NECTAR MANAGEMENT

Principles and Practices

By

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FORWARD

This collection of new information is about Spring honeybee colony activities. The new information is later applied to hive Spring management by the beekeeper. The descriptions of colony activities are the product of several years of detailed observation. More than one hundred colonies were monitored in the early season. The monitoring was accomplished in the early years of trachea mite infestation in Middle Tennessee. The intent of the detailed inspections was to learn more about the internal workings of the hive. Knowledge of the colony goals would presumably assist the beekeeper in helping the colony survive T-mite infestation.

Since T-mite effects take their toll in late Winter to early Spring, inspections were concentrated in that period. Periodic mild days permit hive opening through that period locally. Prior to the T-mite, there was little reason to inspect in detail during that time of year. Inspections were limited to a quick look to check cluster size and location. Any early manipulation was based on that data. The T-mite caused inspections to be moved forward on the calendar.

What was observed in colony operations was often in conflict with descriptions found in the popular literature. The variance between observed colony behavior and what was expected, based on the literature, provided the novice beekeeper with a dilemma: Was the literature incorrect, were the differences a result of T-mite effects, or were the differences a product of his inexperience?

Over a three-year period, a hypothesis was generated which differed substantially from the literature. The hypothesis parts fit together well and some nebulous areas of the literature were explained. It was concluded that literature descriptions were not wrong, but they did not start early enough in the season. Literature descriptions are accurate after the swarming season. Two reasons are offered for this condition: 1) Pre-mite access to colonies was limited in the frosty morning period prior to the swarm season, and 2) The indications seen in an observation hive are not representative of activities in the over wintered colony.

Testing of the swarm prevention aspects of the hypothesis started in the 1996 Spring season. The swarm prevention approach was surprisingly effective. An unexpected side effect was increased honey production. The following few seasons were dedicated to learning the significant elements of honey production. Again, the literature was found to be inadequate. Although population of the colony was recognized as an important factor, there were almost no guidelines on how to increase colony populations. In addition, most recommended swarm prevention techniques actually reduce colony strength.

The recommended swarm prevention technique of this book increases colony strength. The simple, early-season, one-step manipulation promotes both beekeeper objectives. The manipulation accomplishes this by changing the colony motivation from swarm ambition to nectar storage. "Experts" and experienced beekeepers are not likely to give the concepts of this book serious consideration. If they really believe the conventional wisdom of the literature, they will be difficult to persuade. However, skepticism, ridicule, or abject rejection will not prevent the truth from prevailing, indefinitely.

CHAPTER 1

HOW THE WILD BEES DO IT

INTRODUCTION

This small book is prepared to present the observations and deductions of the writer. The information is not found in other bee books. Most bee books are written from the standpoint of the beekeeper's perspective. Those books describe ways and means for the beekeeper to impose his will on the colony or disrupt the colony's normal operation for his convenience. As an example of this approach to beekeeping, consider the queen excluder. The name of this device proclaims that its purpose is to control the bee colony in an unnatural way. It is used strictly for the beekeeper's convenience. This type of control attitude pervades all aspects of beekeeping from maintaining an adequate queen to storing Winter rations. The wild honeybee colony takes care of those operational, survival considerations without help. They do an excellent job of it, when they do not have to contend with a meddling beekeeper.

The concepts presented in the following chapters are available for all to see. Any beekeeper who takes the time to observe what is happening in the bee colony can confirm that these concepts are valid. All colonies in a given bee yard perform the same functions at approximately the same time. Their survival strategy is synchronized to the vegetative growing season and their reading of the advancing season is remarkably consistent from colony to colony.

If the reader wishes to confirm the concepts presented herein, he can monitor for colony indications the writer sees every year. The reader (you) will have the advantage of knowing what to look for, and when, because this text is going to provide you with timing references. The indications require some interpretation. The major indicators of colony "activity of the week" are broodnest growth or reduction, storage patterns of nectar and pollen, forager gathering priorities, and collective worker priorities. Contrary to what the literature would lead you to believe, the colony does not eagerly forage just because a source is available. They use the sources that support their needs at the time, and their needs change with the season advancement.

That brings us to an introduction to changes in colony internal operations as the season advances. There is no question that Spring and Fall operations are different. In the Spring the brood nest is being expanded to increase population. In the Fall, the brood nest is gradually made smaller to the point of total shut-down. These changes reflect the colony changes in objectives for long-term survival.

Between the major internal operational changes at both ends of the growing season, there are several more subtle changes. Several are associated with the swarming season. You will not find those operational changes explained in the popular literature. In this book, an effort will be made to explain the bees' objectives and means of accomplishment for the Spring season. If you can concede that the literature could be weak in this area, you are on your way to a better understanding of the bee colony.

Based on what we see happening in a colony of feral bees, we do not believe that congestion is the cause of reproductive swarming. This small book is oriented toward rebuttal of that popular notion. To make a case for the rebuttal, the stage must be set by offering some background not generally found in the reference literature. Although this book is basically about reproductive swarming, new conclusions based on observation are included. Those new conclusions describe colony internal Spring operations that affect swarm timing. Later chapters provide a swarm prevention approach that has a side effect of producing better honey yields.

SWARM MOTIVATION

All swarms are not reproductive swarms. The reproductive swarm is early and seasonal. Overcrowding swarms occur later and are motivated by colony survival. The reference literature makes no distinction between the two, and therein lays the problem. It's OK to mix apples and oranges in a fruit basket, but when describing the fruit, each must be described separately.

The primary motivation of the over-wintered colony is to produce the reproductive swarm. They have developed unique internal operations to support this objective. Internal operations are different during the early build-up from any other time in the season. The unique operations will be described in Chapter 3.

The wild bee generally does not over-populate. Overpopulation can be traced directly to management practices of the beekeeper, or the queen breeder from whom he purchased stock, or a combination of the two. The beekeeper distorts their perception of the season by "stimulative feeding" or cancels out their natural population control by hive body reversal. The queen breeder selects for honey production. Production of honey is a direct function of colony population, and the queen breeder is selecting for queens with the genetics that overpopulate. After a few generations of such selection, he is selling stock that does not play by the rules of their ancestors.

The wild bee is the product of natural selection. They inherently control population in accordance with their cavity overall volume. Brood volume (population) is continually adjusted in consonance with stores volume to maintain a population that is in balance with stores available. We have named that concept the "Theory of Equilibrium". That's just a fancy word for variables in balance. The bee colony must allocate cells for brood, current usage liquid feed and pollen, and long-term honey and pollen storage. The allocation of cells must keep population in proportion to supplies. Although there is some tolerance for error in their system, maintaining equilibrium requires continual cell allocation adjustment. They have spent eons perfecting their system, and those that get it right are the most likely to reproduce.

Maintaining population in balance with stores and space is just one of the colony management problems. The literature tells us that the honeybee is a social insect but does not point out how that complicates their existence. More on this subject when the swarm process is discussed.

SURVIVAL IS THE PRIMARY MOTIVATION

Virtually everything the wild bees do as a colony is done is in the interest of survival. Their normal operations are tailored to both types of survival. Survival of the existing colony takes priority. Survival of the species runs a close second. Generation of a reproductive swarm is the objective of every over-wintered colony. However, generation of the reproductive swarm will not jeopardize survival of the existing colony. There is always next year, if survival of the existing colony is protected. The bees have built in controls in the process to insure colony survival. Only the colony that can afford it, in any given year, will produce a reproductive swarm.

EUROPEAN HONEYBEE IS A FOREST CREATURE

Even non-beekeepers are familiar with their favorite nest site. There are abundant hollow trees in any established forest. The bees can do very well in an area where there is a solid canopy of treetops within their flight range. There may be very little undergrowth and almost no low-growing forage sources in the area. This means that they must meet survival requirements, and reproduce, on the trees themselves. Some trees bloom before leaf-out, and some well after. The peak of forage availability in the forest is that period of general green-up. We might remind the reader that these bees established their survival requirements a long time before man cleared large areas of trees for his purposes.

Both the bees and trees derive benefits from the relationship. The trees are harboring their specialized pollinators. Trees need pollination early in the Spring. Most other insects have not come out of Winter hibernation at the trail-off of frosty mornings. The honeybee's survival format has them building strength for reproductive swarming in late Winter. At general woods green-up, the divided colony has peak demand for available forage. The honeybee provides excellent pollination capability during the period of peak tree need.

To wrap up the background information, the writer admits to backing into some of the foregoing conclusions. The literature does not make these seasonal associations. When we thought we had a handle on what is happening in the beehive in the spring, it became apparent how well suited the colony operations are to forest survival.

As I write this, pre-dawn, 5 April 2K, my wild bees have abandoned swarm ambition in favor of colony survival. Apples are blooming early because of the mild spring. Some trees are new green, but general green-up has just started. Oaks are not hoodwinked by unseasonably warm weather. The bee's seasonal development timeline has moved forward on the calendar about a week. The temperature is forecast to go down to 30 tonight. They have given up on reproductive swarming, and we are not yet out of the frosty morning period.

With a little practice any beekeeper can learn to read colony development in the hive as the season progresses. Note that the El Nino mild Spring has the bees schedule moved forward. This would seem to indicate that the bees react to forage availability, or possibly average temperature. It would also seem to weaken theories that predictability of actions is associated with "day length". The sun didn't change position this year.

We apologize for writing in terms of volume. The writer is just another beekeeper, and is not staffed to mark and count bees. Volume is something we can see, and brood volume is proportional to population. So, two hive bodies of brood volume are equivalent to a strong population. We have no feel for the actual bee count in thousands.

We should also warn the reader that the tone and language change through the course of this book. The early chapters describe the activities and effects of beehives managed by general literature techniques. Those observations can be confirmed by the reader, regardless of his hive configuration or geographic location. We do not believe that the honey bee changes its basic survival strategy in different locations. But the specific observations are restricted to beekeeping in northern Alabama and Middle Tennessee.

Later in the text, we describe hive activities that are unique to a specific management approach. Chapter 8 provides a hypothesis for why the hive activities are different when managed that way.

CHAPTER 2

THE SWARM GAME PLAN

The main purpose of this book is to propose a colony management system for the Spring season. The recommendations affect swarm prevention and honey production. This chapter will describe elements of the over-wintered colony's effort to produce the reproductive swarm. First, a few words on timing: Some animals nurture their young with intense care until the young are self-sufficient. The honeybee's system does not permit that. The offspring swarm leaves, and after leaving the parent colony, they are on their own. There are a few things that the parent colony can do to improve the odds of offspring survival. Of importance is maximizing population of the swarm and getting them out the door with ample forage availability remaining.

To have a chance at survival, the offspring swarm must have several weeks of forage availability. This can be seen in the swarm season timing in Tennessee. The swarm issue season here is just before, and into, general woods green-up. Since the swarm preparation period leads issue, they must start preparing to swarm while wintry weather prevails. It's not an accident that the reproductive swarm issue period is the optimum timing to assist the swarm in its goal of establishment in a new location. The danger of a killing freeze has lessened and the full spring forage availability period lies ahead. The optimum timing for swarm release would be on the last frost of Spring. This normally occurs locally in the two-week period of apple blooms. General hardwood green-up starts about midway of apple blossom. The bees system of preparation for the offspring swarm is fairly complicated. Considering the details involved, it is remarkable that they come as close to optimum timing as they do. Local dates will show up on figures in later chapters.

It is important from a management standpoint to know when the target swarm issue period is. But it is probably more important to know about the swarm ambition cancellation date. About mid apple blossom, or prime swarm issue time, the colony that has not started swarm cells cancels swarm ambition. It's as if they realized that a swarm generated later would not have time to become established in a new location. Details of the reproductive swarm cut-off timing will be provided in Chapter 3. But for now it will be enough to note that the over-wintered colony has an intense interest in that period.

It should also be noted that overcrowding swarms generated later in the forage availability period, are expendable. The colony with a population that is out of proportion to available storage space can thin their ranks to protect colony survival. Colony survival has priority.

One other general observation that will be expanded in the next chapter is that the early build-up is dedicated to reproductive swarming. From Winter brood rearing to hardwood green-up, all colony activities are oriented to generating the reproductive swarm. The swarm game plan is divided into two parts. In this chapter the steps, or requirements, to swarm commit are described. Chapter 3 will describe the colony operations that are tailored to that objective.

In case you have nodded off with the above lead-in overkill, a little jolt may be appropriate. Our wild bees have demonstrated that the true stimulus for swarm preparation is the limiting of brood nest expansion. <u>The colony that is expanding the brood nest volume does not swarm.</u>

SELF IMPOSED LIMIT

The over-wintered colony expands the brood volume during the build-up by consumption of honey. During this period the colony trades stored honey for population to produce the reproductive swarm. They do not consume all the stored honey. They save some. To use all the honey in this effort would put the colony at risk of starvation in the event of an extended period of non-flying weather or nectar dearth. Weather in late winter is unpredictable. Colony survival dictates that they maintain the safety reserve of honey/nectar through the swarming season. Although the amount of safety reserve varies from colony to colony, it is roughly equivalent to a shallow super of honey. It is interesting that the amount is similar for different sized hives. Both the story and a half and the two and one-half story leave the top shallow super of honey unopened, if field forage is available. However, it is a reserve. They will dip into this reserve if needed.

When the colony has expanded the brood nest to the amount of reserve that they consider appropriate, they have increased population to the safety limit. They are now able to move into the swarm preparation phase.

Expanding brood volume to the safety limit is the first step in the swarm process. It can be seen that weaker colonies do not reach this limit and do not entertain swarm ambition. (Colony survival has priority.) Brood nest expansion does not stop until this self-imposed limit is reached. Actually reaching the limit, and stopping expansion can be viewed as initiating swarm preparation. It is not fair to call it the "cause" of swarming, but it would be fairly accurate to call it the swarm stimulus. The actual cause is the colony motivation to reproduce.

When the colony has expanded the brood nest to the maximum safe volume limit, they are not ready to start swarm queen cells yet. Imagine what would happen if half the workers of all ages left at that point. Half the bees left by the departing swarm would be hard pressed to support this brood volume by an immediate shortage of nurse bees and foragers. There might not be sufficient population to maintain brood nest temperature for that volume. We are still in the frosty morning period of early spring. When space is available overhead, the cluster volume is typically about half again the size of the brood volume, or 150%. If half those bees went away with a swarm, and distribution was similar, only 75% of the brood volume would be protected on a cold night.

These things are not a problem for the swarmed parent colony. First they must prepare the parent colony for a personnel shortage. The first activity of swarm preparation is to reduce the brood volume by providing additional stores. As brood emerges, selected cells are filled with nectar or pollen. We refer to this activity as "backfilling". This term is borrowed from construction jargon. When an in-ground pipe is installed in a trench, the dirt is backfilled to return the area to normalcy. In the brood nest, the honey is consumed in brood nest expansion, the cells used temporarily for brood rearing, and then upper level cells are backfilled with nectar or pollen. In this way brood nest size is reduced from the top down.

We apologize for using a term that is not used in general bee literature. The bees use this process for brood nest reduction several times during the season. There doesn't seem to be a descriptive term for the process in the literature. If the reader doesn't like the word "backfilling" he can describe the process of placing nectar in cells as brood emerges to reduce the brood nest size.

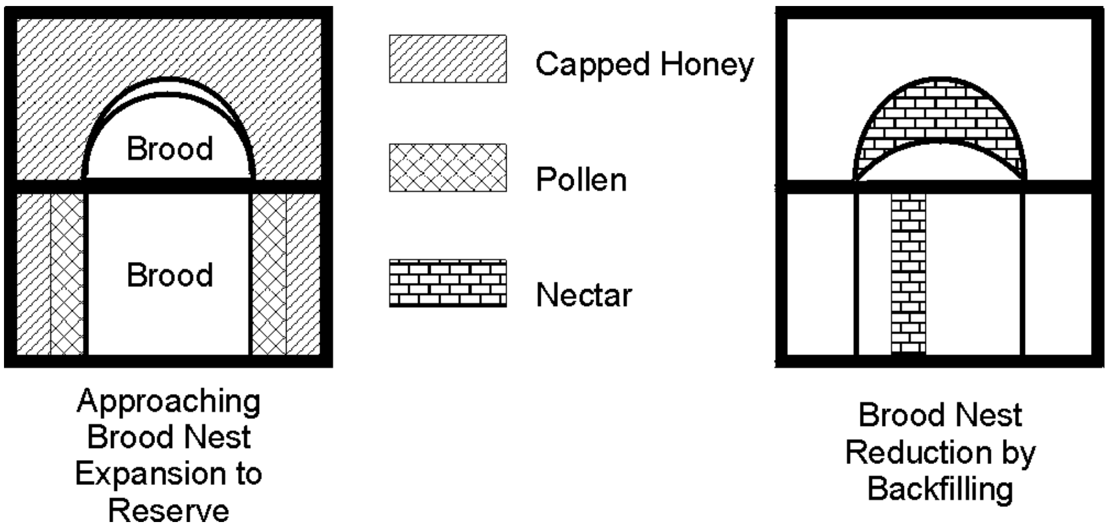

Figure 1: Backfilling

The backfilling sketch above shows the ultra-conservative colony that saves more than normal reserve. The less conservative colony may have brood to the top bars in the center of the expansion dome. Their reserve includes the outside shoulders of the dome and outside frames of the lower hive body.

The full frame of the backfilled brood comb in the lower brood chamber is the result of adding a frame of brood periodically during the late winter lateral brood nest expansion. Lateral, frame to frame, expansion in late winter is discussed later in the text.

The appearance of nectar in the brood nest area is sometimes called congestion. It's a second kind of congestion - the first type being adult bee crowding.

We may as well have our say on the congestion thing at this point. We do not see how either type of congestion could <u>cause</u> reproductive swarming. The build-up process does not create an intolerable level of adult bee crowding. Although increasing population is the objective of this period, it is a controlled process. A limited number of bees can be generated from a specific volume of honey. Wild bees do not generally develop enough population during the period to hinder internal operations of the colony. The first activity of swarm preparations (backfilling) progresses smoothly. Additionally, there is no clustering of bees on the outside. Overcrowding is ruled out on the above, and nectar congestion has been identified as the first activity of swarm preparation. So it could not be the "cause".

We do not contest the occurrence of overcrowding swarms, but they are not generated in the period of frosty mornings when the successful reproductive swarm process is set in motion. The scientists have measured the density of bees that triggers an overcrowding swarm at 2.3 bees per cubic centimeter. In more familiar terms, at two and a half centimeters per inch, that's about 36 bees per cubic inch. That's almost the point of immobilizing workers. The wild bee colony left alone to do it their way is not likely to reach that bee density.

Back to a description of backfilling: It starts in the upper dome of the brood nest, and grows downward. Some advantages to the parent colony survival and the mission of producing a swarm are offered for your consideration:

a. Contraction of the brood nest has already been mentioned. It seems appropriate to reduce the brood volume to a level that can be managed by half the work force after swarm departure.
b. Replenish stores: A substantial amount of honey was consumed in the build-up process. Replacement of stores eases the strain on the swarmed parent colony. They need to make it on a reduced work force and an overload of drones. The colony will continue to cycle drone cells through the mating season. The big-eyed boys have hearty appetites. It sometimes seems that half the residents of the swarmed parent colony are drones.

   It should also be noted that the capped honey reserve at the top is sacred at this point in the season. It's still being saved for a need later in the season timeline. We'll get to that in Chapters 3 and 4.
c. Open Cell Reservoir: The backfilling process creates an expanse of open cell liquid feed. This serves at least two important functions in swarm preparations. A large number of wax makers are required in establishment of the swarm in a new location. Generation of comb is the top priority of establishment. Large numbers of bees tank up for wax making well before swarm departure. Secondly, bees leaving with the swarm will fill up prior to leaving to

sustain the swarm until comb can be built at the new location. The open cell reservoir supports both these requirements.

d. Reduce Queen Laying: To leave with the swarm the existing queen must trim down to be flight-worthy. Egg laying requirements must be reduced to accomplish this. In the early backfilling period, it's important to cycle brood in the bulk of the brood nest. They are still building population to support division by the swarm. However, at some point in the process, it is necessary to almost completely shut down queen laying. They sometimes accomplish this by backfilling whole brood frames in the basic brood nest.

There may be other advantages of backfilling that do not come to mind. Evidence of sufficient nectar availability to accomplish this preliminary requirement may be a factor in committing to swarm. Ample nectar availability may be the criteria for starting swarm cells. To issue a swarm in a nectar dearth is to guarantee its failure. Whatever the stimulus, at some point in the backfilling process, swarm cells are started.

Generation of swarm cells comes in stages, also. First the proliferation of cup bases, then forming of cups, and finally, starting of queen replacements in the primary and secondary cups. We consider the colony committed to swarm when eggs are placed in cups. If they run out of calendar time (Chapter 3) at any point in the process, they can abandon swarm ambition up to swarm commitment. They can easily recover from any stage of the backfilling operations or swarm cup generation.

The swarmed parent colony has an easy job of returning to wintering status. They only have to reduce the brood volume a bit more, and cure and cap the nectar already provided. They can do this handily even with the drone burden on resources. They find themselves in this condition at the peak of forage availability.

In summary, at no time in the swarm preparation process, has the existing colony survival been jeopardized. The swarm game plan is well orchestrated to prevent this.

The next chapter will present the early season Tennessee timeline and a not-so-brief description of internal colony operational considerations for the build-up to swarm period.

CHAPTER 3

BUILD UP TO SWARM

In this chapter the over-wintered colony activities in the early season will be described. It was noted in Chapter 2 that the early season is dedicated to the species survival activities of generation of the reproductive swarm. There was also a reference to the "early season" ending in the period of apple blossom and hardwood green-up or leaf-out in the early Spring. Because that period causes a significant effect on activities in the beehive, it provides a natural breakpoint in this text.

Figure 2 included below shows some of the changes associated with the apple blossom period. The vertical, bold, black line represents colony decision time at this location. Prior to the decision, the colony is dedicated to producing a reproductive swarm. At hardwood green-up, the colony abandons swarm ambition. Any colony that has not populated swarm cells, decides it's too late and turns its attention to colony survival.

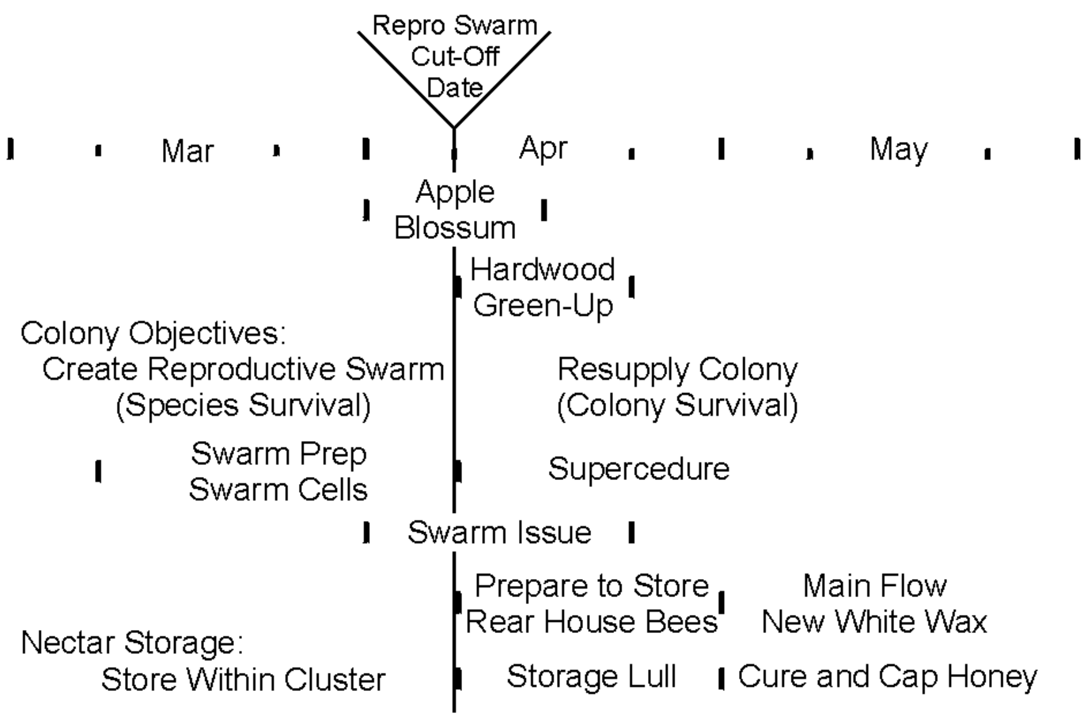

Figure 2: Changes at Reproductive Swarm Cut-Off

We call this decision time the "Reproductive swarm cut-off date" (Repro c/o).

At Repro $^{c}/_{o}$ the decision to change directions is sudden and final. It does not matter how close the colony is to committing to swarm by starting swarm cells. They may have started adding additional bases for swarm cells indicating they are close to putting an egg in the primary cup. But when the consensus endorses Repro $^{c}/_{o}$, the judgment does not make allowances for almost there. What were swarm cups yesterday can be used for supersedure tomorrow. The experts have had a problem describing the difference between swarm and supersedure cells. Some experts will invoke an aura of the unknown and hint of some association between swarm and supersedure. The association is only that the same cups can be used for either of the two. If it's too late to foster a reproduction swarm, the cups can be used for supersedure. When the experts, who write about such things, recognize the suddenness of Repro $^{c}/_{o}$, the fuzziness will clear up some. When supersedure occurs close on the heels of Repro $^{c}/_{o}$, there is no difference in appearance because the cups are physically the same cups. Generally, less cups will be used for supersedure.

Swarm issue spans the decision line. The colony that has committed to swarm by starting swarm cells continues to work toward swarm issue. That colony will prepare to store Winter rations in parallel with swarm issue.

In Chapters 1 and 2, you were told that internal colony operations change with colony objectives as the season unfolds. Chapters 3 and 4 will describe some of those changes as seen in Tennessee. A time line of the changes for this area is plotted against the calendar. Instruction for application of the time line for other areas is included in Chapter 4.

"Internal operations" as used in the following discussion refers to colony activities to accomplish the current objectives. Although the changes in objectives are not described in the popular literature, the colony objectives change with the season several times in each year.

These generalizations are effects of the European honeybee's survival plan. We have mentioned the social insect lifestyle chosen by the honeybee imposes some control requirements on the functional colony. They must maintain a balance between stores and population at all times of the year. Regulating population requires continual adjustment of brood nest size. The steps to generation of a reproductive swarm have controls built in to protect survival of the existing colony. Those controls were identified in Chapter 2. Although the primary focus of this period is population increase, the colony "makes haste slowly". In the case of generating a reproductive swarm, the normal equilibrium is deliberately pushed out of balance in the direction of excess population. The whole purpose of build-up is to split the population with the swarm. But during the final stages of the out-of-balance condition they are protecting colony survival by back-filling the broodnest.

Internal colony operations are unique up to Repro $^{c}/_{o}$. To generate a reproductive swarm, activities in the hive are tailored to those actions which provide the most efficient way to get it done, safely. As noted in Chapter 2, existing colony survival must be protected while working toward the main objective.

The route to generation of a reproductive swarm includes creating a sufficient population of bees to staff two viable colonies. And it must be done early enough in the forage availability season for the offspring swarm to have a chance at establishment in a new location. The swarm will be starting from scratch, and needs a period of weeks to have a chance.

To accomplish the objective, within the severe timing requirements above, the honeybee has developed an approach that has been overlooked by the experts. Internal operations for this period (build-up) are different from operations for the remainder of the season. They have trimmed all unnecessary activities from the resource budget in the interest of efficiency. Non-essential activities, such as wax making, are not accomplished during this period.

Only those activities that support the objective are staffed during the build-up to swarm period. Since the increase in population to support swarming is the primary thrust of the period, activities are limited to those that support that goal. Primary emphasis is placed on brood rearing and increasing the size of the brood nest. Foragers are required to provide pollen for brood feed and water/nectar to thin stored honey to feed consistency. If water is readily available, very little nectar is gathered. It's in their best interest to use water to thin stored honey because it is consumed faster – freeing up cells for brood rearing at a faster rate. The difference is in the food value added by nectar. Brood nest expansion requires honey consumption by the brood and total population.

The early season build-up can be viewed as the period dedicated to species survival. Since swarming is the reproduction method, activities relating to that effort are those that insure perpetuation of the species. At some point in the season, survival of the existing colony takes priority over species survival. The colony must abandon swarm ambition and gear up to store survival rations.

Repro c/o is the change from species survival to colony survival. This causes an abrupt change in the internal operations. All colonies in the same location change objectives within a few days of each other. The change occurs quite early in the season, and locally occurs prior to general hardwood green-up. We do not know what the bees use to cue the change, but whatever it is, all colonies read the cue fairly uniformly.

Because the colony internal operations change significantly at the reproductive swarm cut-off date, the description of internal operations is broken into two parts. Here in Chapter 3, those activities up to the cut-off date will be described. Chapter 4 will treat activities oriented to colony survival after the cut-off.

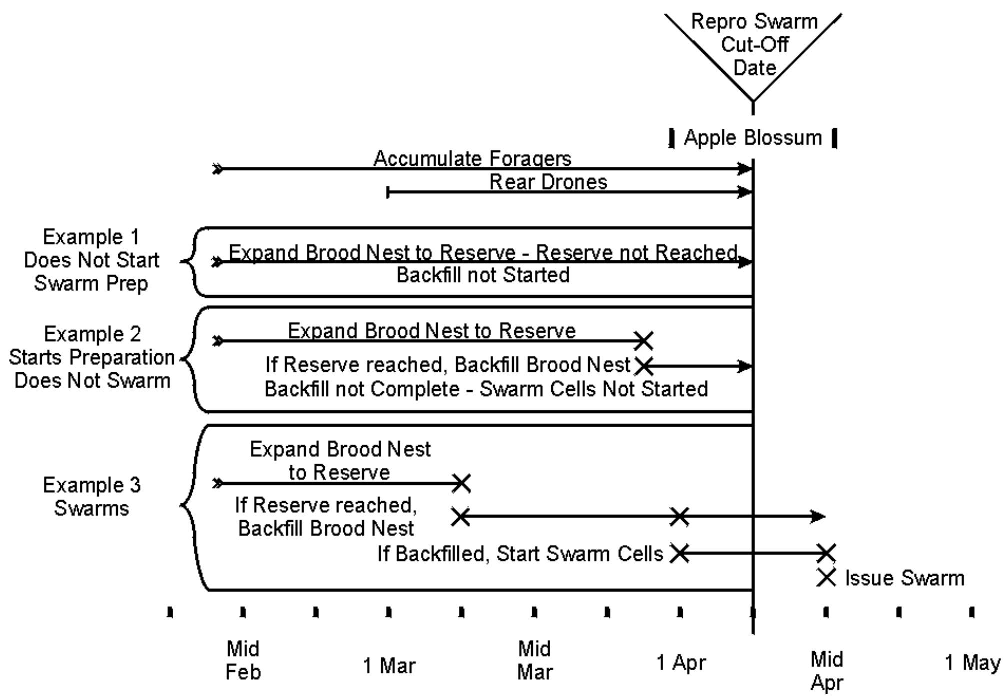

Figure 3: Colony Strength versus Operational Changes Prior to Repro Cut-Off

Figure 3 presents a progression of three colony's efforts to produce a swarm, plotted against the calendar. In Chapter 2, the basic elements of the swarm game plan were presented.

The first line on the figure shows the accumulation of foragers. Starting in late winter, foragers are accumulated during the whole build-up. The reason for use of the word accumulate here is that the foragers are not used to capacity. The foragers are only supporting brood pollen needs and water/nectar requirements for brood nest expansion.

Most house bee duties are not required during the early season development. Specifically, there is no need for nectar processors or wax makers. They are not storing nectar or converting it to honey. Old wax is used for brood capping and cells are being shortened from honey storing depth to brood rearing depth. Of course, cell cleaning and nurse bee work are an integral part of brood rearing. When those duties are complete, young workers graduate to foraging capability.

We have seen no data in the literature on how many house bees are required to support a field bee during the main flow. Tongue-drying sounds like a slow process, and wax makers need to fill up with nectar, find a quiet place to be motionless, and wait for the wax glands to generate wax.

The most significant feature of the early build-up is the efficiency aspects of nurse bees graduating to foraging capability, without spending time as house bees. When the bulk of the population is foragers on stand-by, the colony can more readily exploit early season opportunities. In the early season both forage availability and flying weather are limited. To be able to send nearly the whole work force to the field during those short windows of opportunity is obviously in the colony's best interest. When there is a colony "need" such as a feed pollen shortage, having a full complement of unnecessary house bees would be an inefficient way to operate. Honeybees are efficiency experts.

We credit the Trachea mite for exposing this unknown characteristic of the over-wintered colony. The colony that loses a disproportionate number of fall bees through the early winter to Trachea mite infestation, has a much smaller cluster. Early winter honey consumption was at normal rates for the starting cluster size. In late winter, bee loss causes the smaller cluster to have empty cells within the cluster perimeter. After the January start of brood rearing, the cluster is locked in place. The colony is not going to move to stores and leave the brood. The colony treats empty cells within the cluster as an acute need. All available foragers are pressed into service to fill those empty cells with nectar. Filling empty cells within the cluster has a higher priority than foraging of pollen to support brood rearing.

It is a survival trait of the colony to limit foragers in the field under marginal flight conditions. When weather and temperature improve to the point that foragers are not likely to be trapped in the field by a sudden change in conditions, they send the full force. We call it an "all-out" foraging day when the temperature is above 60 degrees, sunny and not overly windy.

On an all-out foraging day, when a colony "need" is perceived, the solid cluster disappears. There are concentrations of bees over open brood and in the storage areas. You can lift out a full frame of capped brood and there are only a few scattered bees on it. Most of the cluster bees are in the field foraging. Even the single layer of bees over open brood do not appear to be enough to keep the brood warm. This "all-out" indication is transient and early. As the population grows with brood cycles all the foragers are not required to support colony brood rearing requirements. The absence of house bees is not obvious with a large number of stay-at-home foragers.

There are, however, some house bee duties that are neglected throughout the build-up. Most beekeepers are aware of the absence of wax makers through this period. With wax available, stored as bridging and burr comb, new wax is a luxury they can do without. The appearance of new wax at the beginning of the "main flow" is generally ascribed to field nectar availability. In this area, field nectar is plentiful at least six weeks prior to that. The raised empty hive body that was reversed early can be filled with nectar in a few short days in the frosty morning period before general green-up.

In the early season dead bees can be seen in the overhead honey or accumulated on the bottom board floor. Later in the season the bees are quite tidy and keep dead bees removed as they die. Most beekeepers are also aware of improved gentleness in the early season of colonies that are quite defensive later in the season. Both guarding and undertaking are house bee duties that are given lower priority in the early season.

There is some evidence that bees above nurse bee age are primarily foragers, but accomplish some house bee duties in between foraging opportunities. For example: we normally consider wax working to be a house bee function. This might include working of old wax into clusters of drone cells for early drone rearing. But on an all-out foraging day, partially constructed clusters of drone cells can be seen without any bees working in the area.

You experienced beekeepers will see more of these clues, if you look for them. First, you must convince yourselves that it might possibly be true. The rest is easy.

Line two of Figure 3 reflects their sudden and intense interest in rearing drones about halfway into the build-up. Drones are required to support the impending mating season. The rearing of drones will not be denied. They will rework worker cells to drone size or locate drone cells outside the brood nest, and rear drones with a remote mini-cluster.

The timing of the early drone-rearing is evidence that the whole build-up period objective is to produce the reproductive swarm. It takes nearly twice as long to get a mature drone on the wing for mating as it does for a queen. If, as the literature suggests, the colony did not consider swarming until congestion prompted the building of swarm cells, drones to mate with the replacement queen would be in short supply. If the colony started rearing drones at the same time as queens, there would be at least two weeks before mature drones would be available in sufficient numbers. The swarm game plan times the operations to support the objectives.

The swarm game plan of Chapter 2 defines the sequencing of steps to committing to swarm. Building the brood volume to the capped honey reserve triggers backfilling. When the brood nest is sufficiently reduced by backfilling, swarm cells are started and the colony is committed to swarm. All of these actions must be started prior to the cut-off date, or reproductive swarm ambition is cancelled for the season.

There is no date or time limit for initiation of these steps. Colonies housed in smaller hives with less honey meet the requirement for starting these activities sooner. Brood nest growth is controlled by the amount of overhead honey that must be consumed by the population. The smaller the amount of overhead honey, the sooner a nominal cluster reaches the reserve limit. The prime swarm preparation period is the three weeks prior to the cut-off date.

The examples on Figure 3 are the result of colony over-wintered strength in cluster size from the weakest to the strongest. In all three cases the colony is building brood nest size into the same amount of overhead honey.

Example 1 presents the weaker over-wintered colony. The colony builds brood volume at a slower rate, and does not reach the brood nest limit of the reserve. As a result, this colony does not start the first activity of swarm preparation- (backfilling).

Example 2 reaches the expansion limit of the reserve, and starts backfilling. They do not reach the swarm commit point prior to the cutoff date. As a result of running out of calendar time, swarm ambition is canceled. The significant lesson here for the beekeeper is that honey production is limited by the preliminary backfilling. The colony did not build swarm cells, but the brood nest was reduced by some backfilling and there will be less population to exploit the flow.

Example 3 depicts the colony that successfully produced a reproductive swarm. Note the three-week period for backfilling. We have not specifically monitored the progression of backfilling. Since the backfilled area of comb is continuous from the top down, it could have contained brood of all ages. This would lead to the conclusion that at least a full worker brood cycle was used for backfilling. We have seen the 2 ½ story colony completely backfill the upper hive body without starting swarm cells.

In the timeline presented, the delay between element start times is arbitrary, and not supported by scientific test data. They are shown this way to depict sequencing.

Chapter 4 will pick up the Tennessee timeline at reproductive swarm cut-off.

CHAPTER 4

CONTINUATION OF TENNESSEE SPRING TIMELINE

In Chapter 2 you were introduced to the honeybee colony swarm game plan. In Chapter 3 the timing of the game plan was discussed along with some description of internal colony operations. Those unique operations support the species survival requirement of generation of the reproductive swarm. Discussion ended at the reproductive swarm cut-off date. At the cut-off date, the primary objective of the colony changes from species survival (swarming) to colony survival.

Colony survival requires replenishment of stores to sustain them over the winter. This chapter of the book will describe the operational aspects of the restocking period. Although this sounds like a very elementary subject, we suspect the reader will find some surprises in the following treatment.

In the period immediately prior to the reproductive swarm cut-off date (Repro $^{c}/_{o}$) the colony was operating without a full complement of house bees. When the objective changes at Repro $^{c}/_{o}$ to existing colony survival, the colony must generate the house bees to support storing. A full brood cycle of just over three weeks is dedicated to rearing nectar processors, wax makers, and other house bees. The colony emerges from this brood cycle with wax making capability. Within a few days they are prepared to store nectar at peak accumulation rates.

The discussion of activities or internal operations of the colony can be supported with facts already known to experienced beekeepers. It's just a matter of interpretation of those known facts. A few observations that are not generally known will be thrown in to help convince the reader.

When we first came to the conclusion that early season worker population was primarily comprised of foragers and nurse bees, the obvious question was raised. When do they change internal operations to the familiar literature rendition of serving as house bees before becoming foragers? Looking for some clue to the answer to that question, it was observed that there was a consistent three week period prior to new wax "main flow" when nectar storage made no gain. Suspecting that period might be the transition between internal operations, we went on record with that conclusion.

Supporting observations came as we experimented with nectar management for swarm prevention.

To continue with the lull in nectar storage during the three week period prior to the appearance of new wax: In some literature descriptions of the swarming process, the lull is attributed to scout bees turning their attention to looking for nest sites. On the timeline continuation sketch, note that the swarm issue season is parallel with the early part of the house-bee-rearing phase. The storing slow-down has nothing to do with scout bees not locating nectar sources. Although that's not a bad guess, it shouldn't be presented as fact.

All colonies, whether they have any intent to swarm or not, have this slow-down in nectar storage. It's the period between the "early flow" and the "main flow". It's very conspicuous in a colony that has been induced to store overhead nectar by beekeeper manipulation. The colony that was reversed early and given empty comb above stores nectar overhead immediately. The three-week break in storage prior to the "main flow" is more obvious.

Locally, in Middle Tennessee, black locust blooms during this period. In seasons that black locust is very showy the bees work it to support brood rearing, but put no nectar in the supers. This would seem to indicate that the period of rearing a full brood cycle of house bees is a strain on resources. It's all the foragers can do to support brood rearing through this period.

One other possibility comes to mind. The existing foragers are deliberately only supporting brood rearing during this period. The bulk of the foragers are marking time. They are waiting for the corps of house bees to be ready to store honey. When the support troops are in place, they go after nectar in a big way.

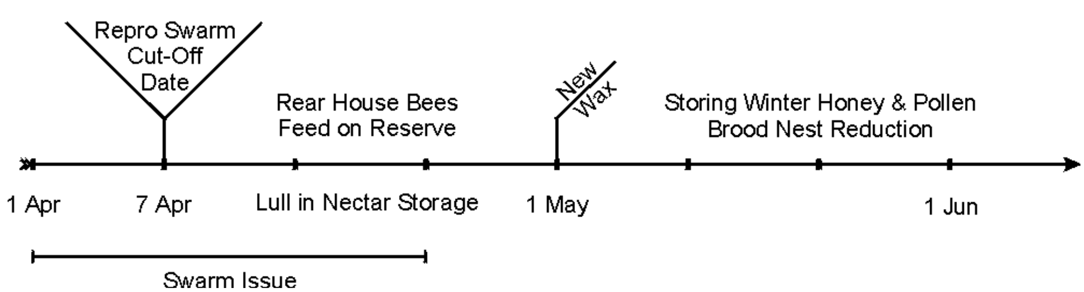

Figure 4: Protect Colony Survival Period Subsequent to Reproductive Swarm Cut-Off

If you don't like either of the above scenarios, generate one of your own. Your guess is as good as mine. But the lull in storage is real and predictable. We are convinced that it is associated with the internal operations of the colony in preparing to store honey. Note that the lull in nectar gain occurs at the peak of native nectar availability. Here, we consider the peak of nectar in the field to be the period of black locust and the overlapping tulip poplar. It's also the period of no gain in the supers. The peak of nectar availability is a boon to the swarm in a new location, but the parent colony or non-swarming colony is busy with preparation to store honey.

A related observation came in the period of nectar management experimentation (Chapter 6). During the three week period between Repro $^{c}/_{o}$ and the white wax "main flow," the cluster volume, or working level does not grow. The phenomenon is mind boggling to this beekeeper. Considering that a full brood cycle of bees generated from three stories of brood should nearly double the population in the period. As the average temperature moves upward in late Spring, the word "cluster" loses some of its relevancy, but there is still an upper limit to the volume of concentrated bees. Late in the build up, we refer to the top of the concentrated bees as the "working" level. The colony will store nectar overhead during the build up within this working level limit only. Later, during the white wax flow, they will readily open gaps in the solid bees though capped honey and continue to store at the top. The fact that the working level does not increase appreciably during the period between Repro $^{c}/_{o}$ and white wax is ample reason for the lull in storage. The question then, is not why there is a storage lull, but why the working level doesn't increase.

This beekeeper has very little experience with overcrowding swarms. During our novice, hive-count-increasing years, two swarm calls came in May. Those two swarms were later in the season than reproductive swarms, and were much larger. The reaction at the time was that these swarms had to come from a beekeeper's hive. Perhaps the reason that we have not seen overcrowding swarms in our beeyards is that, from day one we have supered optimistically. Bowing to the literature opinion that congestion was the "cause" of swarming, we added empty supers before they were "needed".

In spite of our inexperience, a book about swarming needs to include something on the subject of overcrowding. We think the observation above that the working level (cluster) doesn't grow during the lull in storage is significant. But a discussion of that observation provides more questions than answers. Consider the following:

Regardless of the volume of the brood nest, the hatchout of a full brood cycle of young bees will occupy more space than the space between frames. With legs extended, the mature bee occupies substantially more space than the compact cell spacing from which they emerged. And there was already bees occupying some of that space.

Wax makers that need 100 degrees to secrete wax will accumulate at the top of the brood nest to increase temperature and contemplate while wax glands do their job. Cell cleaners and nurse bees are occupying nearly half of the brood comb surface. Although some of these workers sequencing of responsibility might cause them to be counted more than once, the trend is to increase crowding in the cluster. The stream of new bees is continuous as a result of recycling brood cells.

Any relief from overcrowding comes from the loss of foragers to the perils of their trade. Going into Repro ℅, the worker population was heavily weighted with foragers. On an as-needed basis, the foragers are supporting brood rearing needs during this period.

If forced to guess, based on the cluster not growing, we surmise that there would be more crowding of adult bees during this three week period than during the reproductive swarm process. The crowding would be cumulative, and the beekeeper who waits for white wax to appear before adding supers is begging for overcrowding swarms. If you open a colony that is "boiling over" with bees, that colony should have been provided space at least three weeks earlier.

A second indication of operating in the house bee-rearing phase muddies the water a bit further. During the three week period after Repro ℅ the colony is feeding on the capped honey of the reserve. Chapter 2 described the reserve maintained above the brood nest through the swarming season. We said that this honey was survival insurance for the swarming season. With Repro ℅ occurring approaching peak nectar availability, the reserve has served its purpose through the swarming season. The colony is now intent on consumption of the old honey and replacing it with fresh nectar. You may have wondered why an abandoned, stacked-up hive, or a feral colony has no crystallized honey at mid-season, when they have more stored honey than they could possibly use. It's because they feed on last season's honey until it's used up. They can be feeding on old honey in one frame, and storing nectar in the next adjacent frame at the same time. For the colony that has not been reversed and the capped honey is still in place above the brood nest, opening the capped honey to feed on also opens the path for overhead storage or "moving into the supers".

There are two less obvious signals that the colonies have reached the Repro $^{c}/_{o}$. Either or both of these signals on a few colonies tells the beekeeper that all colonies will be in the house bee rearing phase within a few days.

Some colonies will start supersedure when they abandon swarm ambition. If they are not going to requeen by swarming they opt to requeen by supersedure. Since they build bases for queen cells on the bottom of frames at each level as the brood nest expands upward, they have the bases to start supersedure promptly. When nectar managed (Chapters 6 and 7) all colonies will supersede within the next few weeks, but not all start at Repro $^{c}/_{o}$.

The second early indication of Repro $^{c}/_{o}$ is new wax deposits. Some colonies generate a few wax makers during the swarming season, even if the colony has no intent to swarm. We suspect this is the result of genetic programming. When the colony reaches Repro $^{c}/_{o}$ those wax makers deposit their wax to prepare for foraging. If they are feeding on darker fall honeys at the time the wax will not be white. The off-colored wax is difficult to detect. It sometimes shows up as a very fine bead of wax along the upper, outside edge of top bars in the nectar storage super above the brood nest. It may be used normally for cell deepening or stored as burr comb.

This purging of wax makers only lasts a few days. The swarm preparation wax makers that are not needed after Repro $^{c}/_{o}$ can deposit their wax holding in a short time. Then there is a period of a couple weeks of no new wax. When the wax makers generated for the white wax "main flow" start, wax making is continuous as long as surplus nectar is coming into the hive.

The colony that swarms also has a temporary period of wax maker purging. All the wax makers generated during swarm preparations do not leave with the swarm. The random selection of bees leaving with the swarm leaves some of the wax makers behind. They will deposit their wax within the first few days after swarm departure. Swarm departure timing is not associated with Repro ℅, and can lead or lag by a couple weeks either way.

Whether the new wax purging of bees is the result of Repro ℅ or swarm wax makers left behind, the wax is deposited in a few days. In both cases the worker has an imminent job change as a result of colony objective change and resultant change in operations. Following the wax deposits of either of these changes, there is a period of no new wax. A new wave of wax makers is generated for the white wax "main flow."

The appearance of white wax heralds the start of the "main flow", or that is what we have been conditioned to believe. This maverick beekeeper is convinced by observation that white wax is the result of the honeybee's survival strategy, and has nothing to do with field nectar availability. We have spent several handwritten pages trying to convince the reader that the peak of native nectar availability precedes the appearance of white wax. During the peak nectar period the colony is <u>preparing</u> to take advantage of the downslope of nectar availability.

White wax is, however, the most prominent indication of seasonal timing of internal operations of the colony. When you subtract weeks from the white wax appearance date at your location you can tell when your Repro ℅ occurs and when the prime swarm preparation/issue occurs. Repro ℅ is a brood cycle (strong three weeks) prior to new wax and prime swarm preparation is the brood cycle before that.

To look at the timing from another perspective, we believe that Repro ℅ sets in motion the process that generates the wax makers for "main flow" storing. When the colony abandons swarm ambition, they start the brood cycle of house bees required for honey storage. At the end of that brood cycle, nectar processors and wax makers are ready to store honey at efficient rates.

All colonies at the same location show new, white wax within a few days of each other. This may be the reason that the appearance of white wax has been associated over the years with nectar availability in the field. You will not see this on a scale hive, but locally nectar has been plentiful in the field for two months before the appearance of white wax at the start of the "main flow". The hive scale is recording what is brought in by the bees. There are times when the colony survival requirements do not include increase in nectar storage. This is true for nearly the whole build-up period. The exception is the brief period of backfilling in early swarm preparation. Prior to backfilling, the emphasis is on honey consumption to increase brood nest size. The lull in nectar gathering after Repro c/o was discussed above.

The new wax flow is the period of brood nest size reduction to the maintenance level. Pollen is backfilled at the bottom and the top is backfilled with nectar as brood emerges. In this way the brood nest size is reduced and sandwiched between the two food requirements for winter brood rearing. Brood nest reduction actually starts about a week into the nectar storage lull, and is well underway at the beginning of white wax. Reduction continues into the white wax flow until the colony reaches the size nest that produces replacement bees, only.

It should be noted that first year colonies have a slightly different approach to winter stores. In the tree hollow the swarm starts comb construction at the top and expands down and out. Pollen storage stays above the brood. Pollen is difficult to move and would impede the growth in the down and out direction. For this reason the first year colony often goes into its first winter with a block of stored pollen above the brood nest. The sides and bottom are generally surrounded by nectar/honey. In other words, the second year colony often starts the season with their stores upside-down. Stored pollen in the early brood nest growth direction may be part of the reason that second year colonies typically out-perform more established colonies.

The new wax flow is the first time of the season that the colony conforms to the literature descriptions of nurse bees serving as house bees before graduating to forager duties. The result is a balanced work force to take advantage of the remaining forage availability. Internal colony operations for this period are described in the literature. The period of rearing house bees is not described in the literature. This may be the result of the operations of an observation hive not being representative of the overwintered colony. The restocking period of the Spring season, which we have referred to as the colony survival period has two distinct operational periods. At Repro c/o, the colony starts the three week worker brood cycle that produces the house bees that support honey accumulation. At the end of that period, the work force is available to process nectar brought in by the foragers. The timing and basic operational activities are presented on the timeline continuation figure. The literature-described operations continue from appearance of new, white wax through the fall flow.

A summary figure has been included to associate colony operations with available, local nectar sources. During the build-up the sources identified provide fairly continuous nectar availability. Lesser sources supplement the continuity. As noted in Chapter 3, very little of this nectar is used when water is readily available. After filling empty cells within the cluster perimeter very early with nectar, the emphasis shifts to consumption of honey for brood nest expansion. The colony that is building brood volume into solid capped honey will show a weight loss all the way to the appearance of new wax at the beginning of the "main flow". A colony that reaches the reserve expansion limit and starts backfilling nectar will show a modest weight gain for that period. Scale hives are a very poor source of nectar availability data. The weight changes that are recorded are always seen through the objectives and internal operations of the colony being weighed.

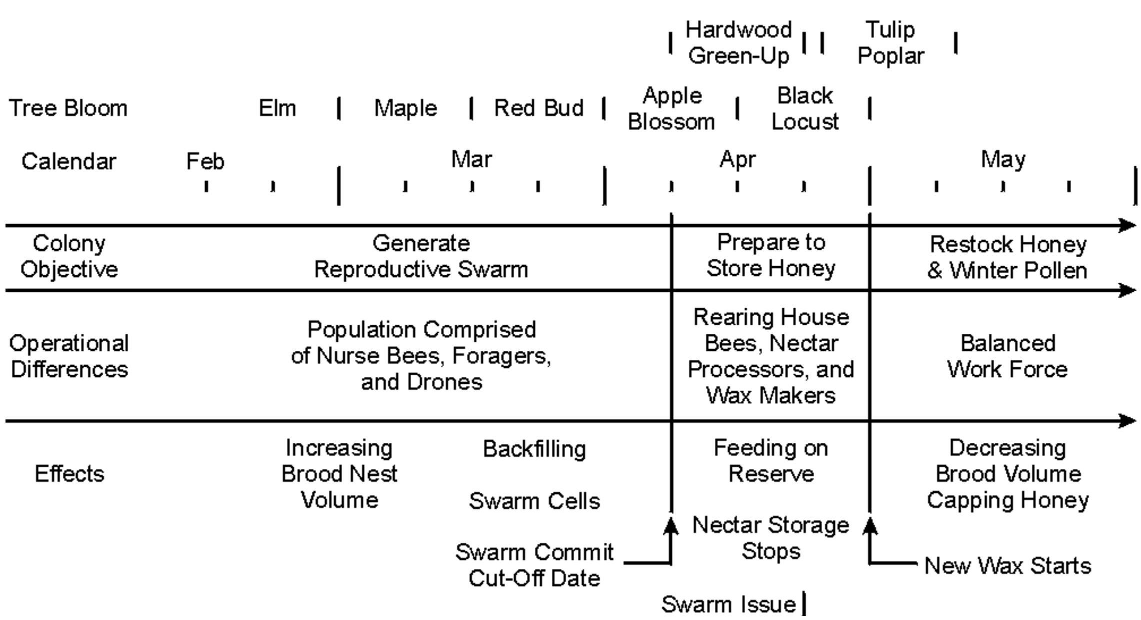

Figure 5: Spring Operations Summary Chart

The summary figure shows the progression of operations through the Spring season for my area. The bottom section of effects are the indications of these changes that can be seen by the beekeeper.

In the period up to the first dark vertical bar at the end of the first week of April, the colony is dedicated to generating a reproductive swarm. Depending on the progress made toward the objective, the internal operations may change several times. Most of the operational changes are steps to generation of the swarm, such as growth of the brood nest, backfilling, and rearing of replacement queens. Some beekeepers might consider the rearing of drones in large numbers to be a change in operations. We see all of these operational activities as evidence of colony dedication to reproduction during this period.

April 7, or thereabouts, all colonies without swarm cells in work abandon swarm ambition. A colony that has nearly reached swarm commit by starting the increase in swarm cell bases turns off swarm ambition as readily as those with no progress in swarm requirements. If they have not populated a swarm cell with egg or larva, they change directions abruptly. Two days later, they may start a queen cell, but that cell will be a supersedure queen.

Repro c/o precedes the "main flow" appearance of new, white wax by about 24 days. It is important to know when white wax appears at your location. You will be armed with better judgment data for determination of swarm versus supersedure queen cells.

The appearance of new, white wax normally is first seen as an extension of cell depth where nectar has been stored earlier. Cells that have been filled with nectar to the brood-rearing or uncapping depth are extended to the honey capping depth. This generates the appearance of a white "frosting" where cells are filled with nectar prior to reaching wax making capability.

As noted earlier in this text, brood nest reduction by backfilling starts in the storage lull preceding white wax capability. The upper limits of the brood nest are filled with fresh nectar, but the nectar immediately above what was the top of brood has been in place longer. It is mostly cured by longer exposure to brood nest heat rise. For these reasons, white wax starts at the upper limit of the brood nest and grows both up and down; up with increased nectar storage and down with brood nest reduction. To see the start of white wax, the beekeeper will need to penetrate the hive to where cells are filled with nectar.

Each hive makes an independent judgment of when to invoke Repro c/o and start the process that generates house bees for white wax storing. Hives of different European races make the decision very close together, when compared hive to hive. The timing only varies a few days. But the variation caused by seasonal differences can scatter over more than two weeks. In other words, different colonies, regardless of race, read each season fairly uniformly, but all read seasonal variations the same way. We have seen them, collectively , move Repro c/o to more than a week early , and more than a week late, when compared to “normal” timing. The beekeeper needs to see white wax start for several seasons to establish nominal timing. If he is paying attention to seasonal variations such as temperature and forage availability at his location, he can predict shifts in timing to some degree. He can at least project the direction (early or late) of the timing shift, if any.

CHAPTER 5

SWARM PREVENTION BY STANDARD MANAGEMENT

In Chapter 2, you were told that stopping of brood nest expansion, by saving the safety capped honey reserve, was the starting point of swarm preparations. You were also told that reducing brood volume, by placing nectar in cells where brood had emerged (backfilling), was the first action of swarm preparations. In Chapters 3 and 4, you were told that there was a time in the early season when the urge to reproduce is canceled in favor of existing colony survival. You already knew that at some point the colony loses interest in swarming. We just provided some information on timing and called it the reproductive swarm cut-off date. In most of the above, the discussion refers to reproductive swarming. Overcrowding swarms, generally occurring later, have been given minimal coverage.

In this segment, standard management swarm prevention techniques will be discussed. Using the baseline provided in the first four chapters, an effort will be made in the following to show why these techniques are beneficial, if sometimes unreliable. Every season is different in some ways. The bees key on the season as it unfolds in terms of forage availability. A swarm prevention technique that works like a charm this year may not be as effective next year.

The literature tells us that timing is critical, but makes no effort to identify the timing elements. Any swarm prevention technique that delays the starting of swarm cells until after the cut-off date is effective in that season. If swarm cells are cut out within a few days of the cut-off, that colony will abandon swarm ambition. But if they commit to swarm by starting swarm cells three weeks before the cut-off, the beekeeper will be cutting out cells again and again. Having already committed to swarm, their incentive to increase brood volume is reduced. It should be noted that when cutting out swarm cells, brood nest volume is already reduced by substantial backfilling. It seems that the colony, no matter how severely they are jerked around, does not lose contact with their cue(s) for cut-off time.

The safety reserve of capped honey left overhead during build-up has not been recognized for the role it plays in reproductive swarming. We wrote in Chapter 2 that the reserve, or expansion of brood volume to it, initiates swarm preparations. Although the effects of the reserve have not been specifically identified, until now, several swarm prevention techniques attack the reserve. By attack, we mean open up, or remove, the capped honey barrier to overhead nectar storage. A weakness in the honeybee swarm game plan is that the colony will store nectar overhead, if empty comb is provided at the top of the brood nest. However, they sometimes do not appear to recognize empty space above the reserve. If they store nectar overhead, the nectar that would normally be used for backfilling is diverted overhead, and not used for the first step of swarm preparation. The colony is thereby induced to fail to meet the preliminary swarm preparation requirement of backfilling part of the brood nest.

Depending on how it is done, the taking of brood for splits can open the reserve to overhead storage. A split to us is the removal of two to four frames of brood to be used to start a new colony. Ideally, those brood frames would be replaced with empty brood comb. If at least one of the brood frames or feed frames taken is removed from the upper brood chamber, the solid honey of the reserve is opened with empty comb. The bees do not put brood in these empty cells until after they have been filled with nectar. When filled with nectar, brood displaces the nectar. In the process, they have stored nectar through the capped honey reserve. If drawn comb is added above the brood chamber, nectar storage continues into the added super. This serves to subvert the backfilling requirement.

It should be noted that replacing frames of brood with frames of foundation does not necessarily get the same results. In the pre-swarm period, the colony has not developed wax making capability. Foundation is a barrier of its own. The wild bees ignore foundation until well after the swarm season. Some bees from queen breeders will draw foundation on incoming nectar before that period, but those strains of bees are the exception. Additionally, generous feeding can induce early wax making, but feeding is labor-intensive, and increases management cost.

The taking of splits can be a reliable swarm prevention technique. If the overhead honey of the reserve is deliberately opened to storage in the manipulation and drawn comb is added above, it becomes more effective swarm prevention. However, there is a penalty paid in honey production. The colony weakened by this technique during development is going to make less surplus honey.

The discussion above on splits is also applicable to dividing the colony into two equal parts. The advantage of division is that to make the halves equal, opening the reserve to nectar storage is almost guaranteed. In my area, the penalty in honey production is more severe. With an early season, neither half gets up to strength before it's too late.

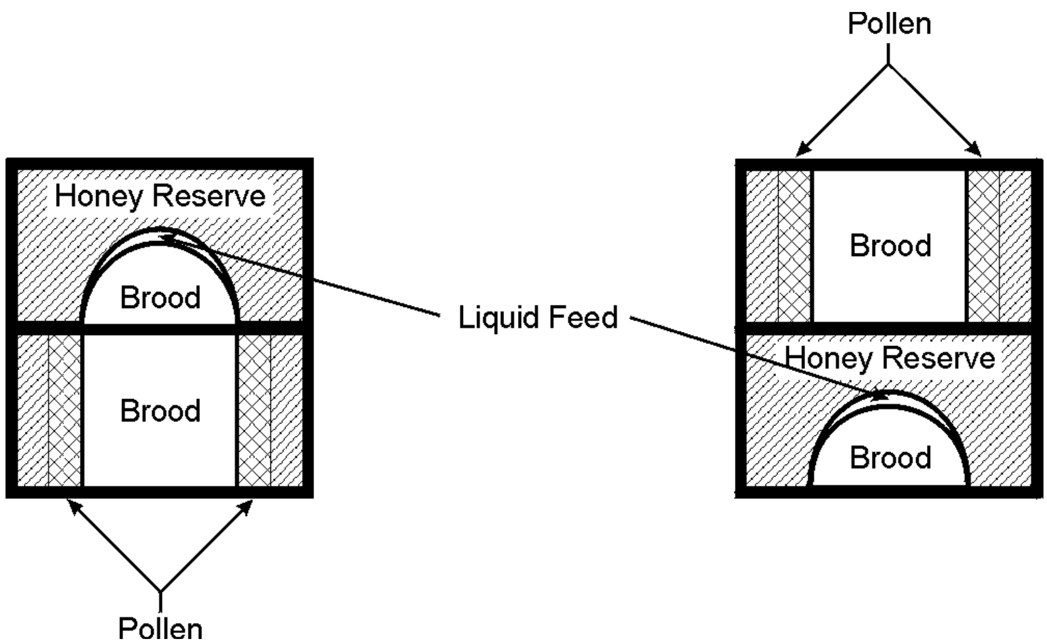

Figure 6: Hive Body Reversal

Hive body reversal is the favored literature swarm prevention manipulation. Reversal helps to prevent swarming in two different ways. First, a significant development delay is induced. In the two-deep colony, where the lower hive body is full of brood and a dome of brood has reached well into the upper hive body, each box has one type of brood food. The upper hive body contains the arc of liquid feed between the brood and capped honey. The lower unit has feed pollen at the sides of the basic brood nest. Pollen storage generally does not penetrate the upper hive body with the brood nest dome. This means that all brood feed pollen is in the lower box. The liquid feed band in the top box is feeding not only the brood, but also the whole colony. When these two hive bodies are reversed, both segments of the brood volume are separated from one of the essential feed requirements. This stops development in its tracks for at least two weeks. The confusion period where stores must be relocated to support continued growth is further hampered by brood to the top bars in the upper hive body. The insulating bees of the cluster are now located over brood. This complicates reestablishment of the liquid feed band at the top of the brood volume.

While this recovery period halts colony development for some time, it is beneficial from the swarm prevention standpoint. If the development delay extends to the reproductive swarm cut-off date, reproductive swarming can be averted.

The second advantage to reversal is the removal of the overhead capped honey reserve. When reversed, the reserve is sandwiched between two segments of brood volume. Brood to the top bars of the upper hive body encourages prompt overhead nectar storage if comb is provided above. The adding of drawn comb above at the same time as reversal is so important that we feel both actions should be described in one word. Drawn comb above assists the colony in re-establishment of the liquid feed band, and lessens the impact of reversal. More importantly, overhead storage of nectar diverts nectar that could be used to meet swarming requirements. Active overhead nectar storage reduces the tendency to backfill brood volume, and decreases the chance of reproductive swarming.

Discussing the advantages of reversal without mentioning the disadvantages might mislead the reader. We have already described the minimum of two weeks of arrested colony growth. You are reminded that the swarm preparation season is the period of population "explosion". In this area, there are only two brood cycles between the late-winter start-up and the brood cycle dedicated to rearing house bees. To stop development in the second cycle is self-defeating from the standpoint of population and honey production.

Sandwiching the capped honey reserve between brood volumes creates potential problems of its own. The bees will unite the two brood volumes by consuming the honey reserve and converting the cells to brood volume. This creates two full hive bodies of brood and no reserve. If no comb has been added at the top for space and nectar storage, two undesirable effects are possible.

By turning over this large brood volume, overpopulation is possible and a late swarm generated. Note that if they had not been reversed they would be reducing brood volume by backfilling according to the reproductive swarm game plan.

When induced to consume their reserve honey by reversal, the colony has been deprived of the reserve intended to safely carry them through the brood cycle of rearing house bees. Some literature accounts credit "over stimulation" as the cause of "starvation just before the flow". If by flow we mean the new wax-storing period, just before is toward the end of the house-bee rearing period. The colony deprived of its reserve during this time is at the mercy of the elements. A period of inclement weather or a nectar dearth can put them out of business.

Dr. Roger Morse wrote, "The best way to relieve congestion is to reverse hive bodies". Thinking in terms of bee crowding, for many years, we considered the statement false. The beekeeper would not likely be clumsy enough to make an appreciable dent in the population, and after the reversal, the same number of bees would be located in the same volume.

However, if by "congestion" he was referring to nectar clogging the brood nest, the statement might be valid. In Chapter 2 we describe backfilling of the brood nest with nectar as a key element of the swarm process. The backfilling normally starts at the top of the brood nest and the bees prefer it there. When the bottom hive body, with brood to the top bar, is raised, the bees start over with backfilling at the top. This provides a reprieve on committing to swarm. To solidly backfill an area of brood of all ages would take at least three weeks. Additional reversals, if required, are normally recommended at two-week intervals.

In looking for a better way to discourage swarming, without the attendant disadvantages of hive body reversal, we settled on a system we call nectar management. Nectar management will be described in Chapters 6 and 7.

CHAPTER 6

NECTAR MANAGEMENT HISTORY AND DEVELOPMENT

Nectar management is an approach to swarm prevention that is accomplished above the brood nest. There is neither disturbance of the brood nest nor disruption of colony population growth through the build-up. Actually, population growth is accelerated. Simple manipulations are performed in the honey/nectar above the brood nest. Application of this system substantially increases colony populations and honey production.

The beginning seems like a reasonable place to start. In 1995, we had made preliminary observations of the operational changes that take place in the hive in the early season (Chapters 3 and 4). We suspected that brood nest expansion to the capped honey reserve initiated swarm preparation, and that nectar backfilling of recently vacated brood cells was a preliminary phase of swarm preparations. We had given up on hive body reversal years earlier because of the retardation in development (Chapter 5).

Swarm prevention at that time was limited to increased wintering honey overhead. Initially we wintered in a hive body and a shallow of honey. Even a modest cluster can expand the brood volume to fill the hive body with brood to the shallow super of capped honey reserve, and most swarmed. We wintered in a double deep for a couple seasons. There was less swarming, but still more than we wanted. When we added a feed box at the top of the double deeps to winter in 2 ½ stories, swarming was reduced to a tolerable level. Only the very strongest could build brood volume to the top of the upper hive body in the allotted calendar time. We were confident that wintering in three hive bodies would almost eliminate swarming in this area, but it seemed like a waste of marketable honey. There must be a better way.

The decision was made to try to offset the backfilling phase of swarm preparations. Still wintering in 2 ½ stories, three frames of honey were removed from both the upper hive body and the shallow at the top. Frames 3, 5, and 7 of our nine-frame system were removed and replaced with empty brood comb. We recognized we were treading on sacred ground – taking honey from the brood nest has been taboo forever. The intent of this manipulation was to provide a path for overhead nectar storage. If the bees would store nectar overhead, there might be less backfilling and swarming might be reduced. If they would not store nectar in the empty frames, we thought that the six of nine frames of honey left in place should be enough to support colony feed requirements.

The thinning of overhead honey with empty comb was accomplished in December of 1995. As the 96 season progressed, the results of this preliminary test of nectar management were startling. After two weeks of wintry weather in early March, we found that the bees had filled the empty frames to the cover with nectar. This meant that they had stored that nectar in February. Off to a good start. Supers of drawn comb were added the next day, and overhead nectar storage continued into the supers as brood volume increased.

Checking for swarm cells in the strongest outyard during April, several supersedure queen cells were fractured. On five of the twelve colonies in that yard, when the upper hive body was tilted up for inspection, the replacement (supersedure) queen pupa fell out on the lower hive body top bars. A large queen cell on a bottom bar is almost always attached to the next lower top bar. Two of the five had already terminated the old queen and were forced to raise a replacement queen by the emergency process. We got the message, and stopped looking for swarm cells. The colonies were not going to swarm, and were requeening themselves by supersedure.

The overall results of the first season test included no swarms generated, and a substantial increase in honey produced. Our normal honey production period is May and early June. In spite of a nectar dropout for the last two weeks of May (our normal peak production period), the colonies that wintered well produced more honey than we had seen before. The overall average was about 80 pounds, or just slightly above normal production for the area of 50 to 70 pounds with standard management.

While on the subject of honey production, five years of nectar management production will be summarized before proceeding into evolution of the system over that period:

96 - No swarms; production average 80 pounds.

97 - No swarms; production average 130 pounds.

98 - Some swarms; production average 180 pounds.

99 - No swarms; production average 80 pounds.

2K - No swarms; production average 145 pounds.

98 was an outstanding season. We may never see another like it. Even the colonies that swarmed produced several supers of honey. 99 was a bust. We didn't add a total of a half dozen supers after the appearance of new wax on the twenty test colonies. The 80 pounds harvested were the result of nectar stored overhead during build-up, and backfilling the brood volume during the brood volume reduction period. Mother Nature evened the score in 99 for the super season of 98. Most of my local contemporaries harvested almost nothing in 99. Based on these numbers, it appears that a production average approaching twice the standard management average is a reasonable expectation. Keep in mind that my bees are feral stock. My contemporaries are using stock selected for production.

The swarms of 98 were unexpected. After two swarm-free years, the old man suffered from a bad case of overconfidence. The trailers were located at Alabama orchards for apple pollination during the prime issue time. But a few small swarms issued after returning to home base. A few of those colonies that were slow getting started on honey production in May were checked for evidence of swarming. Yep. They had swarmed. It was obvious that overhead storage of nectar was not foolproof.

In 99 they were kept at home so they could be monitored more closely. Two of twenty showed swarm intent by adding a raft of swarm cups. They had not started the primary swarm cell yet. Close inspection showed that both had blocked brood nest expansion overhead. They had failed to uncap the overhead honey and reworked the bottom of the empty comb for drone cells. They had placed pollen around the drone cells for feed. The capped honey frames alternated with pollen for drone rearing had effectively blocked brood nest expansion. The shallow super with the blockage and the cups was raised to the top above two empty supers of drawn comb. It was replaced at the top of the brood nest with a super of nectar in one case and a super of empty comb in the other. Swarm ambition subsided in both cases. Both colonies reared a supersedure queen subsequently in the raised super, three supers above the brood nest.

Conclusions that could be drawn from the forgoing account: 1. Limiting brood nest expansion is the true stimulus for swarm preparation. 2. Capped honey or pollen immediately above the brood nest are the enemies of swarm prevention. 3. The hypothesis of the role of the safety reserve in the initiation of swarm preparations in the undisturbed colony appears to have merit.

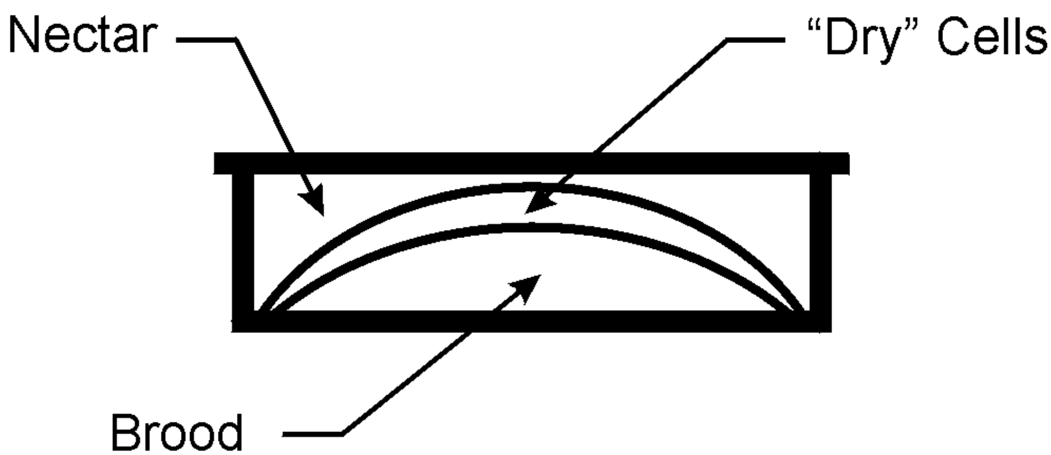

Figure 7: Drying Cells for Brood Nest Expansion

The beekeeper can confirm brood nest expansion is in progress by lifting out a frame with the expansion dome defined. Open-cell nectar is at the upper, outside of the dome arc. Inside the dome arc is brood. If the colony is expanding the brood nest, there will be a band of cells between the liquid feed and brood that appears to be empty at arms length. We call this appearance drying cells for expansion. Closer inspection may reveal that the "dry" band contains a low level of liquid feed if consumption is still in progress. If the colony has already populated the expansion band, it may contain eggs or larval brood. This band of "empty" cells is all the evidence you need that the colony is not contemplating swarm. Drying cells for brood nest expansion is exactly the opposite of backfilling the upper part of the brood nest to meet swarm requirements.

We have stated more than once in this book that the colony that is expanding the brood nest does not swarm. Monitoring for brood next expansion has advantages over looking for swarm cells. A few of those advantages include: increased time between required inspections, broader tolerance of inspection weather restrictions, and reduction of brood-nest disturbance.

CAUTION:

DO NOT - REPEAT - DO NOT thin honey in the Fall to increase fall honey accumulation.

In the first year of nectar management experimentation, we were so impressed with results in the Spring that we thinned honey through the summer, and into early Fall. In January, we were scrambling to feed to prevent starvation. During a walk-by inspection in January, we noticed all colonies were foraging for nectar. One of our strongest colonies, with a basket ball-sized brood volume starved while we were gearing up to feed. The rest were salvaged.

The same preference for storing overhead when empty comb exists that makes nectar management an effective swarm prevention technique creates serious problems in the Fall. To prepare the winter brood nest, they must backfill the broodnest with nectar toward brood rearing close-out. They need solid capped honey overhead to act as a reflector for backfilling the brood nest.

We normally harvest honey down to the top box containing solid capped honey all the way across. That box is left in place. If broodnest reduction to the maintenance level is not complete, the colony will continue to add capped honey above the broodnest. When honey is extracted the "wets" are put back on the hives for clean-up. Presuming the flow has weakened to a trickle, drying the wets helps the colony reduce the brood nest more. When the wets, now dried, are removed for storage, there may be another fully capped super that can be taken and still leave solid capped honey in the next lower box. If so, that super is taken at that time.

With all harvest supers removed, mite treatment is applied, depending on the need. That mite treatment is almost always for a shorter time than recommended. When the mite treatment is removed, an empty harvest super is added before the fall flow. If it gets filled and capped another is added. The purpose of maintaining empty comb above their capped honey is not to acquire fall honey, although some seasons produce some. The primary purpose is to insure proper preparation of the winter broodnest. An early freeze can shut down nectar availability in the field while the colony still has some brood. In that case the partially filled cells upstairs can be relocated to the brood nest to backfill the brood volume.

We find it somewhat awesome that these little insects have built into their survival format ways and means to accommodate the vagaries of season change. Spring and Fall have regularly irregular weather patterns, and they can handle them all. While most insects are hiding out, the honeybee colony is taking care of the business of survival.

Chapter 7 will provide some specific recommendations for application of nectar management.

CHAPTER 7

NECTAR MANAGEMENT MANIPULATION

In this chapter, the one-step manipulation will be described with respect to the season timeline for colony seasonal development. The manipulation timing needs to precede the internal operation that it is intended to affect. There is no harm done if the manipulation precedes the operation timing by weeks, but it should not be late. Before we get started on the manipulation, a few thoughts are offered on space for growth and population standing room.

When we first started experimentation with nectar management, we made allowances for the literature opinion that swarming is caused by congestion. An early rule of thumb was to maintain two empty supers of drawn comb above the working level of solid bees. By maintain, we mean when the bees start storing in the lower of the two empties, add another. We no longer believe that congestion is a factor in reproductive swarming, but we subscribe to the theorem "If it ain't broke, don't fix it." So we maintained two empties at the top all the way from thinning the capped honey overhead in late winter through the end of the white wax flow. For several seasons of experimentation, the importance of maintaining empty comb at the top was not recognized. In the 2001 season, new information emphasized the importance. Beekeeper negligence permitted a very strong colony to fill their comb to the top. They promptly swarmed.

There are other reasons why empty space is beneficial. The wild bees do not use added space immediately. It takes time for them to adjust their space available perception. They have to inspect the new space thoroughly before putting it to use.

In the tree hollow, they set out to fill the entire cavity with functional comb. When they have the cavity filled with comb, they regulate population by brood volume adjustment to be proportional to available stores. If you had not thought about it in these terms, consider the bee count in a four-frame nucleus to be wintered. You couldn't stuff the bees of a double deep fall cluster into the four-frame nucleus space even if you crushed them into a pulp. This regulation of population in consonance with stores and overall cavity space has implications in supering. If you wait until the last super is nearly full before adding another, the bees will be throttling back on brood volume.

Brood volume is proportional to population, and population is reflected in colony storing rates.

During the build-up, the wild bees treat empty cells within the cluster outline, as an acute "need". They will fill empty cells in the cluster with nectar on a priority basis. As the cluster volume increases, more and more nectar is accumulated above the brood nest. One of the desirable features of nectar management is the accumulation of nectar during the build-up. The bigger the brood volume grows, the more nectar is in place prior to the production period of the main flow. The relationship between cluster volume and brood volume is what contributes build-up nectar storage. The cluster volume will generally be up to 50% larger than the brood volume. The extra bees accumulate above the brood volume. The cool night cluster will then be three stories for two stories of brood. In that case, the top hive body will be filled with nectar. We refer to the top of the solid bees of the cool night cluster as the "working level". The colony is eager to store nectar within the working level, and resists storing above it during build up.

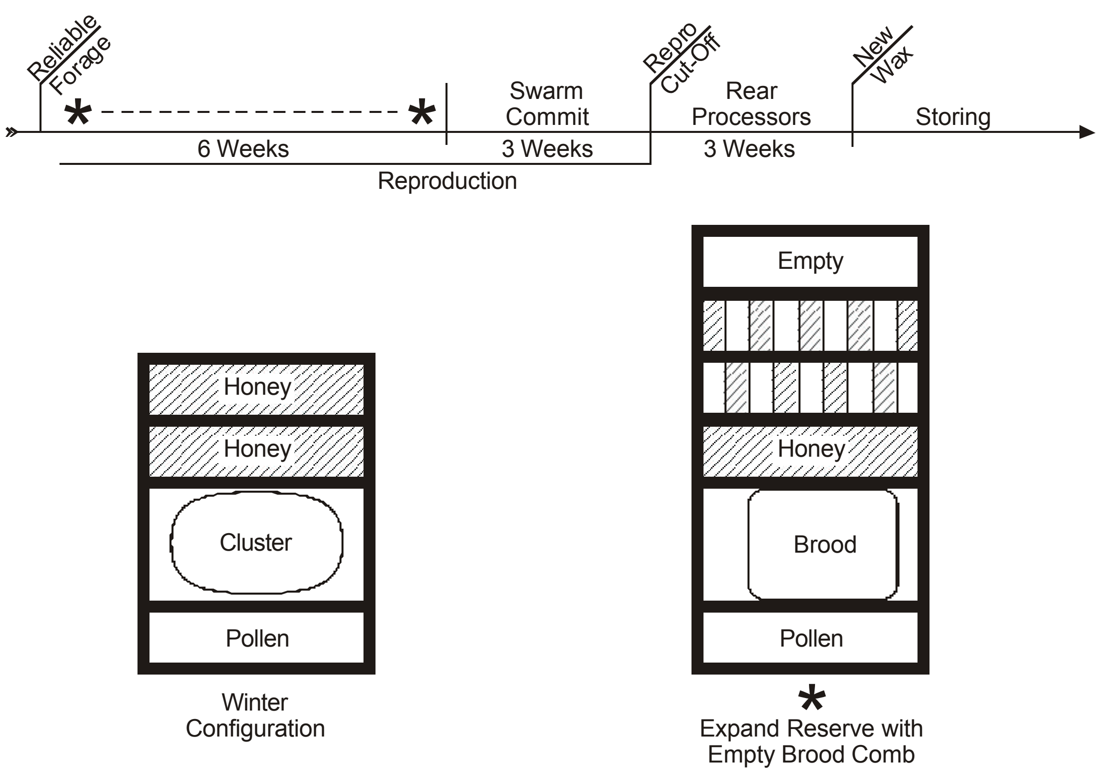

Figure 8: Nectar Management Manipulation

The manipulation guide presented is provided to assist the reader in application of the concepts contained in the forgoing six chapters. The most consistent response to these recommendations is that it is too complicated for the novice. We believe the average eight-year-old could move frames above the brood nest, with a five-minute introduction to the procedure. It is certainly simpler than taking a split, and providing a caged queen. That type of procedure really intimidates the novice.

What is complicated is the internal operations of the colony that make this system successful. If those internal operations were simple, they would be common knowledge in the beekeeping community. We accepted the risk of damaging our credibility by describing what we see happening in the hives in the spring. We could have recommended the manipulations without going into a description of the internal operations on which they are based. What would be missing in the recommendation would be the timing of effective application. A timeline, without calendar references, is provided at the top of the manipulation sketches. To apply the procedures in a timely manner, count back from normal new wax for your location. Roughly three weeks before new wax is the reproductive swarm cut-off date. Prime swarm preparation period is the three weeks before that.

The one-step manipulation is performed after forage becomes reliably available. In this area, that is also the time when a nominal cluster has just about filled their basic hive body with brood and are approaching expanding the brood nest into the next higher box. The manipulation is identified with the ★ on the timeline and the second hive configuration on the manipulation sketch. This configuration, described below, accomplishes several objectives with one simple step.

First, it raises the apparent top of the capped honey reserve. The colony appears not be able to distinguish the difference between solid capped honey overhead, and capped honey, alternated with empty comb. The colony's objective is to increase brood nest volume to a shallow super of reserve. Doubling the apparent reserve causes the bees to increase brood volume into the lower half. Had the reserve not been doubled, swarm preparations (backfilling) would have started a shallow super lower.

Secondly, the empty comb overhead causes the colony to store nectar there. As population increases, the cluster volume grows with the brood volume at a half –again level as the brood volume. These are the bees that would generate crowding without providing additional space. The colony cannot tolerate empty cells inside the cluster perimeter. Cells are filled with nectar at the earliest opportunity. Storing nectar above the brood nest serves two separate purposes in the nectar management scheme. Storing nectar overhead offsets the tendency to backfill brood volume to attain swarm commit requirements, and provides frames of open cell nectar to accelerate continued brood nest growth.

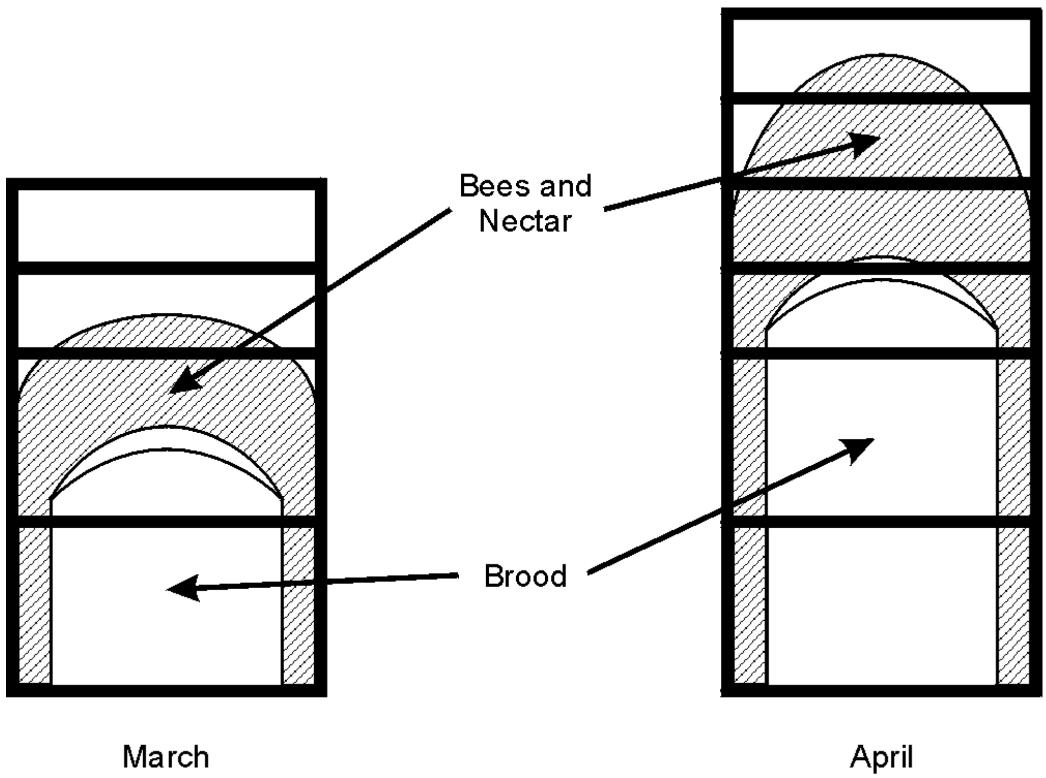

Figure 9: Cluster Volume During Build-up

Empty brood comb above the brood nest contributes to improvement of honey production. Brood nest growth in volume is accelerated by alternate frames of nectar. When the brood nest is growing into solid capped honey overhead, that honey must be consumed by the population to increase brood nest size. Thinning the amount of honey that must be consumed speeds up brood nest expansion. Population is the key to honey production, and of course brood volume is the key to population. Getting the population built up early pays big dividends.

The second honey production advantage is described above in relation to nectar storage in the empty comb. As the cluster volume grows, nectar is stored within the cluster boundaries, and above the brood nest dome. Overhead nectar is accumulated all through the swarm preparation season. This nectar is accumulated during the period when standard swarm prevention techniques would have you reducing colony strength for swarm prevention. By encouraging overhead storage early, two to three supers of honey can be added to total production. This subject is treated again in discussion of honey production at the end of this chapter. Nectar management induces faster and greater population growth with the same manipulation that prevents swarming. If that sounds contradictory, welcome aboard the fast train away from horse and buggy technology.

To start the manipulation, in the comfort of your honey house, select a super of comb suitable for rearing brood. It doesn't matter whether the comb is light or dark colored, but the cells must be deep enough for brood rearing. The bees will not use cells too shallow for brood. Select a super of worker brood comb for each hive on which you are going to apply nectar management techniques. Having selected a work box of empty comb suitable for rearing brood, remove alternate frames of honey in the top hive box and place them in the box to be added. Replace the frames of honey removed from the top box with empty frames from the work box. Both boxes will then have frames of honey alternated with empty brood comb. Add the work box at the top of the hive. As the cluster enfolds the empty comb, the bees will store nectar in the empty frames. Although it might not be needed this early, we normally add a full empty of drawn comb above at the same time.

Maintain empty supers of drawn comb above the cluster volume for storage at least to the appearance of new wax. At that time foundation can be used.

The winter configuration presented in the sketch reflects our current thinking. Two good drivers are the ease of manipulations with shallow frames, and the fact of never having to lift a deep of honey. A deep of brood is much lighter in weight than a deep of honey. A cell of brood at any stage of development weighs far less than an extended cell of capped honey. A third advantage is that when medicating you know where the brood nest will be.

It is true that honeybees much prefer to rear brood on the larger expanse of comb provided by deep frames. It's as close as they can get to the continuous comb of the wild brood nest in the tree hollow. But a choice of two deeps to prepare the winter brood nest is one too many. They do not want the brood nest spanning the gap in functional comb between the two deeps. So they have to decide, before brood nest closeout in the fall, which to use. In my area the choice is about 50/50. Half the colonies choose the lower, and half elect to winter in the upper hive body. Occasionally, a colony will straddle the decision fence and wind up going into winter with a cluster two or three frames wide and two stories high. This produces an inefficient winter cluster shape, but is probably better than selecting one or the other of the two hive bodies.

In the double deep, during the white wax flow, the colony stores winter rations. They often treat the gap in functional comb between deeps as the dividing line between stores. Some will fill the upper with capped honey, and some will fill the lower with pollen. This pushes the cluster into the other box. In both cases the brood nest is competing with winter stores for space. This restricts brood nest expansion in the fall when they need to be rearing young bees for wintering.

Three features of their normal preparations for wintering do not get much press in the literature. First, they literally fatten up for wintering. Large amounts of pollen are consumed in late fall/early winter by the bees expecting to winter. Pollen is consumed to enlarge internal fat bodies for wintering.

Secondly, they want to winter over liquid feed in the center of the cluster. The liquid feed can be diluted honey, nectar, or a combination of the two. This liquid feed is backfilled after the last brood emerges in the fall. The cluster feeds on this in early winter, freeing up cells for mid-winter brood rearing. The northern literature reflects empty cells in the cluster are for bees to fill to assist the insulation properties of the cluster shell. In the southeast, the only time we see bees upended in cells is when that colony starved. The properly-prepared winter brood nest has no empty cells in early winter.

Thirdly, the colony wants to scale the cluster volume going into winter to be proportional to winter stores. The theory of equilibrium holds that the colony must strike a happy medium between two extremes. If they have too many bees for stores available, they run the risk of winter starvation. If they do not have enough bees, build up will be slow, and the colony will not meet reproduction requirements. The timing of brood nest close-out in the fall reflects this characteristic. Those with ample bees stop brood rearing earlier. Those with fewer bees will often extend brood rearing into hard freeze weather, and fail to get their brood nest prepared for winter.

At the risk of boring the reader beyond endurance, we want to pursue the evils of the double deep a bit further. If you recognize that your production season starts in the preceding fall, you will be patient. We believe that the double deep is the worst possible choice of wintering configurations for the southeast. A single deep and feed box shallow, or three intermediates is better. Although the double deep is the standard for a large area of the United States, it gives the bees problems in the fall. They do not want to have their winter cluster span the gap in functional comb of about an inch and a half between hive bodies. That is exactly where they would like to have their cluster, but for the gap. They want to have the cluster located between honey stores above and pollen stores below.

In the southeast, the colony does not generally "move-up" by consumption of honey in the winter. Those that opt to winter in the lower hive body, and forage availability supports proper brood nest preparation, over winter in the lower. Upward movement is limited to <u>expansion</u> of the brood nest in late winter/early spring. In late winter they will expand the brood nest laterally, frame to frame, until the lower box is filled with brood. Only then will they jump the fearsome gap to rear brood in the upper. They will continue to maintain brood in the lower while expanding the brood nest into the upper.

The colony that fills the upper hive body with capped honey during the "main flow" in early summer automatically is rearing brood in the lower. Conversely, the colony that filled the lower with pollen is rearing brood in the top chamber. Where pollen is concerned, "filled" is not accurate. It would be more accurate to say some pollen (perhaps less than half a brood depth cell) in all cells. It is obviously stored for the long term because it is ugly with honey glazing. Current feed pollen is generally filled near the top of cells and is dry, retaining its bright colors.

Back to where we were headed: The colony that has all its brood in either chamber will generally get that chamber properly prepared for winter, and winter there.

The colony that has brood in both chambers at the end of the white wax flow must decide which one to prepare for wintering. Since they have cut back on brood production, they will often have random frames of brood and pollen in both boxes. There is no well-defined brood nest. No matter which hive body they choose, the brood volume is competing with stores volume to rear young bees for winter.

The worst case scenario is the colony that opts to use the bottom box for a brood nest. They have a tendency to want brood below honey stores. They make this choice in late Summer, as the Fall flow is starting. There is already substantial pollen in the bottom box when the decision is made. Pollen is difficult to move and must be consumed by the population and brood. (Adult bees eat pollen) This complicates consolidating the brood nest. Then, in late Fall/early Winter, when consumption of pollen increases for the "fattening up" process, that colony is uncomfortable with their situation. They panic, and move the cluster up into the upper hive body of solid capped honey. Located over solid capped honey, the winter brood rearing is slowed, getting them off to a poor start for the following season. Consumption of honey with increased cell depth is much slower than nectar at brood rearing depth.

In summary, the colony does not need a break in functional comb right where they would like to have their winter cluster. Note that in the recommended winter configuration the break is above and below the single hive body. There is no doubt in their wee minds where they want the winter cluster.

Since moving to this configuration, we have seen a positive improvement in wintering. Instead of one in four colonies emerging from Winter with feeble clusters, the February clusters are more uniform in strength. Two seasons may not be solid proof of the advantages, but the results are definitely encouraging.

Further, the fall hive openings for medications have revealed what can only be described as contentment. The colonies are not struggling with meeting survival requirements in spite of the design of their residence.

The bottom shallow of pollen is also an investment in wintering. To encourage reliable wintering in the deep, the colony needs the confidence factor of pollen stored below. Several ways were tried over several years to make this happen. We knew all along that placing a shallow of brood on the bottom board would be effective, but at the time we were using double deeps. When we replaced the upper deep with two shallows, it simplified the manipulation required. When the shallow above the deep is filled with brood, move it to the bottom board. In this way, no brood is separated from either the pollen or liquid feed requirements. The previous winter pollen box can be used higher in the stack for continued brood nest expansion. It is obviously brood comb because it had brood in it when it was placed there. It may not be necessary to replace it with a super of brood if the center frames are filled with brood or pollen. Some colonies will expand the brood nest down into pollen. But if it is essentially empty, replace it on the bottom board with brood and move it up. During the brood nest reduction of the "main flow", the bottom shallow of brood will be backfilled with pollen. Although this is an extra manipulation in a low-effort system, the results are worth the time invested. It is not part of nectar management for swarm prevention. But wintering is definitely a significant element of honey production. The wintering benefit of this manipulation comes from making the colony comfortable with filling the deep with brood in the Fall. Rearing more brood in the Fall produces more young bees for wintering.

The shallow supers used above the basic brood nest deep do not seem to impede brood nest expansion enough to cause concern. In the Spring build up, the colony is driven by the urge to reproduce. Equivalent to the mammal sex drive, that's a strong motivation. In this area, with a short build up season, a nominal over wintered colony can fill four shallows with brood to add to their deep. The top two are harvestable after brood nest reduction during the "main flow." Contrary to literature innuendo, we see no degradation of premium honey extracted from brood comb. Feed pollen trapped upstairs by brood nest reduction may be a nuisance during the extraction process, but if put back on the colony, will be cleaned out by consumption. Pollen is the primary target of the "wax" moth. Avoid the temptation of storing frames with some pollen content.

Comparable swarm prevention results can be achieved in the double deep by thinning the honey in the upper hive body when the cluster is located in the lower. Remove three frames of honey from the upper, and replace with brood comb. Select the three frames on an "every other one" basis, through the center frames. If brood comb is not available, carefully uncap and extract the honey, and return to their original location. There is no harm done if those frames are missing for several days to a week in the early season.

Of course, if the cluster is located in the upper hive body, all that is required is the reversal of hive bodies and adding brood comb at the top. They will sometimes use the "empty" at the bottom for pollen to rear full frames of brood in the upper. The pollen will be stored in the upper edge of the bottom box and will be out of reach when raised.

We consider this swarm prevention system to be dirt simple, but that may be because it is familiar to us. The system is ideally suited to the weekend hobbyist. Standard management, where the beekeeper needs to check for swarm cells within the nine-day larva capping period, imposes a weekly check. Weekends in late winter/early spring often do not provide hive-opening weather on either day. The weekender is forced to grit his teeth and hope for the best, or inspect the colony under adverse conditions. Nectar management provides a wider timing tolerance for inspection. When you learn to read the signals described in this book, you will realize that you can inspect for swarm intent less frequently. And when you gain confidence in reading those signals it will be apparent that looking for swarm cells is not required at all.

In Chapter I, the writer declared a swarm free year, early in the swarm season. It was not intended to brag, but to stimulate reader interest in the possibility of a better way. A week earlier the hives showed the effects of reproductive swarm cut-off (Chapter 4). And all hives were expanding the their brood nests into open-cell nectar overhead. Those two conditions equal no swarms, and do not change or turn around with advancing time.

In the years of '98 and '99 when some swarms were generated and intent to swarm showed up in the following year, it was decided that we were wintering in too much overhead honey. The extra overhead honey was a benefit to swarm prevention before we switched to nectar management. (Chapter 6) In the nectar management approach, brood nest expansion plays a key role. Alternated frames of honey and nectar reduces the number of frames needing blockage to stop brood nest expansion. Capped honey is an automatic blocker of expansion. In the example provided in Chapter 6, the frames of nectar were blocked with pollen. As time passes, the bees may find other ways to block expansion in the alternated nectar frames.

The '99 season blockage caused the writer to rethink the overhead wintering honey used as swarm prevention in prior years. We dropped from wintering in two deeps and a shallow to two shallows of overhead honey above a deep brood chamber. This configuration encourages brood nest expansion through the capped honey before the swarm preparation season. The accelerated expansion of alternate frames of nectar helps them build brood volume through the capped honey, and break out into solid nectar overhead sooner. The reliability of field nectar, locally lets me do this. In areas where build up nectar is less reliable, the beekeeper would need to assess local patterns to establish optimum overhead honey for wintering.

Nectar management works best when the colony is expanding the brood nest into solid overhead nectar. The colony is not likely to block expansion in all frames of the expansion dome with open-cell nectar all the way across. When the colony is expanding brood volume into solid overhead nectar, you can take a vacation during the swarming season. Nectar management is low-effort beekeeping. Pile on some supers (brood comb at the bottom) and take a break. Return in time to super for the white wax flow.

In case you missed it earlier, we'll say it again. The colony that is expanding the brood volume does not generate a reproductive swarm. By deliberately maintaining storage space at the top, overcrowding swarms are also averted. If your queen breeder has not significantly altered the characteristics of your bees, they will respond as described in this book. If they play by the rules of their ancestors, 100% swarm prevention is achievable. The management system is available if you choose to use it. If not, perhaps the information provided will help you make your favorite swarm prevention technique more reliable.

Swarm prevention is just part of the picture. The intense populations fomented by this system increase honey production by large margins. Some reasons for increased population are offered for your consideration:

Alternate frames of nectar in the overhead capped honey accelerate brood nest expansion during the build-up. Expansion rate is a product of honey consumption. With alternate frames of nectar, the total food value of a given volume is reduced, and consumption is accelerated. You are probably aware that hive body reversal of an empty on the bottom produces brood in the raised empty quite quickly. After filling the empty with nectar, the dome of brood displaces the nectar promptly. Alternate frames of nectar produces a brood volume growth rate somewhere between the empty reversed and growth into solid honey overhead. Brood volume growth is even faster into solid overhead nectar.

When unrestricted brood volume is encouraged, much larger brood volumes are generated. Nectar management induces queen supersedure after the swarm season. The supersedure queens can cycle brood at volumes above three hive bodies in our nine-frame system. That is generally 15 full deep frames of brood. That results in a strong population. Compare that with a double deep, ten frame brood nest. Typically the outside frame on both sides will contain the nectar / honey reserve or feed. The second frame in is allocated to feed pollen. That leaves six full frames of brood in the middle. Disregarding any backfilling that may have occurred during the swarm season, that leaves a maximum of 12 frames of brood. The competitive edge goes to the unrestricted brood nest.

Further, most colonies will increase brood volume into the house bee rearing phase of the Spring season. This means that population will be maximized for the white wax flow.

We have seen no evidence that the expanded brood nest of this system produces a "consumer" bee problem after the white wax flow. In seasons ranging from extra good to extra bad the bees have been able to regulate population such that there has been almost no erosion of accumulated honey. One Summer of extended dearth prior to the fall flow, some colonies moved up some, but stayed in the allotted brood chambers. Areas where the "flow" patterns are different from ours may not produce the same results.

CHAPTER 8

RECOVERY OPERATIONS HYPOSTHESIS

In Chapters 2, 3, and 4, changes in objectives and activities of the overwintered colony were described in general terms. The objectives and activities during the spring build up change as the season progresses. The early part of the build up is dedicated to creation of the reproductive swarm. Whether a swarm is produced or not, later in the spring season all colonies must adjust activities to restock the existing colony. Worker bee activities change in response to the objective of each period. We referred to these activities as "internal operations" of the colony.

The internal operations described in earlier chapters were those that affected reproductive swarming. Other seasonal adjustments in internal operations were not described. The fall brood nest shut-down, for example, is obviously a change in colony objectives with a corresponding change in internal operations.

The experts are unanimous in rejection of the concepts of internal operations described in this book. Reactions range from hilarity to hostility. It is human nature to summarily reject any concept that is contrary to our beliefs. Recognizing the futility of changing the minds of those entrenched in "conventional wisdom", we now take our message to the beginning beekeeper. The effects of the spring internal operational changes of the colony can be seen by anyone who will look for them. But the all-knowing expert, who is sure it ain't so, is not listening. The message here is that you shouldn't wait for your neighborhood expert to endorse these concepts. That will not happen for a very long time.

In this chapter, a hypothesis is offered for which proof is obscure. The hypothesis presents a description of an internal colony operational mode that is induced by colony perception of stores available. We only see the results of this mode, and to date, the effects of the operation in this mode only provides circumstantial evidence of its existence. Operation in this mode is triggered by colony awareness of need, and we suspect that operation in this mode is the reason for the success of nectar management.

The hypothesis jelled as a result of random observations during the 2001 spring season. We see reason to believe that nectar management induces a separate mode of operations that is oriented to colony survival. In Chapters 1 & 2 it was pointed out that colony survival takes priority over reproduction.

In the 2001 season, two separate, seasonal conditions led to a shortage of honey stores for the build up. The second year drought in the Fall caused less than normal honey accumulation going into Winter. Secondly, in late Winter/early Spring, flight opportunities were limited by cool, wet weather. The combination of circumstances led to more consumption of honey reserves than normal for this area. Some colonies consumed a substantial part of their reserves, and exhibited some of the same indications as a nectar managed colony.

Automatic supersedure of colonies that are nectar managed was a source of puzzlement from the beginning. In 1996, several supersedure cells were broken in checking for swarm cells. Checking for swarm cells was discontinued when it became obvious that nectar management induced supersedure in place of swarming. In subsequent seasons, the trend continued. The nectar managed colony will supersede between the reproductive swarm cut-off date and early in the "main flow." For some colonies, supersedure is the first order of business at reproductive cut-off, and when seen in several colonies is a good indication that reproductive cut-off has passed.

Swarming is a colony's preferred means of requeening on a regular basis. In this area, when prevented from swarming by beekeeper intervention, they will often supersede in mid Summer. On one occasion, an outyard of twelve colonies was between queens at the same time during the summer doldrums. Supersedure during the prime swarm issue period is notably abnormal. In retrospect, it appears that supersedure at that time is evidence that the nectar managed colony is operating in an abnormal mode.

HYPOTHESIS:

The honey bee colony that perceives empty comb above their brood nest goes into the recovery mode of internal operations. In this special mode the objective is to fill the overhead space with nectar. For the period it takes to fill that space, the normal season objective of swarming is put on hold and brood nest expansion continues. If the space is filled they can revert to the season objective of producing a reproductive swarm. If the space does not get filled, or the colony runs out of calendar time at reproductive cut-off without commitment to swarm, they will requeen by supersedure.

DISCUSSION:

In the wild, where the swarm goes to the top of the nest cavity to start building comb, this mode of operation would seldom be used. As they build comb down and out from the top of the cavity, the upper levels are filled first. In subsequent seasons, the brood nest is free to float up or down with stores availability. It would take a very lean fall season to have empty comb at the top. But if the need exists they will move honey down to the brood nest surrounding comb space. When they retrieve overhead honey to feed on, the honey is opened in a random pattern. This leaves patches of open cell honey scattered overhead. For reasons not obvious to this beekeeper, they generally do not use all the honey in those opened cells. They leave a low level residual in opened cells while opening other cells. Another interesting feature of overhead honey retrieval is the number of bees involved in the process. When opening overhead honey stores, that super will be filled with bees, wall to wall even if they have opened honey on only three frames. It gives the impression that those bees bold enough to dip into stores need a lot of encouragement from family members.

When desperate, the colony can retrieve overhead honey in colder, clustering temperatures. If the capped honey is separated from the cluster by empty comb, there will be wispy streamers of bees across the empty comb. They can crawl at temperatures too cold to fly. The retrieval crew in the capped honey forms a small clump of bees to retain enough warmth to do their job. When this is seen by the beekeeper, that colony needs feeding at, or in, the cluster immediately.

The colony has survival characteristics to accommodate whatever Mother Nature throws at them in seasonal forage availability. Forage availability varies greatly from season to season, and survival strategy varies with it. One example of survival strategy that shows up in the literature is the stopping of brood rearing when honey stores reach a cut-off level. When honey stores fall to about the equivalent of three deep frames of honey they put a hold on brood rearing. They not only stop recycling brood cells, but also stop feeding larval brood in development. Note that they do not wait until they run out of stored honey to invoke this survival strategy. They normally would not do this if there is nectar in the field, but in a dearth, they wait it out with their minimum reserve. When nectar is again available they pick up where they left off in brood rearing. Without foraging wear and tear, the adult bees have not aged much in the interim.

The experts know about this colony decision and its stark effects on internal operations. And still they reject any discussion of other operational changes. Pardon if we digress for a moment: When the colony decides that survival honey is getting low, and stops brood rearing, all developing larval brood discolors. It changes from the "pearly white" through yellowed to brownish when the brood starves. In our novice years we burned two colonies that had a "brood disease" that we didn't recognize. More recently, a colony with this condition was provided a super of honey and showed a miraculous recovery.

The reason this condition is belabored is that the reader has not been prepared for colony decision making and its results. The suddenness and totality of a change in operations was mentioned in the discussion of reproductive swarm cut-off. But you may find it difficult to believe that forty thousand residents can change their mindset overnight. In the bee colony, there are no dissenters; consensus prevails.

Back to a discussion of the recovery mode:

In more northerly locations where it takes more honey to sustain the colony through the Winter, the bees often have brood to the top. If the lower empty is raised, the colony is operating in the recovery mode immediately. All that is required to prevent swarming is to maintain empty comb above the raised empty hive body, so as to not let them fill the space to the top.

In the Southeast, where forage and flight weather are available before the colony has outgrown the hive body that they wintered in, swarming is a bigger problem. If they wintered in the top box and the lower is empty, it is much like their northern counterparts. If they wintered in the lower box and have a deep of solid capped honey above, swarm prevention is more difficult. They will use only part of the honey above before starting swarm preparations.

Nectar management serves the same purpose as brood to the top. Empty comb through the solid overhead capped honey improves the colony awareness of empty comb above. When they fill that empty comb to the top of the capped honey, they can't ignore the empty comb above. Nectar storage continues into the empty super above. Brood nest expansion continues through what would have been the reserve capped honey. The colony continues to operate in the recovery mode as long as empty comb is maintained at the top, or until reproductive swarm cut-off.

2001 SEASON:

Poor fall nectar availability and limited flight opportunity in the early season caused several colonies to have short reserves overhead in the late Winter. Most were wintered with two shallows above the deep brood nest. Although some had a few frames capped at the top, some had an empty at the top and less than a full box in their super above the brood. Several had a frame or two of brood above the deep in the first shallow. In other words, they had nectar-managed themselves by consumption of overhead honey or failure to fill it in the fall. They had opened a path through their reserve by using the honey for late Winter feed. Although unusual for this area they had improved their visibility of overhead empty space, and exhibited the same indications of a nectar-managed colony. It seems at this time that nectar-management thinning of overhead honey simulates a shortage of stored honey.

If this is true, it is a real shocker. For 200 years beekeepers thought they wanted their hives to go into Winter "fat", with solid capped honey overhead. In the Spring, they struggled with swarm prevention. Wouldn't it be ironic if those two goals were naturally, mutually exclusive?

With few exceptions, most of the observations presented in the "Wild Bee" book were the result of an attention-getting single hive. A colony would be doing something that the literature had not conditioned us to expect. Instead of requeening them because they were doing something "wrong", we encouraged them to do it their way to see if it could be determined how it might support survival. If the trend to react to the circumstances showed up in other hives to some degree, it was considered to be a survival trait of the species. This approach to investigation has yielded substantial useful information in just a few years. The information may not be 100% correct because some interpretation of observations is involved, but it is a start in the right direction. We suspect that we have just scratched the surface. The bees continue to add new data each season.

In the early years of nectar management investigation, we thought the reason the approach worked was that nectar accumulation consistently out-ran the target objective of a shallow super of reserve. In seasons 2001 and 2002, the bees demonstrated that the failure to reach the self-imposed limit of the reserve was not the reason for success of the scheme. Both those seasons provided less overhead nectar accumulation, and some colonies actually had less than a super of nectar overhead for different reasons. 2001 had very limited flying weather and in 2002 field nectar availability was limited by late season freezes. The indestructible maple actually failed in 2002, and other build up nectar sources were retarded.

If the hypothesis of his chapter is valid, it is an interesting turn of events. In an effort to offset one survival trait (maintaining the reserve) another survival trait (recovery mode) was exposed.

Having made my contribution, this beekeeper is inclined to step down, and let future beekeepers pursue investigation of survival traits that can be applied to hive management. When beekeepers start thinking in terms of survival traits, and not imposing their will on wild creatures, the sky is the limit.

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Call any day between 7 and 8 PM, I'm NEVER too busy to talk bees!