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Resilience Despite Damage: Structure and Mechanics of Multicycle Loading in the Mussel Plaque[1] MENAKA WILHELM, EMMANOUELA FILIPPIDI, J. HERBERT WAITE, MEGAN VALENTINE, Univ of California - Santa Barbara — The proteinaceous byssal plaque-thread structures created by marine mussels exhibit extraordinary load-bearing capability. Knoweldge of nanoscopic protein interactions that support interfacial adhesion in the plaque has improved in recent years, but supramolecular mechanisms of energy dissipation that confer toughness are less understood. We have used multicycle loading in the plaque-thread structure, complemented with scanning electron microscopy of strained plaques, to probe force response and strain-induced structural changes. We find that multicycle loading decreases small-strain stiffness, but does not compromise the critical strength or maximum extension, as compared to plaques that are monotonically loaded to failure. The strain-dependent plastic damage does not appear to be reversible or repairable on hours-long timescales, but this work suggests that a redundancy of load-bearing mechanisms contributes to plaque toughness in repeated loadings. Improved understanding of energy dissipation on lengthscales ranging from microns to millimeters provides new insight into the mussel system, and offers potential strategies for the design of soft, tough and resilient synthetic structures.

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