Very Special Places: Thermal Wetlands


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Yellowstone National Park has the largest, most undisturbed, and most famous concentration of geothermal features in the world. More than 300 major geysers—including such often predictable giants as Grand, Castle, Daisy, and, of course, Old Faithful—and some 10,000 brilliantly colored hot springs, bubbling mud pots, and steaming fumaroles combine to make Yellowstone a place unlike any other in the world.

What might, at first glance, seem to be an uninhabitable place is actually teeming with life. The temperatures of the hot springs vary tremendously, from cool springs with only a little thermal influence to effervescent superheated springs that are actually a few degrees hotter than the boiling point, about 199°F at the park's average elevation of 7,500 feet above sea level. Even at this temperature, far above the upper temperature limit for photosynthesis, there are hardy heat-loving microorganisms known as thermophiles, visible only with microscopes.

The ability of thermophiles to reproduce in boiling water was discovered in 1967, when microbiologist Thomas Brock determined that there were organisms in almost all of the hot springs. This discovery of life forms, known as "extremophiles," that live in such conditions has led to industrial and medical applications reaching far beyond the park. Subsequent research has identified and cloned an enzyme from one thermophile, *Thermus aquaticus*, first isolated from a hot spring in Yellowstone. This enzyme has made possible the process of DNA fingerprinting, which is applied to investigations of crime scenes, identification of birth defects, and biotechnical research. The search for other thermophiles is not confined to planet Earth. Scientists have used the Yellowstone hot springs as a model for predicting life on other planets, and speculate that life could be present even in the extreme environment that exists on the planet Mars.


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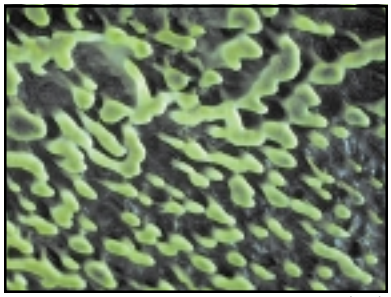
Abyss Pool. Top right: monkeyflowers growing near a hot spring.

Most hot springs owe their color to the bacteria and algae growing in the water, though minerals color some unusual hot springs. If a feature is extremely hot, well over 180°F, only microscopic thermophiles are present and the water will appear blue, just like any other body of water. (Water absorbs most colors except for blues and blue-greens, which are reflected back. If any other material is present in the water, its tint is added to the blue.) As the water cools to below 167°F, thermophilic cyanobacteria (commonly referred to as blue-green algae, though it is a photosynthetic bacteria and not a plant at all) will begin to appear, first bright yellow and then brilliant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Cyanobacteria.

Brine flies. J. Whipple

orange. Dark browns and true greens appear when the water temperature drops to 120–130°F—still much hotter than it is safe for humans to touch. (The water temperature in a hot tub is usually around 100°F, and in a bathtub around 90°F.) True algae can survive in areas with acid runoff, appearing bright green. Other runoffs support a mixture of cyanobacteria and algae, producing yet a different color scheme altogether.

Vascular plants are able to grow and reproduce in thermal areas when the temperature drops below 113°F (Brock 1994). One of the showiest plants found near thermal areas, yellow monkey flower (*Mimulus guttatus*), has been found blooming as early as February, when the adjacent ground is still in winter's grip. The heat allows the plants to grow through the winter on thermally warmed ground and along snow-free hot spring channels. During winter, the stems are short and leaves grow close to the warm ground. As soon as the weather warms, the stems grow quickly and the plant begins to bloom.

Although the upper temperature limit for animal life is also about 113°F, there are large areas where the thermal waters have cooled enough that animals can live. The most common hot spring animals are brine flies and their larvae that feed on the cyanobacteria mats. These flies, in turn, are food for larger predators, such as dragonflies, spiders, tiger beetles, wasps, and mites. These predators often attract even larger animals like mountain bluebirds, killdeer, and insect-eating rodents.

Geothermal areas in the winter are some of the best places to view concentrations of wildlife. When winter buries the park in snow and ice, bison and elk congregate near thermal areas where snow is not as deep, feeding and resting on the geothermally warmed ground. The warm influx from thermal features also keeps rivers like the Firehole and Madison from freezing, providing habitat for ducks, geese, and swans. The thermal influence in the Firehole River has also altered rainbow trout spawning time from spring to fall, as fish eggs would otherwise cook in the high temperatures—60°F to 80°F—found in spring and summer.

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Hot spring at the Chocolate Pots.

Overleaf: looking downstream from the bridge at Castle Geyser (J. Whipple).