# To swim fast or to go far, answers from 1-guilla, a bioinspired robot

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**Abstract**

Anguilliform swimmers, like eels or lampreys, are highly efficient swimmers. To analyse the effect of the undulatory kinematics on the hydrodynamic performance of anguilliform swimmers, we designed a bio-inspired robot, named 1-guilla, consisting of eight in-line actuators. The prescribed body kinematics result from open-loop controlled sinusoidal variations of the joint angles with a constant joint amplitude, spatial wavelength, and frequency for all joints. The resulting swimming velocity in terms of stride length, the cost of transport, and body kinematics are determined first through free-swimming experiments for a broad range of joint amplitudes, wavelengths, and frequencies. These first experiments reveal the existence of a trade-off between speed and efficiency. Speed, in terms of stride length, scales with the maximum tail angle, described by the newly proposed specific tail amplitude and reaches a maximum value around the specific tail amplitude of unity. Efficiency needs a whole-body motion, travelling wave-like kinematics, and lower specific tail amplitudes. The robot is tethered and attached to a six-component load cell in our recirculating water channel in a second set of experiments. Here, we study the robot's performance behind an oscillating airfoil that mimics the presence of another swimmer. The performance of our robot is determined for various lateral and streamwise distances to the airfoil to create a performance map indicating advantageous and disadvantageous downstream swimming positions. Our results provide insights into the key characteristics affecting undulatory swimming performance with and without upstream disturbances.

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