Pheromones are not what you think

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What are the distinguishing characteristics of pheromones and signature mixtures??

Surprisingly, it seems it's not the innateness of responses to pheromones nor the specificity of pheromone receptor proteins, though these are common to many (most?) pheromones. Instead, the distinguishing characteristics of signature mixtures (SMs)* are the combination of a requirement for learning and the variability of the cues learnt (Figure, below) (Wyatt 2010).

Confusing the two ideas has, for example, caused a majority of researchers to deny that mammals have pheromones. In contrast to a species-wide pheromone, there is no single SM to find as, I suggest, SMs are a 'receiver-side' phenomenon and it is the differences in SMs which allow animals to distinguish each other. Mammals, social insects, and other animals both have pheromones and SMs.

Many of the presumed differences between pheromones and signature mixtures (SMs) are not supported when examined in detail (Wyatt 2010). For example, though male moth response to female sex pheromone shows highly specialized receptors for pheromone and dedicated brain areas specific for pheromone processing, other non-sex pheromone processing in insects may be by less specific receptors, without dedicated glomeruli in the brain. Narrowly tuned specialized receptors and dedicated glomeruli are not a prerequisite for a pheromone (e.g. honeybee alarm pheromone, Wang et al. 2008).

* Signature mixtures: ‘variable subsets of molecules of an animal’s chemical profile which are learnt by other animals, allowing them to distinguish individuals or colonies’. [Derived from Wyatt’s (2005) ‘signature odor’ and Johnston’s ‘mosaic signal’ (sensu 2003 and 2005)].

Conclusions. Distinguishing between signature mixtures and pheromones could help our understanding. For example, a male mouse’s urine contains a complex mixture of his individual profile plus pheromones with primer effects on females, including the Bruce effect (contact with an unfamiliar male blocks the pregnancy (Brennan 2009)). When a female mates, she learns the individual SM of her male mate in her accessory olfactory lobe — a memory which prevents his pheromones from blocking the pregnancy block. Thus there are two distinct kinds of chemical information: male testosterone-dependent pheromone(s) (the same for all males), and each male’s different individual SM (including his urinary odour type and peptides related to the MHC).

Karlson and Lüscher ended their 1959 paper introducing ‘pheromones’ by throwing the definition open for discussion. In a similar spirit I would welcome comments and suggestions for improving the ideas presented here. I am also updating Pheromones and animal behaviour for its second edition, due 2011.

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