The Twilight Zone

By Jeff Hajenga

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Cave salamanders are often found in the the twilight zone of West Virginia's limestone caves.

You are now entering the twilight zone! You may not believe it but we have a twilight zone right here in West Virginia. Actually, thousands of them spread throughout the eastern mountains of the state, mainly in limestone areas. I'm not referring to the science fiction phenomenon shared by millions of television viewers in the past, but the wonderful, unique caves of West Virginia. Caves provide not only recreational opportunities and natural scenic beauty for residents and nonresidents to enjoy, they make up one of the most interesting habitats that contain some of the largest assemblages of rare species in the state.

When you are in a cave, the twilight zone often appears as a soft bluish glow.

When understanding caves and cave habitats it is important to keep three things in mind: the zones of the cave, the species present, and the energy flow in cave systems.

The first thing to consider when looking at caves is the different zones of the cave. The three main zones that exist within all caves are the light zone, the dark zone and the twilight zone. The light zone is the area at the entrance that still receives daylight throughout most of the day. The dark zone is the area further back in the cave that never receives light. The twilight zone, however, receives indirect lighting from the sunlight outside the cave. When you are in a cave, this light often appears as a soft bluish glow around the corner or further down the passage.

Each of those zones listed above can vary greatly in the organisms present and pose a unique opportunity when investigating cave habitats. Although most rare species occur in the dark zone, it is in the twilight zone where outside organisms and some cave dwellers share the cave habitat. This overlap leads to an important exchange of energy between the outside environment and the cave environment.

The diverse biota present within caves can be divided into a few main categories. For terrestrial species these categories are accidentals, troglobites, troglophiles and


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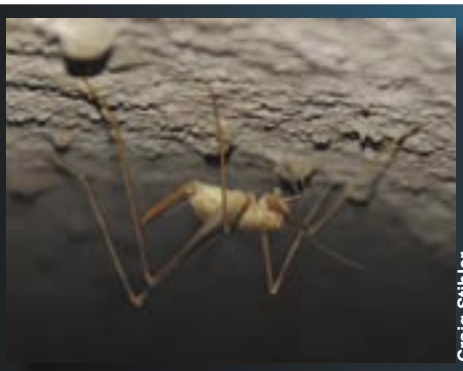
Cave orb weaver spider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Cave cricket


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Cave millipede

trogloxenes. When referring to aquatic species, the prefix 'troglo,' which refers to terrestrial species, is replaced with 'stygo.' The aquatic equivalents would therefore be called stygobites, stygophiles and stygoxenes.

Accidentals are organisms that accidentally wander, fall, or wash into a cave. Unless they are able to find their way back out to the surface they usually perish. Common examples of accidentals are turtles, frogs, snakes, groundhogs, opossums or any other "surface-dwelling" species. During decomposition, these animals can be a very important source of nutrients for the cave community.

Troglobites are true cave dwellers; all stages of their life, including reproduction, take place within the cave environment. These species would not survive outside of the cave. They frequently lack eyes and pigmentation, and exhibit an elongation of appendages or sensory organs such as antennae. These are some of the rarest species of all the cave organisms. Examples include the cave crayfish, the Madison Cave isopod *(see Fall, 2005 issue)*, cave beetles and cave millipedes.

Troglophiles are species that use the caves but need to leave the cave in order to survive, usually to find food. Some common examples of these are bats, woodrats, mice and raccoons.


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The Indiana bat is a federally endangered species found in 18 caves in West Virginia.

Trogloxenes are species that are able to complete their entire life cycle within caves but can also be found outside the cave environment, such as cave salamanders and cave crickets. Although uncommon in West Virginia, the cave salamander has been found in the twilight zone of limestone caves found in the southern portion of the state's karst area.

Cave ecosystems are different from most ecosystems in that they are not directly dependent on sunlight as a source of energy. All energy in a cave system is either found within the system or imported in from the surface environment. This energy (nutrient) import is commonly in the form of washed-in debris, animal droppings, or surface species that perish after becoming lost or stranded within the cave. Energy flow within the cave consists of an intricate web of relationships between decomposers, the primary consumers and an assortment of secondary consumers.

Cave ecosystems are very unique because the decomposers, typically fungi and bacteria, actually play the role of producer in an environment devoid of sunlight. Once the decomposers begin to break down the imported debris, it is time for the consumers to start. Species like earthworms, springtails, millipedes, mites, beetles and gnats are among the first species to benefit from the

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action of the decomposers. These species are in turn consumed by pseudoscorpions, spiders, salamanders and mice.

Aquatic systems work in much the same way with bacteria and fungi as decomposers, and amphipods, isopods and snails being the initial consumers. Crayfish, fish and salamanders act as secondary consumers.

A never ending balancing act plays out between the different groups of organisms within the cave, all based on the nutrients imported from the outside and the environmental conditions of the cave. Any increase or decrease in nutrient availability, temperature, airflow, or humidity will have consequences, both positive and negative, on all species in the system. It is this sensitivity to environmental conditions and change that make caves one of the most threatened habitats in West Virginia.

In summary, approximately 93 individual species of cave organisms live in the state, with a majority (60 percent) of these species found only in West Virginia. Eighty-five of these species are considered rare: two are federally endangered species (Virginia big-eared bat and Indiana bat) and one, the Madison Cave isopod, is federally threatened.


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Looking out from the twilight zone at the Greenville Saltpeter Cave where volunteers and DNR staff are constructing gates to protect the cave.

It is hoped that through proper land planning, adequate pollution control and sound caving ethics, the caves of West Virginia, and their unique animal communities, will survive for future generations to enjoy.

Jeff Hajenga is a wildlife biologist stationed in Beckley.

Did You Know?

•The Allegheny woodrat, right, constructs "houses" that consist of one or two nests, caches of acorns and other food items, and piles of debris found in the area. It is thought that these piles of leaves, twigs, and litter help to alert the woodrats when predators or other woodrats come around. Often there are odd types of man-made trash, such as the plastic beverage rings shown below *(middle)*, which help give the woodrat its nickname of "pack rat."

•The Herald moth *(left),* often found in caves in the winter, is one of the first moths seen in the spring, thus "heralding" better weather. It overwinters as an adult and has special adaptations -- tympanic air sacs -- which are thought to have been used by their ancestors to detect bat sonar. Whether these sacs are still used for this purpose is uncertain, but they do help conserve heat.


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Herald moth


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Woodrat nest


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Allegheny woodrat