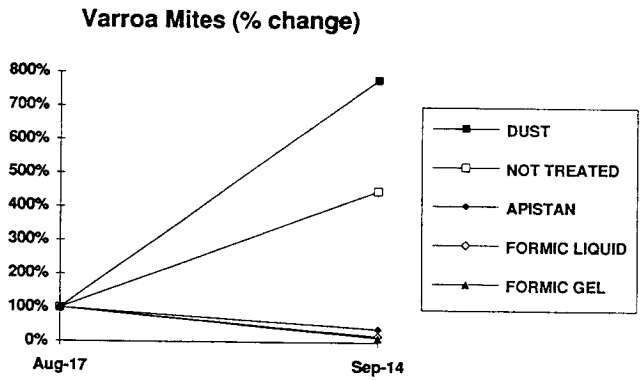
Proceedings of the American Bee Research Conference

The 1994 American Bee Research Conference was held on October 15-18 in the Hoblitzelle Center at the Texas Agricultural Experiment Station in Weslaco, Texas. The Tenth American Bee Research Conference will be held October 7-10, 1995, at the University of Georgia in Athens. The following are abstracts from the 1994 conference.

1. Clark, K.[a] — CONTROL OF VARROA MITES IN BRITISH COLUMBIA WITH EITHER FORMIC ACID OR APISTAN[S]— Varroa mites were first found in British Columbia in September 1992. By the fall of 1993, varroa mites were present in practically all hives in the lower Fraser Valley region, and about 10% of the hives were in a "collapse" phase.

In 40 two-story colonies in late August, pretreatment varroa populations were measured by installing two Apistan strips and counting the mites falling onto a sticky board. Groups of 8 hives were treated with: (1) no treatment; (2) dust: 50 g of wheat flour or brewers yeast applied with a sifter onto top bars in 5 applications at 4 day intervals; (3) two Apistan strips applied as on the label; (4) liquid 65 % formic acid, 5 applications of 40 ml, at 4 day intervals, onto absorbent napkins on top bars; or (5) two 115 g strips of a prototype gelled (to prolong evaporation) 73% formic acid, one strip across top bars, the other across the bottom board. In mid September, post treatment varroa populations were measured by another 1 day mite fall with 2 new Apistan strips.

Varroa counts increased about 5 fold in colonies left untreated or treated with dust (see figure). Colonies treated with either Apistan or formic acid showed a decrease in mite count of about 90%. Apistan was the simplest treatment, with a material cost of about $4 per hive. Formic acid liquid cost $1 per hive, required more care and labor, but had the added benefit of reducing tracheal mite populations.



2. Cobey, S. & B. H. Smith[b] — ANALYSIS OF TRACHEAL MITE INFESTATION LEVELS OF BUCKFAST AND CARNIOLAN HONEY BEES AND THEIR RECIPROCAL HYBRIDS — Two commercially recognized honey bee stocks, the Weaver Buckfast and the New World Carniolan and their reciprocal hybrids, were used to determine if the process of hybridization will reduce tracheal mite infestations. Virgin queens were instrumentally inseminated with selected drones to obtain the desired crosses and established in full size colonies. Samples of 50 bees per colony were collected at monthly intervals to determine infestation levels. Population estimates of each colony were made to determine growth patterns.

Mite levels remained on average low in colonies throughout the study relative to our previous study (Sammataro *et al.,J. Econ. Entomol.* 87: 910-916.), though significant differences were observed among the lines. The Buckfast colonies maintained a median of 0 % infestation throughout the study. During spring the highest level observed in Buckfast colonies was 1% infestation. The Carniolan colonies maintained median infestation levels below 0.5% until spring when levels reached a median of 1% with a one colony high of 9.5%. The hybrids showed intermediate infestation levels with greater variability between colonies. Levels were maintained at a median 0% throughout the year with a one colony high of 18% in spring.

Significant differences in mite levels and population buildup were observed between the various crosses in spring. Mite levels increased in colonies which also showed faster spring buildup. For example, during April Carniolan colonies had a median of 18 frames of bees compared to a median of 9 frames in the Buckfast colonies. The Buckfast colonies showed no increase in mite levels and the slowest population buildup. The Hybrids colonies were intermediate in both population buildup and infestation levels. The increase in mite infestation in colonies with fast buildup can be attributed to a higher number of young host bees (Phelan *et al., J. Chem. Ecol.* 17: 463-473).

The Carniolan colonies had a better overwintering survival rate than the Buckfast and Hybrids. Only 1 of the 13 Carniolan colonies died compared to 2 of the 11 Hybrids and 4 of the 12 Buckfast colonies. Colonies wintered with ample stores, though the winter was severe.

These data show that differences in infestation levels may be due to genetic effects on such colony characteristics as rate of spring buildup. An effective program to select for resistance to tracheal mite infestations must take into consideration colony characteristics and growth patterns of the stock being selected.

3. Coelho, J. R.[c] & J. B. Sullivan[d] — COLONIZATION OF WILDLIFE NEST BOXES BY HONEY BEE SWARMS — In West-central Illinois, a significant proportion of nest boxes that had been originally deployed for a study on raccoons was found occupied by honey bees. To determine the reasons for bee colonization, we analyzed the characteristics of the nest boxes and the sites where they were deployed *a posteriori*.

In the fall of 1989 nest boxes were deployed in a mixed hardwood forest located in Brown County, Illinois to examine the effect of nest site augmentation on raccoon population density. The area was divided into 30 1-ha grids, and one nest box was placed as close to the center of each hectare as possible. Nest boxes were checked periodically in order to determine the frequency of raccoon use. In the spring of 1993 boxes were closed by nailing a piece of plywood over the entrance holes in order to exclude raccoons and examine effects of nest site depletion on raccoon population density. On 21 Dec. 1993 all boxes were inspected, checked for animal occupancy and closure of the entrance.

The inner dimensions of the boxes resulted in a volume of 86.9 L. A ~250 cm^2 oval entrance hole was located on the upper end of one side. Six 0.5 inch dia. ventilation holes were bored in the bottom, and two similar holes on each of the left and right sides for a total of ten ventilation holes.

Between box placement and entrance closure in Feb.-Mar. 1993, virtually all boxes were apparently used by raccoons, squirrels, or owls, but no bees or evidence thereof were found in any of the nest boxes. On 21 Dec. 1993 eight of the thirty nest boxes were occupied by live bees and one box contained a dead colony. Hence, after box closure, the frequency of bee colonization increased significantly (X^2 = 10.6, 1 df, $P < 0.005$). By the time the nest boxes were removed in the spring of 1994, all of the bee colonies had died, even though all had honey remaining in their combs.

Nest box height (t = 1.2, 28 df, $P > 0.2$) and tree DBH (t = -1.0, 28 df, $P > 0.2$) had no effect on bee colonization. Mean height of all nest boxes was 5.3 ± 0.14 m, and mean DBH of all trees was 45.7 ± 1.9 cm. There was no statistically significant effect of nest box orientation, tree species, or nest box exposure on colonization rate.

For approximately three years the nest boxes were not used by bees at all, yet when the entrances were closed for one season, 30% of the boxes became colonized. We believe that the nest boxes were not attractive to bees while the entrances were open because the entrance holes were too large.

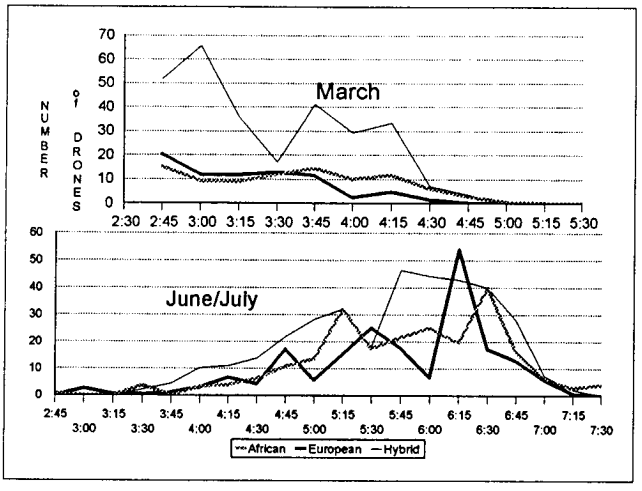
These data suggest an obvious means to avoid colonization of nest boxes by honey bees: use boxes with large entrance holes and leave them open.

4. Collins, A. M.[e] & J. S. K. Mbaya[f] — DRONE FLIGHT TIMES IN SOUTH TEXAS: AHB AND EHB — Previous observations of drone flight times in the tropics (Taylor,*et al.*, personal communication; Hellmich, *Amer. Bee J.* 127:846 and *Proc. IUSSI*, India 1990:141-142) have shown that there were some differences between Africanized and European types. European drones began to fly earlier in the afternoon, although their flights coincided with Africanized drones later in the day. If this earlier flying by European drones is also true in subtropical south Texas, beekeepers would be able to improve mating of European queens from their colonies. This could result in considerable savings, as queens would no longer have to be purchased from outside the area of Africanization.

Two apiaries were established in Starr County, Texas, one with European and hybrid colonies and one with Africanized and hybrid colonies. Identity of the bees in each colony was established by a marked, purchased queen or by morphometrics (Daly, *et al., J. Kan. Entomol. Soc.* 51:857-869). Drones were reared in all of the colonies and allowed to fly freely.

Because temperature might influence the flight times of the drones (Hellmich, personal communication), observations were made at two times of the year, March and June/July, 1994. The average temperatures between 2:00 pm and 7:30 pm were 82.3 - 79.5 °F. in March and 106.5 - 94.5 °F in July. The number of drones exiting the colonies was counted by several observers moving between the colonies of each apiary and observing each entrance for five minutes. Each colony was observed an average of 18 times in an afternoon.

The figure shows that there are no periods when predominantly one type of drone is flying. Therefore, in this area of Texas, it does not seem likely that manipulations of queens to restrict mating flights to early hours of the afternoon could be usefully employed to improve mating success. However, improvement of European to European mating has been achieved by massing of drones in queen flight areas (Eischen, *et al., Amer. Bee J.* this issue, abstract #8).



The number of drones observed leaving Africanized, European or hybrid colonies during each 15 minute afternoon period in March or June/July 1994.

5. Danka, R. G. & J. D. Villa[g] — OBSERVATIONS ON THE SUSCEPTIBILITY OF AFRICANIZED HONEY BEES TO AMERICAN FOULBROOD — Africanized and European honey bees (*Apis mellifera* L.) were compared for hygienic (nest cleaning) behavior and physiological susceptibility to infection by *Bacillus larvae* White, the causative agent of American foulbrood. These investigations addressed uncertainty about disease resistance of Africanized bees by focusing on two factors known to be important in governing resistance to American foulbrood. Two prior studies on hygienic activities (Cosenza & Silva, *Ciência e Cultura* 24:1153-1158; Lengler, *Anais do 4 Congresso Brasileiro de Apicultura, Curitiba, PR, Brazil*) yielded inconsistent data on the comparative rate of dead brood removal by Africanized bees. The susceptibility of larval Africanized bees to *B. larvae* has not been measured previously.

Our tests in Costa Rica compared local Africanized bees to European bees (queens imported from Hawaii). Hygienic behavior was tested by killing with a pin the brood in 50 sealed cells per colony (Newton & Ostasiewski, *Am. Bee J.* 126:278-281). Proportions of cells uncapped and of cells with complete removal of dead brood were recorded for the following three

days. Nine colonies of each bee type were tested. Bee type means of transformed (square root of the arcsine) proportions for each parameter were compared with two-tailed *t*-tests. The percentage of dead brood uncapped was similar for the bee types one day after treatment (European colonies, 98 ± 4% ($\bar{x}$ ± sd); Africanized colonies, 94 ± 8%; $P > t = 0.182$). Uncapping was complete on day two in European colonies and on day three in Africanized colonies. The percentage of uncapped dead brood removed was greater among European colonies than Africanized colonies on day one (European colonies, 91 ± 14%; Africanized colonies, 64 ± 33%; $P > t = 0.056$) and day two (European colonies, 100 ± 1%; Africanized colonies, 77 ±31%; $P > t = 0.042$). European bees virtually completed brood removal by day two, while three Africanized colonies still had dead brood on day three. These times until complete nest cleaning in European colonies (one to two days) and Africanized colonies (two to three or more days) correspond to mean times found by Newton & Ostasiewski (*Am. Bee J.* 126:278-281) for bees shown to be resistant (1.95 days) and susceptible (2.80 days), respectively, to American foulbrood.

Physiological susceptibility to infection was tested using the method of Bamrick & Rothenbuhler (*J. Insect Path.* 3:381-390). Larvae that were on average 18 hours old (range 12-24 hours) were obtained from eight colonies of each bee type. Eighty percent of larvae were treated with a dose of ca. 1000 locally obtained *B. larvae* spores in 0.23 µl of sterile water; remaining larvae were treated with water only as a control. Combs of larvae of both bee types were nursed in common colonies. After two weeks, mortality of treated larvae was measured and adjusted using mortality of control larvae. Mortality of treated Africanized larvae (25 ± 18%, range = 3-78%) was lower than that of treated European larvae (50 ± 24%, range = 18-72%) ($P > t = 0.043$).

Africanized honey bees were not immune to American foulbrood; symptoms of the disease occurred in both bee types when larvae were inoculated directly with spores of *B. larvae*. The comparatively low infection rate among Africanized larvae does suggest that these bees may possess some physiological resistance to this disease. However, Africanized colonies exhibited comparatively reduced hygienic behavior. Further investigation is necessary to clarify the practical consequences of the apparently conflicting trends of the two facets of disease resistance we measured.

6. Danka, R. G. & J. D. Villag — RESISTANCE TO INFESTATION BY TRACHEAL MITES IN BUCKFAST HONEY BEES: FIELD TEST AND INVESTIGATIONS OF MECHANISMS — The goals of this project were: (1) in a large scale field test, to evaluate several promising stocks of honey bees, *Apis mellifera* L., for (a) resistance to infestation by honey bee tracheal mites, *Acarapis woodi* (Rennie) (HBTM) and (b) comparative colony production performance; and (2) to identify mechanisms responsible for any resistance noted.

Characteristics of four stocks first were evaluated in commercial honey production operations in Iowa, Mississippi and Texas for one year beginning in October 1991. Test stocks were Buckfast (imported from the United Kingdom), ARS-Y-C-1 (Carniolan bees imported from Yugoslavia), Survivor (developed from colonies in a Louisiana apiary known to have been infested with HBTM) and Unchallenged (developed from a feral Louisiana population never exposed to HBTM). The 15-20 colonies of each stock at each location were inoculated with HBTM-infested bees at the start of the test to ensure mite challenge.

HBTM infestations increased much more markedly in Survivor and Unchallenged stocks than in ARS-Y-C-1 and Buckfast stocks. Mean infestations in the resistant stocks (ARS-Y-C-1 and Buckfast) remained below 15% and thus were below levels associated with economic damage. The susceptible stocks had mean infestations that ranged from 13 to 95% at each site during the final five months of the study. Mortality increased more rapidly among Survivor and Unchallenged colonies than among ARS-Y-C-1 and Buckfast colonies as infestation increased in 1992. Honey production was greatest by Buckfast, intermediate by Survivor, and least by Unchallenged and ARS-Y-C-1 stocks. Populations of adult bees and brood tended to be largest in Survivor and Buckfast colonies. For the parameters measured, stock rankings generally were consistent at each test site. The results support the feasibility of an approach using genetic resistance to manage problems caused by HBTM. ARS-Y-C-1 and Buckfast stocks are currently available commercially to the U.S. beekeeping industry.

In the second phase of the project, a resistant stock (Buckfast) and a susceptible stock (Survivor, augmented with colonies from coastal Louisiana) were used to investigate general mechanisms regulating HBTM infestation. Using a standard colony bioassay (Gary & Page, *Exp. Appl. Acarol.* 3:291-305), adult bees ≤6 h old were exposed to mite parasitism in infested colonies for nine days to evaluate the contributions to resistance of reduced mite transfer, reduced mite reproduction, or both. In three trials using colonies infested at moderate levels (38-64% of bees infested), infestation percentages and numbers of foundress mites per infested bee were less in resistant bees. There was no difference in mite reproduction between stocks. Differences in transfer level also were noted in two other experiments (four versus nine days of exposure, and three weeks of exposure), while no differential mite reproduction in the stocks was found. Stock differences in infestation were not evident when test bees were exposed to either very high or very low HBTM challenges.

7. Eischen, F.A. & B.A. Underwoodh — FLORAL COMPETITION DURING COMMERCIAL CANTALOUPE POLLINATION — Honey bees practice optimal foraging, or more simply, they work flowering plants in the vicinity of the colony that offer the best reward for the time and energy spent. Sometimes this becomes a problem for the commercial pollinator when a second plant is blooming near the crop and bees prefer working it. Woody perennials blooming during the spring cantaloupe season may present this sort of competition during the time of cantaloupe flowering in the Lower Rio Grande Valley. To examine this, we fitted 20 honey bee colonies with OAC-type pollen traps and placed them in two cantaloupe fields where hermaphrodite flowers had begun to open. One field (R4), bordered the Rio Grande and the second field (S2) lay about 4 km north of the river. Field S2 bordered mesquite scrub habitat compared to the reverine mesquite forest along the Rio Grande. Traps were emptied every 48 hrs. and pollen was cleaned, weighed, mixed thoroughly and a 30-gram sample removed for clearing (acetolysis). Cleared pollen samples were examined microscopically wherein 100 pollen grains were randomly selected and identified using reference pollen grains. In both fields, three plants provided the bulk of collected pollen (table). In R4, mesquite (*Parkinsonia aculeata* L.) were the most intensively foraged. A slightly different profile was found for S2 colonies. Popinac (white popinac lead-tree, *Leucaena leucocephala*) an exotic from Central America, replaced retama as a prevalent species.

An unusual relationship between mesquite and melon pollen collection was found for R4 colonies. On any given day when melon pollen collection was high, mesquite collection was lower and the converse was true. No such relationship was found for retama. The cause for this is unknown. The evidence is clear though, that all colonies responded similarly on the same day. That is, on days when melon pollen was dominant for any given colony, it was dominant for all colonies. Whether this is genuine competition will require further study.

Table — Pollen Collection by Honey Bee Colonies on Cantaloupe Fields R4 and S2 of SunTex Farms, 1991.

Species	SunTex F4 Average± SD[1]	SunTex S2 Average ± SD[1]
Mesquite	34.9 ± 9.2	41.1 ± 14.4
Melon	33.1 ± 8.3	14.8 ± 8.6
Retama	9.0 ± 8.0	2.4 ± 1.9
Salix	6.2 ± 3.4	4.0 ± 2.9
Cenizo	2.1 ± 1.7	2.7 ± 3.3
Prickly Pear	1.0 ± 0.7	1.0 ± 0.9
Popinac	0.1 ± 0.3	14.7 ± 9.1
Sunflower	0.2 ± 0.6	0
Unknown #1	1.5 ± 1.6	4.7 ± 4.8
Unknown #2	0.5 ± 0.7	1.4 ± 1.7
Unknown #3	0.1 ± 0.3	0
Lycopodium	11.9 ± 1.5	12.9 ± 5.9

[1]100 pollen grains were randomly selected and counted (Lycopodium spores were used as a reference).

8. Eischen, F.A.[h] — PRODUCING EUROPEAN HONEY BEE QUEENS IN AN AFRICANIZED AREA — The invasion of Africanized bees in the Lower Rio Grande Valley has caused substantial beekeeping changes. Regular requeening with manageable European stock is recognized as desirable, however, purchasing European queens is prohibitively expensive for many operations. The alternative is to come up with methods allowing the breeding of European queens locally. During melon pollination thousands of colonies are massed in melon fields and reach densities of 70-160 colonies/km^2. Depending on drone numbers, flooding ratios of European males can exist over areas that encompass the normal flight range of queens. In this study, the feral drones were surveyed on Starr Produce Farm using aerial drone traps baited with queen pheromone. Drone surveys were conducted both before and after managed colonies were brought to the farm. Over a 10-day period, 968 managed colonies headed by European queens (purchased in Hawaii) were moved onto the farm. Thirty of these colonies were randomly selected and the number of resident drones counted. Thereafter, 128 honey bee nuclei with mature queen cells were placed in three apiaries on the farm. During the time of queen mating, we resurveyed the flying drone population. About 40 days after mating, 30 newly emerged adult worker bees from each colony were collected and frozen. Sampled progeny were examined for two polymorphic enzymes, malate dehydrogenase (MDH) and hexokinase (HK), using gel electrophoresis. On average, 39% of hexokinase (HK) alleles were HK-2 (and is probably derived of African stock). HK-2 frequency dropped to only 9% during pollination. Progeny analysis found that 11% of the hexokinase alleles were HK-2. MDH allele percentages were typical of European bees. In a survey of Valley bees done in 1990 and prior to Africanization, MDH allele percentages were similar (Taylor, Rubink, & Eischen, unpublished data). Managed colonies had on average 69.3 drones indicating that the total managed drone population was about 67,082 (968 x 69.3). After pollination on Starr produce, 720 of the colonies were moved to the Villarreal Ranch where the study was replicated. The level of Africanization in the feral drone population was about the same as that found on Starr Produce. With the managed colonies present, the percentage of HK-2 alleles dropped to 2.7%. The average number of adult drones in the managed colonies was 86.9, for an estimated total of 62,568 managed drones. Progeny analysis found that only 2.5% of young workers carried the HK-2 alleles, while MDH 1, 2 and 3 allele percentages were typically European. Why the level of mating control on Villarreal was higher than on Starr is not known, but we suspect that the number of Africanized colonies near the Rio Grande is higher. Because the level of Africanization at the two sites was about the same, we conclude that the overall population of feral drones was much lower at the Villarreal site. In general, mating control approached 95% and could be improved with feral drone control. We think that the massing of colonies with consequent flooding provides a practical way of breeding European queens in the Lower Rio Grande Valley.

9. Garza-Q. C.[i] & W. T. Wilson[e] — DIFFERENT SAMPLING METHODS FOR ASSESSMENT OF *VARROA JACOBSONI* INFESTATIONS — *Varroa jacobsoni* has become in the last decades the most important parasite of *Apis mellifera.* Lots of effort and money are invested to detect varroa infestations. Beekeepers should be able to easily and precisely estimate the degree of infestation in their hives using a reliable and cost-efficient sampling method. Effectiveness of different detection methods is given as the total number of mites found. However, not much is known about the real number of mites present in a colony at a given time. When estimating a varroa population, it is very important to relate the numbers obtained through different sampling methods. The infestation of the selected colonies was estimated based on these methods: (1) ether roll (200-400 bees), (2) sticky board (24 hrs.), and (3) adult honey bee subsample wash. For each sampling date, 2 to 4 colonies were killed. Supers and brood chambers were separated in plastic bags and sprayed with Sumithrin and the samples labeled and frozen in the laboratory. The bees were washed in a warm detergent solution using a mechanical shaker.

Correlation coefficients using the values of the 8 colonies killed until July were calculated for the total infestation and the number of mites counted by the ether roll, the sticky board and the subsample of adult bees.

Regardless the sampling date, the highest correlation coefficient found was among the total and the adult bee subsample infestation (r = 0.97), followed by the ether roll (r = 0.94) and the sticky board (r = 0.83).

Estimators relating the total number of mites on adult bees in the colony with those obtained with each sampling method were estimated monthly. These values are given in the table. If these factors are multiplied by the number of mites obtained through the different sampling methods, the varroa population can be estimated. Further studies are necessary to establish the economic threshold of this mite under different conditions. Having such estimators and knowing the correlation between each sampling method and the real population, beekeepers will have a tool to decide the best time to treat for mite control.

Estimators	January	April	July
Ether roll	21.00	29.00	16.30
Sticky board	63.00	9.10	2.20
Adult bee subsamp. infes.	0.56	0.87	0.70

10. Garza-Q., C.[i] & W. T. Wilson[e] — PRELIMINARY OBSERVATIONS ON POPULATION DYNAMICS OF *VARROA JACOBSONI* IN THE RIO GRANDE VALLEY — The mite *Varroa jacobsoni* represents the most serious problem that *Apis mellifera* beekeeping confronts in the world. The biology of this parasite must be understood in order to control it. These preliminary results are part of a research project that is being undertaken to understand the biology of this mite in the Rio Grande Valley.

In order to study the population dynamics of the mite throughout the year, four sampling dates were determined, (January, April, July and October). Fifteen untreated colonies were selected and distributed in four bee yards near Weslaco, TX. These colonies showed different infestation rates, which were estimated based on four sampling methods: 1) ether roll (200-400 bees), 2) sticky board (24 hrs.), 3) adult honey-bee wash (150-300 bees) and 4) honey-bee brood (50 cells random selected). In addition, honey-bee population and brood amount were estimated by means of covered frames. For this purpose, the data of eight colonies were selected for the first three seasons. The results presented in the table are monthly averages (± S.D.).

The adult honey-bee infestation showed an increase in April followed by a decrease in July, also recorded through the number of mites counted by the ether roll method. The higher infestation in July was due to the larger honey-bee population in this month.

The number of mites captured with the sticky board showed a slight increase for the same period; however three colonies showed a disproportionate high number of mites, which raised the average.

In relation to the brood infestation, an important increase in April was recorded, followed also by a decrease in July. This coincides with a higher amount of brood observed in April and its drop in the following month.

Large variations between colonies were observed; they might be influenced by several factors, which remain unexplained until now. Differences in rates of infestation between seasons are evident from this study, which has been verified for other parts of the world. A very precise knowledge of the varroa mite population dynamics is needed to determine the most suitable time for treatments in different locations.

	January	April	July
Mites on Ether Roll	8.8 (±3.7)	39.8 (±26.1)	15.1 (±13.5)
Mites on Sticky Board	12.4 (±14.0)	104.3 (±47.9)	121.4 (±107.6)
% infest. adult bees	5.1 (±3.9)	6.5 (±4.5)	5.6 (±2.1)
% infest. bee brood	5.0 (±3.7)	26.5 (±13.7)	15.0 (±9.0)
Covered frames w/bees	5.0 (±1.8)	7.6 (±1.9)	5.2 (±2.9)
Covered frames w/brood	2.1 (±0.9)	4.7 (±1.1)	3.3 (±1.8)

11. Guzman, L. I. de & T. E. Rinderer[g] — COMPARATIVE RESISTANCE OF DIFFERENT STOCKS OF *APIS MELLIFERA* L. TO INFESTATION BY TRACHEAL MITES — The resistance potential of the ARS-Y-C-1 (Carniolan bees imported from Yugoslavia) to *Acarapis woodi* (Rennie) infestation was compared to other honey bee stocks using two methods. Using a field test, ARS-Y-C-1 was compared to Hastings, ARS-Y-C-1 x Hastings, and Louisiana stocks. Colonies were monitored from July 1990 to June 1992 (trial 1), and from August 1991 to August 1992 (trial 2) by examining 30 bees per colony per sampling date. The stock was then compared to Buckfast, their reciprocal hybrids, and Louisiana stocks using a choice experiment.

Using the SAS Mixed Procedure, the field test showed a highly significant (P = 0.0001) interaction between stock and sampling date (trial 1). At the start of the experiment, *A. woodi* infestations in all the stocks were similarly (P = 0.5223) high ranging from 20.6 ± 6.06 to 32.39 ± 6.93%. Tracheal mite infestations in the ARS-Y-C-1 and hybrid colonies continued to decrease and were maintained at about 10% throughout the experimental period. In contrast, infestation levels in the Louisiana and Hastings stocks started to increase reaching a maximum in October of about 76 and 62%, respectively.

In trial 2, the same trends were observed. The initial infestation of *A. woodi* was significantly higher in the Louisiana stock at the start of the experiment as compared to less than 10% in the other stocks. Tracheal mite infestation remained significantly higher in this stock with its peak (83%) recorded in October. *A. woodi* infestation in the Hastings stock increased gradually with the highest infestation (61%) observed in February. As in trial one, ARS-Y-C-1 and the F_1 hybrids maintained about 10% infestations throughout the experimental period.

The number of tracheal mites per infested bee was monitored from August 1990 to August 1991 for trial 1 only. Results showed a significant (P = 0.0069) interaction between the stocks and sampling date. The initial mite load revealed no differences (P = 0.7061) among stocks, which ranged from 8.76±1.8 to 11.37±2.06 mites. Infested bees from Hastings and Louisiana colonies had the highest load of 13 and 18 mites, respectively. ARS-Y-C-1 and F_1 hybrids had about 1-7 mites per infested bee.

The choice experiment displayed similar strong levels of resistance. ARS-Y-C-1 stock consistently had about 10% infestation, which was comparable to that of Buckfast and their reciprocal hybrids. This observation corroborates the findings of Milne *et al.* (*Am. Bee J.* 131: 713-718) and Lin *et al.* (*Am. Bee J.* 132: 810) regarding the Buckfast stock. The Louisiana stock was more susceptible to infestation (P = 0.0001). Similar numbers of mites per infested bee were observed in all the stocks (P = 0.2568).

Based on both tests, ARS-Y-C-1 consistently displayed considerable resistance to *A. woodi* parasitism. Infestation in this stock was maintained at about 10% throughout the experimental periods. Tracheal mite infestations above 25% cause economic damage in honey-bee colonies (Eischen *et al., Apidologie* 20: 1-8; Otis & Scott-Dupree, *J. Econ. Entomol.* 85: 40-46). The results suggest that these stocks will not require as much or any chemical treatments for the control of tracheal mites.

12. Harbo, J. R.[g] — FIELD TEST OF BEES THAT HAD BEEN TREATED WITH HEAT — The purpose of this study was to measure the effect of artificial heating of package bees (1) on the population of tracheal mites, (2) on the population of varroa mites, and (3) on the survival and brood rearing of worker bees.

A large group of bees was collected into a cage and subdivided into populations of ca 550 grams of bees in cages (14 x 22 x 16 cm). The control bees were kept at room temperature (22 - 25° C) for two days; test bees were kept at 40° C (102° F) for two days (relative humidity was 55 ± 10% in both groups). Bees were fed water and candy (a 2 : 1 mixture of confectionery sugar and honey). Colonies were established on 19 November by placing two cages of bees, four broodless combs, and a caged queen into each of 13 standard Langstroth hives (5 with treated bees, 8 with controls).

Populations of bees and mites were measured on 15 December and 16 February to evaluate a broodless and brood rearing period, respectively. Queens were released on 3 January and numbers of capped brood cells were measured in each colony on 21 January and 4 February. The initial varroa population in the control colonies was 34 per 1000 bees. Data were evaluated with *t*-tests.

Although heat had some effect on tracheal mites, the effect was not great enough to provide adequate control. During the broodless period that ended 15 Dec., the proportion of bees infested with tracheal mites did not change significantly (8.3% on 19 Nov.(n = 120); 7.9% in the heated bees and 10.8% in the nonheated bees on 15 Dec. [n = 240 in both

groups]). In all stages of tracheal mites, the number per infested trachea was lower in bees that had been heat-treated. The total mite levels were 10.1 ± 9.2 in the heat-treated group and 15.0 ± 11.2 [mean ± SD] in the controls, (P = 0.11). However, only numbers of eggs per infested trachea were statistically different (1.7 ± 2.8 *vs* 3.3 ± 2.2, P = 0.044) between the heat-treated and control groups.

During the broodless period, varroa mites had a higher survival rate than bees (89% vs 59% in control bees). Therefore, a month of broodlessness did nothing to rid the bees of varroa mites. On 15 Dec., the varroa population was 12 ± 3 (per 1000 workers) in the treated colonies and 43 ± 9 in the controls (P = 0.001).

I concluded that heating worker bees for 2 days at 40° C did not affect their survival or their brood rearing capabilities. Heated bees had a survival rate of 54 ± 3% during the broodless period; survival for controls was 59 ± 4%, (P = 0.06). This is about normal for bees in Baton Rouge in November (Harbo, *Environ. Entomol.* 12: 1559-1563). Population growth during the brood rearing period was 24 ± 18% for heat-treated bees and 14 ± 13% for controls (P = 0.24). Brood production (cells per adult bee for 22 days) was nearly identical in the two groups (0.60 ± 0.14 for the heated bees, 0.58 ± 0.13 for controls; P = 0.85).

13. Loper, G. M.,[j] O. R. Taylor,[k] M. Winston,[l] L. Foster,[l] & J. Kochansky[l] — RELATIVE ATTRACTIVENESS OF QUEEN MANDIBULAR PHEROMONE COMPONENTS TO HONEY BEE (*APIS MELLIFERA*) DRONES[s] — The aerial response of honey bee drones to the full complement of the 5 known queen mandibular pheromone (QMP) components, and to 4 separate components was determined. The observations included behavioral responses to lures which were elevated 10 m above-ground in a drone flyway 170m SW of an apiary on the West Campus of the Univ. of Kansas, Lawrence, KS. In a separate set of tests, at the same location, the copulation response of free-flying drones with pseudoqueens in response to aliquots of QMP, 9ODA and a virgin queen extract was observed. Drones responded only to QMP, 9ODA and the virgin queen extract; the other individual components of QMP (HDA = 9-hydroxy-2-decenoic acid, HOB = methyl p-hydroxy-benzoate, and HVA = 4-hydroxy-3-methoxyphenylethanol) and a chemical isolated by Russian scientists from the fruit of *Evodia hupehensis*, 13-hydroxy-2-oxotridecane, (HOD) elicited no response even when the QMP components were tested at 10 queen equivalents/lure.

In both kinds of tests (aerial response, copulation response) there was a tendency for the drones to respond more actively to the full QMP than to 9-ODA. However, weather conditions did not allow us to run enough replications to obtain statistically significant differences.

14. Montesinos-A., P.[m] — SEASONAL PATTERN OF BROOD REARING AND ABSCONDING IN MANAGED AFRICANIZED BEES IN VENEZUELA — The objectives of this study were to measure the seasonal patterns of brood rearing and absconding in managed Africanized honey bees. The study was done in an excellent honey-producing area of Venezuela.

Thirty nucleus colonies were prepared in January 1989, each consisting of 4 deep combs covered by Africanized bees. Two combs had sealed and unsealed brood, one had only sealed brood, and the fourth had honey. Each nucleus was allowed to rear its own queen.

The rate of brood rearing was estimated every 4 or 5 weeks using a modified version of the technique described by Rogers *et al., J. Apic. Res.* 22: 232-241 and Burgett & Burikan, *J. Econ. Entomol.* 78: 1154-1156. To evaluate brood rearing, I added the number of eggs and the amount of sealed brood that were present during the three measurement periods before the colony absconded. One comb of brood in this study, is about 4000 cells.

Seven of 30 colonies (23%) absconded, one in May, three in July, and three in October. Because the colonies of the experiment were fed whenever needed, the deteriorating conditions of the dry season (Feb. - Aug.) and beginning of the rainy season (Sept. - Dec.) should not have caused absconding in these colonies. Means were calculated for 7 colonies that absconded and for 7 randomly chosen colonies that did not abscond.

The colonies that did not abscond always had an average level of brood rearing that was higher than the absconding colonies. In May, the non-absconding group of colonies had a mean of 7.25 combs of brood (mean of previous 3 measurements). One colony that never absconded had 4 frames of brood; the colony that absconded had 5 combs. In July, non-absconding colonies averaged 8.5 combs of brood; the three colonies that absconded averaged 5.7 combs of brood. In October, the non-absconding colonies averaged 13.75 combs of brood, the three absconding colonies averaged 10.2 combs of brood.

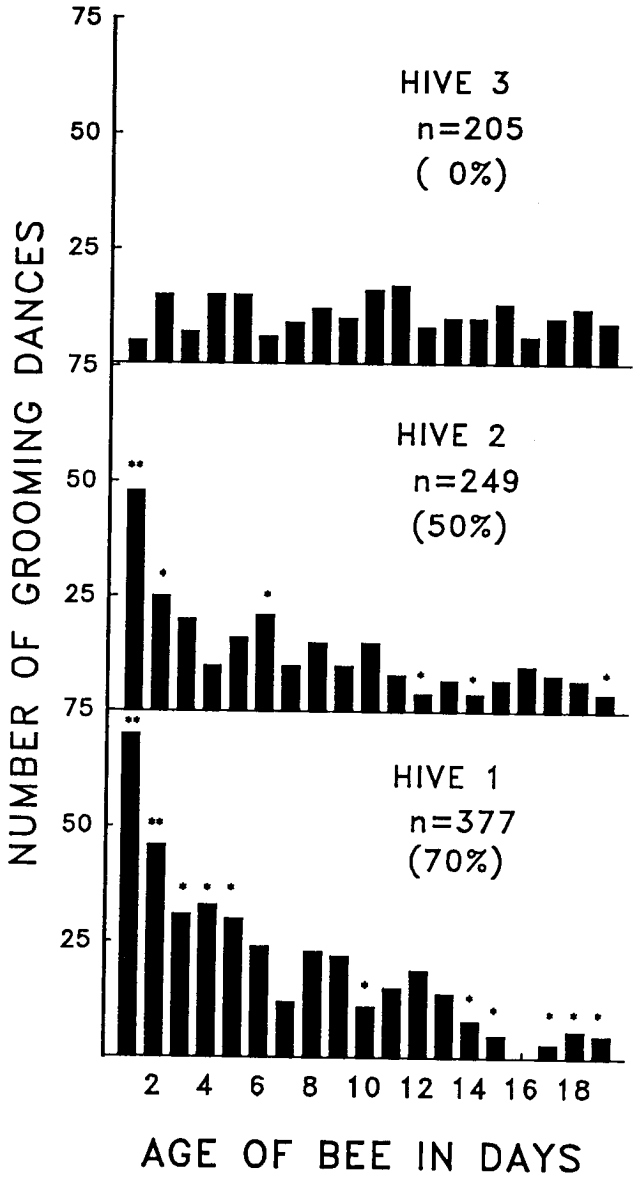
There seems to be an amount of brood at any given time which determines whether a colony stays or absconds. Perhaps a beekeeper could add brood to a colony to meet the minimum threshold of brood needed to avoid absconding. However, since there is probably a genetic component here, beekeepers should be aware that some colonies may require more brood than others to reach a level that would prevent absconding. Also, colonies genetically related to the absconding colonies should be eliminated in order to reduce the genetic tendency of the colonies to abscond.

15. Pettis, J. S. & T. Pankiw[l] — GROOMING BEHAVIOR BY THE HONEY BEE AND TRACHEAL MITE DISPERSAL — A grooming dance has been described in the European honey bee which includes two distinct heritable behaviors, the dance itself, and the response by a grooming bee (Haydak, *Amer. Bee J.* 85:97-104, Frumhoff & Baker *Nature* 333:358-361, Kolmes, *Anim. Behav.* 37:1048-49). Tracheal mites, *Acarapis woodi,* disperse on the exterior of workers and could elicit dancing and/or be impacted by host grooming.

To determine if tracheal mites elicit grooming dances, newly emerged workers were monitored for 19 days and the number of grooming dances performed recorded. Marked workers (1,000/hive) were introduced into each of three 4-frame-observation hives which had tracheal mite prevalences of 70, 50, & 0% for hives 1-3, respectively. Dancing was significantly more common early in a bee's life, but only in the tracheal mite infested hives. Thus, we conclude that tracheal mites elicit grooming dance behavior. Workers from hive #3 danced at low levels, indicating other stimuli also elicit dancing, most likely the low levels (prevalence <20%) of *Acarapis dorsalis* present in all three hives.

In a second experiment, workers from four distinct patrilinies were introduced (50bees/line, 200/hive) into eight tracheal mite-infested colonies for five days to determine if these lines would become differentially infested. The four lines had been previously screened and were classified as; exhibiting high grooming behavior (HG), high dancing behavior (HD), or being intermediate for both traits (I-1 and I-2). Of the 1592 mites that dispersed, the HG line had significantly more mites (35%) than expected (X^2=33.48, 7df, p<0.001) while the HD line had significantly fewer mites (18%) than expected (X^2=13.56, 7df, p<0.05). The HD line presumably has a lower dance threshold, stimulating grooming. In contrast, the HG line may have a high dance threshold, not eliciting grooming, and thus acquiring more mites.

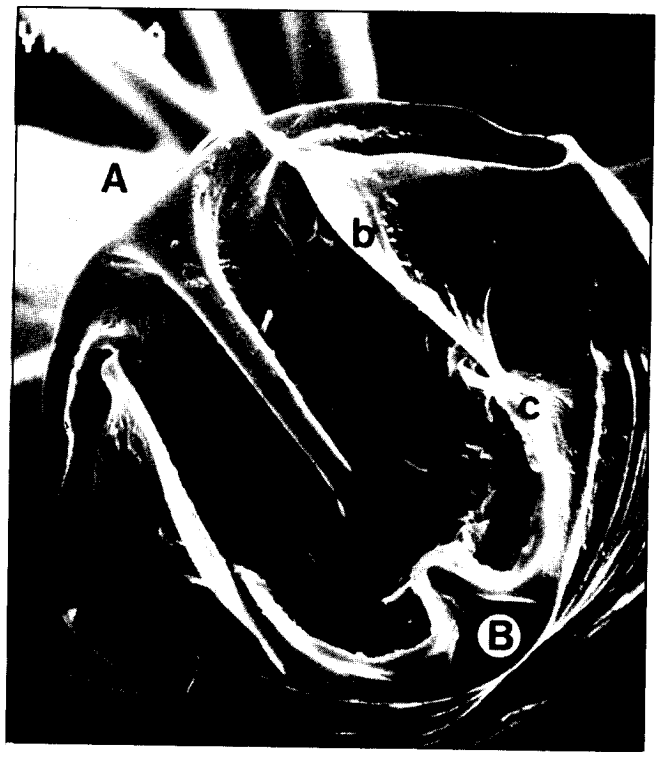
These studies provide evidence that tracheal mites elicit grooming dances and this behavior could be a resistance mechanism. More elaborate studies on mite dispersal and host grooming are needed to determine how efficient host grooming is in limiting tracheal mite populations.



Number of grooming dances (daily totals from five 5-minute scans/hive) performed by worker bees over their first 19 days of adult life in three observation hives with varying tracheal mite prevalence (x%). Asterisks indicate significant differences within hives (expected values = total dances per hive (n)/19 days, X^2, 1df, * = $p < 0.05$, ** = $p < 0.01$).

longitudinal and transverse sections of the ambulacrum of Varroa did not reveal the presence of a sucker-like apparatus (in preparation). The conformation of the claw-like pretarsus is not adapted for movement over wet or dusty surfaces, especially when the pretarsus is covered with small particles (*e.g.* dust) as noted by Sadov *et al., Veterinariya,* Moscow, 36-39. The "plugging" of the pretarsus may explain why Sineacar", one of the first products used to control varroa, knocked down the mites from the adult honey bees without killing them immediately. Sineacar is a mixture of powdered sugar (98.2% glucose) and choropropylate and bromopropylate (1.8%).

The use of fine dust applied to the brood chamber offers a practical method to control varroa and other phoretic bee mites and may be combined with the control of American foulbrood by using fine glucose and streptomycin together. One advantage of a physical control for varroa and other bee mites, is that it is not likely to induce resistance of the animals to the treatment.



Conformation of the ambulacrum of a female *Varroa jacobsoni,* frontal view. A - dorsal sclerite, a - dorsal claw, B - ventral sclerite, b - laterodorsal claw, c - central apical claw.

16. Ramirez B., W.[n] - CONFORMATION OF THE AMBULACRUM OF *VARROA JACOBSONI* OUD. AND MITE CONTROL WITH DUSTS[s] — *Varroa jacobsoni* is an ectoparasite on honey bees (*Apis* spp.). Fertilized females are phoretic on adult bees, especially young bees and drones, on whose hemolymph they feed. Acarids that live on animals with hairs or feathers have developed several methods of attaching to the host, including chelicerae and pretarsal claws (Houck & O'Connor, *Ann. Rev. Entomol.* 36: 611-636).

The ambulacrum of all legs of the adult male and female varroa is a claw-like complex (see figure) composed of two large basal sclerites (A & B in fig.) and two lateral, opposing, flat and apically pointed claw-like extensions (b) as described by Ramirez & Malavasi (*Int. J. Acarol.* 17: 109-111). Internal

17. R. Rivera, A. M. Collins & L. T. Lopez[e] — STING PHEROMONES OF SOUTH TEXAS HONEY BEES — Pheromones are important in honey bee communication. Pheromones attract drones to queens for mating, swarms to nest sites and trigger defensive responses. The honey bee alarm pheromone is found in the sting apparatus. When a honey bee stings, a pheromonal scent is left, marking the target for other honey bees to sting. Eight of these pheromones were identified by Blum *et al.* (*J. Apic. Res.* 17: 218-222) and two more were reported by Collins & Blum, *J. Chem. Ecol.* 9: 62. The amount of chemical in the alarm pheromones in the sting could be what stimulates stinging behavior in honey bees.

Honey bees were taken from colonies in Weslaco, Texas

(European honey bees) and in Starr County, Texas (Africanized honey bees determined by morphometrics). Live honey bee samples were collected from outside frames of the colony to ensure that newly emerged bees were not collected. Newly emerged bees have not begun to produce alarm pheromone (Collins, *et al., J. Chem. Ecol.* 15: 1750). The bees were put into plastic bags and put on ice. The sting apparatus was removed using forceps. The stings from ten bees were put into 2 ml vials with 0.5ml methylene chloride and 0.1g Na_2SO_4 and sealed with crimp top. The samples were now ready for gas chromatographic analysis. A Hewlett-Packard 5890 gas chromatograph with a 25M X.53mm ID capillary column was used in the analysis. The chemicals that were separated from the sting apparatus were: 2-methyl-1-butanol, butyl acetate, hexyl acetate, isoamyl acetate, 2-heptanol, hexyl acetate, 1-octanol, 2-nonanol, and octyl acetate. Our data showed no significant difference in the nine compounds between the Weslaco and the Starr County bees.

18. Rubink, W. L.,[e] E.A. Sugden,[o] W.T. Wilson[e] and A.M. Collins[e] — OBSERVATIONS ON THE NATURAL COMB-CELL SIZE OF HONEY BEE COLONIES BEFORE AND AFTER AFRICANIZATION — Since 1988 the USDA-ARS Honey Bee Research Unit in Weslaco, Texas has maintained several, long-term bait-hive transects to monitor honey bee populations in the northeastern Mexican state of Tamaulipas and adjoining southern Texas. During the course of this effort, over 3,000 swarms have been collected and sampled. This study reports the results of 1653 cell-size determinations, and presents hitherto unavailable information on the natural comb-cell size distributions of tropical and subtropical, pre-Africanized and Africanized, honey-bee populations.

Table — Comb Cell Diameter (mm) of Honey Bee Colonies from Bait Hives.

Variety	Year	N	Mean	SD
Southern Tamaulipas, Mexico				
European	1988	22	5.27	0.19
Africanized	1989	3	4.97	1.10
European	1989	72	5.26	0.15
Central Tamaulipas				
European	1988	185	5.29	0.12
Africanized	1989	2	5.08	--
European	1989	91	5.30	0.11
Africanized	1990	75	5.00	0.13
European	1990	147	5.25	0.12
Africanized	1991	288	5.01	0.11
European	1991	118	5.09	0.12
Africanized	1992	90	5.03	0.14
European	1992	11	5.07	0.08
Africanized	1993	37	4.95	0.08
European	1993	13	4.97	0.10
Africanized	1994	51	5.01	0.16
European	1994	6	5.05	0.12
South Texas				
European	1988	107	5.22	0.13
European	1989	91	5.25	0.13
Africanized	1990	1	4.80	
European	1990	89	5.23	0.13
Africanized	1991	19	4.90	0.11
European	1991	9	5.19	0.14
Africanized	1992	68	4.97	0.10
European	1992	48	5.17	0.11
Africanized	1993	5	4.89	0.08
European	1993	5	5.16	0.13

Cell-size measurements were made in the field in three widely separated geographic areas during the course of bait-hive monitoring and sampling. In 1988 and 1989, 97 samples and cell-size measurements were collected from southern Tamaulipas, Mexico (22.5 deg. N. Latitude). From 1988 to present, 1556 samples and measurements were collected from central Tamaulipas (23.7 deg. N. Lat.) and southern Texas (26 deg. N Lat.). Both cell measurements and full morphometric analysis (Daly and Balling, *J. Kans. Entomol. Soc.* 51:857-69) were done on each colony. Bee colonies were identified as Africanized if morphometric analysis showed a probability of Africanization exceeding 50%.

Mean cell-sizes of tropical European-origin bees prior to the arrival of the Africanized honey bee were similar from each of the three areas of study (see table). The most recent cell-sizes (4.9-5.0 mm) of the Africanized bee type that we report are larger than those published for pure African bees (4.8 - 4.9mm). Africanization resulted in a gradual decrease in European cell-size measurements to more African-like values, which have remained relatively constant through the study period.

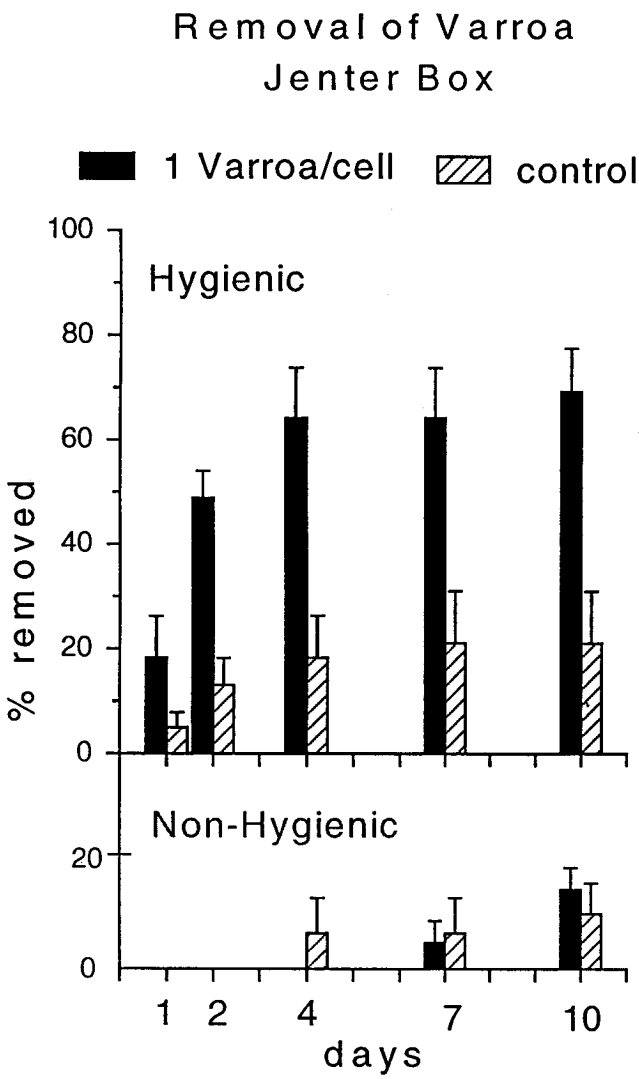
19. Spivak, M., G. A. Reuter, R. Melton, & J. Breyfogle [p] - HONEY BEE HYGIENIC BEHAVIOR AND TOLERANCE TO *VARROA JACOBSONI* [s,t] - Hygienic behavior is considered a behavioral mechanism of resistance to two honey bee diseases; American foulbrood, and chalkbrood. Although some lines of bees demonstrate physiological resistance to the diseases, behavioral resistance (or tolerance) is conferred by hygienic bees detecting, uncapping, and removing diseased brood from the nest before the pathogen becomes infectious. Is hygienic behavior also a mechanism of tolerance to varroa mites, *Varroa jacobsoni*? Some *Apis mellifera* colonies have been found which are able to detect, uncap, and remove pupae experimentally infested with varroa mites (reviewed by Boecking & Ritter, *Am. Bee J.* 134: 689-694).

In the present study, we used a commercial line of bees, "Starline." Our approach differed from that of other researchers in that colonies first were selected on the basis of their hygienic response to freeze-killed pupae, and subsequently were tested for their removal response of mite-infested brood. Colonies were chosen that uncapped and removed a 200 cell section of freeze-killed pupae within 48 hours (hygienic) or > 7 days (non-hygienic). Queens were reared from these colonies and inseminated with drones from different hygienic or non-hygienic colonies, respectively. Using a "Jenter Box" (commercially available queen rearing device), one mite per cell was introduced through the removable plug at the base of cells within the box containing 5th instar larvae. Ten "sham operated" cells served as controls. The infested pupae were left in 4 hygienic and 3 non-hygienic colonies for 10 days. The number of cells that were opened and the pupae removed was recorded on plastic transparencies following the methods of Boecking (*Apidologie* 23:127).

The results are shown in the figure. Hygienic colonies removed a significantly higher percentage of the mite-infested pupae than the non-hygienic colonies on all days. Previous studies indicated that the removal response was significantly higher in plastic combs than in natural wax combs (Boecking & Drescher, *Exp. Appl. Acarol.* 16: 321-329). To test whether the plastic cells of the Jenter Box influenced the removal rate, we also infested 5th instar larvae in natural wax comb, again following the methods of Boecking & Drescher. Our results demonstrated that comb type made no significant difference in the response of the bees, although there was a tendency for the bees to remove the infested

more quickly from the Jenter Box. By day 10, the four hygienic colonies removed 55% ± 12.9 (mean ± s.d.) of the mite-infested pupae from the wax comb, as opposed to 69.1% ± 15.0 from the plastic comb.

Selecting colonies on the basis of their hygienic response to freeze-killed brood may provide a means of determining if colonies demonstrate tolerance to varroa mites. However, the extent to which hygienic behavior interrupts the reproduction of the mite remains unclear.



The removal response of 4 hygienic and 3 non-hygienic colonies to pupae infested with *Varroa jacobsoni*. One mite/cell was introduced into 10 pupae/colony within a plastic "Jenter Box" comb; 10 other cells within the plastic comb served as controls.

20. Szabo, T.I.[q] — OBSERVATION OF QUEEN PARASITISM IN HONEY BEES IN ONTARIO — Female social reproductive parasitism has been associated with Africanized bees (Final Report, *Committee on the African honey bee,* Washington, DC., Natl. Res. Counc., Natl. Acad. Sci. 95 pp., 1992; Michener, *Ann. Rev. Entomol.* 20: 399-416). Rinderer & Hellmich, in *The "African" Honey Bee*, Westview, 1991, observed parasitism among European honey bees in Baton Rouge. They state that the sources of parasitizing queens are unknown, but suggest that the small clusters of invading bees are absconding swarms or afterswarms. During the 1994 queen rearing season, eight observations (see table) were made on queen parasitism in Puslinch, Ontario. Near to an apiary with 40 colonies, small nuclei were established and later inspected for the presence and condition of their queens. All of their queens had been individually marked with colored and numbered discs. In four nuclei the queens were laying at the time of inspection and a few days later two of these queens were found in the nearby apiary on the ground in front of two different hives, balled by worker bees. Thirty minutes earlier the hives had been opened and checked and the balled queens were not noticed. The bees from two other nuclei (observations 2 and 7) had absconded 4 and 6 days before one of the queens was found balled on the ground in front of a hive entrance and the other queen was found on the side of the hive cover surrounded by approximately 200 workers. Another queen with her attendant workers (Observation 4) was briefly spotted on the top of a hive, but was found 5 days later on top of another hive (Observation 6). A queen, which had been laying in her nucleus on July 8, was found laying in a populous colony 4 days later. The colony had apparently been queenless. Nucleus of observation 8 had absconded and the queen was found 10 days later laying in a queenless hive.

All of the 7 queens in the presented observations came from absconded nuclei and at least 4 of the queens were in laying condition before the nuclei absconded. Six queens settled on or were found balled in front of a populous colony which had just been opened and examined. Four queens with their attendants had absconded for several days before they were recovered. Two queens had been accepted in queenless colonies.

Table - Queen parasitism in honey bees in Ontario.

Obs. No.	Inspected Queens in the Nucleus Colonies			Queens recovered after or during colony inspection	
	No.	Condition	Date	Date	
1	14	laying	July 8	July 13	Front of hive no. 19, balled by workers
2	6	absconded	July 8	July 12	Front of hive no. 20, balled by workers
3	9	laying	July 8	July 12	Front of hive no. 16, balled by workers
4	31	laying	July 8	July 13	On the side of the top super of hive no. 21 with appr. 200 workers, queen lost
5	23	laying	July 8	July 12	Laying in colony no.15
6	31	absconded	July 13	July 18	On the side of the top super of hive no. 37 with appr. 200 workers
7	63	absconded	July 13	July 19	On the side of the top super of hive no. 32, with appr. 100 workers
8	93	absconded	July 20	Aug 1	Laying in a hive where queenless bees were shaken

21. Szabo, T.I.[q] — RATE OF INFESTATION OF *VARROA JACOBSONI* IN HONEY BEE COLONIES IN SOUTHERN ONTARIO[s,t] — Honey bees were selected for high hygienic behavior in order to enhance their possible resistance to *V. jacobsoni* (Szabo, *Am. Bee J.* 133: 868). Ten highly hygienic colonies of the third generation of selected bees were moved from Puslinch to Kingsville, Ontario to expose them to *V. jacobsoni*. All colonies were equipped with

sticky boards and were inspected 45 days after relocation and then at 28 d intervals (see table). Judging from the numbers of dead mites found, the increase of the mite population was very rapid. As the number of dead mites on the inserts increased, the percentage of those injured decreased. In a few colonies, however, up to 27% of the dead mites showed injuries, mainly to their legs. On September 8, after 129 days of exposure of the honey bee colonies to the mite-infested territory, the mean percentage of bees with mites was 8.8; the mean colony population was 49,848 of worker bees; the mean number of mites in 200 capped brood cells was 53.3 and the mean total number of mites per colony was 9,612 (ranging from 1,449 -18,110). Fluvalinate treatment increased the mite mortality by 6 times.

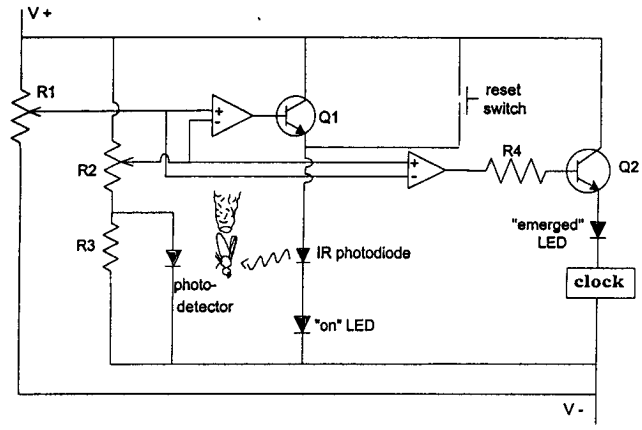
A commercial mite-infested apiary in another area closer to Puslinch was tested for the effects of fluvalinate (Apistan, 2 strips/brood chamber), 65% formic acid (30 ml, 6 times, 3-4 d intervals) and periodic drone comb removal. Drone combs were obtained by replacing the third comb of the second brood chamber with an empty frame and then one week later replacing the eighth comb of the same brood chamber. On these empty frames the colonies rapidly built drone combs and reared drone brood. At 21 day intervals throughout the season, prior to drone emergence, these combs were exchanged with empty frames up to 12 times per colony. The mite population did not increase, remaining low during and after the treatments. The ratio of the mean no. of mites in worker vs. drone brood ranged from 0:39 to 1:1.5, with a seasonal average of 1:9.8.

Table - Rate of natural mortality of *V. jacobsoni* in 10 colonies of honey bees.

Date	Days	No. of Mites	Injured Mites No.	%	Range	Increase
May 2, 1994	0	0	0	0	0	
June 16	45	5	3	60.0	66-100	
July 14	28	31	16	51.6	33-100	6 times
August 11	28	1353	325	24.0	11.6-47.4	43 times
September 8	28	5378	498	9.3	5.8-22.1	4 times
September 15	7					
No fluvalinate, 5 colonies		2514	304	12.0	8.1-27.0	
Fluvalinate, 5 colonies		14735	338	2.3	1.2-17.0	5.9 times

22. Webster, T. C.[o] — A TIMER TO RECORD HONEY BEE EMERGENCE TIMES[t] —The maturation time for honey bee worker, queen and drone brood has considerable practical significance. This is a heritable trait that varies within populations and between races. A relatively short postcapping period limits reproduction by *Varroa jacobsoni* in the cell, and affords some resistance to this parasite (Moritz, *J. Heredity*, 76:267-270; Buechler & Drescher, *J. Apic. Res.* 29:172-176). The relatively short developmental period of brood in African race colonies is an important factor in the biology of those bees (DeGrandi-Hoffman *et al., Amer.Bee J.* 129:717-719). Published studies of developmental times have relied on periodic visual observations, a method which is both tedious and inaccurate. A device to record worker, queen or drone emergence times would seem to have considerable value to researchers.

A circuit includes an infrared diode, an infrared-sensitive resistor, and a clock. To minimize expense, a small digital clock (American Science and Surplus, Skokie, IL) was used. The diode and resistor are mounted so that a bee emerging from a predetermined brood cell will pass through the infrared beam. When this happens, the clock is initiated and the diode is turned off. If the bee passes again between the diode and resistor, the circuit and clock are unaffected. The clock indicates the time elapsed since emergence. A reset switch returns the circuit and clock to the original state. A cage surrounding the brood cell of interest excludes other bees and supports the diode and resistor.

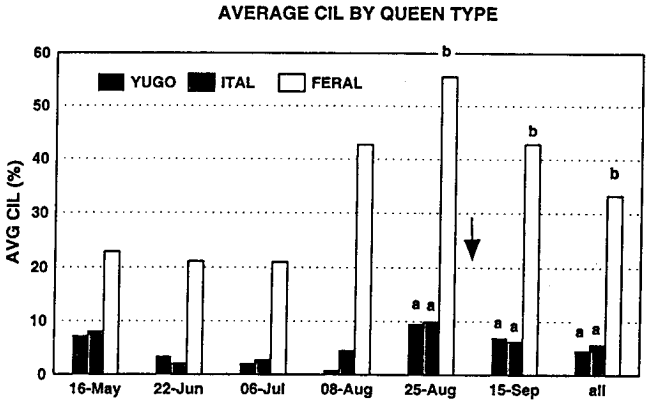


A circuit to measure bee emergence times.

23. Williams, K. R., E. A. Sugden, & T. C. Webster[o] — EFFECTS OF HONEY BEE QUEEN TYPE AND AGE ON TRACHEAL MITE INFESTATION IN KENTUCKY — In spring of 1994 we began a test of honey bee susceptibility to tracheal mites in 3 apiaries in Franklin Co., KY. Colonies were headed by queens of 3 types: (1) "Italians" from 2 commercial sources, (2) "Yugo" ARS-YC1 from a single commercial source, and (3) managed "ferals", representative of typical, naturally requeened colonies in Kentucky (N= 9, 5, and 8 colonies, respectively). Queens were also classified into 3 age groups: <1, ~1, and >=2 years old. Samples of 25-50 workers were taken from inner covers or top bars every 3 weeks from May to September. Analysis was by the "thoracic disk" method; data were analyzed with Kruskal-Wallis and Dunn's pairwise comparisons tests and are expressed as colony infestation level [CIL, (No. bees/Total) X 100]. Menthol was applied to all colonies in late August (fig. arrow).

By late August, Yugos, Italians, and ferals had reached CILs of 9.6%, 9.8%, and 55.6%, respectively (see fig.); <1-yr-, ~1-yr-, and >=2-yr queen colonies had CILs of 10.5%, 38.1%, and 49.7%, respectively. Differences between ferals and both Yugos and Italians and between >=2-yr and both ~1yr and <1 yr-queen colonies were significantly different by late August and in seasonal averages. Yugo and Italian CILs subsided to less than 5% by mid-summer. Feral CILs began increasing in early August and some colonies reached 100% by September. Although not significant in comparison with Italians, Yugo colonies attained the lowest overall CIL (0.8% in early August).

Our results support recommendations for yearly requeening with high quality queen stock. Although our preliminary data do not indicate significantly greater resistance of the Yugo ARS-YC1 line compared with Italians under Kentucky conditions, indications are that further testing might show the Yugo stock to be superior.



24. Wilson, W. T.,[e] M. Ellis[r] & A. M. Collins[e] — CITRAL FUMIGATION AND THREE METHODS OF FEEDING APITOL FOR TRACHEAL MITE CONTROL[s,t] — Apitol(R) (cymiazole) is a systemic miticide that is used in Europe to control *Varroa jacobsoni*. It is mixed with sugar syrup and sprinkled over adult honey bees. The bees ingest the Apitol when cleaning up the syrup. However, this practice is labor intensive, and therefore not cost effective for U.S. beekeepers. Eischen *et al.* (*Am. Bee J.* 127:844) reported control of *Acarapis woodi* in adult worker bees fed Apitol in sucrose syrup in Mexico. Dietz et al. (*Am. Bee J.* 128:801-802) prevented the transfer of *A. woodi* from infested workers to young queens by feeding Apitol in syrup. Citral is used as a flavoring and a fragrance. It has also been used in synthetic pheromone mixes to attract honey bees to bait hives (Schmidt et al., *Am. Bee J.* 129:468-471). In adult bees, it is secreted by the Nasonov gland. Under laboratory conditions, Ellis (pers. comm. 1994) reported that the fumes of citral killed adult tracheal mites in bees held in small cages.

In the spring of 1994 in Arkansas (AR) and Iowa (IA), 3 methods of Apitol application were tested. Apitol dosages and treatment methods were: (1) 2 or 4 or 8g in each 170g Terramycin extender patty, (2) 4g in 1000 ml fructose syrup, and (3) 2g in 170g pollen cake. In Iowa, citral was applied to paper pads in the top of each hive. Two 50-ml treatments of citral were applied 4 weeks apart. All colonies had natural infestations of *A. woodi* and some had *V. jacobsoni.*

Feeding Apitol gave beneficial control (32-79%) of the tracheal mite, but probably not at levels high enough to meet the needs of beekeepers. Likewise, citral fumigation results were encouraging, but mite control (67%) was less than needed for controlling infestations. However, both chemicals warrant further testing at higher doses and under different conditions.

Table - Percentage of adult *A. woodi* killed in bee colonies located near Marvell, Arkansas (March - May) and Cresco, Iowa (May-June) either 2 or 4 weeks following application of miticide.

Treatment	Amt.	Total g		No. of hives		Mean % control	
		AR	IA	AR	IA	2wk AR	4wk IA
<u>Apitol</u>							
Syrup	3 or 2 liters	12	8	19	20	79A(1)	32b
Pollen cake	3	6	NA	20	NA	71a	NA
Extender patty	1	2	4	20	20	43b	36b
Extender patty	1	NA	8	NA	20	NA	54a
Untreated	0	0	0	15	20	11c	12c
<u>Citral</u>							
Liquid	100ml	NA	NA	NA	20	NA	67a

[1] Means within a column followed by a different letter are significantly different (P<.01) by ANOVA & protected LSD test (SAS Inst. 1985). NA = not applicable.

25. Wilson, W. T.[e] & A. M. Collins[e] — NEW MITICIDES FOR VARROA CONTROL[s,t] — One of the most successful and widely used methods of controlling *Varroa jacobsoni* on honey bees (*Apis mellifera*) has been plastic strips impregnated with a miticide. Apistan® strips (Sandoz Agro Inc. Dallas, TX) containing fluvalinate are the best example. However, other miticides are being tested.

Twelve honey bee colonies located near Edinburg, Texas were treated with a miticide in a plastic slow-release device (tag) in June and July 1994 for 28 days. The treatments were: (1) 1, 2, 3 or 4 tags containing YT-1103 per colony, (2) 1, 2, 3 or 4 tags containing YT-1601 per colony, and (3) 4 untreated controls (eventually 1 control died). The Y-Tex Corp., Cody, WY furnished the experimental miticides. Sticky boards (Dewill Inc.) were placed under each colony to collect varroa. After 28 days, the tags were removed from all colonies. Colonies were left untreated for 3 days after which 2 Apistan strips were placed in each of the 11 colonies including the 3 controls. Mite kill from Apistan was determined over a 2-day exposure period.

The two types of plastic tags gave good varroa control. YT-1601 was very effective in 3 out of the 4 colonies with an overall mite reduction of 91.3%. One heavily infested colony with two YT-1601 tags was slow in reducing mite numbers. The YT-1103 tags gave excellent (99.9%) varroa control with most of the mite knockdown in the first week. No obvious bee mortality was noted in the colonies. (However, more recently 3 or 4 YT-1601 tags produced adult bee mortality in other colonies). Mite control from these tags was further substantiated by the Apistan treatment at the end of the study where: mite kill in colonies with YT-1103 averaged <1 mite per day, YT-1601 averaged 24 mites per day and controls averaged 245 mites per day. Plastic tags appear to be an effective and safe way of administering miticides to honey bee colonies.

Table - Average number of adult varroa per day and percent mite reduction from sticky boards under bee colonies treated with plastic tags containing 1 of 2 different experimental miticides.

Treatment	Adult mites on day		Percent Reduction[1]
	1	28	
YT-1601	166	21	91.3
YT-1103	128	0.3	99.9
Control	77	115	0

1 Formula from: Lloyd, J.E. et al., 1983. *Insect. & Acaric. Tests* 8:241.

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