Bruce M. Boman, Thien-Nam Dinh, Keith Decker, Brooks Emerick, Christopher Raymond, and Gilberto Schleiniger
Why do Fibonacci Numbers Appear in Patterns of Growth in Nature?,
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Abstract

While many examples of Fibonacci numbers are found in phenotypic structures of plants and animals, the dynamic processes that generate these structures have not been fully elucidated. This raises the question: What biologic rules and mathematical laws that control the growth and renewal of tissues in multi-cellular organisms give rise to these patterns of Fibonacci numbers? In nature the growth and self-renewal of cell populations leads to generation of hierarchical patterns in tissues that resemble the pattern of population growth in rabbits, which is explained by the classic Fibonacci sequence. Consequently, we conjectured a similar process exists at the cellular scale that explains tissue renewal. Accordingly, we created a model (cell division type) for tissue development based on the biology of cell division that builds upon the cell maturation concept posed in the Spears and Bicknell-Johnson model ("mating"-like design) for asymmetric cell division. In our model cells divide asymmetrically to generate a mature and an immature cell. Model output on the number of cells generated over time fits specific Fibonacci p-number sequences depending on the maturation time. A computer code was created to display model output as branching tree diagrams as a function of time. These plots and tables of model output illustrate that specific patterns and ratios of immature to mature cells emerge over time based on the cell maturation period. Conclusion: Simple mathematical laws involving temporal and spatial rules for cell division begin to explain how Fibonacci numbers appear in patterns of growth in nature.