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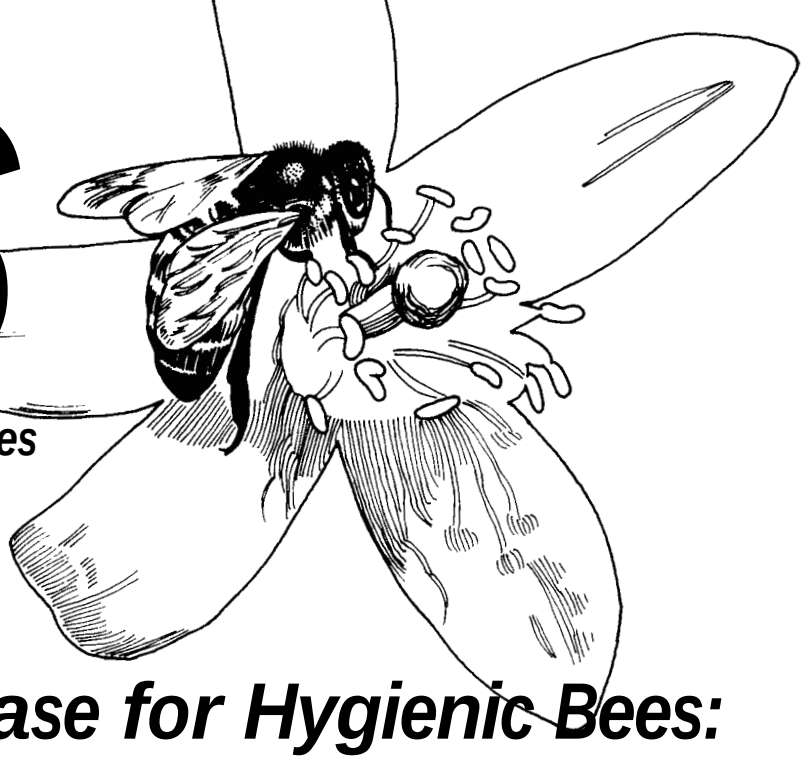

Inside APIS:

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The Case for Hygienic Bees:
A Little-used Technology

THE HONEY BEE is perhaps one of nature's neatest and cleanest organisms. These characteristics are especially important in social insects. Numbers of individuals crowded together for extended periods is risky because if one becomes infested with a disease or parasite, the chances of others likewise being affected are very great. In human history, this tendency is well exhibited in great disease epidemics, such as those associated with the "Black Death," or bubonic plague. Sanitation in humans was found wanting in most instances where plague established a foothold, brought on by rat populations and their fleas that spread the bacterium *Yersinia pestis*[1].

Like humans, honey bees are not necessarily equal when it comes to keeping a tidy house. We now know this tendency is ruled by genetics and thus determined by chance in bee populations. It was Dr. Walter Rothenbuhler, retired from The Ohio State University, who first used the term "hygienic behavior," for this trait, according to Drs. M. Spivak[2] and M. Gilliam[3]. They have written a detailed review of the subject, which will soon appear in *Bee World*, published by the International Bee Research Association[4]. Dr. O.W. Park and colleagues working at Iowa Agricultural Experiment Station in the 1930s pioneered this work in their attempt to find honey bees resistant to American foulbrood (AFB)[5].

Ideas leading to the current knowledge of hygienic behavior proceeded through several stages, according to Spivak and Gilliam:

1. Determining variation in AFB resistance in bee populations.
   a. Resistance to AFB consists of the colony's ability to detect and remove brood before the causative organism (*Bacillus larvae*, now renamed *Paenibacillus larvae*) reaches the infectious spore state.
   b. Early removal of diseased larvae, which contain noninfectious rods only, prevents spread of the disease, but removal of spore-infected larvae contributes to transmitting the disease.
   c. Light cases may sometimes be overcome, but heavy cases are not. Spread of the disease is not so much determined by the number of spores, but by the extent to which general contamination is produced by removing diseased brood.
   d. Since diseased brood is removed whether or not a colony recovers from the disease, it is evident that colony resistance does not depend entirely on this behavioral characteristic.

Continued next page

[1] http://communityhigh.org/~katelevy/plague/index.html
[2] http://www.ent.agri.umn.edu/Faculty/spivcv.htm
[3] http://gears.tucson.ars.ag.gov/home/gilliam/
[4] http://www.cf.ac.uk/ibra/index.html
[5] http://hammock.ifas.ufl.edu/txt/fairs/1253

2. Determining whether AFB resistance was behavioral or physiological. Dr. Rothenbuhler and V. Thompson subsequently showed that although resistance was behavioral in adult worker bees, it was also physiological or inherent in larvae.
3. Determining the genetics of this trait in worker honey bees. This was a major focus of Dr. Rothenbuhler and his students at The Ohio State University until the early 1960s. Spivak and Gilliam summarize the results as a two-locus process of uncapping a cell containing dead brood and removing the contents. Both characteristics are thought to be recessive and found at different locations (loci) on the chromosome. Thus, two recessive genes are needed at two separate locations on the chromosome before workers show both traits. There could be intermediate populations, therefore, that may show one trait (uncapping), but not the other (removing) with respect to affected larvae.

Dr. Rothenbuhler appears to have been remarkably prescient in coining the term "hygienic behavior." Since his landmark experiments on AFB resistance, this trait has been determined to be responsible for a number of other phenomena observed in honey bees. According to Spivak and Gilliam, these include:

1. Resistance to chalkbrood. This disease, first discovered in the United States in the 1960s, is now found throughout North America[6]. Since the causal organism is a fungus (*Ascosphaera apis*) that attacks brood, removal of affected larvae by hygienic bees would seem to be a natural defense mechanism. Both M. Gilliam and S. Taber have been responsible for determining that hygienic behavior indeed confers chalkbrood resistance. The practical results from their research include testing for hygienic behavior, feeding homogenized chalkbrood mummies as a screening tool for resistance, requeening colonies found susceptible to chalkbrood, and preventing symptoms by eliminating stress and ensuring optimal nutrition.
2. Resistance to European foulbrood (EFB)[7]. This concept has much less research behind it. However, the same mechanism found in resistance to AFB or chalkbrood would appear to apply for this disease as well.
3. Resistance to Varroa mites[8]. Research in this area is continuing and seems to hold great promise. It has been shown that the native host of Varroa *Apis cerana* routinely removes infested brood more efficiently than many populations of *Apis mellifera*. Spivak and Gilliam conclude that removing infested pupae may theoretically limit the growth of mite populations by prematurely releasing young mites that can't complete development. It may also damage the mother mite, and/or extend her time being carried by adult bees during what is called the "phoretic" stage.

SPIVAK AND GILLIAM credit Steve Taber[9], retired researcher at the USDA Tucson Bee Laboratory[10], for helping to popularize the hygienic behavior concept. Among other things, he helped establish one of the current techniques for assaying hygienic behavior, which uses a small section (2 x 2.5 inches) of freeze-killed brood. Originally, full frames were used by those developing the test, and in other variations, larvae were killed by cyanide or piercing them in the cell with insect pins. Dr. Jerry Bromenshenk and colleagues at the University of Montana[11] pioneered a further development using liquid nitrogen in a round pipe or container to freeze a part of the comb in the field.

The results and discussion above reveal that hygienic behavior is highly desirable in honey bee populations for many reasons. Unfortunately, it is employed by too few breeders, Spivak and Gilliam conclude. However, there has been some progress, including development of a commercial bee called DR (Disease Resistant) by Taber Apiaries in California, employment of the technique in Argentina to combat a serious AFB problem[12], and other programs used by USDA and University researchers and beekeeper cooperatives[13]. Finally, selection for hygienic queens is often the byproduct of the one common solution beekeepers often employ for many problems — routine requeening.

Although screening reveals the genetic tendency to exhibit colony hygienic behavior, this cannot be considered proof that populations are in fact resistant to specific maladies, Spivak and Gilliam say. It is important to go the next step and challenge colonies with the actual pathogen or organism in question.

Hygienic behavior is heritable and it can be selected for, Spivak and Gilliam conclude. Unfortunately, most colonies exhibit low levels because of its recessive nature. Thus, selection for the trait should become a routine part of any bee breeding operation. Commercially available lines of hygienic stock would help many beekeepers overcome a multitude of problems, especially those associated with mites and disease. This would reduce operating costs by minimizing use of chemicals, with their concomitant possibilities of bee, colony and product contamination. Finally, standard queen rearing and breeding techniques can be used to produce many hygienic queens from a few mothers using any race of honey bees[14].

Research has clearly demonstrated the benefits of hygienic bees. It provides many benefits with no demonstrable negative effects, Spivak and Gilliam say. The unspoken question remains, however. Why is this technology not more widely used by the beekeeping industry? ■

Are Africanized Honey Bees More Hygienic? Risk of Importing Bees

THE AFRICANIZED honey bee, or AHB, has been observed to be more resistant or tolerant to Varroa in Brazil and other parts of Latin America, where it survives without chemical treatment[15, 16]. One of the reasons for this is the possibility that it is more hygienic than other races. Spivak and Gilliam in their soon-to-be-published article, conclude that the results are not in yet in on this important issue. They suggest that there exist enough differences in reported research results to be somewhat skeptical, in spite of the fact that AHB has been found to be more resistant to AFB in some studies. One informal report to this author, for example, concerning AHB in the highlands of Ecuador, indicates a much higher incidence of chalkbrood than in European bees in that Andean country.

The fact that hygienic behavior is found in all races of bees is extremely fortunate. It suggests that importing bees is not necessarily the best answer to many current beekeeping problems. Given the significant risks that arise from this, stock introduction should continue to be considered problematic and best left to the USDA laboratories, which have the appropriate quarantine facilities[17]. ■

Argentina: A Force to Reckon With

TO THOSE attending the VIth Ibero-Latin American Beekeeping Congress in Mérida, Yucatán, México, one thing was apparent. Argentina, already a major player in the world honey market, will be a growing force in the new millennium. FAO figures reported by Miguel Angel Munguia, president of PAUAL (Small Beekeepers of Latin America) showed that in 1992, Argentina became the world's second largest honey exporting nation, surpassing México's production by some 2,000 metric tons, and compared to number-one China, exporting, at that time, 70,032 metric tons. Exportation by Argentina stood at 63,551 metric tons in 1995, compared to China (87,084) and México (30,513). Since that time it has increased to 67,000 tons in 1997, according to information handed out at the Congress.

A complete report of Argentinean beekeeping in French is available through Apiservices[18]. The author, Gilles Ratia[19], details what he found while visiting in 1994. Strengths he reported included vast amounts of yet-to-be-exploited honey flora, few pesticide treatments on crops other than soybeans, low production costs, and lots of motivated beekeepers. Weaknesses at that time were no bee genetics programs, few efforts at differentiating honey types important in the European market, little use of value-added products, no internal or external marketing studies, and low domestic honey consumption. Argentina also has had some other problems, including Terramycin®-resistant foulbrood, causing consternation with its trading partners like Brazil [20]. Spivak and Gilliam, however, report in their publication that hygienic behavior technology was being employed in the country. This, along with other initiatives, including use of other chemicals besides oxytetracycline, appears to be turning the situation around, according to reports at the Congress.

The Integrated Beekeeping Development Program (APINET) being implemented by the Instituto Nacional de Technología de Agropecuaria (INTA) in cooperation with universities and other governmental agencies was the focus of a paper, authored by Ing. Agr. Enrique Bedascarrasbure, at the Congress. He wrote the time had come to accelerate beekeeping development in a number of arenas. These include increasing efforts in both horizontal and vertical marketing of honey, improving the end product, and diversifying existing export markets.

The APINET effort to improve apiculture in Argentina provides assistance in many areas, including honey production and quality, bee genetics and beekeeper training. A focus is communications across the industry. This ambitious plan revolves around the electronic technology of the World Wide Web. The APINET web site[21] includes updated news and bulletins, and lists help through governmental agencies and university extension services. In addition, it links to development agencies and distance learning centers. For example, one can find information on how to obtain a masters degree in applied entomology through the National University of La Rioja from the site. According to Mr. Bedascarrasbure, the unabashed goal of this is to make Argentina the world's number-one honey exporting nation. It may take less time than many think. ■

Validation of SCIRA for Worldwide Application

DR. JACK WHITE and colleagues recently published a study providing evidence that use of an improved internal stable carbon isotope ratio analysis (ISCIRA) can be used worldwide to detect adulteration in honey. Six years of data support the use of this method, the authors conclude. ISCIRA is now valid for honey samples provided by the United States, México, Germany, Italy and Spain. The baseline for the original test, called SCIRA, has also been expanded from 64 to 224 samples. Analysis of 303 Chinese honeys indicates they should have carbon ratios similar to those from other regions of the world, disputing claims otherwise.

The original SCIRA procedure developed in 1978 could not detect low levels of adulteration with corn and other syrups. ISCIRA, however, has overcome this limitation. The authors therefore conclude that this problem no longer exists. That's because the analysis clearly shows the carbon isotopic composition of any honey **before** addition of C_4 sugars. Forty-three percent of 98 suspected samples received during 1994 through 1997 and tested by SCIRA, for example, were subsequently found adulterated by ISCIRA. The study was published in *Journal of AOAC International*, Vol. 81, No. 3, pp. 610–619[22]. ■

September Is National Honey Month

SEPTEMBER CONTINUES to be the sweetest time of year and is traditionally dubbed "National Honey Month." The National Honey Board's theme for this year is "*Honey — The Natural Advantage*." To help generate local media interest, the Board has available information kits, including health benefits of honey, usage ideas, honey industry facts and recipes. To order a copy of the kit, call Jami Yanoski at 1-800-553-7162. For other ideas on promotions during this important month, see the Board's two web sites[23]. ■

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[6] http://hammock.ifas.ufl.edu/txt/fairs/1255
[7] http://hammock.ifas.ufl.edu/txt/fairs/1254
[8] http://www.ifas.ufl.edu/~mts/apishtm/threads/varroa.htm
[9] http://www.ifas.ufl.edu/~mts/apishtm/letters/aix4_25.htm
[10] http://gears.tucson.ars.ag.gov/
[11] http://grizzly.umt.edu/biology/bees/
[12] http://www.ifas.ufl.edu/~mts/apishtm/papers/FIFTH.HTM#5
[13] http://pw2.netcom.com/~griffes/HIP1.html
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[16] http://www.ifas.ufl.edu/~mts/apishtm/papers/TERES.HTM#9
[17] http://www.ifas.ufl.edu/~mts/apishtm/apis90/apjun90.htm#1
[18] http://www.beekeeping.com/articles/argentine/index.htm
[19] http://www.ifas.ufl.edu/~mts/apishtm/letters/aix3_31.htm
[20] http://www.ifas.ufl.edu/~mts/apishtm/papers/TERES.HTM#7
[21] http://www.inta.gov.ar/apinet/index22.htm
[22] http://www.aoac.org/default.htm
[23] http://www.nhb.org/

Honey: The Darker, the Better?

THERE CONTINUES to be more good information about alternative uses of honey. In a recent article Janet Raloff, *Science News* (Vol. 154, No. 11), discusses studies at the University of Illinois (*Journal of Apicultural Research*) and Clemson University suggesting a number of ways honey may be marketed besides its traditional role as a sweet[24]. She reports that Dr. May Berenbaum and colleagues in Illinois examined 19 honeys from a wide variety of sources for biological significance. General results were that the darker the honey, the more its antioxidant content, presumably because of flavanoid content. This is particularly important for a major local Illinois honey derived from soybean nectar[25]. Some honeys, however, bucked the trend, the article says, including light sweet clover with a high antioxidant content and dark mesquite, with relatively little.

Experiments at Clemson University, according to the article, revealed that darker honeys also provide more protection against oxidation in ground-up fruits (apples, pears) and vegetables (yams, potatoes). They also provided better protection for cooked ground turkey. Other information from Clemson University shows that adding honey to foster the browning of meats (Maillard reaction), which retard oxidation and subsequent spoilage, adds to shelf life. This, along with use in other value-added foods, makes the sweet an attractive alternative in a wide variety of products[26].

Finally, the article reports on research sponsored by the National Honey Board in using honey, which produces alpha hydroxy acids (AHAs), a vital ingredient in skin creams and moisturizers. Antioxidants can protect key components of the skin's cells from damage. Thus, many firms are adding antioxidants to sunscreens. If honey can act both as a moisturizer and antioxidant, the article concludes, the commercial potential is enormous[27]. ■

Unique Event in High Springs

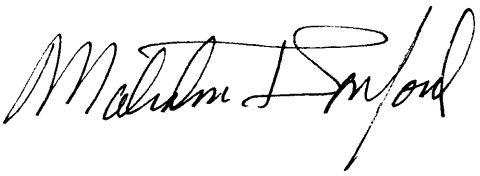
Dadant Comes to Town

JUST UP the road from Gainesville, Florida, where the University of Florida is located, is a little town called High Springs. The tourist trade has found High Springs, a back-road village for many years, sparking a revitalization. Its historic downtown is filled with restaurants and shops, and it hums on weekend evenings with events such as the annual Dickens Christmas Festival. It boasts a ballroom for dancing and an active community theatre. High Springs is also a jumping off place for those interested in tubing, boating or fishing on the nearby Ichetucknee, Santa Fe and Suwannee rivers.

High Springs, Florida, will also be the new home of Dadant & Sons, Inc., southeastern beekeeping supply warehouse. This is the largest facility of its kind in the region. The Dadant folks saw the area as centrally located and an ideally placed just off heavily traveled Interstate 75 to serve their customer base. Thus, they have eliminated both the Hahira, Georgia, and Umatilla, Florida, locations in favor of High Springs.

Mr. Jerry Latner, the manager, intends to roll out the red carpet at this facility on November 13 and 14. The grand opening weekend scheduled for these dates will include many specials and prizes. The warehouse is located between I-75 and High Springs. Take Exit 78, go north on Hwy 441 two miles and turn right down limerock road (County NW 188th St.); tel. (904) 454-0237, fax (904) 454-0240. ■

Sincerely,



[24] http://www.sciencenews.org/sn_arc98/9_12_98/Bob1.htm
[25] http://www.ifas.ufl.edu/~mts/apishtm/apis97/apoct97.htm#3
[26] http://www.ifas.ufl.edu/~mts/apishtm/papers/NHBSEM.HTM#4
[27] http://www.ifas.ufl.edu/~mts/apishtm/papers/COLORADO.HTM#11

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