Using marine mussels as a model organism, we explore the role of geometry and internal interfaces in controlling biological adhesion. We observe the dynamics of mussel plaques as they debond from glass using a custom built load frame with integrated dual view imaging capabilities. We previously found that the shape of the holdfast improves bond strength by an order of magnitude compared to other simple geometries and that mechanical yielding of the mussel plaque further improves the bond strength by ~100× as compared to the strength of the interfacial bonds. Moreover, we determined that a porous, heterogeneous network within the plaque gives rise to novel modes of load transfer within the material. Here, I will present new work exploring how cyclic loading of the holdfast affects plaque debonding. 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. Strain-dependent plastic damage, observed using scanning electron microscopy, does not appear to be reversible or repairable on hours-long timescales. However, our results suggest that a redundancy of load-bearing mechanisms contributes to plaque toughness in repeated loading. These experiments provide new insight into the physical origins of biomaterials properties, and suggest new avenues for design of biomimetic systems with enhanced properties.