A method for quantifying, visualising, and analysing gastropod shell form

Abstract

Quantitative analysis of organismal form is an important component for almost every branch of biology. Although generally considered an easily-measurable structure, the quantification of gastropod shell form is still a challenge because many shells lack homologous structures and have a spiral form that is difficult to capture with linear measurements. In view of this, we adopt the idea of theoretical modelling of shell form, in which the shell form is the product of aperture ontogeny profiles in terms of aperture growth trajectory that is quantified as curvature and torsion, and of aperture form that is represented by size and shape. We develop a workflow for the analysis of shell forms based on the aperture ontogeny profile, starting from the procedure of data preparation (retopologising the shell model), via data acquisition (calculation of aperture growth trajectory, aperture form and ontogeny axis), and data presentation (qualitative comparison between shell forms) and ending with data analysis (quantitative comparison between shell forms). We evaluate our methods on representative shells of the genera *Opisthostoma* and *Plectostoma*, which exhibit great variability in shell form. The outcome suggests that our method is a robust, reproducible, and versatile approach for the analysis of shell form. Finally, we propose several potential applications of our methods in functional morphology, theoretical modelling, taxonomy, and evolutionary biology.