

Until recently, mites had to be dead before being studied under electron microscope. New technology now enables us to record such scenes as these cheese mites mating

Mites & men

Biologists armed with electron microscopes are finding mites in the most unexpected and most unsavoury of places

George Poinar, an American expert on mites, has risked his life many times while scouring the world for exhibits to add to his collection. "It has led to many dangerous situations," he says. "I've been locked up in Morocco and had a gun pointed at me in Mexico. People want to know why I'm bringing back amber that looks as though it doesn't contain anything."

In fact each piece contains a tick, the giants of the mite world. Having once feasted on some prehistoric animal, they contain traces of well preserved 15 to 40-million-year-old blood, each sample a treasure trove of genetic secrets.

● **Living fossils**

Poinar's work was the inspiration for the bestseller *Jurassic Park*, but Poinar says there's a much more frightening possible storyline. What if there were a virus lying in one of these ticks? If unleashed, it could be so far removed from our experience or knowledge that it could wipe out the entire human race.

Mites, which are members of the arachnid class which also includes spiders and scorpions, are living fossils that have evolved little in over 400 million years. They are to be found almost everywhere, having colonised virtually every known type of habitat on Earth, including fresh and salt water, polar and alpine extremes, tropical lowlands and barren deserts, and all types of

All pictures: Pascal Goetheluck, Mona Lisa Production



Cannibal colony
Film directors Quincy Russell and Thierry Berrod discuss images from their video *Cannibal Mites*, which took two years to make

The Oribate dust mite loves damp and dust but hates dry air, ventilation and hoovers



The secret life inside your mattress

When a new mattress is sewn together, right, a new home is created for hundreds of thousands of mites. Even here survival of the fittest applies, as a predatory dust mite (*Cheyletus*) attacks the more numerous *Dermatophagoides pteronyssinus*, above.



Mites thrive in modern homes. If you could see who you were sharing your bed with, you would never sleep soundly again



In the absence of prey, predatory dust mites kill each other. Here a male turns on a female

▶ water including inhospitable hot springs and sea trenches to depths of 5000 metres. So far science has identified about 45,000 species of mite, but this may be as little as 5% of the total number of species.

Most of them are tiny, but the Big Daddy of mites, the Red Velvet tick is 10mm long. At the other end of the scale are the human follicle mites, which can live inside our hair follicles, and the honey bee tracheal mite, which, at 100 microns, is tiny enough to live in a bee's windpipe.

● Uninvited bedfellows

About 30 species of mite live with us, and they thrive in today's modern homes. "By improving house comfort, with central heating, textiles and insulation, we have created excellent conditions for these dust mites to breed," says allergist and asthma specialist Professor Frederic de Blay, of University Hospitals, Strasbourg, France.

If you could see who you were sharing your bed with, you might never sleep soundly again. Every night the human body sheds about three grams of skin particles, and crawling all over our blankets,

pillows and mattresses are thousands of dust mites that want to eat it all. There can be up to 15,000 of these mites in one gram of dust.

And because what goes in must come out – yes, they're doing that in your bed too. It's actually the faeces of the dust mite that are responsible for a common allergy, and for some people this colony of uninvited bedfellows can cause potentially fatal asthma attacks.

"The concentration of allergens contained in their digestive-tract enzymes and in their excrement has exceeded the tolerance limit for many people," says de Blay. "Colds and skin reactions are minor compared to asthma attacks." According to de Blay, the allergens can only be destroyed by heating them to 100C for half-an-hour.

Mites can be formidable foes, but humans face far more dangerous variants than the humble dust mite. Scabies, for example, is spread by a mite of the genus *Scaropes* that burrows into the skin, causing intense itching and inflammation.

Ticks are the giant vampires of the mite world, growing up to 3cm when they have gorged on their



A mite sample is inserted into the chamber of the environmental scanning electron microscope

victim's blood. They are prolific carriers of disease, and believed by some scientists to come second only to mosquitoes as the most dangerous parasites to humans.

When a tick's prey is close enough, it pounces and pierces the skin, injecting an anaesthetic so the host remains oblivious to the parasite, and sometimes ingesting disease along with the blood. An adult female can take so much blood it

grows to ten times its normal size. It then drops off the host and lays up to 4000 eggs, transmitting any diseases from the host to the baby ticks. These then wait in the grass for a host to pass by; they are blind but can detect victims with carbonic gas detectors on their forelegs.

Serious illnesses such as Lyme disease and Rocky Mountain Spotted Fever (see panel, next page) are caused by ticks, but there may be many more such illnesses that we don't know about, as our knowledge of mites is still far from complete.

Until recently, all specimens to be studied under an electron microscope had to be coated with a conducting layer of gold, carbon or gold palladium. This meant organisms such as mites had to be dead. Now, with the development of new electron-microscope detection technology by Philips, it is possible to scan living organisms.

Called an environmental scanning electron microscope (ESEM), the new device uses an environmental chamber with a low vacuum to house specimens for scanning. "Although the standard electronic beam will be partially absorbed by

some of the water molecules in the chamber," says Dr Chris Jones of the Natural History Museum in London, "image resolution can be enhanced by a gaseous secondary electron detector, which amplifies the weaker signals scattered by molecules of atmosphere."

Other advantages of the ESEM over its predecessor include greatly increased accuracy – because no outside elements are introduced in the preparation stage – and the ability to magnify images 100,000 times (instead of just 1000).

● A cost of millions

Freshly plucked leaf plants, mites and other microscopic life-forms are able to survive in this variable controlled atmosphere while being scanned. According to Dr Jones, specimens can survive in the chamber for around 15 minutes before becoming dehydrated.

French film directors Thierry Berrod and Quincy Russell used the prototype ESEM for two years to produce the remarkable images in their video *Cannibal Mites*.

"There are so many different parameters to make it work" ▶



Study in miniature
At the Jardin des Plantes in Paris, mites are pampered in their unique 'micro zoo' for scientific research

It was once common practice to sprinkle cheese mites onto

► Quincy Russell. "Some species are more at home than others. We spent months experimenting just to get 11 minutes of footage."

Although the ESEM is still in development, the significance of these images is obvious – microscopic life forms can be observed live for the

The head and fangs of a predatory dust mite (or Cheyletus)



first time, thus enabling scientists to learn more about species which are costing agriculture millions.

Spider mites, for example, are a major economic hazard in the big farming states of the US. Hard to detect as they hide under leaves, they drain vital fluids from every-

thing from crops, vegetables and fruit trees to house plants. In Europe, the red mite is a notoriously destructive pest to fruit trees, while its two-spotted cousin attacks most greenhouse plants, outdoor flowers, and many fruits and vegetables.

Elsewhere, the varroa mite has seriously damaged the US honey market. First spotted 11 years ago, varroa parasites develop on bee pupae, draining the life out of them so that when they emerge for what would normally be a 30-day life of hard work, the bees are too weak to survive longer than a few days. The mites also infect adult bees and as they reproduce every ten days, it doesn't take them long to decimate the population of a working hive.

So far pesticides have been used to curb the varroa menace, but in four American states these mites have already developed a resistance to the chemicals. Genetic engineering is a possible answer, with the aim of creating super-aggressive bees capable of fighting off the mites when they first attack.

Unfortunately, super-aggressive bees also pose a threat to humans, so that solution is less than ideal.

However, Asian-hatched honeybees appear to have a resistance to the varroa and there are promising developments occurring with some resistant Russian bees that are being carefully introduced into the American market. Interestingly, it also appears that a spot of aromatherapy can help rid hives of these pests; essential oils such as thyme have been found to be effective when sprayed into the hive.

● More valuable than gold

But mites and ticks aren't only in the business of disease and death. Many benefits are also brought by these tiny creatures. In the average forest, for example, you could expect to find about 4000 mites under your feet. They feed on mosses, plants and microbes found on the forest floors, effectively recycling rotting matter. In some Canadian forests the over-use of pesticides is threatening these natural tidiers and without them, there could be rotting matter two metres high.

At Disneyworld in Florida the 150-strong horticultural team that looks after the parks' greenery are using a variety of predatory dust mites: this has allowed them to cut pesticide use by 75%. The ratio of predator to prey is five to one and this is very carefully monitored



Giving cheese that 'je ne sais quoi'

The cheese mite (*Acarus siro*) lives in the rind of some cheeses where it lays its eggs, above. Some French cheesemakers believe the mite adds to the flavour, so they sprinkle their cheese with more mites, right



a piece of toast for breakfast

as once the prey is destroyed the predators devour one another, avoiding the risk of uncontrollable proliferation. Predatory dust mites might be ubiquitous creatures but they don't come cheap – the right mites are fragile and difficult to rear. By weight, they are actually more valuable than gold.

In the Auvergne district of France, certain mites are valued for their contribution to cheese-making. The *Acarus siro* mite lives in the crusts of some traditionally made cheeses. Their role isn't fully understood yet, but the cheese-makers are certain the mites help to give a maturing cheese its flavour.

It is believed that this is partly down to the mites shedding their skin within the cheese. True cheese lovers eat their cheese with both crust and bugs. The *Acarus siro* mites are so valued that it was once common practice to spread the tiny mites directly onto a piece of toast at breakfast time. This isn't quite as extraordinary as it may sound: the mites are actually distant cousins of edible crustaceans such as lobsters.

But even if you enjoy a good strong piece of French cheese, you might not want to see up close what kind of creature's skin gives it its flavour. Indeed people suffer from a phobia about mites – the idea of

these tiny creatures living, unseen, with us is too much to bear. The condition was documented as long ago as the 19th century.

● Extreme measures

Mite expert Dr Glen Needham of Ohio State University has come across many people who have been forced by their fears to take extreme measures. He cites one man who threw out all his belongings then set fire to his house in an effort to rid himself of the invaders.

In another case, the president of a major American company was so obsessed with mites that he shaved his entire body every day, took several showers, and slept with his hand covering his genitals for fear of mites getting anywhere near them. He even put pesticide directly onto his skin.

But these are tragic extremes and it is better just to accept that these creatures are a part of our everyday lives and that we have to live alongside them as best we can. ■

Caroline Green and Keith Wilson

For further information, visit

Internet www.nhm.ac.uk
(The Natural History Museum)
www.fei.beamtech.com
(Phillips' FEI division, developers of the ESEM)

Nature's deadly hitch-hikers

Early 19th-century settlers in one valley in the Rocky Mountains were struck down by a mysterious illness that caused a fatal fever. The native Americans claimed that evil spirits lurked in the area during certain months.

Painless bite. In fact a tick was the cause of the illness, now known as Rocky Mountain Spotted Fever. It's only a problem in the US, but another tick-borne illness is a lot closer to home.

Although Lyme disease was named after the Connecticut town where it was identified 20 years ago, it actually came from Europe, says Dr John Maunder of the Cambridge Entomology Centre. It is caused by a bacterium in certain ticks prevalent in areas where deer and mice are common.

Its bite is painless and releases an anaesthetising cement to ease its passage on board. This causes flu-like



A sheep tick (*Ixodes ricinus*) waits for prey on a blade of grass

symptoms and can lead to more serious conditions such as meningitis. About 500 cases are reported in the UK each year, mainly in wooded areas such as the New Forest.

Woodland peril. But the diseased ticks can also be found in other areas of regenerating woodland. "It's more common a condition than people think," says Dr Maunder.

The ticks will crawl around for a while before deciding where to latch on, so check your clothes frequently.

If you have been bitten, remove the tick by grasping it as close to your skin as you can with a pair of tweezers. Use gentle pressure, twisting anti-clockwise. Even if some of it remains inside your skin, you have stopped the tick from infecting you.



A tick's jagged rostrum makes it hard to remove from the skin