The butterfly Effect: Moth's Sexual Interaction as an Inspiration for Anemotaxis

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Abstract:

The field of anemotaxis, i.e. the ability to track the source of a volatile substance based on chemical sensing, has been tremendously progressed in the last few decades. The ability to truck chemical volatiles may have a significant applicable impact on different topics such as medicine, environmental science, neurobiology, engineering and more.
Learning form chemically navigating organisms may further empower the progress of chemical sensing.

Chemical communication plays a significant role in various aspects of the insects' life cycle, from feeding of the young to adult reproduction. In moths chemical signaling via pheromones play a crucial role in finding a mate: The female releases airborne sex pheromone that is carried away by the aerial physical forces. The male antennae have specific receptors that recognize the sex specific pheromone, and elicit flight behavior, against wind direction toward the calling female. Previous research in our lab showed that males of the of pink bollworm (*Pectinophora gossypiella*) moth are able to distinguish among females of various qualities (i.e.

large vs. small females). Herein, the moths' sexual interaction may serve as a model for chemical sourcing, incorporating the volatile sender (the female), a volatile mediator (the pheromone) and a highly sensitive receiver (the male). Understanding the decisions made by a male moth when following the pheromone plume may provide the framework necessary for the engineering of chemical sourcing.

In my research I tested how different tradeoffs influence male moths' navigation decisions. The tradeoffs included: 1) Biological – "good" or "bad" female; 2) flight distance "close" and "far". Two groups of females (i.e. good and bad) were placed upstream of the wind tunnel in three different configurations: (1) The same distance from the male keeping 10 cm between the two female groups. (2) One group of females is closer to males than the other, creating a virtual triangle between the two female groups and the point of releasing the males. (3) The two groups of females located upstream to the male point of release, creating an overlap of the two pheromone plumes. In each configuration I switched the place of the female groups after several runs. The behavioral tests were conducted in a wind tunnel assay. When the females (good and bad) were presented at the same distance from the male, the latter chose significantly more of the better females. When the higher quality females were placed closer or further to males in the triangle configuration, significantly more males flew toward the better females; When the pheromone plumes overlapped almost all males flew to the better females wen presented closer to the males, but no significant male preference was observed when the better females were behind the low quality calling females.

The results so far revealed high ability of male moths to detect and distinguish between different volatile sources under different conditions. These findings strengthen the notion of using moths as biomimicry agents for chemically mediated anemotaxis modeling. In addition, this research shed more light on the chemical communication of moths, a system that exhibits knowledge gaps. Specifically, our research may provide new insights that will contribute to the development of novel system of ecological pest management.