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# On the influence of natural curvature on the reconfiguration of thin submerged biological structures

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The ability of aquatic plants to passively adapt their configuration with the hydrodynamic load is recognised to be a key factor in allowing them to preserve structural integrity, to capture maximal sunlight, to inhibit the transport of sediments [1]. When considering a clamped flat plate as a proof-of-concept, the progressive reconfiguration lets the drag force increase linearly with the flow speed, allowing the fulfilment of the above biological functionalities. However, this scenario is altered when considering highly curved structures, whose geometrically-enhanced stiffness re-calibrate the bending response, and introduces a snap-through dynamics.
The occurrence of a snap-through mechanism outlines several reconfiguration phases, showing fairly different rates of change in the Gaussian curvature. Along with this complexity, the hydrodynamic loading over a curved structure subjected to a nearly turbulent flow, establishes the need for high-fidelity modelling tools to get reliable predictions. In this connection, a wide computational campaign has been carried out to investigate the combined effect of initial curvature, aspect ratio, and Cauchy number. The fluid field is resolved by means of a finite difference flow solver with direct immersed boundary forcing, whereas the discretisation of the structural domain relies on a NURBS-based Isogemetric method [2], which has proven to be very efficient in capturing large strain gradients with minimal degrees of freedom.
The outcomes of this work bring novel insights on the morphogenetic mechanisms determining biological size and shape, as well as it provides the design space bounds for building biomimetic devices, such as deployable architectural appendages [3], flapping energy harvester, or flexible wings for micro air vehicles.

## REFERENCES

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