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Three-Dimensional Wing Kinematics and Aerodynamic Characteristics of a Beetle in Free Flight TIEN VAN TRUONG, DOYOUNG BYUN, HIEU TRUNG TRAN, TUYEN QUANG LE, HOON CHEOL PARK, Konkuk University, MINJUN KIM, Drexel University — Detailed three dimensional wing kinematics and aerodynamic characteristics are experimentally presented for the free flight of a beetle, Allomyrina dichotoma, which has a pair of elytra (fore wings) and hind wings. The kinematic parameters of the wing motion, such as the wing tip trajectory, angle of attack, torsion angle, and camber deformation, are obtained from a 3D reconstruction technique that involves the use of two or three synchronized high-speed cameras to digitize various points marked on the wings. Our data show outstanding characteristics of wing deformation and flexibility in the free flight of the beetle. To find out the mechanism of aerodynamic force, the leading edge vortex (LEV) and trailing edge vortex (TEV) on both elytron and hind wing were observed by using smoke wire visualization and digital particle image velocimetry (DPIV) technique. Qualitative smoke lines in the region of the most intent vortex shedding demonstrate clearly the interaction between elytron and hind wing in hovering, forward, and climbing flight conditions. In addition, flow fields near regions of the elytron and the hind wing are quantitatively analyzed in order to visualize the LEV and calculate the circulation and lift coefficient by means of a DPIV experiment.

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