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Three-dimensional micro- and nanostructural characteristics of the scleractinian coral skeleton: A biocalcification proxy

Jarosław Stolarski
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The contemporary “two-step model” of growth of the scleractinian skeleton is based mostly on transversely sectioned samples. According to this model, many skeletal elements e.g., septa are formed in two temporally distinct phases represented by (1) “centers of calcification” that are composed of homogenously distributed microcrystalline or/and organic components and serve as scaffolding for the further growth of (2) fibrous skeleton. Based on transverse and longitudinal sections and histochemical staining techniques, I demonstrate herein that in extant corals (i.e., Stephanocyathus, Flabellum, Desmophyllum, “Ceratotrochus”, Galaxea, Platygyra), the entire septal skeleton is composed of superimposed layers of mineral and organic-enriched phases. These may be interrupted in some directions of growth but in other directions there is continuity between “centers of calcification” and “fibers”, making any distinction between these two structures unclear. As an alternative to the “two-step model”, a “layered model” of skeletal growth is proposed, that explains the differences between “centers of calcification” and “fibers” in terms of differential growth dynamics between these regions. Instead of the traditional but inadequate “trabecular” and “centers of calcification” concepts, 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. In the dRAF region, mineral components, ca. 50 nm in diameter, seem to match the size range of nodular structures recently interpreted as nascent CaCO3 crystals. Remarkable regularity of the mineral/organic phase alternations (microbanding) in the TD skeleton of zooxanthellate corals and lack of such regular microbanding in azooxanthellate coralla is a promising criterion for distinguishing these two ecological coral groups on a skeletal basis, and one that could be applicable to fossils.

Key words: Scleractinia, biomineralization, microstructures, nanostructures, “centers of calcification”, fibers.

Jarosław Stolarski [stolacy@twarda.pan.pl], Instytut Paleobiologii PAN, Twarda 51/55, 00–818 Warszawa, Poland.


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