Understanding Structure-Function Relationships in Biological Glass Fibers

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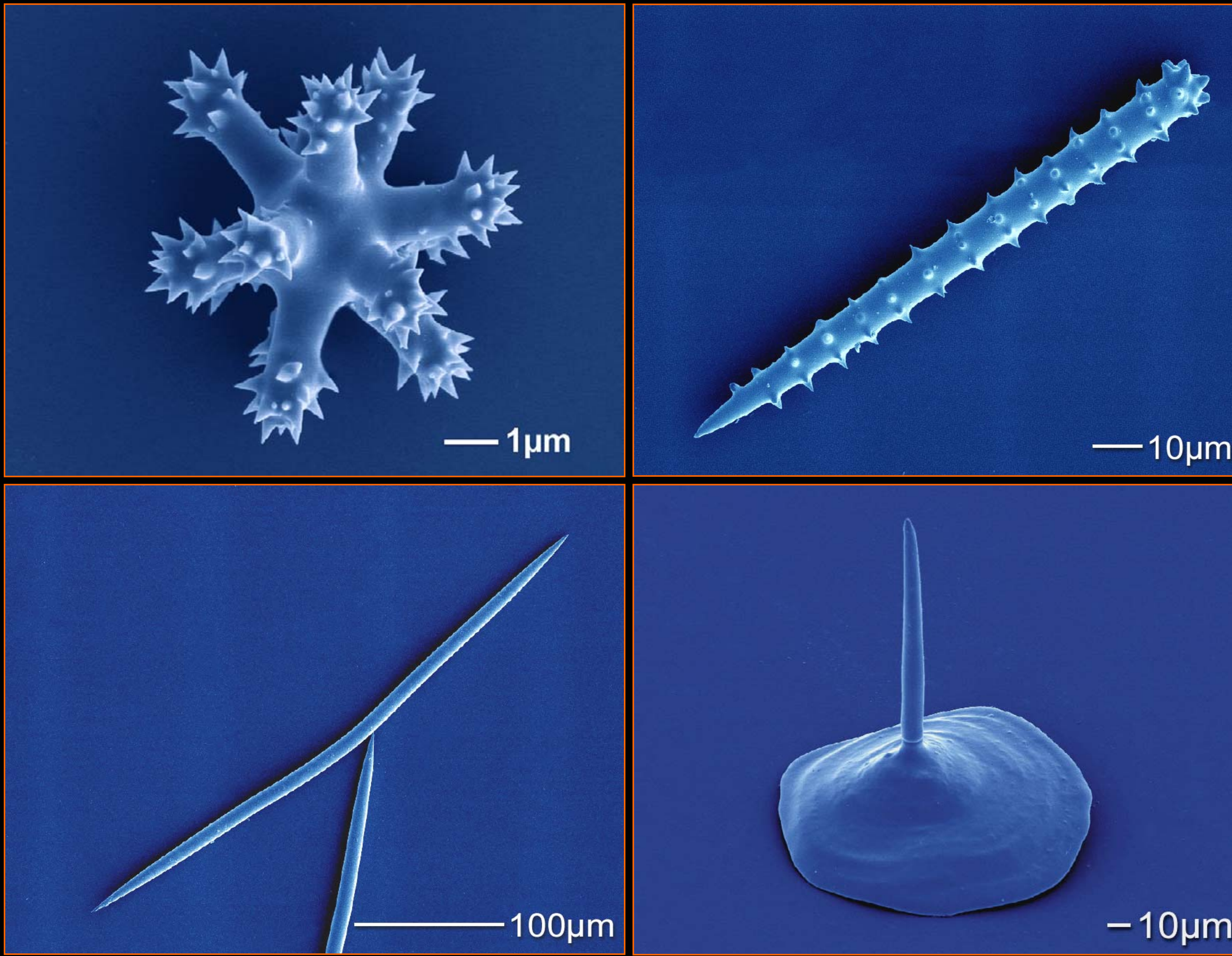
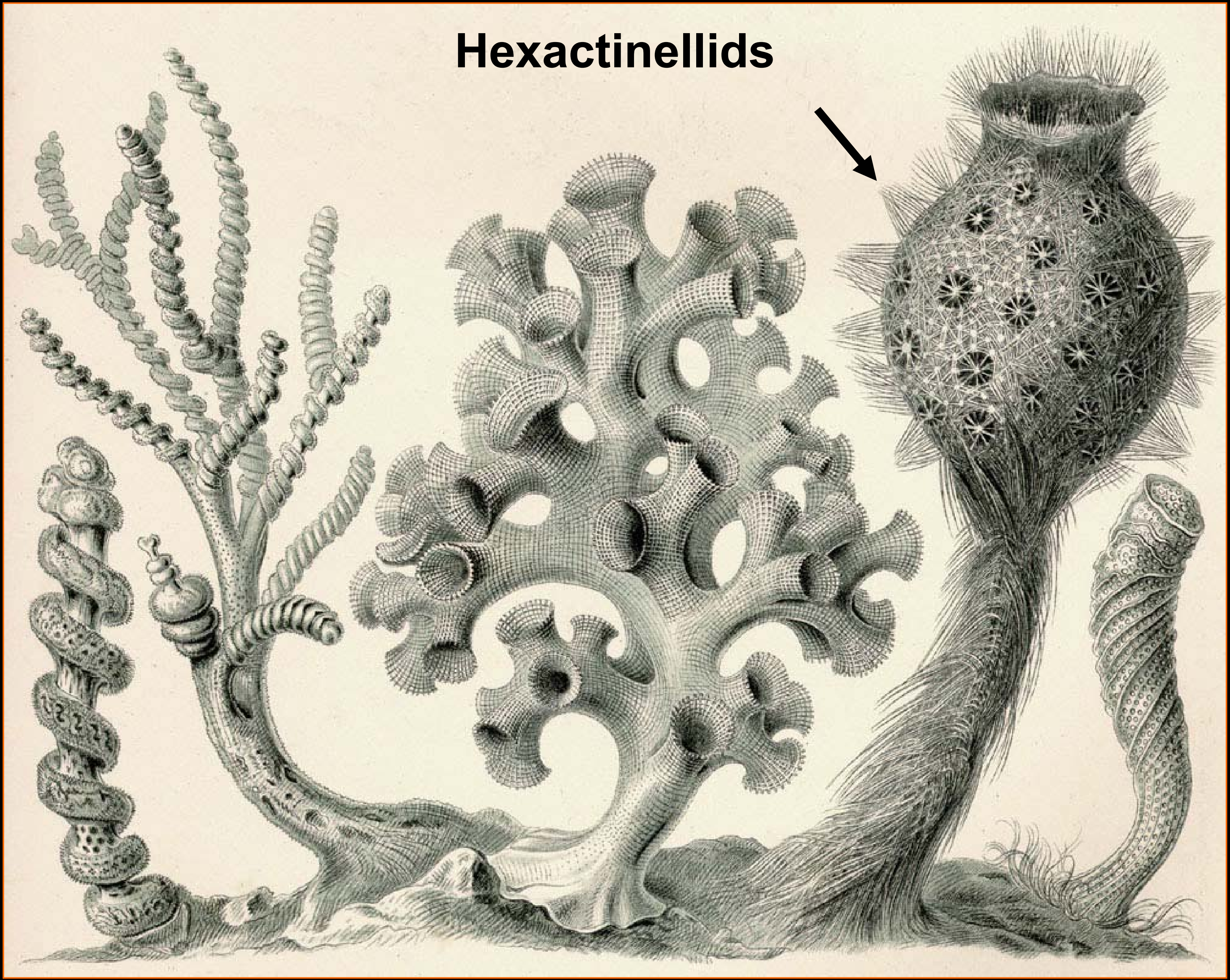
Structural Diversity of Siliceous Sponge Skeletal Elements (Spicules)

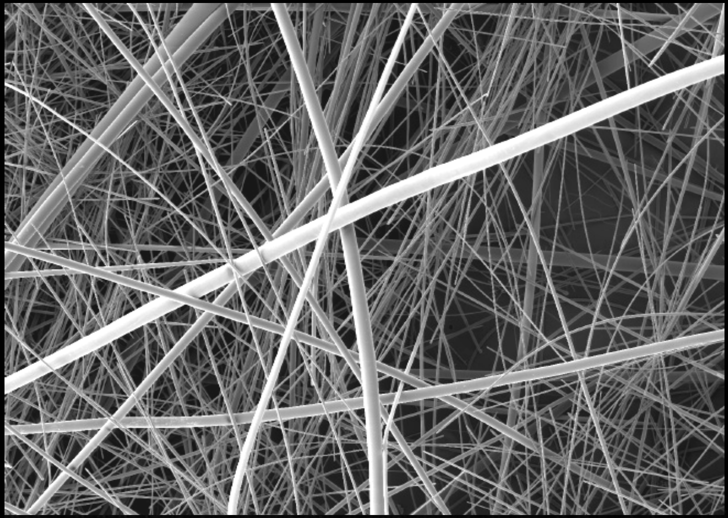




Haeckel, 1904

Sponge Spicule Nomenclature

Generally classified into two major groups



Megascleres:

Typically greater than 1mm

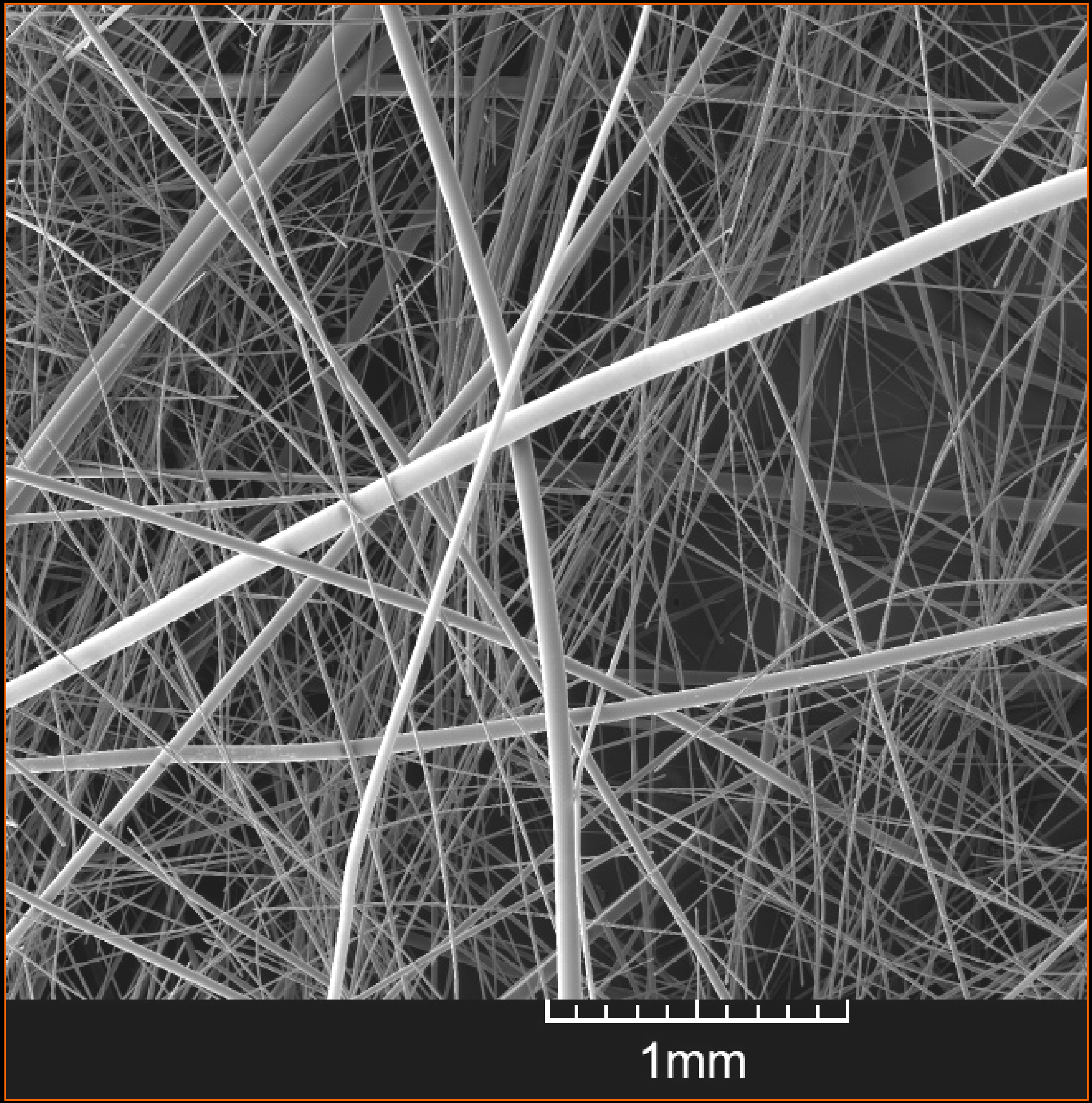
Large-scale skeletal support

Microscleres:

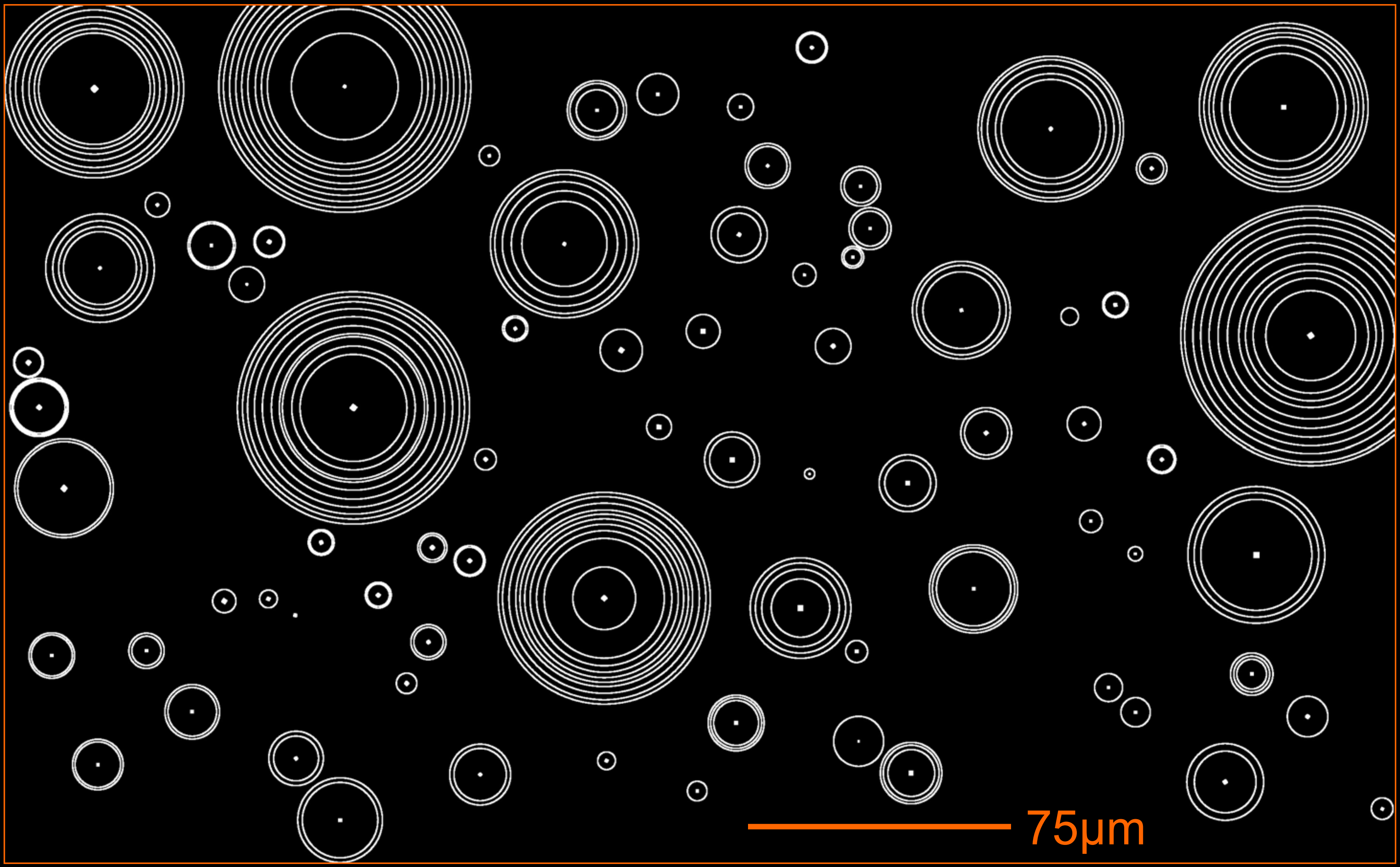
Typically less than 500μm

Small-scale skeletal support

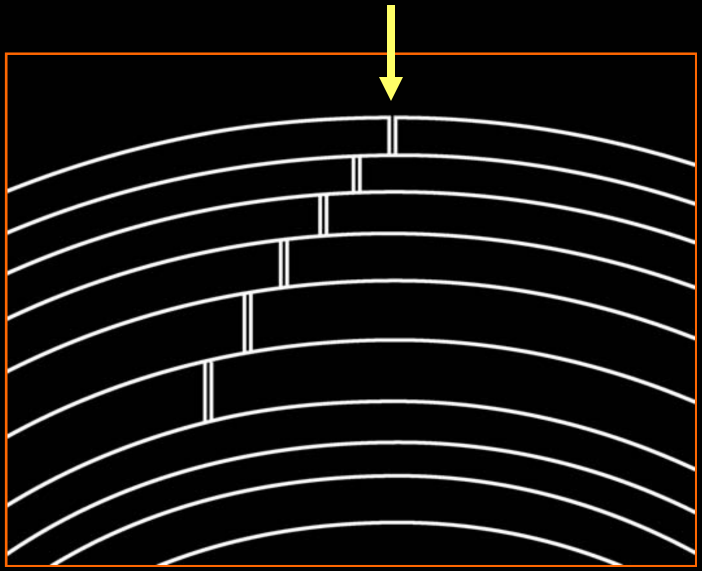
Skeletal System of ***Rhabdocalyptus dawsoni***

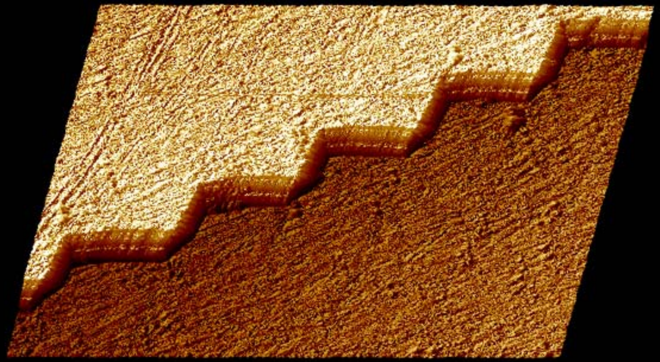


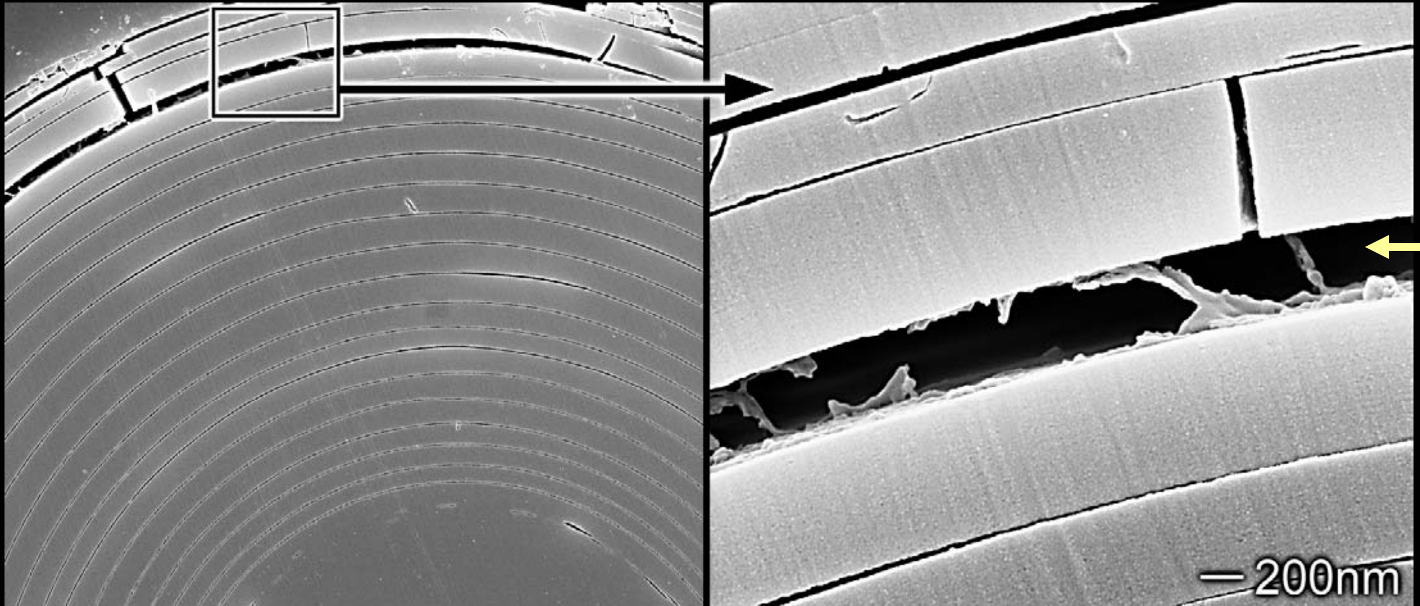
R. dawsoni Spicule Cross-Sections



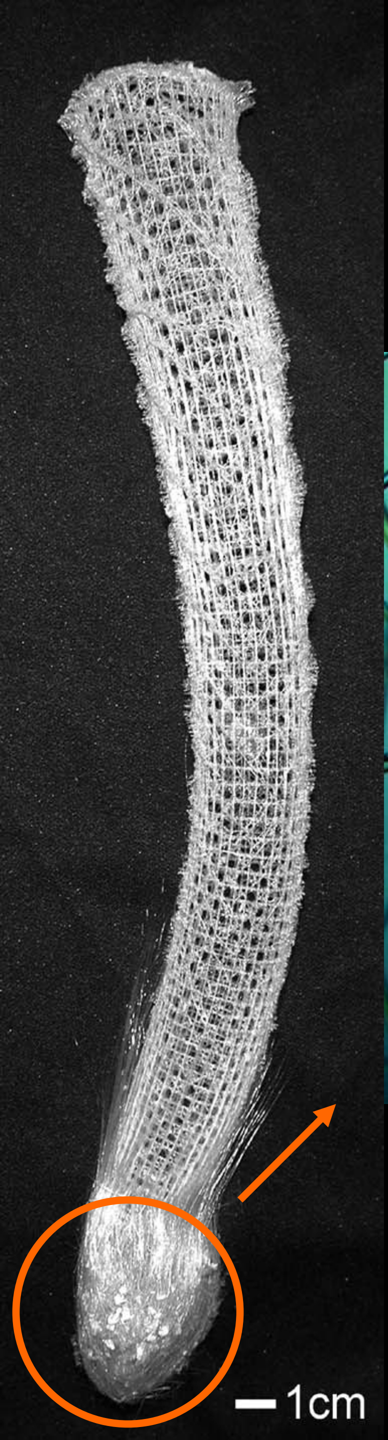
Fracture Dynamics in Laminated Spicules

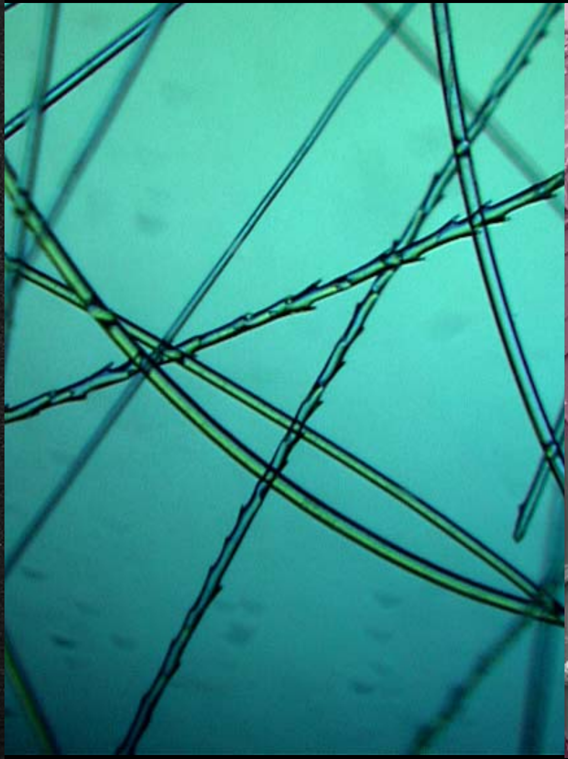




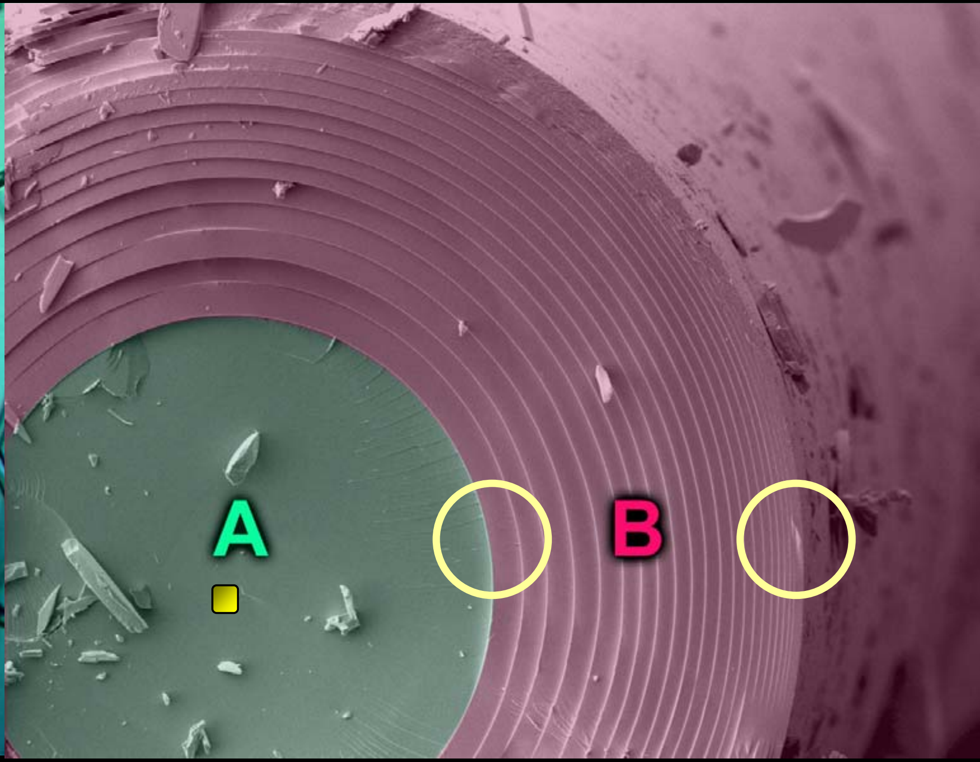


Structural Analysis of *Euplectella aspergillum* Spicules

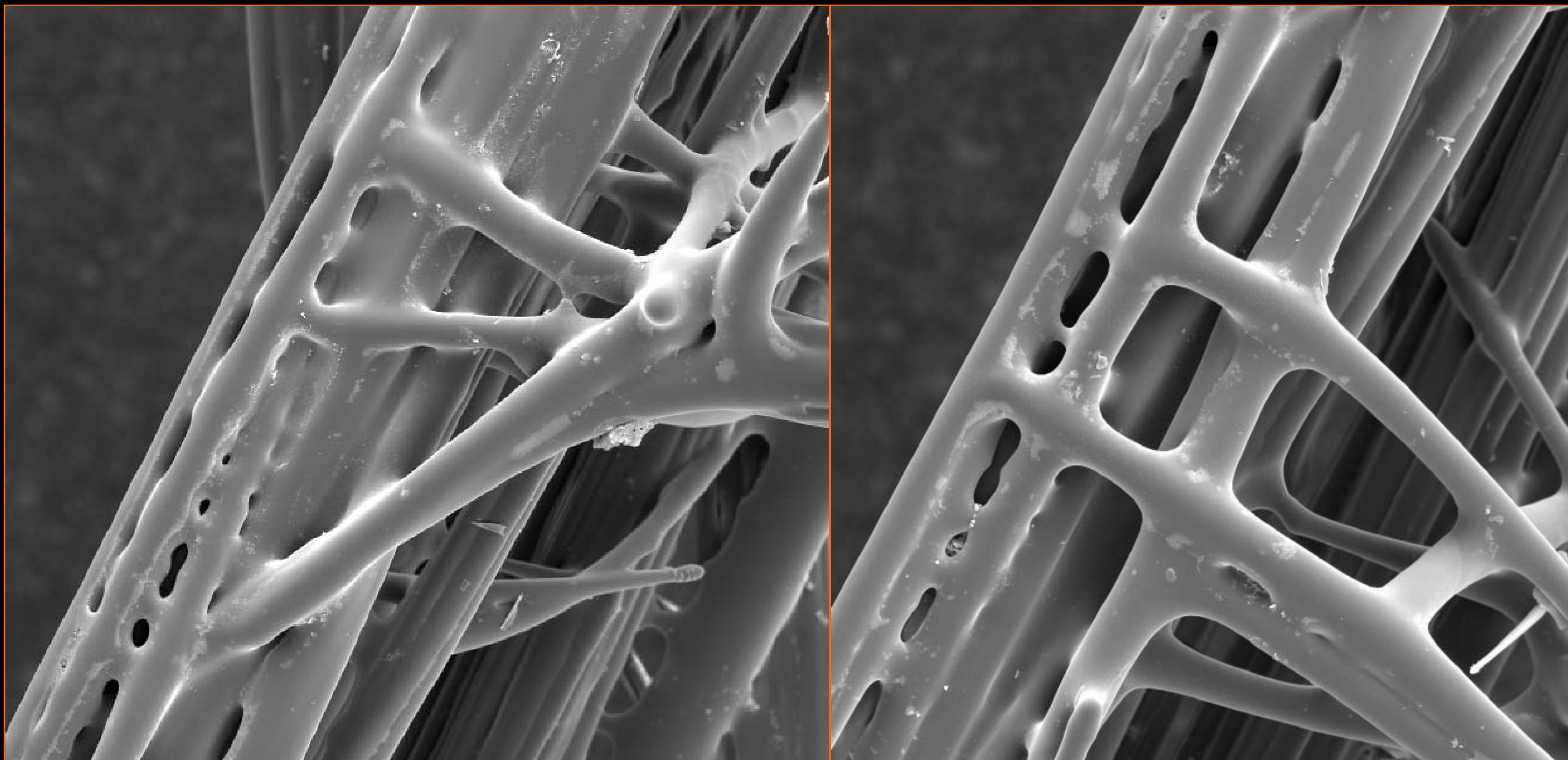




50μm x 10cm

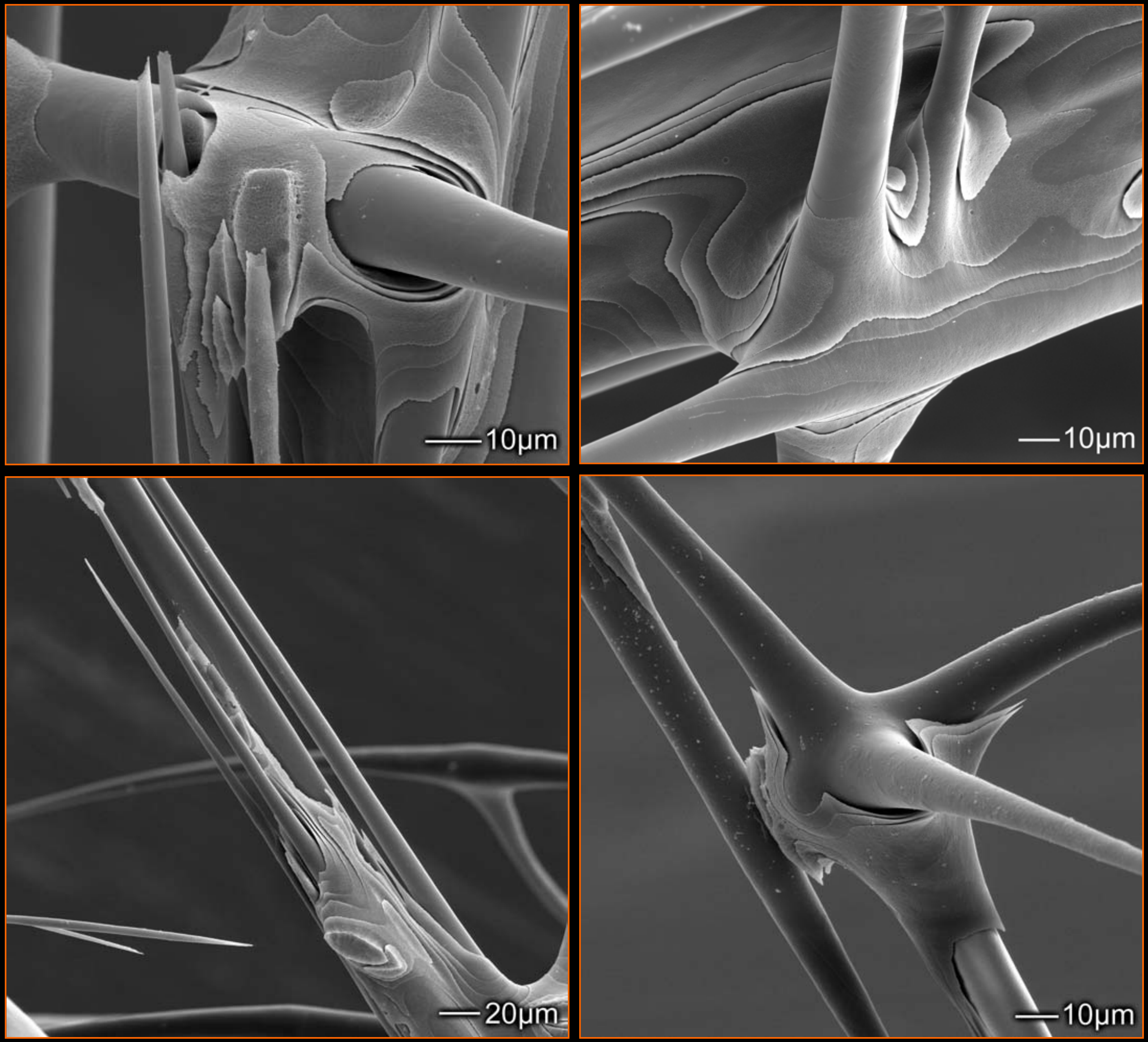


Skeletal Lattice of ***E. aspergillum***

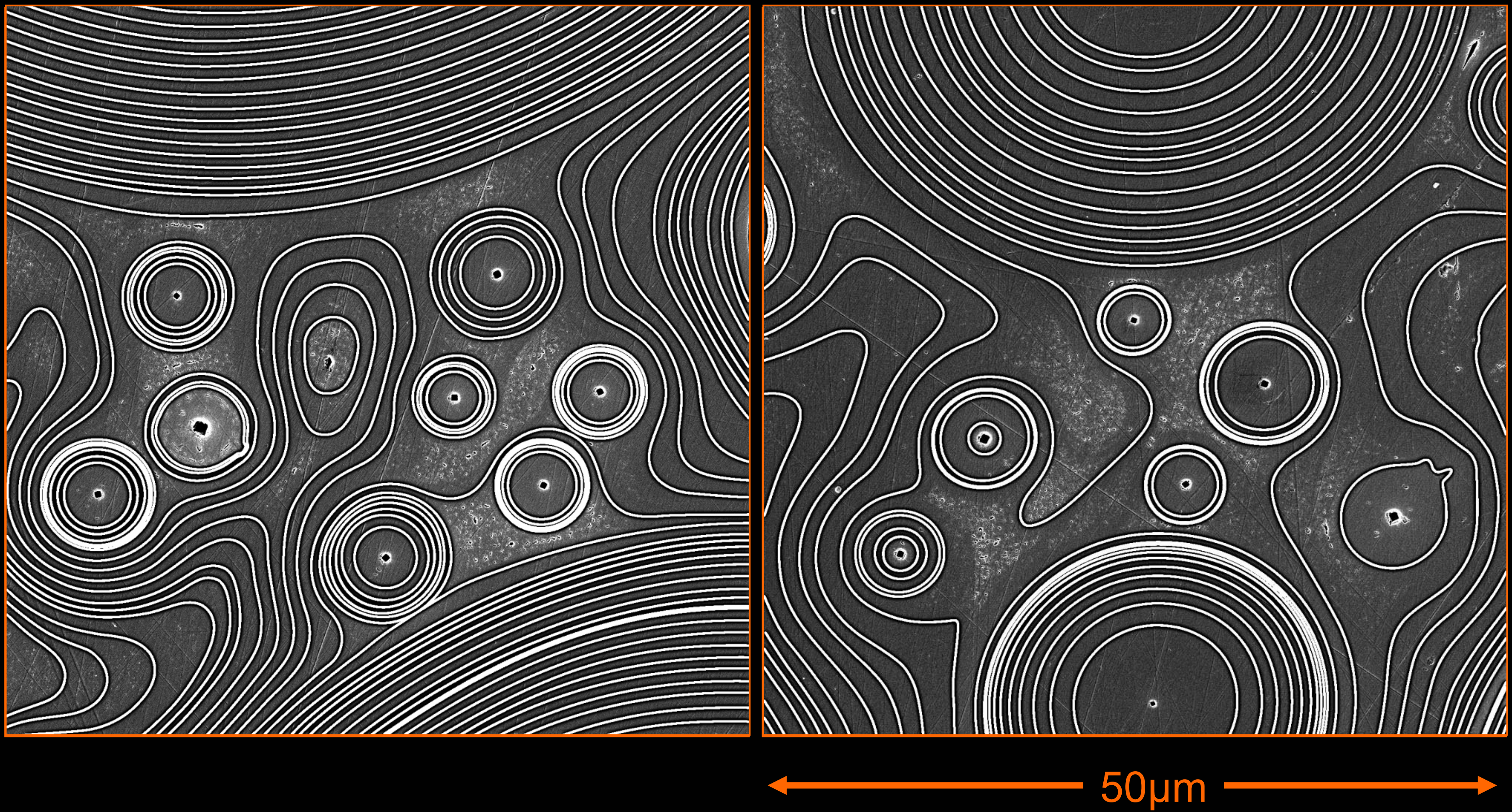


—— 100µm

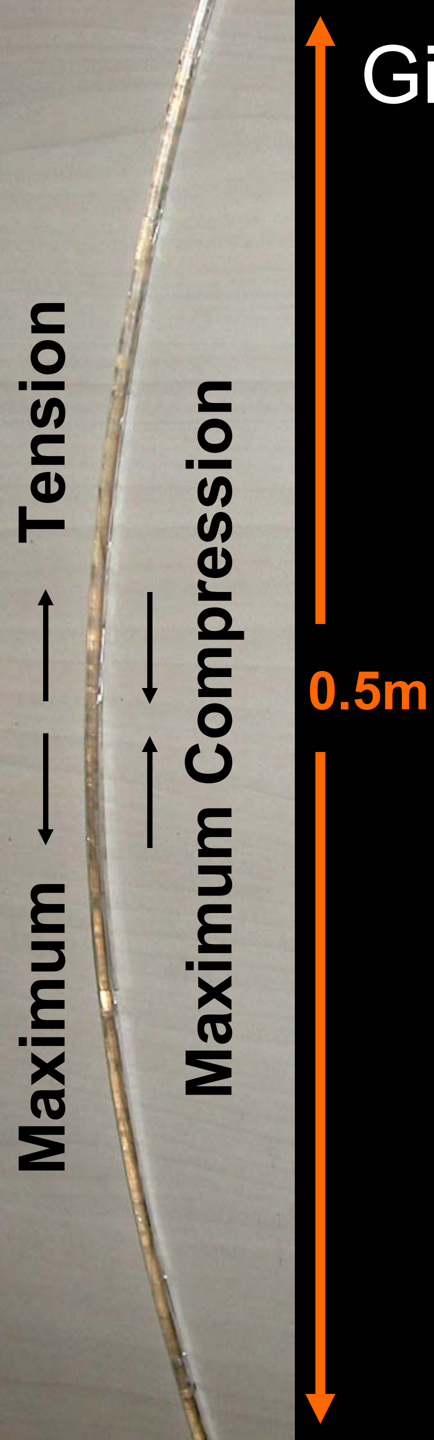
Etching of ***E. aspergillum*** Skeletal Lattice with HF

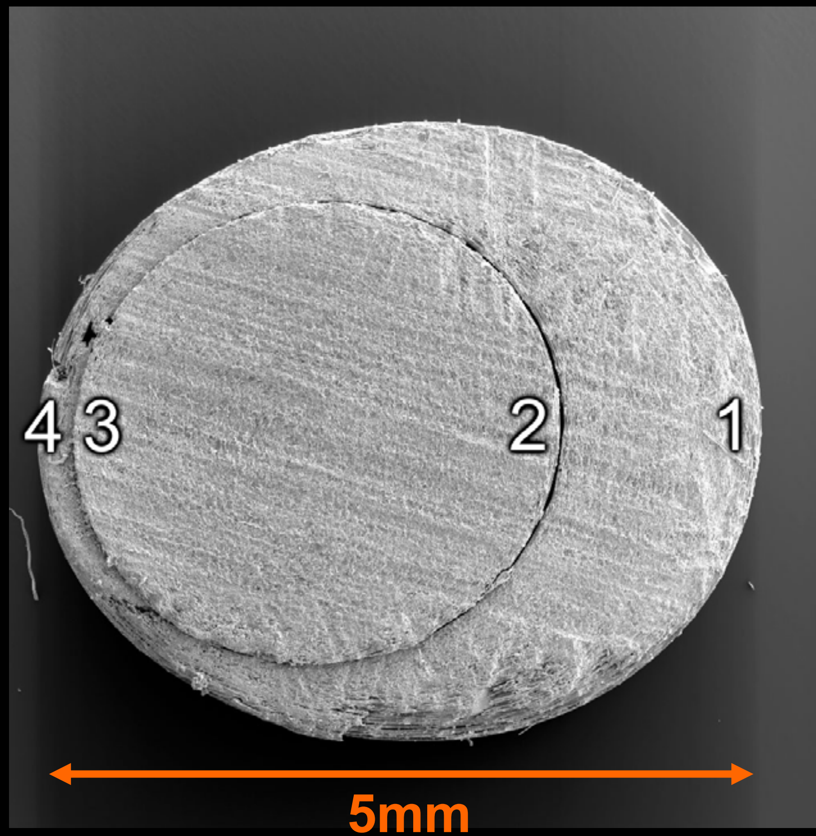


E. aspergillum Skeletal Lattice Cross-Sections



Giant Anchor Spicule of *Monorhaphis chuni*





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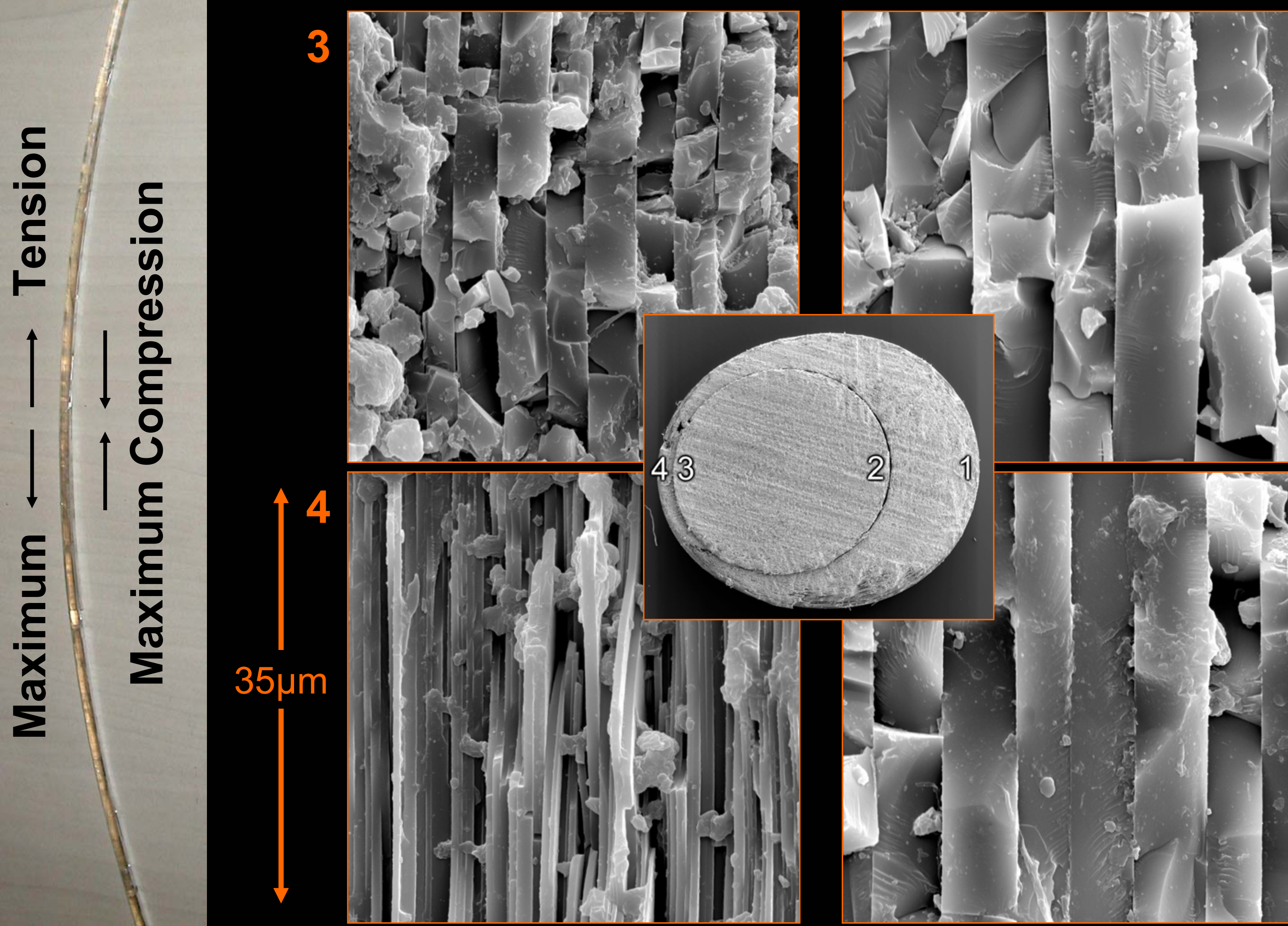
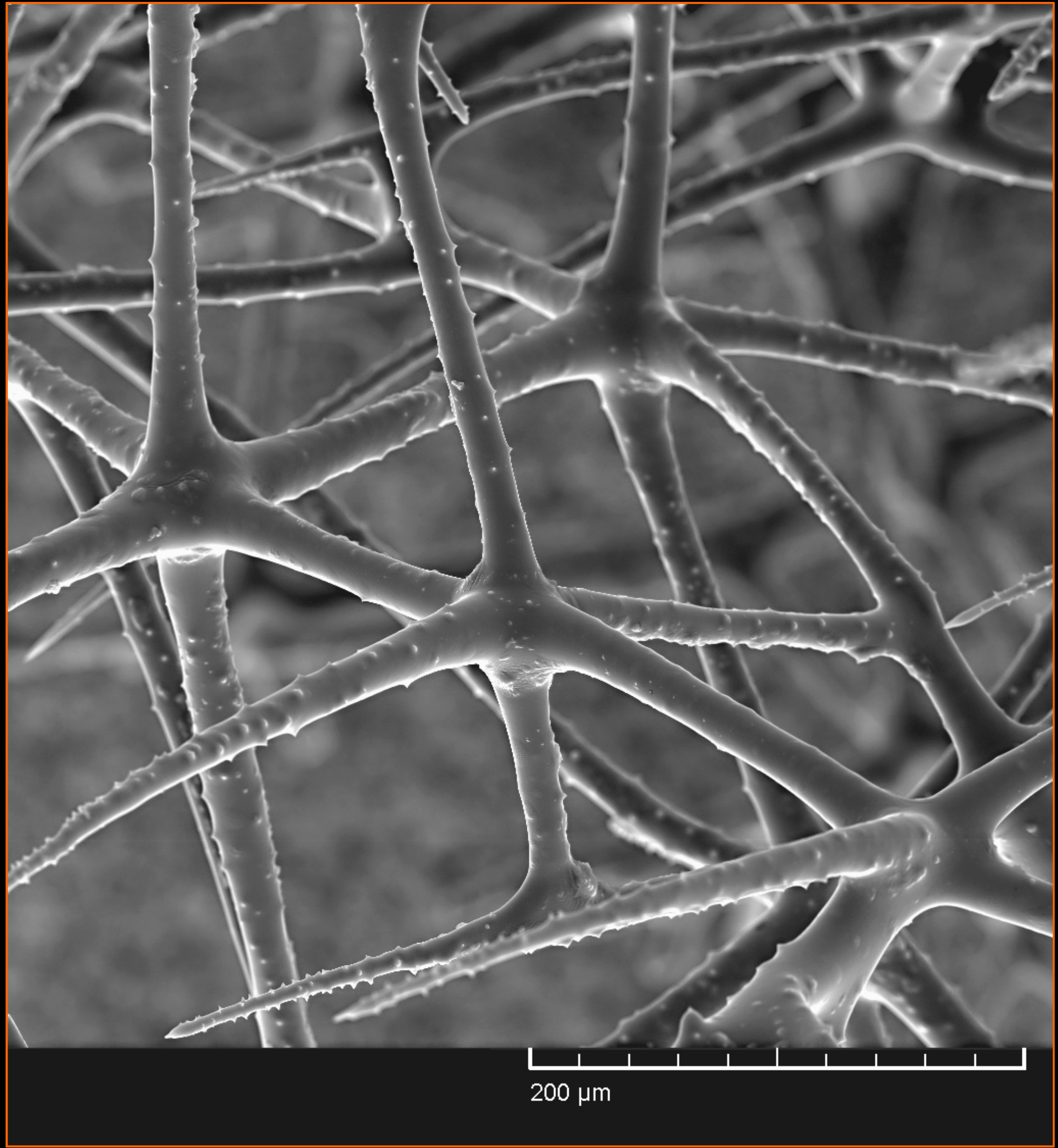


Skeletal System of *Aphrocallistes vastus*



Conclusions

Spicules greater that a few millimeters in length exhibit a unique laminated architecture which effectively retards crack propagation through these materials.

Layer number increases with spicule length and typically decreases in thickness outward from the core.

Large spicules confronting uniaxial loading exhibit a unique graded architecture for enhanced fracture resistance.

Future Work

Identify the specific bio-macromolecules that direct the synthesis of these remarkable structures.

Model the mechanics of these spicules.

Apply the lessens learned in these studies toward the synthesis of more fracture-resistant composite materials.

Acknowledgements

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