Odonata flight: Mechanical study of the wings

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Abstract

Odonata (dragonfly and damselfly) exhibit impressive flight abilities. They can perform many different manoeuvres such as zigzags, linear back and forth motion, sharp turns and quick accelerations. Those trajectories are the results of complex fluid-structure interactions where wing morphology has a prominent role, as shown in previous studies. Insect wings are heterogeneous structures composed of an elastic membrane and a network of veins that control the local stiffness of the wing. The size, geometry, vein pattern, and other wing characteristics strongly vary across the different phylogenetic lineages.
We aim at understanding the role of the different wing's characteristics on the aerodynamic force production and connecting them with flight modes of dragonflies. Such results could be extrapolated in evolutionary perspective, starting from early apparitions of the first Odonatoptera in the early late Carboniferous.

In this work, we perform a comparative study of dragonfly wings from 14 genres (distributed in 2 infraorder, 8 family) using vibrational tests to determine the resonance frequency. A large amplitude study was carried out on some of them in order to study the non-linear aspect of their behaviour.
If the first part of the study seems to highlight the fact that the natural frequency of the wings is well below the flight frequencies as advanced in the literature, the study in large amplitude reveals a softening system. This raises the question of the resonance frequency of the wings in flight conditions.

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