Spider Glue Protein: A New Structural Biomaterial

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ABSTRACT

The various silks that make up the web of the orb web spiders have been studied extensively. However, success in prey capture depends as much on the web glue as on the fibers. Spider silk glue, which is considered one of the strongest and most effective biological glues, is an aqueous solution secreted from the orb weaving spider's aggregate glands and coats the spiral prey capturing threads of their webs. Studies identify the major component of the glue as microscopic nodules made of a glycoprotein. To date, little is known regarding the molecular and structural features of spider glue proteins. This study will identify and characterize the two genes that encode the glue-glycoprotein of the golden orb weaving spider *Nephila clavipes*. Cloning of these glycoprotein genes may enable large-scale production studying their biochemical traits and developing new bio-based glue for numerous purposes.

OVERVIEW

Six of the seven silk-producing glands have been shown to produce fibers with the exception being the aggregate gland. Micron-sized drops coat the sticky spiral threads of orb weaving spiders in order to retain prey in the web. These drops are composed of a viscid glue, which behaves like a viscoelastic solid[1].

Chemical analysis of this complex aqueous solution shows relatively high concentrations of water-soluble organic compounds related to neurotransmitters, free amino acids, small peptides, low concentrations of various inorganic salts, and glycoproteins. A previous study from our laboratory showed that two genes encode two subunits of the aggregate spider glue 1 and 2 (ASG1 and ASG2) of the golden orb weaving spider *Nephila clavipes*[2].

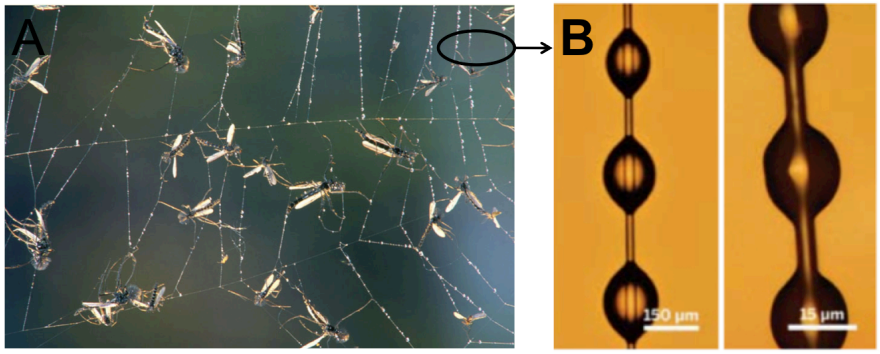

Figure 1. (A) Glue droplets can hold on to fast-flying insects when they initially impact webs and retain trapped insects for a time period long enough for them to be subdued by the spider. (B) Enlarged image of spiral thread coated with glue droplets, which is key in spider prey-capture.

RESULTS FROM EARLY WORK

Clones for ASG1 (2181 bp) and ASG2 (2905 bp) were isolated from a previously constructed cDNA library of a *Nephila clavipes* aggregate gland[2], encoding 695 aa and 910 aa, respectively. There are no reports that the 5'-end of the coding sequence has been discovered. Because spider glue proteins lack a consensus amino acid repeat, we propose that they have distinct architectures compared to the "traditional" spidroin family of proteins.

ONGOING WORK

A genomic DNA library from the *Nephila clavipes* abdomen was constructed. The library has been screened using two PCR-generated probes: 413 bp ASG2 and 350 bp ASG1. Probes were created using the cDNA library as the template with primers based on the previously isolated clones.[2]

A new cDNA library is being constructed using a kit that can generate insert sizes >2.0Kb. The cDNA library will be screened with the ASG1 and ASG2 probes. Northern blots will be performed to detect the message size for ASG1 and ASG2 using probes from the 5'-end and 3'-end of both genes.

CONCLUSIONS & FUTURE DIRECTIONS

The knowledge of these genes and their partner proteins is essential for further biological and chemical studies on the structure and function of these proteins. Once the genes are fully described, they can be cloned and expressed, enabling a large-scale production of the glycoprotein that can be used to develop a new bio-based adhesive.

REFERENCES

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Images taken from: Vasav Sahni/U of Akron & Lee, H. Intelligent glue. *Nature* **2010** *465,* 298.

FUNDING

USTAR (Utah Science Technology and Research), AFSOR (Air Force Office of Scientific Research), DOE (Department of Energy).