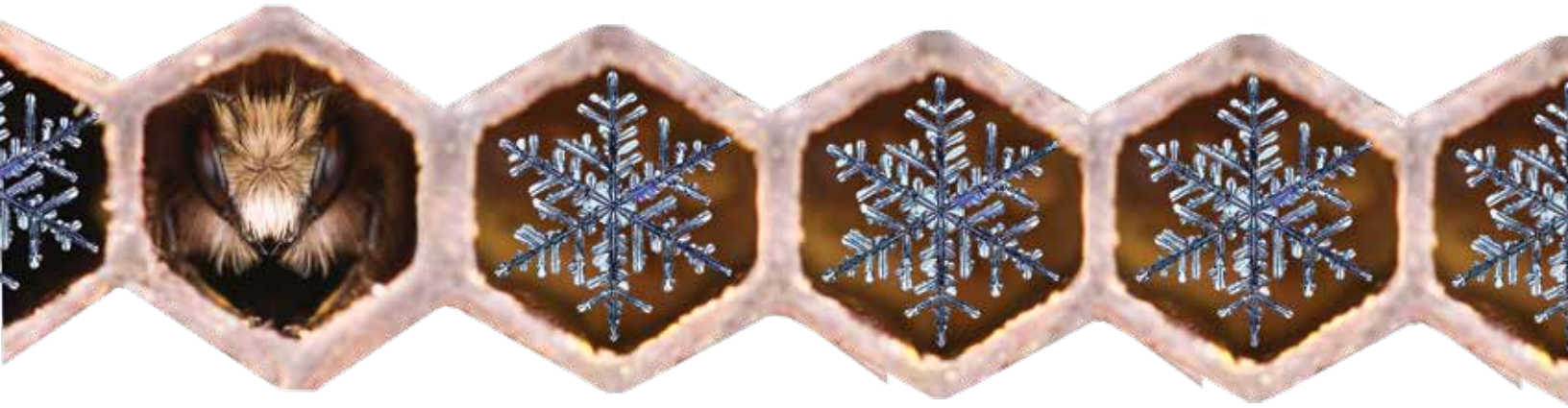

INSECTS HAVE COOL STRATEGIES TO WEATHER WINTER EXTREMES

Insect antifreeze, purging moisture from bodies – these creatures have adapted to freezing and much colder temperatures

By Scott Schell

My dear mother loved furry and feathered creatures and was a keen observer of nature.

She didn't, however, have those same feelings about insects and often said after the first hard frosts of fall that, "One good thing about the cold weather is that it kills all the bugs!"

Luckily, that was not an accurate observation. If there ever came a spring when insects didn't reappear, all of the plants and animals that live in the temperate and arctic zones that depend on them for pollination or food would perish. Some life stage – egg, larvae, or adult – of every insect species that lives in areas of the Earth that get below-freezing temperatures has a way of surviving.

Preparing for the Cold

Frostbite is the term applied to the terrible damage caused to human flesh by the formation of ice crystals, i.e., freezing. If an insect is not properly prepared for the cold, freezing also destroys its tissues.

Insects are very diverse and, even in dry and cold Wyoming, there are an estimated 12,000 to 15,000 different species of insects. How do these insects survive when it is so cold the snow squeaks underfoot? There are four primary winter survival strategies known for insects.

Honeybees Shiver to Warm Queen

The honeybee uses the rarest type of winter survival method. A honeybee colony uses social cooperation and food energy from honey they eat all winter to keep all members of the colony at temperatures above freezing. The colony does this by all coming together and forming a ball around the queen bee. The worker bees in the ball then create heat by shivering.

Honeybees will die if their body temperatures get below 44 F for very long.

Shivering muscles, even tiny insect ones, produce heat. The workers continually rotate from the warm center to the cold periphery of the cluster while the queen stays in the center at a toasty 86 to 95 F. On warm, sunny

Mourning cloak butterflies thaw and freeze repeatedly and seek shelter under loose tree bark.

days in winter, honeybee workers will leave the warmth of the cluster to go outside and eliminate body waste so they don't foul the hive.

Some Insects Produce Natural Antifreeze

Freeze avoidance is the term used for the most common insect winter strategy. Insects do this by voiding from their bodies particles and molecules on which ice crystals could form.

Snow scorpion flies survive Wyoming winters in soil insulated by snow.

Insects also produce sugars and polyol chemicals, like glycerol, which lower the freezing point of their blood. This process can be termed cold hardening and takes some time to happen. Insects not prepared physiologically will die when exposed to rapid freezing. A good example of an insect species that uses freeze avoidance is the mountain pine beetle. Their larvae, which live under the bark of trees, will cease feeding and empty their digestive tract as temperatures cool in the fall. When fully cold-hardened, most larvae can live through temperatures well below zero just under a tree's bark. However, if temperatures fall all the way to -43.6 F, the super cooling point, or below, ice crystals will form regardless of the presence of their chemical antifreeze and kill the larvae.

Severe cold like that will also damage any trees and shrubs not suited for USDA plant hardiness zone 2. Winter mortality can also occur at temperatures above the super cooling point if insects are not sufficiently cold-hardened when an arctic air mass arrives early in the season.

Some Freeze and Thaw

Freeze tolerance is the next most common survival strategy. This is when insects have ice crystals form in their bodies at just a few degrees below 32 F. In many species, the egg stage can easily overwinter in a frozen state. The ice crystals form outside of the cells of vital organs and are kept small and non-damaging with chemicals in the insect blood. This strategy is useful for insects living in areas with rapidly changing, variable temperatures, like the alpine tundra. For example, an insect could feed during a sunny afternoon after freezing during a hard frost the night before or feed during a period of mild winter weather without having to go through extensive physiological cold hardening.

An example of insect species that

can freeze and thaw repeatedly is the mourning cloak butterfly (*Nymphalis antiopa)* – a beautiful insect that has dark purple wings with iridescent blue spots and yellow bands on the top, outer edges. This species spends the winter in the adult stage exposed to winter air temperatures while sheltering under loose tree bark. On warm, sunny days in April, they can be observed flying in groves of aspen, poplar, and willow tree groves where overnight lows will still be well below freezing.

Others Replace Water with Trehalose

The term cryoprotective dehydration has been given to the most recently discovered survival method used by insects and other Animalia that dwell in extremely cold regions. The critters using this strategy get rid of almost all of the water in their bodies and replace it with trehalose. This molecule is essentially two glucose molecules, the simple sugar used for cellular energy by most animals, joined together with a chemical bond. This biochemical process with trehalose protects their delicate cells and proteins from freeze damage. This strategy is thought to provide the maximum protection from ice formation damage to insects living where the temperatures can regularly get below about -44 F.

Some Live in Favorable Winter Habitats

Some insects avoid freezing by living in habitats that never get extremely cold. Aquatic insects living below the ice are very chilly but are protected from subfreezing temperatures by the specific heat properties of water. Ants, termites, and bumblebee queens can retreat below the frost line in the soil to spend the winter. As little as 6 inches of snow over the soil effectively insulates from extremely cold air. This snow-soil interface is called the subnivean zone and rarely gets more than a few degrees below freezing. There, insects such as the aptly named snow scorpionfly and other animals, are adapted to living very actively throughout the winter.

How can you use knowledge of insect winter habits as an aid to pest control?

If you have consistent problems with certain insect pests in your yard or garden, you may be able to use cultural control to disrupt their overwintering habitat. An example would be performing late fall tillage on your garden to expose the pupa of variegated cutworms to severe winter air temperatures and burying the young larvae of the army cutworms in the soil to starve. This is a form of cultural control used in integrated pest management.

Conversely, if you have a butterfly garden with host plants for the caterpillars of pretty butterflies, you will want to leave the stalks, stems, and fallen leaves in place for the winter. Many butterfly species use that "messy" habitat as a place to pupate and wait out the winter.

As I get older, the insect winter survival strategy I would most like to adopt would be the one the last generation of monarch butterflies produced during the summer use. The majority of these lucky insects migrate south to central Mexico to spend the winter in cool, but not freezing, temperatures and return to the north with spring!

Scott Schell, *University of Wyoming Extension assistant entomologist, might adopt his winter survival strategy noted above; otherwise, he's probably busy doing what he does best – studying insects. He can be reached at (307) 766-2508 or at sschell@uwyo.edu.*