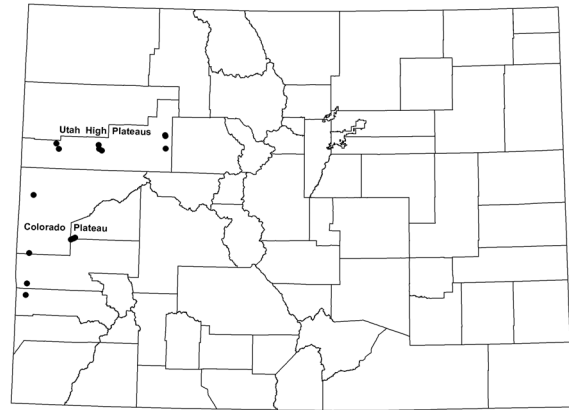


COLORADO PLATEAU HANGING GARDEN



R. Rondeau



extent exaggerated for display

AQUILEGIA MICRANTHA SATURATED HANGING GARDEN HERBACEOUS ALLIANCE
Aquilegia micrantha - *Mimulus eastwoodiae* Herbaceous Vegetation
Sullivantia hapemanii – (*Aquilegia barnebyi*) Herbaceous Vegetation [provisional]

Overview: Hanging gardens are a small patch community type in the canyons of western Colorado. These highly localized environments are found in canyonlands with perennial water sources (seeps) that form pocketed wetlands and allow the draping of vegetation across wet cliff faces. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris*, *Adiantum pedatum*, *Mimulus eastwoodiae*, *Mimulus guttatus*, *Sullivantia hapemanii*, *Cirsium rydbergii*, and several species of *Aquilegia*. This system includes hanging gardens of the Utah High Plateau ecoregion, which differ somewhat in geology and species composition from those of the Colorado Plateau to the south.

Characteristic species: Often species diversity is low, although it is typically much greater in the gardens on the Colorado Plateau than in those of the Utah High Plateaus. Species may be shared with nearby riparian vegetation, but there are a series of species, including algae, that are unique to hanging gardens (Welsh 1989). The classic alcove type of hanging garden in the Canyonlands of southeastern Utah consists of an overhanging back wall, a vaulted face wall, a detrital slope, and a plunge basin. The back and face walls support clinging plants of *Adiantum capillus-veneris*, *Primula specuicola*, *Mimulus eastwoodiae*, *Petrophyton caespitosum*, and several other species. The wet, sandy detritus supports *Carex aurea*, *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Epipactis gigantea*, *Perityle specuicola*, *Dichanthelium acuminatum* (= *Panicum acuminatum*), *Cirsium rydbergii*, and *Zigadenus vaginatus*. A fringing margin of *Celtis laevigata* var. *reticulata* (= *Celtis reticulata*) and *Quercus gambelii* often occurs outward from the footslope where the plants tend to conceal the alcove base. The outer and drier edges support grasses typical of the prairies and plains of the western U.S. In the Utah High Plateaus gardens, the dominants are usually *Sullivantia hapemanii* var. *purpusii* and *Aquilegia barnebyi* with *Mimulus guttatus* common.

Vegetation in hanging gardens varies from canyon to canyon as well as separate alcoves within a canyon. There are generally some common species that are found at most of the hanging gardens (e.g., *Maianthemum stellatum*, *Adiantum capillus-veneris*, *Adiantum pedatum*, and *Mimulus* spp.), but numerous endemics occur that may be represented at just one or two sites. The following species are endemic to hanging gardens of the Colorado Plateau region: *Aquilegia micrantha*, *Carex curatorum*, *Cirsium rydbergii*, *Erigeron kachinensis* (one occurrence outside of hanging gardens in the Abajo Mountains), *Erigeron sionis*, *Erigeron zothecinus*, *Platanthera zothecina* (= *Habenaria zothecina*), *Mimulus eastwoodiae*, *Perityle specuicola*, and *Primula specuicola*.

- Environment:** Hanging gardens are surrounded by an arid environment and associated with canyon country. Annual precipitation is low and varies from 5 to 14 inches. While mean annual temperatures are high, extreme temperatures are probably more important than mean temperature to the survival of plants. Summer temperatures greater than 100 °F (38 °C) are common.
- Dynamics:** The complexity of the plant community in a hanging garden is a function of the quantity and quality of water, developmental aspects, and ability of plant species to disperse to it. Gardens vary in size, aspect, exposure to the elements, water quantity and quality, number of bedding planes, and amount of light received. Gardens can occur at all exposures of the canyon walls, but are always shaded for a significant portion of the day. Temperature and humidity are relatively stable compared to the surrounding environment. Water quality, in some degree, controls the type of plants found in hanging gardens. Quality of water is dictated by the nature of the formations through which the water passes. Water is often of drinkable quality, but may be saline or laden with calcium, which results in tufa deposits in the gardens.
- Variation:** Colorado Plateau hanging gardens are characterized as alcove, terrace, or windowblind types. The type of garden is determined by the nature of the geological formation and the presence or absence of joint systems. In general, the hanging gardens are the result of the ancient swales or valleys in a sand dune-swale system that developed between the Cretaceous and Pennsylvanian periods (65-310 mya). Massive sandstones seem to be best suited for alcove development coincidental with garden formation. The formations with greatest development are the Navajo and Entrada, both cross-bedded, massive formations composed of wind-blown sand and containing ancient pond bottoms that serve as impervious bedding planes. The Wingate Formation lacks significant hanging gardens. The sands of formations suitable for hanging garden development were deposited mainly on land, as dunes with interdunal valleys. These interdunal valleys were often the sites of lakes, whose bottoms were made impervious by accumulations of dust and other fine particles. Turned to stone, the ancient lake and pond basins continue to exist within the strata. Water percolating through the porous rock encounters the ancient bedding planes, still impervious and capable of holding water. When filled to overflowing, these bedding planes carry the water downward to the next bedding plane beneath or to another impervious stratum at the base of the formation. Joint systems within the rock act as passageways for water. Where the joint systems are exposed along canyon walls the water flows over the moist surfaces.

In the Utah High Plateaus, the hanging garden ecological system is associated with springs, seeps and waterfalls. The waterfall vegetation grows in the cracks behind and beside the waterfall and is best described as hanging gardens. In the seeps adjacent to waterfalls and in the splash zones at the base of waterfalls, the substrate is saturated during most of the growing season. The vegetation is continually wet, at least near the bases of the plants, and water can very commonly be seen dripping from leaves, exposed roots and old stems. Suitable growing sites are limited on the steep rock walls such that each of the available ledges has an abundance of plants which grow on it. Most of the hanging gardens in the Utah High Plateaus are associated with calcareous shales of the Green River Formation. Although large occurrences of hanging gardens are primarily associated with waterfalls, smaller occurrences occur along cliff seeps above the streams, especially in the Roan Plateau area.

Welsh, S. L. 1989. On the distribution of Utah's hanging gardens. *Great Basin Naturalist* 49(1):1-30.

Rank:	A	B	C	D
① CONDITION				
Community structure	A mosaic of hanging garden plant species with a diverse age class and structure.	A mosaic of hanging garden plant species with a diverse age class and structure.	Reduced species and structural diversity.	Highly altered vegetation structure, low species diversity.
Invasive exotics with major potential to alter structure and composition (e.g., <i>Tamarix</i> , <i>Cardaria</i>)	Absent.	Nearly absent (<1% cover).	May be present with >1% cover.	Present.
Other non-native spp.	Absent or <1%, native species dominant.	May be present in small, isolated patches, usually in small disturbed areas.	Present and abundant in over 10% of the occurrence.	Dominant, or co-dominant with native increaser species.
Disturbance (e.g. recreational use, dumping, energy resource development)	No surficial disturbance is evident, or, if present, confined to small isolated patches.	Anthropogenic disturbances are limited to less than 10% of the occurrence area.	Anthropogenic disturbances are limited to less than 25% of the occurrence.	Anthropogenic disturbances are more than 25% of the occurrence.
Ground cover	Ground cover is not trampled (e.g. from unusual high human visitation). Soil erosion is not accelerated by anthropogenic activities.	Ground cover is intact in at least 80% of the occurrence.	Disturbed ground cover on less than 50% of the occurrence.	Ground cover has been removed or disturbed in more than 50% of the occurrence.
② LANDSCAPE CONTEXT				
Surface and groundwater quality and quantity Because hanging gardens rely on ancient precipitation, current impacts to groundwater may have a significant lag time (decades to centuries) before showing an effect.	Groundwater quality and quantity is intact – not anthropogenically altered.	Groundwater quality and quantity is at least 90% intact.	Groundwater quality and quantity is impacted but is at least 75% intact.	Groundwater quality and quantity has been severely impacted and threatens to dry up the hanging garden occurrence.
Surrounding land and landscape connectivity	Highly connected; area around the occurrence is largely intact natural vegetation, with species interactions and natural processes occurring across communities.	Moderately connected – area around the occurrence is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging.	Moderately fragmented – area around the occurrence is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots (total area no smaller than ten times the minimum “C”-rated size).	Highly fragmented – area around the occurrence is entirely, or almost entirely, surrounded by agricultural or urban land use; occurrence is at best buffered on one side by natural communities.
③ SIZE				
Acres	>=0.5	0.33-0.5	0.20-0.33	< 0.20