SYMPOSIUM ON MITES OF THE HONEY BEE

The 1994 American Bee Research Conference will host a symposium entitled *Mites of the Honey Bee* on Monday, October 17, followed on Tuesday by presentations of research that is not related to mites. Authors must submit manuscripts for peer review if they choose to include their work in the book entitled *Mites of the Honey Bee,* scheduled to be published by Wicwas Press in July 1995. Authors need not be present at the conference to have their work included in the book. See footnote v for details.

Proceedings of the American Bee Research Conference

The 1993 American Bee Research Conference was held on September 26 - 28 in College Station, Texas. Meetings were in Rudder Hall on the Campus of Texas A & M University. The ninth American Bee Research Conference will be held October 15 - 18, 1994, at the Texas A & M Experiment Station in Weslaco, Texas, site of the USDA's new honey bee research laboratory. The following are abstracts from the 1993 conference.

1. Božič, J.[a] - RECRUITMENT SUCCESS IN ATTENDERS AND FOLLOWERS OF THE WAGGLE DANCE - Behavior pattern of the waggle dance contains directional and distance information about the foraging of the dancing bee (von Frisch, *Springer Verlag* 1965). During the search flight to the food station, bees may use the dance information (Frisch 1965; Mautz, *Z. vergl. Physiol.* 72:197-220; Gould, *Science* 189:685-693) or they may only search by olfactory cues (Wenner, *Nonverbal communication*: 133-169, Plenum Press 1974). Regardless of how bees find the food source, bees must be aroused to foraging behavior and have to be excited enough to fly out of the hive to search for the dancer's food source.

Behavior of bees around the dancers were evaluated by observing different approaches of the bees to the dancer's body and by observing other behaviors around the dancers. Inner approach of the bees was described as left approach to the dancer when the dancer turned to the left side in the next waggle run, and to the right side when the dancer turned to the right side. "Figure eight" pattern of the waggle dance favors the following of the bees on the inner side of the dancers. With factorial analysis of behavior transitions, four behaviors around the dancer were evaluated: (1) walking around the comb, (2) searching behavior, (3) following either the inner side of the dancer or (4) following the outer side of the dancer. Attenders attempted to interact with any foraging bee or walked around the comb and only occasionally approached the waggle dancer.

During a two-day recruitment experiment, 335 individually marked bees were observed at the feeding station. At the same time, hive behaviors around the dancers of 56 marked bees were recorded on VHS video tape. From all observed bees in the hive, 30 were recruited to the feeding station, and most of them (27) followed the inner side of the dancer before their flight out of the hive. Long following behavior did not favor recruitment success in bees which exited the hive immediately (2 min. after leaving the dancer) on either experimental days (*Maximum likelihood analysis*). Bees which didn't fly out of the hive, but came to the feeding station later during the same day, had exchanged food less frequently as unrecruited bees. Some bees were not recruited on the first day, but their attending behavior on the first day contributed to recruitment success on the second day.

Bees were excited to exit the hive by high foraging arousal, which was generated during contacts with foragers and especially when they followed the dancers in the hive. High arousal most likely originates in higher activity of bees, which can be observed in higher body temperature (Stabentheiner & Hagmuller, *Naturwiss.* 78:471-473). Investigations of involvement of biogenic amines, juvenile hormone and sugar metabolism in foraging arousal and excitement of bees are in progress.

2. Collins, A. M.[b], W. T. Wilson[b], J. Baxter[b] & J. Maldonado[b] -MANAGEMENT TECHNIQUES FOR DEFENSIVE COLONIES [t,u] - With the spread across the Americas of the excessively defensive Africanized honey bee (Collins *et al., Science* 218:72-74), there has been great concern about improved methods of working with these colonies. Beekeepers, nearby people and animals, may be at greater risk of severe stinging than with European honey bees. This study compared eight new management approaches with the traditional technique using smoke and a control using nothing during colony manipulation.

The treatments were: (1) smoke alone, (2) sugar syrup (50%) spray used in lieu of smoke, (3) sugar syrup + citral/geraniol (1% by vol), (4) sandbag entrance block + scroll covers (two sheets of heavy fabric laid across the open colony leaving space for removal of only one frame at a time), (5) mosquito repellent (DEET, 15%) spray used in lieu of smoke, (6) fume board with BeeGo®, (7) fume board with menthol (Wilson & Collins, *Am. Bee J.* 129:825-6), (8) CO_2 from dry ice as a fume board, (9) ammonium nitrate smoke and (10) nothing. Colonies of Africanized and European honey bees from five apiaries in northeast Mexico were opened and all of the frames in the brood nest inspected. The participants rated the video-taped response of each colony as 1 -no defense, 2 - localized defense, 3 - extended defense, or 4 -explosive defense. (See Table).

Using sugar syrup spray and DEET in lieu of smoke were as effective as smoke only. Citral/geraniol added to the sugar syrup did not enhance the effectiveness of the sugar syrup. The entrance block/scroll cover was also very effective. The BeeGo fume board worked well, but was smelly and cumbersome. The

menthol and CO_2 fume boards were not as effective as smoke. The ammonium nitrate smoke anesthetized most of the bees in the colony within five seconds. The workers recovered within an hour but this approach was so disruptive we only tried it once.

In one apiary that became very defensive during testing, we sprayed all entrances with sugar syrup and sprayed DEET in the air before we left. Within 10 minutes the bees had returned to active foraging and very few remained defensive.

Table - Average defensive behavior of honey bees based on videotape recordings of colony manupulations as rated by four observers.

Treatment	Rating	N
Smoke alone	1.7	13
Sugar syrup	1.9	18
Sugar syrup + citral/geraniol	2.9	2
Entrance block/covers	1.6	14
DEET	1.5	16
BeeGo fume board	1.2	2
Menthol fume board	2.1	2
CO_2	2.3	2
Ammonium nitrate	0.6	1
Nothing	3.4	14

3. Eischen, F. A.[c] & B. A. Underwood[c] - THE EFFECT OF DELAYING POLLINATION ON CANTALOUPE PRODUCTION - During the growing seasons of 1992 and 1993, the pollination of cantaloupes were delayed by either 0, 6, or 12 days. Pollination was prevented by covering plants with Reemay® row covers at the time of first female flowering. Plants were left covered for either 6 or 12 days and then exposed to bee visitation. Cultivars used in the 1992 season were 'Cruiser', 'Explorer', and 'Primo'. 'Cruiser', 'Mission', and 'Primo' were used in 1993.

In the 1992 test, cultivar Primo delayed six days produced more fruit weight/plant than those not delayed or delayed 12 days. 'Cruiser' and 'Explorer' produced smaller fruit when pollination was delayed 12 days, but were unaffected by a six-day delay. The 1993 trial found that 'Mission' delayed 12 days produced more fruit/plant. No difference in fruit quality or number were observed in other cultivars when pollination was delayed. In both trials the median harvest time was about the same as controls when pollination was delayed for six days.

These data suggest that in areas with low feral honey bee populations, the time that managed colonies need to be in the field could be reduced. That is, pollination could be delayed by about a one week without negatively affecting productivity or harvest time. This would provide growers additional time in which to apply insecticides should they be needed, and reduce honey bee exposure to insecticides from adjacent fields.

4. Ferrari, T. E.,[d] B. J. Palmer[d] & A. C. Carlson[d] - FORAGING PATTERNS OF ENPOLLINATED HONEY BEES - Honey bees are used to cross-pollinate flowers of important crops. Unfavorable conditions can lead to suboptimal fertilization and inadequate flower set. To mitigate adverse pollination conditions growers often disperse precollected pollen onto honey bees (enpollination). Enpollinated bees had greater pollination efficiency and produced more almonds, cherries and apples than untreated honey bees (see Ferrari, *Am. Bee J.* 130: 801). Such studies focused on yield from treated vs untreated trees or orchards.

Our recent research investigated *where* enpollinated honey bees distributed pollen within almond orchards. Supplemental pollens containing genetic "markers" were used to enpollinate colonies. Flowers fertilized by sperm cells in pollen were detected by examining embryos for presence of genotype-specific proteins (Ferrari, *Am. Bee J.* 131:775). Location of flowers coupled with presence of markers indicated the area enpollinated bees foraged.

Colonies were in groups of 16 to 24 around orchards (16 or 32 ha). Pollen (75 gm/ha), placed in two-way dispensers at hive entrances, was applied (15-20 gms/dispenser) once each day for 3 to 4 days as bloom progressed from 10% to 60%. Treatments, completed within 2 hours, were performed between 0900 and 1100 hrs when bee activity was at least 100 bees per minute entering and leaving the entrance. About 1 in 5 colonies (the strongest) were enpollinated, and pollen was dispersed within 30 minutes. Pollen viability was measured by positive staining with fluorescein diacetate. Pollen vigor was analyzed following hand-pollination of flowers: pistils routinely contained more than 50 pollen tube penetrations per stigma.

Paternity tests were begun when embryos reached at least 2 mm in diameter. Nut samples (N = 20/tree) were taken from 6 to 9 trees per row, at increasing distances from the orchard perimeter. Trees at identical positions in four equidistant rows were averaged for each orchard.

Nut set due to supplemental pollen (incorporation) was, in 8 of 11 orchards, lowest on trees within about 70 meters (10 trees) of a row end. Then incorporation increased as distance from enpollinated hives increased (max. 118 m) and decreased near the center (min. 274 m) -- producing an "M-shaped" foraging pattern. In 2 orchards, incorporation increased and reached a single peak near the row center. In 1 orchard, incorporation decrease as distance from hives increased. The foraging habit of bees was most consistent with a Gaussian distribution of resource sites as hypothesized by Buchmann & Shipman (*Am. Bee J.* 131:771).

Bloom in almond trees begins in the top, when most pollen was dispersed. Therefore, a preponderance of nuts with markers should occur within the tops of trees. Four orchards were examined by sampling nuts in the top- vs bottom-half of trees. Three orchards, which bloomed in S to N sequence, had more nuts with "markers" in the top- than bottom-half (%, top/bottom: 30.0/6.8, 30.0/23.4, 26.6/23.2). The northern-most orchard which was inadvertently pollinated later in the bloom cycle, had less incorporation in the top than bottom-half (16.8/23.2).

No orchard examined displayed uniform foraging by enpollinated bees. Distance of pollen dispersal, based on nut set, was previously shown to be less when bee flight was perpendicular to rows (Ferrari, *Am Bee J.*, 130:801). Results indicate that incorporation and distribution of pollen can be improved by placing more colonies at the ends of rows than along the sides of an orchard.

5. Garza -Q., C.[e] & F. Souza-V.[f] - EVALUATION OF 10% FLUVALINATE TO CONTROL VARROATOSIS IN MEXICO - The mite, *Varroa jacobsoni*, was detected in Mexico in May 1992 and since that time the Mexican government has been trying to find products to control it. This work reports the evaluation of 10% fluvalinate in Mexico. The objectives were: (1) to test this product (trade name Apistan®, under the conditions found in the humid Mexican tropics with the recommended dosage used in other countries for the control of varroa and (2) to determine the effectiveness of different dosages in Mexico.

The work was carried out near the port of Veracruz from October 24 to December 19, 1992. The level of mite infestation before and after treatment was determined using 3 types of samples: (a) 350 adult honey bees (analyzed as suggested by De Jong *et al.* (*Ann. Rev. Entomol.* 27: 229-252. 1982), (b) 10-15 cm^2 of sealed brood (*i.e.* 50 cells) and (c) weekly collection of the hive debris.

For the first test, we selected 24 hives that showed infestations of 2.9 to 55.7%. Three different doses were tested (1, 2 and 3 Apistan strips) with 6 replicates each and 6 untreated controls. The product was applied for 8 weeks. The infestation of mites in sealed brood increased significantly in the control hives, but not in the other treatments. Hives treated with 1 strip showed less of a decrease of infestation than the hives treated with 2 and 3 strips.

Analysis of variance showed the control to be significantly different from the other treatments, but no differences among the three treatments. This was attributed to the high variability in the

infestation in the sealed brood at the beginning of the study. Therefore, we applied analysis of covariance, using the number of strips as the treatments and time (0 - 8 weeks) as the covariate. Treatment means were compared at each week with LSD mean separation. In week 8, the treated hives with 1 strip had an infestation in sealed brood that was higher than found in hives with 2 and 3 strips, but the differences were not statistically significant.

The number of mites found per 100 adult bees of the control group showed a tendency to increase at week 8. Hives that received 3 strips showed no mites on adult bees after the 4th week. As time passed, there was a decrease in the number of captured mites in hives treated with 2 and 3 strips. The number of captured mites increased in control hives and in hives treated with 1 strip. From the 3rd week onwards the number of mites captured in hives with 2 and 3 strips were nearly equal and close to 0. In hives treated with 1 strip, mite levels approached 0 until week 7.

In conclusion, 10% fluvalinate effectively controlled varroa at dosages recommended by the company. Smaller doses of this product should be tested in order to validate the results obtained. If smaller doses would provide effective control of varroa, cost would be substantially lower and there would be less chance of contaminating honey and wax.

6. Harbo, J. R.[a] - EFFECT OF HEAT ON TRACHEAL MITES - In the first experiment worker bees of unknown ages were collected from a colony infested with tracheal mites (*Acarapis woodi* Rennie) and placed into 3 cages. The cages (8 x 8 x 9 cm) were screened on one side and on the bottom and provided with pollen, honey, and water. The cages, each with about 100 bees, were placed in separate incubators set at 34.5, 39, and 42° C (94, 102, & 107° F) (all at 50 - 70% RH). The tracheae of freshly killed bees were examined at 24-hour intervals to determine if adult mites were dead or alive (see figure for results).

In a second experiment, adult worker bees (<24 hours old) were marked and then placed in a colony that was infested with tracheal mites. Three days later, the newly infested bees were collected and divided into two groups (paired *t* design) and placed into cages (as above); one group was put into an incubator at 39°, and the other was kept at 34.5°C (both 50 - 70% RH). Forty-eight hours later, the cage of bees in the 39° incubator was moved to be with the control bees at 34.5°.

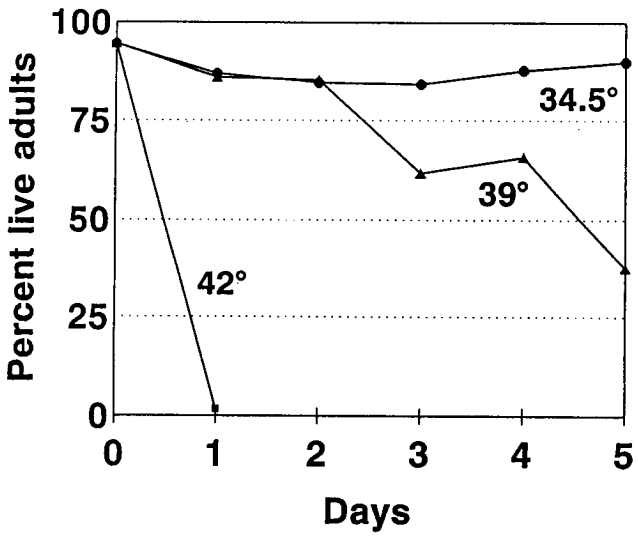


Figure - The effect of ambient temperature on the survival of adult mites in the tracheae of worker bees. Mites died quickly at 42[a] C (108[a] F), but most of the bees died shortly therafter. There was significant mortality of adult mites that were kept at 39[a] C (102[a] F) for 3 days (Chi square = 10.4, $P = 0.001$), and no apparent mortality of mites at 34.5[a] C (94[a] F). There was no mortality of bees at either 34.5 or 39[a].

Mite populations in the two treatments were compared when the bees were 9 - 10 days old. In four replicates, bees kept at 34.5° (controls) contained 2.7 larval mites per adult mite; bees exposed to 39° contained 0.01 (paired *t* test: df = 3, P = 0.001). Control bees also contained more mite eggs (2.8 *vs.* 1.5 eggs per adult mite) ($P = 0.04$). This suggests that existing eggs died or did not develop during the 48 h at 39° and that viable eggs were not produced during that period.

These and other experiments (Harbo, *J. Apic. Res.* 32, in press) show that tracheal mites can be killed inside live bees at temperatures that do not kill bees. Perhaps heat accounts for the summer decline in populations of tracheal mites. Furthermore, stimulating bees to excessive fanning or other activity (the resulting heat) may be the mode of action for some of the "nontoxic" chemicals that are reported to control tracheal mites.

7. Harbo, J. R.[a] - EVALUATING BEES FOR RESISTANCE TO VARROA MITES - Honey bee stocks previously selected for short and long postcapping periods, were tested in Louisiana for comparative resistance to *Varroa jacobsoni.*

On 24 June 1993, 20 colonies were established from bees that had been collected into a large cage. Initial populations consisted of 8578 ± 111 (mean ± SD) bees and 148 varroa mites in each colony (bees in the source cage contained 17.3 mites per 1000 bees).

The queens for this experiment were each inseminated with semen from two drones from a different colony than the queen, but of the same stock type. During the first brood cycle, the worker progeny of each colony were evaluated for duration of capped brood by measuring the time between the first capped brood cell and the first emerging bee.

Mite and bee populations were evaluated on 31 August. Mite populations were measured on adult bees by collecting a known weight of bees (ca. 300 g) from each colony and placing the caged bees at 40° C (104° F) for 2 days. Freezer paper, coated with oil and placed under each cage, captured all mites from the bees within 48 hours. To estimate mite populations in brood, capped worker cells and adult varroa mites were counted until 10 infested cells were included. I used GLM analysis of covariance with stock type as the treatment and duration of capped brood as the covariate.

After 68 days, bee populations were 7326 ± 1521 (mean ± SD) and mite populations were 942 ± 387 per colony (range was 320 - 2086). This included adult mites in the brood cells as well as on the adult bees.

There was a positive relationship between duration of the capped period and mite population (similar to that found by Buchler and Drescher, *J. Apic. Res.* 29:172-176). The analysis showed no interaction between stocks ($P = 0.26$), so data from the two stock types were combined into an analysis that assumed equal slopes for both groups. The results were $Y = -8625 + 33.8X$ and $Y = -8116 + 33.8X$ for the stocks that had been selected for long and short duration of capped brood, respectively (X = duration of capped brood in hours and Y = number of varroa mites per colony, $P = 0.07$ for the slope).

When evaluating mite populations on adult bees only, duration of capped brood had a significant effect within the stock selected for short duration of capped brood ($Y = -10792 + 41.4X$, $P = 0.0025$, n = 9), but not within the stock selected for long duration of capped brood ($Y = -1011 + 5.3X$, $P = 0.50$, n = 11). In these equations, X = duration of capped brood in hours and Y = number of mites on the adult bees in a colony.

Therefore, in this experiment, when there was a significant relationship between duration of capped brood and mite population, there were only 41 fewer mites for each hour that the capped period was shortened.

8. Hoopingarner, R. A.[b]& O. R. Taylor[i] - FORAGER POPULATION DYNAMICS OF NEWLY ESTABLISHED AFRICAN HONEY BEE SWARMS - Swarms collected over a

two-week period in early April, 1993 near Linares, Mexico were established in seven-frame hives. Twice during the next two weeks pigment-marking dispensers (Boylan-Pett & Hoopingarner, *Acta Hort.* 288:111-115) were put on the entrances of the hives in order to mark all of the foragers. The second evening after the dispensers were put on, all frames were photographed. The kodachromes were projected and the total number of bees as well as the number of marked forager bees were counted in each colony.

At the time of the first count the colonies ranged from two to 16 days in age from the time of establishment. The average size of a colony was 5,226 bees at this time. Populations declined by an average of 18.8% over the next week to average populations of 4,008 total bees. If you remove from the statistics the colony that actually gained bees during the week, the decline in bees was 28.7%. (The colony that increased was last photographed on the 21st day after establishment.) The average percentage of marked bees (foragers) was 26.5% for the first week, and increased to 34.4% at the time of the second photographic count, 6 days later.

The percentage of foragers increased significantly as the swarms increased in age. This was in spite of a decline in population and an increase in the amount of brood. There was a larger population of foragers in the larger swarms, whereas, the percentage of foragers was higher in smaller swarms. This later fact would agree with that found in European bees by Nelson & Jay (*Manitoba Entomol.* 6:5-8). There were a few colonies that had a very low percent foraging during the first few days after establishment. This could indicate that these colonies had a difficult time adjusting to their nest box.

The great variation in foraging population within these relatively uniform sized swarms would indicate that this marking and counting method would be a simple way to determine which colonies to use to select for a greater foraging force.

9. Kralj, J.[j] & J. Božič[a] - BEHAVIOR OF HONEY BEES ATTENDING THE QUEEN - Honey bees attending the queen during rest periods between egg laying activity exhibited four different behavior patterns: workers (1) waved their antennae close to the queen's body, (2) palpated the queen with antennae, (3) licked the queen, or (4) brushed their forelegs to the queen's body. These behaviors most probably serve to spread the pheromones from the queen's body to the antennae and mouth parts of worker bees (Free, *Pheromones of social bees*, 1987).

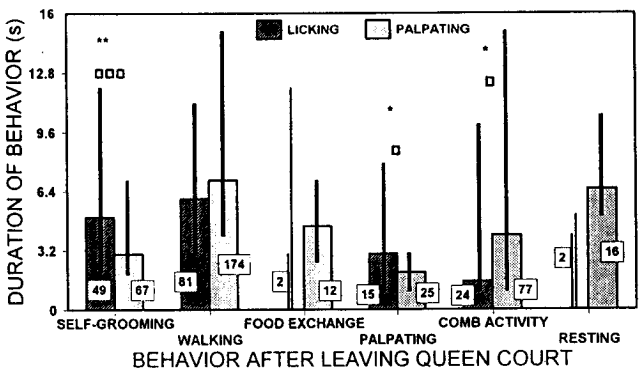


Figure - Duration of behaviors of 11 licking attenders and 16 palpating attenders after leaving the queen attendance. Bars represent median values and thick lines show interquartile ranges. Numbers in squares represent number of observed behaviors and thin lines are separate values when only two observations of behavior were ovserved. *** P <0.01, ** P = 0.01 -- 0.05, * P = 0.05 -- 0.10 represent significance levels for the Kruskal-Wallis test. Small squares were used for the median test.

During the antennal movement and palpation, the worker bees moved irregularly towards and away from the queen.

Other behaviors were apparent after the workers no longer attended the queen. Immediately after leaving the queen, those bees that had previously shown licking behavior walked significantly faster (median test, $P = 0.0018$, median = 6.8 mm/s) than those previously seen palpating (median = 5.4 mm/s). The previously licking bees then self-groomed more frequently and for a longer time (median test, $P = 0.0049$). These bees also engaged in comb activities more often than the previously palpating bees (Figure). The self-grooming behavior occurred in a sequence: cleaning of antennae and mouth parts, cleaning of fore legs, cleaning of middle legs, and finally cleaning of hind legs against the abdomen. This pattern of cleansing relocated the pheromones from the antennae and mouth parts to the worker's abdomen. When only the body surface was evaluated, the largest amount of the radioactive labeled pheromone was found on the abdomens of bees when they were attending the model queen (Nauman *et al., Behav. Ecol. Sociobiol.* 29: 321-332 & *Can. Ent.* 124: 917-934). No detectible amounts were found on the antennae. Further transfer of the pheromones to the bodies of the other worker bees was probably accomplished during accidental encounters of pheromone contaminated individuals.

10. Loper, G. M.[k] - SIZE OF CELLS (MM) AND OF BEES (GRAMS/10) FROM FERAL HONEY BEE COLONIES IN S. ARIZONA[u] - Beginning in March 1993, 54 swarms of feral bees were caught in Schmidt & Thoenes, *Bull. Entomol. Soc. Am.* 33:155-158, swarm traps using the 3-component pheromone lure (Schmidt & Thoenes, *Environ. Entomol.* 21:1130-1133). The established colonies were transferred to 6-frame nuc boxes by removing brood combs, queen and bees. The queens were painted to identify them by location. Usually, 2 brood combs were cut from the traps and placed in folding frames (20.3 x 43.2 cm) and placed in the center of the nuc boxes. One additional frame was placed on either side of the center frames. These frames had a 25 mm "starter" strip of molded (5.40 mm/cell, Duragilt, Erickson *et al., Glean. Bee Cult.* 118:98-101) foundation imbedded in the top bar. As the bees began to fully draw-out the comb on these 4 frames (2 folding and 2 starter) 2 full-foundation Duragilt frames were added to completely fill the nuc box. Between Aug. 31 and Sept. 3, cell-size measurements were made on each type of comb from as many colonies as was feasible (some comb was too convoluted for accurate measurements). On each side of each frame, 3 separate measurements were made, as described by Spivak *et al.*, In *Africanized Honey Bees and Bee Mites,* Ellis Harwood Limited. On September 9 and 10, 30 degastered worker bees from each of 28 colonies were weighed (fresh wt.) and compared with the weight of domestic honey bees.

The cell size (mm/10 cells) of naturally built brood combs as transferred from the swarm traps averaged 5.17 ± .07 SD (n=70); from the starter frames the average was 5.20 ± .09 SD (n=85) and on the Duragilt foundation the average was 5.40 ± .04 SD (n=56). A two-tailed *t* test showed that the cell size of natural and starter comb was just barely significantly different ($P < 0.05$) and that both were highly significantly different ($P < 0.01$) from the cell size drawn on Duragilt foundation. None of the comb built on the Duragilt, and used for broodrearing, showed any abnormal patterns. This indicates that the bees had no difficulty adjusting to larger cell-size construction. These results support the data of Spivak & Erickson, *Am. Bee J.* 132:252-255, which show that cell size of natural comb is primarily determined by genetics.

The fresh weight of 30 degastered bees was determined in the field using an O'Haus Model CT-200-S electronic balance. The fresh weight of 30 bees was divided by 3 to obtain the average weight of 10 bees as per the FABIS protocol (Sylvester & Rinderer, *Am. Bee J.* 127:511-516). The average value for the feral samples (n=28) was 0.514g which is not significantly different from the value of 0.535g for European honey bees (Sylvester & Rinderer, *Am. Bee J.* 127:511-516). For comparison, honey bees from one of the first colonies of the Africanized honey bees

found in Tucson, AZ on June 17 averaged 0.467 grams/10 bees which is just barely in the range for Africanized honey bees (0.365-0.477) of Sylvester & Rinderer, *Am. Bee J.* 127:511-516.

After one swarm was established in a hive (with the queen painted) it absconded, but was found to have entered another swarm trap 5.8 km (3.6 miles) from its original hive location. This may be a distance record for European honey bees.

11. Oliver, R.,[a] J. Woodring,[a] T.D. Dreesen[a] - PIGMENT GRANULES IN THE COMPOUND EYE OF *APIS MELLIFERA* - The pigment granules of the compound eye of *Apis mellifera* were examined to determine if they might serve as a model for the investigation of pigment uptake systems known to exist in *Drosophila melanogaster*. Uptake of pigment precursors is thought to be controlled in drosophila principally through the interaction of three membrane proteins. In drosophila, these three proteins are the products of the *white (w), scarlet (st), and brown (bw)* genes. Molecular and genetic analysis indicates that these proteins are members of the ABC family of active transport complexes (Dreesen *et al., Mol. Cell Bio.* 8:5206-5215). Mutants deficient in any of these proteins exhibit various degrees of inability to deposit pigments in the eye.

Biochemically there are two classes of screening pigments found in the insect eye. The ommochromes contribute the brownish colors and are derived from tryptophan. The red color of dipteran eyes comes from pteridines which derive from GTP. The pigment pathways of *Apis* and *Drosophila* are known to be similar (Tucker, in *Bee Genetics and Breeding,* Rinderer *(ed.)* Academic Press, pp. 57-87), although the red pteridine pigments of the fly are replaced by colorless ones in the bee. However, it is not known if homologs to the drosophila transport proteins are present in the bee nor if the mechanism of pigment deposition is the same for the two groups.

Transmission electron microscopy (TEM) was used to study the arrangement of the pigment granules of the honey bee. The honey bee eye is composed of ommatidia with fused rhabdoms and no ommatidial cavity. Three types of pigment cells, primary, secondary, and tertiary, contain pigment granules. Some of the pigment granules appear to be membrane-bound, but others may be unbounded protein structures as indicated by literature references (Tucker, *ibid*). Those that appear to be membrane-bound are the most likely to involve the membrane transport systems as evidenced in drosophila. Attempts to immunolocalize the brown protein from drosophila in the honey bee were unsuccessful. However, this does not prove that a homolog is not present since an antibody raised to the drosophila protein might not recognize the honey bee protein.

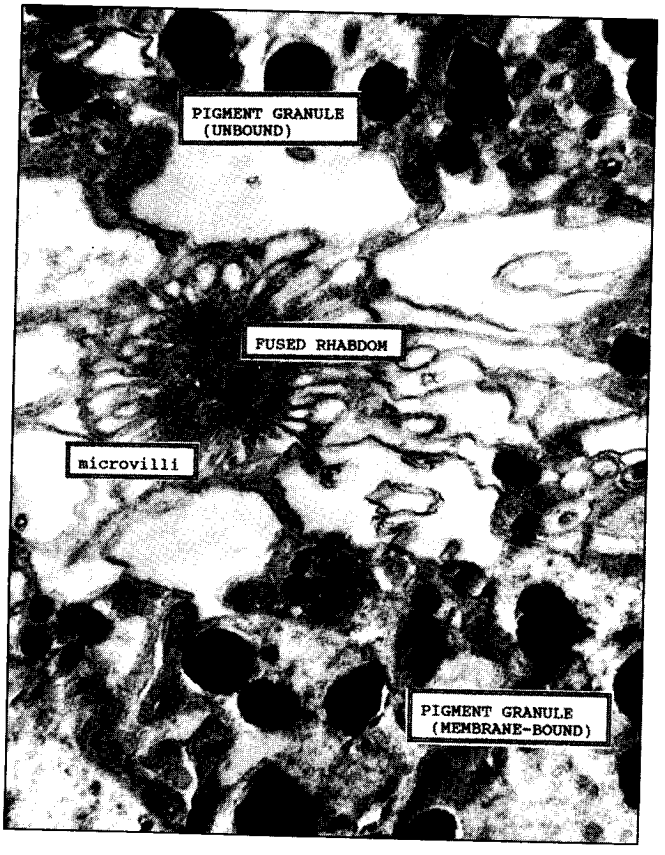


Figure - Ommatidia of the honey bee, *Apis mellifera*, showing pigment granules of secondary pigment cells.

12. Ramirez-B., W.[i] - TRUTHS AND MYTHS ABOUT AFRICAN BEES IN THE NEW WORLD - Beliefs about African honey bees (AHB) include: (1) swarms invade and displace European colonies; (2) colonies do not accept European queens; (3) swarms reject new boxes to nest, (4) they do not accept or build wax foundation for European honey bees (EHB); (5) they produce less honey; (6) they swarm several times in a year; (7) they have high absconding rates; (8) they prefer to nest in small cavities; (9) they nest in the open; 10) they do not respond to the use of little smoke; (11) swarms abscond when hived; (12) they are very aggressive or assassins.

Over a 10-year period, the author has observed that swarming can be prevented; AHB produce abundant honey (up to 172 kg were harvested from a primary swarm) when properly managed and hived in two standard boxes as a brood chamber and 2 or 3 deep supers for honey storage. Hive volume must be reduced to the brood chamber, and supplemental sugar must be provided during the wet season (dearth period) to prevent absconding. Invasions of queen-right European colonies, or nuclei, by swarms of AHB do not occur; they easily accept European queens and the wax foundation made for EHBs; the AHB swarms stay when hived in new boxes. The large AHB feral population forces swarms to accept suboptimal nesting sites such as small cavities or no cavity (nesting in the open). AHB colonies can be managed using little smoke, and (as with EHB) they are defensive, not aggressive.

13. Rivera, R.[b] & A. M. Collins[b] - HYDROCARBONS OF HONEY BEE STING APPARATUS - Cuticular hydrocarbons of termites, flies, mites and bumblebees have been used to differentiate subspecies. These hydrocarbons of the cuticle protect the insect from desiccation, make the insect waterproof, protect the insect from disease, and could possibly have a pheromonal effect. Hydrocarbons from honey bee cuticle have been described and identified by other researchers (Francis *et. al., J. Apic. Res.* 24:13-26; Smith, *Bee Science* 1:23-32.) Specific hydrocarbons have been used as taxonomic indicators. McDaniel *et al.* (*Sociobiol.* 8:287-297) did a preliminary investigation of sting apparatus and sting shaft hydrocarbons as chemotaxonomic characters.

Hydrocarbons of the sting apparatus were selected as a factor in identifying and differentiating subspecies of *Apis mellifera*. Honey bee sting apparatuses were collected on black suede-leather patches from two locations in Mexico (Tapachula, Chiapas and Toluca, Mexico) and from Weslaco, Texas, USA. Samples shipped in alcohol or air dried showed little or no change in hydrocarbons. Comb and cuticular hydrocarbons are frequently contaminated with hydrocarbons from pollen and other sources. However, hydrocarbons from the sting apparatus are usually free of contaminants, giving a much cleaner representation of the hydrocarbons produced by the bee. Hydrocarbons were extracted from honey bee sting apparatuses using hexane and then analyzed by capillary gas chromatography.

Differences were detected between Africanized and European honey bees. To be useful in classification, the hydrocarbons must not be influenced by environmental factors such as primary food source, or geographic location. These must only depend on the population of bees in question. We found small differences in several unsaturated C-29, C-31 hydrocarbons between colonies

and between geographic locations, but greater differences between subspecies.

14. Rowell, G.A.,[m] M.E. Makela[n] & L.T. Wilson[n] - COMPUTER SIMULATION OF AFRICANIZED HONEY BEE POPULATION DYNAMICS: COLONY IMMIGRATION, EMIGRATION, BIRTH AND DEATH - There have been several recent efforts to build multi-colony models of Africanized honey bee population dynamics or population kinetics (Makela *et al., Ecological Modelling* 67:259-284; Matis *et al., Am. Bee J.* 132: 811-812; Otis, 1991, in: *The "African" Honey Bee,* Westview). The computer model, BEEMIG, was used to examine patterns of immigration, emigration, and colony birth and death in simulated populations of Africanized honey bees (AHB) in Texas. The temporal distribution of these events might be useful in understanding the overall dynamics of feral or natural populations of honey bees.

Details of BEEMIG are reviewed elsewhere (Makela *et al., Am. Bee J.* 132:811; Rowell *et al., Am. Bee J.* 132: 813-814). The simulated population (see figure) was based on a point location ca. 10 km northwest of Hidalgo, TX. A density dependence factor assumed a 11.5 sq km foraging area per colony. The starting population consisted of 30 colonies at Hidalgo, and 10 colonies at Laredo, Texas. The simulated run-time was 6 years. The maximum total number of colonies (N) reached just under 100 per study cell yielding a density of ca. 0.80 colonies per sq km. Densities of AHB in Africa, AHB in South America, and European honey bees in North America have been observed at 7.8, 4.7 - 7.1, and 0.5 colonies per sq km, respectively, (Schneider & Blyther, *Insectes Sociaux* 35: 167-181).

Peaks in total population size occurred in mid August and lowest values were in the months of February through April. Much of the initial growth phase was due to high levels of immigration into the simulated study area. Similarly, emigration made a major contribution to the overall fluctuation in total N. Swarming and death appeared to make only small contributions to the growth and decay phases at this location. Swarming and death appeared as discrete periods during the annual cycle with swarming occurring mostly in April though June and death occurring as early as August and September, but mostly in December through February. Immigration and emigration appeared to occur more or less continuously throughout the year.

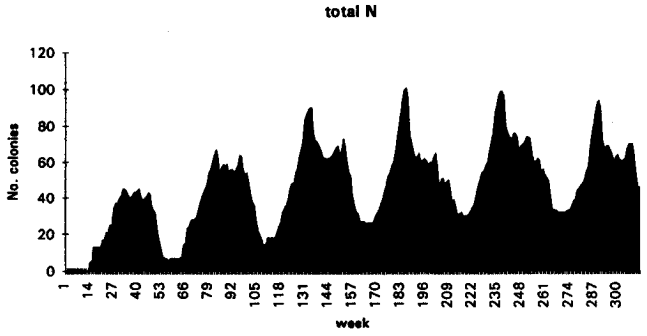


Figure - Fluctuation in total population size of simulated populations of Africanized honey bees.

15. Szabo, T.I.[o] - SELECTIVE BREEDING OF HONEY BEES FOR RESISTANCE TO *VARROA JACOBSONI* - Honey bee colonies have been bred for resistance to *V. jacobsoni* on the basis of the infestation rate of the colonies (Rinderer *et al., Am. Bee J.* 133: 197-200). The infestation rate can be influenced by: bee behavior such as grooming and biting of the mites (Peng *et al., J. Invert. Path.* 49: 54-60), hygienic behavior such as detection and removal of mite-infested or dead brood (Boecking *et al., Am. Bee J.* 132: 732-734), a shorter capped period in worker brood development (Buchler & Drescher, *J. Apic. Res.* 29:172-176), the preference of the mite to reproduce on drone pupae (Fuchs, *Apidologie* 21: 193-199).

In May, 1992, an apiary consisting of 24 colonies of honey bees from Ontario stock was established at Puslinch, Ontario. The colonies were not infested with *V. jacobsoni* therefore, the selection criterion for the removal of damaged brood was used, which relates to *V. jacobsoni* detection and removal (Boecking and Drescher, Int. Conf. on the Asian Honey Bees and Bee Mites, Bangkok, 1992, p. 49). During the summer of 1992 the 24 colonies were checked seven times for their ability to uncap and remove dead brood using the technique of Newton & Ostasiewski, *Am. Bee J.* 126: 278-281 and a high variability was found (see figure). New generations of queens were then reared from the three best and three least hygienic colonies and the first generations of high and low hygienic bees were established. In the summer of 1993 the colonies were again evaluated and of 11 with high hygienic and 10 with low hygienic behavior honey production on average was 55.5 kg and 40.0 kg and chalkbrood was found in 1 and 4 colonies ($P < 0.1$), respectively. From the four colonies with best hygienic behavior queens were reared and 40 new ones were established while the low hygienic colonies were eliminated. Upon examination the four best colonies were also most resistant to *Acarapis woodi*. It is planned to continue to select the stock for resistance to *V. jacobsoni* by evaluating the biting behavior as described by Ruttner and Hanel, *Apidologie* 23: 173-187.

Apis mellifera carnica honey bees were surveyed in Hungary and Austria for developed resistance to *V. jacobsoni*. The importation and incorporation into the breeding program of Carniolan honey bee stock is under consideration.

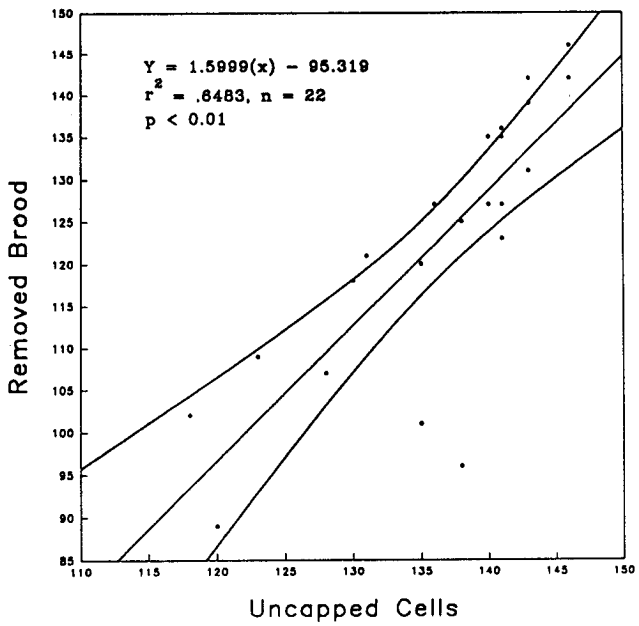


Figure - Regression of the removed dead brood on the number of uncapped cells in 22 colonies.

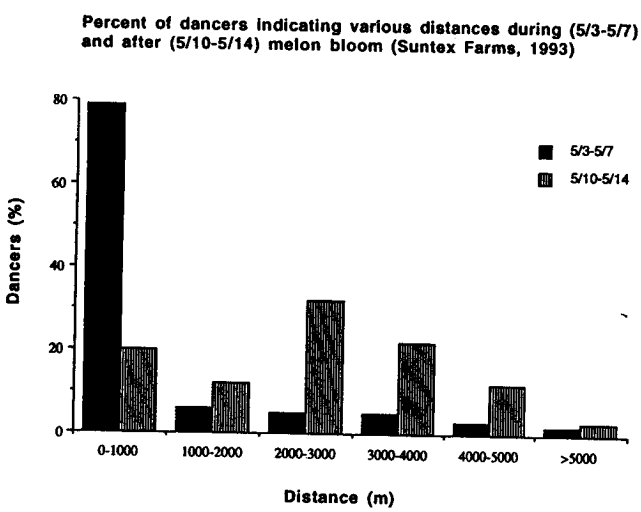
16. Underwood, B. A.[c] & F. A. Eischen[c] - HONEY BEE COLONY FORAGING DISTANCES IN A SOUTH TEXAS CANTALOUPE FIELD - Numerous studies (see reviews by Free, *Insect Pollination of Crops*, 1970 and Ribbands, *The Behavior and Social Life of Honeybees,* 1953) have shown that the median foraging radius of colonies under agricultural conditions is only a few hundred meters. Consequently, the usual pollination practice has been to place colonies near the target crop. A recent study by Buchmann and Shipman (*Am Bee J.*,131:771) seems to challenge that practice by indicating that the median foraging radius of a colony may actually be about 2 km.

The present study was conducted in a large cantaloupe planting (180 ha) near Rio Grande City in south Texas. A 4-frame

observation hive (approx. 10,000 bees) was installed inside a mobile home on the edge of the field. During the first week of observation (May 3-7, 1993), about 800 commercial pollination colonies were situated within 1500 meters of the observation colony.

Foraging distances of bees were determined by observing recruitment dances of successful foragers. The number of dances for a particular pollen type has been shown to be highly correlated with the number of returning foragers bearing that type of pollen (Visscher & Seeley, *Ecol.* 63: 1790-1801). Thus, the recruitment dances are probably a reliable indicator of actual foraging activity. Using techniques similar to those of Visscher & Seeley, we recorded the recruitment dances of foragers for two 5-day periods during (5/3-5/7, 1993) and after (5/10-5/14) melon bloom. The timing of our observations was such that during the first week, the melons were attractive to the bees, while during the second week, the vines were in decline.

The figure shows that during the first week, nearly 80% of dancers (N = 266) indicated distances < 1000 m. The following week, the foraging pattern changed dramatically, with nearly 80% of dancers (N = 222) indicating distances > 1000 m. During the first week, the median foraging distance was 500 m, while during the second, it was > 2500 m. Statistically, the two data sets are very different ($p < 0.001$, *t*-test). These data indicate that the present practice of scattering pollination units throughout the field is probably a sound one.



17. Villavicencio, R. A.,[p] A. Suazo[p], H. G. Hall[p] & M. T. Sanford[p] - EVALUATING HONEY PRODUCTION IN FIRST GENERATION AND BACKCROSS HYBRIDS OF AFRICAN AND EUROPEAN HONEY BEES IN HONDURAS - Honey production in European stock from Hawaii and African honey bees found in the valley of El Zamorano, Honduras, along with first and second generation backcross hybrids was examined. Two areas were used in this study. That of the valley of El Zamorano, a zone of heavy cultivation, and the other in Las Manos, a more forested region less affected by commercial agriculture.

Thirty-four of 43 initial colonies survived in Las Manos (79%) and 24 of 34 initial colonies (71%) in El Zamorano. Units used in this study were five-frame standard depth nuclei, including a brood chamber and one or two supers. The results presented in the table show that the African colonies were generally more productive than the Europeans. There was no significant difference between the African (A) and hybrid (AE) in this study and both were superior to the other four groups. First generation hybrids of African matrilines (AE) produced more honey than those of European matrilines (EA). Honey production by backcrossed hybrids (AEE and EAA) was considerably less.

The AE hybrid was considered better from a management standpoint because it swarmed and absconded less and tended to exhibit reduced defensive behavior. These results appear to support previous observations that the African bee foraging population is more effective, building more rapidly and staying in the fields longer than Europeans (Michener, *Ann. Rev. Entomol.* 20:399-416, 1975). This conclusion, however, must be tempered with the fact that these were not feral colonies and that human management may allow marginal populations to survive and produce honey where their wild counterparts might not.

Recent metabolic studies carried out using the same colonies in Honduras (Harrison & Hall, *Nature* 363:258-260, 1993) showed that the European and hybrid bees possess significantly lower metabolic rates than the African bees. Hybrids of African matrilines (AE and AEE) had higher rates than hybrids of European matrilines (EA and EAA).

Findings from both investigations suggest that genetic contribution from the African matriline, perhaps via mitochondrial DNA, may be one of the factors in the success of African bees in the American tropics. From a practical standpoint, if African-European hybrids are used in breeding programs, these results suggest the focus should be on African matrilines and first generation crosses (EA).

Table -- Average honey production (pounds/colony) for six treatments in two regions of Honduras.

Treatment	No. of Hives	Mean ± SD	Range
A-African (feral stock)	7	32.1 ± 10.5	19 - 45
AE-African queen/European drone	7	27.8 ± 9.0	17 - 42
EA-European queen/African drone	5	14.4 ± 11.1	3 - 27
E-European (Hawaiian stock)	5	11.2 ± 9.2	0 - 22
EAA-European queen/African drone, backcross to AHB drone	8	7.1 ± 9.4	0 - 25
AEE-African queen/European drone, backcross to EHB drone	2	2.5 ± 3.5	0 - 5

18. Webster, T. C.[q] - *NOSEMA APIS* SPORE TRANSMISSION AMONG HONEY BEES - Experiments were designed to determine whether worker and queen honey bees can receive *Nosema apis* spores via trophallaxis from workers which have recently ingested spores. If spores are passed among bees in this way, workers are not protecting the recipient bees from infection.

In one experiment, workers were confined to both sides of a cage divided by a screen through which they could not pass but could feed each other. Bees on one side ("donor bees") fed through the screen top of the cage on sucrose syrup (50%) containing spores (2 million/ml) and rubidium (1000 ppm as RbCl). Rb was used as a label to determine the amount of syrup consumed by individual bees. Bees on the other side (recipient bees) of the cage could not reach the feeder and could only be fed by donor bees. The bees were caged and fed in this way for three days. At the end of the experiment, individual bees were sampled to determine the number of spores (by homogenizing the bee and counting spores with a hemacytometer) and Rb (by atomic absorption spectrophotmetry) they contained. To date, data indi-

cate that recipient bees ingested approximately as many spores as donor bees, in proportion to the amount of syrup (measured by total Rb in the bee) ingested. Thus, spores are readily transferred among workers via trophallaxis.

In a second experiment, cages of bees including workers with a queen were fed the diet described above. Data evaluated so far show that queens actually contained more spores than the workers relative to the amount of syrup consumed. This indicates that workers ingesting Nosema spores may not be able to protect their queen by retaining the spores when they feed her with their crop contents.

19. Wenner, A. M.[r] & R. W. Thorp[s] - CAVITIES OCCUPIED BY FERAL COLONIES ON SANTA CRUZ ISLAND, CALIFORNIA - Since 1975, several studies have been done on the nesting habits of feral bees (reviewed in Gambino, P., *et al., Apidologie.* 21:35-45; see also Winston, 1992, in *The Hive and the Honey Bee*, pp. 73-79). Those studies have relied heavily on reported chance encounters of feral colonies. Gambino, *et al.*, in the most complete study, recognized an inherent bias: "...nests [found were] near human activity and within sight of observers on the ground."

In 1988 we began to search for all feral honey bee colonies on Santa Cruz Island, a 96 square mile (25,000 hectare) island off the coast of Santa Barbara, California. Bees foraging on blossoms or visiting water sources were converted to a scented sugar/honey solution in order to obtain homeward bearings and round trip times (Wenner, *et al., Bee Science.* 2:64-70). The 135 original colonies methodically located to date would appear to represent the types of cavities occupied -- for bees isolated from the mainland and beekeeping activity for more than 110 years.

The 213 colony locations (Table) fell into three broad categories: natural, cavities reoccupied by new swarms, and newly occupied swarm hives. Although existing colonies fell into six categories (cliff hole, rock crevice, rock overhang, clay bank, tree trunk, and tree bole), the first three of those (65%) represent colonies in rocky cliff faces. During the six-year period, only six of the 213 colonies were chanced upon by hikers. About 13% of all colonies were in classic "bee trees" -- another 18% occupied cavities underneath scrub oak trees.

Of the 88 swarms intercepted in the last three years (after four drought years), approximately half (42) had reoccupied colony sites that had been treated and reopened, in about the same proportion for various types of sites as had been discovered earlier. Thirty-six of the swarms ended up in swarm hives placed around the island; only 10 swarms had moved into sites not previously recognized, some within a few meters of previous colony locations.

Table - Cavities occupied by feral colonies on Santa Cruz Island (off the coast from Santa Barbara, California). Included is information on swarm re-occupation of formerly emptied cavities, as well as on swarm occupation of swarm hives (installed as survey hives.)

	East Half	Re-Occupied Cavities (by Swarms)	West Half	Total
Cliff Hole	25	11	11	**47**
Rock Crevice	26	11	7	**44**
Rock Overhang	11	7	6	**24**
Clay Bank	4	1	3	**8**
Tree Trunk	14	4	5	**23**
Tree Bole	18	8	5	**31**
Subtotal	98	42	37	**177**
Swarm Hives	21	6	9	**36**
TOTAL	**119**	**48**	**46**	**213**

20. Wenner, A.M.[r] & R. W. Thorp[s] - SWARM CHOICE: SURVEY HIVES OR NATURAL CAVITIES - In our bee colony removal project on Santa Cruz Island, offshore from Santa Barbara, California (Wenner & Thorp, *Glean Bee Cult.* 121:272-275), we have installed 129 swarm hives with lures (e.g., Schmidt & Thoenes, *Am. Bee J.* 130:811-812) in six years (1988-1993 -- 0, 30, 54, 60, 68, and 129, cumulative totals by year). The swarm hives included 73 large tubs (9 gallons), 30 small tubs (6 gallons), 11 rectangular, and 15 rectangular with foundation frames, all furnished by Schmidt and Thoenes.

During treatment, natural colonies are calmed with an anaesthetic and all entrances stuffed with plastic (e.g., dry cleaner bags, trash bags). After smothering, wasp, bee, and ant scavenging preceded wax moth destruction of combs. We then opened the colony by retrieving the plastic pieces, thereby providing another type of swarm hive (former colony cavity). Eighty-five additional cavities thereby became available in six years.

Both swarm hives and former cavities were inspected as often as time permitted (under no regular schedule -- island topography and road conditions limit travel). No swarming was observed in the first three years (extreme drought conditions), but more recent bountiful and wellspaced rainfall permitted ever more swarms (table).

The number of swarms occupying swarm hives approximately equaled that in former colony cavities, but the percentage capture of swarms in available sites was higher in formerly used natural cavities (49% of 85) than in swarm hives (30% of 129). Swarms occupied no hives equipped with frames, while large tubs, small tubs and empty rectangular swarm hives were about equally effective. So far, fewer than 12% of 88 swarms have been found in new locations.

The high rate of swarming and rapid buildup observed on the island is a Dark European Bee ("German") characteristic (e.g., Ruttner, F. *et al.*, 1989, *The Brit. Isles Bee Breeders Assoc.*). An example: one swarm hive installed on 13 March 1993 already had brood combs (with no honey storage) by 4 April, with swarm cells already formed.

Table - The number of swarms caught in the last three years of a six-year period on Santa Cruz Island (off the coast from Santa Barbara, California). No swarms were observed in earlier (drought) years.

	West Half			East Half			Total
	91*	92	93	91*	92	93	
Swarm Hive	3	5	3	3	5	17	**36**
Cavity of Former Colony	--	2	--	2	15	23	**42**
New Cavity	--	--	1	0	4	5	**10**
Total	**3**	**7**	**4**	**5**	**24**	**45**	**88**

* A "March Miracle" rainfall came too late to promote much swarming in 1991.

21. Williams, K. R.,[q] E. A. Sugden,[q] & T. C. Webster[q] - RESPONSE OF TRACHEAL MITES (*ACARAPIS WOODI*) TO HONEY BEE CUTICULAR HYDROCARBONS AND CO_2 - Although tracheal mites are widespread and have caused a great deal of damage, their detection is still problematical. Development of an inexpensive, practical method of sampling is still needed. One such method would consist of a lure inserted into the hive which would mimic the features of a honey bee attractive to tracheal mites. Tracheal mite attraction to honey bee cuticular hydrocarbons (HCs) (Phelan *et al., J. Chem. Ecol.* 17:463-473) and to a pulsed air stream (Hirschfelder & Sachs, *Bee World* 33:201-209) has been demonstrated. Attraction to CO_2 has also been suggested (*ibid.*). Our research sought to incorporate these factors in development of a tracheal mite lure.

We used cotton pipe cleaners to simulate the hairiness of a bee and to serve as a carrier for potential chemical attractants: hexane extracts of day-old bees and of old bees, three combinations of

commercially available HC's in hexane (C23-25, C26-28, & C30 + 32-33) and a hexane control. These were applied randomly to sets of 6 pipe cleaners in 1 and 10 bee equivalents and inserted into the brood nest of test colonies for 24 hours. Ten infested (13-50%) baby nucs headed by sister queens were used for each of the two replicates. Pipe cleaners were placed into individual vials of 70% propanol. The vials were agitated, the solutions centrifuged, and the pellets stained and observed for mites. No mites were observed on any treatment (N = 20 sets of lures).

In a separate experiment, a three-choice test was used to bioassay the attractiveness of streams of air vs. 50:50 CO_2 + air mixture (heretofore CO_2) vs. control (nothing). Gases were applied at ca. 0.12 cc/min. through 1 µl pipettes. Subjects were obtained by sacrificing infested bees and transferring dispersing mites directly from body hairs to a test arena (N = 162). Mites were observed for 5 minutes. Results were scored as the first and final treatments chosen and the average time spent in each treatment sector. The order of preference was CO_2 > AIR > CONTROL in the last two parameters considered and CO2 = AIR > CONTROL in the first treatment chosen, although the only significant difference was between CO_2 and CONTROL in the last treatment chosen (Chi square, 31 vs. 19 mites, respectively).

Our data indicate that HCs alone are not sufficient to attract tracheal mites to a lure, but that CO_2 is attractive and might be incorporated into a lure. Further experiments will test the combined attractiveness of CO_2 plus HCs, alternative physical carriers, and the incorporation of sticky or toxic mite-retaining substances into prospective lure designs.

22. Wilson, W. T.[b] & A. M. Collins[b] - FAILURE OF FORMIC ACID TO CONTROL *VARROA JACOBSONI* IN A HOT CLIMATE[t,u] - European scientists have reported satisfactory control of adult *Varroa jacobsoni* using formic acid (FA) in both cold climates (Fries, *Swed. J. Agric. Res.* 19:213-216) and hot climates (Bracey & Fischer, *Am. Bee J.* 129:735-737). During late 1992, *varroa*-infested *Apis mellifera* colonies near Mission, Texas were treated with one of three acaricides in the broodnest for mite control. Starting September 1, 14 colonies each received 2 Apistan strips, 14 each got 3 Miticur strips, 7 were fumigated with 20 ml of 65% formic acid weekly for 3 times and 7 were left untreated. Each colony was comprised of ca. 7 to 10 frames covered with adult workers and 4 to 6 frames of brood in one deep Langstroth hive body. Sticky boards were not used to capture the mites that dropped because of bottom board construction. The ether roll method was used to determine mite levels with ca. 300 workers obtained from each colony for each data collection. The pretreatment adult mite counts per sample from each colony on August 24 were Apistan ($\bar{x}$ = 12.0), Miticur ($\bar{x}$ = 14.1), FA ($\bar{x}$ = 15.0) and control ($\bar{x}$ = 11.4).

One month after miticides were first applied, we anticipated that the average varroa count per colony would be low. This was true for both Apistan ($\bar{x}$ = 2.1 mites/colony) and Miticur ($\bar{x}$ = 0.5), but the varroa counts were still high in FA ($\bar{x}$= 20.1) and untreated ($\bar{x}$ = 12.4) colonies. Two months after treatment (Oct. 27), the results were 1.5, 0.1, 14.8 and 14.0, respectively. FA fumes had failed to adequately control varroa. On October 6, the 7 FA colonies were each retreated with 40 ml of 65% FA weekly for 3 times. Both types of plastic strip stayed in the colonies for 45 days (n = 7) or 4.5 months (n = 7). On January 5, 1993, the avg. mite count per colony was Apistan (0.2), Miticur (1.5), FA (18.2) and untreated (48.8). Daytime temperature range: 20-32°C.

The results showed that both Apistan and Miticur were effective in controlling varroa. However, the FA treatment was not effective except near the end of the study when minor control may have been achieved. In earlier studies, we assumed that the adult varroa on a sticky board had died from exposure to FA fumes. However, we found that when the bottom board was warm and a sticky substance was not present, the mites knocked down by FA fumes were frequently alive. Some of these mites were able to reattach themselves to adult bees walking across the bottom of an observation hive. This might explain the report by Lupo & Gerling (*Apidologie* 21:261-267) that 30 or more FA treatments per colony per year were needed in Israel for varroa control. Also, continuous brood rearing in a hot climate may provide a reservoir of varroa that reinfests a colony when a miticide, such as FA, has dissipated. Another explanation for the high mite count in FA-treated colonies was reinfestation from nearby hives that were untreated. Although reinfestation cannot be totally excluded, it was unlikely in this study since mite counts remained low even after Apistan and Miticur strips were removed on day 45.

23. Wilson, W. T.[b] & A. M. Collins[b] - FORMIC ACID OR AMITRAZ FOR SPRING OR FALL TREATMENT OF *ACARAPIS WOODI* [t,u] - Moffett *et al.* (*Am. Bee J.* 128:805-806) reported that amitraz in an aerosol formulation controlled 93% of tracheal mites in treated colonies while 2 types of plastic strip impregnated with amitraz were less effective (ca. 70% control). Starting on September 14, 1992 near Marvell, Arkansas, 55 colonies, each in 2 or 3 deep Langstroth hive bodies, were examined and later treated with (1) 6 Miticur® strips per colony for more than 7, weeks, (2) 40 ml of 65% formic acid (FA) on a paper pad in the top of each hive weekly for 3 times or (3) untreated (controls). The number of colonies was: 24, 24 and 7, respectively. The colonies were heavily infested (prevalence W = 61.8%) with tracheal mites (*Acarapis woodi*), but no *Varroa jacobsoni* were seen. Daytime temperatures were in the low 20s C. In an expanded study starting on February 1, 1993 near Vidor, Texas, 120 colonies in single deep Langstroth hive bodies were treated with one of the following: (1) 3 Miticur strips in brood nest for 3 weeks, (2) 4 ml of liquid Mitac® (19.8% amitraz) on a paper pad over the top bars weekly for 3 times, (3) 1 filter paper/saltpeter smoke strip with 0.2 ml of Mitac burned on the bottom board weekly for 3 times, (4) 30 ml of 65% FA on a paper pad over the top bars weekly for 3 times, (5) filter paper/saltpeter smoke strip without Mitac, (6) untreated. Number of colonies: 25, 25, 25, 25, 10 and 10, respectively. Live and dead adult mite counts were used to determine the per cent of dead mites in each group and to determine the efficacy of each treatment. Tracheal mite prevalence W = 37.7%. Foraging bees collected pollen and daytime temperatures were ca. 16°C. Varroa mites were present in the Texas colonies.

In Arkansas, live and dead tracheal mites were counted three weeks after treatment with an average mite mortality per colony of: Miticur 32%, liquid FA 94% and untreated colonies 38%. Seven weeks after treatment, the mortalities were 30%, 74% and 25%, respectively. In Texas, 1 week after the first treatment the average mortalities of adult tracheal mites were: Miticur 35%, liquid Mitac 39%, Mitac smoke strips 66%, FA 79%, smoke strips without Mitac 34% and untreated colonies 30%. Final live and dead mite counts made 3 weeks after the first treatment gave mortalities of 22%, 23%, 96%, 94%, 24% and 25%.

Unfortunately, the Miticur strip was not effective for tracheal mite control in the Arkansas and Texas studies, and liquid Mitac did not work well in the Texas project. However, smoke containing amitraz was efficacious and killed 96% of adult mites during the 3 weeks after the initial application. Texas colonies fumigated with FA had 94% adult mite control. From this study, we conclude that amitraz employed as a smoke fumigant is highly effective in controlling *A. woodi*, but Miticur strips and Mitac liquid apparently did not give off enough amitraz vapors to penetrate into tracheal tubes to kill adult *A. woodi*. We recognize that Miticur was not applied according to the manufacturer's product label.

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t. This report gives the results of research only. Mention of a pesticide does not constitute recommendation by the USDA for use, nor does it imply registration under FIFRA as amended.

u. Mention of a commercial or proprietary product does not constitute an endorsement by the USDA.

v. Titles of papers to be presented at the symposium, *Mites of the Honey Bee*, must be received by 15 September 1994. Authors choosing to submit manuscripts for publication in the book, *Mites of the Honey Bee*, must submit three copies of the manuscript by 1 November 1994 and a copy on computer disk at the time of acceptance. Manuscripts accepted for publication will be assessed a page charge (less than most journals) to keep the price of the book low and thus maximize distribution. Instructions for submitting manuscripts, an explanation of publication procedures and fees, and all other questions should be directed to John Harbo, USDA Honey Bee Breeding Laboratory, 1157 Ben Hur Rd., Baton Rouge, LA 70820, USA; FAX 504-389-0383; Tel. 504-766-6064; E-mail JHARBO@ASRR.ARSUSDA.GOV. Whether or not an article is included in the book, *Mites of the Honey Bee*, a paper presented at the symposium may be included as an abstract in the 1994 Proceedings of the American Bee Research Conference, scheduled for the December issue of the *American Bee Journal*.