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relative roles of the ankle and proximal joints depend on the ratio between foot translational velocity and rotational velocity (advance ratio, "AR"). We hypothesize that the ankle has two roles in swimming: (1) To produce hydrodynamic power by rotating the foot and (2) to control the orientation of the foot, thus transmitting power from proximal muscles as the foot translates. We expect that the ankle shifts between these two functions as AR changes from one swimming stroke to the next. Using a blade element approach, we modeled both the hydrodynamic forces on the foot as well as the ankle moment required to produce this fluid force. Preliminary findings show that, for a given hydrodynamic power output, ankle power is maximum at low AR. As AR increases, ankle power decreases, reaching a minimum of 28% maximum ankle power. These results suggest that plantaris muscle power contribute significantly to hydrodynamic power both by rotating the foot and by controlling its orientation to the surrounding flow.

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A6.62

Aerodynamics of the bird wing: Flow patterns surrounding rotating bird-like wings

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Force production in bird wing flapping may be related to both conventional attached flow as well as development of leading edge vortices. The shape of the bird wing emphasizes the different uses for different sections of the wing: The arm wing is shaped like a conventional airfoil, with a round leading edge and substantial thickness. The hand wing is thin with a sharp leading edge, much analogous to the shape of insect wings which have shown to use strong LEVs during flapping. During flapping flight, a bird wing faces an air flow composed of translational as well as rotational motion. The translational component is closely related to gliding without wing flapping, with the flow being steady and attached. The rotational component is more closely related to hovering. To get a clearer picture of the relative function of the two wing sections and their aerodynamic features we strive to study them separately as well as in unison.
To study the rotational component, we developed a rotary system for flow visualization and force measurement on bird wing models. With this system, we have tested the effects of different local effective and geometric angles of attack and velocity profiles on development of stable LEVs on the revolving wing. These data are compared to LEV development for water tunnel flapping and gliding models to show the differences between LEV structures and conditions for shedding in each of the modes of movement.

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Is the Japanese skeleton shrimp *Caprella mutica* a filter feeder? II. Mechanics

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During filter feeding, a feeding current is passed through a filtration structure to separate food particles from the medium. Filter feeding at low Reynolds number poses specific problems. A Reynolds number represents the ratio of inertial to viscous forces. At low Reynolds number, any disturbance in the flow tends to be damped out by viscous shear. Water flow around small animals therefore tends to be laminar. This means that the boundary layer around the animal's appendages is relatively thick. A study of the kinematics of filter feeding in *Caprella mutica*, a small marine amphipod, showed that the appendages work at a low Reynolds number indeed ($Re \sim 3$ based on the distance between two antennal setae), similar to what has been found for acorn barnacles. To understand the mechanics involved in filter feeding at such a Reynolds number, we visualized and quantified the flow patterns generated by a swaying *C. mutica* using Particle Image Velocimetry. At the start of a swaying cycle, the water surrounding the animal is standing still. This makes it difficult to accelerate it. The animal first moves slightly backwards, dragging along the surrounding mass of water and then quickly reversing the direction of movement and sweeps through the mass of water that was moving towards it. Local Reynolds numbers, leakiness and filtration capacity of the setae on the second pair of antennae will be discussed.

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Onboard video in free-flight analysis of birds; use of head and eyes in vision-based flight control

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Birds of prey are highly dependent on vision for flight. However, previous studies of vision in birds have been principally laboratory-based, using restrained birds and focusing on physiological scope. Here we consider the natural use of head movements in free-flight, utilising onboard video cameras mounted face-forwards on a Steppe Eagle *Aquila nipalensis* to collect footage from which we derive quantitative data. Birds exhibit only limited eye movements within the orbit, hence gaze shifts are achieved largely with movements of the head. Characteristically, fast saccadic gaze changes are alternated with periods of gaze fixation. This is known as nystagmus, and confers two clear functional benefits: maximisation of steady vision, and minimisation of unwanted visual input. Frame-by-frame analysis from several flights over four days confirmed