SUGGESTED BIOLOGICAL MANIPULATIVE TREATMENT FOR CONTROL OF HONEYBEE MITES

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What is biological management?

Biological management of beehives is not new but is seldom practiced anymore. Basically, it is similar to beekeeping the way Grandpa used to do it around the turn of the century.

Because today's conventional drugs and chemicals used in the treatment of bee diseases, pests and parasites are aimed at suppressing disease symptoms, they do not have a place in a long-term program of biological treatment and control. In the end chemical controls only add problems for the beekeeper. Colony distress is an important symptom, a signal, which is initiated by the colonies own defense mechanism. Learning to recognize these stress signals is therefore important for early initial biological treatment. To suppress and mask symptoms of bee diseases, pests and parasites with chemicals without finding their origin is contrary to the philosophy of long-term biological control.

It is of vital importance to realize that the various symptoms of bee diseases, pests and parasites should not be viewed totally nega tively, rather they should be viewed as positive constructive symptoms initiated by the colonies' own healing mechanism, in its effort to restore balance and heal itself. When this is clearly understood by the beekeeper, then time and resources will no longer be wasted on methods that mask symptoms with quick fix remedies and provide only temporary relief. The beekeeper will then aim at eliminating and correcting the underlying causative factors of bee diseases, pests and parasites, and begin supporting the colonies own recuperative powers.

Concept of origin and spread of diseases, pests and parasites

It is a known fact that both honeybees and mites have been on this Earth and have co-existed for many millions of years. Parasites cannot survive if they kill their host. The question then is what has gone wrong? Why do colonies die from *Acarapis woodi* and *Varroa jacobsoni* infestations? How do normal healthy beehives change into parasitic mite infested colonies with secondary stress diseases without cause and effect transpiring?

The well-known colony stress symptoms — unexplainable fatigue, loss of appetite, physical abnormalities, nervous or runny behaviour, lack of housecleaning, poor flight activity —, create increasing degrees of ill health and would have to be considered consequences of mites. Since both honeybees and mites have co-existed for many millions of years, it must be assumed that something done artificially to honeybee colonies during their domestication and management by man has created the problem of parasitic mites that ultimately result in the destruction of the colony population by them and their secondary diseases. By looking at cause and effect we find that beekeepers themselves have wrought cause and effect in several ways. Combined, they have created the situation they now find themselves in.

First the colonies have to be stressed (the cause) causing the hives to become susceptible to mites and related stress diseases (the effect). It has been suggested that *Acarapis woodi* may have evolved very recently, perhaps in Britain and as recently as 1900 (DEJONG et al., 1982). However, this hypothesis must be treated with caution. Nevertheless, the very close similarity of the various species of *Acarapis* mites does suggest that they evolved symmetrically of *Apis mellifera* from a common ancestor (DELFINADO-BAKER and BAKER, 1982). If beekeepers were to study comb size history they would easily perceive that introduction of larger and larger comb cell sizes used in colonies since the turn of the century have developed evolutionary changes in honeybees through artificial mutation of body size, therefore making bees more susceptible to parasitic mite attacks. With today's comb cell foundations now on the market near or exceeding measurements per square decimeter for *Apis dorsata* for most of today's European honeybee races, no small wonder there is a parasitic mite problem (see tabel 1). The European honeybees are merely out-of-tune with natural feral races and strains of bees by way of body and comb sizing. Based on observations and study of comb cell sizes, it should be hypothesized instead that honeybees have since the early 1900s been artificially mutated larger by beekeepers using bigger and bigger comb sizes, thus causing the parallel evolution of mites as their food source changed.

The causes

1. Artificial oversized brood combs. Since the time of Baudoux in following Huber's experiment in 1791, but by using artificial means instead of drone combs, causing creation of larger worker bees, beekeepers have been artificially mutating the body size of honeybees larger (GROUT, 1931). This has

Known documented measurements of the dimensions of honeybee brood cells per square decimeter on natural comb

Location	Beekeeper	Year	Size
Attica, Greece	Georgandas	1968	733 minimum, 854 maximum 815 average
Peloponnesus, Greece	Georgandas	1968	846 minimum, 892 maximum 863 average
Arta, Greece	Georgandas	1968	836 average
Crete	Georgandas	1968	835 average
Macedonia	Georgandas	1968	821 average
	Collin	1865	854
	Langstroth		838
Italy, House of Fratelli Piana			860
Italy, House (unnamed)			813, 807, 854
	Baudoux		854, 807
	Pincot (for Italian race)		764
Burgundy	unk		798
France (common black bee)			854
France (degenerated common bee)			924
	Halleux	1890	845
North Africa	Rambaldi		940
	Fremont	1893	825
United States	Grout	1931	857
	Schwammerdam	1937	870
	Maraldi	1937	789, 954
	Reaumur	1937	832
	Klugel	1937	832
	Castellon	1937	763, 828
	A.D. Betts (200 years ago)		830
India	Rahman & Singh	1946	1013.17 *A. indica,* 2380.61 *A. florea,* 796.10 *A. dorsata*
United States	A.I. Root		825, 850

placed honeybees with each successive upsizing of comb more out-of-tune with Nature and natural bee flora. Why, because it is difficult to create new honey plants and bees which can be reproduced as such, which have been developed through thousands of years and adjusted to the existing climatic conditions, soil, and especially existing bee flora (CHESHIRE, 1888; GEORGANDAS, 1968). This then creates and adds to the second cause.

2. Artificial diet causing inadequate nutrition. Poor nutrition is a serious stress factor of any organism. What happens when key nutrients are present in insufficient quantities for generation after generation? Larger honeybees require richer nutritional diets, yet have access to less in Nature by being out-of-tune through body size to appropriately match natural bee flora. Colonies can be in a state of inadequate nutrition through either their geographic location placement or placement on artificial enlarged comb foundation creating imbalance with bee flora, or fed diets of pollen substitutes and sugars that are inadequate. One or more of the key nutrients can be insufficiently represented or entirely lacking in the bee's body. Since we believe that a queen reared this way, cannot give to her offspring what she does not have herself, the result is that the queen constitutionally transmits a predisposition for disease and mite attack to her offspring. If honeybees acquire a predisposition for stress diseases due to inadequate nutrition, beekeepers can expect disease and mite infestations in their colonies.

3. Artificial medical treatment by chemicals rather then biological treatment through natural management, causing neurological disorders (CHANEY, 1988), queen supercedures and brood deaths, leaving the honeybee colony unable to function properly to fight off bee diseases or mites.

Mite prevention — a possibility

Since a small population of parasitic mites is nondetectable by either chemical or biological examination methods, beekeepers wait for the appearance of a large infestation to tell them that something is wrong. By then it is often too late for the hive. An approach is needed that looks at the situation in reverse. First the honeybee colony drifts into a pathological state, with the final symptom being a severe infestation of parasitic mites. Logic should compel beekeepers to try to detect the underlying stress signals which are the forerunners of mites, and through biological treatment manipulations eliminate the artificial stimulations that result in mites attacking colonies. This can be accomplished with a long-term biological manipulative treatment program which can be used to either prevent or wean colonies from parasitic mites (LUSBY and LUSBY, 1992).

There is no denying that methods consisting of heavy medication do wage a battle against parasitic mites and stress diseases. However, at the same time chemicals only mask the symptoms and perpetuate the problem. In addition, beekeepers run the high risk of chemical contamination and product recall of wax, pollen, and honey crops. Advanced stages of stress, indicated by symptoms of high parasitic mite populations, prevent beekeepers from implementing biological manipulation treatments easily, because once on chemical dependency treadmills, it is almost impossible to stop treatment without loss of colonies.

Stress symptoms develop for several reasons that work in combination

In the beginning, the honeybee colony is in perfect health without diseases, pests and parasites. Then through the combination of placement on improper sized brood combs for localized geographic regions, and improper nutritional needs over extended periods of time, the colony develops the loss of this healthy condition. Stress factors weaken the honeybee's natural defense system inherent within the hive. Minor stress symptoms appear in the form of foulbrood and other body diseases. In succesive generations, more advanced symptoms appear in the way of various fungal diseases. Both diseases, along with mite infestations can easily gain a foothold in a stressed colony. The colony is destroyed from generations of abuse and stress. The mites and diseases are not the problem, they are merely the advanced stages of an artificially caused problem. The stress resulting from generally accepted beekeeping practices of artificial enlarged combs, nutrition, and chemicals repeated over many years, is the real killer of domesticated honeybee colonies.

The most important weapon in the fight against parasitic mites and their secondary stress diseases is prevention. Beekeepers must be alert to the signs of distress within their colonies. When stress symptoms are apparent, beekeepers must take action to put their colonies back into biological balance with manipulative treatments. This can be accomplished through dietary change if an artificial diet is being used, and by replacing the brood comb with natural sized comb foundation in harmony with the geographic region where the colonies are being maintained. Culling excessive drone combs will also help. The down sizing of the brood comb foundation will realign the bees' body size to again match their native flora. Changing the diet from artificial pollen substitutes and sugar syrups back to pure natural pollens and honey from the colonies own geographic region will also improve colony vigor. The removal of stress by beekeepers is, of course beneficial, like removal of contaminated combs and their replacement with disease free combs. But this in itself does correct the underlying reason the hive came down with the malady. The whole hive must be restored to full health by placing it back onto a natural system that acts to relieve stress.

If the colony is still in the early reversible stage of development of stress diseases, the therapeutic administration of natural key nutrients and natural sized brood comb foundation, sized to ones own beekeeping region, will in most cases bring about the restoration of health to the colony. The result is that the bee's own natural defense system and capacity for recovery will again be activated and begin the work of clearing away the problem within the hive. Stress diseases will be eliminated and the mite population will naturally decrease to a level well below economic thresholds for survival of the hive.

Beekeepers must bear in mind that in treating and curing honeybee stress diseases and getting rid of parasitic mites, that these disturbances to colonies do not possess a capacity for unbridled autonomous growth. Their behaviour depends entirely of the state of health of the honeybee colony as a whole harmonious working unit. The nutritional healing of the colony coupled with replacement back onto natural sized brood comb foundation has a number of important advantages:

1. In a colony that has been restored to health, the natural defense systems of bees are fully operational again, whereas treatments such as chemotherapy for parasitic mites can have the opposite effect, that of damaging the bees by causing neurological disorders (CHANEY, 1988), as well as probably causing comb and hive product contamination.

2. No secondary infections by foulbroods, chalk broods, etc., can take place because infected brood will be destroyed by the bee's own natural communal defense system.

3. The size of the worker bee returns to normal and again fits the natural flora of the region. This is important because the ratio of worker size honeybees to drone size bees is 20%, a four to five ratio of body size, that remains constant no matter what size the worker is and by returning the worker bee to normalcy, you change the size of the thorax of all bees in the colony, including the drones. The automatic downsizing of drone dimensions by the downsizing of worker bees is extremely important for fighting *Varroa jacobsoni* infestations. This is important because drones are also periodically thrown out of hives after each honey gathering season. We believe that this downsizing of honeybees aids in reducing the parasitic mite population in important ways:

a. The size of the honeybee is correlated with the capacity of the cell. Small cell, small bee; big cell, big bee (BAUDOUX, 1933). The size remains the same during the whole of the bee's life in perfect ratio one caste to each other. Since the only place *Acarapis woodi* mites can get into honeybees is through the first thoracic spiracle (EICKWORT, 1988), cell size is an important artificial mutant that can be rectified by beekeepers through use of natural sized brood comb foundations. Once placed onto natural sized brood combs the bee's thorax size is reduced, and *Acarapis* mites have lost a very valuable avenue of entry for hive destruction.

b. In Brazil, cell sizes for Africanized and domestic (European) honeybees when measured averaged 4.5 to 4.8 and 5.0 to 5.1 mm per cell, respectively (MESSAGE and GONÇALVES, 1983). They further reported that *Varroa* infestation rates were 4.8 and 11.5 percent respectively. CAMAZINE (1988) calculated female *Varroa* replacement rates for Africanized and domestic (European) honeybees at 1.2 and 1.8 with drones present and 0.8 and 1.5 without drones, respectively. (A female *Varroa* replacement rate of less than 1.0 indicates that the mite population is declining while a 1.0 rate is indicative of zero population growth.) Keeping this in mind, it makes perfect sense to downsize artificially enlarged brood combs to take advantage of the 0.8 population replacement of *Varroa jacobsoni* when drones are seasonally ejected by colonies at the end of each honey gathering season. It also makes perfect sense to cull drone combs to less than 10% of all combs in a hive to keep *Varroa* populations down to a minimum. Thus it may be possible to suppress *Varroa* populations in domestic colonies by using small strains of bees with shorter development times reared in smaller cells (ERICKSON et al, 1990). Both these points appear now proven and have been incorporated into a biological manipulative treatment program for long-term control of parasitic mites by 1) queen rearing techniques (DEGRANDI-HOFFMAN et al, 1989), and 2) biological field manipulative techniques (LUSBY and LUSBY, 1992).

c. Downsizing also reduces basic food stimuli attractiveness for mites. It has been documented by KULZHINSKAYA in 1956 that worker larvae in enlarged oversized cells received 21% more food and 21.4% more protein than worker larvae reared in normal sized cells. He also found that the weight of larvae increased by 12.4% and that of adults reared in oversized cells by 10.4%. Since it is common knowledge that mites prefer drone cells, in the case of *Varroa jacobsoni,* over worker cells and Wolfgang RITTER (1988) stated that "Varroa cannot reproduce in the worker brood of *Apis cerana,* according to RITTER et al, 1980; KOENIGER et al, 1981 confirmed this and additionally found *Varroa jacobsoni* offspring only in drone bood", then logic should dictate that the additional food and protein in enlarged oversized cells does indeed act as a mite attractant. HÄNEL (1983) points out that one of the reasons for such differential reproductive behaviour of *A. cerana* bees could be due to their juvenile hormone level. Varroa takes in various amounts of juvenile hormone III during its primary intake of hemolymph when feeding. This induces oviposition in the mite. In the first 60 hours, the drone larvae of *A. cerana* and *A. mellifera* contain more than 5 μg/ml JH in their hemolymph. Worker larvae of *A. mellifera* contain 3—7 μg/ml and, those of *A. cerana* contain only 1 μg/ml. The level of juvenile hormone in worker larvae of *A. cerana* is apparently not sufficient to induce oviposition in the mite. This has proved to be a selective advantage to the bee during the course of its host and parasitic evolution. Only in this manner does the parasite prevent death of its host and thus its own death. F. RUTTNER in his paper "Characteristics and variability of *Apis Cerana*" points out that "Contrary to the customary assumption, *A. cerana* is not generally a small bee when compared with *A. mellifera*. This frequently-held opinion holds true only when *A. cerana* is compared with European *A. mellifera*". We believe that this is a comparison of a feral sized naturally occuring type of honeybee to an artificialized oversized domesticated European sized honeybee that has received more food and protein, thus more juvenile hormone by being reared on artificial combs. Therefore, downsizing would have the impact of reducing juvenile hormone levels, food and protein contents of the larvae jelly, all of which are mite attractants in oversized cells.

d. Downsizing also compacts the brood nest by density and our observations by inserted temperature probe, show that it raises the brood nest temperature, which we believe helps to speed up the gestation cycle of the brood. Combine with being able to select for faster developing queens (DEGRANDI-HOFFMAN et al, 1989) and it becomes possible to breed for bees with shorter development times as in aid in overcoming *Varroa.* Remember in the end, surgical removal of stress by beekeepers is always possible if the colonies own defense system proves to have been so debilitated as to be incapable of returning to normalcy. If surgery by beekeepers is necessary, a healthy honeybee on a proper nutrient diet will better generate strong recuperative powers once causitory brood combs have been removed and replaced.

REFERENCES

DE JONG, D.; R.A. MORSE; G.C. EICKWORT (1982) — *Ann. Rev. Entomol.* 27 pp. 229—252

DELFINADO-BAKER, M.; E.W. BAKER (1982) — *Internat J. Acarol.,* 8 pp. 211—226

GROUT, R.A. (1931) — A biometrical study of the influence of size of brood cell upon the size and variability of the honeybee *(Apis mellifera* L.). M.S. Thesis, Iowa State College

CHESHIRE (1888) — Bees and beekeeping, pp. 317—318

CHANEY, W.E. (1988) — The effect of synthetic pyrethroid insecticides on honey bees in Indiana; laboratory studies and a survey of beekeepers and pesticide applicators. PHD Thesis, Purdue University

BAUDOUX, U. (1933) — The influence of cell size. *Bee World,* Vol XIV, No. 4, pp. 37—41

MESSAGE, D.; L.S. GONÇALVES (1983) — The effect of the size of honey bee cells on the rate of infestation by *Varroa jacobsoni.* 29 International Congress of Apiculture, pp. 250; *Apiacta* 1984, pp.62

GEORGANDAS, D. (1968) — Natural comb of Greek bees and comb foundation. *American Bee Journal,* Jan 1968, pp. 14—15

KULZHINSKAYA, K.P. (1956) — *Apicultural Abstracts,* 37, pp. 177

ERICKSON, LUSBY, HOFFMAN, LUSBY (1990) — On the size of cells. *Gleanings in Bee Culture,* February 1990, pp. 98—101 Part 1 and March 1990 pp. 173—174

DEGRANDI-HOFFMAN, G.; D.A. LUSBY; E.H. ERICKSON Jr.; E.W. LUSBY (1989) — Managing colony genetics by grafting and selecting for queens with shorter development times. *American Bee Journal,* Vol 129 (II) : 717—719

CAMAZINE, S. (1988) — Factors affecting the severity of *Varroa jacobsoni* infestations on European and Africanized honeybees. In *Africanized Honey Bees and Bee Mites,* Chapter 59, pp. 444—451

EICKWORT, G.C. (1988) — The origins of mites associated with honeybees. *In Africanized Honey Bees and Bee Mites,* Chapter 40, pp. 332—333

RITTER, W. (1988) — *Varroa jacobsoni* in Europe, the tropics, and subtropics. In *Africanized Honey Bees and Bee Mites,* Chapter 42, pp. 349—351

HÄNEL, H. (1983) — *Apidologie,* 14, pp. 137—142

KOENIGER, N.; G. KOENIGER; H.P. WIJAYAGUNASEKARAN (1981) — *Apidologie* 12(1), pp. 37—40

RITTER, W.; T. SAKAI; K. TAKEUCHI (1980) — Apimondia Symposium, Bad Homburg, pp, 69—71

LUSBY, D.; E. LUSBY (1992) — Suggested biological management program for control of parasitic mites. (Unpublished)

RUTTNER, F. — Characteristics and variability of *Apis cerana* (Fabr.), pp. 130—133

BETTS, A.D. (1932) — The influence of cell size, *Bee World,* Jan 1934, pp. 2—5

SCHWAMMERDAM — *Bee World* (1937) pp. 43

ROOT, A.I. (1978) — The ABC and XYZ of bee culture, A.I. Root Company (publs.) Medina, Ohio

RAHMAN, K.A.; S. SINGH (1947) *Bee World* September 1947

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