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Model of skin friction enhancement in undulatory swimming UWE EHRENSTEIN, CHRISTOPHE ELOY, IRPHE, Aix-Marseille Univ, France — To estimate the energetic cost of undulatory swimming, it is crucial to evaluate the drag forces originating from skin friction. This topic has been controversial for decades, some claiming that animals use ingenious mechanisms to reduce the drag and others hypothesizing that the undulatory motion induces a drag increase because of the compression of the boundary layers. In this paper, we examine this latter hypothesis, known as the "Bone–Lighthill boundary-layer thinning hypothesis".[1] Considering a plate of section s moving perpendicular to itself at velocity $U_\perp$ and applying the boundary-layer approximation for the incoming flow, the drag force per unit surface is shown to scale as $\sqrt{U_\perp/s}$. An analogous two-dimensional Navier-Stokes problem by artificially accelerating the flow in a channel of finite height is solved numerically, showing the robustness of the analytical results. Solving the problem for an undulatory plate motion similar to fish swimming, we find a drag enhancement which can be estimated to be of the order of 20 to 100%, depending on the geometry and the motion.

[1]M.J. Lighthill, *Proc. R. Soc. Lond. B* **179**, 125 (1971).

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