# IMPACT OF *VARROA DESTRUCTOR* ON THE HONEYBEES OF SOUTH AFRICA

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***Abstract***

*The destructive mite* Varroa destructor *was first found in the Cape region of South Africa by P. KRYGER in August 1997. By 2000 it had spread from the Cape region occupied by* Apis mellifera capensis *bees to the highveld regions around Pretoria and southern end of the Kruger National Park, both regions occupied by* A.m. scutellata *bees. There has been much speculation about the impact of* Varroa *in South Africa for two reasons:*

*1.) It has been shown that the rapid development of the sealed brood phase of* A.m. capensis *may severely affect the ability of the mite to produce viable offspring.*

*2.) Africanised bees, a hybrid of African bee's* A.m. scutellata *(Pretoria region) and European bees, are naturally tolerant to* Varroa *in South and Central America. Therefore, it was hoped that the African bees would show a similar natural tolerance towards the mite.*

*Initially there were reports of honeybee colonies in South Africa that were apparently healthy despite harbouring tens of thousands of mites (M. ALLSOPP, pers. com.). Therefore, we compared the reproductive ability of mites invading sealed brood cells of* A.m. scutellata *with previous studies carried out on both Africanised and European bees. We showed that* Varroa *was able to reproduce at similar levels to those found in European bees which explained the huge mite populations previously reported. We also reviewed the developmental time of the* A.m. capensis *bee. We found that although they do process one of the shortest sealed brood developmental times found among* A. mellifera *races it is sufficient for* Varroa *populations to increase within these colonies. This finding was confirmed by some direct observations of the number of mature females emerging from cells occupied by* A.m. capensis *workers.*

*It is proposed that the initial ability of the colonies to survive with large mite populations is due to the natural rarity of the overt form of key bee viruses such as deformed wing virus which is transmitted by the mite and leads to the collapse of the colony. Thus, it is predicted that once the viruses become established within the* Varroa *infested colonies, the wide spread bee losses that have occurred in many countries will occur in South Africa.*

## Introduction

The ectoparasitic mite *Varroa destructor* Anderson is the most destructive pest of the honeybee *Apis mellifera* of recent times. Despite the occurrence of many races of *A. mellifera*, there is only one clear case where a race has exhibited a natural tolerance towards the mite *V. destructor*. This is the Africanised bee (AHB), the infamous "killer bee", which is a hybrid of the African bee *A.m. scutellata* from South Africa and *A. mellifera* from Europe (MORITZ, 1994). The AHB is now found throughout South and Central America and several studies (De JONG, 1996; VANDAME, 1996; MEDINA and MARTIN, 1999) have shown that *Varroa* infested colonies can survive without any form of control. However, the underlying mechanism of tolerance is still not understood. The only other honeybee race which is suspected to be tolerant towards *V. destructor* is *A.m. capensis* since this race has a shorter sealed brood development time than most other races (MORITZ and HANEL, 1984). As both *A.m. scutellata* and *A.m. capensis* are found in South Africa, the impact of *Varroa* on the South African bee population is of great interest and is hotly debated by both scientists and beekeepers.

In February 1997, *V. destructor* was found at the Cape of Good Hope region of South Africa by P. KRYGER and R.F.A. MORITZ and was later confirmed to be well established throughout the area (ALLSOPP et al., 1997, ALLSOPP, 1998). Accidentally assisted by beekeepers, by 2000 the mite had spread from the Cape region occupied by *A.m. capensis* to the highveld regions around Pretoria occupied by *A.m. scutellata*. Recently, it has reached the southern edge of the Kruger National Park (MARTIN, 2001a). Therefore, it was possible to conduct a comparative study of the reproduction of *Varroa* in the South African races of honeybees with studies previous conducted on European and AHB.

## Materials and Methods

The study was conducted during October 2000 in the Pretoria region of South Africa. All *A.m. scutellata* colonies studied had become naturally infested with *V. destructor* during the past year. In addition, several *Varroa* infested *A.m. scutellata* colonies which had been invaded by *A. m. capensis* workers were obtained from a local beekeeper.

The duration time of the worker sealed brood stage of the two races of honeybee were determined by measuring the time of cell sealing and brood emergence by recording the positions and times on transparent sheets. One day prior to bee emergence the sealed brood was placed in an incubator held at 35$^{o}$C. A light metal mesh placed over the comb allowed the bees to remove the cell cap but not to emerge.

Frames of worker and, where found, drone sealed brood were removed from several colonies and individual cells carefully opened. If mites were present they were removed and their sex and developmental

stage determined. In addition all female deutonymphs were classified into five size groups using the photographs in IFANTIDIS (1983). This allowed each mite family to be reconstructed (MARTIN, 1995a) and the birth order and mortality rates of each offspring to be determined. The race, sex and developmental stage of the host honeybee were also recorded. The data obtained from the worker and drone cells of *A.m. scutellata* were compared with data for AHB (MEDINA and MARTIN, 1999) and European (EHB) bees (MARTIN, 1994 and 1995b). Only data collected from mites occupying cells sealed for 230 h (grey pads stage) or longer were analysed further. This reduces the errors that arise estimating the number of mite offspring which will be viable at the time of bee emergence.

The data obtained from this and previous studies were used in a simulation model (MARTIN, 2001b) which was been designed to investigate the interactions between *Varroa*, various bee pathogens and different races of honeybees. This allowed a visual comparison of the growth of *Varroa* populations in different races of honeybees. The effects of all viral pathogens where excluded from the simulations.

## Results

### *Duration time of worker sealed brood stage*

The mean duration time of the *A.m. capensis* worker sealed brood stage was (255±S.D., 9 h, n=17) which is similar to that in *A.m. capensis* workers (264 h, MORITZ and JORDAN, 1992; 260h, CALIS et al., 1996) but which is much shorter than those of both *A.m. scutellata* (281±S.D., 9 h, n=30), AHB (275 h, ROSEN-KRANZ and ENGELS, 1994; 278 h, VANDAME, 1996) and EHB workers (282 h, MARTIN, 1994; 284 h CALIS et al., 1996).

### Varroa *reproduction*

A total of 188 and 87 mite families were reconstructed from 1000 *A.m. scutellata* and 1700 cells containing the *A.m. capensis* workers respectively. In addition, 98 mite families from 265 *A. m. scutellata* drone cells were reconstructed.

The mean number of eggs laid by the mothers in worker cells (only cells capped longer than 200 h and containing three or more eggs were used) was 4.5±0.7 (n=68) in *A.m. scutellata* compared to 3.9±0.7 (n=27) in *A.m. capensis* and 4.9±1.0 (n=45) in *A.m. scutellata* drone cells.

Table 1 compares the reproductivity of the mother mites in this study with that found in previous studies. The mites' ability to reproduce successfully is as follows: *A.m. scutellata* drone = EHB drone >> *A.m. scutellata* worker = EHB worker>AHB worker. This indicates that the mites are able to reproduce within *A.m. scutellata* colonies at a similar level to that found in EHB (Table 1) and that the tolerance shown by AHB towards the mites (MEDINA and MARTIN, 1999) is lacking in the African bees. The data from the *A.m. capensis* worker cells are considered elsewhere (MARTIN and KRYGER, 2001) since the number of viable females produced by *Varroa* appears to be greatly affected by the mismatch in cell size which does not occur in natural *A.m. capensis* colonies.

*Table 1*

**Reproductive fate (%) of *V. destructor* invading brood cells from this (bold) and previous studies along with number of mature and viable (fertilized) females produced per invading mother mite**

| | Worker cells | | | Drone cells | |
|---|---|---|---|---|---|
| | ***A.m. scutellata*** | Africanised bees[1] | European bees[2] | ***A.m. scutellata*** | European bees[3] |
| Mother dead | **6** | 2.0 | 2 | **6** | 5 |
| Viable offspring | **51** | 43 | 63 | **59** | 63 |
| Non viable due to male death | **11** | 19 | 12 | **9** | 10 |
| Non viable due to other causes | **4** | 13 | 4 | **4** | 5 |
| Only male | **15** | 11 | 9 | **20** | 14 |
| No offspring | **13** | 12 | 10 | **2** | 3 |
| | | | | | |
| Mature females | **1.0** | 0.9 | 1.0 | **2.5** | 2-2.2 |
| Viable females | **0.9** | 0.7 | 0.9 | **2.2** | 1.9-2.1 |

*[1]MEDINA and MARTIN, 1999; [2]Recalculated from MARTIN; [3]MARTIN, 1995b.*

The relative growth of *Varroa* populations in four races of honeybees (*A.m. scutellata, A.m. capensis*, EHB, AHB) were compared using the simulation model (MARTIN 2001b). All variables such as colony size etc. were standardized for each run. Only the duration of the sealed brood stage, number of viable *Varroa* females produced in worker and drone cells and the percentage of *Varroa* mothers dying prior to egg laying were varied. For *A.m. capensis* the mite data was assumed to be similar to those of *A.m. scutellata* so

only the duration of the sealed brood was varied. Figure 1 confirms that mite populations in *A.m. scutellata* and EHB colonies

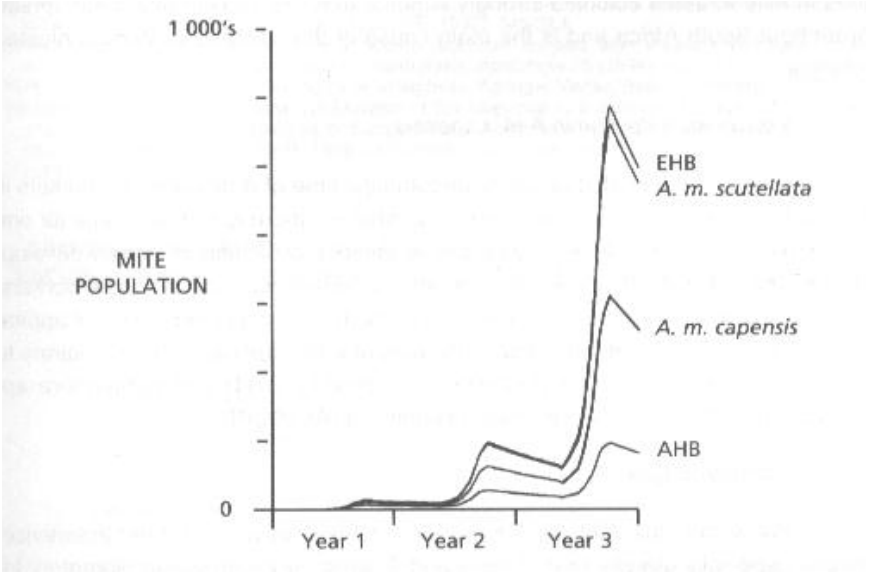


*Figure 1 – Model comparing population relative growth of* Varroa *in four different races of honeybee (EHB=European,* A.m. scutellata, A.m. capensis, *AHB=Africanised) using variations in the development time of the bee and the number of viable* Varroa *females produced*

increase at similar rates and even the very short worker development period of *A.m. capensis* cannot prevent the growth of the mite population. However, AHB, with a similar developmental time to EHB and *A.m. scutellata* bees has by far the lowest rate of mite increase which is due to the low number of viable *Varroa* females being produced in worker cells (Table 1).

**Discussion**

Varroa *reproduction in* A.m. scutellata

The ability of *V. destructor* to produce viable female offspring within both worker and drone cells of *A.m. scutellata* was similar or enhanced relative to that in EHB, especially as the period brood is present in races of African bees is longer than found in EHB. This explains the tens of thousands of mites present in South Africa honeybee colonies (ALLSOPP, 1988; ALLSOPP et al., 1999; personal communication). The initial apparent healthy condition of these colonies despite large mite populations is probably due to the absence of the overt form of key bee viruses, especially deformed wing virus, which when transmitted by the mite causes the colony to collapse (MARTIN, 2001b). Prior to the arrival of *Varroa* deformed wing virus has been found in honeybees from South Africa, (B. BALL, personal communication), and the presence of large numbers of deformed bees in mite infested colonies strongly suggest that this virus is now wide spread throughout South Africa and is the main cause of the collapse of *Varroa* infested colonies.

Varroa *reproduction in* A.m. capensis

Although the sealed brood developmental time of *A.m. capensis* workers is the shortest of any race of *A. mellifera* so far studied, there is sufficient time for one and sometimes two viable females mites to emerge according to *Varroa* developmental charts (MARTIN, 1994). This prediction containing *A.m. capensis* workers, which were ready to emerge. Therefore, the shorter capping time does not appear to prevent the success of the mites in colonies of *A.m. capensis*. This is contrary to what was previously thought (MORITZ and HANEL, 1984) and furthermore appears to be confirmed by recent field observations (ALLSOPP, 2000).

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