



# The Varroa mite –

a deadly and dangerous bee parasite



  
bee care

# Honey bees – Small insects, big impact

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### Infection

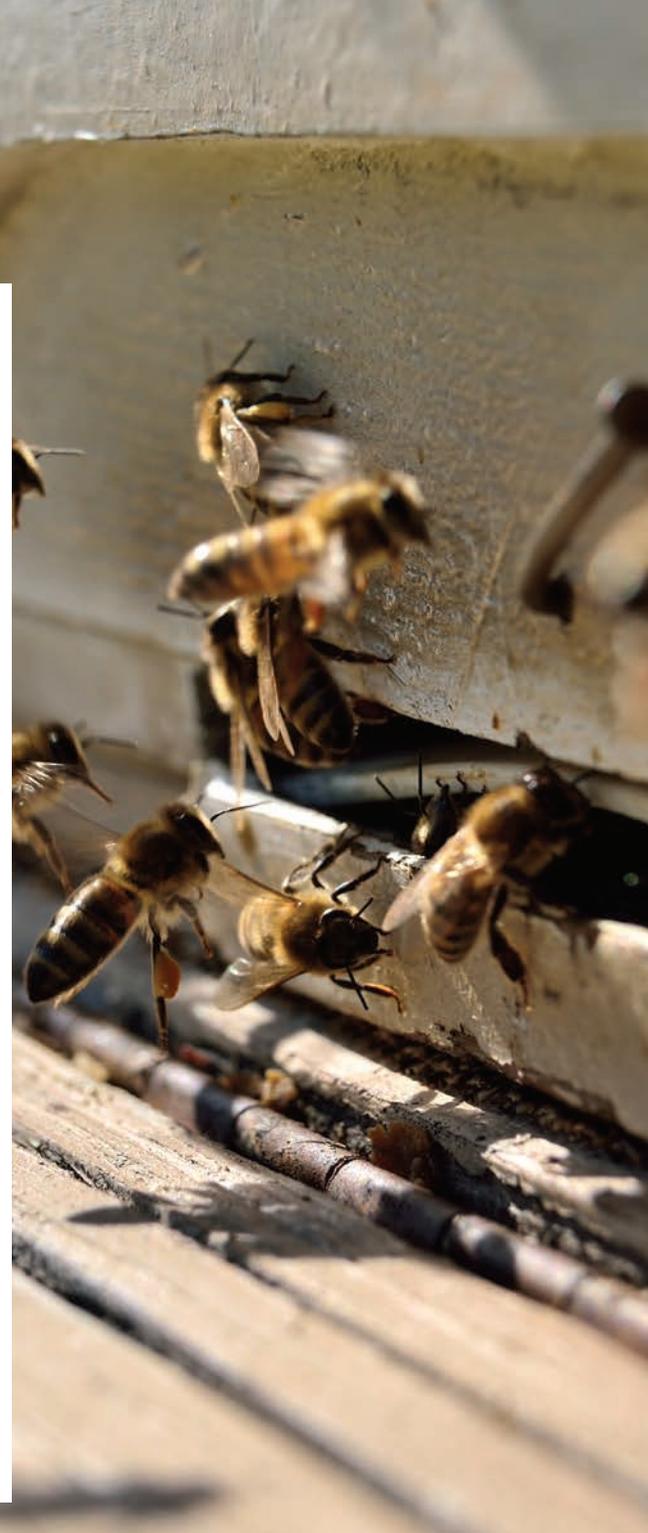
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Big tasks for little insects: the work done by honey bees is of great importance to humans. The honey bee is essential for pollination of a wide number of crop plants, making them an important part of food production. A large proportion of our food is produced, to some extent, with the help of bee and other insect pollination. That is why protecting and improving the health of bees is so important.

Although the number of honey bee colonies has grown across the world in the past 50 years, poor bee health has reached alarming levels in some regions of the world. One of the main causes, and one of the honey bee's worst enemies, is a tiny mite called ***Varroa destructor***. There are currently only a few ways to protect bees from the mite. Using the few effective control products and measures available, combined with good beekeeping management practices, it is possible to reduce the impact of *Varroa* and keep the impact of this parasite in check.



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**We hope this material may be useful for your *Varroa* training courses.**



# Varroosis: the infestation of bee colonies



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Right:  
Varroa mites at various  
development stages in a  
bee colony brood comb

Left:  
Varroa mite attached to adult  
bee showing symptoms of  
deformed wing virus (DWV)



It is small and yet highly dangerous: the *Varroa destructor* mite is the most destructive enemy of the Western honey bee (*Apis mellifera*). The parasite has now spread to almost all parts of the world – except for Australia. Mite infestation has hit Europe and North America particularly hard, and the parasite is a serious threat to bee health. Without human intervention, a bee colony infested with mites will typically die off in these regions within three years.

In addition to the threat posed by the *Varroa* mite itself, there is also the danger of secondary infection from various mite-vectored diseases, which have also become more widespread and additionally weaken the bee colonies. The parasitic *Varroa* mites – much like ticks – transmit diseases that often prove fatal to adult honey bees and their brood.

Combating the mite is a difficult task for researchers. This is because – despite a number of promising ideas – they have not yet managed to develop simple and long-lasting treatments for fighting the bee parasite, nor have they yet managed to breed a *Varroa*-resistant strain of the Western honey bee.

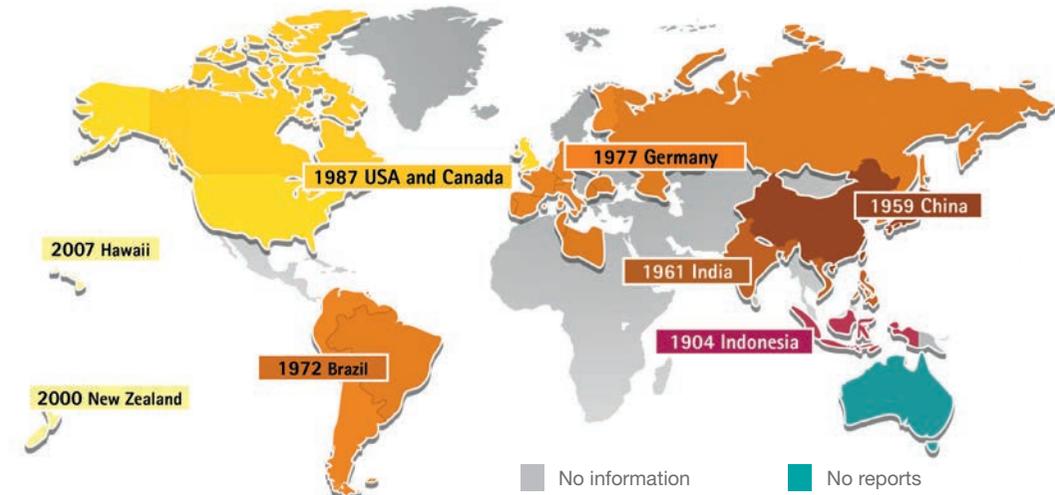
# The expansion of the *Varroa* mite

The *Varroa* mite is originally native to Asia, where it was first discovered on the island of Java in Indonesia over 100 years ago. The Dutch zoologist Antonie Cornelis Oudemans gave it the name *Varroa jacobsoni*. The mite initially preyed on the Asian honey bee (*Apis cerana*). But over thousands of years the bee successfully adapted its behavior to the parasite. The bees fend off the mites through their intensive cleaning habits in the hive, thus minimizing harm to the colony.

When European settlers brought the Western honey bee (*Apis mellifera*) to Asia, it also fell prey to the *Varroa* mite. Through these infested colonies the parasite was then introduced to Europe, where since the 1970s it has continued to spread. Recent genetic investigations have revealed that *Varroa jacobsoni* comprises 18 different genetic variants with two main groups: *Varroa jacobsoni* and *Varroa destructor*. *Varroa destructor*, the newly identified type, inflicts a great deal of harm in Europe, North America and elsewhere because the Western honey bee lacks sufficient defense mechanisms. Clearly, the equilibrium between *Varroa destructor* and the Western honey bee has not yet been established.

The mite is now found in many areas of the world: it is common not only in China and Russia but also in Central Europe and North and South America. Even New Zealand and Hawaii reported cases of infestation in the first decade of the 21st century. Australia is the only part of the world where the mite has not yet spread, mainly as a result of intensive biosafety protocols at the borders.

## Mite migration



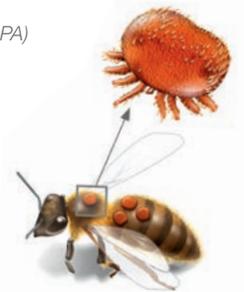
Spread of the *Varroa* mite in the selected countries with the year of detection in the corresponding decade.



Source: adapted from Webster TC, Delaplane KS 2001, *Mites of the Honey Bee*, (ECPA)

// The *Varroa* mite originated in Asia, but has since spread towards the west and now threatens the Western honey bee almost all over the planet.

// Only Australia has managed to keep the parasite at bay to date.



# The biology of the parasite

## Body structure

*Varroa destructor* literally means “destructive mite.” And although the parasite’s name more or less says it all, this tiny arachnid is not much larger than a millimeter and lacks hearing and sight. The body of the mite has four pairs of legs and piercing and sucking mouthparts. It uses the numerous **sensory hairs** all over its body as receptors to sense its environment. The *Varroa* mite’s flattened shape and the suckers on its feet enable it to optimally grip the bee’s body. It uses its mouthparts to pierce the bee’s **exoskeleton** and feed on its **hemolymph**, a circulatory fluid similar to blood.



// Body structure: *idiosoma* (main body region) and *gnathosoma* (mouth and feeding parts).

// The mite has four pairs of legs and piercing and sucking mouthparts.

// The hairs on the top and bottom of the mite’s body enable it to cling to the honey bee.

// The parasite feeds on the hemolymph of both adult bees and their brood.

## Gender differences

Male and female mites differ significantly from one another. Male *Varroa* mites are more rounded and yellowish-white. And, measuring in at only 0.7 to 0.9 mm, they are also markedly smaller than females, which are approximately 1.1 mm long and 1.6 mm wide. Females are also more heavily sclerotized, giving them a harder cuticle, and are brownish in color.

In addition, the mouthparts of females are much more pronounced than those of males. This means that only females can penetrate the exoskeleton of honey bees and their brood; males, on the other hand, cannot reach the hemolymph without damaging themselves. The male mite is confined to the brood cells and feeds on the bee brood at a feeding spot created by the female mite. For this reason, only females can survive outside the brood cells. The function of male mites is limited to mating with the females.



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### Female morphology

- 1.1 mm long and 1.6 mm wide
- flattened body
- heavily sclerotized = mechanical protection
- brownish in color
- have suckers (*apoteles*) on the last section of each leg (*tarsus*)
- two teeth are situated at the end of their jaws (*chelicerae*)

### Male morphology

- smaller than the female
- 0.7 mm long and 0.9 mm wide
- yellowish-white in color
- rounded body
- can survive only in the capped brood cells

Female *Varroa* mite top right and male bottom left, below

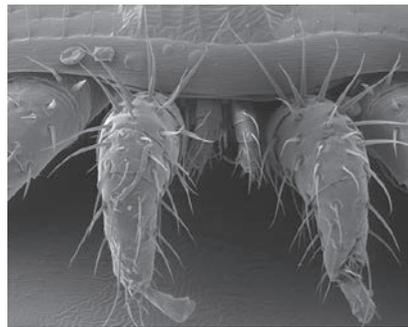
# The reproduction process of *Varroa destructor*

## Sensory perception of the *Varroa* mite

The *Varroa* mite orients itself without any sense of sight or hearing – it can only differentiate between light and dark. However, the receptors on its sensory hairs are highly developed: the mite is able to detect differences in temperature, moisture and chemical stimuli. The parasite uses its acute sense of touch to find its way around the beehive and can pick up the smallest of vibrations. It uses its front legs much as insects use their antennae – to sense its environment. Research has also discovered that the *Varroa* mite is endowed with the senses of smell and taste through a sensory organ located in a small cavity on its front legs. The mite's highly responsive sensory system enables the parasite to locate the brood cells in the beehive.

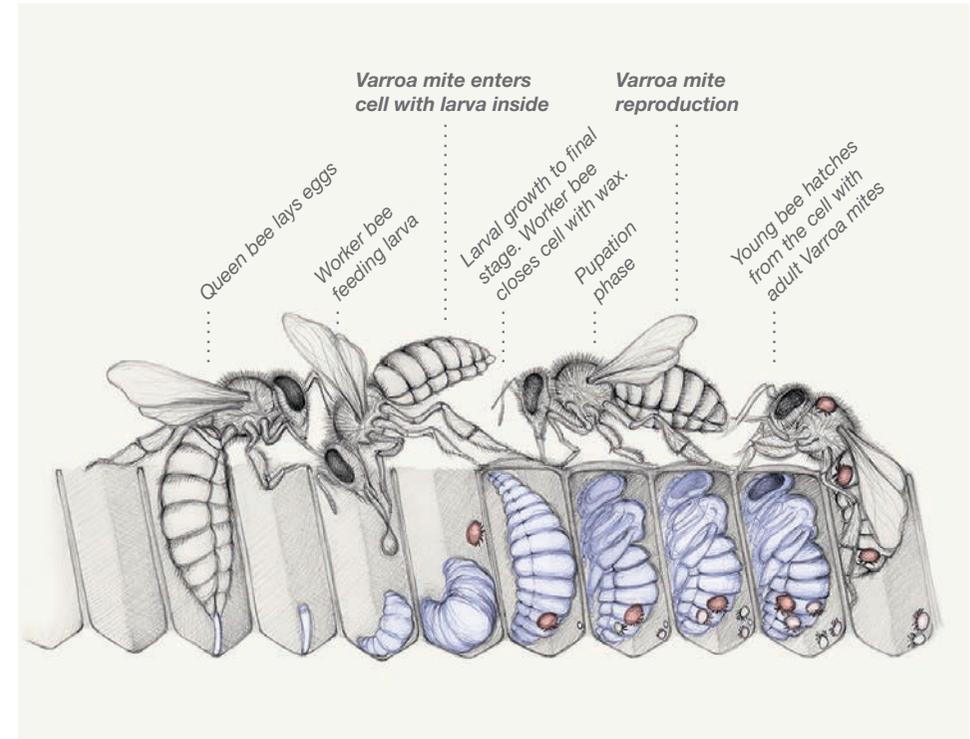


Electron microscope picture of a *Varroa* mite



Close-up detail showing *Varroa* mite front legs, with mouthparts in between

// THE FRONT LEGS OF *VARROA DESTRUCTOR* CONTAIN AN OLFACTORY SENSE ORGAN THAT ENDOWS THE PARASITE WITH THE ABILITY TO SMELL AND TASTE. IT USES ITS FRONT LEGS LIKE ANTENNAE TO SENSE ITS ENVIRONMENT. //



Development of *Varroa* mites in a honeycomb cell

The parasite preys on both adult honey bees and their brood. *Varroa* females can also survive outside the brood cells by attaching themselves to adult bees. However, the parasite only reproduces in the sealed brood cells of the honey bee. Shortly before the brood cells are capped, the *Varroa* female mites enter and crawl to the bottom of these cells – they protect themselves from the bees that tend to the brood by hiding under the larvae. Here they first immerse themselves in the liquid brood food. Once this is depleted, the *Varroa* mite feeds directly on the bee larvae. The parasite has strongly adapted to its host in terms of habitat and food.

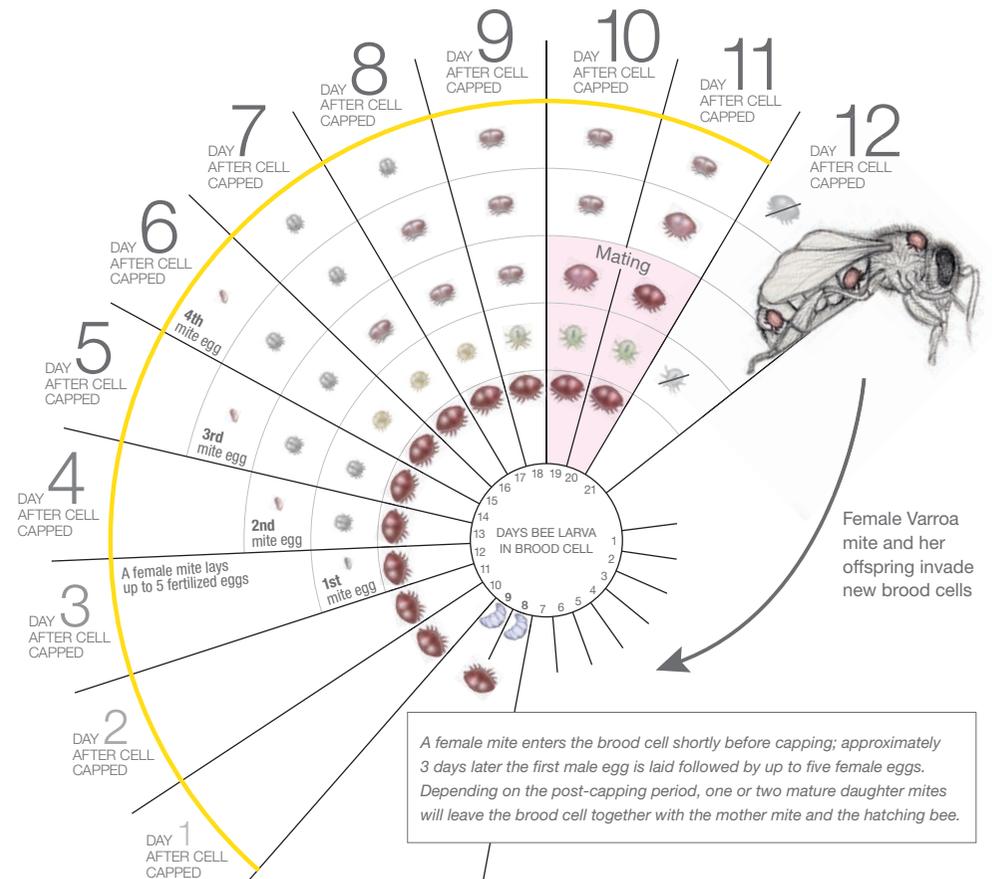
## Egg laying in the brood cell

The pheromones emitted by the bee larvae and the capping of the honeycomb cells with wax by worker bees activate *Varroa* egg development – so-called **oogenesis** – approximately six hours after infestation. After finalization of oogenesis – approximately 60 hours after the brood cell is sealed – the female mite starts to lay eggs. The first egg is not fertilized and always develops into a male. The mite lays at daily intervals the remaining four to five fertilized eggs, which become female mite offspring. The **nymphs** are white and mature into adult female mites in about six days, passing through various development stages during this process. Males need about seven days to mature. The juvenile mites are unable to feed themselves, so the mother mite pierces a hole in the bee pupa to create a communal feeding site for her offspring. During the development period the mother mite has to expend considerable energy to maintain the communal feeding site, as it is the sole source of food for the mites.

## Mating behavior

To complete the mating process, the mites remain for twelve days with the developing worker brood – and even as long as 14 days in the cells of the drone brood. The drone brood is typically infested five to ten times more often than the worker brood. Mating in the broodcell proceeds efficiently and purposefully: the males wait for the mature females near the common excrement area. Mating with each of the female mites needs to occur before the bee hatches, because males and unmated females die after the bee emerges from the cell. The mating behavior shows that the *Varroa* mites have optimally adapted their feeding and reproduction to the hive environment of the honey bee. This enables parasite infestation to double every three to four weeks during the breeding season.

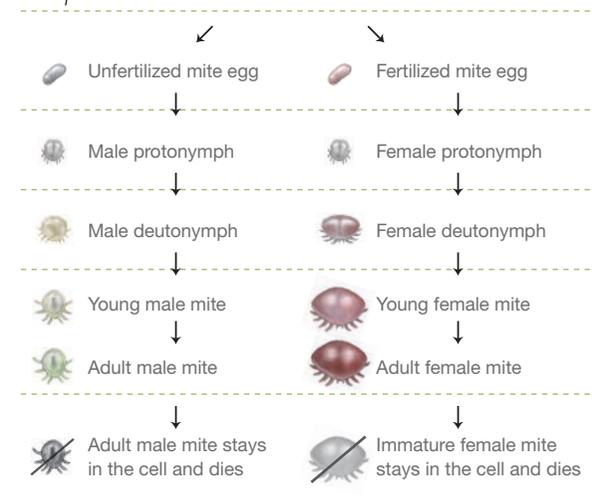
// THE DRONE BROOD IS INFESTED FIVE TO TEN TIMES MORE OFTEN THAN THE WORKER BROOD. //



## Graphic showing *Varroa* mite development stages

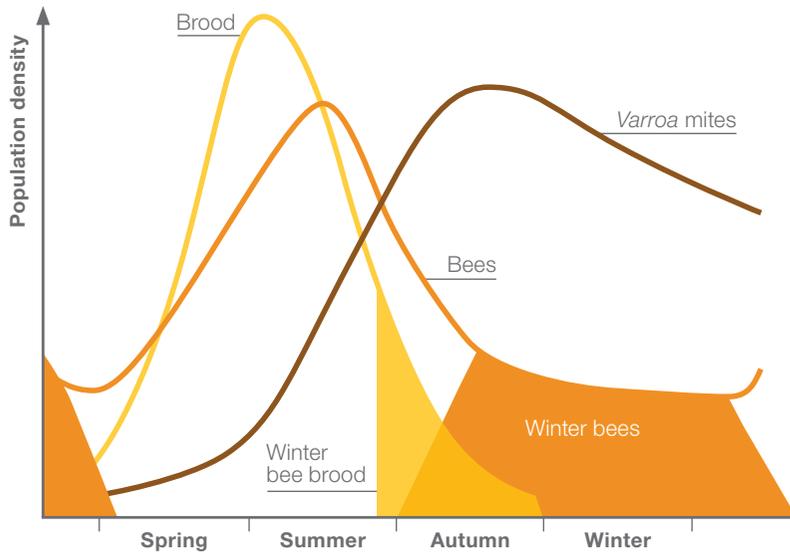
The first development stage of the *Varroa* mite is as a six-legged larva which develops inside its closed egg. After hatching, the second development stage emerges – the eight-legged **protonymph**. This protonymph develops into the third phase - the **deutonymph**, which then becomes the adult mite. Following the final nymph phase, the developing mite becomes immobile and becomes a chrysalis. Young nymphs are white in color and after several moltings during the development process of the mite the last immobile stage – the deutochrysalis – turns brown, taking on the color of the female adult *Varroa* mite it will finally become.

## Development of the *Varroa* mite



## After the bee exits the cell

A mite's life span is two to three months in summer, and six to eight months in winter. But the parasite is strongly dependent on its host – it can only survive up to seven days without bees and their brood. Dead mites fall to the base of the hive.



Graphic: *Varroa* population

*Debris* is the term used to describe the remains that drop to the bottom. The honey bees' different movements and activities cause the remains, such as wax, cell caps, food and dead mites, to fall into an insert on the floor of the hive. The infestation level can be monitored by counting the number of dead mites (*debris diagnosis*).



// THE *VARROA* POPULATION CAN **DOUBLE** EVERY FOUR WEEKS DURING THE BREEDING SEASON. IT CAN GROW FROM 50 MITES UP TO AROUND **3,200** MITES FROM THE BEGINNING OF FEBRUARY TO THE END OF AUGUST – WHICH ENABLES IT TO WIPE OUT EVEN A STRONG BEE COLONY OVER THE WINTER. //

# Transmission of honey bee viruses

Unlike its South-East Asian counterpart, the Western honey bee lacks sufficient defense mechanisms to fend off the non-native parasites. Infested honey bees are weakened as a result of the mites feeding on their hemolymph, which puts a strain on the bees' immune system. This adversely affects their performance and shortens their life span. When the parasite feeds on the larva, it also transmits dangerous viruses directly into the bees' hemolymph. The viruses can spread and harm the bees during their vulnerable development stage. *Varroa* increases the extent of the infection, because in the hemolymph, many viruses become deadly. Since there are no effective medicines to treat honey bee viruses, control of the *Varroa* mite to reduce the spread of viruses is essential.

One such virus that is very widespread is the **deformed wing virus (DWV)**, which can occur both in the brood and in adult bees. Often an infection does not produce any visible symptoms, but if the parasite transmits the virus to bee pupae, the young bees will develop deformed wings. These bees are unable to fly – and have a shortened life span compared to healthy bees.

The *Varroa* mite also transmits other viruses such as the **acute bee paralysis virus (ABPV)**, which can infect adult bees and larvae alike. It is primarily found in fat body cells and in the bees' salivary glands, but does not produce any typical signs of disease. The mite transmits ABPV directly into the bees' hemolymph. From there it spreads to the vital organs: once in the brain, the virus induces behavioral disturbances and impairs orientation and development – all of which can have lethal effects on the bees. An infection with ABPV is particularly critical in the case of winter bees – it severely affects their ability to survive until spring.



Bee larva with parasitizing *Varroa* mites

## Honey bee viruses



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Virus	Abbreviation	Symptoms of the disease
<b>Acute bee paralysis virus</b>	<b>ABPV</b>	The virus thrives in the bees' fat bodies and salivary glands, but the infection usually does not produce typical symptoms. Through the hemolymph, however, ABPV can reach the bee's brain. In this case the virus causes problematic behavioral displays, such as bees flying to the wrong hive. They become disoriented and disturbed in their development and die within a short time.
<b>Chronic bee paralysis virus</b>	<b>CBPV</b>	Symptoms include black bees lacking hair, trembling and inability to fly. Affected bees are often seen around the hive entrance. Infestation may sometimes cause diarrhea. Excrement spreads CBPV throughout the entire hive.
<b>Israeli acute paralysis virus</b>	<b>IAPV</b>	2004 IAPV was first described in Israel, where infected bees were seen with shivering wings, progressed to paralysis, and then died outside the hive. IAPV is spread by bee excrement in the hive. The <i>Varroa</i> mite can also carry the virus and kill both pupae and adult bees very fast after transmission into the hemolymph.

### THE VARROA MITE HARMS HONEY BEES IN VARIOUS WAYS:

- // IT **WEAKENS THE BEE'S IMMUNE SYSTEM**, CAUSING DISEASE PROGRESSION TO BE MORE ACUTE.
- // IT **TRANSMITS VIRUSES** THAT SPREAD QUICKLY WITHIN AND BETWEEN BEE COLONIES.
- // IT TRANSMITS VIRUSES DIRECTLY INTO THE BEES' HEMOLYMPH – PREVIOUSLY HARMLESS VIRUSES CAN THUS BECOME **LETHAL**.

Virus	Abbreviation	Symptoms of the disease
<b>Slow bee paralysis virus</b>	<b>SBPV</b>	SBPV infection typically produces no symptoms in bees. But the <i>Varroa</i> mite transfers the virus directly into the bee's hemolymph, where the infection can be deadly.
<b>Deformed wing virus</b>	<b>DWV</b>	The widespread DWV infects bees in all development stages. At first, the infection does not produce any symptoms. If the <i>Varroa</i> mite transfers the virus to a pupa, it will develop deformed wings. The adult bee is unable to fly and thus unfit for survival.
<b>Sacbrood virus</b>	<b>SBV</b>	SBV typically infects brood that is fed with infected jelly. Diseased larvae fill with liquid and their body loses structure within a tough, sac-like outer shell (exoskeleton). Eventually, the brood dries out and dies. A dark scab forms on the dead bodies. Adult bees typically do not show visible symptoms of SBV. But they develop faster, collect less food and die sooner.
<b>Kashmir bee virus</b>	<b>KBV</b>	Infection with KBV is deadly to adult bees in a very short time. The <i>Varroa</i> mite increases its spread within the beehive. Wasps and bumble bees can also get infected by KBV. Symptoms include black bees lacking hair and a higher number of dead or dying bees inside or outside the hive. KBV leads to weakening of the colony.
<b>Cloudy wing virus</b>	<b>CWV</b>	CWV spreads through the air in the entire beehive. <i>Varroa</i> mites strengthen the infestation of the brood. The bee's wings become translucent.

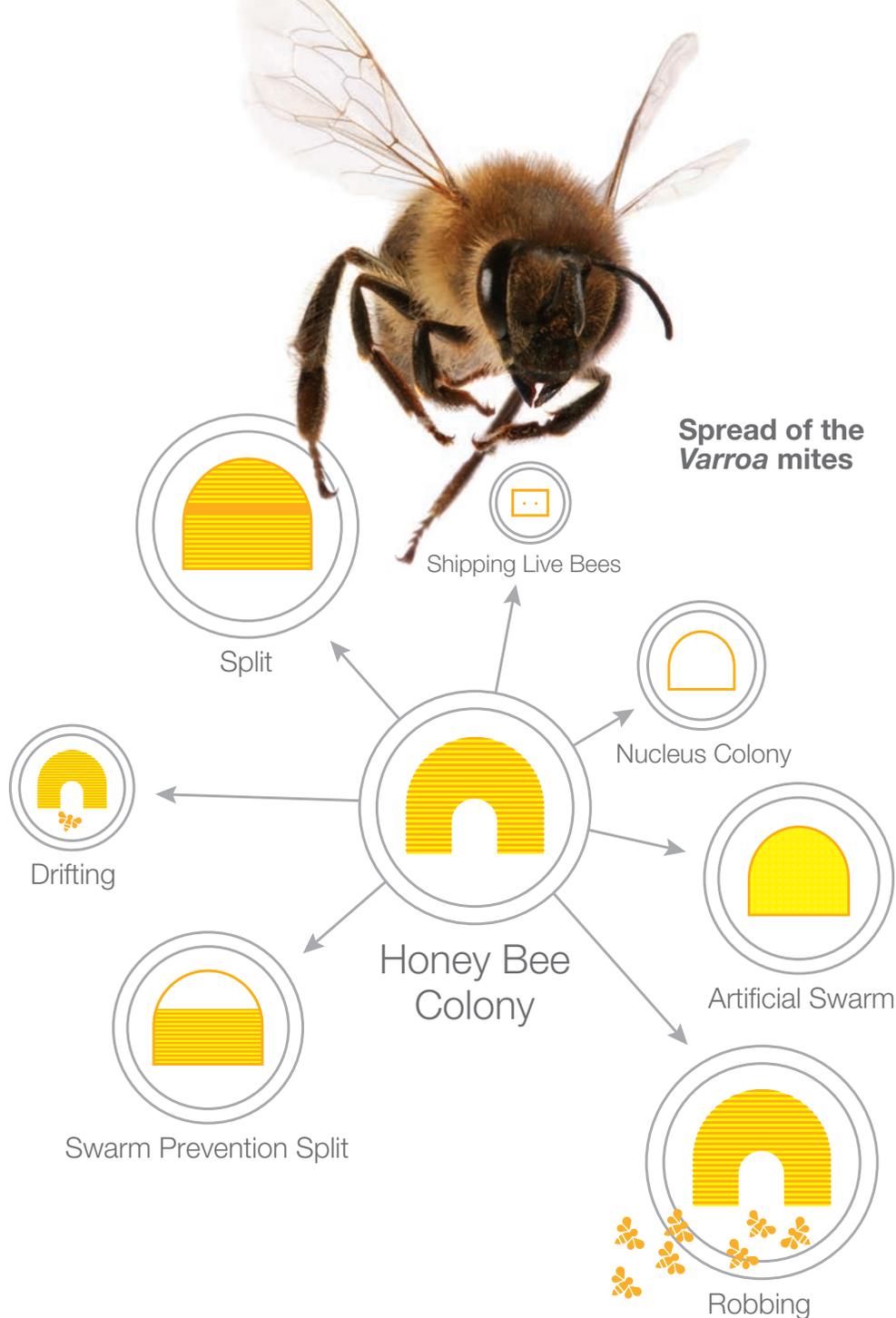
# Infection with the *Varroa* mite

*Varroa destructor* depends on honey bees to move from hive to hive. This is possible because when searching for food, bees regularly come into contact with bees from other colonies (**drifting**), even those located several kilometers away. As a result, even colonies that were treated for *Varroa* mites are at risk of being reinfested by bees from untreated colonies. A high density of honey bee colonies in some areas further facilitates the spread of the parasite. The spread of *Varroa* mites through so-called **mite reinfestation** was long underestimated, but is now considered a significant contributor to rapid increases in *Varroa* numbers, particularly in the late summer and fall periods.

**Swarming** is a colony's natural method of reproduction. When the brood nest becomes too crowded, roughly half of the bees will swarm out to establish a new colony with the old queen – taking the *Varroa* mites with them to their new home. The parasites mate inside the new brood cells, and the *Varroa* mite's reproduction cycle starts all over again.

The mites may also spread when beekeepers build up new honey bee colonies, for example through a process known as splitting, which involves removing **brood combs** from established honey bee colonies to start a new honey bee colony (**nucleus colony**). This method allows the nurse bees which stay with the brood to raise a new queen from fresh larvae material and set up a new honey bee colony. A split can also be carried out with adult honey bees: beekeepers initiate an **artificial swarm** to form a new colony from worker bees and an established queen to start a new colony on a broodless basis. After establishing on brood free honey combs the queen starts egg laying and the development of a new honey bee colony.

In a **swarm prevention split**, beekeepers relocate the existing hive including the old queen to a new location. A new hive will be placed instead, filled with brood material, pollen and nectar from the relocated hive. The foraging bees from the "old hive" will return to the old location and start immediately to raise a new queen from the larvae material as a foundation for a new honey bee colony. **Splitting** can be an efficient way to reduce the *Varroa* population. In all described splitting methods the mites hitch a ride on the bees from the old hive to the new one, although the natural degree of mite infestation is lower in the split colonies than in the parent colony. An additional *Varroa* treatment when using splits, artificial swarms or removing the queen to break the brood cycle helps to further reduce the parasites in the new colony.



# Combating the *Varroa* mite

It happens that foraging bees **drift** to other bee colonies. That is how colonies owned by different beekeepers come into contact with one another. It cannot be controlled by the beekeepers, since they cannot predict when their bees will swarm in the neighborhood.

Scientists see **robbing** as the primary risk factor for the transmission of *varroosis*. From late summer to fall as food sources become scarce, honey bees start to steal from winter stockpiles of weaker colonies; those infested with *Varroa* mites are particularly susceptible to such attacks. The *Varroa* mites also find less and less food in the weakened colonies, causing them to latch on to the invading bees. The robber bees not only return home with food, but also bring back new parasites.

The bees left behind face an even greater danger. This is because around two-thirds of the *Varroa* mites reside in sealed brood cells, which has the effect of significantly increasing the proportion of infested bees in the overall population. In the worst case the colony dies, or the honey bees leave the hive in the fall – the peak months for *Varroa* mites. When **swarming occurs under emergency conditions** the bees depart with the queen to search for a new home, leaving behind the infested brood in order to ensure their colony's survival.

// THE *VARROA* MITE SPREADS FROM HIVE TO HIVE THROUGH CONTACT WITH BEES FROM OTHER COLONIES, EVEN TO COLONIES LOCATED **SEVERAL KILOMETERS** AWAY. DURING NATURAL AND ASSISTED **REPRODUCTION** AND DURING **ROBBING**, THE *VARROA* MITE TRAVELS ON THE BACK OF THE HOST BEE TO NEARBY HIVES, WHERE IT CONTINUES TO MULTIPLY AND SPREAD. //

When it comes to improving honey bee health, one of the main activities of beekeepers in Europe and North America is fending off the *Varroa* mite. In fact, the beekeepers' most important task – particularly in late summer – is to minimize the level of colony infestation. This is crucial to ensure that sufficient numbers of bees survive the cold months of the year, thus enabling a strong colony to develop again in the spring.



Download the picture at:  
[www.beecare.bayer.com/varroa](http://www.beecare.bayer.com/varroa)

*Hanging a *Varroa* mite control strip between the combs in a beehive*

## Diagnostics

Before taking special control measures, beekeepers should periodically determine whether their hives are infested with the *Varroa* mite, and if so, survey to determine mite levels. They can then use their findings to decide the appropriate control measure. Beekeepers should also check parasite levels during and after anti-mite treatment in order to monitor the measure's success.



For diagnostic purposes, the dropped Varroa mites are counted on a white plastic drawer. The photo shows Bayer bee health expert, Peter Trodtfeld, checking the mite fall on the plastic drawer.

One detection option is to use a so-called **sticky board**, which involves placing a flat insert underneath the brood box. Dead mites and other debris will naturally fall from the hive onto the floor. This enables beekeepers to count the daily mite drop, which they can use to estimate the severity of infestation and to determine the appropriate control method. The *Varroa* floor is very simple (beekeepers only need an open mesh floor) but it is an extremely imprecise method of surveying for mite infestation; thus it is only suitable for regularly monitoring approximate parasite levels.

Another technique is the **powdered sugar method**. Beekeepers collect approximately 500 bees in a jar. They dust them with five tablespoons of powdered sugar and shake the jar several times. This causes the mites to lose their ability to cling to their host. Beekeepers then separate the mites from the powdered sugar using a mesh sieve and count them on a light surface. The bees are finally put back in the hive without causing them any damage. This treatment is heavily dependent on weather conditions; beekeepers should therefore carry out this procedure only on dry days. The powdered sugar and bees must also be completely dry.

The **washing method**, on the other hand, can be performed in any weather to monitor the level of *Varroa* mite infestation. This technique also requires beekeepers to remove bees from the hive. After washing the mites off the bees with water and detergent in a jar, beekeepers sieve out the parasites and count them.



Download the table at:  
[www.beecare.bayer.com/varroa](http://www.beecare.bayer.com/varroa)

## ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT SURVEY METHODS

### ADVANTAGES      DISADVANTAGES

#### STICKY BOARD

- Simple monitoring of *Varroa* infestation
- Additional information on the colony's state gleaned from the hive debris
- Ongoing monitoring possible
- No disturbance of the bee colony during the diagnostic inspection
- The natural death rate of the mites depends on colony strength and the brood activity in the colony, and must be taken into consideration in the survey
- Wind and ants can distort the results
- Commercial sticky boards can add significant operating costs

#### POWDERED SUGAR

- Colony strength can be taken into consideration
- Level of mite infestation in the colony can be determined
- Dependent on weather conditions: dry weather is required
- The assessment of the level of mite infestation depends on the brood activity in the colony and the season
- A sample of living bees has to be used for diagnostic inspection

#### WASHING

- Colony strength can be taken into consideration
- Survey can be performed in any weather
- Level of mite infestation in the colony can be determined
- A sample of living bees has to be used for diagnostic inspection
- The assessment of the level of mite infestation depends on the brood activity in the colony and the season

# Measures to combat

Various biological, physical, chemical, and biotechnical options are available to combat the *Varroa* mite in the hive. If beekeepers want to effectively protect their colonies, they must accept an important fact: a rapid increase of the mites during the fall period needs a very effective late-season treatment to protect the hatched winter bees during this time. Mite numbers do fall toward the end of the year, but the bees that have matured beforehand during the period of high mite feeding are considerably weakened, which means that the colony may not survive until spring. Beekeepers also need to combine appropriate measures whilst taking into account their particular location and approach to apiary management. *Varroa* treatment products that require specific temperature and environmental conditions are only suitable for certain regions in the world. Marketed products to control *Varroa* mite are not registered for use in all countries, because of differing regulatory and marketing conditions.

// **ACARICIDES** IS THE NAME GIVEN TO CHEMICAL AGENTS USED TO COMBAT MITES AND TICKS – CHEMICAL AGENTS SPECIALLY DEVELOPED TO COMBAT THE *VARROA* MITE ARE CALLED **VARROACIDES**. BEEKEEPERS SHOULD ADMINISTER THE FIRST CHEMICAL TREATMENT IMMEDIATELY AFTER THE LAST HONEY HARVEST OR IN BROODLESS PERIODS. //

## Chemical methods for use during the breeding season

One chemical substance that effectively protects bees from the *Varroa* mite parasites is **formic acid**. The liquid compound vaporizes and disperses throughout the hive in gas form. The vapor bath even penetrates into the sealed cells and kills off the mites feeding there, thus protecting not only the adult bees but also the developing brood. Formic acid rapidly decreases the level of mite infestation. Temperature plays a decisive role in the treatment: if the dose of formic acid is too large because of high ambient temperatures, the brood is damaged – but if the dose is too small, it does not have any effect at all. Formic acid is therefore used mainly by beekeepers in countries with mild climates, particularly as the main control measure from July to August after the last honey harvest has taken place.

## Varroacides

In addition to organic acids, there is another possible control method – **varroacides**. These veterinary medicinal products have been specially developed to combat parasitic mites without causing damage to the host bees. Varroacides are particularly effective when applied from late summer into the fall.

### Examples include:

#### Amitraz

Products which contain the active ingredient **amitraz** do not directly kill the mites but instead paralyze them, causing the parasites to fall off the bees and die from starvation. Bees pick up the active ingredient via a **plastic strip** hung between the combs in the central brood chamber. The honey bees spread the compound through the entire hive during social interaction.

#### Coumaphos

Products based on **coumaphos** are also spread among the bees by hanging **plastic strips** between the frames in the hive. Bees pick up the active ingredient when they rub up against the strips. Then they pass the compound on to all bees in the hive during social interaction. This is how the female *Varroa* mites living on bees outside the brood cells come into contact with coumaphos and are killed.

#### Flumethrin

Products based on **flumethrin** – a chemical substance that offers effective protection against *Varroa* mites – are

well tolerated by bees. A **plastic strip** embedded with the active ingredient is hung between the combs in the central brood chamber. The bees pick up the active ingredient when they walk over the strips and then distribute the compound evenly among themselves during social interaction in the hive. When the mites feed on the hemolymph, they ingest the active ingredient and die as a result.

#### Tau-fluvalinate

The active ingredient **tau-fluvalinate** adheres to the bees' bodies when bees walk over the **plastic strips** hung between the combs in the central brood chamber. The chemical substance is transferred to other bees in the hive through social interaction, thus killing the *Varroa* mites that are attached to adult bees.

#### Thymol

Varroacides based on **thymol** are evaporated in the hive from **cellulose wafers** or **gel carriers**. The concentration of the substance in the air poses no risk to bees, but is toxic to the *Varroa* mite. The mites drop off the bees and die. Thymol-based products are most effective at maximum temperatures of 20 to 25 degrees Celsius. Such products have only limited efficacy at temperatures below 15 degrees Celsius, and they should not be used if temperatures exceed 30 degrees Celsius.

Marketed products to control *Varroa* mite are not registered for use in all countries. The legal regulations of a country must be strictly followed during use of a product.

# Biotechnical methods

## Chemical methods for use *outside* the breeding season

**Lactic acid** is an effective **spray treatment**. When colonies no longer have any brood, the 15-percent lactic acid is lightly and evenly sprayed on each side of the combs. Young, broodless colonies can be treated at any time. However, this method of treatment is very labor-intensive since each individual comb must be removed and sprayed on both sides.

**Oxalic acid** is preferably used for **winter control** in broodless colonies. The oxalic acid is trickled evenly onto the bees in the spaces between the combs. The solution adheres to the bodies of the bees, which then pass it on to other bees in the hive. Beekeepers should complete the treatment during the broodless period, because after application it is necessary to wait until the following spring to harvest the honey.

// OVER TIME, THE *VARROA* MITES DEVELOP **RESISTANCE** TO THE ACTIVE INGREDIENTS – THUS RENDERING THE *VARROACIDES* INEFFECTIVE. BEEKEEPERS SHOULD USE A **COMBINATION** OF CONTROL METHODS TO COUNTERACT THE EMERGENCE OF SUCH RESISTANCE. //

In addition to the main and follow-up control measures with chemicals in the late summer and winter period, there are additional biotechnical methods to stop the spread of the *Varroa* mite. They can be performed at any time, even during the foraging period of the honey bees, and do not require any medicines or other chemicals. Especially useful are methods such as **drone brood removal** during the entire period of drone brood rearing (April to July), as the mites infest drone brood as much as five to ten times more frequently than worker brood. This method involves hanging an empty frame on the outermost part of the upper brood nest and then cutting off the drone comb full of the sealed drone brood, a measure that beekeepers should repeat every two to three weeks.



### **Cutting out drone brood**

*An empty brood frame is frequently placed along an outer edge of the upper brood chamber - the area in the beehive where brood development takes place. Every two to three weeks the capped drone brood is removed from the brood frame.*

By consistently removing the drone brood, beekeepers can greatly reduce the level of infestation in a colony. Since additional drone brood is reared in another part of the hive, there is a sufficient number of drones in the colony to mate with the young queens.

The **establishment of young colonies** is another method for controlling mites in the parent colony. Here drone combs are removed from the parent colony. Any mites present are easier to kill in the broodless young colony by applying, for example, lactic acid – and are no longer able to multiply in the parent colony.

Beekeepers can also develop **artificial swarms** using adult bees. This involves taking approximately 1.5 kilograms of bees away from the parent colony and producing an artificial swarm. During this time the *Varroa* mites mainly reside in the brood cells and have less contact with adult bees – infestation in the young colonies is thus automatically low. The newly established young colonies are also broodless, which means that beekeepers can treat them for mites as well.

# What's next in bee research?

## Breeding *Varroa*-resistant bee populations

Helping honey bees help themselves: breeding *Varroa*-resistant bee populations is a long-term solution for the mite problem. A number of honey bee colonies are showing the first signs of resistance – honey bees with a behavioral trait called **Varroa-sensitive hygiene (VSH)** can detect the *Varroa* mites in the closed brood cell. These bees pull out the infested pupae and thus stop the *Varroa* mite from multiplying in the colony. This behavior was originally only known to occur among Asian honey bees. On the basis of these observations, researchers intend to strengthen this defensive capability by practicing selective breeding among European bee populations, and thus create long-lasting protection against the parasites. The research being carried out by the **Arista Bee Research Foundation** is showing promising results and could significantly improve the health of bees in the future – but several more years of study are required. It is therefore still necessary that researchers and beekeepers continue to work on developing new methods to combat the *Varroa* mite.



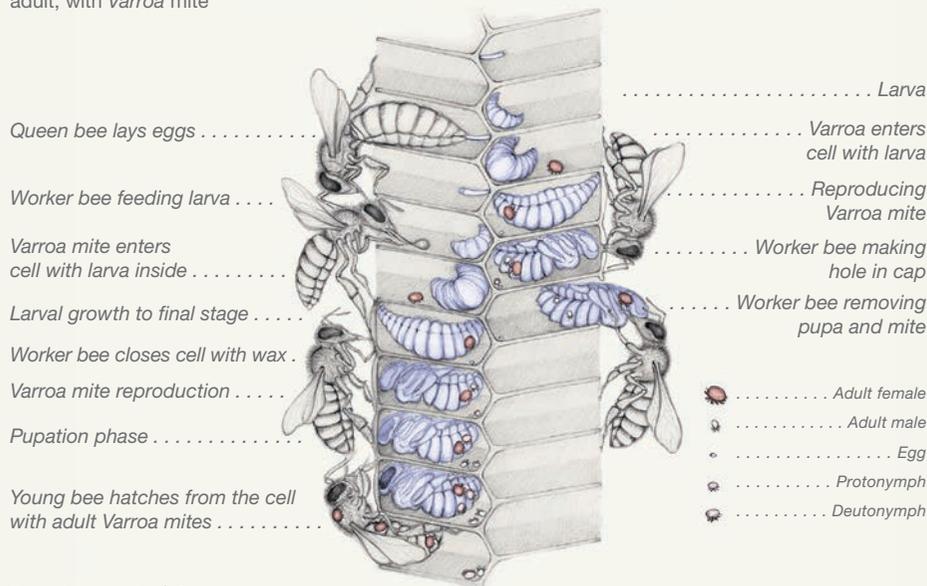
Download the graphic at:  
<http://aristabeereseearch.org/varroa-resistance/>

### Honey bee *Apis mellifera*

Development from egg to adult, with *Varroa* mite

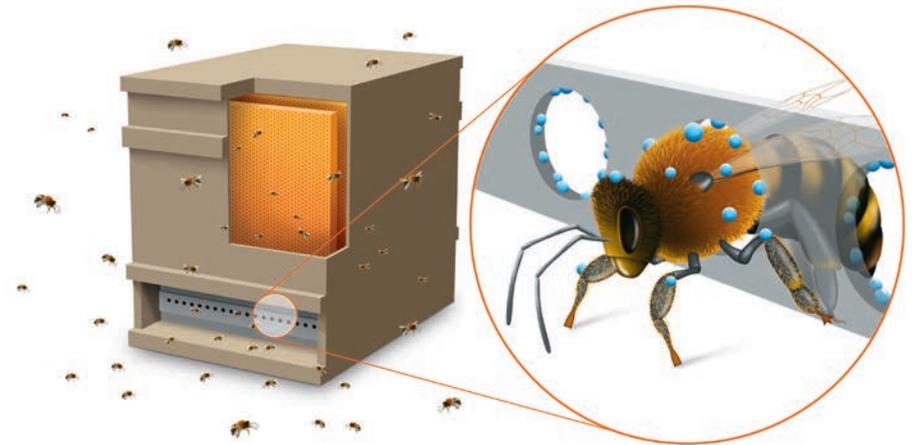
### *Varroa*-resistant honey bee

*Varroa*-sensitive hygiene behavior



# *Varroa* gate technology

In the future, bees may be able to apply varroacides to themselves at the beehive door. Bayer's scientists have been working to develop the **Varroa gate** – a strip of plastic with holes that contain an active substance. Beekeepers fit it over the entrance to the hive. When the bees squeeze through one of the holes in the strip, the active substance adheres to their legs or hair. In the future the strip should automatically replenish the substance on the surface of the strip – but only as much as necessary, to protect the honey bees against the *Varroa* mite. That means it keeps working for several weeks. Beekeepers will thus be able to protect their bees in the hive and also prevent new infestations from outside sources.



*Varroa* gate model



Download the illustration at:  
[www.beecare.bayer.com/varroa](http://www.beecare.bayer.com/varroa)

## Further research activities

It is especially important to get to know the enemy better through intensive monitoring of the *Varroa* mite. In long-term observations, researchers gain significant facts and figures about the mites' population and the efficacy of current countermeasures. These results help them optimize and complement *Varroa* treatments. So far, they were even able to identify sexual attractants – so-called **pheromones** – that can help to specifically develop new natural or synthetic varroacides in the future. Currently, experts are examining and testing the pheromones in the laboratory. Other treatments are used, for example the **sterilization** of male and female mites or **heat treatment**, to protect the bee colonies from the *Varroa* mite.

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