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A Two-Decade History of the Varroa Mite

Malcolm T. Sanford

The following is a 20-year-summary of the historical aspects of introduction of the Varroa bee mite (*Varroa destructor*) into the United States. "I have been informed that my pending visit to Australia in 2007 for the Apimondia meeting will be like a beekeeping journey back in time. 'Down Under' in 'Oz' beekeepers continue to enjoy being free of beekeeping's greatest nemesis, the Varroa mite (*Varroa destructor*). I look forward to seeing and experiencing beekeeping as it once was in the United States , a simpler time, when the honey bee was a more "wild" (feral) animal that could look after itself without being actively aided by the beekeeper. For, truthfully, this insect is now a much more 'domestic' animal in most of the world than previously because of this mite.

"In recent years, there appears to be a resurgence of hobby and sideline beekeeping according to my sources. I have seen corroborating evidence of this by seeing who is in attendance at various association meetings, and have recognized the emergence of two populations of beekeepers, which I characterize as before Varroa (BV) and after Varroa (AV). The AV folks really have no idea of what beekeeping used to be like for us that are in the BV community, and shouldn't, for the landscape has inalterably changed with introduction of the Varroa mite, except for a few places like Australia.

"Tempus fugit (*el tiempo vuela*) "time flies" as this month (October 2007) is the twentieth anniversary of the first detection of the Varroa mite in North America. As one of those on the front lines at that time, I have seen and felt the invasion first hand. It is worth looking back on this singular episode and subsequent events in order to get a historical perspective of what beekeepers have gone through in the last two decades."

"Introduction of the Asiatic bee mite (*Varroa destructor*) is a nightmare come true for the North American beekeeping industry. Even as I write this, many persons are in a state of shock. As of this date (October 20, 1987), some nineteen of Florida 's sixty seven counties have had positive finds. Latest information is that there has been confirmation of the mite's presence in the states of Pennsylvania, Ohio, Illinois and Wisconsin . The great majority of finds so far have had some kind of Florida connection.

"As a first step in attempting to assess the situation, the Commissioner of Agriculture on the advice of Varroa Mite Task Force and the Honeybee Technical Council has placed a two-week moratorium on bee and beekeeping equipment movement. This is to try to get an idea of the mite's present distribution. Emergency teams made up of Florida bee inspectors and APHIS (Animal Plant Health Inspection Service) of the U.S. Department of Agriculture are now combing the state for infested colonies.

“There is near unanimous opinion that the Varroa mite is potentially the most serious pest ever to threaten U.S. beekeeping. As evidence for this, consider that both Canada and Mexico have sealed their border to U.S. bees because of the recent finds. Reports from other areas where the mite has been introduced, especially temperate climatic regimes, indicate great losses of colonies have occurred

“On November 9, 1987 a Varroa Mite Research Work Group was created, chaired by Frank Robinson, then Secretary-Treasurer of the American Beekeeping Federation and retired Professor of Apiculture from the University of Florida , the purpose of the group is coordination of research, regulatory and extension activities related to the Varroa mite situation in the state. The following is a brief summary of the research activity going on in Florida at the time:

“To address the short-range problem of bee movement around the state, which is a top priority, Drs. Harvey Cromroy, IFAS (University of Florida) and Everett Nickerson (Methods Development, Division of Plant Industry, FADCS) have initiated paperwork which is being assembled in Tallahasee by Jim Downing, FADCS to request a Section 18 Specific Exemption label for the miticide, Amitraz. This is to develop the necessary information on the material's dosage (how much material should be applied and in what manner), efficacy (how many mites are killed during treatment of a colony) and residues (how much miticide might get into bees, honey and wax).

"In spite of all the regulatory effort noted above, it was too late. The Varroa mite literally was everywhere and no amount of expense or effort would limit its spread. The above paragraph contained something extremely significant, the beekeeping industry was embarking on a road to chemical treatment.

“Some years ago the above statement would have raised more than a few eyebrows. Many questions by beekeepers each year concern using pesticides to rid colonies of invasions by ants, wasps, wax moths and on rare occasions, beetles. No answers, however, ever indicated pesticides were to be used near colonies, much less inside them. The closest to this was wax moth control which involved fumigating empty supers with pesticides. To most beekeepers, pesticides were an anathema, responsible for killing untold numbers of colonies in agricultural and urban areas, and agriculturalists and mosquito controllers were considered a collective enemy for using them.

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“The worm has turned. With detection of the tracheal mite and now *Varroa destructor ,* the hue and cry for pesticide use within the hive by beekeepers reached a crescendo. This irony was not lost on some of my colleagues, who've been plagued with beekeeper complaints about pesticide use over the years. Not that pesticides don't have a place in control of mites, but the all-too-prevalent view that they are somehow a ‘magic bullet’ which will mean the end of the pest and a return to business as usual was disconcerting.

“This philosophy may come from the experience with Terramycin ®, which is now routinely used as a preventative treatment for American foul brood (AFB). As successful as this has been, it has not entirely eliminated the disease. Most bee inspection services are in place today specifically because American foul brood is still a threat. Hundreds, perhaps thousands, of colonies nationwide are burned each year to eliminate American foul brood reservoirs. Many beekeepers emphatically state that if they see a colony with AFB, they immediately destroy it themselves, even in states like Florida where an indemnity is paid if a bee inspector burns a colony for AFB.

“It's important to realize that the management system to control AFB did not come about overnight. It is the result of a good deal of learning on the part of beekeepers, scientists and others since the 1920s, when thousands of infested colonies were routinely burned in an effort to control infestation.

“And as effective as it appears to be at present, use of Terramycin® is not without possible future complications which run the gamut from contaminated honey to an antibiotic-resistant bacterium strain. Fortunately, the causative organism, *Bacillus larvae (editor’s note: now named Paenibacillus larvae larvae),* has not shown resistance to Terramycin®. Routine treatment for American foul brood also means that the line between bees which have some innate resistance to the disease and those that are susceptible becomes fuzzy. Nevertheless, colonies continue to be routinely treated despite proof that resistance to the disease by several mechanisms does exist within some bee populations. Thus, should *Paenibacillus larvae larvae* eventually become immune to Terramycin®, bee populations which are resistant to AFB might be difficult to find.

“In Varroa control, resistance by mites to chemicals improperly used and/or applied has already been established, particularly phenothiazine in Japan and amitraz in Israel . This means that pesticides must be used far more judiciously within the colony than is currently done with Terramycin® or resistant mite strains will quickly develop.”

"Looking back on these statements reveals how prophetic they were. The beekeeping community adroitly clambered aboard what many have called the 'pesticide treadmill' in a futile effort to find a “magic bullet” for Varroa control. The first candidate was quickly approved by the authorities on an emergency basis, using Mavrik® (active ingredient fluvalinate) soaked on plywood strips. I had first seen this technology in Italy in 1989, although the material had the brand name Klartan® in that country.

"On March 21, 1988, it became no longer legal to use fluvalinate-treated wood sticks. Instead, only plastic strips manufactured to slowly release small quantities of fluvalinate, were legal and had to be used under an emergency compliance agreement with the Florida Division of Plant Industry. Apistan® indeed appeared to be a magic treatment and the industry was to get ten good years of use from this material.

"The use of Apistan® did not fully alleviate the fears of many that honey could be contaminated by fluvalinate, which might morph into a big problem for the honey market. And it in August of 1990, I wrote the following, "It was only a matter of time. *The Boston Herald* reported that honey from a specific outfit had been contaminated with fluvalinate, the active ingredient in Zoecon's Apistan® plastic strips. Taking this conclusion further, the newspaper then implied that the contamination came from the strips themselves. The facts do not bear this out, the Corporation says, in a packet of information sent to industry leaders. According to the Corporation, it would take some 96 strips placed into a colony all at once to reach contamination levels reported by the newspaper (1.14 parts per million). If used according to the label, Zoecon points out, honey cannot be contaminated using the strips.

"There are a number of ways that honey might become contaminated with fluvalinate. This active ingredient, also marketed in other products to control insects on ornamentals or turf, may be applied to beehives in many ways. Plastic Apistan® strips can be left in the brood nest too long. It is not legal, nor wise, to leave the strips in a colony longer than listed on the label. Wax and honey contamination, as well as build up of resistant mite populations, are the likely outcomes of this practice. Experience in Israel , where fluvalinate impregnated in wooden strips are often used to control Varroa, indicates the material builds up in wax and possibly honey. The result of this episode of contaminated honey and the attendant press coverage will be increased testing of product destined for the consumer market. The state of Florida has added fluvalinate to its honey testing protocol and this will probably be the case in other states as well.

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A problem with Varroa is that it is devastating to most honey bee populations. Over 90 percent die, depleting the landscape of this heretofore ubiquitous insect, something that commercial beekeepers could not tolerate and stay in business. Thus, beekeepers became paranoid about treating their bees in an effort to rid them entirely of mites, more often than not treating due to the presence of a single mite. Because the first treatment material, the pyrethroid fluvalinate, formulated as Apistan®, was so effective, killing well over 90 percent of the mites in a colony, this appeared to be a definitive answer to mite control. But in the end this only accelerated the development of resistance by Varroa to the treatment. In addition, there were rumors of increasingly use of "extra-legal" applications that worried many in the regulatory and research community.

In April, 1992, I wrote: "The rest of the United States is starting to realize what many beekeepers in Florida have learned in the last two years. Varroa mites are here to stay and monitoring the mite population is the best way to keep parasite populations low. Dr. Eric Mussen in his January/February 1992 issue of *From the UC Apiaries* published a piece called 'Varroa Getting Nasty.' It seems many beekeepers in California got a surprise when their colonies collapsed last fall. The symptoms at first seemed to be classical for tracheal mites: 1. rapid loss of adults; 2. tiny clusters of bees with a queen; and 3. abundance of stored honey and pollen. Not characteristic was varying amounts of capped brood. The latter revealed that something else was going on; the adults were not being replaced. Developing pupae were killed in their capped cells by mites and never emerged.

"To prevent colony collapse, Dr. Mussen suggests checking bees for Varroa two to four times per year. Finding a mite or two doesn't mean the colony is in immediate jeopardy, but it will require treatment sooner or later. And if another check, not too much later, turns up a lot of mites, then you are the unlucky recipient of someone else's failure to detect a problem. Choose your method of colony examination (ether roll, tobacco smoke, Apistan®), he concludes, early detection is critical to colony protection.

" 'Looking for trouble,' is the way Dr. Roger Morse categorized the perpetual hunt for Varroa in the April, 1992 issue of *Bee Culture* magazine. He concluded, '...in all probability every beekeeper in the continental U.S. and Canada will have infested hives within two to four years.' He recommended, therefore, that beekeepers in the U.S., Canada and Mexico check colonies for Varroa at least twice a year. Although it has been reported that colonies sometimes take years to die after being infested with Varroa, there are exceptions. Dr. Morse described a New York beekeeper whose hives produced over 100 pounds of honey in July and August, yet were dead by late fall. And Dr. Mussen related about a California beekeeper, who after a good producing season, saw 75 percent of his colonies severely damaged or dead by Christmas. That beekeeper is no longer in business and had to sell out at submarket prices. These cases may be because of drift by bees from nearby heavily infested apiaries that were not treated. Also the fact that mites are hidden and protected in capped brood cells may mean a serious undercount in those found on adults or in bottom board debris.

“Fortunately, detecting Varroa is a fairly simple process. A number of methods are described by Dr. Morse, including: examining brood or adults; sorting through bottom board debris; and using the ether roll. The technology to determine when a Varroa infestation reaches a treatable level by any detection method currently in use has not been well worked out. Detection results may vary and are dependent on bee/mite population dynamics. For example, in the fall, Dr. Morse says, with little or no brood, you are more likely to find mites on adults, whereas in the spring they will be easier to find in brood. Practical experience by the Florida Division of Plant Industry indicates that when 20 mites in an ether roll of approximately 300 adult bees are found, a colony should be treated with Apistan®. However, Dr. Harvey Cromroy of the EntomologyNematology faculty, University of Florida , believes more than five mites is a treatable level. Dr. Morse concludes finding 30 to 40 mites per hundred bees (ether roll) is serious and the colony may be beyond saving. The ability to correlate ether roll with other detection methods is not presently available. Such lack of a suitable treatment threshold has confused the Varroa control issue considerably, and which to some extent still exists today.

"Since that time, other detection methods have been implemented beyond the ether roll, which had the disadvantage of killing bees and using smoke from materials like citrus leaves that disrupted the colony’s organization. Dr. William Ramirez of Costa Rica had suggested powder be used as a control as far back as November, 1987. This concept is now being employed using powdered sugar pioneered by Dr. Kamran F. Fakhimzadeh, of U. Helsinki in Finland and the University of Nebraska. In addition, many kinds of monitoring boards have been developed that can be inserted into beehives, often with greased surfaces to trap fallen mites and not allow them to return to their host bees. These employ a screen (8 mesh to the inch), which allow the mites to fall through, but keep the bees from contacting the monitoring device (sticky board) on the bottom board. These screened bottom boards are now in widespread use and beekeepers have often found them advantageous in their own right, eliminating moisture from a colony ensuring better winter survival.

Drone brood is preferred by Varroa. It has a longer post-capping period and so a female mite infesting a developing drone can potentially produce more offspring. Drone brood is the only caste affected by Varroa in the original host, the Eastern honey bee (*Apis cerana*). The mite is so devastating on the western honey bee (*Apis mellifera*) precisely because it infests both drone and worker brood. Drone brood management, therefore, can be used effectively to detect as well as control mites. Trapping mites in drone brood and then removing them before emergence has become an excellent strategy, especially in developing countries where pesticides are often not an option. Dr. Zachary Wang at Michigan State University has developed what he calls a Mite Zapper®, which also targets drones.

"Pesticides, so-called 'hard' applications, have become the treatment of choice when available, especially in large-scale operations where time and labor expended on Varroa control needed to be kept to a minimum. Beekeepers got a good decade of effectiveness from the pyrethroid, fluvalinate, originally applied via wood strips, but later in plastic strips, formulated as Apistan®. However, for many it has now lost its effectiveness. The next chemical to come along was the more highly toxic and problematic organosphosphate, coumaphos, formulated on plastic strips as CheckMite+®. Beekeepers are only beginning to experience dealing with this material and already it shows signs of mite resistance. A third material, amitraz, representing a different class of pesticides, was employed for short period as the labeled material, Miticure®, formulated on plastic strips, but was withdrawn from the market by the manufacturer as too problematic. The fact that amitraz resistance by Varroa mites now exists, however, suggests that it has often been used in 'extra legal' formulations.

Hard pesticides like fluvalinate and coumpahos were relatively flexible molecules that worked across a wide range of temperature and other variables. This allowed beekeepers to rely totally on them to manage mite populations. With elimination of these materials through Varroa resistance fostered by continuous use, beekeepers have had to become much smarter in mite control by using less-toxic, more so called “soft” materials. These include organic acids (formic and oxalic) and essential (thymol, wintergreen) and other (food-grade mineral) oils. These materials were much less forgiving and more or less effective based on environmental circumstances in the bee hive. However, the potential of them impacting the honey crop through contamination was less because many are found naturally in honey.

"As beekeepers have lost effective materials due to resistance, they have resorted to a technology called Integrated Pest Management or IPM. Although often viewed as not employing chemical treatments at all, IPM is really about managing pesticide use to minimize contamination and the development of resistance. Its touch stone is the idea that beekeepers should not use pesticides to totally rid bees of mites (eradication philosophy), but to maintain a low non-damaging level of Varroa in their colonies. This is done using a number of technologies, including hard pesticides, soft chemicals (organic acids and oils, and biomechanical tools (screened bottom boards, powdered sugar dust, drone trapping).

"Varroa is here to stay. This conclusion may seem obvious, but cannot be stated too many times in the modern U.S. beekeeping climate. Martín Braunstein, an Argentine queen breeder, has even suggested it be referred to as the fourth individual in the colony after the queen, worker and drone. Given this circumstance, the long-term solution to Varroa mite control must be looked at in terms of innate tolerance or resistance through genetic management. There are indications that the European honey bee (*Apis mellifera*) itself can take advantage of this, just as has its cousin the Asian honeybee (*Apis cerana*). Two outstanding examples of this have been documented.

The Africanized honey bee is a New World example of this phenomenon. Varroa mites were introduced via Japan in the 1970s into Paraguay and quickly spread to much of Latin America . Mite tolerance or resistance by Apis mellifera is most documented in Brazil . The Africanized honey bee in this sleeping giant of a country has metamorphosed from a beekeeping industry pariah due to defensive behavior, to savior, where few treatments of any kind are used by beekeepers. Clearly, the Africanized honey bee infested with Varroa cannot produce the prodigious amounts of honey per colony that true European honey bees do. This is made up for by the sheer number of feral colonies found in the wild, generally due to increases in swarming, but responsible for a diminished honey crop for beekeepers.

The other example, more recently come to light, is South Africa . Relatively recently infested with Varroa (1997), I wrote the following in my report of the Apimondia meeting in Durban, South Africa in 2001: "It will be instructive for the rest of the world to closely follow the Varroa situation in south and central Africa. This situation not only has great importance for beekeeping, however. The honey bee is a native insect in Africa and therefore its survival and health is important for many wild plant communities that rely on it for pollination and propagation. The jury is in with a report in the 40th Apimondia conference in Melbourne, Australia just concluded. "The rapid development of mite tolerance in South African honey bees is thought to be due to the well-developed removal of Varroa-infested brood and the short post-capping period of worker brood, particularly Cape honey bees. Together these resulted in a very rapid increase in infertile mites in the colony, the collapse of the mite population, and Varroa tolerance." Tellingly, it was concluded: "A 'live and let die' approach to the wild and commercial honeybee populations was crucial to the development of population-wide Varroa tolerance."

"There is more and more evidence that Varroa tolerance already exists at least in rudimentary ways in European honey bees in the U.S. and perhaps elsewhere. The introduction of Russian honey bees, as well as breeding bees for hygienic behavior in general and Varroa in particular, are quite promising."

This ends the twenty-year history of Varroa mites from their unfortunate introduction in 1987 until 2007. Since then, as could be suspected, there have been fits and starts at control based on most of the principles that were described above, but no "magic bullet" has been found. For a shorter history along with an update on control methods, readers are directed to the following website.