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Flow Structure and Force Variation with Aspect Ratio for a Two-Degree-of-Freedom Flapping Wing[1] MATTHEW BURGE, JAMES FAVALE, MATTHEW RINGUETTE, State University of New York at Buffalo — We investigate experimentally the effect of aspect ratio (AR) on the flow structure and forces of a two-degree-of-freedom flapping wing. Flapping wings are known to produce complex and unsteady vortex loop structures, and the objective is to characterize their variation with AR and how this influences the lift force. Previous results on rotating wings demonstrated that changes in AR significantly affect the three-dimensional flow structure and lift coefficient. This is primarily due to the relatively greater influence of the tip vortex for lower AR. At Reynolds number of order O(10^3) we test wings of AR = 2-4, values typically found in nature, with simplified planform shapes. The lift force is measured using a submersible transducer at the base of the wing in a glycerin-water mixture. The qualitative, three-dimensional vortex loop structure for different ARs is obtained using multi-color dye flow visualization. Guided by this, quantitative three-component flow information, namely vorticity, the Q-criterion, and circulation, is acquired from stereoscopic particle image velocimetry in key planes. Of interest is how these parameters and the vortex loop topology vary with AR, and their connection to features in the unsteady force signal.

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