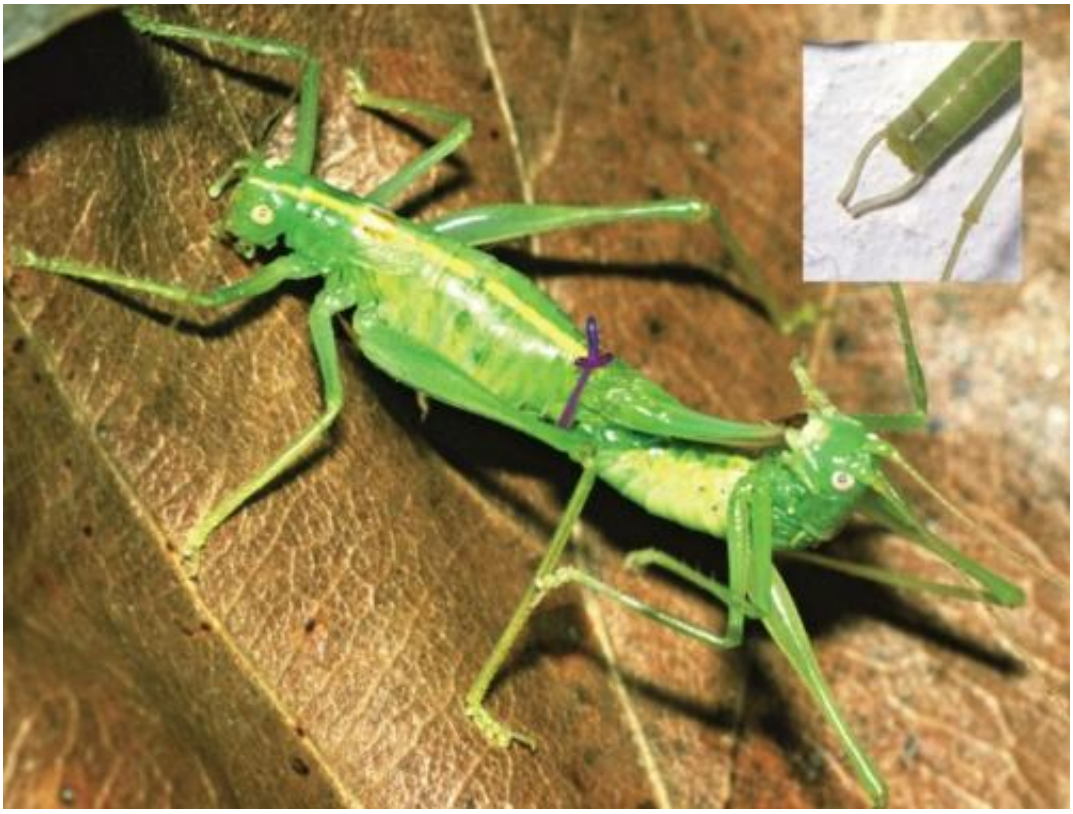
From monogamous termites to male-eating spiders, an ecologist explains

June 4 2014, by James Gilbert



Mating pair of Meconema bushcrickets, female to the left, with male's genital tongs highlighted in purple. C. Roesti

The Conversation organised a public question-and-answer session on Reddit in which James Gilbert, postdoctoral researcher at the University of Sussex, explained weird and stunning insect reproductive strategies.

What is an example insect reproductive strategy that you would describe as especially 'creative'?

I use the word "creative" because that's precisely what some of the strategies evoke to me. However, I must stress that it is evolution being "creative" here – I'm not trying to claim that the individual male is being "creative" or even evaluating what he is doing.

I think one embodiment of evolutionary creativity in the arms race over mating would be a recently discovered behaviour of unwanted suitors in water striders. These insects sit on top of water, using surface tension to stop them falling in. But their vibrations are sensed by predators underneath the water, like fish. When mating, the male climbs on the female's back and is relatively safe from predators, but she can still be snapped up. Now, when mating, the female has a virtually impregnable hatch that covers her genital area that allows her (all else being equal) effectively to control completely who gets to mate. This presents a problem to unwanted males. Their solution is to climb on top of the female and produce vibrations that attract predators until the female "consents" to open the hatch and let them mate. Effectively this is insect blackmail. Although the individual male may not realize what he's doing, in evolutionary terms I think this is an amazingly creative – if horrible – solution to what might otherwise have been a very difficult problem for these males to overcome.

My bug-loving 7-year-old asks: how do worms have babies?

Earthworms are hermaphrodites, which means each individual worm is both male and female. Two worms thus fit together by lying in opposite directions. After mating, both worms ooze away, and after a while each one produces a ring-shaped cocoon around itself into which it deposits

the fertilised eggs, and then slips out backwards. The cocoons are like little eggs in the soil. I believe quite a few are parthenogenetic too, that is there are only ever females, and they have babies without mating.

Is there any truth to the theory that caterpillars and butterflies evolved as separate species and then converged?

An extraordinary hypothesis. However, it was very controversial and the hypothesis has since been rejected.

For those that didn't see it, the original paper proposed that caterpillars were originally their own separate lineage of animals that were related to an extremely odd kind of animal called a velvet worm, and that these velvet worms somehow hybridised with butterfly-like insects to produce an organism with a larva like a caterpillar and an adult like a butterfly.

On one hand this appears to be science working extremely well: the author proposes a hypothesis, makes some predictions, and the predictions are taken by other scientists and tested, and found to be false – job done.

However, in this case the hypothesis was absolutely outlandish and went against a ton of existing evidence – furthermore, the predictions were very easy to test, and really the author should have taken the extra step of testing them first to provide some concrete evidence for the claim, before advancing something so controversial and unfounded – so as not to waste the time of other authors who have better things to do than test wild theories.

As for how we really think metamorphosis evolved – well, that remains somewhat of a mystery.

Do you have examples of forced reproduction in insects?

Traumatic insemination, as practised by bedbugs, is perhaps the most horrific – and there are plenty of examples. Some of the best documented are in water striders and seed beetles, but it has been reported from damselflies, diving beetles, bushcrickets, and many more. You could argue that bushcrickets too are an example of forced copulation.

How can I identify insects?

Some insects look positively ancient. If you have found an insect you are curious about identifying, I would say the first stop would be to send photos to the folks at BugGuide together with a description of where it was and what it was doing – they reply very quickly and will help to identify it.

In many cases if you would like it identified right down to its species level you'd sadly have to kill the specimen – but don't do this until the experts say that's necessary, as some species are recognisable from photos and locations.

What insect has the weirdest shaped, um, equipment?

I reckon you would have to go a long way to beat the seed beetles. The gin-traps of the bushcrickets in our study do a good job, as does this rove beetle.

Unfortunately researchers have typically made much more effort looking at male than female equipment – so it is hard to tell whether females usually have equivalently bizarre systems. I think my candidate for the

weirdest system so far has to be this barklouse, discovered only this year, where females have penis-like structures and males have vaginas, and females hold males down and scoop the sperm out of him over three days.

Has monogamy ever been seen in insects?

Yes, insect sex is not all crazy. Although, in animal terms, monogamy itself is pretty crazy in that it is extremely rare.

Termites are lifetime monogamous, with a queen and a king. Additionally, many ants are monogamous in that the queen is singly mated, although that was probably not the kind of monogamy you're asking about.

There are also plenty of insects where the male sticks with the female for much, or even all, of the process of parental care. Burying beetles provide one well-studied example (in some cases), but males will often attempt to attract additional females, and the female will actively kick him over to stop him producing the pheromones to do so!

The family Passalidae of dead-wood beetles are monogamous – the pair and their offspring form cooperative family groups in dead logs. There is a remarkable insect, a dung beetle *Cephalodesmius*, which lives in Australia. Males and females stay together throughout the provisioning period and the original paper proposed that they mate for life. This is probably because their form of parental care is particularly intensive – instead of collecting dung, they collects leaves and let them ferment into a ball of "homemade dung". But this ball needs constant topping up and that is intense work, if you also have to defend the nest. Unfortunately this is a very poorly studied species and there are only really a few papers on it – and are not really widely available.

Why do mantises eat the heads of their mates?

It's not immediately obvious what females get out of sexual cannibalism, but it could be a number of things. Males often make poor-quality meals, but in mantises, the hungrier a female is, the more she is likely to eat the male. However, female orb spiders tend to attack everybody, and by doing so they can weed out the weaklings and only mate with the strongest males. Finally some female spiders kill males whose attention just attracts predators and would endanger the female – after that, it doesn't make sense not to eat him. But it seems mantises and spiders are particularly prone to sexual cannibalism, because their sizes matter. The smaller the males relative to the females, the more likely they are to be gobbled up. In mantises and spiders, females commonly dwarf males.

Is there a fly that has a sperm which is 2.5 inches long?

Yes, the fly is called *Drosophila bifurca* and produces 6cm sperm, more than 20 times the length of the male. Utterly incredible. The male produces only about 5 sperm per mating, which he feeds into the female until they snap. Producing such enormous sperm entails enormous testes, and the testes of a *D. bifurca* male can reach 11% of his body weight.