

THE NEVADA DESERT FISHES AND ASH MEADOWS

BY PETER J. UNMACK

The author, Peter Unmack, has produced this article for JAKA as a modified version of an article that was originally published in: American Currents, the magazine of the North American Native Fishes Association, 2010, 35 (4): 23–24.

The North American Native Fishes Association (NANFA) usually holds its annual convention somewhere along the east coast of the USA and occasionally west of the Rockies. This year, however, the 2010 NANFA convention is going to be someplace different... the western deserts of North America. The term desert is not something one might associate with fishes. However, even in the driest deserts water is often present, and so are various kinds of fishes, usually with a suite of fascinating traits that allow them to survive in small and often harsh environments.

North America has a diverse range of desert environments, typically classified into the Sonoran, Mohave, Great Basin, and Chihuahuan deserts. The center of this year's convention activities will be in Ash Meadows, part of the Death Valley system, or Amargosa River. The river is located on the eastern edge of the Mohave Desert, approximately 70 miles northwest of Las Vegas. This is the driest and hottest region in North America.

The Death Valley system comprises the Amargosa River, which arises north of Beatty, Nevada, and flows for 185 miles to Lake Badwater in Death Valley. Within this large river system there are only a few pockets of permanent water that are inhabited by fishes, including: Beatty, Ash Meadows, Shoshone, Tecopa, Saratoga Springs, Salt Creek and Cottonball Marsh. Except for Beatty, all of these locations have different species or subspecies of pupfish (*Cyprinodon*), while speckled dace (*Rhinichthys osculus*) are found at three locations. A killifish known as the Ash Meadows Pool Fish (*Empetrichthys merriami*) was endemic to Ash Meadows, but was extinct by the 1960s (Soltz and Naiman, 1978).

Despite being in an area that receives only two inches of rainfall per year, Ash Meadows has the highest number of endemic species for its given area than any other place in the USA. This is largely due to fossil water that fell as rain around 10,000 years ago and which now emanates from a variety of springs fed by a vast aquifer. Most of these springs are much



Big Spring, in southern Ash Meadows is around 20 ft deep and is one of the largest springs in Ash Meadows. Historically this habitat was home to three native fishes, but in recent years has had problems with invasion by largemouth bass from private landholdings. Photo by Peter Unmack.

smaller than a typical backyard swimming pool, but they teem with unique fishes and invertebrates. Imagine these springs as islands in a sea of desolate desert. This is one aspect that makes them such fascinating places because many of these different spring systems have been isolated for thousands of years, even though they may be less than a few miles apart. Molecular work suggests that some pupfish populations likely mixed during the last glacial/pluvial cycle 10,000 years ago, when habitats were more interconnected, but others have remained isolated from one another for perhaps as long as one million years (Echelle et al., 2006; Duvernell and Turner, 1998). Similarly, the speckled dace at Beatty appear to have been isolated from the lower populations for around half million years (Smith and Dowling, 2008).

One of the most special environments within Ash Meadows is Devils Hole, home of the Devils Hole pupfish (*Cyprinodon diabolis*). This fish lives in one of the most incredible aquatic habitats in the world—essentially an eye into the aquifer that formed when the ceiling of the aquifer collapsed around 60,000 years ago (Riggs and Deacon, 2004). The current pool is around 12 feet wide and 70 feet long, situated deep inside the opening of Devils Hole, making it the smallest habitat of any vertebrate species. No one really knows how the fish came to be in the hole as the pool has never overflowed nor been inundated. The water in the hole is a fairly constant 92°F and for 99% of the time it is one of the most stable aquatic environments in the world. The two main perturbations are caused by local rainfall events, which wash a lot of debris



Devils Hole represents an eye into the aquifer and the smallest known habitat for any vertebrate species. It is the only natural home for the endangered Devils Hole Pupfish (*Cyprinodon diabolis*). Photo by Peter Unmack.

into the hole, and earthquakes. Essentially, Devils Hole acts as a natural seismograph, as the water level can fluctuate in response to earthquake shock waves. For example, an earthquake that occurred in 1992, with a nearby epicenter, resulted in a fluctuation of about ten feet, although most water level bounces caused by such seismic events

along the west coast of North America would be much smaller (Riggs and Deacon, 2004). Another aspect that makes Devils Hole extremely harsh is that it only gets four hours of direct sunlight in summer, and none in winter. With only limited input of other sources of energy and nutrients into the system, primary productivity is therefore quite low.

By definition water is a valuable commodity in deserts. This has rather unfortunate consequences for many aquatic inhabitants. Most desert fishes have been harmed by human utilization of this scarce water supply regardless of where they occur in the world. Not all human impact on desert aquatic habitats necessarily causes extinctions. However, extensive modification to these habitats, coupled with the introduction of non-native species, usually has a debilitating effect that is

difficult to reverse (Unmack and Minckley, 2008). Ash Meadows, and specifically the Devils Hole pupfish, turned into a massive battle between conservationists and developers that is still going on today and will continue well into the future (Deacon and Williams, 1991).

Initial development at Ash Meadows



The Devils Hole pupfish, *Cyprinodon diabolis*. Photo by Jack Williams © 2010.

was relatively minor. Spring channels were diverted for irrigation by local ranchers, but only on a small scale. This all changed in the 1960s as developers started buying tracts of land for growing alfalfa to supply a large cattle feedlot. This required vast amounts of groundwater pumping as well as the excavation of spring pools and diversion of outflow into concrete canals. A groundswell of concerned biologists

formed the Desert Fishes Council in 1969 to fight for the conservation of these fishes, leading to a Supreme Court decision in 1976 that protected the Devils Hole pupfish from excessive groundwater extraction, therefore making intensive farming operations not feasible. Conservationists thought they had won the battle, but the U.S. Fish and Wildlife Service (FWS) turned down the opportunity to buy Ash Meadows, and it was ultimately purchased by a housing developer with plans for a city of 10,000 people. Finally, in 1983, the land was purchased by The Nature Conservancy and turned over to the FWS in 1984. It has since become a national wildlife refuge, one of the few specifically established for fish and invertebrate conservation. Despite extensive federal protection the area is still under continued threat, initially from the development of Yucca Mountain, with the threat of groundwater contamination from radioactive material, and now from thirsty

Cyprinodon nevadensis shoshone. Photo by A. Terceira.





Cyprinodon nevadensis amargosae. Tecopa Bore, California. Photo by A. Terceira.

Las Vegas. This city is making massive land and water rights grabs across Nevada to feed its urge for growth at any cost. If they are successful, this will spell the end for many aquatic habitats in Nevada, as most are reliant on groundwater flow which will undoubtedly be affected by the scale and extent of proposed groundwater withdrawals.

We invite you to visit this special and unique region, home of the legendary Devils Hole pupfish, before it is too late. What better time to do it than during the 2010 NANFA convention, which will be held in Ash Meadows, Nevada on October 14-19. For details see <http://www.nanfa.org/convention/2010.shtml>, and check back for updates.

References

- Deacon, J.E. and C.D. Williams. 1991. Ash Meadows and the legacy of the Devils Hole pupfish. In: W.L. Minckley and J.E. Deacon (editors), *Battle Against Extinction: Native Fish Management in the American West*. University of Arizona Press, Tucson, Arizona, USA: 69–87.
- Duvernell, D.D. and B.J. Turner. 1998. Evolutionary genetics of Death Valley pupfish populations: mitochondrial DNA sequence variation and population structure. *Molecular Ecology* 7: 279–288.
- Echelle, A.A., E.W. Carson, A.F. Echelle, R.A. Van Den Bussche, T.E. Dowling and A. Meyer. 2005. Historical biogeography of the New World pupfish genus *Cyprinodon* (Teleostei: Cyprinodontidae). *Copeia* 2005: 220–239.
- Riggs, A.C. and J.E. Deacon. 2004. Connectivity in desert aquatic ecosystems: the Devils Hole story. In: D.W. Sada and S.E. Sharpe (editors), *Conference Proceedings, Spring-fed Wetlands: Important Scientific and Cultural Resources of the Intermountain Region, May 7–9, 2002, Las Vegas, NV*. DHS Publication No. 41210. Retrieved (March 17, 2010) from Desert Research Institute web site: <http://www.wetlands.dri.edu>
- Smith, G.R. and T.E. Dowling. 2008. Correlating hydrographic events and divergence times of speckled dace (*Rhinichthys*: Teleostei: Cyprinidae) in the Colorado River drainage. In: M.C. Reheis, R. Hershler and D.M. Miller (editors), *Late Cenozoic Drainage History of the Southwestern Great Basin and Lower Colorado River Region: Geologic and Biotic Perspectives*. Geological Society of America Special Paper 439: 301–317.
- Soltz, D.L. and R.J. Naiman. 1978. The natural history of native fishes in the Death Valley system. *Natural History Museum of Los Angeles County, California, Science Series* 30: 1–76.
- Unmack, P.J. and W.L. Minckley. 2008. The demise of desert springs. In: L.E. Stevens and V.J. Meretsky (editors), *Aridland Springs in North America, Ecology and Conservation*. University of Arizona Press, Tucson, Arizona: 11–33.