Comb Honey II: Super Management

Part II of Three Parts[1]

by JOHN A. HOGG[2]

FORWARD:

Beekeeping lore reminds us that to produce fine comb honey colonies must be brimming over with bees in a strong honey flow, and that bees must be crowded or forced into supers to get started or lured into supers by bait comb. It is thought that bees are reluctant to occupy the small cavities in comb honey section supers.

The importance of colony strength and strong honey flows in comb honey production cannot be questioned; but a better definition of what constitutes adequate colony strength and honey flow intensity is needed, while the belief that bees must be or even can be forced into supers is a myth. Bees are never forced in any way against their natural inclination, but are simply enabled to do what comes naturally, and then not given another choice.

Admittedly, it is very likely that bees perceive comb section compartments to be small and tend to resist occupying them to some extent for this reason. For instance, it is reported that bees enter Halfcomb cassettes better than Round sections - presumably because the individual compartments are several fold greater, and possibly because of clarity (vs. opaqueness). But compartment size is only a secondary factor as a barrier to the start of work in comb supers.

In fact, the principal factors which are usually responsible for the failure of a colony to start work in supers are 1) lack of colony strength 2) poor or interrupted honey flow 3) the existence of substantial empty comb or 4) preparations for swarming have started. We will see that the bees start drawing comb in supers only when and as it is needed because that incoming nectar is both the reason for the needed comb and the principal stimulus for its construction.

The occasion of the need to start comb building in supers in a honeyflow, *as perceived by the bees,* is a pivotal event in colony direction; either the bees are enabled to start and build comb apace with the requirement for new comb to store nectar, or they prepare to swarm. It is the house bees, the principal architects of honey comb, that are apparently diverted to orchestrate the swarm.

The notion has been adopted that a "supernumerary" house bee population, idled variously and automatically exiled to the periphery of brood, is the principal factor responsible for initiating the swarm syndrome; and that the underlying strategies which represent the "best in the art" throughout this series on Hive and Super Management are effective when initiated on the threshold of the main season nectar flow, because they 1) provide full and timely employment of the house bee population or 2) control their behavior by radical intervention and sometimes 3) blunt the "peak" of the house bee population. This notion will be fully elaborated and placed in context with hive and super management practices in the final paper of this series entitled "Comb Honey III: The Swarm Syndrome in Perspective."[3]

New knowledge about how the bees process nectar and regulate comb building, combined with old insights, now provides a better understanding of the art of comb honey production and how the beekeeper might further improve the management of comb honey supers.

I. INTRODUCTION: THE STATE OF THE ART.

The state of the art with respect to the processing of nectar and comb building has been reviewed for key information useful to the comb honey producer and abstracted here with source references for further study. This knowledge is of fundamental importance in order to understand and manage the start, continuation and completion of work in comb honey supers.

A. THE QUEEN AND BROOD ARE ESSENTIAL STIMULANTS FOR COMB BUILDING.

H.R.Hepburn reviewed the role of the queen and brood in comb building and summarized the experimental evidence in his book HONEYBEES AND WAX (1986)[4] as follows:

"Comb construction itself depends very greatly on the quality or 'state' of the queen. That some egg-laying-workers and virgin queens stimulated comb construction, but not to the same extent as did mated queens, strongly points to the importance of the relative composition of the queen-like scent as the driving force in comb construction, all other things being equal.. . . . The combined measurements and experimental observations (of several investigators) reveal the role of brood as a stimulus for the development of wax glands and subsequent secretion and comb construction, all juxtaposed against the queen as a stimulus. . . . .
the combination of queenright and broodright appears to be a more powerful stimulus than any of the other conditions investigated to date."

It has long been known by comb honey producers that queenless bees do not build comb[5]; and that the presence of brood is an important stimulant for the start of work in supers.[6]

B. BEES BUILD COMB FOR NECTAR STORAGE ONLY WHEN NEEDED.

Colin G. Butler in his book THE WORLD OF THE HONEY BEE (1974)[7] was the first to record in detail the processing of nectar by house bees, and to formulate the hypothesis, based on "the sense of that time" that comb building by honey bees is tightly linked to the need for it. It is useful to know how nectar is processed - in Butler's words:

"On returning home with a load of nectar a forager gives most of it up to one

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or more household bees, each of whom seeks out a quiet part of the hive *and proceeds to manipulate the nectar with her mouthparts. A bee that is processing nectar in this way opens her mandibles and regurgitates a little nectar from her honey-stomach at the same time as she moves her tongue forwards and downwards from its resting position beneath her head. The tongue's tip is then slowly raised and, almost immediately afterwards, retracted again. The complete cycle of movements is repeated over and over again, the tip being raised a little further each time and a little more nectar regurgitated, until quite a large drop has appeared and lies exposed below her still partly folded tongue. The whole drop is swallowed once more and the process repeated perhaps eighty or ninety times during the course of about twenty minutes. In this way a relatively large surface area of nectar is continually being exposed to the drying influence of the hive atmosphere and evaporation of water from it takes place quite quickly.. . . . . After she has manipulated the nectar for about twenty minutes the housebee deposits it in a cell - usually an empty one or one which already contains a little semi-processed nectar. Sometimes, when room is scarce and nectar is coming in fast, it is dumped temporarily in a cell containing an egg, or even a young larva, and it may be put in the cell in this way without receiving any preliminary processing. Later on, often at night, this semi-processed nectar, or unripe honey, is taken out of the cells by household bees and subjected to further processing. Eventually when its water content has become reduced enough by evaporation, a good deal of which occurs whilst it is in a cell awaiting further manipulation by the bees, it is taken and sealed away in storage cells."*

Note the temporary use of even occupied brood cells to ripen nectar. This accounts for the shower of nectar when a brood frame is shaken, indicating that a flow is in progress, which is called a "shake". Butler reasons, elsewhere in his text, that:

"If there is insufficient comb space available for the storage of this nectar, the household bees are compelled to retain it temporarily within their own honey-stomachs. Now it seems that when a bee has to function as a reservoir for nectar for hours on end a fairly high proportion of the contained sugar is assimilated, and that this results in the wax glands secreting wax scales abundantly. Provided that there is enough space in the hive, or nesting cavity, to allow the bees to extend old combs and build further, new, ones they do so. Thus by means of this simple sequence of events sufficient comb space is developed, as and when required, for the storage of "surplus" honey. . . . . . wax secretion and comb building appear to be linked up with a colony's requirements for comb space in which to store incoming nectar. . . . . The whole thing is brought about automatically and most effectively."

C. THE REGULATION OF COMB CONSTRUCTION

Thomas D. Seeley in his book THE WISDOM OF THE HIVE (1995)[8] presents experimental validation of the tight link between nectar intake and comb building, as hypothesized by Butler; but goes much further to establish experimentally the factors which regulate the start, continuance and termination of comb building, as well as how the collection and processing of nectar is coordinated. Of interest is Seeley's discovery that the function of the tremble dance by foragers, the one remaining dance that von Frish had failed to explain, is to recruit the house bees for nectar processing.

1. The Start of Comb Building. Seeley et al showed that in small queenright/broodright colonies the two co-factors required to initiate comb building are a) high nectar intake and b) nearly full (60-80%) storage combs. This is to say that, in a nectar flow, comb building is started only when the available empty comb is near full - *as perceived by the bees.* But once started, comb building will be shut down when the nectar intake (honeyflow) stops.

The definition of "comb fullness'' by which bees sense the need to build comb is important new information for beekeepers. That first super of foundation should be in place sooner than the beekeeper may think to enable a smooth start in comb building and subsequent supers as well to avoid the termination of comb building automatically in preceding supers as they approach fullness - known by beekeepers to be the case.

2. The Continuation of Comb Building. The "surprising discovery" (seemingly a paradox) was that, once comb building has started, fullness of combs ceases to be an essential factor to *maintain* comb building. The bees continue to build comb even in the presence of empty comb. Only the high nectar intake is required, as was shown by manipulating empty comb space in the presence of continuous high nectar intake.

Seeley notes that in nature, a colony will probably never experience an abrupt emptying of its storage combs, as was experimentally contrived, especially when a nectar flow is under way.

It may be possible, however, to put this discovery to good use by the discrete use of a partially filled extracting super on top as the flow-end approaches to enable completion of the last comb super(s). (See Section IIC)

This extra nectar storage space could serve as a stimuli to foraging without shutting down the construction of that last comb - a seeming paradox in view of the effect of empty comb as a deterrent to the start of comb building at the beginning of the flow.

3. The Termination of Comb Building. Seeley also notes two circumstances encountered in their experiments, aside from the lack of incoming nectar, which shut down comb building.

One of these circumstances occurs in a fall flow after brooding declines and vacating brood cells provide *alternative nectar storage space*, thus eliminating the need for new comb. This is why comb honey production in the fall is "iffy", except in an exceptional flow.

The second circumstance was the occasion when the bees in the experimental hive were observed to have built queen cells in preparation to swarm.

It has long been known to comb honey producers that bees will not *start* work in supers preparing to swarm; and that when bees *stop* working in seemingly unfilled supers, it is usually a signal of preparations to swarm. By analogy with their sense of comb fullness before starting to build new comb, perhaps the bees also sense the pending fullness of the surplus compartment and stop building comb in advance even as nectar is still incoming - given no further super.

The question of cause or effect might be asked here: Do the bees stop comb building because they are preparing to swarm or do they prepare to swarm because comb building has been terminated by some mechanism that induces swarming. This will be further discussed in the final paper of this series.

4. The Capping of Honeycomb. It is important to know that it is largely the housebees less than ten days of age that cap the comb. Any circumstance in which the housebee population is too low at the time of capping should be avoided - since capping of comb by older bees may explain why the capped comb is sometimes less attractive in a colony which had earlier produced fine cappings.

II. DISCUSSION: SUPER MANAGEMENT

The important and obvious difference between comb honey production and extracted honey production is the simple fact that in the latter case the bees, given supers with a super-abundance of empty comb continuously, have no need to build new comb at the start and during the honeyflow and are far less likely to swarm as a result. The management of comb supers must therefore differ from that of extracting supers in order to maximally enable the start, continuation and completion of comb building during the flow while avoiding the swarm.

A. GETTING BEES STARTED IN COMB HONEY SUPERS.

Getting bees to start building comb is the name of the game. To illustrate, the following situations have been selected.

The start of work in supers depends so much on the "status quo" within the super at the start of the honeyflow. This, in turn, is either the resultant of the spring management style or is "manipulated" on the threshold of the honeyflow to assure a start of work in supers.

1. Supering the Unmanaged Hive. When comb honey supers are given to essentially unmanaged colonies on the threshold a honeyflow, the result becomes a matter of chance, depending on those conditions within the hive, i.e. the "status quo".

If the bees do not start work in the comb honey super on such hives, or work only in some small portion of it, the reason, aside from the quality of the honeyflow, is usually one of the following:

a) Colony Strength is Inadequate. The population of the colony should be sufficient for the cluster to fully occupy and keep warm both the brood chamber(s) and the comb super space given them - especially at night when much of comb building occurs, and when low ambient temperatures may cause the cluster to contract away from the comb honey super in order to keep the brood warm.

Hepburn[4] states that "How wax *synthesis* and comb-building are constrained by thermal conditions is not well understood." but goes on to say that:

"The onset of comb production in spring is well correlated with 52ºF ambient temperature for a temperate stock of bees (Koch 1961) and it has been suggested that sustained comb-building in practical apiculture occurs at about 61ºF (Brunner 1905). . . . . It has often been claimed (Philipp 1930; Budel 1958; Weiss 1965), but never shown, that a nest temperature of 92ºF is essential for wax secretion and comb-building. Indeed, Darchen (1962b) recorded a range of temperatures around festoons varying from 86ºF to 93ºF, while Hepburn et al. (1984) recorded a maximum of just below 92ºF in the core temperatures of clusters of building bees [festoons]."

Better thermal regulations in the comb supers may account, in part, for the popularity of single brood chambers vs. double in comb honey production. Certainly, erratic ambient temperatures early in the season are not only responsible for difficulty in thermo regulations in supers, but also for brood mortality in a poorly organized brood nest.

b) Under-utilized Comb. Recall that bees do not build new comb for nectar storage when there is a substantial reserve of empty comb; that is, until there is a need for it. Such a colony is simply not yet ready to start comb building.

c) The Colony is Preparing to Swarm or Has Swarmed. As we have seen (I C-3) colonies with swarming preparations underway do not build comb. If swarm cells are present and they have not already swarmed, such "unmanaged" colonies may be candidates for managed control by the strategy of renewal, *provided a seasonally sustainable honeyflow is imminent and that nectar is already coming in.*

2. Supering a Hive "Timed" for Peak Readiness. Many knowledgeable beekeepers rely on their skill to *Time* peak readiness without swarming to start work in comb honey supers just when the principal honey flow arrives; these involve "resetting the clock" early on by making splits, equalizing colonies (adding or removing brood) etc. or other "open brood nest" practices such as the widely acclaimed deep-swap for temporary swarm control. Success is a matter of finesse with some luck. The luck depends on the probability that the start of the flow will precede peak readiness; the other way around, they are likely to swarm.

3. Managed Control of the "Status Quo". By the hive management strategy of renewal described in Part I of this series "Comb Honey I: Hive Management" *ABJ* (Jan.1997)[1], control of the start of work in comb supers without swarming is achieved, provided that a seasonably sustainable honeyflow is imminent and that minor flows are in progress when implemented. It is not a substitute for those preflow swarm control procedures mentioned above, generally classified as "open brood nest management".

The aim in the strategy of renewal is to simulate, at least in part, the condition of an already swarmed hive without the loss of the bees so as to maximize honey production and to offset the inclination to swarm.

This strategy, exemplified by the Juniper Hill plan which will now be revisited briefly, is implemented by a *managed discontinuity in brood rearing* of duration approximately equal to that which occurs in natural swarming.

This is accomplished by the *temporary* use of the classically acclaimed DeMaree plan for swarm control, because, in the DeMareed hive (fig.1), the queen is isolated from most of her brood by an excluder. Thus, inherently, the period of brood rearing discontinuity is *initiated* in hive body #2 - which is to become the honey producing hive body - and is terminated ten days later by the split (fig.2). Overall, the DeMareed hive remains queenright and broodright throughout. If a queen other than the hive queen is returned to #2, she must be cage-introduced and queen cell presence must not be overlooked.

If it had been necessary to remove queen cells during the DeMaree, an empty extracting super or a partially drawn comb super is required on top (fig.1). The shal-

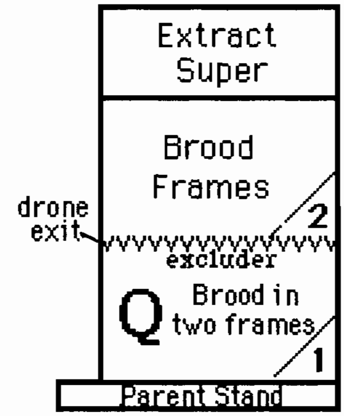

Fig.1 - Temporary DeMaree for Brood Break

low super will serve as a buffer after the split to avoid staining and pollen in the comb honey super(s). Later, at the time of the split, the comb honey super(s) must be placed on top.

After the split, with comb honey super(s) in place and the hive queen returned to her brood, the bees will promptly move the logjam of honey up into the comb super(s) to make room for brood when the queen begins to lay. Work in the supers has been jump-started giving the appearance of an artificial honeyflow; that honey stored during the break has been reserved to go into the comb super(s).

4. Supering the Extract Producing Hive: A Failsafe "Opportunistic" Alternative. There is a simple alternative which is as failsafe as it gets for the extracted honey producer to also produce comb honey[1] with no change in the hive management plan in use.

Powerful colonies in the best locations are selected "opportunistically" *after* they are beyond risk of the swarming well into the "heart of the flow"[9]; working vigorously in extract supers and obviously still free of any notion to swarm.

At this time, transfer the extract supers from the chosen hive to a neighbor colony with extract supers and install at least two comb supers in their place: then after the comb supers are full, return the hive to extract production.

There is now reason to believe that, it may be feasible to leave one of the partly filled extract supers on top of the comb supers to enable completion of the last comb supers, as will be explained under "completion of work in supers." If an extract super should be used on top as an extra stimulant and the flow is strong, the comb supers should be removed promptly when completed or the bees will build burr comb in the space below the extract super when it is filled.

This plan is compatible with any extract-producing equipment or system; the risks are significantly reduced; and if the flow falters, the comb supers are sim-

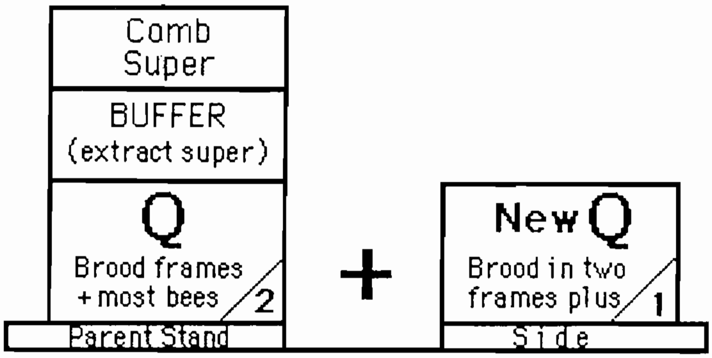

Fig. 2 - The split on parent stand, with side hive *rear facing* to be requeened and reunited later

ply set aside to another time while the extract supers will assure whatever crop is to be had. The only additional capital investment is the standard comb honey super itself.

B. THE CONTINUATION OF WORK IN COMB HONEY SUPERS.

Space control management (supering) now becomes the name of the game, an art which is perhaps best covered by pointing out a few of the principles which have guided successful comb honey producers.

Once the bees have started to work in comb honey supers they will continue, given enough space and a continued nectar flow to do so. A shallow super of honey (or a rim of honey over brood), once a barrier to the *start* of comb building, now becomes an ally by minimizing the chance of pollen (or brood) in sections and or on the finished sections.

All cracks or holes at the super level, including the opening of inner covers, should be closed because cool air intake will suppress comb building near them, except in periods of very hot weather with warm nights.

With the exception of the Killion system[6], the general practice followed by many comb honey producers has been to expand super space rapidly in the early part of an extended flow and then to concentrate it in the latter part to minimize the number of unfinished sections.

E.R.Root in ABC/XYZ OF BEEKEEPING, 1935 edition[10] under "Comb Honey - How to Produce" stated one of the important guidelines for managing super space: *"The surplus compartment, whether made up of one super or half a dozen supers, should have some fresh foundation being drawn until near the close of the honeyflow."* But just how much?

It is evident to the comb producer that bees, building comb in a fixed allotment of supers, normally stop building short of filling them completely and usually prepare to swarm if the flow continues. The continuance of work in supers depends on adding further supers at a rate that *the bees perceive* to be non-limiting, and we don't know quantitatively what that limit is.

It is here that the major benefit of managing hives by the strategy of renewal becomes apparent, as taught by the Killions. They have demonstrated that the swarm simulated hive can be supered conservatively (crowded) with better results in filling supers; and have given us a practical formula for adjusting that "reserve" comb building space - namely, add the next super when the last one is 50% full. To quote again - *"It is impossible to crowd the bees enough to make them swarm."*

Following is the tiering up (super rotation) plan recommended by C.C.Miller[5] and used extensively with improvements by the Killions[6] in their unique renewal system: Each new super is placed on top and when 50% full, rotated to the bottom as the next is added on top, previous supers being moved up in order. The arrangement after the fourth super, for example, becomes as shown in fig. 3.

In this way progress in the last super on top is easily monitored to determine when it is time for rotation; each super then has its turn on the bottom where comb building is favored; then it moves up away from brood where cappings are less likely to be brood-nest travel stained, and finally harvested from the top *as soon as it is finished.*

The foregoing says that we can crowd bees in supers to get better results, not that we must always. For instance, it may be desirable sometimes to add a pair of supers to start with - such as in a very strong flow on a hive "brimming over with bees." Remember that, as sections fill, the cluster space inside the supers becomes markedly reduced. This provides the extra space for processing nectar as well as building comb, which will affect this problem early-on when it is most needed.

C. THE COMPLETION OF WORK IN SUPERS

The same principle which holds for the continuous completion of supers throughout the honeyflow also applies to that last near-full super at the end of the flow, as restated in another way by E.R.Root[10].

"The nearly finished super is usually finished more promptly if the bees are permitted to build comb in another super at the same time."

By this axiom, that "other" super will itself never be finished at the end of the flow. So, what does one do about that?

Comb honey specialists in the past have resorted to the practice of moving such near finished supers to the most pro-

Fig. 3 - Super tiering up arrangement after addition of 4th super.

ductive hives near the flow end or harvesting them and concentrating the unfinished sections into other supers to be returned, hopefully to be better filled. The latter practice is labor intensive and no longer practical in today's equipment.

Again E.R.Root[10], in his excellent summary of comb honey practices of that time, gives us a clue to one practical solution, namely: Intentionally dedicate an extra comb super with no expectation that it will be finished that season. At the end of the flow, this super "should *have but little unsealed honey stored in it, yet the foundation should be well drawn out and some of the combs at least partly built. This super, if taken off promptly and the bees permitted to clean out the little honey it contains, is just right for the first super next year.*"

The new Halfcomb super[11] is ideal for this purpose. By virtue of the clear plastic cassettes the termination of comb building, the end of the flow, can be readily monitored in the top super.

But the most important aspect of the Halfcomb cassette for this purpose is the durable nature of this new honey comb form when partially drawn (fig.4) and its reusability in a marketable product; the bees do not damage the comb when permitted to "clean out the comb" nor do they reinforce the foundation when work is resumed next season. This is because the foundation is embossed into the bottom of the plastic cassette and does not become part of the edible comb

This concept of intentionally oversupering near flow end with the notion of reusing it again next season, in round robin fashion, is ideal because the problem of getting comb building started in supers next season is minimized. Especially note that in the Juniper Hill plan, featured in this series, that the first super to be installed at the DeMaree stage if the bees had been preparing to swarm, should be one with drawn comb.

III. RECOMMENDATIONS

Because success with comb honey super management is so tied to hive management, especially at the start, these recommendations focus on the use of hive management strategies. The Juniper Hill plan, in particular, was designed for flexible use in full season comb honey-production or temporarily on extracted-honey producing hives.

1. FULL SEASON "COMB HONEY ONLY" PRODUCTION

The comb honey producer who chooses to produce comb honey only, or has no extractor or extracting supers, needs a plan by which comb production can be managed continuously over the full honey producing season. The Juniper Hill plan conducted in full through the three phases described in Part I of this series[1] is such a plan. However, the plan *must not be initiated* until the beginning of that substantial honeyflow (in any given region) that will occupy the bees; other means of pre-flow management, for buildup and swarm control should be practiced.

2. MIXED COMB HONEY AND EXTRACTED HONEY PRODUCTION

The extracted honey producer who chooses to also produce some comb honey needs a plan which is compatible with his systems. The Juniper Hill plan was designed also for this purpose. Phases 1 and 2 of the plan[1] (see IIA-3, this manuscript) may be conducted on selected hives in extract production on the threshold of the best flow, thus interrupting extract production and returning to it by reuniting (phase 3) up to six weeks into the main flow or beyond e.g. for the fall flow.

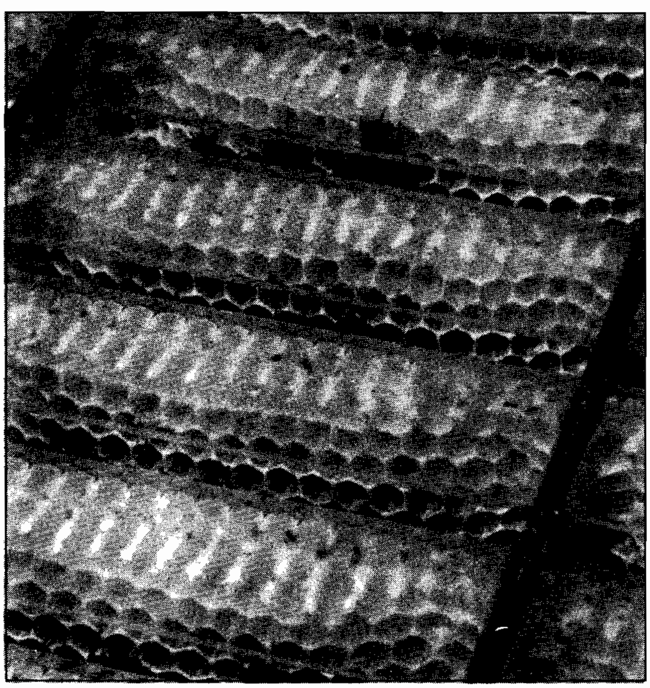

Fig. 4 - A partially filled Halfcomb super ideal for carry over to next season.

3. AN ALTERNATIVE FOR MIXED EXTRACTED HONEY AND COMB HONEY PRODUCTION.

For the extracted honey producers who wish to diversify into comb honey with the least possible extra investment in time or deviation from their extract system, the "Heart of the Flow" plan (See II A-4, this manuscript) is the way to go.

In this age, most beekeepers are extracted honey producers; most, I find, have a demand for some comb honey and some foresee comb honey as an opportunity and are looking at the options.

Hopefully these recommendations will serve to both encourage and enable an emerging new interest in comb honey.

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