THE SHORT-COMINGS OF ANTI-VARROA METHODS

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PREFACE

This text describes and often crificises some ways of struggling against Varroa jacobsoni Oudemans, *the parasite menacing the survival of honey bees and thus* also *the food chain. Our best honey collector and least dangerous species for the beekeeper: Apis mellifera mellifera named 'abeille noire' in Europe and 'common western bee' in the USA, is particularly vulnerable to thisparasitism.*
I wish to thank Pierre Bresc, the beekeeper who allowed me to study in his apiary, Professor Michel Bounias who transmitted me much information about the Varroosis and whose comments upon this paper were very useful, Daniel Holender, Régine Kolinsky and Monique Radeau: in order to permit me to work on the field, they gave my lectures on ethology during one year.

INTRODUCTION

Around 1960, the common western bee, a better honey and pollen collector than the Asian species *(Apis mellifera Cerana)*, is imported into China in order to increase the production of these foods on the Asian continent[39,41]. But most hives of these imported bees die because, unlike the Asian bee, the common western one does not defend itself in all efficient against *Varroa jacobsoni Oudemans*, a honey bee mite rather frequent in Asia. The common western bee workers don't remove the varroa females from their sisters'bodies whereas the Asian workers do[15]. The temperature in their hives is nearer to varroa's preference than the temperature in those of the Asian ones[26]. Their haemolymph contains a greater quantity of juvenile hormone, favourable to the parasite's development[15] and they rear relatively more drones *than Apis cerana*. And, the female varroa lays its eggs in the bees' brood cells but prefers those containing male rather than female offspring. The former cells are larger and diffuse pheromones which it likes better[27,54].

For these reasons, *Apis mellifera mellifera* suffers much from the damages caused by varroa to its nests. The male parasite does not directly hurt the bees: it does not eat, fertilises one or more females (disagreement about their number in the literature) and then dies. But the female mite feeds herself with the bees', the drones' and eventually also with the queen's haemolymph, sometimes already during their development in a brood cell and during their adult life. Simultaneously, she injects a substance into the host that could be anaesthetic, anticoagulant and/or digestive[2]. Contaminated in this, way, the bees' life span decreases'*. They emerge mutilated from their brood cell where they have been contaminated (shortened abdomen, deformed wings and underdeveloped hypopharyngial glands: 13). Varroa also exerts indirect disastrous effects. The contaminated insects become more vulnerable to other pathogenic agents as well as to intoxication by pesticides (unfortunately frequently used) and serious alterations of their behaviour may occur. Their 'cluster' formed around the queen during winter are sometimes so agitated that rest becomes impossible. In suchcases the bees remain awake and their queen goes on laying eggs which allows the varroa females to pursue their reproduction and expansion[12,31]. In addition the work in the hive often loses its organisation in a spectacular way and another most surprising change in the bees' behaviour can be observed: they steal the food reserves belonging to neighbouring hives*.

From 1960 onwards, varroa progressively invades several countries more and more distant from each other[3,8,15,57] probably because the international sales of bee swarms and queens progressively also increase and because the hives are transported by their keepers over greater and greater distances. The ecologists fear for the bees' survival, a necessary link of the food chain, their foraging mainly assuring the crossed pollination of numerous plants[18,58]. And, varroa's expansion goes on despite the numerous arms used against this animal. This battle, in the way it is actually engaged, thus seems hopeless.

SHORT-COMINGS AND QUALITIES OF ANTI-VARROA METHODS.

The following text may require one to consult the following table, summarising the development of a worker bee in a brood cell contaminated by a varroa female going through a reproductive cycle.
We shall discuss seven anti-varroa remedies, immediately mentioning that the four first ones (the use of pesticides, the infested bees' exposure to heat that kills varroa from 45°C. onwards, the attempts to attract the parasite into a death trap and the bees' powdering with fine dusts in order to hinder varroa's adhesion on its hosts), all have, besides from their specific limitations, a serious common weakness. They can not possibly influence the numerous parasites in the operculated brood cells of the hive, where their reproduction takes place and where they go on to parasite the larvae and the nymphs of bees and drones which will be contaminated by several varroa females as they emerge and contaminate the other insects in the hive.

Table

Summary of the development of a worker bee and of varroa in moderately favourable conditions for the parasite's reproduction (the varroa mother has chosen a cell containing female* bee brood, lays an egg every 27 hours, the eggs develop within 6,5 days).**

Day and hour	vorker bee	varroa mother	varroa offspring	other events
1	:gg			
2				
3	arva			
4				
5				
6				
7		enters brood cell		operculation
8				
9 0h		lays:	female egg 1	
10 3h	ıymph		male egg 1***	
11 6h			male egg 2	
12 9h			female egg 3	
13 12h			female egg 4	
14 15h			female egg 5	
15				
16 12h			daughter 1 adult	
17 15h			son adult	fertilisation of varroa mother and/or of daughter 1****
18 18h			daughter 2 adult	fertilisation of daughter 2?
19 21h			daughter 3	fertilisation of daughter 3?
20				
21 0h	birth	leaves cell (if not too old)	daughter 4 adult, 4 adult daughters leave the cell.	fertilisation of daughter 4? son dies or did so before****

Legend:
* : in a cell with male bee br ood the varroa fema remains 18 days on a age, instead of 15 for female brooc
** : in optimal conditions 6 e ggs are laid, one every 24h, and they develo 5 days (14),
*** : a single male egg is laid p er cycle (either the fir at or the second one: 15),
**** : according to some author s the male fertilises a single female and then es (15), according to others it may fertilise several females (14).

1. Pesticides.

These treatments present, in addition to the shortcoming just mentioned, other serious inconveniences. Acaricides as well as their residues are dangerous for bees andbeekeepers and they pollute honey and pollen by their deposits in these products. M'Diaye and Bounias[29,30] have proven that Fluvalinate and Amitraze, rather popular pesticides, although often advised[52] and proclaimed harmless[59], do, on the contrary, poison the bees in an alarming way. Their physiological state becomes sub-lethal and incompatible with work demanding great energy. Foraging may thus become impossible and, as a consequence, the decrease or disappearance of their pollination activity may endanger the survival of plants. The effects of two acaricides, Amitraze and Fluvalinate, is biphasic, small doses producing more serious effects than large ones. The toxicity of acaricides has been proven but not their efficiency. The studies dealing with this topic have only shown that their effects on varroa are limited ('at fork): part of the parasites survive because they rapidly become resistant to the pesticide by transforming it biochemically[45,46,47]. The chemists must therefore continuously find new formulae. On the market, the appearances of Folbex (bromopylate in fumigenic paper), Anti-varroa 'Schering' (Amitraze), Périzin 'Bayer', Klartan, Apitol and Apistan (tissues impregnated with Fluvalinate) have rapidly succeeded one another. Several beekeepers deplore their inefficiency like, for example, Jean-Prost[21,22] did for the use of Amitraze. Since pesticides can not influence the numerous varroas in a hive's brood cells, some beekeepers use these chemicals in the absence of insect offspring; during the winter, when in principle, there should be none since the bees and their queen are normally inactive or at moments when they have either removed the brood from the hive or artificially stopped the queen's egg-laying by removing this animal from the hive or by putting it in a small cage within the hive[16]. The first method leads to failure in case of serious infestation for a reason already mentioned: the hive being unable to cluster, their queen goes on laying eggs which allows varroa to pursue its reproduction. The second procedure, at first view more judicious, also presents disadvantages. The separation between the bees and their queen may seriously alter their behaviour. In 'orphan' hives (without a queen), the bees 'weep' and isolated queens behave in the same way. They emit a particular sound that, until proof of the contrary, has never been heard in other circumstances[4,25,56]. In addition, the worker bees may start laying unfertilised eggs engendering an overpopulation of drones, incompatible with an organisation assuring the hive's survival". Finally, this method needs to be combined with other difficult manipulations in order to be efficient in the long term. Without brood cells in a hive, avarroa female is unable to lay eggs. Thus, if the queen's egg-laying is blocked during 15 days (maximum duration of the bees' brood cells' operculation plus one day) there will be no varroa offspring at all in the hive. The use of pesticides at such a moment may thus kill a relatively great number of parasites but we remain with the problems of their toxicity, of their 'fork' efficiency, and with that of a new possible contamination of the colony by the workers susceptible to carry parasites when they return into the hive after foraging. Beekeepers regularly transport their hives to good foraging sites, which are over congested with other hives. Therefore foragers from contaminated and from uninfested hives may visit the same flowers and this may allow a varroa female to 'jump' onto a clean host (as it frequently does, attracted by pheromones it prefers and by the electrical-magnetically charges carried by bees: 43). Thereafter, she may then travel with its new host to a previously varroa-less hive. But, varroa's development being about three times faster than that of bees[14,15,see also table], such an arrival, even of a single non-fertilised female can rapidly contaminate the whole hive (this female may lay an unfertilised egg which will develop into a male that will fertilise her and permit her then to give birth to females: 46). In order to avoid these contaminations, a beekeeper should thus treat all his hives with pesticides within a time interval as short as possible and avoid to place them within the proximity of another beekeeper's hives at a distance that is greater than that of the bees' longest possible travelling capacity. But, if necessary, these insects may forage flowers at (at least) 10 km away from their hive[54, 55].

2. 'Thermotreatment'.
Heller[20], Khmara[24], Pätzold & Ritter[38] as well as Stell[48] tried to eliminate varroa by exposing the contaminated bees to heat. The temperature lethal for the parasite being above that at which the wax cells of the bees melt (45°C.), the procedure is laborious. The beekeeper must drive all the insects from a contaminated hive and lead them into an enclosure heated at 47°C during 10 minutes[20]. Thismethod only relieves the bees and the drones of the pests for a short while. Once back in the hive they may rapidly be contaminated again by newly emerged insects invaded by (usually several) parasites (see table).

3. Attractive traps for varroa.
Some researchers tried to manipulate varroa by attracting the females into a trap containing bees' (preferentially male) crushed brood, diffusing pheromones they like[54]. The procedure is of course time consuming and difficult to cover with a beekeeper's numerous tasks. In addition, I ignore whether this method has been tested on the field or only in the laboratory where, often, a remedy is easier to apply and more efficient than in natural conditions. Scientists can more easily than beekeepers control important variables for a hive's survival.

4. Fine dusts on the bees.
Ramirez[42] tried to clear varroa from its hosts by dusting the bees with several kinds of powders (glucose, a crushed pollen substitute, flour, talc, etc.) in order to render the varroa female's cuppings*, one of its means for adhering onto its host, inefficient. He reports good results for the use of this remedy in laboratory conditions. Glucose was, after some hours, successful in all cases: no more varroas on any of the treated bees. The other powders were slightly less powerful (success varying from 87 to 97%). But we may legitimately question the long term benefits of the procedure. It would be normal that a bee full of dust, will soon start energetic self-grooming. The possibility that this activity causes varroa to leave its host for a short while only, remains open. Finally, powdering bees with dust (including talc!) does not seem too safe for their respiratory system.

5. Anti-varroa ('Schmidt'Schen') frames.
This procedure[23] aims at shortening the workers' and the drones' development in order to shorten the time during which varroa's reproduction can go on. The beekeepers replace thenormal frames in the hive by others with enlarged cells. The queen always lays female eggs in the numerous small and male eggs in the relatively few large cells of a normal frame but, when only the enlarged cells are available, a change in this behaviour occurs. The queen nevertheless lays a majority of female eggs in the anti-varroa frames. Since the worker bees provide these cells with more food than the small cells of a normal frame, the female larvaes' and nymphs' maturation is accelerated: it lasts in between seventeen and nineteen days instead of twenty one under normal circumstances. The users of these frames thought that this would stop varroa's reproduction, probably because they were unaware of the progress realised by studying the parasite's development[14]. But, when consulting the table above, it is obvious that worker nymphs aged between seventeen and nineteen days can already be contaminated by one or more females among which at least one is fertilised. We thus can, unfortunately, only conclude that, in a hive with anti-varroa frames, the varroa female gives birth to less offspring than in a normal one.

6. Hybridisation or selective breeding.
Some beekeepers cultivate hybrids from two sub-species among which one is more resistant to varroa than the other, or selective breeding of bees possessing a defence against the parasite. For example, Trégarot[50,51] crossed the black and the Asian bees, hoping that their hybrids would inherit the Asian superiority. Guth[19] systematically selected bee populations practising the shortest possible operculation time of their brood cells. Some remarks are necessary. Firstly, misunderstanding the forager bees' dances indicating a foraging source is likely to occur in a hive where hybridisation is practised because all different (sub)species dance in, at least slightly, different ways[28,55]. This of course will hinder the organisation of the colony's work. Secondly, a hybrid is not necessarily superior to its parents, the contrary may happen (some hybrids are less well adapted for surviving than each of their two parents). Finally, I am afraid that selecting bees for a short operculation time will not help more than the use of an anti-varroa frame. A varroa female may, in good conditions (cf. legend of table above) have adult offspring on the fifth day following its cell's operculation. It will of course be impossible to cultivate by selective breeding, a population of bees operculating their brood cells during an even shorter period.

7. Feeding contaminated bees with organic cupric salts.
An anti-varroa method, much more subtle than all the other ones, has been designed and tested (in the laboratory and on the field) by Popeskovic and Bounias[17,37,40]. Appropriate doses of copper sulphate or, even better, of copper gluconate are added to the hive's food. A varroa absorbing the haemolymph of a bee or a drone nourished in this way, is asphyxiated within some days. Indeed, varroa's respirationis assured by external membranes (peritremes) and by particular cells (haemocyanins) transporting the oxygen to its whole organism. Copper salts 'block' these cell's activity and are harmless for the bees because their respiration is assured by a tracheal system. The toxicity of copper sulphate is virtually absent for bees provided that their diet is sufficiently rich in pollen. If not, they will suffer from a slight excess of sugar in their haemolymph[5,6,7,34,35]. Bees fed with copper gluconate apparently do not suffer at all, they are, on the contrary, in a physiological state of 'hormesis'[33], favourmg longevity and protecting against intoxication by Amitraze, Fluvalinate and probably alsoby other pesticides[7,36,37].

Good results are obtained with this method in cases of low or moderate contamination of a hive by varroa. Unfortunately the procedure becomes inefficient when there is acute parasitism[37]. Copper sulphate and gluconate kill varroa within some days (five on average) but such a time lapse still allows a certain proportion of their females to lay eggs (at least one: see table).Therefore the treatment can not exercise a 'choc' effect. When the parasites are too numerous in a hive, they reproduce themselves more rapidly than the chemicals' effects they endure. Nevertheless' the bees treatment with copper gluconate is, even in such cases, advisable because it helps them overcoming intoxication by pesticides[37].

Popeskovic and Bounias' method has been criticised by some researchers who say that varroa possesses a 'differentiated' tracheal system, that such an equipment is incompatible with the presence of haemocyanines in its haemolymph and questions the usefulness of the bees' treatment with copper salts. Varroa tracheal system is composed by five anterior and four posterior ramifications in junction with each other at three levels[43,44]. At present, we completely ignore whether this system can or can not oxygenate varroa's organism entirely, lacking physiological data on this point. But, it is certain that, without the presence of haemocyanines in the parasite's haemolymph, it becomes impossible to explain the success of Popeskovic and Bounias' remedy in cases of low and moderate contamination of a hive. The criticism is thus at least partly unjustified.

CONCLUSION

The struggle against varroa, as actually engaged, is useless. Varroasis is now a 'quasi' universal ('mondial'?) problem, which is not surprising. Feeding the bees with copper gluconate is the only non-polluting and possible remedy available to the beekeeper for fighting against the parasite. But this method is only successful when the hives are not too seriously contaminated. What then should be done in case of intense parasitism? Some (if not most) beekeepers, I assume, will use pesticides. They may benefit from an amelioration: protect their bees against poisoning by these chemicals by simultaneously adding copper gluconate to their food. Nevertheless, this does not rule out other undesirable consequences: the pollution of the environment , the 'fork' efficiency of the pesticides and the danger of new contamination of the hive by newly emerged bees and drones and by returning foragers. For these reasons, the creation of new remedies is essential. But this will imply some changes in our research strategy. I proposed the following ones in an article not yet published. Firstly, we should not systematically try to kill varroa in order to learn more about its behaviour and particularly about its communication. Such studies are now feasible. Researchers design and progressively ameliorate an artificial feeding system: a membrane through which the female varroa accepts to absorb an artificial haemolymph[9,10,11]. At the same time, the attempts to rear the parasite in laboratory conditions are progressing[1,32]. The knowledge of an animal's way of communicating may allow us to interact with that animal without polluting the environment (for example, by exposing it to the alarm signal of its species, we may cause it to flee). Secondly, such remedies should be used preventively (before the parasites invade the hive and particularly its brood cells). Finally, research in this field needs collaboration between beekeepers and scientists. Beekeepers possess important knowledge with regard to the problem of Varroasis, often transmitted without texts and on the other hand, scientists obtain equally important data which are not always transmitted in a way that is accessible to beekeepers. ■

*Ventouses in French: organs exerting a sucking or pumping action; in varroa's case they, in addition, secrete a kind of glue favouring even more its adhesion onto the host.

REFERENCES

Abbas N.D. & Engels W. (1989). Rearing of varroa in artificial cells on drones. Present status of Varroatosis in Europe and progress in the varroa mite control. *Proc. Meet. EC Experts'* Group, Udine 1988,R Cavalloro (ed.), C.E.C., Luxembourg, 223-228.

Akimov LA. & Gorgol V.T. (1988). Glandes salivaires et excretrices de la femelle Varroa. *L'Abeille de France,* 727,212.

Arnold G. & Le ConteA.V. (1989). Abeilles en peril? La lutte s'organise. LA *Recherche,* 209, 546-548.

Berland L. & Bernard F. (1949). Ordre des Hymenopteres, Hymenoptera Linné, 1758. P.P. Grassé (ed.) *Traité de Zoologie* Masson. Paris, 771–831.

Bounias M., Andre J.F. & Kruk I. (1993). Synergistic and molecular interactions between the formamidine Amitraz and copper (II) sulphate, used against the mite *Varroa Jacobsoni* O., a parasite of the honeybee *Apis mellifera L.. Biometals,* 6, 49–53.

Bounias M., Andre J.F., Nectoux M. & Popeskovic D.S. (1994). *Vurroa jacobsoni* control by feeding honey bees with organic cupric salts, *Bee Science,* 3, 111–119.

Bounias M., Navone-Nectoux M. & Popeskovic D.S. (1995). Toxicology of Cupric salts in Honeybees, I. Horrnesis Effects of Organic Derivatives oil Lethality parameters. *Ecotoxicology and* Environmental *Safety,* 31, 127-132.

8 Bresc P. (1989-1995). Communications personnelles.

9 Bruce W.A. & Chiesa F. (1988a). An artificial diet for *Varroa jacobsoni. Africanized honey bees and bee mites.* G.R. Needham, R.E. Page, M. Delfinado-Baker, C.E. Bowman(eds), Ellis Horwood Ltd., Chichester, 487–492.

10 Bruce W.A. & Chiesa F. (1988b). An artificial diet for *Varroa jacobsoni Oudemans (Acari: Varroïdae).* European Research on Varroatosis control, *Proc. Meet. EC Experts'* Group, *Bad Homburg 1986.* R. Cavalloro (ed.), Balkema, Rotterdam, 125–127.

11 Bruce W.A., Henegar R.B. & Hackett K.J. (1991). An artificial membrane for *in vitro* feeding of *Varroa* jacobsoniand *Acaparis woodi,* mite parasites of honey bees. Apidologie, 22, 503–507.

12 Colin M.E. (1988). Pouvoir pathogène de *Varroa jacobsoni. L'Abeille de France, 732,487.*

13 Dejong D., Morse R.A. & Eickwort G. C. (1982). Mite pests of honeybees. *Annual Review of Entomology* 27, 229–252.

14 Donzé G. (1989). L'étude de la reproduction de varroa à Liebefeld. *L'Abeille de France,* 739, 279-282.

15 Faucon J.P. & Flèche-Seban C.(1988). La Varroatose. L'Abeille de France, 729, 338–348.

16 Goetz C. & Goetz L. (1985). Le blocage de la ponte, un espoir. *Revue Française d'Apiculture,* 437, 15-18.

17 Guiraud G., Nectoux M., Andre J.F., Bounias M. & Popeskovic D. (1989). Evaluation of cupric sulphate as an acaricide against *Varroa jacobsoni. Journal of Apicultural Research,* 28, 4, 201-207.

18 Gordon E. (1987). Varroa, fléau des ruches. *Le Monde,* 18 février, 17.

19 Guth J. (1989). Abeille à tolerance Varroa. *supplement à L'Abeille de France et l'Apiculteur,* 742, 14–15.

20 Heller J.P. (1989). Therrnotraitement. *L'Abeille de France, 738,232.*

21 Jean-Prost P. (1987a). Invasion d'un rucher. *Revue Franpise d'Apiculture,* 464, 290–291.

22 Jean-Prost P. (1987b). Le traitement. Revue Française d'Apiculture, 465, 348–349.

23 Jedar M. (1987). 'Schmidt'Schen' et *Varroa jacobsoni Oudemans. L'Abeille de France,* 712, (dossier), 48.

24 Khmara P. (1988). La vitalité des abeilles et des acariens *Varroa jacobsoni Oudemans* durant le traitement thermique. *L'Abeille de France,* 725,102.

25 Kosttrzewa Z., Chuda-Mickiewicz B. & Prabucki J. (1981). L'analysespectrale dusignil acoustique émis par une colonie d'abeilles. Rapport de l'Université de Moscou, 258, (6) 134-138.

26 Le Conte Y. & Arnold G. (1988). Etude du thermopreferendum de *Varroa jacobsoni Oud. Apidologie 19,* (2), 155-164.

27 Le Conte Y. &Arnold G. (1989). Comment les

Varroas détectent les larves d'abeilles. L'Abeille de France, **738, 221–222.**
[28] Lindauer M. (1971). *Communication* among *social bees.* Harvard University Press, Harvard.
[29] M'Diaye K. & Bounias M. (1991). Sublethal effects of the Formamidine Amitraz on Honeybees' Gut Lipids, following *in vivo Injections. Biomedical and Environmental Sciences* **4, 376–383.**
[30] M'Diaye K. & Bounias M. (1993). Time and Dose-related Effects of the Pyrethroid Fluvalinate on Haemolymph Carbohydrates and Gut Lipids of Honeybees, Following in *vivo* Injection of very low Doses. *Biomedical and Environmental Sciences,* **6, 145–153.**
[31] Muller M. (1987). Le développement de l'acarien *Varroa jawbsoni Oudemans* durant les mois d'hiver. L' Abeille de France, **717, 287.**
[32] Nazzi F. & Milani N. (1994). A technique for thereproductionof *Varroa jacobsoni Oud.* under laboratory conditions. *Apidologie,* **25, 579–584.**
[33] Neafsy P.J., Boxenbaum H., Ciraulo D.J. & Foumier D.J. (1988). A Gompertz age-specific mortality rate model of ageing, hormesis & toxicity: fixed-dose studies. *Drug Metabolism Reviews,* 19 **(3&4), 369–410.**
[34] Nectoux M., André J.F., Guiraud G., Bounias M. & Popeskovic D. (1988). Bilan expérimental des potentialités toxiques du sulfate de cuivre dans la lutte contre la Varroatose de l'abeille. Comptes rendus de la Société de Biologie **162, 466–477.**
[35] Nectoux M., Bounias M. & Popeskovic D. (1994). Toxicology of cupric salts to honey-bees. II. Feeding behavior for different organic salts and comparative toxikinetics of dietary gluconate and sulphate. *Acta Veterinaria,* **44, 5–6, 255–270.**
[36] Nectoux M., Bounias M. & Popeskovic D. (1995a). Toxicology of cupric salts to honey-bees. III. Action of *in vivo* gluconate injections on haemolymph carbohydrates and gut lipids. *Journal of Environmental Biology,* **16, 3, 243–252.**
[37] Nectoux M., Bounias M. & Popeskovic D. (1995b). Toxicology of cupric salts to honey-bees. IV. Gluconate and Sulfate Action on Haemolymph Threhalose Activity In Vivo and in Vitro, *Journal of Biochemical Toxicology.* **10, 2, 79–86.**
[38] Pätzold S. & Ritter W. (1989). Studies on the behaviour of the honey-bee mite, *Varroa jacobsoni Oudemans,* in a temperaturegradient. Journal of applied Entomology **107, 46–52.**
[39] Popa A. (1985). Un acarien nommé varroa. *Revue Française d'Apiculture,* **439, 143–146.**
[40] Popeskovic D.S. & Bounias M. (1986). Le blocage du fonctionnement des hémocyanines de l'acarien Varroa jacobsoni comme base physiologique spécifique d'un traitement par voie systémique de la Varroatose de l'abeille. *Comptes rendus de la Société de Biologie 180,* **662–668.**
[41] Poudou J. H. (1987). Un paradisperdu. Revue Française d'Apiculture, **463, 253-254.**
[42] Peut-on lutter contre Varroa avec de la "poussière"? supplement à *L'Abeille de France,* **742, 11-13.**
[43] Richard D. (1989). Capacités perceptives de *Varroa jacobsoni. Rapport Scientifique,* Toulouse.
[44] Richard D., Colin, M. E. & Lhomme M. (1990). Anatomical organisation of the tracheal system of *Varroa jacobsoni Oudemans. Journal of applied Acarology,* **9, 63–72.**
[45] Robaux P. (1986). Varroase: infestation: leseuilcritique. Revue Française d'Apiculture **453, 308–309.**
[46] Robaux P. (1988a). La lutte contre *Varroa jacobsoni Oudemans:* son avenir. *Revue Franpise d'Apiculture,* **471, 78.**
[47] Robaux P. (1988b). Résistances accoutumances: l'autre danger qui menace l'apiculture face à *Varroa. L'Abeille de France,* **727, 232–233.**
[48] Stell R. (1988). Varroase: méthodes thermiques, contrôle de la temperature. *Revue Française d'Apiculture* **471, 78.**
[49] Tonelli S. (1988). Traitement par les méthodes naturelles en ltalie. *L'Abeille de France. 733.532-533.*
[50] Trégarot E. (1989a). Possibilités de contrôler la Varroase par des moyens naturels. *L'Abeille de France,* **734, 25–26.**
[51] Trégarot E. (1989b) Sélection et élevage d'abeilles résistantes à la Varroase. *L'Abeille de France,* **739, 276–277.**
[52] Tricoire J. (1996). Communiqué de SWARM aux apiculteurs belges. *La Belgique apicole,* **2, 49.**
[53] Tursch B. (1987). Varroase: une méthode de lutte conçue en Belgique. L'Abeille de France, **712, 50–53.**
[54] von Frisch K. *(1956 & 1989). Vie et moeurs de abeilles.* Albin Michel, Paris, 220 pp.
[55] von Frisch K. (1962). Dialects in the language of the bees. *Scientific American,* August, 1-5.
[56] Wenner A. (1964). Sound communication in honeybees. *Scientific American,* April, 24-31.

ANONYMOUS PUBLICATIONS
[57] (1988). Des Acariens varroa trouvés aux USA, (Revue de *'The American Bee',* 1987.11, L'Abeille de France. **723, 5.**
[58] (1988). Sans les abeilles. *L'Abeille de France,* **732, 473–474.**
[59] (1989). Anti-tique. Échos de l'Industrie, novembre.

HAPPY

HIVE

SALTS@

MAKE THE MITE FEEL BLUE

***Feeding organic cupric salts in the spring and autumn as directed every year will result in a happy hive and very low levels of mite infestation.**
If a hive should become neglected for whatever reason, or a beekeeper takes charge of a hive severely infested with varroa(several thousand mites/deformed bees seen 30 or more natural mite falls a week during the season) then the hive should be fed two doses of the salts a month apart any time during the season April to October.
***Treat every hive in the apiary twice a year as directed even if mite levels are very low, as reinvasion (particularly in the autumn) is a serious problem.**
****Happy Hive Salts* are ideal for feeding to swarms at the time they are hived.**
***What a beekeeper puts into a hive matters as far as the pure image of honey is concerned with the public and for the well-being of the bees.*Happy Hive Salts* are the only tratment for varroa that fulfils both criteria.**

FACTS

***Bees prefer syrup with salts than without.**
***Efficiency is not brood dependent& works in sealed brood and on the bee.**
***Salts continue working over several months.**
***Salts are not toxic to bees even at high doses.**
***Salts have a hormetic effect on bees.**
***Mite numbers never rise above very low levels.**
***Treatment has a stimulating effect on hive strength.**
***Salts are not toxic to people,mammals need copper.**
***Salts protect bees against poisoning from pesticides.**
Varroa is asphyxiated,and cannot become resistant to *Happy Hive Salts.
***Honey crops are larger when using salts.**
***Fits simply into the beekeepers feeding programme.**

***Make up a very thin syrup and add *Happy* Hive *Salts* (appros quater teaspoon per pint of syrup) and use in a garden plant hand sprayer. Use in place of the smoker, spray on the bees and frames all season !**