

## Mimicking the humpback whale: an aerodynamic perspective

### ABSTRACT

This comprehensive review aims to provide a critical overview of the work on tubercles in the past decade. The humpback whale is of interest to aerodynamic/hydrodynamic researchers, as it performs manoeuvres that baffle the imagination. Researchers have attributed these capabilities to the presence of lumps, known as tubercles, on the leading edge of the flipper. Tubercles generate a unique flow control mechanism, offering the humpback exceptional manoeuvrability. Experimental and numerical studies have shown that the flow pattern over the tubercle wing is quite different from conventional wings. Research on the Tubercle Leading Edge (TLE) concept has helped to clarify aerodynamic issues such as flow separation, tonal noise and dynamic stall. TLE shows increased lift by delaying and restricting spanwise separation. A summary of studies on different airfoils and reported improvement in performance is outlined. The major contributions and limitations of previous work are also reported.

**Keyword:** Biomimetics; Low Reynolds number aerodynamics; Humpback whale tubercles; Leading edge flow control