

Insect defence all blood and guts

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Armour is not enough for these ground crickets

Armoured crickets have a bizarre and striking way to avoid being eaten.

To become unpalatable, the insects squirt toxic blood out of gaps in their body and make themselves sick by throwing up food they've just eaten.

A few insect species including beetles and katydids actively bleed when attacked, but the benefits of taking such extreme measures were not clear.

Now scientists have shown the tactic really does work to deter predators such as lizards.

Armoured ground crickets (*Acanthopplus discoidalis*) are fat, flightless insects that live in the African bush across Namibia, Botswana and South Africa.

They are relatively large, growing up to 5cm long, have sharp spines across their thorax and legs and a pair of strong biting jaws. Males are also able to make a harsh loud noise by rubbing body parts together in a behaviour called stridulation.

Each feature adds to an arsenal of defence mechanisms that the insects use to avoid being eaten by predators.

 The blood is pale green and rather acrid smelling 
Entomologist Bill Bateman

However, the crickets also use two highly unusual and quite bizarre tricks to stymie any attack.

Firstly, the crickets regurgitate through their mouths food they have just eaten.

They also squirt blood, which in insects is called haemolymph, from gaps in their exoskeleton on their backs and under their legs.

Blood squirting

A number of insects, including blister beetles, stonefly larvae and bushhoppers behave in similar way when attacked. One katydid is so renowned for this tactic that in German it is called a 'blutspritzer', or 'blood squirter'.

But while this bizarre behaviour is well known, its effectiveness has never before been tested.

"When I was moving them to larger quarters I was thinking about how they would grip a branch and when I pulled I would inevitably feel the squirt of the blood jetting out from under their legs," entomologist Bill Bateman of the University of Pretoria in South Africa told the BBC.

"This is a recognised defence mechanism and has been mentioned in other invertebrates, but no one had published on what exactly makes them do it or whether it actually is effective against predators."

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So Bateman and colleague Trish Fleming of Murdoch University in Western Australia tested the defensive abilities of the armoured ground crickets.

First he mimicked attacks by predators by grabbing the insects from the side or above with tweezers. The crickets responded differently depending on the mode of attack.

When attacked from the side, the crickets stridulated and tried to bite their attacker. About two-thirds of the time, they also squirted out acrid-smelling haemolymph from seams in the connective tissue of their legs and from just behind the head.

Attacked from above, a direction in which they could not bite, the crickets oozed toxic blood almost nine times out of ten, Bateman reports in the *Journal of Zoology*, the journal of the Zoological Society of London.

Sometimes the crickets squirted their own blood up to 6cm.

Green and acrid

"The blood is pale green and rather acrid smelling. I couldn't bring myself to actually taste it fresh but it leaves an acrid, tobacco-like taste on your fingers if you do not wash it off," he says.

He then further tested how the crickets responded to both bearded dragon lizards (*Pogona vitticeps*) and striped skinks (*Trachylepis punctatissima*).

When he placed a male cricket in a cage with four bearded dragons, one lizard immediately tried to eat the insect.

Instantly it autohaemorrhaged, forcing the lizard to drop it and retire to wipe clean its jaws. A second lizard seized it for the same to happen. A third lizard approached the insect but refused to attack it.

Bateman also tested the power of the haemolymph and regurgitated food, by painting another smaller species of cricket in either substance, and then seeing if striped skinks would eat them.

While the lizards ate all of 24 clean crickets, they often refused to eat those covered in haemolymph, and occasionally those covered in regurgitate.

"What impressed me is that they control the release depending on how they are grabbed," says Bateman, describing the actions of the armoured ground cricket.

"If it's from above the blood wells out and coats your hand. If grabbed by forceps from the side, by a leg, they lean towards it and crouch down, then there is a slight cracking sound and the blood jets right along the line of attack."

"Any predator would get a faceful, and our experiments indicated that lizards do not like it all."

Bateman says he was surprised by how sophisticated the crickets' defence responses are.

For example, they target their blood squirting according to the angle of attack, while females, which do not stridulate, rely on squirting and biting and vomiting up food they've eaten more than males.

Cannibal crickets

This blood and guts defence has one downside however.

Ground crickets often swarm in search of new sources of food including protein and salt.

But one of the best sources of both is other crickets, and if given the chance ground crickets become cannibals, feasting on each other.

"When the swarms in the African bush meet a road, lots get squashed and the others gather for a feast, so more get squashed until there can be a thick, acrid pancake of dead and moribund crickets on the roadside, bleeding and attracting more cannibals," says Bateman.

That means that any crickets with haemolymph on their bodies attract the attention of other cannibalistic crickets that assume it is injured.

"Crickets that I induced to squirt blood would assiduously clean any droplets off their limbs when put back in the colony, presumably to avoid cannibalism," Bateman explains.

"I saw other crickets approach a bloody one and begin nipping at it. If intact, the bloody one usually runs off."

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