

## THE SCIENTIST UNRAVELLING A WEB THAT WILL HELP HUMANS

## Spiderman's secrets

Could those delicate threads really make bullet-proof jackets?

**D**R FRITZ VOLLRATH lives in an Oxford suburb, in an overgrown house that has something in common with Miss Haversham's in Great Expectations.

You see, Dr Vollrath has a positively indulgent way with spiders. He absolutely refuses to clear away their cobwebs. He lets them spin silk skeins all over his living room and scuttle around the bathroom, which they festoon with a chaotic tangle of webs.

Visitors are, he concedes, often perturbed, even terrified. But Dr Vollrath, 39, only laughs dismissively at them, blue eyes sparkling under a thatch of boyish hair. He indulges the spiders not because he is fond of them ("They are really quite anti-social creatures") but because they create such beautiful webs.

At Oxford University Zoology Department — where his room has an ominous picture of a tarantula adorning the door — German-born Dr Vollrath is researching the secrets of spiders' silk and web-building.

'Spiders' silk is 100 times thinner than hair and a lot stronger than steel of the same thickness. It is tougher than Kevlar (the strongest man-made material). It is not only strong, but also very elastic. It has to absorb the kinetic energy of an insect flying into it.

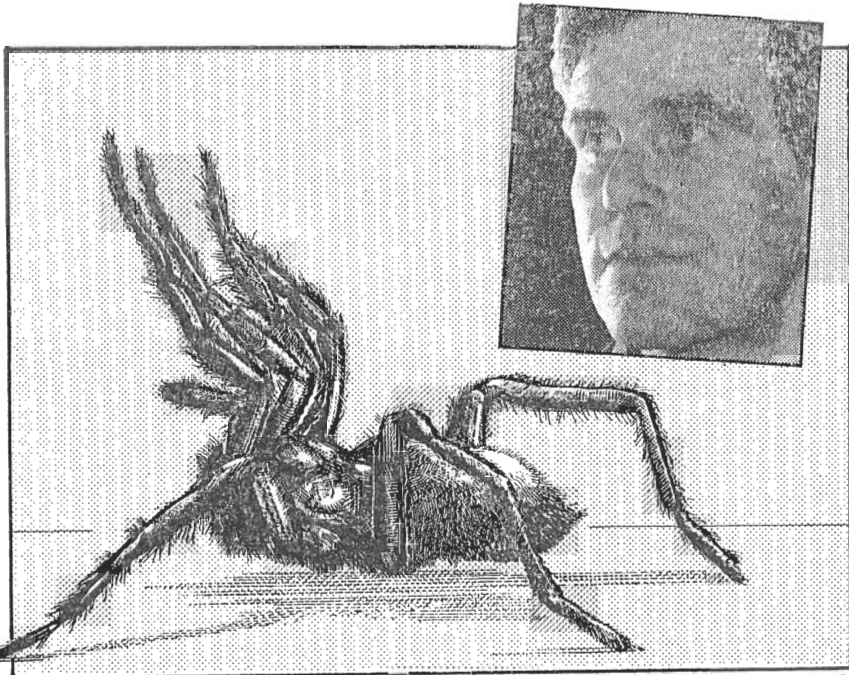
'It is made of a composite very much like fibreglass (the strength of which is derived from fibres of glass mixed with resin), crystals of protein in a rubber-like mass. Individually they are brittle. Together they are incredibly strong.'

Now biotechnologists are even claiming to have discovered a way of turning spiders' silk into bullet-resistant material for Army flak jackets. At a lab in Royston, Hertfordshire, they are isolating the gene sequence for manufacturing drag-line silk (the sort the spider spins to stop him falling earthward).

**T**HEY inject the instructions into a bacterium which (figuratively) gets weaving on the silk, making the spider redundant. The possibilities are legion. Spiders' silk could eventually be used in structural engineering.

The spiders' own engineering techniques are incredible enough. Dr Vollrath, who lent some of his spider colony and expertise to the biotechnologists, explained: 'An adult garden spider, the Orbicular spider — we'll call her Charlotte — spins 30 metres of silk each day. Her web is about the size of a car steering wheel.

'It takes her about 20 minutes to make it. She starts by



THEY'RE aggressive, anti-social cannibals... so why does Dr Fritz Vollrath like these spiders so much?

by **FRANCES HARDY**

putting down spokes. Next she spins a tough, coarse scaffolding spiral (from the inside out) then a sticky spiral (from the outside in). Then she destroys the scaffolding spiral.

'She is up just before sunrise, spinning away before the birds and wasps — her enemies — are active. It is a dangerous life for a spider. More dangerous still if you happen to be a male spider.'

Males, unless they are very canny, are eaten by the females after mating. The clever ones are usually crab spiders. They spin silk bonds to tie their mate to the ground, so they have a head start when she comes chasing after them.

Others, hunting spiders, make a present of food to the female to appease her. Then there are the opportunists who approach the female only when she is gorging on a fly in her web, in the hope (usually vain) that she will be too sated to bother with them afterwards.

'Charlotte builds a new web every day. It is a costly process in terms of energy consumption. She'll need to eat a quarter of a bluebottle to get the energy to build a web. Some days she might not even catch a fly. When she does, her web is destroyed and she has to build a new one.'

'Webs are primarily means of catching food. They're also an early warning system — they vibrate when enemies like birds are approaching — and they provide a protective shield against marauding wasps.'

'Charlotte does not discard her old webs. She eats them and recycles them a day later. We know it takes a day for the silk to process through. We have experimented by making the webs radioactive, so they glow. The recycling process is 95 per cent efficient.'

Mature male garden spiders don't build webs. They do nearly all their eating in early life and stop weaving just past puberty. They are consigned to

a pitifully short, dreary existence which consists of eating, mating, then getting eaten.

'Both male and female spin drag-lines — the silk is even stronger than the web variety — which allow them to live in a three-dimensional habitat,' explains Dr Vollrath. The drag-line, which is as long as a spider walks each day, is a safety rope to stop the spider falling and he is paying it out all the time.

**S**PIDERS cruise around in the sky like Richard Branson in his stratospheric balloon. They are carried up in the wind on strands of drag-line. 'They are alive, but frozen,' says Dr Vollrath. They are cold-blooded and have anti-freeze in their bodies, just like we put in cars — and the Austrians put in wine. It stops them shattering like a frozen bottle of milk.'

Webs are constructed in multifarious patterns. There are five varieties in Britain: Dome, Tanglefoot, Orbicular, Funnel and the dusty, chaotic cobweb sort. The Tanglefoot web has an inbuilt trapping mechanism for unwary prey.

'The spider — a globular little spider called a Theridion — puts droplets of glue on the

strands of web which are fixed to the ground. When an ant scuttles across, he gets stuck and is lifted aloft as the strand of silk detaches from the ground. The funnel web has a sheet of sticky silk to ensnare food, then a funnel-like retreat in which the spider lives.'

'Spiders' silk was used for gun sights, because it is regular and very thin. It has also been used commercially, by the French in Madagascar in Victorian times. They used spiders called Big Golden Orb Weavers which produce 500 metres of silk each day. They also eat each other — unlike mild-mannered silkworms, which co-exist quite amicably on the same bush — so the Madagascar enterprise was short-lived.

'Garden spiders will eat each other too, given half a chance. If two females find themselves on the same web, the bigger one will eat the smaller. They bite as well, and secrete a tiny amount of poison. Not enough to bother a human, but they can give quite a nasty nip.'

'There are some social spiders, but they don't live in England, I'm afraid. Generally they're really very, very aggressive creatures,' muses Dr Vollrath.

'But they do make such extraordinarily beautiful webs.'

How in a way...