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HETERACTINIDS AND HEXACTINELLIDS: A PALAEONTOLOGICAL VIEW OF BASAL SPONGE RELATIONSHIPS

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Relationships between the sponge classes are controversial, and current hypotheses are largely based on molecular and zoological data. The emphasis on Recent taxa has resulted in well-defined boundaries between the classes, since each represents a restricted crown group, relative to past diversity. However, it is often assumed that their distinguishing features have always existed. This has resulted in the assumption that at least Calcarea and Hexactinellida diverged prior to mineralization.

Spicules of heteractinids were shown by Mehl and Reitner (1996) to possess similar internal structure to the extant Calcarea, which suggests a very close relationship. The skeletal morphology and architecture of the Eiffelliidae are also very similar to the simplest extant Clathrinida. Both simple Clathrinida and Eiffelliidae share with protospongioid hexactinellids a body wall consisting of a single layer of spicules, with up to around seven size orders. These are arranged in a regular rhomboidal grid (or rectangular, in later hexactinellids), the spaces subdivided sequentially by successively smaller spicule size orders. The early representatives of the classes differ in spicule symmetry and composition.

An undescribed specimen of *Eiffellia globosa* Walcott has prompted re-examination of the type specimens. This has revealed the presence of a variable proportion of stauractine, and in some cases apparently hexactine, spicules incorporated into the mesh. They are usually third-order spicules or smaller, and subdivide the first-order hexaradiate mesh; their positions are elsewhere occupied by equivalent-sized hexaradiates. In some specimens, over a third of spicules are tetraradiate, although some have non-orthogonal rays.

The composition of spicules of *Eiffellia* and other early heteractinids is uncertain, although later forms are known to be calcitic; those of all heteractinids are presumed to be Mg-calcite and amorphous calcium carbonate spicules secreted by sclerocytes, and surrounded by a membrane, as in modern Calcarea. The composition of Cambrian hexactinellids is similarly uncertain, although spicules were certainly siliceous by the Ordovician, with evidence of axial filaments in many Palaeozoic taxa. Some well-preserved, apparently pyritized specimens of *Eiffellia* show evidence of a bilaminar structure to the spicules, with a possible organic layer separating inner and outer regions; these layers are sometimes differentially dissolved. We speculate that the transition between Mg-calcite and opal compositions involved opal deposition onto an external organic membrane surrounding *Eiffellia*-like calcareous spicules, independent selection of hexactinal symmetry, and resultant loss of the coincidence between spicule rays and calcite crystallographic axes. Subsequent reduction of the calcareous inner region, and growth of the opal layer, would have led to shrinking of the organic membrane to a 2D filament, onto which silica was deposited.

Reference

Mehl, D. & Reitner, J. 1996. Observations on *Astraeospongium meniscum* (Roemer, 1848) from the Silurian of western Tennessee: constructional morphology and palaeobiology of the Astraeospongiidae (Calcarea, Heteractinellidae). *Berliner geowissenschaftliche Abhandlungen*, **E 18**: 243-255.

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