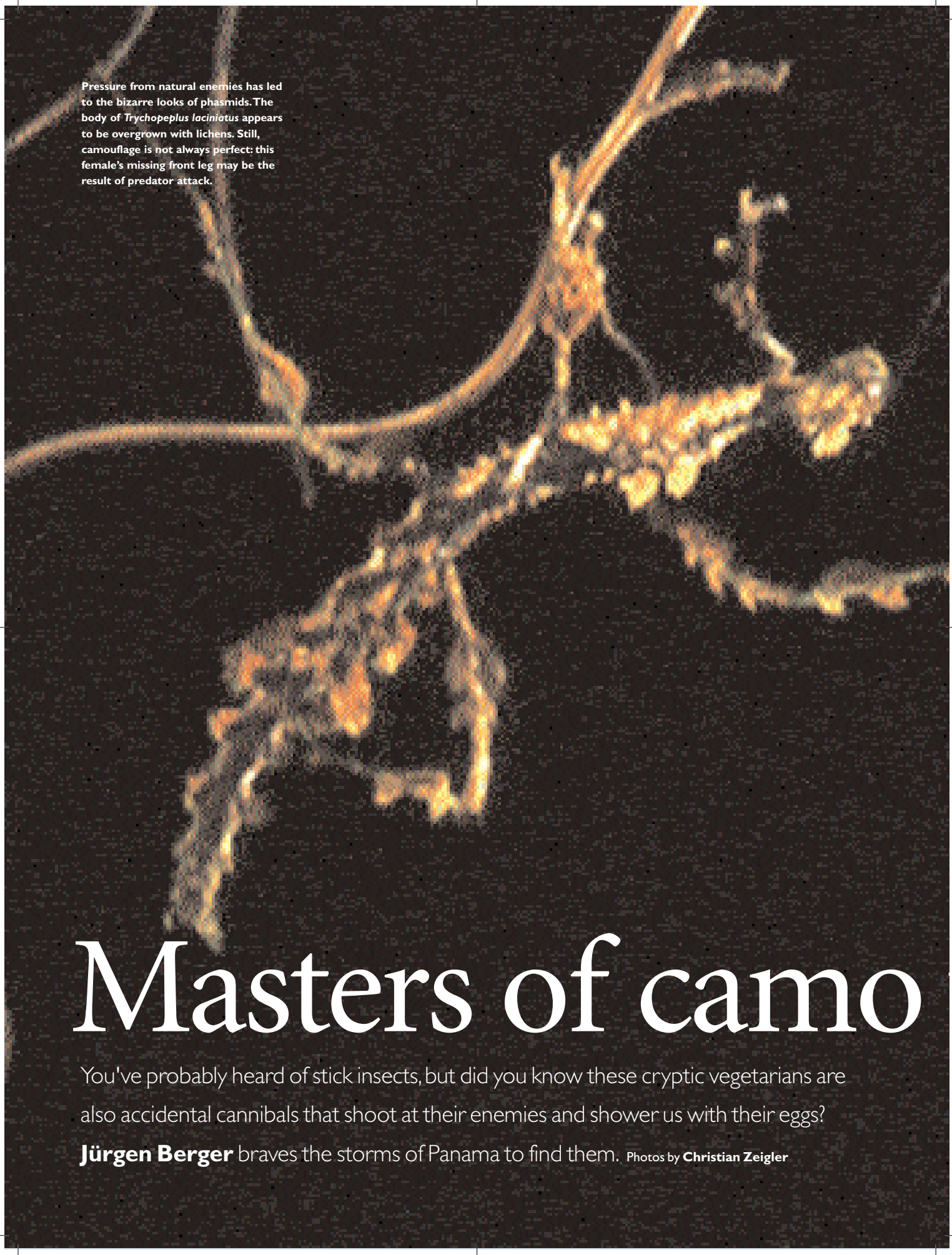
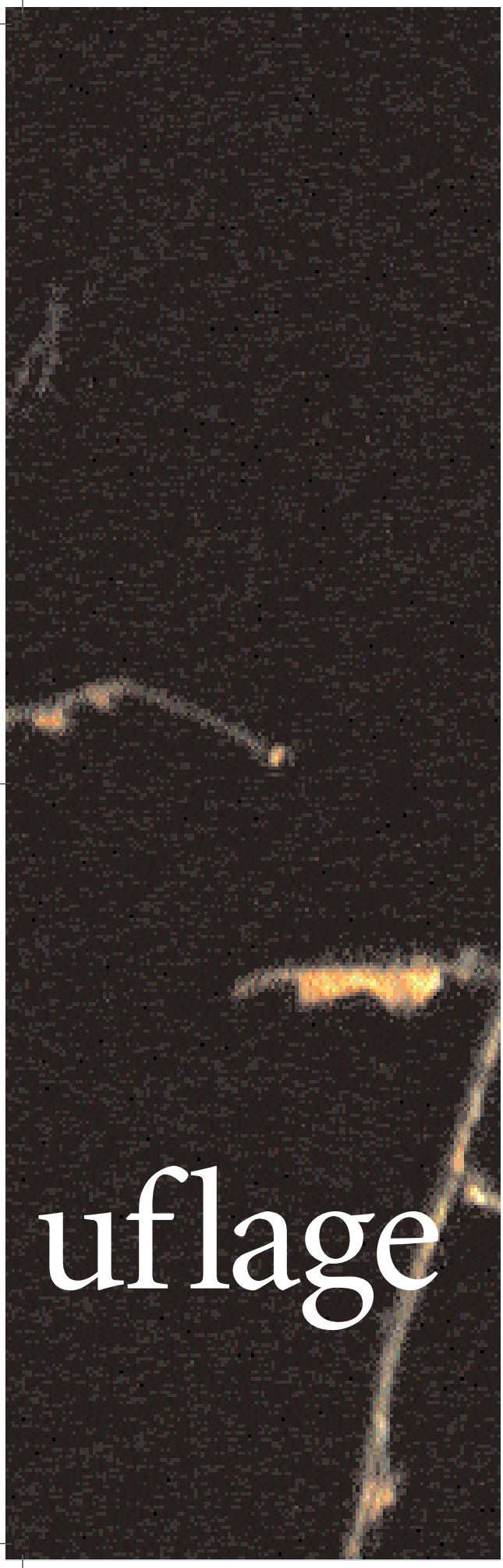


Pressure from natural enemies has led to the bizarre looks of phasmids. The body of *Trychopeplus laciniatus* appears to be overgrown with lichens. Still, camouflage is not always perfect: this female's missing front leg may be the result of predator attack.

Masters of camo

You've probably heard of stick insects, but did you know these cryptic vegetarians are also accidental cannibals that shoot at their enemies and shower us with their eggs? **Jürgen Berger** braves the storms of Panama to find them. Photos by **Christian Zeigler**



uflage

In the twilight far away down south I can see lightning, heavy lightning. I throw an umbrella into a box along with a field guide, net, radio, water and three different headlamps. It's time to go out and hunt for some of the world's most peculiar beasts.

Phasmids or phantoms (from the Latin *phasma*) are the most remarkable and bizarre of insects. Typically, they are either stick-like or leaf-like in appearance – hence they are commonly known as stick insects, walking sticks or walking leaves. Their appearance helps them to blend perfectly with their surroundings, camouflage being their defining characteristic. Besides their weird looks, they stand out from other insects because every member of their order, the Phasmatodea, eats nothing but leaves.

Phasmids are no big deal in terms of worldwide biodiversity: there are 2,500 to 3,000 described species, mainly occurring in tropical regions, compared with 400,000 recorded species of beetle.

But almost nothing is known about phasmid ecology. How do they live in the wild? Do they have many predators? There are reports of phasmid outbreaks in Australia during which whole eucalyptus forests were stripped bare. What triggered these huge increases in population size? Couldn't their predators – birds, lizards, spiders and small rodents – suppress their numbers? I once read about people in Malaysia hearing a sound like rain only to find that it was raining phasmid eggs. Why don't these insects eat Malaysian forests bare? The few studies carried out on phasmid ecology haven't answered these questions.

It's dark now. The air is humid and the vegetation moist from an afternoon thunderstorm. A gentle breeze blows from the South – a perfect night for a phasmid hunt. A boat takes me to the other side of Barro Colorado Island in Panama. The search has begun.

To get an idea of the number of phasmid species present and their abundance, I regularly walk the same forest paths and scan the wall of leaves with my lamp. In the beginning, I hardly found any stick insects. They just blend with their environment too well. I mistook them for twigs, or I mistook twigs for phasmids.

It will be a tiresome hunt. Only when feeding or looking for mates do phasmids expose themselves by either sitting or hanging on leaves or twigs.

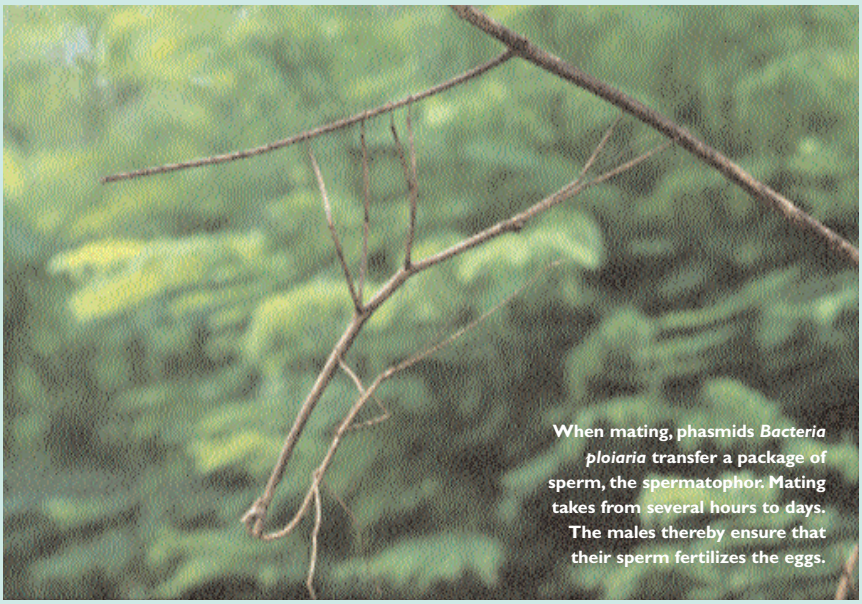
Their striking resemblance to their food can fool even their own kind – they sometimes take a bite out of each other.

When phasmids rest, they wear cloaks of camouflage. Evolution has merged them with their environment in many varied ways.

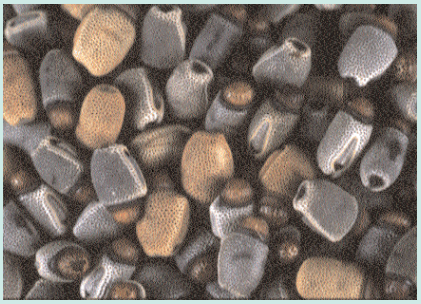
Only a small fraction, about 20 species (the Phylliinae), adopted the looks of leaves. These all occur in South-east Asia, with the commonest walking leaf being *Phyllium bioculatum*. This species' striking resemblance to its food can fool even its own kind – sometimes individuals mistakenly take a bite out of each other.

Working in the New World tropics, I won't encounter these part-time cannibals. But the stick insects here in Panama are by no means easier to spot. Most are modelled on twigs – for merging into an environment built of trees and bushes – and they continually swing their bodies ▶

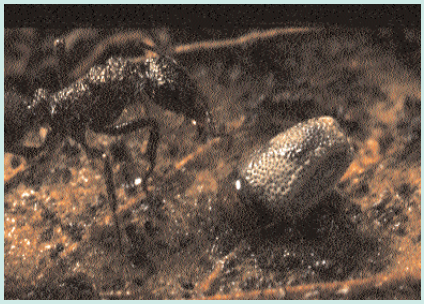
The procreation of a phasmid



When mating, phasmids *Bacteria ploiaria* transfer a package of sperm, the spermatophor. Mating takes from several hours to days. The males thereby ensure that their sperm fertilizes the eggs.



Many phasmid eggs resemble seeds. *Bacteria ploiaria* equips its eggs with a protein-filled cap.



The relationship between ants and phasmid eggs gives protein to the ant and shelter to the egg.

The eggs of stick insects are large and often strangely sculptured, resembling plant seeds. The number of eggs a female lays depends on the species. They are dropped singly, flicked, buried, glued to a surface in groups or riveted to a leaf.

An egg can take from three weeks to more than a year to develop, but once ready, it takes just a few minutes for a nymph to hatch. It must break free and stretch out rapidly (often extending to four times the size of the egg) before its exoskeleton hardens.

A phasmid nymph (here *Otocrania* sp.) must break free of the egg fast before its exoskeletons hardens.

Newly hatched nymphs (first instars) look just like adults, albeit much smaller. They undergo a series of moults over the next three months, through up to seven instars, before finally becoming adults.

Some stick insects rely on ants to disperse their eggs. The eggs have protein-rich caps (capitula), which attract the ants. In dry habitats in Africa, Australia and Costa Rica, the eggs are carried by ants into their nests and are thereby protected against parasitic wasps and fires.

Ants also carry stick insects' eggs in wet tropical forests. Here, larger ant species sometimes take eggs into their nests, but they soon kick them out without eating the protein. The moist environment means that everything is prone to fungal attack. The protein of the egg cap can accelerate the growth of fungi, which occasionally enter the egg and kill the embryo.

Fortunately for the stick insects, tiny ant species, ubiquitous on the forest floor, are highly efficient at finding eggs and carrying them back to their nests. As the eggs are too big to fit through the nest entrances, the ants remove all the protein from the caps, leaving nothing for fungi to grow on.

back and forth, as if dancing in the wind like the twigs around them. They have also adopted the coloration of their template and added meticulous details. For instance, *Trychopeplus laciniatus* appears to have lichens growing all over its brownish body. And *Prisopus berosus* achieves perfect camouflage by flattening its body, clutching its wide hindlegs to its sides and fitting its head perfectly into the concave indentations of its forelegs.

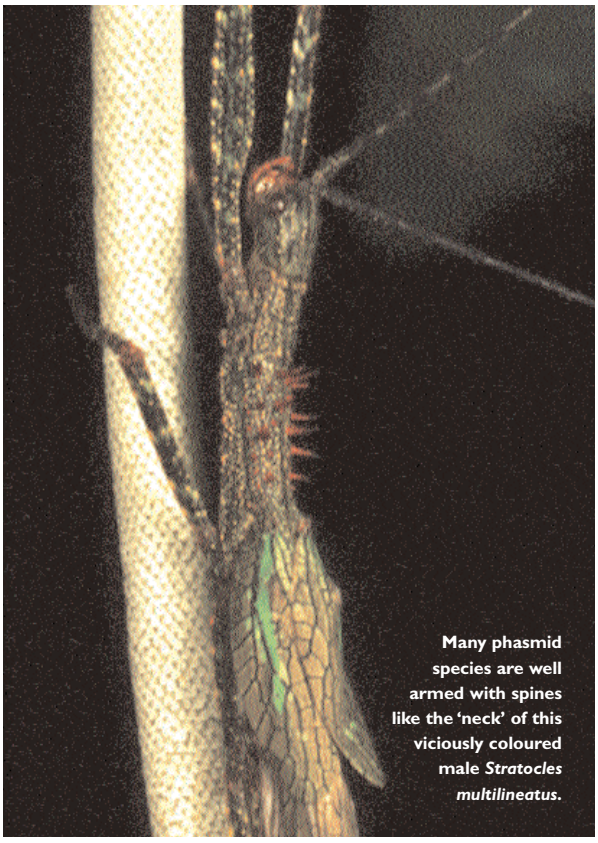
Selection hasn't left phasmids without help. Once targeted, secondary defences kick in.

Most phasmid nymphs prefer the undersides of leaves. And given that they stick to the mid-rib while resting, I imagine that many escaped my view. But tonight I spot one under a pepper leaf. It's just hatched from its egg and is one of the commoner species on the island, *Metriophasma diocles* – the subject of my scientific studies. This species is a good example of why phasmids play hide-and-seek. They face a wide array of enemies, including birds, lizards, rats, frogs, spiders, ants, assassin bugs and bats. In the first two weeks after hatching, about 50 per cent of *M. diocles* nymphs end up in some predator's gut. Such selective pressure exerted by natural enemies has led to phasmid camouflage. Being cryptic is a primary defence – it's active even when there are no predators around.

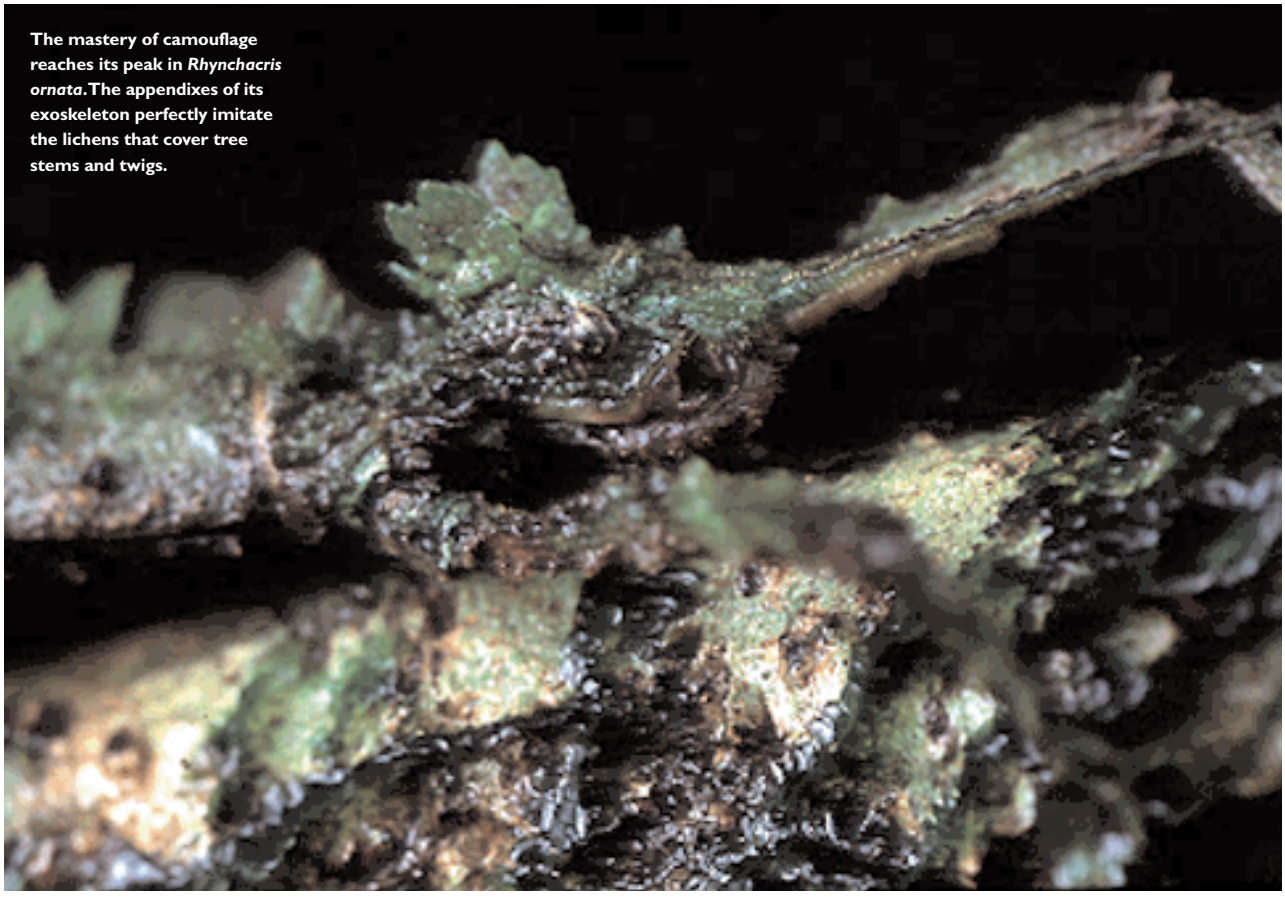
But what happens when a phasmid attracts an enemy's attention? In the struggle for survival, selection hasn't left phasmids without help. Once targeted, secondary defences kick in.

There is a brownish, 10cm-long stick insect on a leaf. I pick it up carefully, and immediately it comes alive, spreading out its fragile wings with blue spots at the base. Displaying its wings makes the insect appear bigger and often reveals warning ▶

The colouring of the male *Prisopus berosus* allows it to merge perfectly into the bark of a tree. This is camouflage at its best.



Many phasmid species are well armed with spines like the 'neck' of this viciously coloured male *Stratocles multilineatus*.



The mastery of camouflage reaches its peak in *Rhynchacris ornata*. The appendixes of its exoskeleton perfectly imitate the lichens that cover tree stems and twigs.

Jürgen Berger holds a female *Bacteria* sp. With a body length of 25cm, this is one of the longest insects on Earth.

coloration. As I measure this *M. diocles* adult male and take notes about the plant I found it on, I notice a strange smell. Many phasmids have glands behind their heads at the prothorax, the first chest segment. These glands release smelly secretions that can be quite effective at keeping predators at a distance. Some phasmids, such as the Australian *Megacrania*, can even shoot a milky-white substance up to 2m to deflect an enemy's interest.

Other species, such as *Epidares nolimetangere* (Latin: 'don't touch me') from Borneo, rely on spines all over their bodies for protection. The back of the beautiful neotropical *Stratocles multilineatus* is covered in red barbs, while thick thorns on the hindlegs of the New Guinean *Eurycantha calcarata* can easily penetrate human skin.

My eyes lock onto a male *Oncotophasma martini*, the New World counterpart to *Eurycantha*, though its thorns are not so intimidating. This harmless herbivore fooled me several times when I was getting to know it. Once when I picked one up, it bent its back, scorpion-like, to sting me. I let it go before realising that phasmids can't sting. Too late. Once dropped, phasmids play dead and merge with the leaf-litter.

I let it go before realising that phasmids can't sting. Too late. Once dropped, phasmids play dead and merge with the litter.

I'm now face to face with the insect giant of Panama. Though not the longest insect known (a South-east Asian giant, *Phobaeticus kirbyi*, holds the record at a massive 32cm), this female *Bacteria* sp. has a 25cm-long body and is hanging on a vine. At 15cm long, the males are much smaller, and unlike the females, they have wings. Such sexual dimorphism is common in stick insects.

Phasmids feed on a variety of different plants. *M. diocles*, for example, lives in a patchy world, because not all plants are equally edible. It has to search for scattered food resources in a sea of non-palatable green. And whether its offspring survive is more than simply a question of camouflage: it's also about escaping starvation. Here, another advantage of wings comes to the fore. Female *M. diocles* can fly in search of food-plants and then glue their eggs to the stems. This ensures that their nymphs find suitable food soon after hatching.

Lost in a phasmid cosmos, I haven't even noticed the thunderstorm. Sitting under my umbrella in the heavy tropical downpour, I think it all over again. I've only discovered the answers to some of my questions; the rest will have to wait.

Jürgen Berger has just finished his PhD in tropical ecology. He spent two and a half years searching for stick insects in Panama's forests. He works on the interactions of herbivorous insects with their host plants and natural enemies.