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Spatial Patterns of Recurved Sensory Organs in Drosophila

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The fruit fly Drosophila is one of the most intensely studied models of development. A subset of -nominally- identical cells on the anterior wing of Drosophila begins to differentiate at puparium formation, each developing a sensory organ. In wild type flies, every fifth cell becomes such a sensory organ. Recent studies on mutant flies have shown that the transcription factor Senseless and the micro RNA miR-9a play significant roles in the choice of bristle density and the regularity of their arrangement. We propose that this cell differentiation is due to a Turing-type bifurcation whereby periodic concentration gradients emerge spontaneously from a uniform background. A paradigmatic model with intra-cellular networks and lateral activation and inhibition between neighboring cells (for example, through the Notch signaling pathway) is shown to generate the observed arrangements of sensory organs. The theory makes several experimentally verifiable predictions. For example, we propose methods to create mutant flies with systematically increasing numbers of ectopic bristles. In our theory, post-transcriptional regulatory action of the micro RNA occurs through the choice of stable solutions of the network.