

## Multicellularity drives the evolution of sexual traits

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### Abstract:

From the male peacock's tail plumage to the floral displays of flowering plants, traits related to sexual reproduction are complex and exaggerated. But why has sexual reproduction become so complicated? Why have such exaggerated sexual traits evolved? Early work posited a connection of multicellularity with sexual traits such as anisogamy (i.e., the evolution of sperm and eggs), which in turn drives the evolution of other forms of sexual dimorphism. Yet, the relationship between multicellularity and the evolution of sexual traits has not been empirically tested. The volvocine green algae offer a tractable system for understanding the interrelationship of multicellular complexity and sex, including anisogamy and other forms of sexual dimorphism. Here we reconstruct the evolutionary history of six sexual traits, demonstrating a complex evolutionary history, multiple gains and/or losses, in every trait. Our results demonstrate that anisogamy repeatedly evolved from isogamous multicellular ancestors and that anisogamous species are larger and produce larger zygotes than isogamous species. We show that species with higher metrics of multicellular complexity have significantly more derived sexual traits, including anisogamy and exaggerated sexual dimorphism. In the volvocine algae, the evolution of multicellularity likely drives the evolution of anisogamy, and anisogamy subsequently drives exaggerated sexual dimorphism, suggesting that multicellularity sets the stage for the overall diversity of sexual complexity.