The Memory of Water: Life in Ephemeral Water Holes

Craig Childs

I went looking for a water hole in the desert and when I got there it was dry. Walking in the stinging summer heat of southeast Utah for days, all of my needed belongings carried on my back through untrailed canyons and cliffs, I was counting on this water hole. It had always been full before, marked by the green tower of a single young cottonwood tree beneath a shading ledge eight hundred feet up a rock outcrop. It is a place where rain collects in a natural basin. When I found it empty, I stood still for a moment, astonished and afraid.

It is a hard and beautiful way to live, counting on ephemeral water holes like this. You have to be ready for long periods of waiting, traveling at night to preserve water in your body, sleeping in daytime shade. Then the rains come and you bathe in liquid prosperity, filling every bottle you have, drinking and drinking, even washing your face.

Instead of walking away from this dry hole dejected, I shrugged off my pack and dropped to my knees, my eyes sore and burned from the sun. I reached my hands in and began digging. Pawing into the sand I hoped for at least a taste of moisture, maybe a damp, wretched ball of clay I could pack into my cheek to keep me going to the next water.

There are holes I know of in other parts of the desert that are ridiculously rich with water. Some of these water holes, burrowed into the Navajo sandstone of the Utah-Arizona border, hold enough rainfall to fill a swimming pool. In the best years, these water holes are crowded with *Triops*, crustaceans one or two inches in length that look like tiny horseshoe crabs, rare water-dwellers deep in the desert. Whenever I see water filled with *Triops* performing energetic somersaults around each other, I am amazed that such creatures have found a niche in the desert.

Triops look ominous, with their shield-like carapaces and two poppy-seed eyes, a fleshy, pronged tail ringed like that of a rat, and wired sensory organs splayed off the front. They are among the oldest "living fossils" on earth, bodies completely unchanged for approximately four hundred million years. After predatory suction-feeding fish evolved about three hundred million years ago, the only *Triops* that remained were those not in the oceans. Congregating in loose aggregations of water holes, *Triops* survive by moving from one temporary water hole to the next, waiting out dry times in the form of eggs as parched as dust.

If there were any *Triops* in this dry Utah hole, they existed only in the form of anhydrobiotic cysts, the animal's waiting phase. Anhydrobiosis—life without water—is an adaptation common to many water-hole creatures. It is a form of existence in which all mea-

surable life processes are shut down. Basically, these animals die but can, under the right circumstances, come back to life. Many invertebrates living in ephemeral water sources rely on anhydrobiotic stages to bridge the long, desiccating periods between rains. In their larval or egg form, they in essence become "seeds" that can withstand incredible pressures and doses of radiation that would quickly kill the adult phases. Unprotected cysts taken by space shuttle to outer space and exposed for prolonged periods to cosmic radiation were still able to come to life when added to water back on earth. Like pollen grains, the cysts of each species are uniquely shaped, with hooks or wings that grab onto passing animals or catch the wind in search of the next rain, the next water hole. They are models of physical endurance and patience.

At this empty water hole I was not in *my* waiting phase. I was very thirsty. I put my back into digging down through sand, spraying it out behind me until I reached a layer of putrid black clay that was slightly damp. At that layer I began digging outward, forming a basin. Black water beaded out of the clay. I quickly gathered flat pieces of sandstone and built up the edges of my basin, hold-

Tadpole shrimp (genus *Triops*) live only in temporary freshwater pools. They have an accelerated life cycle that allows them to develop from egg to adult in a matter of weeks. Photograph by Betty Nottle.

ing back the black clay. Clear water appeared through my sandstone cistern, slowly filling a cup in the bottom that I gathered in my palms and drank. It tasted good. After an hour, I had a couple of gallons of fresh water.

I once worked mapping water holes for the United States government along the border between Arizona and Mexico, a remote and desolate part of the Sonoran Desert. It is a region where you would expect no water at all, arid basins twenty miles wide broken by thorny, barren mountains. But there is water in the mountains, natural holes worn into bedrock collecting sporadic rainfall. In a good year I counted several thousands of gallons of water in the water holes of one of these ranges, and almost all of them were heavily populated with various crustaceans: tiny, bustling ostracods, clam shrimp in their own translucent shells, and fleets of fairy shrimp cruising the holes like sharks.

Even in the harshest of landscapes, water gathers into pools following rainstorms. Although they last only weeks or days, such pools often teem with life. Photograph taken at Vermillion Cliffs, Utah, by Zane Paxton.

As their name suggests, clam shrimp look like bivalve molluscs but are actually crustaceans. The female lays her eggs into a space beneath her shell; they are released when she molts. The eggs can survive up to seven years without water. Photograph by Betty Nottle.

Bees and dragonflies visited these water holes, slipping in and out while I took measurements. At times, when I rested in shade nearby, I heard bighorn sheep clattering down through loose rocks to the water, where they dipped their heads and drank. The water holes are strongholds of life.

What amazes me is the ability of invertebrates in these pools to determine how long water will last and to adjust their life cycles accordingly, each pool requiring distinct calibration. One observer visited an Arizona stock tank for the nineteen days that it held water after a heavy summer rain. Nearly twenty species of invertebrates and amphibians appeared during this time, and he took note of each. Predaceous beetles, *Eretes sticticus*, hatched by the thousands from eggs laid by adults that flew in from unknown water sources. Their development followed in perfect stride the slow vanishing of the pool. On the nineteenth day, at 10:30 in the morning, the pool came very near to drying. En masse, the beetles, which had only recently reached their adult phase, suddenly produced an intense, high-pitched buzzing sound. Then, as the researcher stood watching, the entire group of beetles lifted into flight at once. The swarm set off to the southwest, disappearing at the horizon. Within one hour the pond went dry.

This kind of ability to perceive subtle environmental signals of impending change is common among dwellers of ephemeral water sources. Phenotypic plasticity allows organisms to alter their body shape in step with changes in the surrounding environment. Toads, fairy

The end can be abrupt for inhabitants of temporary pools. Dead clam shrimp litter this dry water hole, but their eggs remain as cysts, lying dormant until the next wet period. Photograph by Betty Nottle.

shrimp, and beetles will shrink and stretch their growth rates in precise cadence with the pool's life span. Development rates in water holes depend not on the original size of the pool but on the rate at which it dries. Thus, small pools do not necessarily produce small organisms. Rather, pools that dry quickly produce small organisms because the animals must develop rapidly, resulting in dwarfed adults. It is not the actual volume of water that matters, but how fast the volume is decreasing.

No one yet knows how this rate is perceived. After numerous studies, mostly involving mosquitoes, researchers have been left guessing, suggesting that the organisms distinguish the changing amount of time or effort necessary to move from the top of a pool to the bottom, or that they gain cues from increased crowding. It could be that the mosquitoes discern a changing volume of air in their tracheal systems during their descent to the bottom of the pool. Whatever it is, these organisms appear to know exactly how long their habitat will last. In the case of *Eretes sticticus*, it was down to the hour.

My own adjustments are simple calculations, trekking across the desert feeling the dwindling weight of water on my back, scanning the horizon for a likely canyon, wash, or plain of sand-

stone where rainwater might collect. After building my cistern, I filled all the bottles I had and hitched my pack onto my shoulders. I moved back into the open desert, a blistering landscape of red stone and blue sky. That night I set a camp and was awakened by a searing crash of thunder and the smell of rain. An unexpected thunderstorm barged in. Rain pummeled me. I had no sleeping bag, no tent, only a wool serape pulled over me. The ground was still hot from the day, and the pounding rain was welcome. My serape quickly soaked through to my skin and I lay in a bath of wind and rain.

Thunderstorms are fickle. They will drop a quarter of the year's precipitation, maybe two inches, in one canyon and leave neighboring canyons absolutely dry. With such localized, sporadic rainfall, some water holes go empty for years at a time. Yet when the rains come and the holes fill, life quickly springs from (or into) the water. The predaceous, aquatic backswimmer *Notonecta* flies from hole to hole. To find the next water hole, it seeks polarized ultraviolet light reflected from smooth bodies of water, the same method used by water striders and dragonflies. Ultraviolet sensors are located in the lower portion of its compound eyes. *Notonecta* flies with its body tilted fifteen degrees to the horizon, placing these UV sensors at a level that will be struck by polarized light off a flat surface at an optimum angle, initiating a dive-and-plunge response. Once, sitting in the desert with a cup of water in my hand, I was bombarded by backswimmers. Five of them made a bull's-eye into the cup. Its mouth just four inches across, it contained the only water to be found in the area.

With all this rain around me on this night, the desert exploded into streams and small flash floods. Even after the thunderstorm departed, dragging its pulses of lightning elsewhere, I lay on wet sandstone listening for hours to burbling, grumbling water that finally dwindled into drips that sounded like chimes on the rock. In the morning I walked back to the water hole I had found dry the day before. This time it was filled to the top with a hundred gallons of red floodwater. I knelt at the edge, cupped my hands, and drank. It was not a wise thing to do, but the water seemed like such a blessing that I could not help myself. Within a minute my stomach cramped into a knot. I doubled over and waited for the pain to pass, knowing it would not linger. I had done this many times before, perhaps a foolish act. It's just hard for me not to drink fresh floodwater when it comes, and feel the zing of life inside of me. The water hole had been waiting, its floor packed with cysts silently prepared for any touch of moisture. When the water came, life erupted and I could feel it in my stomach, the sharp taste of the desert being born again.

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