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Why fishes have a fish shape CHRISTOPHE ELOY, LIONEL SCHOUVEILER, IRPHE, Marseille, France — The relation between form and function for elongated swimmers is revisited by solving a multi-objective optimization problem. We consider elongated fishes of varying elliptic cross-section whose motion is prescribed by a time-periodic curvature. The two semi-axes of the cross-section, the curvature amplitude and phase are assumed to vary continuously along the fish length. Hydrodynamic forces acting on such fishes are modeled in the elongated-body limit by considering both reactive and resistive forces. Applying Newton's second law, the heave and pitch amplitude and phase, as well as the swimming velocity can be found. The total power needed can also be calculated yielding the swimming efficiency. The multi-objective optimization consists in finding the fish shape and associated motion which corresponds to maximum efficiency, maximum velocity or any trade-off between the two. This optimization problem is solved using a genetic algorithm whose principle is to start with an initial random population and to evolve it by mutation and selection. We find that the most efficient shape resembles existing fishes and arguments are given to explain the relation between this particular fish form and performance.

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