Shape matters: the relationship between cell geometry and diversity in phytoplankton

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Abstract

Size and shape profoundly influence an organism's ecophysiological performance and evolutionary fitness, suggesting a link between morphology and diversity. However, not much is known about how body shape is related to taxonomic richness, in particular in the microbial realm. Here we analyse global datasets of unicellular phytoplankton, a major photosynthetic group with an exceptional diversity of cell sizes and shapes. Using two measures of cell shape elongation, we quantify taxonomic diversity as a function of cell size and shape. We find that cells of intermediate volume have the greatest shape variation, from oblate to extremely elongated forms, while small and large cells are mostly compact (e.g., spherical or cubic). Taxonomic diversity is strongly related with cell elongation and cell volume, with both traits, in combination, explaining up to 92% of total variance. Diversity decays exponentially with cell elongation and displays a log-normal dependence on cell volume, peaking for compact, intermediate-volume cells. These previously unreported broad patterns in phytoplankton diversity reveal selective pressures and ecophysiological constraints on the geometry of phytoplankton cells which may improve our understanding of marine ecology and the evolutionary rules of life.

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