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The tale of a love song

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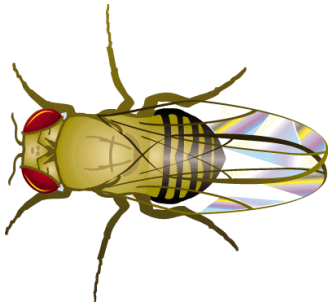
Romeo chose to sing softly to Juliette after dusk, on a warm summer's night. And the onset of daylight, like the blowing of a cool breeze, would only have interfered with his lyrical hum. *Drosophila* has no such qualms when playing a serenade to the loved one. Neither a change in light nor a change in temperature has any effect on the fruit fly's courtship song. What is *Drosophila*'s light- and temperature-insensitive love song? Put bluntly, it is a case of acoustic communication with an end to mate. Just like Romeo.

When *Drosophila* males woo, they do so by holding out their wings at right angles to their body and vibrating them in the vertical plane. This behaviour produces an acoustic signal – the love song – which is perceived through the female's antennae. Accordingly, she consents. Although she may have little choice in the matter since it has been suggested that the net air movement produced by wing flapping may stop her from walking away. And at the heart of all this is a protein termed the period circadian protein, or clock protein.



Drosophila melanogaster

The clock protein is involved in the generation of biological rhythms in *Drosophila*. Biological rhythms are quite an issue and have been extensively studied in all kinds of organisms. Athletic performances, flowers blooming, bees using the Sun as a compass, mosquito flight activity and *Drosophila*'s love song are all part of biological rhythms, which are of paramount importance. If a flower does not open when an insect is around, it misses its chances of pollination. Likewise, there is no point in *Drosophila* flapping its wings if there is no female in the vicinity.

Biological rhythms depend on two mechanisms: the environment but also internal biological clocks. The clock protein is part of *Drosophila*'s internal biological clock and it is involved both in the pupal eclosion rhythm and the adult's locomotor activity, implying that a single clock system can control more than one process. Indeed, it came as a surprise to scientists when they realised that there seemed to be a relationship between the love song and *Drosophila*'s circadian rhythm.

How does the clock protein affect the love song? There is still much of the tale to be told. There are a number of isoforms, one of which could have a role in the courtship song. Mutations at specific sites –the per locus – can alter *Drosophila*'s daily rhythm drastically by making it shorter (a day of about nineteen hours), longer (a day of about twenty eight hours) or mad (no defined rhythm at all). Remarkably, these mutations also affect the song cycles. Indeed, *Drosophila*'s first stanza is about one minute long. A per mutation affects the stanza's period in the same way as it affects *Drosophila*'s daily cycle, i.e. by shortening it, lengthening it or bestowing upon it a random time span.

The clock protein is predominantly a nuclear protein and present in the fly's brain. The level of expression oscillates daily but it is most

abundant just before the light period. In addition to these daily oscillations, the clock protein changes in size between its appearance and its passing. How? Seemingly, it undergoes posttranslational modifications as a function of time, most of which are the result of phosphorylation. So, pop some phosphor onto the clock protein and *Drosophila* will sing for you. Will it sing louder – or longer – in the event of hyper-phosphorylation? No. Hyperphosphorylation probably brings about death and, hence, the arrest of any kind of love making.

Drosophila melanogaster's song was recorded by Kyriacou et al. in the 1980s by placing a male and a virgin half its age in a cell. The experimenters then created their own peepshow by cutting a porthole in the box. The male's song was amplified and recorded for 5 to 6 minutes, or until copulation had occurred. The scientists discovered that the song has several acoustic components, one of which is a succession of pulses with an interpulse interval of approximately 34 msec.

This interval turned out to be species-specific: males of *Drosophila simulans*, a species closely related to *Drosophila melanogaster*, sing with an interpulse interval of 48 msec. As a result, this specific pause in *Drosophila*'s love song may serve to recognise females of its own species and thus preserve sexual isolation… Remarkably though, though the clock protein is involved in rhythm and locomotion, there is nothing to indicate that it has anything to do with the interpulse interval.

Cross-references to Swiss-Prot

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