(Fig. 1b). Since the positions of these openings appear to be different for each egg, it is conceivable that they are made by spermatozoa penetrating the chorion during the fertilization process.

A network of hexagonal ridges extends over the entire surface area of the egg except for the micropyle region and the opposite pole of the egg which is covered by a prominent layer of adhesive material (Fig. 1c). The source of this adhesive material in not known. The hexagonal ridges, or polygonal cell imprints, correspond to the boundaries of individual follicular cells (Hinton, *Ann. Rev. Entomol*. 14:343-68).

5. Guzman, L. I. de[d] & M. Delfinado-Baker[e] — IDENTIFICATION OF A NEW SPECIES OF *VARROA* ASSOCIATED WITH *APIS KOSCHEVNIKOVI* IN BORNEO — Examination of a collection of *Varroa* specimens collected by T. E. Rinderer from *A. koschevnikovi* in Borneo has resulted in the recognition of a new species of *Varroa* associated with *A. koschevnikovi*. The new mite is the third species known under the genus *Varroa* and associated with cavity nesting bees in Asia. This new species of *Varroa* is probably the mite previously identified as *V. jacobsoni* by MDB collected from Borneo (Otis, 1991, *Diversity in the Genus Apis*, D. Smith, ed., Westview Press, Boulder, CO, pp 29-49). Specimens of the new species were collected from drone brood of *A. koschevnikovi* and compared with those collected from *A. cerana* colonies. All source colonies were kept in an apiary located at Tenom Agricultural Park, Borneo. Measurements of characters were taken using a digitizer, with data input into a computerized program and analyzed using *t*-tests. All measurements are given in microns.

The new mite resembles *V. jacobsoni* but may be separated from it primarily by it lacking a seta on the trochanter of the palpus. This seta is always present in *V. jacobsoni*. Other distinguishing features of the new species include a truncated shape of the tectum, a bladelike bidentate fixed chela of the chelicera, and large bladelike corniculi with rounded tips and finely serrate margins. Specimens of the new species are larger and have long and widelooped peritremes, more setae on the marginal and endopodal shields, and reduced numbers of setae and pores on their sternal shield than *V. jacobsoni* (Table).

The biology of this mite is not known. However, it is possible that this new species is specific to *A. koschevnikovi* bees. Further examination of samples showed no mite contamination or cross infestation between species despite the observed interspecific colony invasions of foragers between both host bee species (TER personal communication). In addition, TER noticed differences in the phoretic behavior of the two mite species during the collection. *Varroa* mites from *A. cerana* tended to hang onto the host upon removal of the pupa while *Varroa* from *A. koschevnikovi* remained inside the cells. Obviously, studies should be done to determine the biology and pest potential of this new species.

Table. Comparison of morphological characters between *Varroa* n. sp. from *Apis cerana* in Borneo, Malaysia (Mean ± standard error).

Characters	*Varroa* n. sp. (n = 10)	*Varroa jacobsoni* (n = 11)	P > |T|
Body length	1,180 ± 11[a]	1,077 ± 6[b]	0.0001
Body width	1,698 ± 14[a]	1,596 ± 10[b]	0.0001
Peritreme length	582 ± 13[a]	426 ± 9[b]	0.0001
Loop distance	49 ± 2[a]	18 ± 2[b]	0.0001
No. of marginal setae	23 ± 0.5[a]	19 ± 0.4[b]	0.0001
No. of endopodal setae	12 ± 0.5[a]	7 ± 0.3[b]	0.0001
No. of sternal setae	9 ± 0.3[b]	10 ± 0.3[a]	0.0011
No. of sternal pores	9 ± 0.4[b]	11 ± 0.4[a]	0.0253
No. of metapodal setae	23 ± 0.8[a]	22 ± 0.5[a]	0.28[ns]

Row means with different letters differ significantly from each other (P = 0.05 student *t*-tests).

6. Harbo, J. R.[d] & R. Hoopingarner[a] — RESISTANCE TO *VARROA* EXPRESSED BY HONEY BEES IN THE USA — Resistance of honey bees (*Apis mellifera* L.) to varroa mites (*Varroa jacobsoni* Oudemans) has been reported in many parts of the world (Ruttner *et al. Apidologie* 15:43-62; Ritter *Apidologie* 21:368-370; Anderson *Apidologie* 25:412-421). In every case, including this study, resistance in bees appears to be associated with the failure of female mites to produce progeny after they enter a brood cell (non-reproduction of mites).

Our study was a field test with 27 colonies. As a genetic source, we assembled 8 colonies that we thought had potential for resistance to varroa. Queens and drones were propagated from this group to produce 27 instrumentally inseminated queens, each queen mated to only one drone. Test colonies were established on 12 May by subdividing a large mixture of mite-infested bees into 27 populations. Each population consisted of 986 ± 13 (mean ± SD) grams of bees and about 290 mites. Colonies were given only combs with worker-sized cells for brood production. On 24 July (70 days after queen release) we ended the experiment by measuring the mite population (mites in brood cells plus mites on adult bees) and the weight of the adult bee population of each colony. During the experiment, we measured grooming behavior, hygienic behavior, duration of the postcapping period, and the frequency of non-reproducing mites in brood cells.

Of the four characteristics listed above, only non-reproduction of mites was significantly related (using linear regression) to changes in the mite populations ($F = 6.2$, $P = 0.02$, df = 1, 21, $R^2 = 0.23$). Final mite populations were 873 ± 413 (mean ± SD); bee populations were 1982 ± 335 grams. One colony had 238 mites and 2178 grams of bees (fewer mites than at the beginning of the test and a better-than-average increase in the bee population). This colony was not hygienic, it was above average in grooming behavior (27%), and it had a relatively short capped period (273 hours). Most importantly, only 17% of mites in the brood cells were producing progeny.

Eggs and young larvae from the mite-resistant colony (described above) were exchanged with those from a susceptible colony (92% reproduction). The result was similar to that found by Beetsma & Zonneveld (*Exp. Appl. Acarol.* 16:303-312) and Fuchs (*Exp. Appl. Acarol.* 18:309); non-reproduction of mites was controlled by events that preceded their entering the cell. Brood from the resistant colony supported a high frequency of mite reproduction (82%) when infested with mites in the susceptible colony. Conversely, brood from the susceptible colony had a low frequency of mite reproduction (36%) when infested with mites from the resistant colony.

This study shows (1) that resistance to mites exists in honey bees in the USA. Resistance may be rather common but may be masked by multiple mating of queens. Thus, the single-drone inseminations used in this experiment may have made mite resistance easier to detect. (2) Non-reproduction of mites is an important characteristic that has been repeatedly associated with mite resistance. A queen (her progeny) being evaluated for non-reproduction of mites needs to have been producing brood in a colony for at least 6 weeks. When inspecting cells for this trait (examine purple-eyed bee pupae), a non-reproductive mite may be dead in the cell, it may be "wallpapered" to the cell wall by the cocoon of the honey bee, or it may be alive.

(Fig. 1b). Since the positions of these openings appear to be different for each egg, it is conceivable that they are made by spermatozoa penetrating the chorion during the fertilization process.

A network of hexagonal ridges extends over the entire surface area of the egg except for the micropyle region and the opposite pole of the egg which is covered by a prominent layer of adhesive material (Fig. 1c). The source of this adhesive material in not known. The hexagonal ridges, or polygonal cell imprints, correspond to the boundaries of individual follicular cells (Hinton, *Ann. Rev. Entomol*. 14:343-68).

5. Guzman, L. I. de[d] & M. Delfinado-Baker[e] — IDENTIFICATION OF A NEW SPECIES OF *VARROA* ASSOCIATED WITH *APIS KOSCHEVNIKOVI* IN BORNEO — Examination of a collection of *Varroa* specimens collected by T. E. Rinderer from *A. koschevnikovi* in Borneo has resulted in the recognition of a new species of *Varroa* associated with *A. koschevnikovi*. The new mite is the third species known under the genus *Varroa* and associated with cavity nesting bees in Asia. This new species of *Varroa* is probably the mite previously identified as *V. jacobsoni* by MDB collected from Borneo (Otis, 1991, *Diversity in the Genus Apis*, D. Smith, ed., Westview Press, Boulder, CO, pp 29-49). Specimens of the new species were collected from drone brood of *A. koschevnikovi* and compared with those collected from *A. cerana* colonies. All source colonies were kept in an apiary located at Tenom Agricultural Park, Borneo. Measurements of characters were taken using a digitizer, with data input into a computerized program and analyzed using *t*-tests. All measurements are given in microns.

The new mite resembles *V. jacobsoni* but may be separated from it primarily by it lacking a seta on the trochanter of the palpus. This seta is always present in *V. jacobsoni*. Other distinguishing features of the new species include a truncated shape of the tectum, a bladelike bidentate fixed chela of the chelicera, and large bladelike corniculi with rounded tips and finely serrate margins. Specimens of the new species are larger and have long and widelooped peritremes, more setae on the marginal and endopodal shields, and reduced numbers of setae and pores on their sternal shield than *V. jacobsoni* (Table).

The biology of this mite is not known. However, it is possible that this new species is specific to *A. koschevnikovi* bees. Further examination of samples showed no mite contamination or cross infestation between species despite the observed interspecific colony invasions of foragers between both host bee species (TER personal communication). In addition, TER noticed differences in the phoretic behavior of the two mite species during the collection. *Varroa* mites from *A. cerana* tended to hang onto the host upon removal of the pupa while *Varroa* from *A. koschevnikovi* remained inside the cells. Obviously, studies should be done to determine the biology and pest potential of this new species.

Table. Comparison of morphological characters between *Varroa* n. sp. from *Apis cerana* in Borneo, Malaysia (Mean ± standard error).

Characters	*Varroa* n. sp. (n = 10)	*Varroa jacobsoni* (n = 11)	P > |T|
Body length	1,180 ± 11[a]	1,077 ± 6[b]	0.0001
Body width	1,698 ± 14[a]	1,596 ± 10[b]	0.0001
Peritreme length	582 ± 13[a]	426 ± 9[b]	0.0001
Loop distance	49 ± 2[a]	18 ± 2[b]	0.0001
No. of marginal setae	23 ± 0.5[a]	19 ± 0.4[b]	0.0001
No. of endopodal setae	12 ± 0.5[a]	7 ± 0.3[b]	0.0001
No. of sternal setae	9 ± 0.3[b]	10 ± 0.3[a]	0.0011
No. of sternal pores	9 ± 0.4[b]	11 ± 0.4[a]	0.0253
No. of metapodal setae	23 ± 0.8[a]	22 ± 0.5[a]	0.28[ns]

Row means with different letters differ significantly from each other (P = 0.05 student *t*-tests).

6. Harbo, J. R.[d] & R. Hoopingarner[a] — RESISTANCE TO *VARROA* EXPRESSED BY HONEY BEES IN THE USA — Resistance of honey bees (*Apis mellifera* L.) to varroa mites (*Varroa jacobsoni* Oudemans) has been reported in many parts of the world (Ruttner *et al. Apidologie* 15:43-62; Ritter *Apidologie* 21:368-370; Anderson *Apidologie* 25:412-421). In every case, including this study, resistance in bees appears to be associated with the failure of female mites to produce progeny after they enter a brood cell (non-reproduction of mites).

Our study was a field test with 27 colonies. As a genetic source, we assembled 8 colonies that we thought had potential for resistance to varroa. Queens and drones were propagated from this group to produce 27 instrumentally inseminated queens, each queen mated to only one drone. Test colonies were established on 12 May by subdividing a large mixture of mite-infested bees into 27 populations. Each population consisted of 986 ± 13 (mean ± SD) grams of bees and about 290 mites. Colonies were given only combs with worker-sized cells for brood production. On 24 July (70 days after queen release) we ended the experiment by measuring the mite population (mites in brood cells plus mites on adult bees) and the weight of the adult bee population of each colony. During the experiment, we measured grooming behavior, hygienic behavior, duration of the postcapping period, and the frequency of non-reproducing mites in brood cells.

Of the four characteristics listed above, only non-reproduction of mites was significantly related (using linear regression) to changes in the mite populations ($F = 6.2$, $P = 0.02$, df = 1, 21, $R^2 = 0.23$). Final mite populations were 873 ± 413 (mean ± SD); bee populations were 1982 ± 335 grams. One colony had 238 mites and 2178 grams of bees (fewer mites than at the beginning of the test and a better-than-average increase in the bee population). This colony was not hygienic, it was above average in grooming behavior (27%), and it had a relatively short capped period (273 hours). Most importantly, only 17% of mites in the brood cells were producing progeny.

Eggs and young larvae from the mite-resistant colony (described above) were exchanged with those from a susceptible colony (92% reproduction). The result was similar to that found by Beetsma & Zonneveld (*Exp. Appl. Acarol.* 16:303-312) and Fuchs (*Exp. Appl. Acarol.* 18:309); non-reproduction of mites was controlled by events that preceded their entering the cell. Brood from the resistant colony supported a high frequency of mite reproduction (82%) when infested with mites in the susceptible colony. Conversely, brood from the susceptible colony had a low frequency of mite reproduction (36%) when infested with mites from the resistant colony.

This study shows (1) that resistance to mites exists in honey bees in the USA. Resistance may be rather common but may be masked by multiple mating of queens. Thus, the single-drone inseminations used in this experiment may have made mite resistance easier to detect. (2) Non-reproduction of mites is an important characteristic that has been repeatedly associated with mite resistance. A queen (her progeny) being evaluated for non-reproduction of mites needs to have been producing brood in a colony for at least 6 weeks. When inspecting cells for this trait (examine purple-eyed bee pupae), a non-reproductive mite may be dead in the cell, it may be "wallpapered" to the cell wall by the cocoon of the honey bee, or it may be alive.

7. Harbo, J. R.[d] — OBSERVATIONS ON HYGIENIC BEHAVIOR AND RESISTANCE TO CHALKBROOD — Hygienic behavior of honey bees has been linked to chalkbrood resistance by Gilliam *et al.* (*Apidologie* 14:29-39). They found that colonies of hygienic bees contained fewer spores of the fungus (*Ascosphaera apis*) that causes chalkbrood than did colonies of non-hygienic bees.

The objective of this study was to measure the relationship between chalkbrood disease and hygienic behavior in a group of 27 colonies with queens that were each mated to one drone (the colonies described in abstract #6). I evaluated chalkbrood by counting the number of mummies found on the combs, on the bottom board, and at the entrance of each colony. The first count was 18 days after queen release, when the adult population of each colony consisted of bees from the large cage of bees that served as the source for the initial populations. The first measurement verified that naturally occurring chalkbrood was present in the colonies and that the brood was susceptible to chalkbrood. Since hygienic behavior is expressed only by adult bees, a correlation between chalkbrood and hygienic behavior can be meaningful only after adult bees are produced by the queen in the colony being tested. Therefore, a second evaluation of chalkbrood and a measurement of hygienic behavior were made about 6 weeks after queen release. Hygienic behavior was evaluated by removing a section of comb with capped brood (about 50 cells) from each colony, freezing the section for 24 hours to kill the brood, returning the combs to their colonies, and then counting the percentage of capped cells that were removed by the bees within the next 24 hours.

Using linear regression, I found no significant relationship between the amount of chalkbrood in a colony and hygienic behavior ($F = 0.2$, $P = 0.65$, $n = 27$). A second analysis used only colonies that had high levels (> 30 mummies) in the first evaluation, and data were created for a third analysis by subtracting the number of chalkbrood mummies found in the first measurement from the number found in the second. Neither of these analyses showed significant correlations with hygienic behavior. This does not prove that hygienic behavior and the occurrence of chalkbrood are independent events, but it suggests that there may be factors more important than hygienic behavior in controlling the appearance of chalkbrood disease.

Only one colony was found to be free of chalkbrood in both evaluations. This colony was not hygienic (only 50% brood removal in 5 days). Queens were exchanged between this colony and a colony that was physiologically susceptible to chalkbrood but hygienic (100% brood removal within 24 hours). Chalkbrood mummies (over 100 cells) were then found in the colony that had not had a case of chalkbrood. These were found in the brood produced by the new queen. When the original queen returned and produced brood, the chalkbrood disappeared. This suggests that larvae of honey bees can possess resistance to chalkbrood.

Since the queens in these two colonies were producing hygienic and non-hygienic bees, their exchange enabled me to monitor the hygienic behavior of a colony as the adult bees from the new queen gradually and temporarily replaced those from the original queen. Hygienic behavior was measured weekly in each of these colonies for 6 weeks. Results showed that very young bees (< 4 days old) and very old bees (> 25 days old) were not hygienic. Hygienic behavior was best expressed when bees were 1- 3 weeks old.

8. Loper, G.M.[f] — SOME ATTRIBUTES OF THE AFRICANIZED HONEY BEES IN SOUTHERN ARIZONA: WING LENGTH, HYGIENIC BEHAVIOR, WORKER EMERGENCE TIME AND BROOD NEST TEMPERATURE[q] — Colonies established from swarms caught during 1994-95 in the vicinity of Tucson and Sierra Vista, AZ were kept in hives in an apiary west of Tucson. Other swarms, caught in pheromone bait hives (between Jan. - Jun., 1995), were destructively sampled to obtain wing-length measurements (FABIS) only. Swarms/colonies were removed from city water and electrical boxes, flower pots and from trees and buildings. Tucson city water meter boxes (below ground) have been increasingly colonized since Africanized bees first arrived in 1993. In 1993 (Oct. -Dec.), 1994 and 1995 (Jan. - Jul.) some 24, 225 and 325 colonies/swarms (respectively) have been removed from these small, 14 liter spaces.

Between May and July 1995, Africanized (AHB) and European (EHB) colonies in the apiary were tested for worker emergence times (queen caged for 24 hrs.), hygienic behavior (capped cells punctured with an insect pin) and brood nest temperatures (Omega RD-Temp electronic recorders).

Based on mitochondrial DNA analyses, 3 AHB colonies and 3 EHB colonies were tested for worker emergence times. Although values in the literature have indicated emergence from AHB within 18-19 days after egg-laying, no adults in my test emerged before 20 days. By the beginning of day 21, AHB emergence averaged 82.3% (range of 50-100%) and EHB emergence averaged 57.8% (range of 30.7-100%).

Hygienic behavior tests showed that AHB colonies ($n = 12$) rapidly uncapped and removed destroyed pupae (90.0% in 24 hrs., 98.7% in 48 hrs.) whereas EHB colonies ($n = 17$) had a much more variable response; some cleaning the cells in 24 hrs., but many not cleaning them completely even after 72 hrs.

The ambient temperatures during the brood nest temperature study were extremely hot (max. = 48.6°C or 119°F). The colonies were not shaded, but water was available within 75 meters or less. The average brood nest temperature (5 consecutive days) of 16 AHB was 35.2°C and that of 3 EHB colonies was 34.9°C. All colonies had daily periodicities between cooler and warmer periods, but some AHB colonies varied as much as 4.8° C whereas EHB colonies were within a 2.7° C range.

FABIS wing length measurements revealed an increased proportion (compared to pre-1993 samples) of swarms with smallwinged (8.6-8.9 mm) bees. Samples from local feral colonies ($n = 45$) obtained in 1991 had relatively long wings; no colony averaged (10 bees/sample) shorter than 9.0 mm. The wing length of bees from swarms caught in Tucson in April 1995 ($n = 73$) were shorter; 41% of the colonies averaged shorter than 9.0 mm and in June ($n = 92$), 55.5% were shorter than 9.0 mm. These data (April and June) may represent times when AHB swarming predominates over EHB swarming which is historically greatest in May in the Tucson area. Further analysis of the data may reveal differences in swarming periods between AHB and EHB in this area.

9. Nelson, D.L.[g] — POPULATION AND BROOD DYNAMICS OF INDOOR WINTERED COLONIES — Little research has been done on brood rearing of indoor wintered colonies. However, with the presence of parasitic mites, brood rearing dynamics of indoor wintering colonies may be a very important consideration in colony managment and mite control methods. Indoor wintering is still very popular in many parts of North America, yet only one recent reference could be found on winter brood rearing (Pirker, *Canadian Beekeeping*, 1980, 69-71).

To assess bee and brood dynamics of indoor-wintered colonies, single and double chambered colonies were prepared at Beaverlodge, Alberta, Canada (lat. 55º 10' N) and moved into indoor-wintering facilities on October 18th. The building temperature was maintained at 4-6º C, except for one three-day period (Nov. 9-11) when maximum temperatures reached 14º C. Two colonies from each group were removed from the wintering facility and killed at monthly intervals from November through April. The number of eggs, larvae, pupae and adults were counted. Remaining colonies were moved outside on March 24th and the final evaluation was completed on April 14th.

The average number of adults in November for single and double chambered colonies was 14,200 and 31,700, respective-