Curvature control during insect wing unfolding

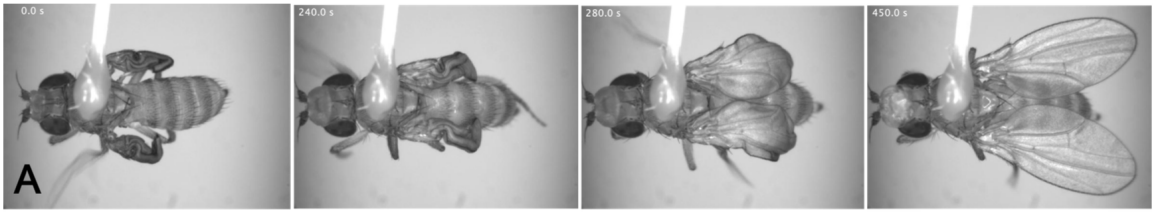
Host labs: IUSTI, Marseille / IBDM, Marseille

Supervision: Joel Marthelot, Marie-Julie Dalbe, Benoit Aigouy, Raphael Clément

The shaping of biological tissues emerges from the interplay of mechanical forces, geometry, and genetic regulation. In the pupal case or cocoon, insect wings, which are larger than the case itself, develop in a folded configuration. Upon emergence, they are deployed within just a few minutes. We recently described the biophysical basis of this process (Hadjaje et al., Nature Communications 2024): insects increase their internal pressure and essentially inflate their wings with hemolymph, the insect equivalent of blood. In wild-type individuals, this produces perfectly flat wings, enabling flight. However, well-known mutations give rise to the Curly wing phenotype, where adult wings remain curved. In thin sheets, such curvature typically arises from a mismatch, geometric or mechanical, between the two opposing surfaces.

The aim of this internship is to investigate the determinants of wing flatness versus curvature, by combining imaging at multiple scales (from subcellular to organ level) with mechanical measurements of wing stiffness. Imaging will be performed at IBDM and IUSTI, while mechanical measurements will be carried out at IUSTI. By integrating kinematic analysis, mechanical measurements, and genetic perturbations, we aim to establish a unified biophysical framework to understanding how hydraulic pressure ensures wing flatness.

More broadly, insect wing unfolding represents a striking example of hydraulics-driven morphogenesis, a mechanism enabling extremely rapid, large-scale transformations of entire organs. This process not only remains largely unexplored in developmental biology but also holds promise as inspiration for bioinspired strategies in the engineering of soft deployable structures.



Expected profile

We are looking for a motivated student who is excited by the interface of physical biology and developmental morphogenesis, and eager to engage in hands-on experimental work.

Future opportunities

This project is embedded in a new long-term research program, and motivated students will be actively encouraged and supported to pursue a PhD after the internship.

Scientific environment

The intern will benefit from multidisciplinary supervision (biology, biophysics, and mechanics) within a highly active and stimulating interdisciplinary environment in Marseille. They will also have access to the seminars and events of the Turing Center (CENTURI), a campus-wide initiative dedicated to interdisciplinary approaches in the life sciences.

Contact

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