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Can drag and thrust be separated in undulatory swimming? NEELESH PATANKAR, Department of Mechanical Engg., Northwestern University, ANUP SHIRGAONKAR, Department of Mechanical Engg., MIT, MALCOLM MACIVER, Department of Mechanical Engg., Northwestern University — Aquatic organisms are motivating new biomimetic underwater vehicles. To that end it is essential to obtain the swimming velocity and efficiency of organisms using reduced order models. The swimming velocity is often determined by equating the drag and thrust on swimming bodies. This has led to many conflicting results in the past. It has been proposed that one of the root causes of the disagreements is that, in general, drag and thrust on swimming bodies can not be separated from each other. This is considered to be true when movement is generated by undulations as in anguilliform, gymnotiform, and balistiform modes of swimming, among others. We did high-resolution numerical simulations to study the forces acting on the undulatory ribbon fin of a gymnotiform swimmer – the black ghost knifefish. In spite of the above expectations, we have surprisingly found a new way to approximately decompose the net force into drag and thrust producing mechanisms in undulatory swimming modes. Such decomposition is unexpected for non-linear finite Reynolds number problems. This result appears conceptually analogous to how a linearization of the Navier–Stokes equations, or Carrier's equation, captures the drag-determining features of the flow around objects.

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