Comparative analysis of energy allocation to tissue and skeletal growth in corals

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ABSTRACT: In aquatic invertebrates that form exoskeletons, the partitioning of energy between skeletal and tissue growth is an important tradeoff, especially under resource limitation or physiological stress. Here, we provide the first comparative analysis of energy investment into tissue and skeleton in corals. We develop a mathematical growth model based on colony geometry, tissue mass and quality (enthalpy), and predicted cost of calcification. For hemispherical colonies, the model predicts greater investment in tissue at small sizes, but a shift to skeletal-dominated growth at colony sizes greater than 5-14 cm radius, depending on tissue mass and quality. A similar transition occurs in branches, but is a function of radius and length. An experimental study to assess the impact of resource (light) limitation and physiological stress (sediment load) on energy partitioning in small hemispherical colonies (*Goniastrea retiformis* Lamarck) and branches (*Porites cylindrica* Dana) showed that tissue mass and quality varies greatly over small increments in colony or branch size. In particular, allocations to tissue growth varied tenfold (from positive to negative) more across sediment treatments than did allocations to skeletal growth. A model of energy acquisition versus loss (scope for growth) indicated that tissue growth is more responsive to resource variation and physiological stress than skeletal growth. These results suggest that (1) skeletal and tissue growth rates are weakly correlated across environmental conditions, and that (2) variation in tissue properties is a better proxy for coral health or stress than skeletal growth.

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