Bacterium makes the male parasitic wasp redundant

A bacterium in the reproductive organs of female parasitic wasps ensures that only females hatch out. What is more, these wasps no longer need males to reproduce. A boon for biological pest control.

TEXT NICOLE VAN 'T WOUT HOFLAND **PHOTO** BUGSINPSPACE.NL

The American parasitic wasp *Muscidifurax uniraptor* has given a whole new meaning to the slogan 'girl power'. The female wasp reproduces without the help of a male. Thanks to a bacterium in its reproductive organs, nearly all the eggs hatch into females and the male of the species is disappearing. The underlying mechanism is less complex than hitherto believed, concluded entomologist Yidong Wang during his PhD research at Wageningen University. The parasitic wasp, which originally came from Costa Rica, is no more than a couple of millimetres in size. The sex of the miniscule insect is not determined by sex chromosomes as it is in humans, but by the number of chromosomes in a cell. The males have a single set of chromosomes in every cell, while the females carry a double set. Normally, a fertilized egg develops into a female and an unfertilized egg into a male.

A Wageningen scientist discovered back in 1990 that bacteria in the reproductive organ of parasitic wasps causes the insects to produce daughters only. But the mechanism, the trick used by the microbes, remained a mystery for a long time. Scientists used to believe that the bacterium, *Wolbachia*, used a number of signals to cause unfertilized eggs to hatch into females instead of males, in a similar way to what happens in other parasitic wasps. But in this particular wasp species, it turns out only to need one trick: doubling the genetic material in the egg.

MADE IN THE LAB

Wang demonstrated this with a female parasitic wasp made in the lab without the bacterium. This wasp carried not two but three copies of every chromosome. 'Some of her unfertilized eggs contain a single set of chromosomes, and others two,' explains Wang. Those eggs hatched into males and females respectively. The entomologist concluded from this that the number of chromosome pairs was the only determining factor. So the bacterium only needed to double the genetic material and no further signals were necessary on its part.

The bacterium intervenes just after meiosis takes place, the process by which chromosome pairs divide to create egg cells. Through a mechanism yet to be identified, the bacterium causes two chromosome sets to fuse, and the egg subsequently hatches into a female wasp. The bacterium has good reason for this, says Wang. 'Unlike the females, the males don't pass the bacterium on to their offspring.' So, the bacterium's chances of survival are greater if the females

Almost all American parasitic wasps of the *Muscidifurax uniraptor* species – a few millimetres in size – are female.

outnumber the males.
It is not just the Costa Rican parasitic wasp that coexists with *Wolbachia*. It is estimated that half of all insects are infected with this bacterium, although it doesn't always have any effect on their reproduction. Entomologists are also discovering more and more species of bacteria that can turn the family planning of their host insects to their advantage.

NO INTEREST

The parasitic wasp species has lived with the bacterium for so long that it has adapted to asexual reproduction. The sperm cells of the male parasitic wasps – which are still born sporadically – are not viable, and the females show no interest in the males. The males continue to display courtship behaviour to persuade the females to mate, but to no avail. This is not just the case for this American parasitic wasp. Earlier studies have shown that the bacterium disrupts the sexual attraction between the males and females of other species too.
'Even if they wanted to, a male and a female wasp won't get any offspring through sexual reproduction,' says Wang. That is because a special organ in the female for storing sperm no longer works properly in the infected parasitic wasps. That goes one step further in other insects, which have lost their reproductive organs entirely over thousands of years of evolution. 'So the parasitic wasp needs the bacterium to survive as a species,' concludes Wang.

EXACT COPY

Since every female brings offspring into the world asexually, every daughter is an exact genetic copy of her mother. Genetic diversity and evolution are therefore minimal in these parasitic wasps. With changes to the environment, that is probably disadvantageous for this species in the long term, but in the short term the insects benefit from it, according to Wang, because they don't have to spend any time or energy on looking for and mating with the right male.
The female army of parasitic wasps is useful in agriculture as well. Farmers make use of the insects for the biological pest control of flies. The parasitic wasp drills a hole in the hard shell of fly larvae, and lays her eggs there, which go on to eat the pupa. Male wasps don't lay eggs, so it is precisely the parasitic wasps that are infected with *Wolbachia* bacteria – and don't have any males – that form the ideal shock troops. ■

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