

Fine-Dining and Rohypnol: The Molecular World of Insect Sex

Before embarking on his date, a man opens his medicine cabinet and inspects his options. Adorning its shelves are a number of phials branded with cryptic names and filled with corrupt contents. Which will he slip into his partner's drink? Perhaps Acp70A to reduce her interest in sex with other males? Or maybe ovulin to increase the likelihood of fertilisation? Perhaps an anti-microbial peptide? Or HezPSP to stop her producing sex pheromones? Of course, I barely need mention that the usage of such a drug cabinet by a human would be utterly deplorable but for the males of many insects, this nefarious arsenal is available. However, the receipt of these compounds is not via their partner's drink but through the act of copulation.

The ejaculate is a bewilderingly complex construct composed of far more than just sperm. An insect's 'love potion' may contain all manner of protein types from antioxidants, through prohormones, to lectins, and a suite of lipids, salts, sugars, and even non-sperm cells including microbes. A particularly important subset of these ejaculate components are the so-called 'seminal fluid proteins' (Sfps). These 'tokens of love', as they were poetically and somewhat ironically referred to by Mariana Wolfner, have wide-ranging functions that all serve one purpose: to boost the reproductive success of the male. In some cases, the action of seminal fluid components may be mutually beneficial. Male bushcrickets (Orthoptera: Tettigoniidae) transfer a spermatophylax, a rather unpleasant sounding globular mass that is consumed by the female. Whilst not everyone's idea of fine-dining on a date, this secretion is highly nutritious and serves to enhance the size and number of eggs she lays, which, evolutionarily speaking, is good news for both.

However, it's often the case that these ejaculate-transferred compounds have a decidedly one-sided effect on reproductive success. The paradigmatic example of an Sfp is the fruit fly *Drosophila melanogaster*'s 'sex peptide' (or Acp70A), which interacts with a specific class of receptors in neurons innervating the female reproductive tract. Upon receipt of this molecule, female behaviour is reprogrammed: they reject courting males, feed more, lay more eggs, and sleep less. Through this process, the males dramatically lower the risk of their sperm having to compete with those of rival males, thus ensuring certainty of paternity, and effectively turn their mates into efficient offspring-producing machines. Fruit flies are clearly unmoved by Oscar Wilde's quip 'the very essence of romance is uncertainty'. Exposure to this little protein and a number of other Sfps is toxic and, if all of the other manipulative effects weren't enough already, the females die younger. This antagonistic interaction is representative of a phenomena known as 'sexual conflict' in which the fitness of the male and female within a partnership cannot be simultaneously maximised. That is to say, in pursuing a strategy that increases the number of viable offspring, an individual prevents their partner from realising their own ideal.

There are many other ejaculate-mediated effects across insect species including stimulating rapid female engorgement in feeding ticks (*Amblyomma hebraeum*), altered flight behaviour in honey bees (*Apis mellifera*), and structural and conformational changes of the female reproductive tract in *D. melanogaster*. Furthermore, there are many on-going systematic analyses to fully characterise the composition of the ejaculate and the functions of its individual components as exemplified by Mariana Wolfner's, ahem, seminal 1997 review.

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There is a feminism movement currently circulating on social media using the tagline 'I need feminism because...'. One follow up to this opening reads 'science toys shouldn't be in the boys section' and it now seems as though female insects agree for evidence is mounting that they have their own toys at their disposal to retaliate with. Cryptic female choice describes the process by which females can influence the outcome of a mating post-copulation. This occurs through sperm usage and storage by multiply-mated females who may selectively fertilise eggs with the sperm of the sexiest fathers. Work on the spider *Pisaura mirabilis* has shown that females retain more sperm via female choice mechanisms from matings with males who transfer a nuptial gift relative to matings with males that don't, the insect equivalent of 'gold-digging'. Further studies on the red flour beetle (*Tribolium castaneum*) have shown that females preferentially use the sperm of males who rub their legs at higher intensities on the female wing cases and, I mean, who can blame them?

It is tempting after reading about the insect male's arsenal to conclude that females have it hard in the molecular world of insect sex. Margaret Sanger once wrote that 'no woman can call herself free who does not control her own body'. But this hot new topic of cryptic female choice is starting to suggest that we needn't worry for them. Mating isn't harmonious nor is it just a case of male manipulation; it's flat out warfare.