Ultrastructure within the Family Sphenolithaceae

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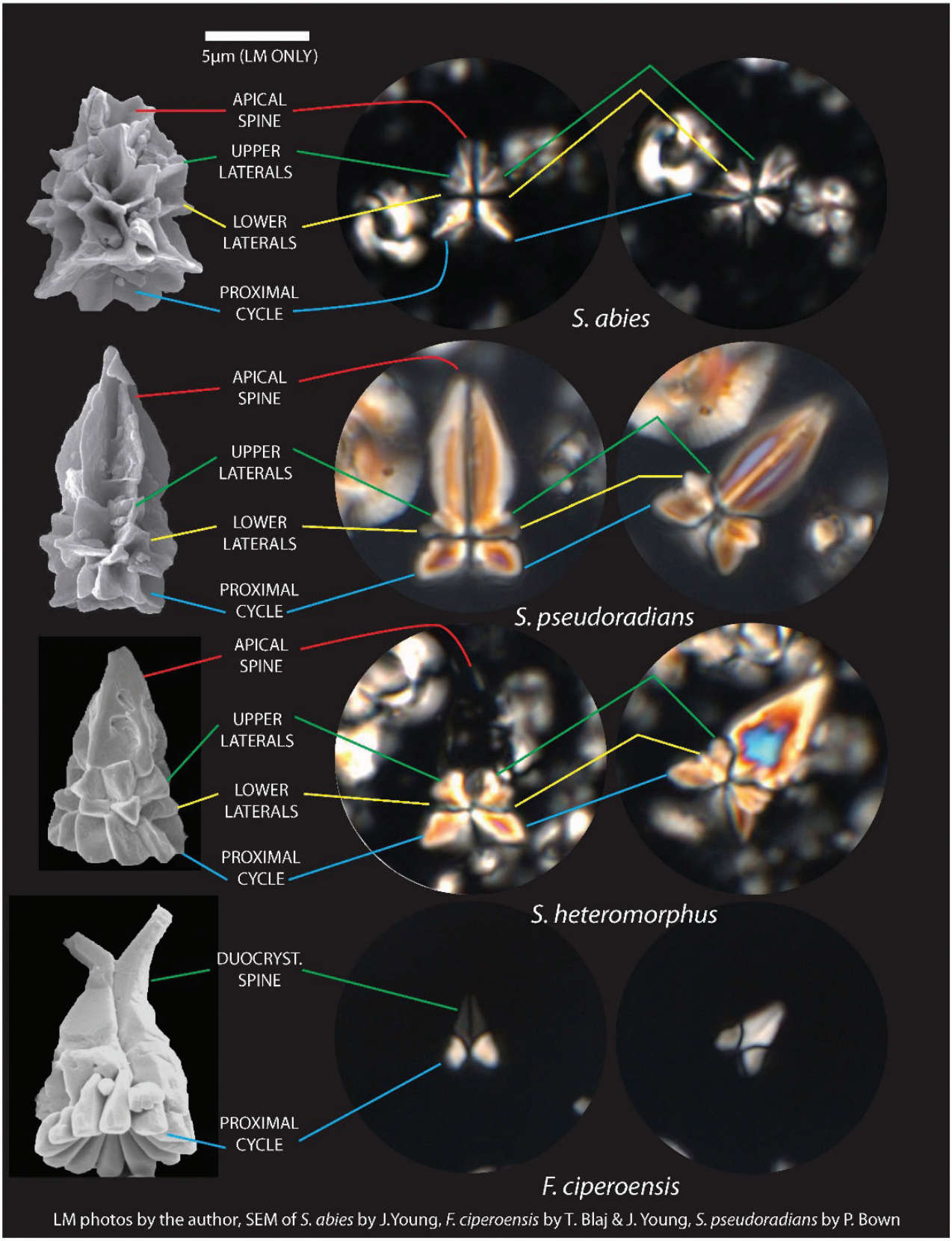
The Family Sphenolithaceae includes the Cenozoic genera *Sphenolithus* and *Furcatolithus*, which have many biostratigraphically important species. In plan view, all sphenoliths share a proximal cycle of elements that are arranged radially, are adpressed, and generally show slight imbrication. In lateral view, the proximal cycle elements are approximately trapezoidal in shape. From species to species, the elements of the proximal cycle vary in height and the lateral extension of the base of the elements relative to the top. All members of the genus *Sphenolithus* have two lateral element cycles (lower and upper) above the proximal element cycle. The lateral cycle elements are low and approximately triangular in plan view. In some species, the upper lateral cycle extends vertically and may have spinose extensions that radiate both vertically and laterally. Above the upper lateral cycle, an apical element cycle or spine is present. In the genus *Furcatolithus*, the apical elements and lower lateral element cycle are absent, and the remaining upper lateral element cycle extends vertically to form a bifurcated duocrystalline structure that is unrelated to the apical elements in *Sphenolithus*.

Much confusion exists concerning the upper and lower lateral cycles and their distinction from each other and from the proximal cycle in cross-polarized light. Many workers refer to the four bright elements seen in the base of the sphenolith as the upper and lower quadrants or "quads". The lower quads are the birefringent elements of the proximal cycle, while the upper quads are the birefringent elements of the two lateral element cycles. Many species' descriptions refer to the size ratios between the upper and lower quads. When a sphenolith is rotated relative to the polarizer, the lower and upper lateral element cycles alternate their birefringence relative to each other. Effectively, the bright "upper quads" are reflecting the birefringence of different elements as the sphenolith is rotated, making the size ratio between the upper and lower quads an unreliable criterion for distinguishing species.

An improved understanding of Sphenolithaceae ultrastructure and how it is seen under cross-polarized light has clarified the distinction between *Sphenolithus* and *Furcatolithus*. Thus, in order to reliably distinguish species, there is a need for a clear characterization of the lower and upper lateral element cycles within *Sphenolithus*.



LM photos by the author, SEM of *S. abies* by J.Young, *F. ciperoensis* by T. Blaj & J. Young, *S. pseudoradians* by P. Bown