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SESSION H. Room: Bach 2 13.20-14.40 hrs

Comparative aerodynamics of Dipteran flight

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Two-winged insects (Diptera) possess specialized flight motor systems and exhibit diverse flight styles, with wingbeat frequencies ranging from 40 Hz in craneflies to 1000 Hz in mosquitoes. Despite this diversity, the role of aerodynamic flight performance in their evolutionary radiation is poorly understood.

To investigate this, we studied hovering flight in 47 Dipteran species across their phylogeny and size range. For each species, we quantify flight kinematics used high-speed videography, and used Computational Fluid Dynamics to estimate the aerodynamic forces, power, and sound production during flight. For nine key species, we used μCT to determine flight muscle morphology and estimate flight muscle power. DNA barcoding identified wild-collected specimens.

Our phylogenetic comparative analysis shows that the aerodynamic power requirement of Diptera flight scales positively with body mass, following physical scaling laws. Thus, despite large variations in flight kinematics, the power requirement for flight is conserved throughout the Diptera phylogeny. However, craneflies and mosquitoes are exceptions. Craneflies are aerodynamically efficient due to their large wings, trading agility for flight efficiency. Mosquitoes require high power for flight, which co-occurs with high sound production and is enabled by large flight muscles; this flight style is likely evolved under sexual selection to maximize sound production for in-flight mating.

Overall our results suggest that, unlike primitive craneflies and mosquitoes, derived Diptera such as flies have evolved a narrow range of aerodynamic strategies balancing flight efficiency and agility. Future studies on Dipteran flight maneuverability will provide deeper insights into these evolutionary trade-offs.