The removal of capped drone brood: an effective means of reducing the infestation of Varroa in colonies

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Some acaricides used as alternative controls against Varroa, for example formic acid or essential oils, are not always sufficiently effective. We propose as complimentary measures the removal of drone brood or the division of young colonies in spring. These interventions serve to retard the development of Varroa populations, and thus reduce the pressure of infestation. They have the advantage of being able to be carried out at the height of the beekeeping season when recourse to chemotherapy would present serious risks of contamination of the honey harvest.

Why does removal of drone brood influence Varroa population?

The preference of the parasite *Varroa destructor* for the drone larvae in *Apis mellifera* rather than worker larvae, has already been described in 1977 by Grobov. This preference (ratio of Varroa in drone cells : Varroa in worker cells) is calculated to be 8.6 by Schulz (1984), and 8.3 by Fuchs (1990).

Ruttner and his colleagues proposed in 1980 to use this preference of Varroa for cells occupied by drone brood as a vehicle for their own end. Other writers have shown that in their respective locations partial removal of drone brood allowed them to significantly reduce the population of parasites in colonies (Schulz, 1983; Rosenkranz et al, 1985; Fries et al, 1993; Marletto et al, 1991).

Purposes of the Trial

The trial presented in this paper had two objectives:

- evaluate under Swiss conditions the impact of removal of drone brood on populations of Varroa;
- determine whether removal of drone brood is valuable in a control scheme based on autumn treatment with formic acid.

Materials and Methods

This trial was carried out on a production apiary of about twenty colonies of *Apis mellifera* established in Dadant Blatt hives. Formic acid was the only acaricide previously used on this apiary located near Berne. All hives were equipped with a mesh-protected base board over the whole bottom of the hive. We divided the hives into two homogeneous groups on the basis of the natural fall of Varroa in October of the preceding year, which gives a reliable indication of the number of overwintering mites (Imdorf et al, 1990; Moosbeckhofer, 1991) and on the strength of the colonies in spring.

The drone frame

One frame of brood, from which we had removed the lower half of the comb, became the drone frame. One such frame was introduced to the side of the brood nest of each hive in the test group at the end of March. During the whole period of brood rearing we regularly removed the capped

drone brood from this frame by cutting out the capped cells, whenever it exceeded a minimum of 1 sq. dm. (photo 1). Drone brood around the edges of other frames was not removed.

Photo 1: A brood frame from which we have removed the lower part of the comb acts as a drone frame. The frame is placed in the brood nest so that it is quickly build and laid in.

Criteria evaluated

The number of capped drone cells removed from the colonies was determined, and the number of Varroa in this comb was counted. All colonies were managed following the same apicultural practice. The strength of colonies was estimated from mid-March till September using the Liebefeld method (Imdorf et al, 1987) in order to evaluate any impact of the removal of drone brood on population development. Honey production was measured. During the whole period of the trial the natural fall of Varroa was measured once a week, giving an indication of the progress of infestation of the colonies. During August and September we made 2 series of 3 short-term treatments with formic acid, then we checked the efficiency of these treatments by the natural fall in October (Imdorf et al 1995). The trial was carried out in 1993, and repeated in 1994.

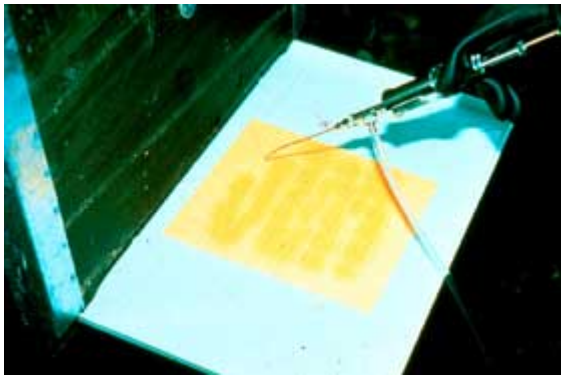


Photo 2: Short-term treatment with formic acid (30 ml of 85%) in the bottom of the hive.

Results obtained for 1993

Effect on Varroa

The year 1993 was marked by an early spring and a good nectar flow which encouraged the raising of drones, and thus permitted the frequent removal of capped drone cells. It was thus possible to take an average of 4.2 cuttings of drone brood per colony (min. 1, max. 6) between 15 April and 15 July.

We removed an average of 3374 capped drone cells per colony carrying 788 Varroa. For these two figures there are important variations per hive (Table 1).

The average natural falls of the test and control groups (graph 1) differed progressively from the month of May. While the fall of Varroa remained low in the hives where we had cut out drone brood, it rose very rapidly in the hives without removal. This increase is an indication that the progress of Varroa populations is to a large extent retarded by the elimination of mites found in the drone brood.

The formic acid treatments in August and September confirmed the effect of the biotechnical measures: the population of Varroa in the test hives at the end of the season were 3.5 times less than in the control hives. In this latter group 5 hives out of 8 showed an infestation greater than 5000 Varroa with a maximum of 12928. Degenerate bees (e.g. deformed wings) were seen in some of the control hives because of the excessive load of parasites.

Effects on the bees

The honey harvest and colony development were not significantly affected by the removal of cells of drone brood. There was no significant difference between the two groups in the total quantities of worker brood raised during the year (test: 140551 cells; control 142852 cells).

Results from 1994

Effects on Varroa

The spring of 1994 was cold and rainy, characterised also by a weak nectar flow, which permitted an average of only 2.3 cuttings of drone brood per colony (min. 1, max. 5) between 3 May and 28 June. We were able to remove 3588 capped drone cells per colony with 434 Varroa (table 2). As in 1993 the natural fall of Varroa in the control group hives rose rapidly from mid-May, while the rise in the test hives did not happen until 6 weeks later, and in a more gradual manner (graph 2).

The controlled treatments with formic acid showed that in spite of the reduced number of cuttings, this biotechnical method had restrained the consequent development of Varroa population. During the formic acid treatments we counted more than double the parasites in the hives without drone brood removal.

Effects on the bees

The unfavourable nectar flow in 1994 did not allow any harvest of honey, and thus made a comparison between the two groups impossible. The colony strength and total number of worker cells raised was not significantly influenced by the removal of drone brood.

Table 1: Results of 1993 trial

Variable	Hive	Number of cuts	Drone cells withdrawn	Varroa in withdrawn drone brood	Natural drop before treat.[a] Varroa/day	Varroa killed by treat. FA	Honey harvest kg
with cutting	168	4	4688	2090	4.7	1159	10.2
	159	5	3925	546	2.0	1610	9.4
	135	6	5069	1876	2.6	1588	8.3
	118	4	3675	898	2.4	1400	9.2
	110	4	601	564	5.3	2696	3.5
	164	1	750	35	6.0	1231	9.8
	101	4	2545	357	0.6	959	0.0
	120	3	2814	550	6.1	1426	6.7
	123	4	5375	223	0.3	526	3.5
	112	6	4301	741	5.0	2714	5.4
	average	4.2	3374	788	3.50	1531	6.6
without cutting	144				31.0	5013	9.0
	130				106.7	12928	9.5
	125				46.4	8163	7.9
	104				75.4	7432	11.8
	143				14.0	1985	2.0
	142				15.9	2580	0.0
	128				8.9	1399	10.7
	145				23.3	6040	10.4
	average	-	-	-	40.20*	5693*	7.7

[a]: Natural drop of Varroa measured in the week before treatment with formic acid.

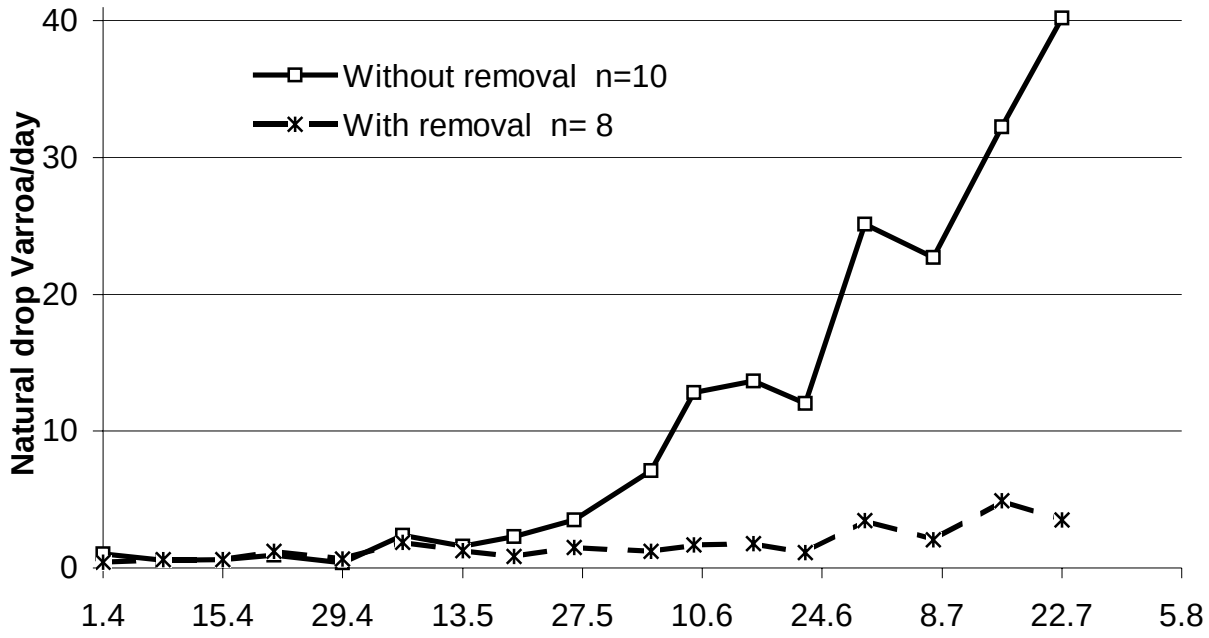
* : the averages of the groups with, and without cutting out of drone brood are statistically different ($p \leq 0.05$)

Table 2: Results of 1994 trial

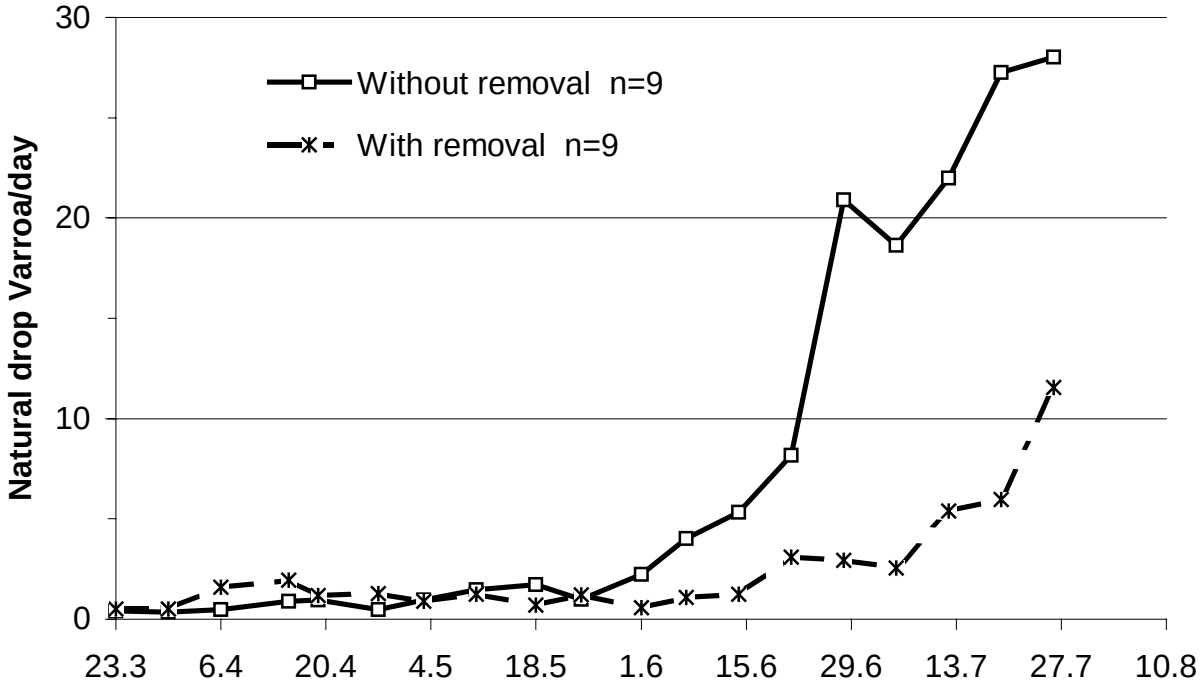
Variable	Hive	Number of cuts	Drone cells withdrawn	Varroa in withdrawn drone brood	Natural drop before treat.[a] Varroa/day	Varroa killed by treat. FA
with cutting	168	2	4563	784	25.0	3637
	135	2	750	291	5.6	950
	118	1	750	149	12.7	2204
	130	2	4312	221	35.7	3707
	164	2	4750	1229	5.3	2422
	101	3	3488	313	3.6	997
	120	2	4188	192	3.1	1476
	123	5	4688	310	3.6	861
	145	2	4800	414	9.3	2581
	average	2.3	3588	434	11.54	2093
without cutting	159				30.4	4062
	110				8.7	2870
	125				12.0	1717
	104				76.3	6461
	124				37.3	6567
	163				18.9	4668
	112				6.4	1714
	127				0.3	1526
	128				61.9	10348
	average	-	-	-	28.02	4437*

[a] and *: see Notes to Table 1.

Graph 1: Effect of the removal of drone brood on the natural drop fall of Varroa in 1993 (average)



Graph 2: Effect of the removal of drone brood on the natural fall of Varroa in 1994 (average)



Discussion

The removal of drone brood removes the pressure of infestation without hindering the colony.

These results show that under our conditions the removal of drone brood is an efficient means of slowing the development of Varroa populations, even when the number of cuttings is reduced. Under our climatic conditions, and in the context of an alternative control programme using only short-term formic acid treatments in autumn, these biotechnical measures are shown to be indispensable in preventing colonies from perishing as early as July. The results are probably the same as for long term treatment with formic acid.

The removal of drone brood as we have described is only one measure of a system, and does not in any case allow the abandonment of other treatments, as has been confirmed by the observations of Rosenkranz (1985), Schultz (1983), and Marletto (1991). Some authors have suggested the introduction of uncapped drone brood in colonies with no other brood with the aim to trap the Varroa (Calis et al, 1997; Schmidt-Bailey et al. 1996). This method is comparatively labour intensive, and even though an efficiency of up 90% can be attained, it does not relieve the beekeeper of using some acaricide treatment.

Colony development

In our trial the removal of drone brood had no negative effect on the development of the colonies.

Allen (1965) claimed that colonies given a frame of drone comb had less drone cells on the edges of the other worker brood frames. The number of drones in our colonies is sufficient to guarantee the fertilisation of queens. An additional advantage is a significant harvest of wax.

Examination of drone brood? Not viable for diagnosis of varroatosis!

Our results showed that it is not possible to calculate the size of the varroa population parasitising a colony simply by examining the infestation rate of drone brood. This is probably influenced in part by the cycles of drone brood production in each colony and in part by the cyclical nature of the infestation of cells by varroa. The parasite load of drone cells was seen to vary from one to six times in the space of a week, without any relation to the actual varroa population. This confirms the observations of Ritter & Ruttner (1980) who also observed the weakness of the infestation of drone brood as a measure of colony infestation.

Will Varroa adapt itself to this biotechnical measure?

The often expressed fear that removal of drone brood will select a residue of Varroa preferring worker brood does not seem to be justified. We should remember that the removal of drone brood occurs only during a short period, and for the rest of the year Varroa is obliged to breed in worker cells. Even during the drone raising season there will always be more varroa in worker cells simply because there is usually ten times more worker brood in a normal colony.

Photo 3: Rendering of drone brood comb in a solar wax melter.

Conclusions:

This trial has shown the efficiency of removal of drone brood in retarding the development of varroa populations. This biotechnical measure allows the deferral of acaricide treatments until the end of summer without damaging infestation of the colony. This method is important for the success of some schemes of alternative control, as for example that which relies exclusively on autumn treatments with formic acid. On its own however the removal of drone brood is insufficient to keep the parasite under control.

Properly planned, the removal of drone brood can be integrated without much increase of work into the normal management of modern apiaries.

What to do in practice?

Three points to note:

- Introduce the drone frame to the colonies sufficiently early (end of March - beginning of April).
- So that it can be quickly build and laid in, the drone frame should never be separated from the brood nest.
- Avoid at all cost the emergence of drones from the drone frame, as this will increase the varroa population. It is suggested that the entire drone comb be cut, or the frame removed, if any visit cannot be made before the emergence of the drones from the capped cells.

To avoid an increase in work, it is necessary to integrate the cutting of drone comb into the normal apiary management for this time of year. Given the normal growth of colonies, swarm control, placing and checking of honey boxes, the removal of drone brood should result in little increase in work.

The drone brood comb can be turned to value by:

- Rendering directly in a steam or solar wax melter (Photo 3)
- Storage in a freezer until rendering at the end of the season
- Disposal of the combs as chicken feed, or near an ant-hill. Chickens or ants will eat the larvae and pupae and the remaining wax can rendered cleanly.

Translation by Peter Kerr, Auckland, New Zealand

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