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the beetle's brothel

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It's nice to have a warm place to mate. You may think this applies only to mammals. But it doesn't. Insects also love to breed in a cosy setting – in particular some beetles that have taken to coupling in large lilies which provide them with heat, as long as they stick around long enough to carry some pollen away. It's a clever invention, based on 'give and take' and a way-of-living largely put into practice by plants since they are stricken with immobility. They're ready to give insects a little of their nectar but they'll also make sure some of their pollen flies off with them for dissemination. How do lilies warm the place for beetles? By way of one of two respiratory pathways – known as the alternative one – which turns the energy produced into heat. A key enzyme involved in this alternative respiratory pathway has the sexy name of 'alternative oxidase'.

Amorphophallus titanum

The biggest lily, not to mention flower, in the world, looks beautiful but smells like a corpse

Source: Wikipedia

Lilies – and many other primitive seed plants – seem to have flourished in unison with beetles since the late Mesozoic era – which was a very long time ago, roughly 200 million years. This is possibly because the plants provided beetles with a warm place to stay for their lovemaking thereby making sure that the lovers ended up covered in pollen and exported it – quite unintentionally – to other flowers. If the surrounding temperature is pleasant, the energy the beetles need to produce in order to copulate – and gather nectar – is far less than the same two beetles would need were they stranded on an ice-berg for instance. The same carry-on continues today. So do lilies produce heat simply to attract insects? Most probably not.

Primitive seed plants such as lilies use oxygen to produce heat in the alternative respiratory pathway while others produce heat via starch or even lipids. Plants which are capable of producing heat – and there are quite a few – grow both in below zero temperatures but also tropical climates. It is all a question of survival, and sex really. Heat production in thermogenic plants occurs when the flower is blooming. Whatever the climate. Some plants flower with melting pools of snow at their feet. The difference between the ambient temperature and the temperature inside the flower can be as much as 40 degree Celsius! Which is more than we can do… The same kind of differences can easily exist in tropical climates where nights can be nippy, and the flower must be kept at a far warmer temperature.

So what is happening at the molecular level? What is it in plants that allows them to produce heat? Plants have two respiratory pathways – which are two different ways of dealing with oxygen molecules in the electron transport chain used to produce energy. The classical pathway produces ATP following activation of proton pumps via ubiquinone. When oxygen is pushed through the alternative pathway, it skips the proton pump steps and instead of producing ATP, it produces heat. One of the key enzymes in this alternative pathway is alternative oxidase which is lodged in the mitonchondrial membrane and happens to be at the crossroads between the classical and alternative pathway.

Besides simply producing heat, thermogenic plants must also have a system to regulate it since a blooming flower must be kept at a constant temperature despite differences in day and night temperatures for instance. How does this come about? It is believed that differences in ambient temperature may cause the mitochondrial membrane to change in structure, thus changing its fluidity which could have an effect on alternative oxidase activity. A decline in temperature could also trigger off the production of thermogenic metabolites which could ultimately have an effect on alternative oxidase synthesis. Surprisingly, or perhaps unsurprisingly, there may be a counterpart of alternative oxidase in animals which hibernate and need to keep their body temperatures at a certain level. However, the pathway is far more complex in mammals – whereas in plants heating occurs merely at the cellular level and only in the flower, the production of heat in mammals occurs over much of the body and is dependent on the nervous system.

For the time being, the biochemistry that lies behind heat production in thermogenic plants is poorly understood. However, the time it actually lasts has undergone much study. Heat production begins in the bud, when the petals are tightly closed, and ends as the flower opens out wide. It takes about 24 hours for the stigma to appear – on which pollen will be deposited – and then the stamina – on which is found pollen. So if the lily guarantees a warm chamber for a night, there is a fair chance that the beetles decide to stay over and in so doing the plants are pretty sure that they'll leave the following morning covered in pollen. It sounds fiendish but it's just a calculated means to survive. What is more, heat emanating from flowers is also thought to enhance their scent – either to attract pollinators or ward off the enemy. Over the years, Mother Nature has certainly devised many different ways of getting what she wants.

Cross-references to Swiss-Prot

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