Comb Fumigation For Nosema Disease

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In my article in the American Bee Journal in June 1955 (Vol. 55(6): pp. 225, 248-254) there was a general account of the epidemiology of Nosema disease and an explanation was given of how the combs of an infected colony act as the principal reservoir of the disease. A brief reference was also made to the sterilization of the combs with the fumes of acetic acid.

In the following account further details are given of the method of sterilizing combs with acetic acid and of the results so far obtained at Rothamsted.

The combs are assembled normally in a brood box which is then placed on a level floor or in an upturned cover. Above it is placed an empty shallow box or a shallow box of combs with a few combs removed from the center. In the shallow box is placed a wad of cloth or other suitable absorbent material and onto this is poured about 350 mls. (¼ pint) of acetic acid (80% to 100% strength). Fig. 1a). With this assembly as the unit, a stack may be built to a convenient height and covered with a top. (Fig. 1b). If the hive parts are in good condition there is no need to seal the joint between the boxes. The stacks are left for a week or longer, preferably in the sun against a wall sheltered from strong winds, or, better still, inside a warm building.

Under these conditions, spores of Nosema apis are killed within two days at temperatures of 50 degrees to 60 degrees F. and within 5 days at temperatures of 32 degrees to 60 degrees F. Fumigation for one week is advised to insure maximum effect.

The treatment will also kill the cysts of Malpighamoeba mellifica, (the cause of Amoeba disease) and all stages of the Greater and Lesser Wax-moths. The eggs of the moths are killed within one day in temperatures as low as 39° F. in higher temperatures fumigation is even more effective. Treatment will not prevent reinvasion by wax-moths from elsewhere when all the fumes have been dispersed, but this is delayed for months if the stacks are left undisturbed.

The spores of Bacillus larvea (the cause of American foulbrood) are not killed by acetic acid fumes.

The acid will not damage the combs or woodwork. There is a slight surface corrosion of metal parts, which is of no significance to hive parts; but it will spoil metal objects, such as tools, if these are in the same room of a building which may be used as a fumigation chamber.

The combs may be introduced to colonies immediately after fumigation with no ill effects to the bees; honey and pollen are not made poisonous and bees seem to have little objection to the fumes. After a few days with the bees the combs have lost the smell of the acid and there is no tainting of honey which may subsequently be stored in them.

The method by which infected colonies may be transferred to sterilized combs is illustrated in Fig. 2. This operation should be carried out in April, May or June. Two months afterwards the disease will have disappeared and no reservoir of disease will remain on the combs to reinfect the winter cluster.

The following account of an experiment with Amoeba disease illustrates the effectiveness of this methods as well as the importance of the combs as a reservoir of disease (Amoeba disease is transmitted in the same way as Nosema disease).

In August 1954, 26 combs from a diseased colony were divided equally into two groups; one group was fumigated with acetic acid as described above. A healthy colony was then divided into two halves; the queenless half, (Colony 1), received the fumigated combs and the other half, (Colony 2) received the non-fumigated combs. (Fig. 3) The queenless half was immediately requeen. At intervals afterwards samples of 100 bees were taken from each colony and the Malpighian tubules of each bee were examined microscopically for Amoeba cysts. Colony 2 had a heavy infection in 1955 but Colony 1 did not. In May, 1956, Colony 2 was transferred to sterilized combs. The combs which were removed from this colony were then inserted into Colony 1 in September. The samples in 1956 showed that the infection had been entirely removed from Colony 2 and placed in Colony 1.

This experiment showed clearly that the combs are the reservoir of
Fig. 2. The method by which a diseased colony is transferred to non-contaminated combs.

(a) The queen is found and placed with a comb of brood in the center of a box of sterilized combs.

(b) An excluder is placed over the box containing the remainder of the brood and the box with the queen is placed over it.

(c) The lower entrance is closed and the bees are given an entrance to the upper box.

After a day or two the queen will be laying in the sterilized combs. The non-sterilized comb in the middle of the upper box is then put below.

After three weeks the lower box is removed to be sterilized. During this period contamination will not be transferred from the old combs to the sterilized ones because the spores are embedded in dry masses of fecal deposit on the combs and are not carried on the feet of the bees.

disease, that their complete exchange for non-contaminated combs eliminates the disease and that contaminated combs can be sterilized by acetic acid fumes.

The following results of the attempt to eradicate Nosema disease at Rothamsted will illustrate the effectiveness in practice of the method of changing combs. In 1954 virtually all the colonies at Rothamsted were heavily infected; most had 50 to 100 per cent of their bees infected in the spring. As many colonies as possible were transferred to sterilized combs in the early summer of that year. In 1955 infection had fallen to 7 per cent, which included a number of untreated colonies, and the infected colonies were transferred to sterilized combs. In April 1956, only ten colonies out of 260 were infected and only one of these had more than 5 percent of its bees infected.

The disease at Rothamsted had obviously been largely eliminated. The most probable reason for the small trace of infection remaining is that a few colonies which may have had a very light but undetected infection had never been treated and

Fig. 3. The course of an infection with Amoeba disease in two colonies of bees.

\[ : \text{Colony 1} \quad \text{Colony 2} \]

\[ : \text{Sterilised combs put in colony 1.} \quad \text{non-sterilised combs put in colony 2.} \]

\[ : \text{colony 2 transferred to sterilised combs.} \quad \text{All non-sterilised combs removed from colony 2.} \]

\[ : \text{non-sterilised combs from colony 2 put in Colony 1.} \]
that nearly all colonies are frequently handled for a variety of experiments. Frequent disturbance of colonies is a potential cause of re-contamination of combs by infected bees which are crushed, or which defecate over the combs after a period of confinement.

A criticism of the method described above for treating Nosema disease has been that it is not economical for commercial beekeepers. It is not possible to assess accurately, from the published evidence, how much damage can be attributed solely to Nosema disease. Judging by all accounts a loss of two or three percent would seem a conservative estimate. This would have to be weighed almost wholly against labour costs as the cost of acetic acid is only about the value of two or three ozs. of honey per brood chamber (in Britain).

Experiments are now in progress to see if the disease can be suppressed, and possibly eliminated after a few seasons, by fumigating all combs, other than those containing brood, in the spring and then returning them to the colonies. The comb containing brood which is left in the center of the colony may be cleaned sufficiently by constant use during the summer. This would be the simplest possible method and may have a greater appeal to the commercial honey producer. For production of queens and of nuclei for sale, the complete change of combs to try to eliminate the disease as quickly as possible should be worth consideration.

Attempts to sterilize combs in the past has been restricted to combs from colonies with American foulbrood. This is rarely done now, largely because the methods are not completely reliable and this may not help to create confidence in the methods described above: but apart from the great resistance of spores of Bacillus larvae to sterilizing agents a few survivors of fumigation are capable of creating a serious infection as effective resistance by bees to American foulbrood is uncommon. This is not so with Nosema (and Amoeba) disease; a diseased colony usually survives and eliminates most of its infection every summer. Therefore even if some combs had a few spores on them which had survived fumigation they would not cause a widespread infection of the colony, if they were introduced during the spring or summer, but would be more likely to be cleaned completely by the bees. Thus the method of treatment, described in this article, greatly assists a natural process.