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Structural Diversity of Self-Assembled Iridescent Arthropod Biophotonic Nanostructures VINOD KUMAR SARANATHAN, Division of Physics and Applied Physics, Nanyang Technological University, RICHARD O. PRUM, Department of Ecology and Evolutionary Biology, Yale University — Many organisms, especially arthropods, produce vivid interference colors using diverse mesoscopic (100-350 nm) integumentary biophotonic nanostructures that are increasingly being investigated for technological applications. Despite a century of interest, we lack precise structural knowledge of many biophotonic nanostructures and mechanisms controlling their development, when such knowledge can open novel biomimetic routes to facilely self-assemble tunable, multi-functional materials. Here, we use synchrotron small angle X-ray scattering and electron microscopy to characterize the photonic nanostructure of 140 iridescent integumentary scales and setae from 127 species of terrestrial arthropods in 85 genera from 5 orders. We report a rich nanostructural diversity, including triply-periodic bicontinuous networks, close-packed spheres, inverse columnar, perforated lamellar, and disordered sponge-like morphologies, commonly observed as stable phases of amphiphilic surfactants, block copolymer, and lyotropic lipid-water systems. Diverse arthropod lineages appear to have independently evolved to utilize the self-assembly of infolding bilayer membranes to develop biophotonic nanostructures that span the phase-space of amphiphilic morphologies, but at optical length scales.

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