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The life of the [cottony cushion scale insect](#) reads like something from the most ridiculous of tabloid newspapers. Dad leaves parasitic body parts in his own daughter, which produce sperm that fertilise her eggs. He is both father and grandfather to his own grandchildren.

On top of that, these insects are mostly hermaphrodites. With the exception of the odd pure male, almost every individual is both male and female. They reproduce by having sex with themselves, fertilising their own eggs with their own sperm. And this means that scale insects can be father, mother, grandfather *and* grandmother to all of their grandchildren. Good luck drawing *that* family tree.

[Scale insects](#) are small animals that suck on plant sap for a living. Encased in bizarre waxy shells, most people wouldn't even recognise them as insects – the cottony cushion scale, for example, looks like a dollop of shaving foam. It and two of its close relatives are the only known hermaphrodites out of several millions of insect species.

In most hermaphroditic animals, an individual grows up and develops the organs that make both sperm and eggs. But that's not the case for the cottony cushion scale. When it mates with itself, it fertilises its own egg with its own sperm. Then, *after the point of conception*, yet more sperm invades the embryo. This “infectious tissue” creates sperm-producing organs inside the daughter* and the resulting sperm eventually fertilises the daughter's eggs. (A note on terminology: obviously, each insect is hermaphrodite but they're referred to as “daughters” because they have the body of a female. The rare pure males look very different.)

How did this bizarre sexual system evolve? In 2009, Benjamin Normark suggested that it's the result of a battle of the sexes. He envisioned a time when males and females were separate entities. When males gained the ability to infect their daughters with “parasitic” sperm, they could fertilise the eggs of multiple generations. This trait spread until the parasitic tissue became the norm, and true males all but disappeared.

Normark assumed that the infectious sperm would be parasitic, that it would always benefit the male

lineage at the expense of the daughters' health or reproductive ability. That's a reasonable assumption, given the sexual conflicts that rage in other insects – many species produce sperm that *do* harm females or even shorten their lives.

But [Andy Gardner](#) and Laura Ross from the University of Oxford think that there's more to the evolution of the scale insect's sex life than males versus females. They developed a mathematical model to simulate these sexual conflicts among ancestral scale insects where the sexes were still separate. The model accounts for the fact that daughters aren't infected with any old parasitic tissue – it comes from their "father", and carries many of the same genes that they have. As such, there's potential for them to cooperate, rather than compete.

Their model predicts that when this odd tactic first evolved, the infectious tissue would probably have harmed the females in some way, who would have adapted to suppress it. In fact, if the harms were high enough, the infectious tissue would probably have evolved to suppress itself – its genes would have had a higher chance of reaching the next generation if it let the daughter get on with things herself and mate with a true male.

Over time, this conflict would have weakened. The infectious tissue would have become more common, and inflicted less harm upon the females. Eventually, daughters would actually benefit from being fertilised by dad's sperm.

At some time, there would have been a tipping point when conflict gave way to collaboration. Females would pass on more of their own genes to the next generation if they mate with their own parasitic fathers rather than with other males. Normal males started to disappear and the hermaphrodites took over. Rather than existing as a distinct sex, males turned into a lineage of parasitic tissue, passed down from one daughter to the next.

There is a final twist to this tale: Gardner and Ross think that the scale insects carry a passenger that could have quickened the demise of the males – a bacterium. Many insects carry helpful bacteria that provide them with important nutrients, and the cottony cushion scale is no different. These bacteria can often be found in tight clusters around the infectious tissue, and if they are killed with antibiotics, females are more likely to produce sons.

To Gardner and Ross, this suggests that the bacteria could help to protect the infectious tissue from being destroyed. Why? Because the bacteria are passed down from mother to daughter. Males are a dead-end to them. In this regard, their "interests" are the same as those of the infectious tissue. Sons are a dead-end; daughters provide vessels that sail into the next generation.

Reference: Gardner & Ross. 2011. The evolution of hermaphroditism by an infectious male-derived cell lineage: an inclusive-fitness analysis. *American Naturalist* citation tbc

Photo by P. Hollinger

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7 Responses to “Hermaphrodite insects fertilise daughters with parasitic sperm”

1. 1. [Zoonotica](#) Says:
[July 15th, 2011 at 10:19 am](#)

V cool bugs (and great post) but is this method of reproduction not harmful to them in terms of genetic diversity? If all of a scale insect's genes come from a single parent and then all of its offspring contain exactly the same genes doesn't that reduce the population's fitness to adapt to its environment? Or is the odd pure male enough to counteract this?

2. 2. [Ed Yong](#) Says:
[July 15th, 2011 at 11:21 am](#)

The rare males probably counteract this. In the links at the bottom, read the first one about the clams. That's another example of an asexual species getting the requisite dose of genetic diversity by very occasionally having sex (and check back on the blog on Monday for another example). And indeed, at least the genetic material is being shuffled from time to time, even if it's the same stock.

3. 3. [Zoonotica](#) Says:
[July 15th, 2011 at 11:25 am](#)

Oooh I shall check that link out. Thank you 😊

4. 4. [laura Ross](#) Says:
[July 15th, 2011 at 11:35 am](#)

Both of you are probably right. Yes when the scale insects reproduce by self fertilizing only, over time their genome becomes homozygous for more and more loci, which might lead to inbreeding depression. We think though that occasional matings with the real males might indeed shuffle the genetic material from time to time and are currently developing molecular markers to test this in the lab. Ed: thanks so much for your amazing coverage of our article!

5. 5. [Ed Yong](#) Says:
[July 15th, 2011 at 11:37 am](#)

You're welcome! Thanks for the awesome study and for answering people's questions in the comments! I LOVE LOVE LOVE it when scientists do that.

6. 6. [Zoonotica](#) Says:
[July 15th, 2011 at 11:42 am](#)

Thanks for replying Laura!

7. 7. [Blackbird](#) Says:
[July 15th, 2011 at 4:46 pm](#)

Wow, thank you for covering this. It is something quite unique!

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Ed Yong is an [award-winning](#) British science writer. His work has appeared in New Scientist, the Times, WIRED, the Guardian, Nature and more. Not Exactly Rocket Science is his attempt to talk about the awe-inspiring, beautiful and quirky world of science to as many people as possible.

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