Proceedings

Third Caribbean

Beekeeping

Congress

September 16-20, 2002
Kingston, Jamaica

TECHNICAL SESSION IV: Pest and Disease Management in Apiculture

Presiding: Dr. Nicola Bradbear, United Kingdom

Control of American Foulbrood without the Use of Drugs: The New Zealand Experience

Cliff Van Eaton
Professional Apiculturalist
Tauranga, New Zealand

While beekeeping worldwide has generally relied on the use of antibiotics for both the prevention and treatment of American foulbrood (AFB) infections, New Zealand provides an interesting example of how non-drug methods can be used successfully to control the disease. The feeding of antibiotics to honey bees for AFB control is illegal in New Zealand, and as a result beekeepers there have never used either oxytetracycline or suphathiazole in their hive management. Control is through the management of beehives to reduce the spread of the disease and destruction of colonies that are found to be infected.

Why New Zealand Beekeepers Do Not Use Antibiotics to Control AFB

One of the major reasons given in New Zealand for not using antibiotic drugs to control AFB is the fear of contamination of honey and other bee products with antibiotic residues. Detectable oxytetracycline residues can be present in retail packs of honey and royal jelly (Matsuka and Nakamura, 1990), and such residues were found in Australian honey exported to Japan that had been produced eight months prior to shipment (Hornitzky, 1989). Japanese government authorities now routinely insist on antibiotic residue certificates of analysis for imported bee products. However, because of New Zealand's AFB drug control prohibitions, antibiotic residue testing is not required for shipments of New Zealand bee products to Japan. New Zealand beekeepers consider it an honour to have received this Japanese government recognition of the purity of their honey, propolis and bee pollen.

New Zealand beekeepers also argue that when it comes to AFB control and eradication, the use of antibiotics alone can never be a total replacement for beekeeping management methods. The feeding of antibiotics is generally not assumed to cure or eliminate existing clinical infections of AFB in beehives, at least under normal commercial beekeeping practices (Hornitzky, 1990; Wilson, et al., 1973; Matheson and Reid, 1992). As well, in states and provinces in North America where a government-sponsored inspection programme is employed in addition to routine antibiotic treatment, AFB incidence is

generally equal to or greater than that in New Zealand, where antibiotic treatment for AFB is prohibited by law (Rendall, 1981; Mungari and Jamnback, 1991).

Regardless of whether antibiotics are used to control AFB, untreated or poorly treated beehives infected with the disease will still always result in a continuing incidence of AFB and a residue of *P. l. larvae* spores that can set off new infections. Beekeepers in many countries therefore often feel the need to protect their beehives from the possible inadequate AFB control activities of their fellow beekeepers, and so resort to using drugs to prevent infections from diseased beehives in the local vicinity. As a result, a drug feeding dependency develops, with beekeepers needing to feed antibiotics on a continuing basis to avoid devastating economic losses from AFB (Shimanuki and Knox, 1994). Indeed, it has been estimated that in areas where antibiotics are routinely used as an AFB preventative, 10-20% of beehives would break down with the disease if antibiotic feeding ceased (Hornitzky, 1989; Cantwell, 1980).

Recently, the National Beekeepers' Association of New Zealand (NBA) obtained the right from the New Zealand government to implement an industry-directed Pest Management Strategy for AFB under the auspices of the Biosecurity Act (NBA, 1996). Part of the formal approval process for the new programme involved an independent cost-benefit analysis comparing the New Zealand non-drug AFB control methods with antibiotic-based AFB control (both with and without a statutory AFB inspection and control programme). The analysis found there would be a significant increase in costs to the New Zealand beekeeping industry for both types of antibiotic feeding programmes, compared to the non-drug AFB programme proposed in the strategy (Meister and Salt, 1995).

Apart from the initial devastation that could occur if antibiotic feeding was withdrawn in countries where the practice has been used routinely for a number of years to control AFB, the suggestion is that compared to non-drug AFB control methods, the use of antibiotics actually increases beekeeping management costs with no significant decrease in hive losses.

New Zealand's AFB Control Programme

The New Zealand beekeeping industry has for many years relied on government funded and administered AFB control programmes, including annual registration of all apiaries, the reporting of all AFB cases by beekeepers, disease control education, and the random and targeted inspections of beehives by both government inspectors and volunteer beekeeper inspectors.

The impact of these programmes on the incidence of AFB has been mixed, due mainly to variability in programme funding, a lack of direct supervision from the beekeeping industry, and varying levels of commitment from government (Van Eaton, 1999).

For instance, there was a significant rise in AFB incidence in New Zealand between 1985 and 1991, with the number of reported AFB cases going up by 130% (see Figure 1). This

coincided with a gradual reduction in government-funded AFB control services, as well as a growth in hive numbers stimulated by rapidly developing demand for pollination of kiwifruit (*Actinidia chinensis*), a major New Zealand crop. During the 1980s, hive numbers in New Zealand increased by 45% in just seven years (Van Eaton, 1992).

In 1991, following a change in New Zealand government policy requiring agricultural industries to fund their own disease control activities, a concerted programme was implemented to reduce AFB incidence. Although the work was still carried out by government personnel, the programme was financed and directed by the NBA, with the performance of government inspectors strictly controlled to detailed contract specifications set by the NBA.

The programme involved the inspection of 4% of the country's apiaries per year by government inspectors, the inspection of a further 4% of apiaries by volunteer NBA inspectors under direction of government personnel, a counseling component for beekeepers with significant levels of AFB infection in their hives, and a research programme carried out by Dr. Mark Goodwin and his team at the Ruakura Research Centre in Hamilton, New Zealand. The research concentrated on factors contributing to the spread of AFB (Goodwin et al., 1993a; Goodwin et al., 1993b; Goodwin et al., 1994a; Goodwin et al., 1994b) and simplified ways of detecting *P. l. larvae* spores in bees and bee products (Goodwin and Van Eaton, 1992).

By whatever measure, this industry-directed AFB control programme was an outstanding success. In the seven years of the programme's existence, reported AFB incidence decreased on average by 12% per annum, from 1.2% of beehives per year at the beginning of the period, to 0.3% of beehives in 1999. The current level is the lowest in New Zealand in 22 years, and the third lowest in the country's history (Van Eaton, 2000).

Methods used by New Zealand Beekeepers to eliminate AFB

The methods New Zealand beekeepers use to eliminate AFB from their beehives are quite simple and straightforward, and have been described in further detail in a book published by the NBA and distributed to beekeepers throughout New Zealand (Goodwin and Van Eaton, 1999). The methods consist of:

- routine and constant AFB inspection,
- managing beehives using quarantines so that the spread of AFB is reduced,
- destroying colonies that are found to have clinical infections of the disease, and
- sterilizing beehive components associated with a case of AFB.

The methods are based on the premise that most AFB infections in beehives are due to the beekeeping practices that are carried out on those hives. It therefore follows that the incidence of AFB in beehives can be reduced by changes in those beekeeping practices.

Increasing Inspections to Reduce AFB Incidence

Reductions in AFB incidence can be achieved by increasing the number, frequency, intensity, and timing of disease inspections in order to find more AFB hives earlier. Beekeepers in New Zealand have been encouraged for many years to inspect brood frames whenever they go into a hive, and especially whenever they take anything from a hive (e.g., brood, honey or boxes) that may immediately or eventually be taken to another hive. As an example, it has been observed that beekeepers in that country who have low AFB infection rates also generally inspect their beehives either when or just after they take their honey off.

Case studies in New Zealand have also shown that changes in the frequency and thoroughness of inspections can reduce the incidence of AFB. The reason is that more frequent and thorough inspections are likely to pick up AFB infections at an early stage, before they have a chance to produce large numbers of infective *P. l. larvae* spores and before those spores can be spread to other honey bee colonies.

Changes in Beekeeping Management to Reduce AFB Incidence

A major beekeeping management technique that has proven successful in New Zealand in eliminating AFB is quarantine. Quarantine involves controlling and recording the movement of materials that have the potential to carry infective levels of *P. l. larvae* spores. There are generally two types of quarantine: apiary quarantine and hive quarantine.

Some beekeepers in New Zealand routinely use apiary quarantine when they take their honey off. They mark stacks of supers according to the apiary site, and then either ensure that the supers go back on the same apiary the next year, or only release the supers into general use after the contributing apiaries have received an all-clear for AFB following several brood inspections the next spring.

Apiary quarantines are used as a matter of routine, rather than just when an outbreak of AFB occurs. They provide a means of ensuring that when an AFB problem is discovered, the disease does not spread via beekeeping equipment to other apiaries.
Hive quarantines are more time consuming, but are definitely used by beekeepers when they experience an AFB outbreak in an apiary. In a hive quarantine, components associated with an individual hive remain with that hive, or are marked with a number identifying it with that hive so that the components can be returned to the hive the next year. The general rule for an all-clear release from such a quarantine is one and a half beekeeping seasons following the finding of the last AFB hive in the apiary.

Risk Materials and AFB Quarantine

The important thing in AFB quarantines is to control the movement of materials that actually have the potential to carry infective levels of *P. l. larvae* spores, rather than putting emphasis on materials and practices that have a much lower potential disease risk.

Research has shown that not every hive infected with *P. l. larvae* spores will develop a clinical infection of AFB, and a significant concentration of spores is required to actually initiate a case of the disease. Materials most capable of carrying infective levels of spores are 1) extracted honey supers, which are often taken unknowingly from AFB hives, and then put on clean hives, generally a year later, and 2) frames of brood and honey, which are often moved unknowingly from hives with sub-clinical AFB hives (i.e., hives not showing visual symptoms) to clean hives (Goodwin et al., 1993b).

A number of materials and situations often thought to be important factors in AFB spread are actually of little or no consequence as sources of infective levels of *P. l. larvae* spores. These include hive tools, smokers and gloves (Matheson and Reid, 1992), the soil in front of hives (Gochnauer, 1981), foundation (Goodwin et al., 1993b), and queen bees (Wilson and Alzubaidy, 1975). Drift of bees from AFB hives to healthy hives is also not a significant source of AFB infection (Goodwin et al., 1994a), and feral (wild) colonies are more likely to become infected with AFB from managed hives, rather than vice versa (Goodwin et al., 1994b).

Robbing can also be an important cause of AFB spread, but it is usually the result of inadequate levels of beehive inspection and improper beekeeping practice, both of which can be altered by changes in beekeeping management.

Sterilizing Beehive Materials Associated with a Case of AFB

A component of AFB control in New Zealand, which appears to have developed as a practice in that country, is the sterilization of beehive woodenware associated with cases of AFB. The technique involves immersion of the woodenware for at least 10 minutes in paraffin wax heated to at least 160^{o}C.

Research has shown that this technique is one of the few effective ways of destroying AFB spores. However, time and temperature (of immersion) are very important since lesser levels of either will leave significant amounts of viable *P. l. larvae* spores remaining (Goodwin and Haine, 1998).

Most beekeepers in New Zealand sterilize the supers, boxes and lids associated with AFB hives. The sterilization technique is very basic, and can be easily set up and operated at a beekeeper's home base of operations. Paraffin wax sterilization has the added benefit of preserving woodenware against fungal rot. It is, however, a dangerous technique if not carried out by a skilled person, and boil-overs of over-heated paraffin can result in fires that can be difficult to bring under control.

Elimination of AFB – A Case Study

The effectiveness of non-drug methods in reducing and eliminating AFB in New Zealand is demonstrated in a set of AFB incidence figures collected over a 35-year period by a beekeeping enterprise in the Hawkes Bay region of New Zealand (Figure 2).

The enterprise had two significant outbreaks of AFB during the period, the first beginning in 1973, and the second beginning in 1989, both associated with the purchase of honey supers from other beekeepers. Nevertheless, using only search and destroy inspections, hive and apiary quarantines, and beehive component sterilization, the enterprise has managed to operate within the internationally accepted veterinary standard for "disease freedom" (0.2% of animals/beehives per herd/enterprise per annum) in 27 of the last 34 years, and in the each of the last 10 years.

Significantly, this low level of AFB incidence was achieved in a large-scale, migratory beekeeping enterprise consisting of some 7000 colonies. A considerable number of the enterprise's hives are placed each year in both apple and kiwifruit orchards for pollination, in close proximity to other pollination hives (and therefore potential sources of AFB infection) belonging to a range of other beekeepers. The enterprise also migrates all of its beehives to at least two honey flows. Over the last four years, in those 7000 colonies, the enterprise did not record a single AFB hive.

Summary

In summary, beekeepers who want to control AFB in their own hives without the use of drugs should use the following 6 point plan:

1. Look for brood diseases whenever you go into a hive.
2. Give your hives a full inspection (all frames with brood) at least two times per year (at the beginning and end of the beekeeping season).
3. Carry out a full inspection of both hives whenever you move anything (combs, boxes, etc.) from one hive to another.
4. Inspect all hives in an apiary either when or just after you remove the honey.
5. Use apiary quarantine as a matter of course, beginning at the end of the honey season and carrying through until you complete your full inspections at the beginning of the next beekeeping season.
6. Use hive quarantine in an apiary whenever you find AFB in a hive, and continue to use it until 18 months after the last AFB hive has been found in the apiary.

References

Alippi, A. 1994. "In vitro" sensitivity of *Bacillus larvae* to different antibiotics. Vida Apicola 66: 20-24. In Spanish.

Cantwell, G. 1980. The use of ethylene oxide to fumigate honey bee equipment in the United States and Canada during the 1970s. Am. Bee J. 120: 840-843.

Goodwin, R., and H. Haine. 1998. Sterilizing beekeeping equipment infected with American foulbrood disease spores. The New Zealand Beekeeper 5(9): 9-13.

Goodwin, R., J Perry, and P. Brown. 1993a. American foulbrood disease part II: sub-clinical infections. The New Zealand Beekeeper 218: 7-9.

Goodwin, R., J. Perry, and P. Brown. 1993b. American foulbrood disease part III: spread. The New Zealand Beekeeper 219: 7-10.

Goodwin, R., J. Perry, and A. Ten Houten. 1994a. The effect of drifting honey bees on the spread of American foulbrood infections. J. Apic. Res. 33: 209-212.

Goodwin, R., J. Perry, and A. Ten Houten. 1994b. Incidence of American foulbrood infections in feral honey bee colonies in New Zealand. N. Z. J. Zool. 21: 285-287.

Goodwin, R., and C. Van Eaton. 1992. Detection of American Foulbrood: Using Bacterial Cultures. Ministry of Agriculture and Fisheries, Hamilton, New Zealand. 20pp.

Goodwin, M., and C. Van Eaton. 1999. Elimination of American Foulbrood Without the Use of Drugs – a Practical Manual for Beekeepers. National Beekeepers' Association, Napier, New Zealand. 78pp.

Hornitzky, M., 1989. American foulbrood in Australia – a 1989 perspective. Australasian Beekeeper 91: 172, 179.

Hornitzky, M. 1990. Honey bee diseases in Australia, 1990. Australasian Beekeeper 92: 20-28.

Matheson, A., and M. Reid. 1992. Strategies for the prevention and control of American foulbrood. Am. Bee J. 132: 399-402, 471-473, 534-537.

Matsuka, M., and K.Nakamura. 1990. Oxytetracycline residues in honey and royal jelly. J. Apic. Res. 29: 112-117.

Meister, A., and Salt, R. 1995. An Analysis of the Benefits and Costs of the Introduction of a Pest Management Strategy to Eradicate American Foulbrood Disease. School of Applied and International Economics, Massey University, Palmerston North, New Zealand. 19pp.

Mungari, R., and H. Jamnback. 1991. American foulbrood: who suffers? Gleanings in Bee Culture 119: 100-101.

NBA, 1996. National Pest Management Strategy for American Foulbrood. National Beekeepers' Association, Hastings, New Zealand. 91pp.

Rendall, G. 1981. Antibiotic risk to bees. Vet. Rec. 28: 194.

Shimanuki, H. 1999. American foulbrood disease – past, present and future. In Proceedings of the XXXVIth Congress of Apimondia, Vancouver. p. 45.

Shimanuki, H., and D. Knox. 1994. Susceptibility of *Bacillus larvae* to Terramycin®. Am. Bee J. 134: 125-12.

Van Eaton, C. 1992. Kiwifruit: pollination and production. Gleanings in Bee Culture 120:494-496.

Van Eaton, C. 1999. Control of American foulbrood in New Zealand without the use of drugs. In: Proceedings of the XXXVIth Congress of Apimondia, Vancouver. pp. 51-52.

Van Eaton, C. 2000. Controlling AFB without drugs – New Zealand's approach. Bee Culture 128: 36-40.

Wilson, W., J Eliot, and J. Hitchcock. 1973. Treatment of American foulbrood with antibiotic extender patties and antibiotic paper packs. Am. Bee J. 113: 341-344.

Appendix

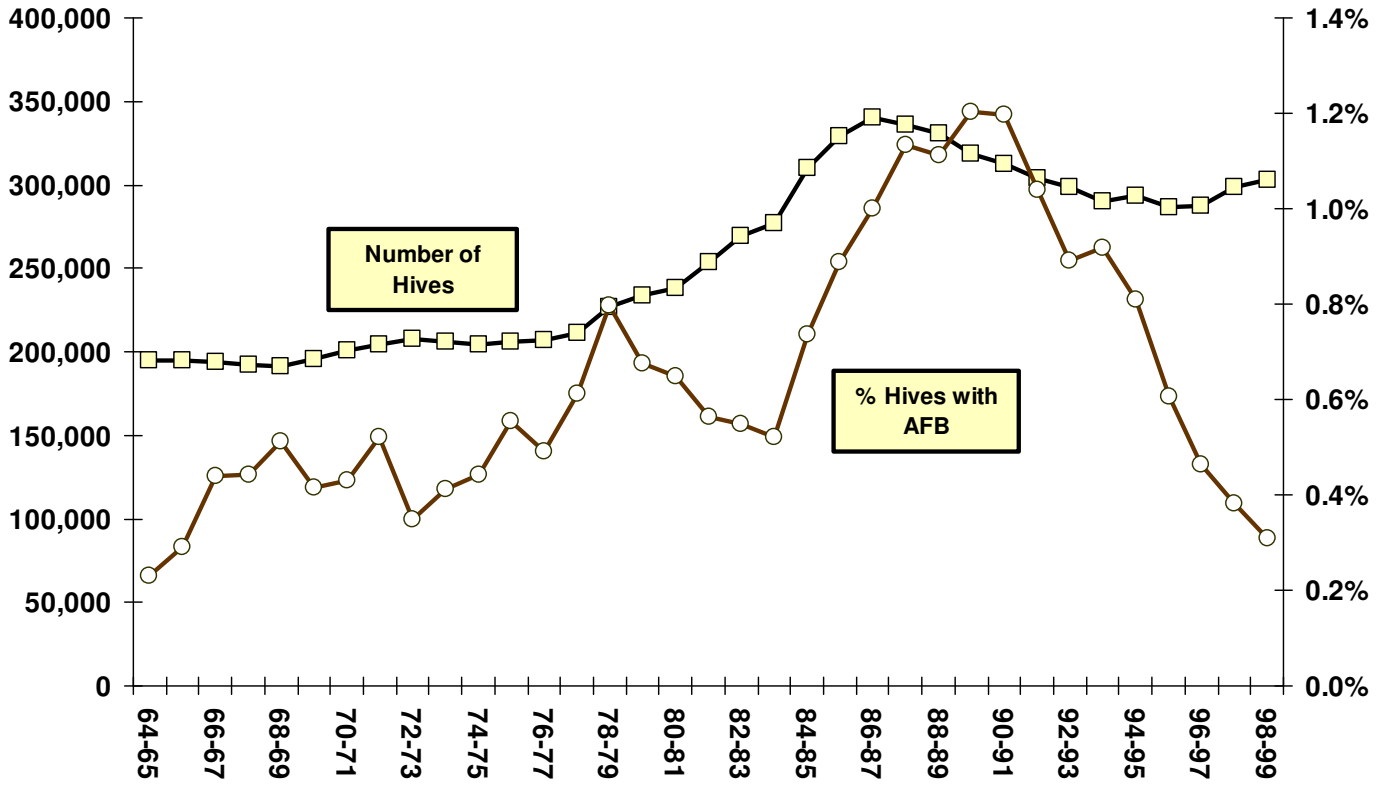

Figure 1: Hive Numbers and AFB Incidence in New Zealand – 1964-1999
(Note: Incidence equals the number of AFB hives reported divided by the total number of registered beehives)

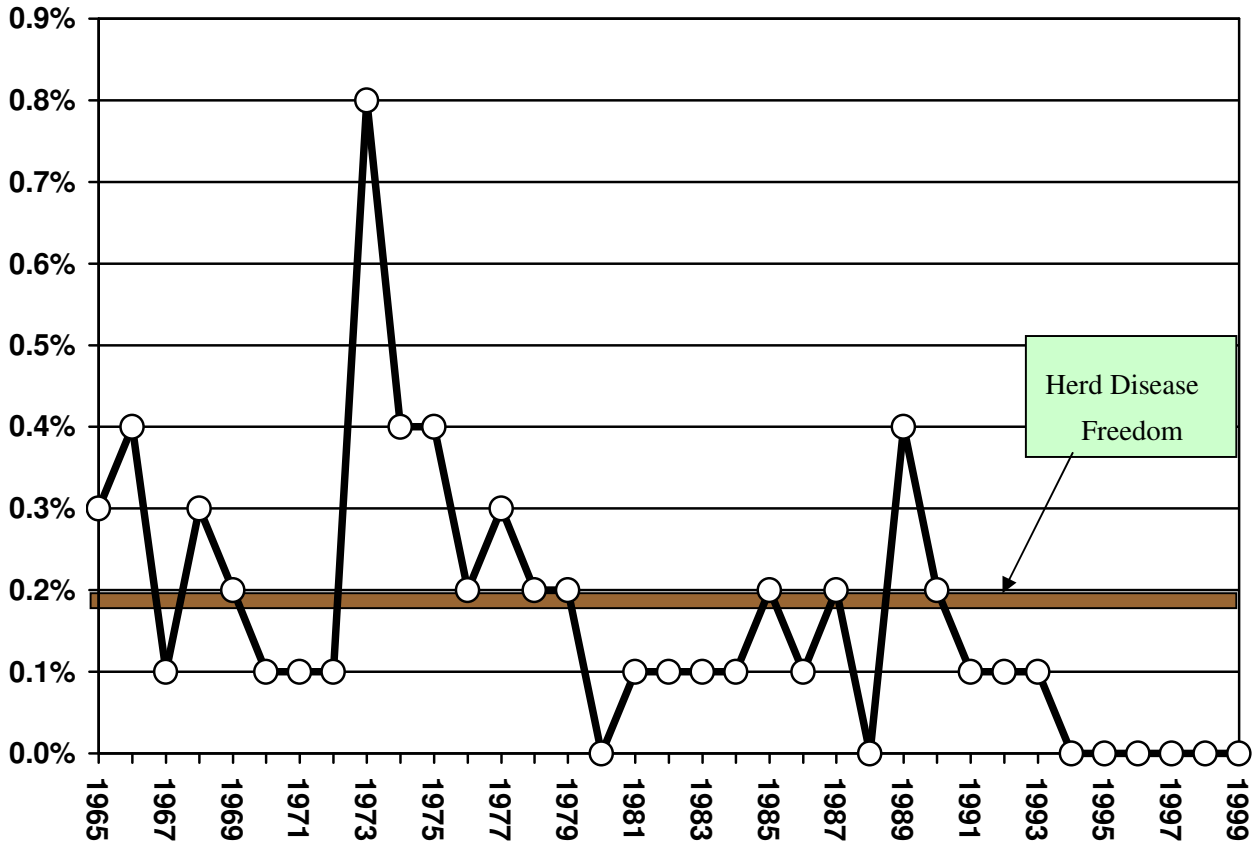

Figure 2: Incidence of AFB in an 8000 beehive enterprise in Hawkes Bay, New Zealand (Note: The internationally accepted veterinary standard for disease freedom is 0.2% of animals per herd per annum)