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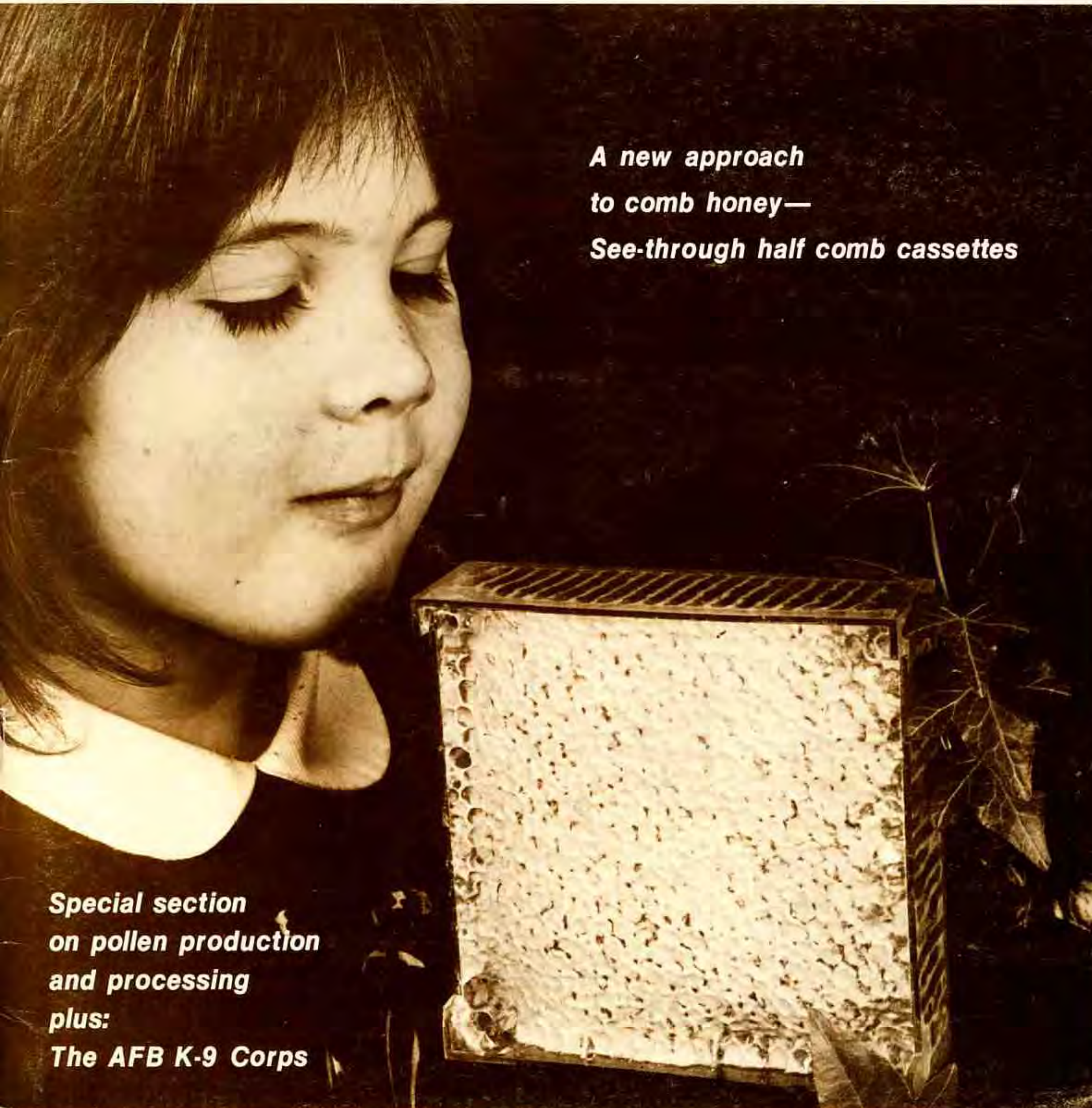

A new approach to comb honey— See-through half comb cassettes

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COVER STORY

A New Approach to Comb Honey

The Half Comb Honey Cassette[1,2]

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"Honey in the comb tells its own story as no human could ever describe it . . . . . It is nature's finest sweet in its own original package . . . . . Each cell of crystal clear honey is enclosed in pure beeswax and retains all of the fragrance of the fields of sweet blossoms from which it is gathered."

From the original "Honey in the Comb"
by Carl E. Killion.

I. **Introduction:**

THE HALF Comb Honey "Section," now termed a "Cassette" was first described in the May 1980 issue of *The American Bee Journal.*[2] The acceptability of the cassette to bees, using a hand-made prototype, was reported at that time.

The half comb honey cassette is a new plastic container for comb honey with comb foundation embossed on the inside bottom. The bees are induced to build comb directly on this base, filling the container with comb honey which is one-sided and deep-celled. Hence, the term "Half Comb." This distinguishing characteristic of half comb (unilateral) over conventional (bilateral) honey comb is illustrated by the cross sectional views in Figures 1a and 1b, respectively.

Half comb honey (fig. 1a) is intended to be used by the consumer directly from the container. It does not have the wax midrib which is present in conventional comb honey (fig. 1b). Thus, half comb honey contains nearly 50% less wax. Those who object to even this much wax can bypass most of it. The delicate wax cell walls are readily pushed aside in the cassette so that "freshly extracted" honey can be removed directly out of the cassette as used. The delicate flavor of the comb honey is not lost.

The concept of half comb honey was envisioned originally as the key (a *sine qua non*) to the design of a modular comb honey cassette which, when used in combinations in conventional Langstroth equipment, would assume the roles of the additional equipment currently required in comb honey production (section holders and separators). Further, the new cassette was envisioned to be of unit molded plastic construction in order to eliminate the need for comb honey section parts and assembly, and to constitute a package with cover suitable for marketing purposes as well as direct consumption of comb honey from the container.

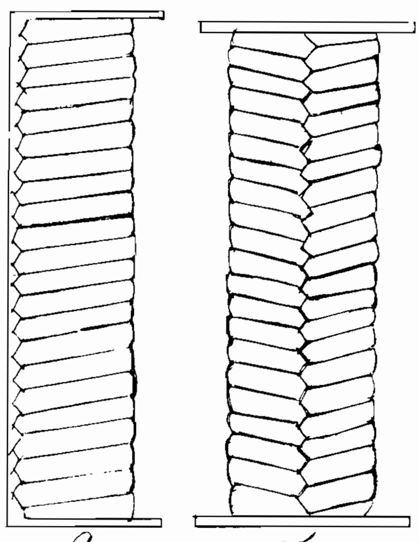

Figure 1: a) Half comb cross section. b) Conventional comb cross section.

In this report the first molded plastic half comb cassette prototype (Figure 2) is described, and the experimental trials with the cassettes on hives are discussed.

Interpretation of the results of these trials has led to the design of an improved plastic half comb cassette,[3] now being produced in a second experimental mold for trial in the 1984 season. The most important discovery and determinant of further design change is the apparent ability of the bees to "see through" the clear plastic of the cassette walls. This enables them to take cues in comb construction from comb structures and/or bee activity on the outside of the wall. In the new design the "see through" principle is exploited where it is advantageous and avoided where it is disadvantageous.

The most striking design change in the now fully developed half comb cassette is the rotating cover. This cover differs significantly in detail but not in principle from that of an earlier disclosure[4] (not shown). The design accommodates changes made to cope with the "see through" phenomenon. The cover is positioned on the cassette so that when on the hive bees have access to the interior. When filled with comb honey, the cover can be repositioned after rotating 90° to close the cassette for marketing or between usages by the consumer.

The improved half comb cassette with cover will be described in detail. The cumulative advantages to be expected from its use over current comb honey sections will be summarized from the points of view of the beekeeper, the merchant and the consumer, respectively.

II. The Experimental Molded Plastic Cassette

The first plastic cassettes were made without covers in an experimental single cavity mold having some capability for later adjustments. As will be seen, the rotating cover was not needed to obtain the further experience needed in this experimental phase for making decisions in design, dimension detail and the acceptability of plastic materials.

However, it was necessary that the interim cassette be square since this would be required to accommodate the anticipated rotating cover. The cover, shown later, is an important feature of the half comb product. Squareness in turn limits the selection of standard Langstroth equipment to house the cassettes to the 4¾" comb honey super, originally designed for 4¼" square beeway wooden sections. The cassette dimensions were adjusted accordingly allowing for accurate bee spacing and travel space. The first prototype is shown in Figure 2.

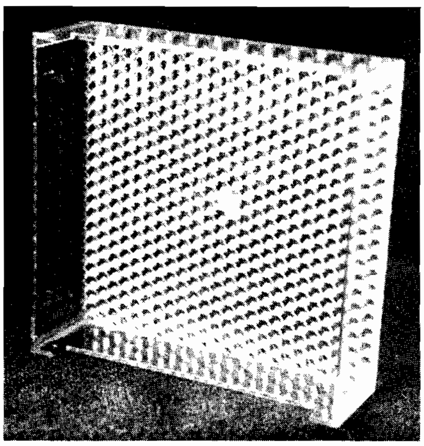

Figure 2: Experimental half comb cassette in clear plastic (without cover).

The inside depth of the first cassette prototype was set at 1 3/16", i.e. ⅞" deep comb plus 5/16" for bee space (which I now believe is more accurately represented by 9/32"). Another determinant of overall dimensions was the objective that each cassette should contain no less than 12 oz. net of honey. The ⅞" comb depth accommodates this objective. The outside depth without cover is 1 5/16". These cassettes are 4 7/16" x 4 7/16". The cassettes are stacked in columns of ten (see Figure 3) to be then placed in supers. The ends of the columns are supported by the follower boards on both sides within the super. Positive pressure on the columns is provided by standard super springs, while small feet in the base of each cassette protrude into the top corners of the neighbor cassette. These together constitute the self-supporting feature of the half comb cassettes when used in combinations in a super. Figure 4 shows a super packed with four columns of cassettes.

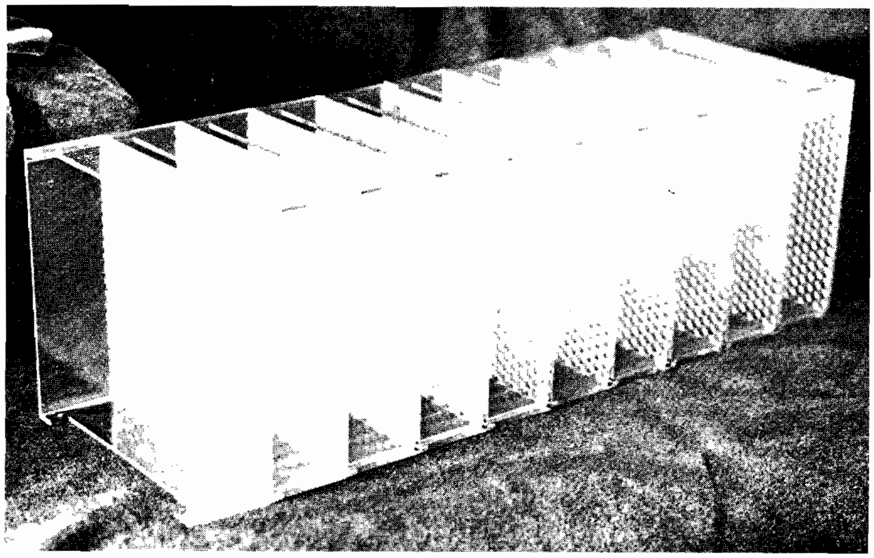

Figure 3: Self-supporting columns of ten (10) experimental half comb cassettes.

Clear plastic, food approved, was selected so that the intricacies and detail of honey comb would be fully visible. This is certainly a feature which would have considerable marketing and consumer appeal.

Twenty supers were assembled and most were placed on hives in the summer of 1983. The plastic foundation in each cassette was beeswax coated using melted wax applied with a foam brush.

III. Hive Management in Half Comb Cassette Trials

The spring of 1983 was cool and damp until early June. Plant growth had been delayed. Chalk brood developed in the hives. Early nectar flows for colony buildup were either suppressed or aborted, and the bees had begun to eliminate drones. Then the weather turned to the other extreme. High temperatures and dryness prevailed in southwestern Michigan through the entire period to the end of the main nectar flows in this area (August 10-15). Infrequent heavy rainfalls occurred on a remarkably non-uniform local basis, so that some apiary locations were favored. The intermittent and restricted nectar flow of the 1983 season was the poorest in 25 seasons on this location.

This scenario was a discouraging one for the producer of any honey form. But comb honey production, which thrives in predictable flows on strong colonies, was contraindicated. However, as will be seen, this apparent adversity may actually have been an ally.

The experimental trials with the half comb cassette supers were conducted either (a) on hives involved in double queen experiments in the consolidated brood nest arrangement[5] being managed to test swarming propensity under maximum inducement conditions;[6] or (b) on hives managed by the "shook swarm" technique[7] using either natural swarms or shook swarms.

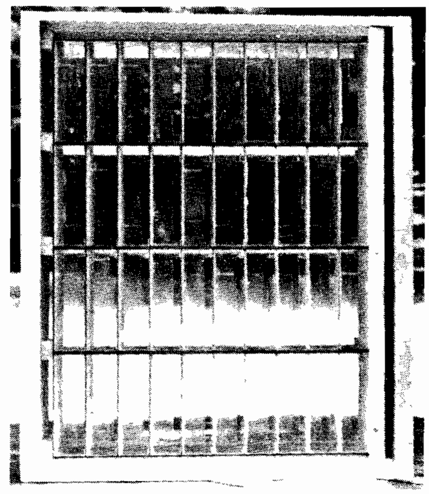

Figure 4: 4¾" comb honey super packed with 40 self-supporting experimental half comb cassettes.

The Killion comb honey super management practices[8] were followed as nearly as possible. Second supers were placed on top when the first super was one-half to two-thirds full and promptly moved below the first super next to the brood nest when a good start had been made. The third super, when that seemed called for, was also placed on top until a good start occurred in it and then moved down next to the brood chamber — raising the first two supers in unchanged order. During these operations supers were reversed front to back when about two-thirds full, retaining their vertical order on the hive.

IV. Experimental with Results and Conclusions

The earlier experimental half comb cassettes made of wood were shown to be well accepted and well filled by

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the bees, except for a curious reluctance to complete the outer rows of cells next to the wood perimenter. See Figure 5.

This was then thought to be due to the aversion of bees to work in such deep cells next to a solid structure. Comb honey in conventional wooden beeway sections appears to exhibit this same problem, but to a far less striking degree; which is consistent with the lesser depth of cells. (Compare Figures 1a and 1b.)

Seeking to find factors contributing to these phenomena, two experiments were conducted. Since bees normally slant cells upward 9-11°, the **first experiment** was to slant the entire hive sideways at a 9-11° angle and keep the hive level front to back. The rationale for this experiment was that the upwardly sloped cells would now be parallel to the upper and lower horizontal walls of the cassette. By avoiding crowding of the wall above and widening the gap below, outer cell rows might be better filled. Keeping the hive level front to back (usually hives are sloped forward) could eliminate a similar but less pronounced deterrent to attach comb on the vertical walls.

The **second experiment** on outer cell row construction was to evaluate the effect of the two possible alignments of cell bases next to the walls in the foundation embossed plastic cassettes. These alignments are either straight along the horizontal walls and zig-zag along the vertical pair (see Figure 6) or vice versa.

The experimental mold was constructed so that the part which serves as template for embossing the foundation in plastic could be installed in either alignment. Half of the experimental plastic cassettes were molded in each position.

One-half of the supers were packed with the plastic cassettes having one of the alignments and the other half in the alternate alignment (Experiment 2). Several of each of the foregoing were placed on a pair of 9-11° tilted double queen hives (Experiment 1). The remaining supers were placed

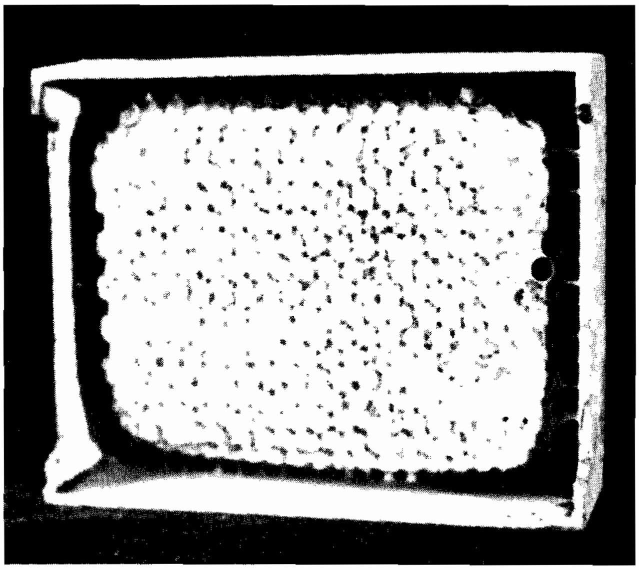

Figure 5: An earlier wood prototype of the half comb cassette showing unfilled outer rows.

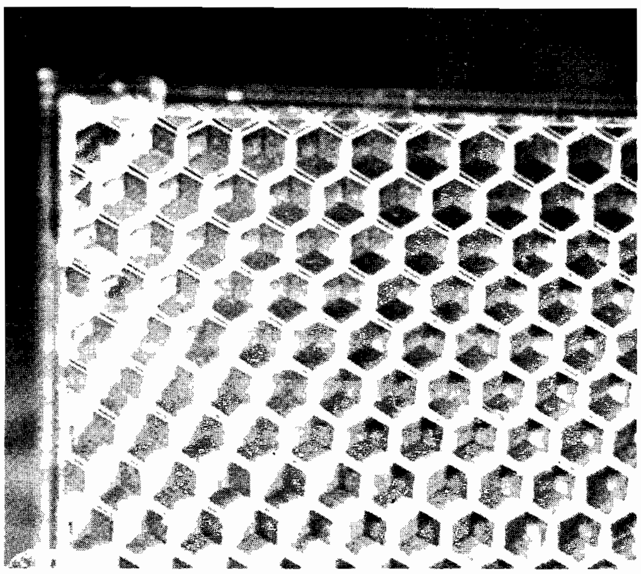

Figure 6: Corner of cassette showing embossed foundation with straight cell alignment along the bee entry slot side (horizontal) and zig-zag alignment on the vertical side.

on level hives.

Nectar gathering was intermittent. Bees hung out in great clusters on the hottest and most humid days, often during foraging hours. The shook swarms and natural swarms were obliged to loiter under conditions of extreme congestion at a time when wax production and comb building had high priority. Nevertheless, about 50% of the supers were filled and the remaining were in various stages of completion by mid-August. This performance was adequate to provide the needed information. The results were surprising.

There was a dramatic improvement in the filling of outer cell rows. These cells were completed, filled and capped right up to the inner cassette walls. This occurred irrespective of hive tilt (Experiment 1) or cell base alignment (Experiment 2). See Figure 7 (compare with Figure 5).

A second surprise, at first alarming, was the appearance of bizarre burr comb construction inside many of the half comb cassettes. The majority of the burr combs were in cassettes from hives that were made up of natural or shook swarms, and from hives forced to prepare for swarming. At first it was tempting to attribute the unwanted burr combs to congestion and loafing induced by inadequate foraging opportunity; and additionally, in the case of swarms, to greater wax secretion in response to the naturally higher priority for comb construction needed to re-establish a colony from a swarm. However, as it has turned out, these circumstances only contributed to the extent of the burr problem. Had there been ideal conditions for rapid filling of the half comb cassettes, the scope of the problem could have been masked.

The first clue to an explanation for the aforementioned differences in comb construction in clear plastic vs. wood cassettes came from the observed sharp contrast in filling the outer rows. In plastic, the bees were constructing continuous comb from one cassette to the next. A logical explanation for this is the possibility that a "visual" influence prevails through the clear plastic. Comb structures on the inside walls of the cassettes were closely examined for evidence of this hypothesis; indeed there was a clear tendency for the comb structures in adjacent cassettes to be mirror images, e.g. see Figure 8. The bees on opposite sides of the clear plastic were in fact constructing comb as though it were uninterrupted by the pair of cassette walls. But, the unpaired walls of the cassettes next to the super rims and those exposed for bee entry were also well filled; from this it follows that the presence of bee activity alone on the outside of the cassette walls is sufficient to induce the bees to fill the outside cell rows.

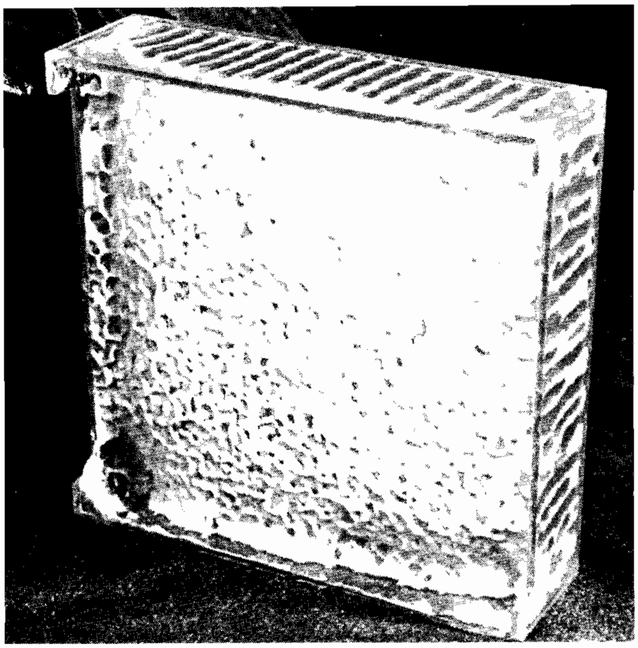

Figure 7: A cassette of half comb honey (without cover) in the experimental clear plastic prototype.

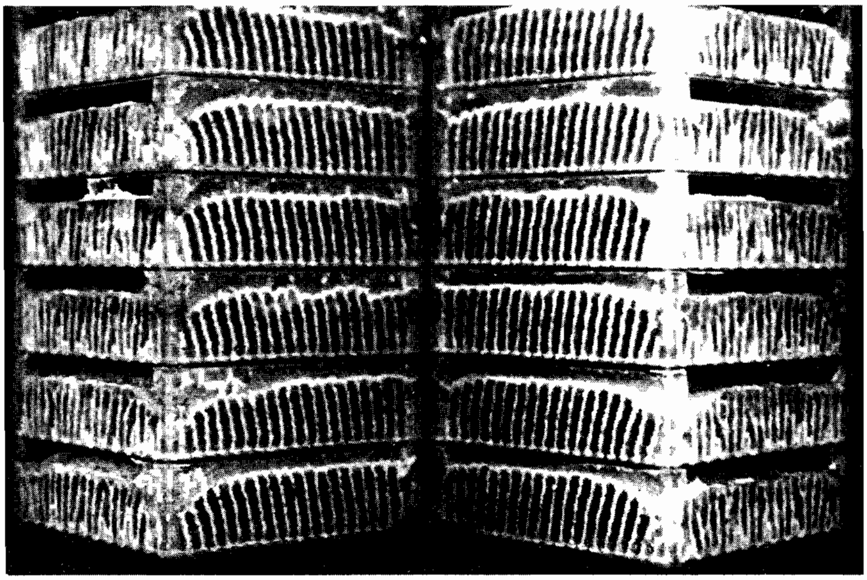

Figure 8: Columns of cassettes opened butterfly fashion from hive relation, as one opens a book, showing mirror image comb construction. (Upper cassette bee slots at outer right and left sides, respectively.)

Could it be that the same phenomenon was also responsible for the unwanted insertion of burr combs? Each type of burr comb was examined for evidence that the bees were taking comb construction cues from comb patterns, or bee activity, according to this "see through" hypothesis. There were three types of burrs, classified according to location as follows:

(1) **Corner Burrs:** The comb surface of a filled half comb cassette shows depressions at most of the corners. (See Figure 7). These depressions occur irrespective of the presence of corner burrs, but are more pronounced when there are corner burrs. An almost identical three-dimensional corner exists in standard 4¼" wood sections when in the super with wood separators, which discourages the filling of section corners somewhat. Yet corner burrs do not occur in these wood sections. This "corner effect" may be induced by the geometry of the three-dimensional corners which are formed in stacked half comb cassettes. It is awkward for the bees to honor the classical 5/16" Langstroth bee spacing. Therefore, the bees violate this imperative as comb construction approaches the corner arrangement. Bees propolize these corners in the standard wood beeway supers just as they do in clear half comb cassette packed supers. In the latter case, however, propolizing is more pronounced — presumably to cover the irregularity caused by the presence of the cassette column support feet resting there.

Once again, the primary difference is between wood and plastic construction; in the latter at these corners the bees "observe" bee activity through all three corner faces, and through one of these they also observe the foundation pattern of the next cassette along the stacked column. Thus induced, the bees now attempt to correct their inclination to violate bee space in such corners by the insertion of small comb structures; but they start from the corners and work outwardly. The matching of burr combs as pairs in adjacent cassettes, when they appear, occurred often enough to provide further evidence for the visual cue hypothesis. Occasionally, they extend these corner burr combs along the juncture of the cassette top edge with the bottom of the next cassette along the column.

(2) **Bottom Burrs:** A second type of burr was occasionally initiated directly on the bottom of a cassette as though the bees were attempting to build on the visible outline of the embossed foundation inside the neighbor cassette. Such burrs seemed to be started before the new cells inside the cassette began to receive nectar. Such burrs were randomly placed on the cassette bottoms, but favored locations near the perimeter opposite the last inside cells to receive nectar. Figure 9 shows the beginning of such a burr comb. Note in Figure 9 that the hexagons are centered by the 3-way junction of the cell outline of opposite side cells, as it would be in bilateral comb. Such comb seems to start as cell extensions of the opposite side foundation, and later convert to a center ribbed type of burr comb.

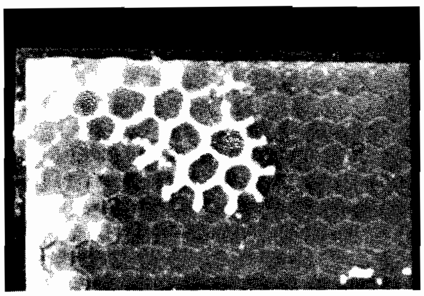

Figure 9: Beginning of a burr comb on the outside bottom of a cassette, cued by the inside foundation pattern.

(3) **Entrance Slot Burrs:** A third type of burr is one which originates as a burr comb outside the super and then is extended into the cassettes by the bees. An atypical case of this type of burr comb was in a shook swarm hive upon which the inner cover was inverted to give the crowded bees more cluster space, which was an obvious mistake. However, note in Figure 10 how the burrs inside the cassettes are aligned, having followed the course of the external burr comb. The bees, influenced by the visible outline of comb structure on the outside, extended this external burr comb inside the cassette before it was completely filled. The solution is to avoid the outside burrs by precise control of bees space between supers (i.e. 9/32").

The combined observations on improved filling of outside cassette rows and unwanted burr comb construction led to the conclusion that the use of clear plastic is indeed responsible for both. Where comb appeared on both sides of clear walls there was a definite tendency for a mirror image relationship. Comb structures appearing on unpaired sides were opposite "visible" bee activity. Such evidence strongly supports the hypothesis that bees "see through" the clear plastic walls. *The low levels of infiltrated light in the hive, or an unidentified source of visual stimulation, enable bees to take cues for comb construction from comb structures and/or bee activity on the opposite side of transparent walls.* The possibility exists that bees respond to the reflection of their own activity as cues.

The outer cell rows in the tilted hives (Experiment 1) were filled just as well as in the untilted hives; the only difference was that the bees improvised compensatory cell structures in untilted hives. It is possible that the logic for this experiment was valid, but that this was obscured by the overriding "see through" influence.

Whereas the alternate alignments (Experiment 2) of outer row cell bases in the cassettes also had no proveable effect on outer row filling, there was a marked difference in appearance of such cells when viewed through the clear plastic. Both were attractive. The zig-zag alignment tended to result in waffled cell lines (Figure 11) while the straight cell base alignment resulted in relatively regular cell lines (Figure 12). In either case, only the cells on the vertical sides were upsloped. This comparison is also seen in the cassette of Figure 7.

Experiments with various amounts of wax coating on the foundation, and full coating vs. rim coating, revealed little difference in how promptly the bees started cell construction. The start of comb construction was much delayed when there was no wax at all.

V. Changes in the Half Comb Cassette With Cover: The Second Prototype In Plastic.

Major changes in design were made in accord with the conclusions drawn from the hive trials.

To cope with the "corner effect" on burr comb insertion, it was necessary to eliminate the corners entirely by extending the bee entry slots the full width of the cassette; and also to eliminate the small feet which cooperated with the corners in neighboring cassettes to provide cassette column support while in the super. Since the principle function of the deleted parts was to serve the self-supporting column feature of the half comb cassette, an entirely new scheme was developed to restore these functions. The new design is shown in the sketches of Figure 13. Note that the upper outside corner edges of the cassette cavity are bevelled at a 45° angle, as are the inside corners of the cover which fits snugly against them. Being square, the cover fits the cassette cavity in either of the rotation positions, i.e. bee slot open for on-hive use or closed for off-hive use. The cover is secured from sidewise slippage along the axis of the open sides of the cover in either position by the contact of bevelled surfaces (a) in the cover of Figure 13 with those (b) in the cavity of Figure 13.

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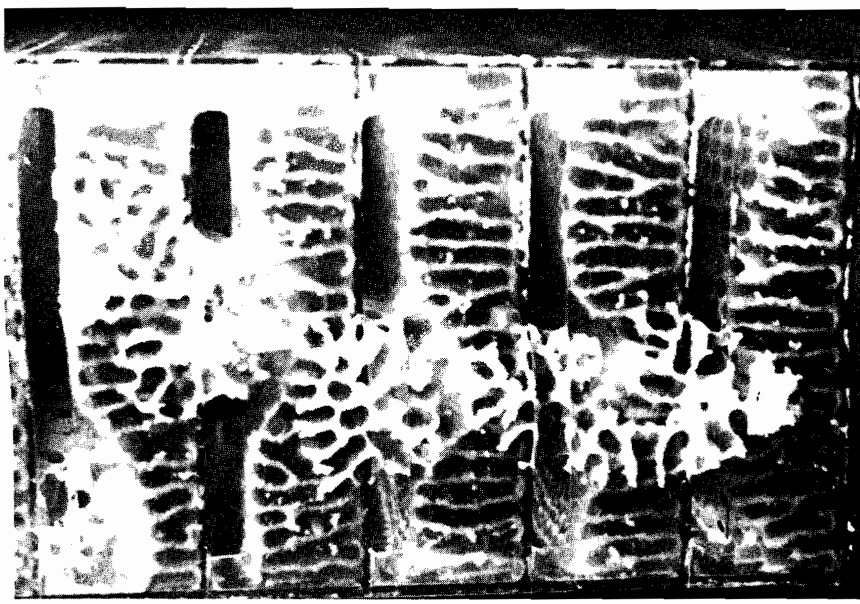

Figure 10: Cassette column showing extension of outside burr combs into the cassettes.

Self support of cassette columns when packed in a super under spring pressure is now provided by ledges (c) at the cassette base which fits inside the ridges (d) on the cover. Sidewise slippage, when so fitted, is also prevented by the additional lug (e) in the cassette base which fits into the receptacle (f) in the cover ridges. All surfaces of the assembled cassette are flush when the cover is in the on-hive position. This is due to the ledges at the two closed cavity sides for the cover sides to rest on. The cover surface is slightly dished (concave) as a template to give the same slightly dished contour to the comb surface.

To avoid the unwanted "see through" effect on the outside cassette bottoms, the new plastic mold was treated to produce a frosted effect there. If needed the frosting barrier for diffusion of image can be re-inforced by further frosting inside the cassette on the embossed foundation. The cover itself, when positioned on the cassette in the hive, serves as an additional barrier. It too can be frosted around the perimeter, further shielding bottom perimeters where most burrs were found. When so frosted, the cassette with cover has a two-tone appearance. The walls of the cassette where the "see through" effect is beneficial remain clear plastic.

VI. Discussion and Conclusion

The "visual" cue hypothesis has implications for additional study. It is reasonable to suspect a visual sensing mechanism other than by low levels of light infiltration through the hive entrance, such as one involving phosphorescense or low level bioluminescence. K. von Frisch[10] proved in 1914 that the honey bee can see colors and that, unlike man, this includes the ultraviolet. The evidence found here leaves no doubt of some visual capability, or its equivalent, in a dark hive. The practical application of this is the "two-tone" cassette. Clear plastic is used to induce comb building by visual cues where this is advantageous, and opaque or frosted plastic is used where comb construction is to be discouraged.

The novel cover is a "fail safe" feature in the event of a burr comb. Should an occasional burr comb appear attached to the inside cover, the cover would not be repositioned. The consumer then could easily detach the burr at the time of first use. The extra comb structure would add variety to the visual display for marketing.

It is possible that hive and super management practices with the clear half comb cassette will deviate from those recommended in contemporary comb honey production by virtue of

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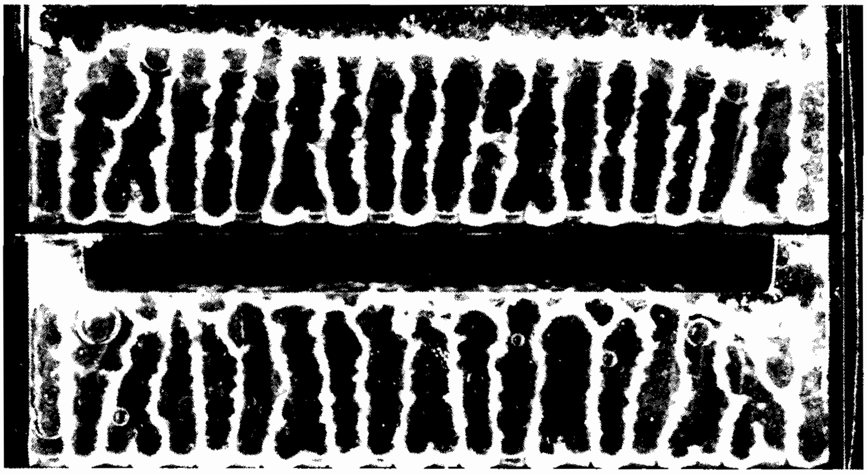

Figure 11: Waffled appearance of cells on the cassette sides with zig-zag cell base alignment; at the right is the lower horizontal side of a cassette, and at the left a vertical side showing upslope.

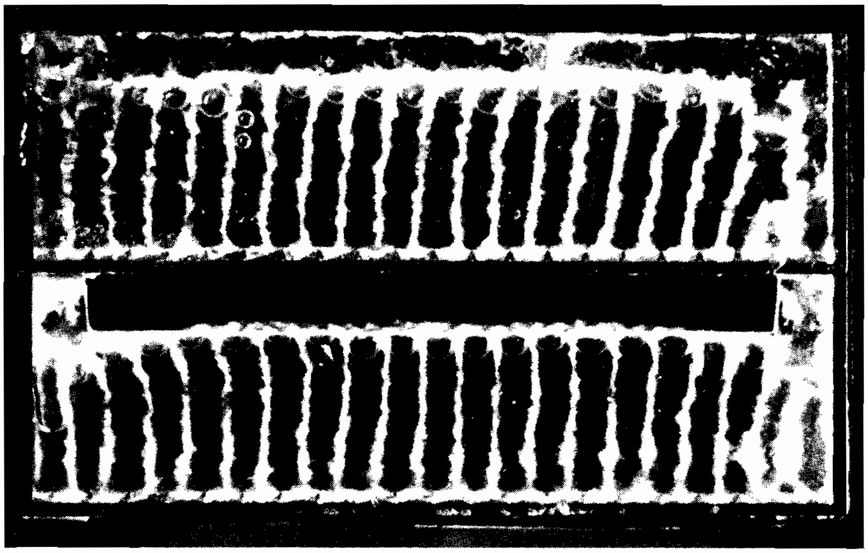

Figure 12: Relatively regular appearance of cells in the cassette sides with straight cell base alignment; at the right is the lower horizontal side of a cassette, and at the left a vertical side showing upslope.

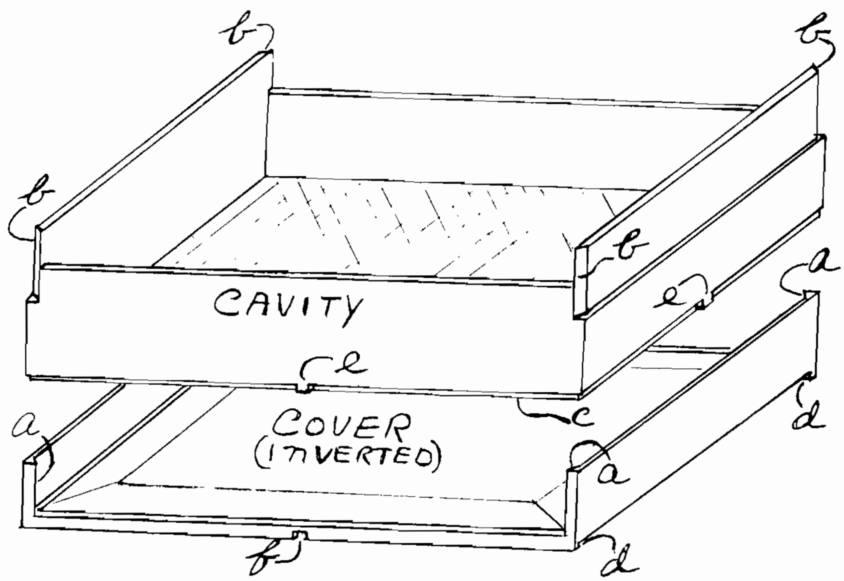

Figure 13: Improved cassette (cover and cavity) showing design detail.

HALF COMB CASSETTES —

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the "see through" capability of bees. It is not yet known whether this principle will also serve to facilitate ready occupancy of supers containing the two-tone half comb cassettes. The first bees to enter may provide visual cues through the clear plastic for others to enter. If so, this would be a welcome alternative to the practice of forcing bees into comb sections by crowding and the extreme measures to prevent the thus induced swarming.

Attention is called to the fact that half comb cassettes present just half as much work area to the bees as do natural comb sections of comparable size. It may be assumed that there is a limiting density for bees at a work site when actively constructing comb. Given the same intensity of comb building activity in a side-by-side comparison of natural comb sections and half comb sections, the rate of filling in the half comb would appear to be slower at the start. The natural comb foundation is being drawn out on both sides at once, compared to only one side in the half comb. Whether this will influence supering practice has not been evaluated; but it may be that for first supering at the beginning of the main nectar flow, two supers should be added at once to provide equivalent foundation work area.

Irrespective of the above considerations and until further experience is gained, I would recommend top supering for half comb supers without further manipulations of super positions. For the half comb cassette loaded super there is an alternative to the Killion comb honey super rotation plan[8] mentioned earlier under Hive Management. Because the cassettes are packed into the super in four columns of 10 cassettes, each column is readily manipulated as a unit with bees still in it. The super is first turned on edge directly on the hive as in Figure 14. Then the follower board with super springs is removed. Columns may be easily rearranged within a super or between supers, or harvested in exchange for empty columns. Individual cassettes within a column that are finished can be harvested and replaced with an empty or partially completed cassette. Early selective harvesting of cassettes when the newly capped half comb honey is whitest is an intriguing possibility. A comb honey super should not be on the hive at all when it is not being actively worked in.

For the 1984 season my further plan for evaluating the half comb honey cassette is to simulate the Killion "reduction-requeening" hive management plan,[11] but in a two-queen setting with simplified agenda. In the Killion plan, when swarm conditions approach just before or at the beginning of main nectar flow, single queen double brood chamber hives are reduced to one brood chamber to crowd the bees so as to force their attention to honey gathering and storage in sections. Simultaneously, a comb honey super is added and first steps are taken to replace the old queen with a new young queen. The reluctance of bees to swarm with a new young queen offsets the stimulus of crowding to do so. Until the new queen is established, this process is demanding of timely attention to detail. The planned two-queen analog of the Killion single queen plan would embrace the foregoing principles, but with two young queens, each in a full brood chamber.[5] The ensuing populous colony with two queens would be established gradually instead of by a precipitous act of reduction; and swarm control would rely on the combined influence of two young queens. Since double queening[5] would be performed considerably in advance of the main flow, interim provisions for collecting the surplus nectar of any minor flows up to the major flow is desirable — such as an extracting super, a food chamber or a cut comb super (over an excluder). Top supering, as suggested earlier, would then be directly on top of the interim super. This interim super provides a honey barrier which should help to limit the extension of the brood area upwards without the use of an excluder there. It separates the super sufficiently from brood so that the darker wax from cappings of emerging brood is not recyled into the new comb honey.

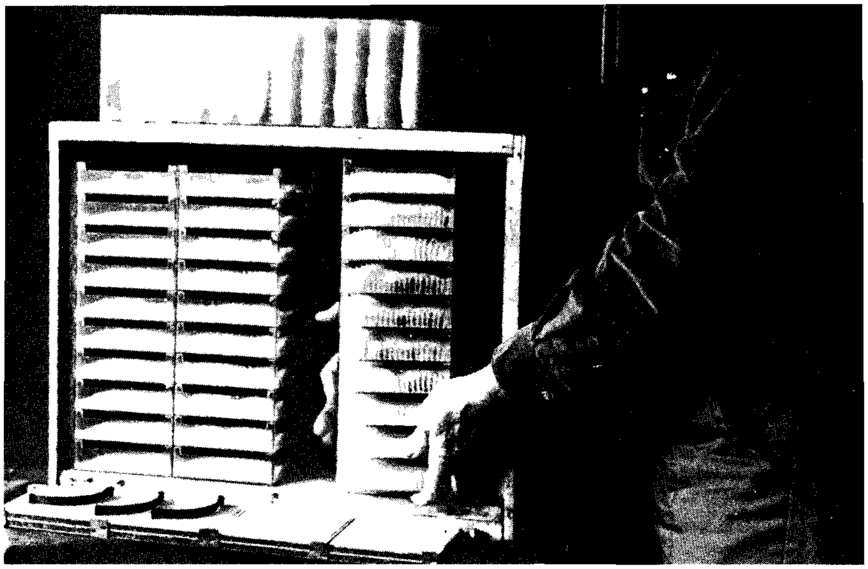

Figure 14: Simulation of on-hive manipulation of cassette columns.

The average net weight of honey in the filled cassettes exceeded the 12 oz. goal with some individual cassettes netting 13 oz. This is just over the minimum net weight for U.S. Fancy No. 1 Comb Honey in the wood framed sections. The 8 oz. net for round comb sections is exceeded by more than 50%. With the anticipated improvement in corner filling in the new design, half comb cassettes should yield a net weight very close to the average for comb honey in the classical 4¼" x 4¼" wood beeway section.

Of considerable importance is the reduced amount of wax in half comb honey due to the elimination of the wax foundation midrib. In natural comb bees tend to reinforce the midrib of the comb with additional wax to give it added strength, especially near the point of attachment to a surface. The amount of wax per unit weight of honey in the half comb is nearly 50% less than in the round comb. Wax adds to the aroma and flavor of comb honey and is not nutritionally objectionable. However, too much wax tends to get in the way. Even this lesser amount of wax may easily be pushed out of the way in the cassette at the time of use leaving essentially wax-free honey. The delicate flavor of comb honey is realized in the form of extracted honey. Further, wax is produced at the expense of honey, requiring six pounds or more for one pound of wax. The reduced demand on bees to produce wax for the half comb becomes a contribution to the overall yield of honey.

With the pre-waxed half comb cassette, the beekeeper will be spared the task of assembling foundation and section parts. Neither wood, nor special plastic holders, nor separators are required; their roles are assumed by the modular nature of the cassettes when in combination. Only follower boards, under pressure by standard super springs, are needed to secure the self-supporting columns of forty cassettes each in the standard 4¾" comb honey super. Super assembly time is short; there are never parts (except the two follower boards) from previous use to be scraped and cleaned. Progress in the cassettes when on the hive is directly viewed through the clear plastic. Time and effort in harvesting and preparing cassettes for market is reduced to a minimum. No further packaging is required; the cover is simply repositioned to close. A label may be applied to seal the cover.

In the marketplace the cassettes can be stacked for display in any multiple without sidewise slippage — and sold singly, or as three or six packs. This display of "bee prepared" cassettes in clear plastic offers an unprecedented view of undisturbed honey comb structures.

For the consumer the half comb cassette is a package in which comb honey is served directly, avoiding transfer to another container. The novel cover protects the honey in storage between table usages. The clear plastic sides serve as windows for viewing the intricate detail and variations of pattern inside comb honey; the new half comb cassette becomes the comb honey analog of the observation beehive. The new dimension of "honey in the half comb" should enhance the status of comb honey as a gourmet food.

It is frequently acknowledged that the demand for comb honey is always far greater than the supply, but that the real deterrents to comb honey production are the tedious preparations and the precise timing and attention to detail required in hive management. The new clear plastic half comb honey cassettes significantly reduce magnitude of these deterrents. The advantages of the half comb honey cassette complimented by simplified comb honey management could have important implications for revitalizing the comb honey industry. ●

REFERENCES (FOOTNOTES)

[1] U.S. Patent 4,329,749.

[2] J. A. Hogg, 1980. "A New Comb Honey Concept," AMERICAN BEE JOURNAL, Vol. 120(5): 357-362.

[3] Patent Pending

[4] Patent Pending

[5] J. A. Hogg, 1981. "The Consolidated Double Queen Brood Nest and Queen Behavior," AMERICAN BEE JOURNAL, Vol. 121(1): 36-42.

And J. A. Hogg, 1983. 'Methods for Double Queening the Consolidated Brood Nest Hive," ibid, in two parts — Vol. 123 (5): 383-388 and Vol. 123(6): 450-454.

[6] The results were interesting and will be published at a later date.

[7] 'How to Raise Beautiful Comb Honey" by Richard Taylor.

[8] Eugene E. Killion, 1981. "Honey in the Comb" published by DADANT & SONS, Hamilton, Ill. page 105.

[9] The author would appreciate receiving any published information available on how bees "see" in a hive.

[10] Frisch, K. von, 1914. "Der Farbensinn und Formensinn der Biene." ZOOLOGISCHE JAHRBUCHER, ABT. ALLGEM. ZOOL. PHYSIOL. TIERE, 35(1-2) 1-188.

[11] Eugene E. Killion, 1981. "Honey in the Comb" published by DADANT & SONS, Hamilton, Ill. pages 79-91.