Diversity, Plasticity and Application of Spider Silks

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Most biomaterials are inflexible and covary with development in animals. However, some biomaterials such as silk are secreted and exert functions external to the secretor, often in spatially and temporally heterogeneous environments. Spider silks are an externally acting biomaterial, which function by absorbing the kinetic energy of flying insects in order to capture food for the spider. Major ampullate (MA) silk has been the model silk used for examining genetic and environmental influences over spider silk expression. MA silk genomes have been sequenced for some orb-web spiders, and functional models have been developed to predict the influence of genes over silk mechanics. Studies that have attempted to match the mechanical performance of MA silk with amino acid composition in free-living spiders have found non-conformity to the predictions of existing models. Genetic expression, thus, only partly explains silk performance and physiological and behavioural factors should also play a role in influencing silk properties. MA silk has been demonstrated to exhibit plasticity since its mechanical properties vary in concordance with environmental shifts, such as changing prey types and climatic factors. Results from current studies suggest that silk encoding genes do not necessarily provide a “blueprint” for producing silk of particular properties, rather they encode for the amino acid building blocks of silks whose properties are adjustable by the environment. The interactive influences of genetics, physiology, and environment on silk performance may explain why attempts at cloning silk fibroins have failed to commercially produce fibers that replicate the mechanics of natural silk.