

Cooperation between figs, wasps and parasites proves 3 is not always a crowd

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This week in the online open-access journal *PLoS Biology*, scientists Simon Segar, James Cook, Derek Dunn, and colleagues at the University of Reading have found that during mutualism, a cooperative relationship between two different species, a third parasitic species may help to keep the relationship stable.

During mutualism, both species benefit. However, the long-term relationship between them can be threatened by individuals who take too much advantage of the relationship in the short-term for their own benefit. This new research suggests that the stable mutualism between tropical figs and pollinator wasps, which is about 100 million years old, may be maintained partly by parasitic wasps. This is contrary to the commonly held belief that parasites always have a negative effect.

The cooperative relationship between tropical figs and specialized pollinator wasps is such that the wasps pollinate the trees, and the trees provide resources for developing wasp offspring. The female wasp enters a fig fruit, and then pollinates the tiny flowers within the fruit. The tree's seeds develop in parts of the flowers known as ovules, and the pollinator lays her eggs into some of these ovules.

Importantly, ovules that contain developing seeds need to be free of wasp offspring because they eat the seeds. Therefore, each egg laid costs the tree one seed and, in return, the female wasp's offspring are responsible for dispersing the tree's pollen once they leave the fig fruit. Trees need to produce both wasps and seeds for the mutualism to persist,

but natural selection should favor wasps that exploit the maximum number of fig ovules in the short-term. This results in a conflict of interest between wasp and tree.

The fig fruits contain hundreds of ovules that can be grouped into ones that are situated closer to the center of the fruit, known as inner ovules, and others that are further away from the center of the fruit, known as outer ovules. Most pollinator wasp eggs are found in the inner ovules, whereas most fig seeds develop in the outer ovules. The female pollinator wasps avoid laying eggs in the outer ovules and this helps to keep the relationship between wasp and fig stable.

This new research has found out that they do this because pollinator offspring developing in the outer ovules are at high risk of attack by parasitic wasps. These parasites lay their eggs directly into ovules from outside the fruit and will kill pollinator offspring. The risk from parasitic wasps is greatly reduced towards the center of the fruit, which is likely to play a part in encouraging pollinators to avoid laying eggs in the outer ovules. It also reduces the total numbers of eggs that the wasps lay.

Professor James Cook, from the University's School of Biological Sciences said, "Inner ovules can provide an 'enemy-free-space' for pollinator wasps to lay their eggs in. Our results suggest that this favors pollinators that lay their eggs in the inner ovules and leave the outer ovules free for fig seeds to develop in. Because a wasp and a seed cannot develop in the same ovule, this is vital to ensuring that fig seed production is safeguarded. Parasitic wasps are generally thought to have negative effects on the relationship between figs and their pollinators, but our results show that in fact they may help to keep a mutualistic relationship stable in the natural world."

Citation: Dunn DW, Segar ST, Ridley J, Chan R, Crozier RH, et al. (2008) A role for parasites in stabilising the fig-pollinator mutualism.

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