# Dragonflies flight: Fluid structure interaction of artificial wings

Camille Aracheloff[*,†], Benjamin Thiria [*], Ramiro Godoy-Diana[*], André Nel[†], Romain Garrouste[†]

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[1]. Those manoeuvres rely on 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 (Fig. 1.b). The size, geometry, vein pattern, and other wing characteristics vary strongly across the different phylogenetic lineages[2]. We aim at understanding the role of the different morphological and structural traits found in dragonfly wings on their aerodynamic force production. The final goal being to establish whether there is a connection between specific wing features found in different species and their behavioural ecology (more specifically, their usual flight mode observed in the wild). Such results could be extrapolated in an evolutionary perspective, starting from early apparitions of the first Odonatoptera in the early late Carboniferous[3]. Additionally, the results obtained can be used in a bioinspiration perspective.

Figure 1: Artificial wing in the flapping setup mounted on a force sensor (left) and details of a *Boyeria Irene* .sp (Odonata: Aeshnidae) wing (right)

In order to do a comparative study of several species with different living modes, we focus on only a few wing characteristics such as the aspect ratio, the relative position of the nodus and the position of pterostigma. In practice, we fabricated a set of artificial wings with 3D-printed simplified vein patterns based on a morphological analysis of real wings of different species. The wings were then studied experimentally using a flapping setup as Antier et al.[4] (Fig. 1.a), varying the different parameters cited above. Using a force sensor we show how the different morphological features of the wings modify the aerodynamic force production. We also use high-speed video recordings to examine the structural deformation under the simplified kinematics imposed by the flapping setup.

[*]Physique et mécanique des milieux hétérogènes (PMMH), ESPCI, Paris, France
[†]Institut de Systématique, Évolution, Biodiversité (ISYEB), MNHN, Paris, France
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[3]Nel at al., *Palaeontographica Abteilung A* (2009).
[4]Antier et al., *Journal of Fluids and Structures* **124** (2024).