Integrated Multistimuli Behavior Analysis and Visual Modeling for Improved Multimodal D. melanogaster Trap in Quail Farm

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Drosophila melanogaster in quail farms poses a serious pest problem, where they disturb the birds, degrade hygiene, and reduce egg production, an important source of nutritious food globally. As potential disease vectors, they also negatively affect animal welfare and farm sanitation. Understanding the sensory mechanisms that govern their visual and olfactory behavior is therefore essential for developing precise control strategies that reduce chemical reliance. Although traditional yellow sticky traps are widely used, they often perform ineffectively because they are designed based on human-visible features rather than the insect's sensory biology. To tackle this, we studied how they integrate multiple sensory cues to guide landing behavior and applied these insights to improve trap design. We used photoreceptor-based spectral visual modeling to identify attractive stimuli and examine how visual contrast influences landing decisions. Our results showed that stimuli calibrated to their spectral sensitivity, especially specific green shades, increased attraction by 1.58-fold over non-calibrated cues. Circular traps with high-contrast edges stimulated innate edge-following behavior and enhanced capture efficiency by 2.38-fold. Olfactory experiments further identified 3% v/v acetic acid as the most effective attractant. By combining these cues, we developed Au-Q+, a multimodal trap that triggered a multimodal synergy, increasing approach rates by 4.5-fold over the control. Obviously, validation in a real quail farm showed that Au-Q+ outperformed standard traps by 3.74-fold and achieved 44.2% species-specific targeting. This work highlights a shift from human-centered to behavior-based design, which potentially leads to more precise, effective, and sustainable pest control.

Awards Won:
Third Award of $1,200