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STOCHASTIC MECHANISMS OF GROWTH AND BRANCHING IN MEDITERRANEAN CORAL COLONIES

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One of the fundamental questions in biology is concerned with the mechanisms that govern phenotype as a result of the interplay between the genetic material and the physical environment of the organisms. This is because the environment can strongly influence the developmental process. In particular, in the growth of marine sessile organisms such as seaweeds, sponges, and corals, there is a strong impact of the physical environment on the growth process, leading to a variety of structural forms [2].

The red coral *Corallium rubrum* is an octocoral species, endemic to Mediterranean and adjacent Atlantic rocky bottoms, which can be found between 10 and 800 m depth. This slow-growing species has a life span that can exceed 100 years. The skeleton of branching colonies is composed of calcium carbonate deposited by the polyps. The colonies exhibit wide variability in growth forms, which are linked to local environmental conditions. Due to extensive harvesting and increase in water temperature, this long-lived and slow-growing species, which has an important role in the three-dimensional structuring of coralligenous assemblages, is at risk of local extirpation in the coastal Mediterranean. Despite many conservation projects that focus on *Corallium rubrum*, little is known about the modular growth mechanisms of its colonies. In particular, theoretical models, which can be used for restoration and guide conservation policies, are lacking.

To this end, we present a simple stochastic model, based on three rules and accurately captures the phenotypic variability of the structures observed in the field [1]. Our model is based on the notion that the growth process can be described as calcium carbonate deposition and branching structures result from the deposition of fork layers on top of the previously deposited layers. As a result of this, and with the inclusion of stochasticity, the same processes, driven by the three rules of our model, result in an infinite number of different realisations of colony structures.

We show that the variations in structures due to the changes in model parameters are representative of the differences in environmental factors that affect the colony development. Repeated simulations on our

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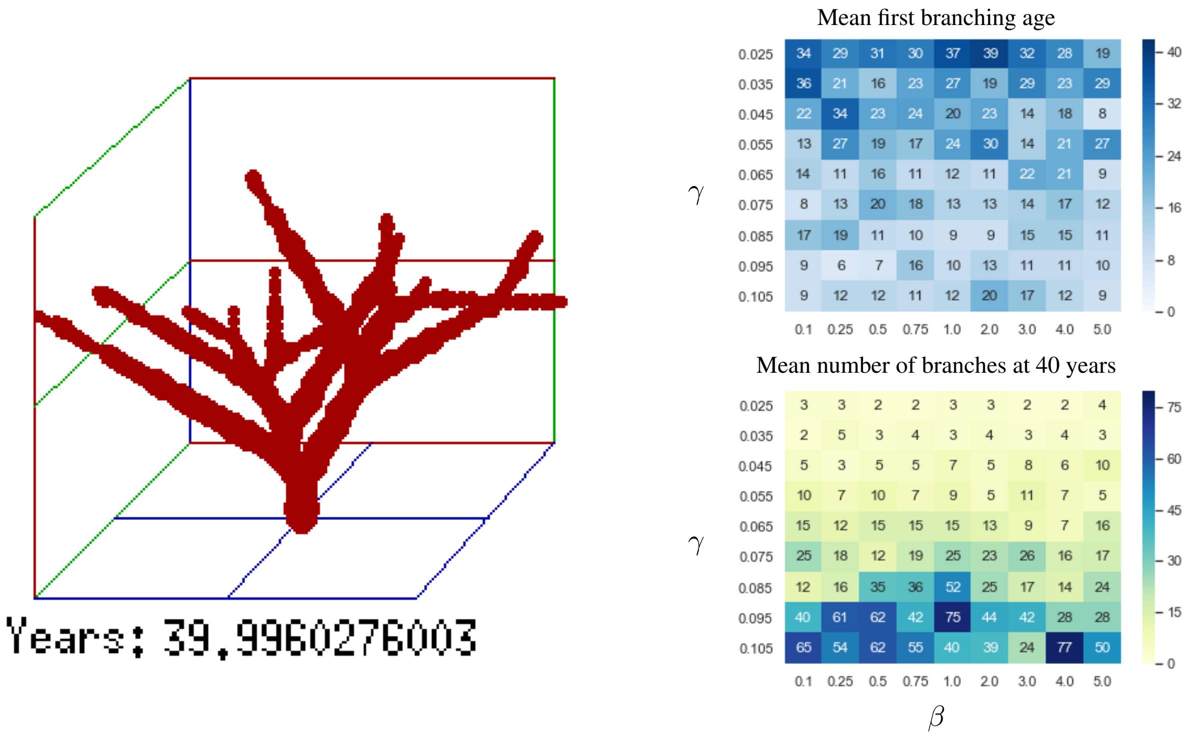

Figure 1: **Left:** A screenshot from a representative video `https://youtu.be/FAH1DgqUO8w`. **Right:** The mean first branching age and the mean number of branches at 40 years age in 10 simulations in response to variations in branching rate (β) and calcium carbonate accumulation rate (γ). The branching age is measured as the simulation time at the generation of the first branching unit.

model with varying parameters suggest that branching and growth are conflicting processes for the colony that may be prioritised in accordance with the environmental conditions (Figure 1). Our analysis provides an overview of how such stochastic models can provide insights into the structure and development of modular organisms.

References

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