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MICROCOSM OF THE CORAL SKELETON

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Perhaps it is a bit of an exaggeration calling a subject of microscopic skeletal studies a microcosm, however, it is equally easy, as in a real cosmos, to get lost in a vast area of different interpretations and proposals concerning objects, often only few micrometers in size. The purpose of this contribution is to provide some hints on how to navigate in this tiny realm.

Interpretations of the minute structure of the coral skeleton published so far are based mostly on two-dimensional observations: single transverse sections, and exceptionally, serial and/or longitudinal sections of comparable skeletal parts. Hence, it is not surprising that many microstructural descriptions bear some of the stigma of the „Flat Earth" concept, in which one of the important dimensions is missing. Many (but methodologically limited) observations of „centers of calcification" and fibers that radiate from those centers founded the concept of the trabecula i.e., a „rod formed by fibers and provided with an axis". Since the 19^{th} century, trabeculae have been of paramount importance in traditional scleractinian classification resulting in a „Big Bang" of studies that has significantly improved understanding of coral skeleton diversity. Only recently did the model of calcification mediated by organic-matrices challenge the widespread model of purely physicochemical control of the skeleton growth, and implied an inadequacy of the trabecular concept. The crux of this new model became „calcification centers" redefined as scaffoldings for the further „fibrous" phase of skeleton growth („two-step model"). However, most data used to characterize „calcification centers" are still drawn from transversely sectioned coralla. The third dimension of „calcification centers" remained unknown and it was implied that they are composed of homogenously distributed organic and microcrystalline components.

The 3D skeletal reconstruction proposed herein is based on differently oriented sections and techniques that stain organic components. The entire septal skeleton of corals is composed of alterations of mineral and organic-enriched phases. They form superimposed layers that may be interrupted in some directions of growth but in other directions there is a continuity between „calcification centers" and „fibers", making distinction between these two structures unclear. As an alternative to the „two-step model" I put forward the „layered model" of skeletal growth which explains the differences between „calcification centers" and „fibers" in terms of differential growth dynamics (and not necessarily different timing) between these regions. As a result, these regions show different proportions (probably also biochemical properties) of mineral-organic components; however, in both regions these components characteristically alternate. Instead of the inadequate „trabecular concept" and „calcification centers", a distinction between deposits of the Rapid Accretion Front (dRAF; which in particular cases can be organized into Centers of Rapid Accretion (CRA)) and Thickening Deposits (TD) is proposed.

Several potentially significant outcomes of this microstructural reinterpretation include the following:

1) Remarkable regularity of mineral/organic phase alterations in TD skeleton of zooxanthellate corals and lack of such regularity in azooxanthellate coralla appears to be a promising criterion to distinguish these two ecologically distinct coral groups on the skeletal basis, possible also in fossils.

2) In dRAF region nanometer-scale (ca. 50 nm in diameter) mineral components seem to match the size range of nodular structures interpreted recently as nascent CaCO3 crystals developed upon a fibrillar organic matrix in the sub-epithelial space.

3) dRAF deposits in some „non-trabecular" stylophyllids appear to differ only quantitatively from typical „trabecular" scleractinians. Taxonomic revision and reassessment of phylogenetic position of this, and perhaps other coral groups, is pending.

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