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A combinatorial morphospace for angiosperm pollen

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The morphology of angiosperm (flowering plant) pollen is extraordinarily diverse. This diversity results from variations in the morphology of discrete anatomical components. These components include the overall shape of a pollen grain, the stratification of the exine, the number and form of any apertures, the type of dispersal unit, and the nature of any surface ornamentation. Different angiosperm pollen morphotypes reflect different combinations of these discrete components. In this talk, I ask the following question: given the anatomical components of angiosperm pollen that are known to exist in the plant kingdom, how many unique biologically plausible combinations of these components are there? I explore this question from the perspective of enumerative combinatorics using an algorithm I have written in the Python programming language. This algorithm (1) calculates the number of combinations of these components; (2) enumerates those combinations; and (3) graphically displays those combinations. The result is a combinatorial morphospace that reflects an underlying notion that the process of morphogenesis in angiosperm pollen can be thought of as an n choose k counting problem. I compare the morphology of extant and fossil angiosperm pollen grains to this morphospace, and suggest that from a combinatorial point of view angiosperm pollen is not as diverse as it could be, which may be a result of developmental constraints.