Resilin springs simplify the control of crustacean limb movements

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Animals can simplify the brain control of their limb movements by moving a joint with just one muscle that operates against a spring made of the almost perfect elastic substance called resilin. This principle is analysed and illustrated by striking photographs and high-speed video footage, published in the open access journal *BMC Biology*, of the movements of the mouthparts of crabs and crayfish.

Malcolm Burrows from the University of Cambridge, UK investigated the presence of resilin, an elastic protein found in many insects and crustaceans, in crabs and crayfish caught in Norfolk and Cambridge, UK, and in Washington, USA. He said, "The exquisite rubbery properties of resilin are known to be put to use as energy storage mechanisms in jumping insects and as biological shock absorbers in many animals. I have now shown that it is used to simplify the sensory and motor control systems at a limb joint."

The limbs studied, called maxillipeds, move rhythmically to deflect the exhalent water currents emerging from the gills. According to Burrows, the water currents created by these movements have two important roles. First, as an active sensor; water is drawn from a wide area in front of the animal over the sensory neurons around its mouth. The flow created in this way mixes odor molecules in the water and thus enables better odor acquisition and sampling. It may also allow an assessment of the amount of particulate matter in the exhalent current that might indicate that the gills need cleaning. Second, as an active communication and signaling mechanism; the currents created distribute odor molecules in the urine

released into them and act as a signal to other animals, particularly of their own species.

Burrows suggests that the use of resilin springs can have two cost saving advantages. First, by saving the space that would be required for a muscle to do the job of 'resetting' the movement, the resilin spring allows the muscle that generates the power stroke to become larger and hence more powerful. Second, the amount of nervous control required can be reduced because one direction of movement is controlled automatically by a spring. As a result of this natural engineering, these limbs of the crab Carcinus maenas can beat in a coordinated way at a remarkable 20 times a second.

More information: A single muscle moves a crustacean limb joint rhythmically by acting against a spring containing resilin
Malcolm Burrows, *BMC Biology* (in press),
www.biomedcentral.com/bmcbiol/

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