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unusual liaisons

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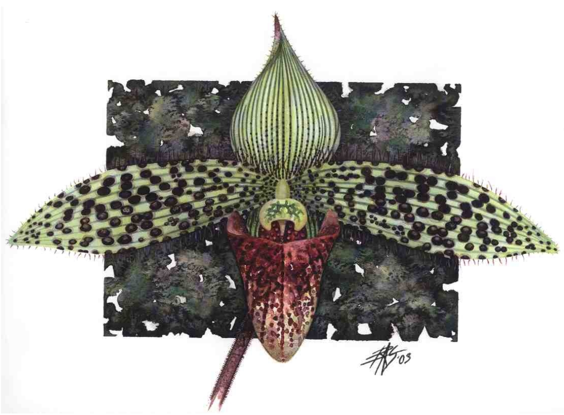
Sex for procreation. It doesn't sound in the least bit eccentric. But how about sex between a flower and an insect? We all know that flowers depend very much on insects to perpetuate their species. It is their answer to a lack of legs or wings. Consequently, over the millennia, plants have devised the most creative ways of luring insects into the places where they keep pollen. Some flowers have thought up shapes that resemble an insect's mate, or places that are ideal for shelter, or they cunningly display colours that are hard for the six-legged species to ignore. Many plants give off scents to trick pollinators. One particular type of orchid has gone a step further and found out how to mimic the sex pheromones of some wasps. The poor wretches are tricked into thinking that the orchid is a potential sex mate and land on it to copulate. It's a SAD story really. Indeed, SAD – otherwise known as stearoly-acyl carrier protein desaturase – is the key enzyme in the synthesis of the fraudulent pheromone.



Paphiopediulm sukhakulii, by Robin Street-Morris

Courtesy of the artist

Orchids have been popular for a long time. Besides their looks, they provide us with the widely favoured vanilla that is used in cuisine all over the world. But good looks are not enough for perpetuation. Orchids – like many plants – have thought up shelters, scents and even food to attract potential pollinators. And pheromones: the ultimate artifice. Luring pollinators by using pheromone cues has been coined 'sexual deception' and was first described at the dawn of the 20th century in the orchid genus Ophrys. In fact, in the Euro-Mediterranean region, pollination by sexual deception is considered to be this particular type of orchid's hallmark. In a nutshell, males of a certain species of wasp are led to the Ophrys orchid, blind to the fact that it is not another wasp. Having reached a part of the flower known as the labellum, the wasp proceeds to copulate and then takes leave with its furry coating surreptitiously covered in pollen. Turned on by yet another Ophrys, the wasp deposits the pollen onto its flower. And so on. Scientists argue that while the shape and texture of the labellum certainly plays a role in luring pollinators, the pheromone mimic is far more powerful.

Mimicking a pheromone is no simple task. It means that the plant has gone to the extent of cracking the chemistry that underlies the female wasp sex pheromones, for instance, and then twisting its own metabolic pathways to mimic it. The sex pheromones of female wasps are a mixture of cuticular hydrocarbons, the most important of which are alkenes and the location of double bonds within them. Different sex pheromones present double bonds at different locations. Different Ophrys orchids actually produce a pheromone parody of a specific female wasp's sex pheromone, thus ensuring that the same species of wasp will keep coming back but, more importantly, will also deliver the pollen to the right flower. Over the years, such manoeuvres have probably had an effect on orchid evolution and scientists argue that orchid speciation may well be a consequence of pollinator adaptation.

Alkenes accumulate in the labella of Ophrys flowers – a protrusion which serves, literally, as a landing platform for pollinators. Stearoly-acyl carrier protein desaturase (SAD) is the name of the enzyme involved in plant alkene biosynthesis of which there are various isoforms. In certain types of orchids, namely *Ophrys sphegodes* (early spider orchid), SAD2 seems to the active one. At the beginning of alkene biosynthesis, SAD2 inserts a double bond into a saturated fatty acid to produce an unsaturated fatty acid. This ultimately leads to the production of alkenes. The location of the double bond is important for the type of sex pheromone produced. Alkenes with different double-bond locations define the kind of pollinator that will be seduced. Consequently, the genes which specify double-bond positions may well be directly associated with pollinator adaptation. An intriguing thought. Likewise, all you need is a change in SAD activity – namely in the binding pocket which creates and locates the double bonds – for a change in alkene specificity, and hence pheromone specificity. What is astonishing is that, at the sequence level, plant SADs are unrelated to their animal counterparts! Which makes the orchid pheromone fraud even more devious.

A question which arises: why specialise pollination to such an extent? Would it not be wiser to let a greater variety of insects pollinate the same species of plant? Would that not perpetuate the species in a more effective way? Even if a tad wastefully? It has all been thought out. If an orchid produces a sex pheromone meant for only one type of wasp, then the said wasp is sure to be seduced by an orchid of the same species. What is more, every orchid releases an astounding 12'000 grains – so progeny are ensured. Although only about 10% of the Ophrys population is actually pollinated, it is enough to preserve the population. As a rule, there is no real guarantee that an insect covered in pollen will actually deliver it to the right flower. So the Ophrys conspiracy is very subtle. Scientists have discovered that when a plant decides to specialise with one pollinator and, what is more, lures it in with a promise of sexual intercourse – the pollinator goes from one orchid flower to another with little pollen loss in the transport process. Such a tight selection on plant traits is believed to be a major driving force in flower diversification and speciation.

But things are even more complex and cunning on behalf of the Ophrys orchids. Only the male wasps are attracted to the flower's labellum. Now female wasps produce male wasps without the help of their men. They only need male wasps to produce female wasps… From an orchid's point of view, it knows that, whatever happens, there will be plenty of pollinators around. But it is also a risk. All in all, here is an extreme example of a plant that has learned how to trick an insect so subtly that the plant has become wholly dependent on it for its survival. Talk about walking on thin ice. Yet sexual deception has evolved several times in different types of orchid, so it must be successful. And the orchids seem to have been very thoughtful too in their plight; the male wasps obviously make the most of their flings and leave a little ejaculate behind them. And, though they ignore their real mates, the ladies are still able to reproduce.

Cross-references to UniProt

Acyl-[acyl-carrier-protein] desaturase 2, chloroplastic, *Ophrys sphegodes* (Early spider orchid) **:** E3PZS2

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