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Experimental investigation of crustacean swimming with variation of limb structures HONG KUAN LAI, MILAD SAMAEE, GEOFFREY DONNELL, ARVIND SANTHANAKRISHNAN, Oklahoma State University, ROBERT GUY, TIMOTHY LEWIS, University of California, Davis — Crustaceans such as crayfish and krill swim by rhythmically paddling a set of four to five limbs (known as swimmerets or pleopods) originating from their abdomen. The limb motion in these animals has been observed to follow tail-to-head metachronal wave pattern with an approximate quarter-period inter-limb phase difference. The goal of this study is to investigate the hydrodynamics of this swimming mechanism as a function of inter-limb phase difference, inclusion of hinges in the limbs, and Reynolds number (Re). 2D PIV measurements were conducted on a scaled robotic model of metachronal paddling, consisting of a rectangular tank fitted with stepper motors coupled to a four-bar linkage that actuated four paddles immersed in water-glycerin fluid medium. The inter-limb phase difference was varied from 0% (synchronous paddling) through 50% across Re range of O(10-1000). Two types of limb models were used, including a simple flat plate and a 'split-paddle' structure with two flat plates connected halfway with hinges. The results of the study show that limb models with hinges generated increased horizontal (thrust-producing direction) fluid velocity compared to the simple flat plate paddles, suggesting that asymmetry between power and return strokes is important to augment thrust.

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