Chem. Senses 36: 123–124, 2011 doi:10.1093/chemse/bjq140

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An Ancient Olfactory Trait

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Worldwide hundreds of millions of people contract diseases that are passed on by blood-feeding mosquitoes. Two of the major vectors, *Aedes aegypti* and *Anopheles gambiae* diverged ~150 million years ago, yet their olfactory systems share morphological and physiological adaptations. Noteworthy, however, the mosquitoes' odorant receptors are encoded by a large and highly divergent gene family raising the question whether sequence conservation and odorant-induced receptor activation correlate. By heterologous expression studies, Bohbot et al. now found that a subset of odorant receptors, which is remarkably well conserved between the 2 species, is highly sensitive to the olfactory cue, indole, and, moreover, exhibits similar response profiles to other odorants. Indole is a ubiquitous volatile that has been linked to host-seeking and oviposition in both mosquito species. The authors conclude that sensitivity to the ecologically relevant volatile cue, indole, within the examined receptor clade represents an ancient trait that existed already before the split of the 2 mosquito lineages. Until now, this ecological adaptation has been preserved as a result of its life cycle importance. The understanding of how similarities and disparities among odorant receptors relate to olfactory function offers insights into the design of strategies aimed at controlling mosquito-borne diseases.

Olfactory Sensitivity in Hunger States

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Prevalence of obesity and its linked metabolic disorders has become a serious problem for research, public health, and socioeconomics. As odor cues are potential triggers of appetite and ingestive behavior, understanding the relation of hunger state to olfactory sensitivity attracts attention. Indeed, in animals enhanced ability to detect food-related and nonrelated odors is associated with periods of high versus low hunger states, suggesting a close relation of the olfactory system to hypothalamic feeding centers. In humans, the situation is less clear, however. Excluding a number of possible confounders Stafford and Welbeck examined further if olfactory threshold and discrimination varied in different states of hunger and by body mass index. They found that acuity to a neutral odor was significantly higher in the hunger state with the reverse being true for a food-related odor. This appears to be counter intuitive but may facilitate rejection of food and cessation of consuming excess calories. It may also serve to engage in other activities after a meal. Moreover, subjects with high body mass index had higher acuity to food-related but not neutral odors after a meal than subjects with lower body mass index proposing that food odors could sustain food intake in overweight individuals instead of attenuating it.

Antennal Lobe Organization and Life History

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The *Hymenoptera* are a behaviorally highly diverse insect order comprising some 125 000 described and up to 1.2 million predicted species. Their behavioral range includes herbivorous, parasitic, and colonial forms that brought about striking external structural specializations suggesting that also the brains of these diverse animals underwent dramatic morphological adaptations during evolution. Dacks and Nighorn examined one of the most extensively studied insect brain structures, the antennal lobes, in the sawfly, Neodiprion, and compared them with those of honeybees. Sawflies are the most basal members of the *Hymenoptera* order. They show herbivorous lifestyle and are behaviorally similar to moths lacking parental care except that they lay their eggs on a host plant. Bees, however, are more developed, frequently building nests for raising the offspring. The authors found that the olfactory receptor neurons project from the antennae to fill the entire glomerular volume but, unlike those of bees, do not form distinct tracts. Like moths, sawflies exhibit 5 output tracts from their antennal lobes. Sawflies and moths are also similar with regard to their distinct populations of local interneurons and centrifugal neurons. Also the serotonergic and histaminergic innervation of the antennal lobes in sawflies more closely resembles that of moths compared with bees. Properties of the antennal lobes that differ between sawflies and moths, such as dopaminergic innervation, also differ between sawflies and bees. The study

demonstrates that the radically different life histories that evolved in the advanced *Hymenoptera* species compared with the primitive sawflies were accompanied by dramatic changes in the anatomy of their olfactory systems. It also offers the opportunity to examine in the future what neural features are malleable to best fit the selective pressure an organism encounters.

Wolfgang Meyerhof