

Jasmine Parkinson

Minions required for symbiotic partnership (with the possibility of leading to garden domination)- see host for details

We all need a little help at times; a PA with the skills and knowhow to help us overcome those daily challenges which we cannot face alone. For you, these challenges might be fixing the plumbing or navigating a new gadget. You may consider yourself a Jack-of-all-trades or a finely tuned specialist, but either way, teaming up and gaining a boost from a friend now and then can save you a lot of time and hassle. The life of an insect is not so different in this regard.

It's a tough old world, and insects need all the help they can get to survive, squeeze out babies for the next generation and keep them alive, all whilst trying to keep up with the Joneses by outcompeting their neighbours. Sap-sucking insects, like aphids, whiteflies and mealybugs (the bane of gardeners worldwide) know this all too well. Throughout their lives, they consume nothing but sap found in the stems of plants, and that poses a serious predicament. Sure, this oozing liquid is full of sugars, but there is hardly any protein to be had in it. Not enough to sustain a growing insect that wants to multiply and take over your prized petunias. It would be like a person trying to live off jelly babies. The solution to this imbalanced food source is tantalizingly so near, and yet so far. Proteins can be made from ingredients found within the sap if you have the right chemical kit, but the insects don't know how to. They literally lack the genetic blueprint necessary to perform such a reaction. For these little blighters, it really is a case of water, water everywhere, but there's nary a drop to drink.

They could hang up their hats and give up, but evolution has a nifty way of working around problems like these. What the sap-suckers need is a sophisticated sidekick to manufacture protein for them, and they acquire it from the most unlikely of places: bacteria. No, the insects have not been drinking Yakult; they have formed symbiotic relationships with specialised micro-organisms. These bacteria actually live inside the insects' bodies quite happily, like tiny hordes of minions, busily harvesting proteins from the sap their hosts eat. You may wonder what the bacteria gain from this relationship, and the answer is a nice home with relatively constant conditions compared to the harsh outside climate, as well as a ready supply of sugars and other nutrients which they can use as they please. The mothers transfer some of these bacteria to their offspring, thus perpetuating the relationship down the generations. It's a bizarre but effective strategy to help both the insects and the bacteria exploit a source of food and an ecological niche that neither of them could achieve alone.

Insect-bacteria symbiosis is a remarkably common strategy, and it's not just for nutrition. Minions can also serve as a potent source of protection from predators. Arch-nemeses of

aphids are the parasitoid wasps. These aren't the black and yellow varieties that plague your picnic table; by comparison, parasitoid wasps make those stinging jam-bandits resemble harmless butterflies. Parasitoids will inject their eggs directly into the aphid's body, where they hatch into wasp larvae that eat the victim from the inside before bursting out, a bit like the film *Alien*. Death by baby parasitoids is a nasty way to go for any critter, but fortunately there's a minion for that. Many aphids harbour a second species of bacterium (which also works alongside a friendly virus just to shake things up a bit). Together, these little helpers will prevent the wasps' eggs from hatching and developing inside the aphid so that it can live another day and produce more babies of its own. Great success!

Not to be outdone, mealybugs have gone a step further in convoluted associations. They have two types of symbiont helpers to assimilate protein from sap, one of which lives inside the other. It's the only case of a bacterium living inside another bacterium, like microscopic Russian dolls, or if you prefer, minion inception. Millions of years of living the easy life have led to an obligate dependency within this trio, and many biochemical pathways now require contributions from all three members. This renders the mealybug-symbiont "holobiont" into a three-legged stool. If one leg is kicked away, the other two will surely fall.

If you think that this whole business sounds rather twisted, you need look no further than your own cells. Each contains mitochondria, tiny factories that perform respiration and allow you to gain energy from glucose and oxygen. The evidence overwhelmingly indicates that these organelles were once free-living bacteria that formed a symbiotic relationship with eukaryotic cells hundreds of millions of years ago. So it's fair to say we all carry little minion hordes of our own.