

Hydrodynamics of bluefin tuna - a review

ABSTRACT

In the recent years, the study of unconventional fish-like bodies has been growing with the purpose of developing more efficient under-water vehicles; inspiration from nature to emulate these life forms to understand their propulsion system and to attain superior manoeuvring has given birth to the field of aquatic Biomimetics. Because of their remarkable capabilities, fish have shown extraordinary adaptation towards underwater locomotion which naturally has led to the sense of curiosity among engineers. A limited number of works has been published on bluefin tuna which is considered the largest Tuna species and the largest bony fish in ocean, weighing over 540 kilograms with length reaching over 3.05 meters and with a lifespan of 30 years. This fish has evolved overtime in terms of high-speed (reaching 75-100 km/hour), making it one of the fastest fish that swims in pelagic zone of oceans. Their torpedo shaped body is the most hydrodynamically efficient shape possible, making them the ultimate fish. This paper presents an overview of literature studies done exclusively and relevant to bluefin tuna. The review is divided into following sections: (I) Introduction (to swimming classification), (II) Thunniform Locomotion, (III) Undulatory Motion and Propulsion, (IV) Energy Efficiency and Energy Extraction, and (V) Computational Studies. The review highlights that this riveting fish is not only fastest but also, warm-blooded unlike any other fish that dives in pelagic zone and how that contributes to its high-speed. This paper aims to show that thunniform locomotion, with an emphasis on the lunate tail propulsion, is the most efficient locomotion only attained by super-advanced fish, and highlights the propulsive efficiency of thunniform motion which reaches about 70%, and the energy saving techniques adopted by bluefin tuna to make it the most efficient engine created by nature.

Keyword: Bluefin tuna; Hydrodynamics; Thunniform locomotion; Propulsive efficiency; Undulatory propulsion