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> ONE MONTH, ONE PROTEIN <

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The life of a whiff

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Any scent conveys a message. It can be a nice one or not such a nice one but a smell always has something to say. And living organisms of all forms and sizes make great use of scents in matters so crucial as reproduction or more down to earth as mere survival. A scent can ward off a predator or, on the contrary, attract an admirer. Flowers are great users of smells; since they cannot move around the way animals do, they make sure their scented emissions can. And they know when to let a whiff off. A scent is a combination of chemicals that a flower synthesizes. A flower, however, will not release a fragrance unless it needs to. What is it that orchestrates the biosynthesis and subsequent emission of a smell or not? In petunias, a protein known as ODORANT-1 seems to be at the heart of smell: without it, a petunia's petal would be scentless.

Nocturnal hawkmoth and a petunia

Courtesy of Cris Kuhlemeier
Institute of Plant Sciences in Bern
Photo by Maria Elena Hoballah.

Flowers use colour, scent and architecture to lure or to repel. It is an intricate world of sensations that humans have been enjoying for thousands of years now. Perfume has been part of human culture for ages. Flowers farmed for their fragrance can be seen portrayed on Egyptian frescoes dating back 5000 years. The Madonna Lily (*Lilium candidum*) seems to have been one of the very first crops to appear. Paintings of ladies in the Pharaoh's environment carrying scented cones on their foreheads are also depicted, and recipes for concocting the scents have been found in scrolls. These involved chopping and pounding petals which were then mixed with ox fat. Closer to our time, the Victorian era – which spanned most of the 19th century – had a very intimate connection with the world of flowers. Flowers decorated anything from clothing to china, and the scent of a particular plant was believed to carry a unique meaning.

A flower's scent transpires from its petals, which is the reason why we approach our nose to a flower's petals and not to one of its leaves. The fragrance itself is a potpourri of chemicals the sum of which gives a specific smell: that of a rose, a lily or a petunia for instance. Each one of these flowers will use a particular scent to attract a particular insect, at a particular time of day in their quest to pollinate and reproduce. *Petunia hybrida* sends off fragrant communiqués towards the end of the day and well into the night, which are received loud and clear by hawkmoths which indulge in the flower's nectar and, in return, lend a hand – or a wing – in Petunia pollination.

It is a blending of volatile benzenoids which give *Petunia hybrida* the characteristic scent hawkmoths are attracted to. Since the 1950s, much research has been made in an attempt to understand the biosynthetic pathways at the heart of benzenoid production, and many enzymes have been pinned down. Besides unveiling the enzymes which synthesize the chemical compounds that make up a smell, what is also of extreme interest is to know how the synthesis of these chemicals is triggered off in the first place and who decides when they have to be emitted or not.

In *Petunia hybrida*, one such candidate has been discovered: ODORANT-1 protein. ODORANT-1 is not a very large protein – barely 300 amino acids long. It is not involved in synthesizing the various benzenoid volatiles that make Petunia's scent but it ***is*** directly involved in orchestrating their biosynthesis. Without ODORANT-1, Petunia has no scent. This particular protein belongs to the R2R3-type MYB family of proteins, which all share a conserved DNA-binding domain and are involved in transcription regulation. *Petunia hybrida* ODORANT-1 is a member of this family but a member of its own kind since – despite sharing a few features with other MYB proteins – it shows many differences and thus defines a new subgroup.

ODORANT-1 is found in *Petunia*'s petals at the time of scent production – late afternoon and evening – and in the two tissues which produce the scent: the petal's limb and tube. And its expression is weakened by morning when *Petunia hybrida* shifts into its odourless state. How ODORANT-1 regulates the transcription of enzymes, which ultimately synthesize benzenoid volatiles, is still a mystery. It may do it by binding directly to the promoters of particular enzymes – either on its own or with other transcription regulators – or by regulating the activity of yet other transcription factors. The intriguing part is that some of the chemicals leading to benzenoids are also needed for the flower's pigmentation. How is it then that the suppression of ODORANT-1 has no influence whatsoever on the petals' colour? This is explained by the fact that the synthesis of petal colour and the scent it emits occur at different developmental stages. A petal's colour is defined well before it is ready to trigger off the process of attraction by scent. Indeed, pigments are synthesized in early stages of floral development and stored in vacuoles.

Humans have been hunting down scents for millennia. Only in the past few decades have they been able to synthesize them by creating chemicals which mimic fragrances as extravagant as the essence of a waterfall or moss imbibed in a morning's dew. All this is not only for the perfume industry but also for day-to-day products such as washing-up liquid and shampoo. Paradoxically – and concomitant with this fragrance frenzy – flowers in shops are losing their scent probably because continuous cross-breeding for characteristics such as better vase-life, colour and quantity have slowly blotted out scent, which is not a prerequisite when you are looking for a bouquet of flowers. The next step would be to restore the original scent of a flower by way of genetic engineering or to bestow upon a petunia the scent of a lily…

Cross-references to Swiss-Prot

ODORANT1 protein, *Petunia hybrida* (Petunia) : Q50EX6

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