

Still Puzzling

Five centuries after Leonardo's Codex on the Flight of Birds was written, there is much that remains unknown about the subject. Three biology researchers introduced their article, "Bird Flight: Insights and Complications: New techniques show that more than the wing participates in flying," with a discussion of Leonardo. G.E. Goslow, Jr., K.P. Dial, and F.A. Jenkins, Jr. (*BioScience*, Vol. 40, No. 2, February 1990), wrote that much has been learned in recent decades about the performance of the wing, including the subtleties of wing movement during upstroke and downstroke as revealed by slow-motion photography. "Nevertheless, due to the complexity of its design and the movement of patterns during a wing-beat cycle, knowledge of the bird wing remains sketchy and incomplete."

They initiated a series of studies on neural control of the wing, biomechanics of the wing and shoulder, and evolution of flapping flight. But, "as was the case

for Leonardo da Vinci, ... we were confronted with unexpected results that required further investigation." The particular problem in understanding the control of the wing, they reported, has been "the inability to document the precise movements of its skeletal elements during flight. They built a wind tunnel for testing small European starlings, using a technique called the cineradiograph to observe the movements of the wing skeleton. To their surprise, they found that the bones of the shoulder and thorax move rhythmically with the wingbeat. Why? They hypothesized that the bird's wishbone (furcula) spreads and collapses with the wingbeat, acting as a secondary pumping system to meet the increased metabolic demands of flight, moving air between the air sacs and lungs.

Like Leonardo in his pursuit of artificial flight, the scientists wrote, they planned to continue their studies along these lines, thereby to understand "the evolution of this most amazing and successful form of locomotion." (More recent work by the authors can be found through the usual online search engines.)

—Susan Welsh