



FIG. 1.



FIG. 2.

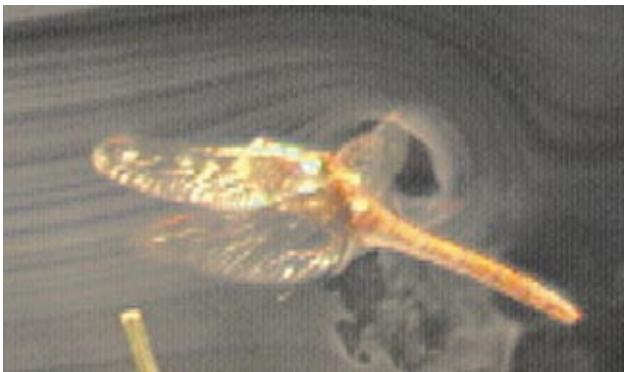


FIG. 3.



FIG. 4.

Visualizing the Flow around Insect Wings

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The photographs above show live insects flying in a wind tunnel. The flow is visualized with smoke in a vertical plane from a hot wire.

Figure 1 shows a large leading edge vortex bound to the forewing of a dragonfly (*Aeschna grandis*). The tip vortex of the hindwing is also clearly visible.

Figure 2 shows one smoke trail splitting at the leading edge of the forewing. Half the smoke reveals the leading edge vortex (visible through the wing), while the other half travels under the wing until it becomes entrained in a shear layer at the trailing edge. The shear layer has been created by two air masses with differential velocities meeting at the trailing edge.

Figures 3 and 4 show another dragonfly (*Sympetrum striolatum*) in free flight, taking off from a reed. Here the leading edge vortex is shown shedding from the forewing (Fig. 3), and as a continuation of the tip vortex (Fig. 4).

Figures 5 and 6 are of a single free flying moth, *Noctua pronuba*, from two perspectives at the same instant. The leading edge vortex appears on the ventral surface of the

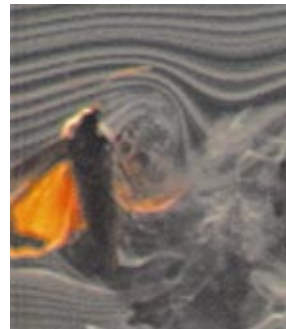


FIG. 5.

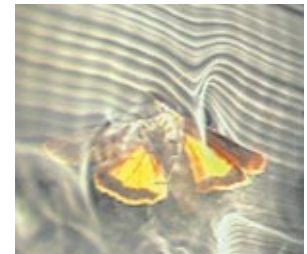


FIG. 6.

reversed, or “supinated,” left wing (right as viewed) on the upstroke—a newly described phenomenon. The video sequence shows the moth performing a vertical climb and turning maneuver (if viewed from above, the moth would turn clockwise), consistent with the concept that the leading edge vortex is a mechanism used by insects for generating high lift.

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