The Outside Story

Of Dewdrops and Spider Webs

By Rachel Sargent Mirus

On a foggy morning walk, it may seem as if the spider webs on your path have turned into jeweled wonders, every thread a string of gems as smooth as pearls and as sparkling as diamonds. Each of these "jewels" is a drop of water the web has collected from the misty air. As with many beautiful natural phenomena, dew drops on a web are shaped by forces we can't see. In this case, two factors are at play: the physics of water and the micro-structures of silk.

Let's talk first about the physics of water, starting by zooming in on the air around us. Some of that air is water, its molecules bouncing about in the gas state. When the air is humid and contains many water molecules, these molecules can accumulate onto objects as a very thin film of liquid water. This water tends to break apart into drops, thus the water that accumulates around the threads of a spider web will quickly separate into individual spheres.

Many surfaces and objects bead with dew, but not all of them collect large, aesthetic drops. On spider webs, the molecular structure of the silk comprising the web actually helps grow the eye-catching drops.

A spider uses three types of silk to build an orb web, the flat, spiral net most of us are likely to picture when we think of a spiderweb. Dragline silk forms the framework, including the radial lines. Super-stretchy flagelliform silk forms the basis of the spiral. A finishing coat from one of two very different sticky silks makes the spiral a successful insect capturing trap. One group of orb weaving spiders brushes woolly cribellate silk onto their capture spirals, while the others blob on gluey aggregate silk.

Water condenses from the surrounding air onto the dragline silk of the web frame, then beads into separate drops. However, the two different types of sticky silks used to coat the web's capture spirals each have unique shapes which interact with water at the microscale.

A microscopic view reveals that cribellate silk is a series of fibrous tangles attached to the smooth supporting flagelliform thread, like rope strung with burs instead of beads. Because they are composed of many fibers, these tangles have a lot of surface area for water to condense onto. That water slides over to accumulate on the smooth supporting thread, leaving room on the cribellate tangles for more water to collect. This process can grow large drops of water over time.

Only a few cribellate orb weaver species live in northern North America, however, so the orb webs you're likely to see in our region have gluey aggregate silk – rather than the cribellate silk – on their spirals.

Aggregate silk achieves the same sticky ends as cribellate silk, but in a completely different way. This silk is composed of gluey blobs that require the right balance of hydration: not enough water and the glue dries out, too much and it becomes too diluted to stick to incoming prey. Each spider species' gluey silk has been tuned by natural selection to have an ideal stickiness in the typical humidity of their home. The spiders achieve this by customizing their aggregate silk mixtures with different blends of salts, which absorb water from air. Species that build by stream sides, for instance, use glue that absorbs just the right amount of water from humid air. Conversely, species that build in meadows have glue that can absorb just the right amount of water from drier air.

Spiders arrange this aggregate silk on the capture spiral in discrete beads, with smooth thread in between, to allow the stretchy underlying silk to deform around struggling insect prey. These gluey beads can swell with water to double their original size on wet mornings. The pattern of the droplets and their spacing matches the microscale glue arrangement laid down by the spider when it spun its web. So those strings of ephemeral gems that appear on spider webs on dewy mornings reveal the otherwise unseen beauty of the micro-verse of molecules and physics.

Rachel Sargent Mirus lives in Duxbury, Vermont. Illustration by Adelaide Murphy Tyrol. The Outside Story is assigned and edited by Northern Woodlands *magazine and sponsored by the Wellborn Ecology Fund of the New Hampshire Charitable Foundation: www.nhcf.org.*

Northern Woodlands
PO Box 270, Lyme, New Hampshire 03768
mail@northernwoodlands.org / 603-795-0660
www. northernwoodlands.org