the DeMaree on a temporary basis is to bring about a brood break in the brood containing hive body on top (Fig. 7), which is the honey-producing hive body to-be, while allowing the full force of field bees to forage unabated during the break. The honey flow is a required condition.

Two experiences with the Juniper Hill plan, as conducted here in the northeast in

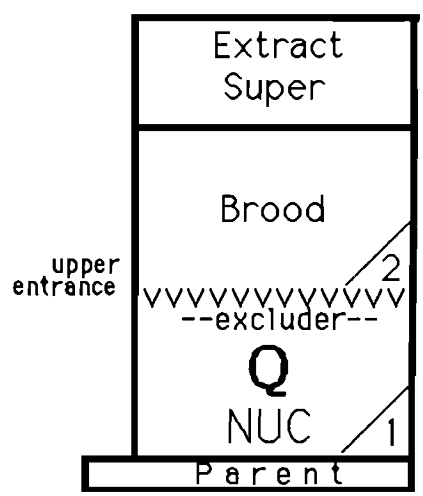

Fig. 7: Basic DeMaree of the Juniper Hill Plan.

April/May of 1997, where the early honey flows were unexpectedly delayed and/or cut off by record cold weather, have demonstrated in a striking way, by serendipity, that the DeMaree in the absence of a flow may fail to reverse and may even trigger the swarm syndrome in accord with the rationale already mentioned above (III.B-2).

In one of these experiences, involving two of the author's hives where swarm cells had been found and destroyed at the time of the DeMaree in May, queen cell cups containing eggs were found on the bottom bars of brood frames (Fig. 8) in the queenless top hive body at the time the colony was split following the 10 day break (phase 2 of the plan). The only explanation for this is that the bees transferred these eggs to the cups through the excluder; and that the swarm syndrome had not been reversed by the DeMaree.

The other experience involved 9 hives in New York State[19] in which the Juniper Hill plan was followed "exactly" through phase 1 (the DeMaree) on April 25 and phase 2 (the split) on May 5. This preceded the fruit bloom (circa May 4) on a nearby 250 acre apple orchard. When examined 11 days after the split (phase 2), during which time it was either raining or too cold for foraging, except for 4 or 5 days, queen cells were found on the bottom bars of all nine hives - some sealed.

Although this may not be a case of egg transfer by the bees through an excluder before the split, very likely the queen cell cups had been built then. In any event, apparently the swarm syndrome developed following the DeMaree since poor foraging conditions offered insufficient employment and even with "plenty of extra comb" house-age bee production outpaced brood expansion.

Fig. 8: Queen cell cups with eggs above the excluder of a DeMarree'd hive.

V. THE "SCREEN ALTERNATIVE" TO THE BASIC DEMAREE.

A modification of the DeMaree as used in the Juniper Hill plan, the use of a double screen instead of an excluder to conduct the brood break, (Fig. 9A) allows the option of an earlier start in the spring - i.e. after mid-April just before the dandelion peak.

This modification, which at the same time serves in lieu of other early season swarm control tactics, such as hive body reversals, is essentially equivalent to the first step in a plan for setting up a two-queen system developed in England by Ron Brown[20] - "A Simple Two-Queen System" (1980) which *"automatically acts as a swarm control method..."*

It is common about mid-April to find all of the cluster in an over-wintered double brood chamber hive upstairs on 6 to 8 frames of brood, with the bees on warm days busily cleaning out the near empty frames below. On such an occasion the screen set-up (Fig. 9A) is most easily accomplished simply by transferring the queen on a frame of brood, free of queen cells, down into #1, and then inserting the screen over an extracting super with the brood containing hive body on the very top.

Otherwise, the frames are rearranged manually to accomplish the same end. All bees on those broodless frames which are to go below (excepting the one with the queen) are shaken back into the brood containing hive body (#2).

The change to this screen modification is still compatible with stages 2 and 3 of the Juniper Hill plan, but imposes entirely different circumstances in phase 1.

Now blocked by the double screen, which has a small upper front opening, the older flying bees return to the lower hive body (#1) with the queen, while the younger "very low mean age" house bees remain above (#2) with the brood; the warmth below helps to avoid brood mortality above in the event of a freeze.

Emergency queen cells are at once constructed above in #2, or swarm cells may already be present. Either way, production of the second queen is under way in the top hive body, easily accessible for monitoring and/or any other manipulation; for instance, alternatively, a ripe queen cell from selected stock may be introduced after 3-4 days, or cells from a selected single hive, screen divided 3-4 days earlier, can become the cell donor for several screen-modified DeMarees. Being the first cell to hatch, the virgin will destroy all other emergency cells for you, and become the new hive queen (Q_N).

Another important difference in the overall plan is that the interval between stages 1 (the DeMaree) and 2 (the split), the brood break period, must now be longer, i.e. until a new queen is laying in the top (#2) hive body - about 3 weeks. Since comb honey production does not

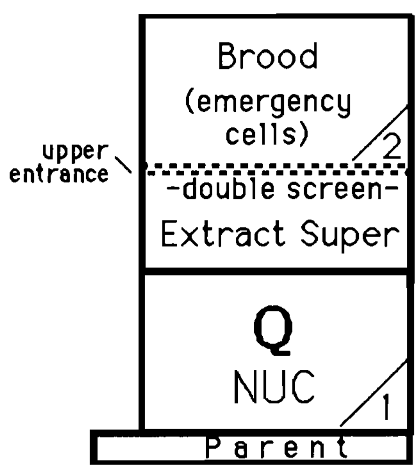

Fig. 9A: Screen modification of the basic DeMaree.

start until after the split (stage 2), assuming that the region will support comb honey production in first flows (fruit/locust etc.), the screen DeMaree should precede that time by about 3 weeks - whereas the excluder modification should not begin until such flows start.

At the time of the split, the flying bees again return to the parent stand (see Fig.9B) to join the new young queen and her bees in #2. Be sure that the old queen is not in the super, or use an excluder under it when in Fig.9A configuration to avoid this. In the unlikely event of the swarm syndrome developing below between phases 1 and 2, this would be reversed at the split because of the loss of flying bees, in accord with the discovery of Snelgrove[9] and of C.C.Miller[3] long before. The mean age of workers on the parent stand becomes sharply higher for some time.

One other important difference is that, following the 3 week +/- interval after stage 1 in the screen alternative, stage 2 (the split) may be by-passed. The screen is simply replaced by an excluder if a "consolidated" two-queen hive is elected for comb honey production, or just removed to unite the hive bodies which may remain two-queen for some time.

VI. CONCLUSION AND RECOMMENDATION

The prerequisite for producing quality comb honey consistently is a plan for building strong colonies in which the bees have been enabled to build comb freely, uninhibited by the influences of the swarm syndrome.

From the perspective of this three-part series, those plans which best accomplish this fall into two broad strategic categories, excepting some "opportunistic" options.

By the first strategy, comb honey is produced over single brood chamber hives which have been brought to strength as a double brood chamber hive via "open brood nest" management (Section IIIA) and then reduced to a single hive body, in the process of which a brood break of two weeks (+/-) is conducted with or without the rearing of a new young queen (Comb Honey I, Fig. 4, stages 1 & 2)[1a]. The full force of bees, disinclined now to swarm, is concentrated for comb honey production.

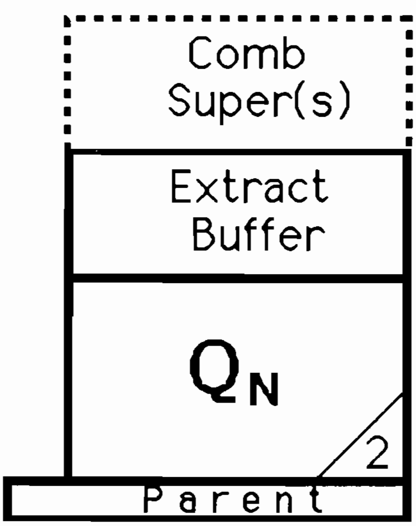

Fig. 9B: The new queen heads honey-producing stand after the split.

By the second strategy, comb honey is produced over double brood chamber hives with two (2) queens, established during a temporary division (screen or split) of a double-deep hive, and thereafter managed for swarm control during the flow(s) by "open nectar storage space" management (III B-1); two-queen hives are less prone to swarm.

In such hives, according to options in the Juniper Hill plan, the two queens either a) coexist, one in each hive body separated only by an excluder - The Consolidated Brood Nest Hive for Comb Honey[21]; (see also Comb Honey I, Fig. 4, phase 3)[1a] or b) overlap for some time in the absence of an excluder (Comb Honey I, Fig. 4, alt. phase 3).

Note: In the Juniper Hill plan these two strategic categories may be practiced consecutively to produce comb honey over a longer season; or the first option only may be initiated for a preferred main flow – reuniting the split for fall and/or winter. In both of these strategies one queen per Langstroth hive body is provided.

By one of the "opportunistic" options (e.g.), strong colonies managed for extra honey and observed to be free of the swarm syndrome by their obvious foraging zeal, are selected and exploited for interim comb honey production in "the heart of the flow" (see Comb Honey II, Part IIA 4)[1b].

In another quite different example, which relies on the principles of Corollary 3, colonies essentially unmanaged for swarm prevention which have swarmed out, but without loss of the bees (see Fig. 1) because the queen has been clipped, may be rescued for comb honey production, as described following Corollary 3. In fact, the clipping of queens is a rewarding practice because it is failsafe with respect to the loss of bees by swarming, except in the case of supersedure. By so doing, the beekeeper reserves the opportunity to intervene at any time between the start of queen cells until after a virgin hatches - a period of 9-10 days. If the swarm syndrome develops in early season, a better choice would be the screen alternative to the Juniper Hill plan (Section V).

The principles underlying the swarm syndrome, which have been restated and elaborated in this *"unified" thesis,* should hopefully enable the beekeeper to better plan and make decisions by rational design.

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