

The background of the cover is a photograph of a rocky cliff face. The rock is covered in patches of green moss and lichen. Several small, green-leaved plants with thin stems are growing from the crevices. One prominent plant has a single, light pink flower with a yellow center. The overall scene is a natural, rugged habitat.





Life on the Edge

Geologic Influences on Unique Habitats

by Bianca Rios, Daniel Barnstable, Jonathan H.
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Quaternary Deposits of Illinois

Wisconsin Episode Glacial and Postglacial Landforms

-  River valleys, floodplains, glacial meltwater channels, dunes, and beaches
-  Lake plains
-  End moraines
-  Till plains

Map courtesy of Illinois State Geological Survey


Illinois Episode Landforms

-  Till plains and end moraines
-  Sand plains, ridges, dunes, and lake plains

Pre-Illinois Episode Landforms

-  Till plains

Unglaciated Landscapes

-  Composed mostly of shale, limestone, dolomite, or sandstone



Clinging to the cliffs along the Apple River in JoDaviess County, the bird's eye primrose (*Primula mistassinica*) is literally experiencing life on the edge. Considered a relict of the preglacial flora of Illinois, its name is certainly appropriate for the precarious perspective it has of life in the canyon below. Perspective, after all, is everything. If you're a microbe hidden in the rich glacial debris that covers almost all of Illinois, you're dwarfed by a quartz

grain, a veritable boulder to you but barely visible to the human eye. If you're a squirrel, you can live your entire life in a few acres of hardwood forest where walnuts with shells the size of golf balls provide a ready diet. And, if you're a bird's eye primrose, you thrive only along the Apple River. The diverse geology of Illinois creates many habitats; and, in these special niches, some of them unique or confined to limited areas, we discover some of the rare and unusual plants and animals that live in our resource-rich state.

Unlike the microbe, squirrel, or bird's eye primrose, humans can record the distribution of landscape characteristics on a map. With such a "bird's-eye" view of our state, we can see the arrangement of distinctive geologic patterns that influence the state's natural divisions. This is exactly what John Schwegman did when, more than 25 years ago, he established the 14 natural divisions of Illinois in the Comprehensive Plan for the Illinois Nature Preserves System.

Build it and they will come. Observations of the natural world tell us that this has been occurring throughout Earth's history. Ecosystems are much more than an assemblage of flora and fauna. They are areas that have been built throughout geologic time by processes both swift and slow. These geologic processes, in part, have given Illinois its rich and fertile soils for agriculture and its building materials for skyscrapers and roads. These same processes, sometimes altered by human activities, have helped create the diverse and special natural resources of our state.

From the bedrock bluffs of the Driftless Area in the northwestern corner of Illinois to the cypress swamps at its southern tip, the diversity of our native flora and fauna in part

reflects the state's geology. Combined with the climatic history of the past several thousand years, this geologic diversity has given rise to habitats suitable for thousands of species of native animals and plants. Although the boundaries of Illinois' natural divisions appear to be based on the distribution of plants and animals, they are significantly influenced by geology—the distribution of bedrock exposures, glacial sediments, topography, and soils.

Buried Under Ice

During the last 1.6 million years, most of the state was repeatedly covered by glaciers, masses of ice up to hundreds of feet thick. The advance and retreat of these glaciers profoundly changed the existing landscape, which had been sculpted by exposure to the wind and weather for hundreds of millions of years before the glaciers arrived. Grinding ice planed down the high spots; as the ice melted, deep valleys were filled with sands and gravels borne by massive meltwater floods, and lesser hills were buried beneath a thick blanket of iceborne sediments called glacial drift. The map of these Quaternary-age deposits, as they are called, shows their distribution and age, including areas that are missing such deposits, the "driftless" areas.

The most extensive glacial advances, which occurred sometime during the Illinois Episode,





Left: algific slope in JoDaviess County; above: Apple River Canyon.

Michael R. Jeffords

Algific Slopes

Instead of being edged with vertical cliffs, several of the streams in the Driftless Area are bordered by steep, north-facing limestone talus (rock fragments) slopes. These slopes are generally covered with a thick carpet of moss, and ice persists beneath the surface throughout most of the summer, creating a cool microclimate on the surface of the slopes. They are called algific (cold-producing) slopes.

Algific slopes are one of the state's most unusual natural areas, and they are confined to the Driftless Area, where less than a dozen exist. These small areas, usually no more than 100 feet by 100 feet in size, preserve a sample of what Illinois may have looked like during the last stages of the Ice Age 10,000 or 20,000 years ago. Even on the warmest summer days, they are blanketed by a thin layer of cold air, a by-product of the subterranean ice trapped in the underlying rock strata.

Algific slopes are an indirect effect of the glaciers. Even though glaciers did not cover this area, their close proximity caused extreme temperature fluctuations that fractured chunks of rock from cliff faces. The broken rock fell to the base of the cliff, accumulating in a jumble of talus. During the winter, cold air penetrates down deep into the rocks under the slope and supercools them. In the spring, when the surface snow and ice melt, the melted water seeps down to the super-cold rocks and instantly freezes. The ice persists throughout the summer. The refrigerated air creates a cold microclimate on the surface of the slope. Even during 90°F summer days, the surface temperature is 42°F.

The slopes frequently support relict northern and Pleistocene biota, such as mountain clematis, beaked hazelnut, and boreal rose, but the cold may change the physical structure of individual plants, causing them to assume odd growth habits and altering their flowering times. Herbs that normally bloom in the spring may be in flower until autumn.

The Iowa Pleistocene snail, a tiny flatland snail, is restricted to this habitat and is a federally endangered species. This snail was thought to be extinct until it was discovered in 1928 in adjacent Iowa and subsequently in Illinois. Before its discovery, the snail was known only from Ice Age fossils. Once widespread during the Ice Age, the snail is now limited to these algific slopes.



Mike Sweet

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between 750,000 and 125,000 years ago, covered virtually the entire state. The ice reached as far south as the northern tip of Johnson County. During the most recent Wisconsin Episode, which occurred between 25,000 and 12,000 years ago, the glaciers that advanced into the state covered the northeastern third of what is now Illinois with a blanket of new glacial drift. The glaciers also profoundly altered the climate in the rest of the state.

Virtually all of the state's soils have developed in the layers of windblown silt laid down during this last glacial episode. Sediment-laden meltwater from the glaciers coursed down the major rivers each summer, filling the valleys with floods that reached from one bedrock wall to the other. When the melting subsided during the winter months, the harsh, dry winter winds picked up the loose sediment from the floodplains and blew it across the landscape to the east, blanketing the state with the material called loess.

Remnants of Time Before Glaciers

The state's northwestern corner, westernmost areas, and southern tip escaped the direct effects of erosion and deposition of sediment by glacial ice, but they were profoundly affected by the meltwater deluges. No area escaped the profound climate changes of the Ice Age. Many of the state's endangered and threatened species are relicts of those colder and wetter periods, and they are clinging to a precarious existence in tiny areas where these earlier conditions are simulated, for example, on algific slopes (see sidebar). A few, such as the bird's eye primrose, may even be a modern connection to preglacial conditions, surviving thousands of years of harsh, drying winds and bitter cold during glacial periods to thrive again in the more temperate conditions of interglacial periods—and today.

The deep ravines and bedrock cliffs of the Wisconsin Driftless Division hint at what much of Illinois' landscape may have looked like before the Ice Age. Although this area

was never buried beneath glacial ice, torrents of meltwater coursed down rivers, altering drainage patterns, deepening canyons filling them with sediments to higher levels, and creating terraces that reflect these former floods. Cliff faces expose 400-million-year-old dolomite and limestone bedrock, rocks rich in calcium carbonate. In places, the rocks are laced with horizontal layers of impervious chert. These layers can direct groundwater so that it seeps downward through the bedrock and laterally out to the cliff faces, providing year-round wet conditions on the steep slopes. “In the summer months,” said Schwegman in 1973, “water from these seepages keeps the plants cool and moist, and in the winter the cascading water freezes over the cliff faces, protecting the roots and seed of the [bird’s eye primrose] from the damaging westerly winds.”

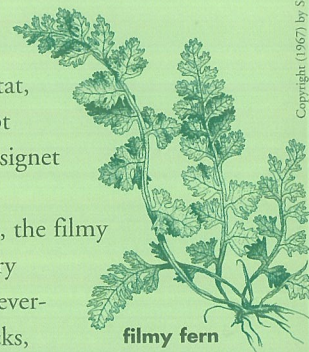
In the southernmost part of Illinois, beyond the reach of the most extensive Illinois glaciers, progressively older layers of bedrock sandstone, limestone, and dolomite lie exposed in a succession of cuestas. In the Shawnee Hills Division, a thin layer of loess covers the rocks on the gentler slopes. Where the slopes are steep and erosion is rapid, bare rock is commonly exposed and forms sandstone and limestone glades in the forest that covers much of the area.

Under the dripline of rock overhangs in the Shawnee Hills, French’s shooting star (*Dodecatheon frenchii*) flourishes, often in a bed no more than a foot wide. It grows in no other habitat, and its existence is confined to the area kept cool and moist by dripping water—itsself a signet of geologic time.

Another rare plant of the Shawnee Hills, the filmy fern (*Trichomanes boschianum*) lives in a very restricted habitat molded by geology. This ever-green plant, with slender, creeping rootstocks, grows on the shaded, moist, vertical faces at the bases of sandstone overhangs. Jackson Hollow, Hayes Creek Canyon, and Bay Creek south of Belle Smith Springs all contain populations of this unusual fern.

At the very southern tip of the state, in the Coastal Plain Division, the rocks exposed at the bedrock surface mark the thin feather edge of a progressively thickening wedge of weakly lithified or cemented clastic sediments. These sediments have been laid down on the coastal plain of North America during the last 70 million years. Except for the glacial deposits, they are some of the youngest sediments in Illinois. Although

Natural bridge at Belle Smith Springs. Insets (left to right): French’s shooting star, Carolina silverbell.



filmy fern



Insets: Michael R. Jeffords



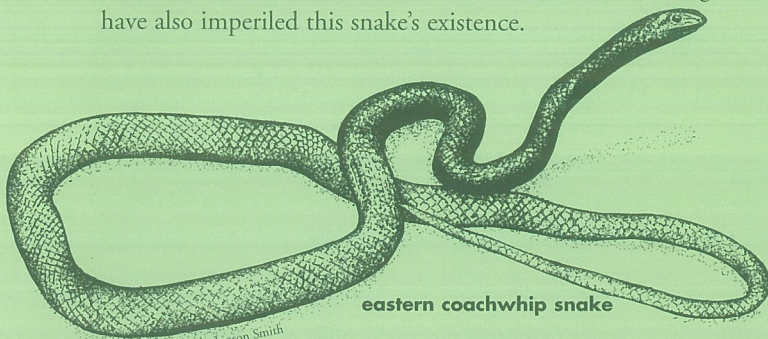
Fults Hill Prairie in Monroe County provides habitat for the eastern coachwhip snake.

they were never glaciated, these low-lying lands adjacent to the Ohio, Mississippi, and Wabash rivers were subject to torrents of sediment-laden glacial meltwater.

The Carolina silverbell (*Halesia tetraptera*) is found only in the Coastal Plain Division of Illinois, mostly in the rich, well-drained soils of terraces formed along the Ohio River and its tributaries and ancestral streams. Terraces that were formed as postglacial streams, now devoid of glacial sediment, cut down through the thick blanket of sandy valley-train sediments deposited by meltwater floods.

Finding a Niche

The eastern coachwhip snake (*Masticophis flagellum flagellum*) reaches the northern limit of its habitat in Monroe County, situated in the Salem Plateau Section of the Ozark Division. This area is part of the Ozark Uplift, a domelike geologic structure of exposed, ancient bedrock centered in the Ozark Mountains of Missouri. The eastern coachwhip prefers seasonally dry, rocky, brushy, or wooded hillsides. This area—with its deeply incised river and stream valleys, steep bluffs facing the Mississippi River, and outcrops of limestone bedrock nearly everywhere—provides ideal habitat. This reptile has become threatened in Illinois because of habitat destruction, for example, forest clearing and mining in the limestone bluffs. Traffic fatalities and indiscriminate killing have also imperiled this snake's existence.



Lynn Hawkinson Smith

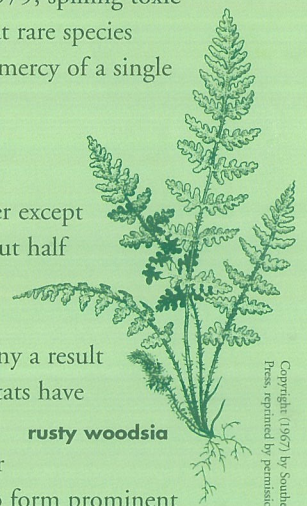
eastern coachwhip snake

In Illinois, the bluehead shiner (*Pteronotropis hubbsi*) has only been found in the Lower Mississippi River Bottomlands Division, which includes the floodplain of the Mississippi River. This species has made its home here, in Wolf Lake and Otter Pond, at the foot of the bluffs of the Salem Plateau. Although lake and pond are connected by a bottomland swamp, Wolf Lake was considered the population nucleus and primary nursery area for this fish. It is an old, mud-bottomed oxbow lake, formed when a meander loop in the channel of the Mississippi River was cut off and abandoned. Most of the bluehead shiners were seen along the inner lake-ward margin of the abundant emergent and floating vegetation. No bluehead shiners have been reported here since railroad tank cars derailed in 1974 and 1979, spilling toxic fluids into the lake—a stark lesson that rare species confined to one locality can be at the mercy of a single catastrophic event.

A River-Rich State

Illinois is virtually surrounded by water except for its border with Wisconsin and about half of its border with Indiana. The state is also traversed in every direction by large and small rivers and streams, many a result of the last glaciation. Few, if any, habitats have not been influenced by rivers.

In northern Illinois, the Rock River has cut into the underlying bedrock to form prominent bluffs where northern relict plants such as the rusty woodsia (*Woodsia ilvensis*) thrive. This plant is commonly associated with rocky areas, particularly dry sandstone cliffs and ledges, where it grows in compact mats on the top edge of exposed outcrops of St. Peter Sandstone. This ancient beach-sand



rusty woodsia

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Michael R. Jeffords

Flatwoods in the Southern Till Plain

deposit is composed of rounded particles, and its sugary, highly porous texture allows rainwater to rapidly infiltrate or evaporate, leaving the outcrop ledges dry and desertlike. These ledges are the distinguishing mark of the Oregon Section of the Rock River Hill Country Division.

The fairly regular seasonal flooding of the Illinois River in the Illinois River Bottomlands Division and the nutrient-rich, sandy, silty sediments deposited in the floodplains of large rivers provide ideal conditions for the decurrent false aster (*Boltonia decurrens*). This flood-tolerant species has evolved specially adapted root cells that store oxygen for use during times of inundation. This advantage gives it the chance to outgrow competing species and gain access to more light.

The great floods of glacial meltwater that periodically coursed down the major drainages when the climate warmed also deposited vast amounts of sand that had been carried within the glaciers. Sand dunes of the Illinois River and Mississippi River Sand Areas Division, now mostly stabilized

by grass and other vegetation, dot the landscape east of the Illinois River in Mason County near Havana. The Illinois chorus frog (*Pseudacris streckeri*), adapted for digging sand burrows with its forelimbs, lives in the sand prairies and sand ponds along the Illinois River.

Illinois chorus frog



Approximately 20,000 years ago, meltwaters from the ice sheet that accompanied the Wisconsin Episode deposited vast quantities of sand and gravel along the lower Wabash River, turning the river into a braided stream with many channels winding through gravel bars. These so-called valley-train deposits were scoured and partially removed about 6,000 years later when ancient Lake Maumee, formed in Ohio and eastern Indiana by meltwater from the Lake Erie lobe glacier, breached a moraine and released a flood torrent down the Wabash River and its tributaries. The northern madtom (*Noturus stigmosus*), a small catfish, is found in the present-day Vermilion and Wabash rivers in areas of mixed sand and rock riffles and runs formed in the valley-train deposits by these floods.

The Southern Till Plain and the till plain of the Western Forest Prairie Division were not covered by ice from the more recent Wisconsin Episode of glaciation, but the area's rivers and streams were important drainageways for its meltwaters. Sandy and gravelly sediments deposited when the streams ran full of sediment-laden meltwater provided the parent materials of the rich, sandy soils of the upland forests formed on terrace steps. In the dry-mesic upland forests along the Kaskaskia River in the Effingham Plain Section of this division, the violet collinsia (*Collinsia violacea*), an uncommon flowering plant, is found.

Beyond the direct reach of the ice present during the most recent Wisconsin Episode of glaciation, drift deposited here by the Illinois Episode glaciers has been sculpted and thinned by erosion for nearly 100,000 years. Unlike the more recently glaciated areas, the Western Grand Prairie natural division has

Prickly-Pear Cactus

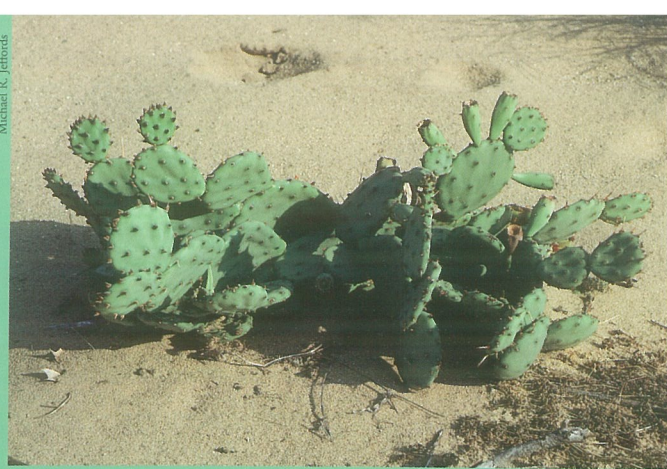
Mention cactus and most Illinoisans think of the desert Southwest, not realizing that three species of prickly-pear grow here in the harsh environments created by geologic forces. Prickly-pear thrives on the deposits of sand blown up out of the state's larger river valleys; the south-facing, rugged topography of hill prairies; and the severe rock outcrops in southern Illinois and along our major rivers.

Plains prickly-pear (*Opuntia macrorhiza*) grows on the windblown sand deposits, loess hill prairies, and limestone glades along the Mississippi River and the upper and extreme lower parts of the Illinois River. The eastern prickly-pear (*Opuntia humifusa*) is found on the sand deposits along Lake Michigan, the Illinois and Kankakee rivers, and the rock ledges of southern Illinois. The rarest of Illinois' prickly-pear, the fragile prickly-pear (*Opuntia fragilis*), has been found at a single site—a sand prairie in the Mississippi River valley of JoDaviess County.

In mid-August 1821, Henry Rowe Schoolcraft noted the prickly-pear's stark existence as he crossed the Illinois prairie near present-day Starved Rock. He recorded these observations: "This elevated cliff on the left bank of the Illinois [River], consisting of parallel layers of white sandstone. . . . The soil which results from gradual disintegration of this rock is nearly pure sand. On descending [from the top of the cliff], we found the prickly pear (cactus) covering a considerable portion of this soil, where scarcely any other plant is hardy enough to vegetate."

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Eastern prickly-pear at Sand Ridge State Forest in Mason County

Michael R. Jafford

a well-integrated drainage system with deep, forested ravines entrenched between flat upland prairie openings. The blazing star (*Liatrix scariosa* var. *nieuwlandii*) is essentially restricted to remnant upland savannas that grow on silt loam soils developed in the loess deposited across the landscape after the Wisconsin Episode. Most blazing star populations are threatened by loss of habitat. Without the wildfires that periodically swept across the prairies before European settlement, trees and other woody vegetation have encroached into the savannas, depriving the blazing star of the light it needs to survive.

Like blazing star, the pale false foxglove (*Agalinis skinneriana*) is found among the steep slopes of the Middle Mississippi Border Division, where many hill prairies were never plowed. Although most of the prairie soils here were developed in loess blown up from the nearby Mississippi River valley, rapid erosion on the steeper slopes has kept the soils thin, and the hill and sand prairies lead a precarious existence.

The Melting Ice

In the Northeastern Morainial Division, wherever the advance of glacial ice was balanced by melting, the leading edge of the ice remained in one place. There it deposited thick piles of flour-fine rock dust mixed with coarser silt, sand, gravel, and boulders, forming moraines. Streams of meltwater flowed off the top of the ice and from beneath it, in many places cascading over the top of these moraines at the ice front, depositing coarse sand and gravel "outwash" in the barren flatland and stream channels beyond them.

A camelback kame in Glacial Park, McHenry County



Both photos: Michael R. Jeffords

Tamaracks grow perfectly well in forest conditions but do not compete successfully with other trees. Because they can tolerate boggy conditions and most other trees cannot, they are relegated to this habitat. Inset: carnivorous pitcher plant.

Wherever the glaciers had stopped advancing and begun to melt and waste away, isolated blocks of ice left by the melting glacier became buried in the glacial drift. Eventually, the buried ice block melted away beneath its insulating blanket of sediment, leaving behind a nearly circular depression called a kettle. Because rainwater drains toward the centers of these kettles, vegetation grows rapidly there. Over time, kettles can become bogs if organic matter builds up; and, in the moist, acidic soils of kettle bogs, the state threatened tamarack (*Larix laricina*) and the state endangered carnivorous pitcher plant (*Sarracenia purpurea*) occur. The pitcher plant is endangered due to habitat destruction, drainage of bogs, and collecting by humans.

Although Illinois possesses rich and abundant natural resources as a result of its geologic and climatic history, some

of our species are situated precariously on the edge of extinction, and others are endangered or threatened. It's important to realize that their unique habitats, as well as our own, are built upon a geologic foundation that took eons to develop. This foundation cannot be easily re-created or reconstructed, if at all.

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