Spring Pools

Robert Frost

These pools that, though in forests, still reflect
The total sky almost without defect,
And like the flowers beside them, chill and shiver,
Will like the flowers beside them soon be gone,
And yet not out by any brook or river,
But up by roots to bring dark foliage on.

The trees that have it in their pent-up buds
To darken nature and be summer woods -
Let them think twice before they use their powers
To blot out and drink up and sweep away
These flowery waters and these watery flowers
From snow that melted only yesterday.

Better known as vernal pools, these ephemeral pools of water defy hydrological definition. Nowhere on Lewis Cowardin's Wetland Classification scheme would you find what Leo Kinney aptly titled his EPA publication - "Wicked Big Puddles." Though Frost was more poetic, these biologically dynamic systems can be classified as hydrologic depressions. Vernal pools are isolated from flowing water and are defined by the life they support.

At least six species in our area, known as obligate species, need these fish – free pools to reproduce successfully. These species are so well adapted to the seasonal drying of the overland flow and snow melted water that nearly 100% of their breeding sites must be vernal pools. If roads and foundations excavate these pools, then so too goes the four mole salamanders, wood frogs and the fairy shrimp. Breeding 67 -99% in vernal pools, dozens of facultative species, would be disrupted as well and they include: bullfrog, green frog, pickerel and leopard frogs, grey tree frog, spring peeper, spadefoot, fowler and American toads, red spotted newts, lung less salamanders, predaceous diving beetle, crawling water beetles, water scavenger beetles, springtails, midges, flies, mosquitoes, dragon and damselflies, backswimmers, water striders, water boatmen, true bugs, etc…

Similar in form to the tiny pet "sea monkeys," fairy shrimp are the first obligate species of note. In order to avoid the increasing number of predators that find the pool by summer, fairy shrimp hatch in late winter and early spring, and they can be seen swimming under the surface of ice-encrusted pools. Female fairy shrimp lay their eggs before pools dry up. They can produce two types of eggs; summer eggs hatch quickly and the young develop in the same season, while winter eggs fall to the bottom of the pool and remain there after the pool dries up. The winter eggs are hard-shelled, withstand freezing and drying, and actually require a period of dryness in order to hatch. They hatch the following spring when the pool refills, and dissolved oxygen levels are at their peak. The rapidity of the fairy shrimp life cycle is impressive. All stages of the life cycle (from the egg hatching, to numerous molts of immature instars, to adult reproduction and finally female egg laying) can occur in as few as 16 days (Peckarsky et al. 1990).

The mole salamanders, so named for their subterranean life style, are four species of the same Genus Ambystoma – the spotted, the blue spotted, Jefferson and the marbled salamanders.

Spotted salamanders generally lay their eggs between mid-March and mid-April. The small, firm egg masses often contain 100 or more eggs in a cluster (Shaffer 1991). The eggs are attached to vegetation in the pool or rest on the bottom. Egg masses may be clear or milky-white, and over time often develop a greenish color from algae. The egg and algae form a symbiotic relationship first described and formally named in 1927 by Lambert Printz, who named the algal species *Oophilia amblystoma*. The genus name means "egg loving." The embryos release ammonia useful to the algae, while the algae during photosynthesis release oxygen useful for the growing embryo. More compelling still is the 2011 discovery that *Oophilia* lives *inside* the embryonic cells of Spotted salamanders. The phenomena known as endosymbiosis is where cells of different species live together in mutually beneficial terms. It was proposed by Lynn Margulis, (Carl Sagan's first wife) as the probable origin of complex eukaryotic cells. New England's largest terrestrial salamander became the first known example in the world of a eukaryotic algae living stably inside the cells of any vertebrate.

Listed as species of special concern, the Jefferson and blue spotted salamanders are genetic enigmas. Known somewhat indignantly as complexes, these vernal pool obligates are capable of polyploidal hybridization. Most vertebrates are diploidal, having two sets of chromosomes – one from each parent. Jeffersons and blue spotteds may contain several sets of chromosomes. This oddity may have ensured genetic diversity while land clearing caused fragmentation and therefore isolating breeding pools.

Spotted, blue spotted and Jefferson salamanders usually deposit spermatophores, or packets of male gametes on available leaves, sticks and logs. The females take in these ampules of sperm in a primitive form of internal fertilization. Fertilized eggs are laid between March and early April. The female lays a series of small egg masses each attached to vegetation or branches in the pool. Jefferson egg masses are clear and hard to see in the water although they often turn a greenish color from *Oophilia*. The eggs develop for a period of thirty to forty-five days and hatch in April and May. The larvae grow for three to four months and transform into immature terrestrial adults from July through August (Hulse et al. 2001).

The marbled salamander differs from the Jefferson and spotted salamanders in its reproductive cycle. Timing could be key here to avoid competition for resources. Shortly after the spotteds and Jeffersons are mature enough to leave the pools, adult marbled salamanders move in to court and mate. The female lays eggs sometime between September and November, depending mostly on local temperatures. She

constructs a nest for her clutch of 48-200 eggs in the autumnal pool basin under leaves, logs, or rocks (Hulse et al. 2001). She usually stays at the nest protecting the eggs, until the pool begins to fill with water from rainfall or snowmelt.
The embryos hatch soon after the nest is inundated with the rising waters of the seasonal pool. The marbled salamander larvae gain a size advantage by feeding and growing for several months before the Jefferson and spotted salamanders hatch later in the spring. Marbled salamander larvae are also the first of the mole salamanders to complete their larval development, a process that takes about four and a half months from hatching to transformation into immature terrestrial adults that leave the pool (Hulse et al. 2001).

Wood frogs spend most of the year in wooded upland habitats. They migrate to seasonal pools in the spring where they breed and lay their eggs. Males travel to the pools during the first rains of spring and begin calling to females with a distinctive quacking call. Their mating call has often been described as "ducks in the woods." Their egg masses contain hundreds of eggs. Unlike the Jefferson and spotted salamander egg masses, wood frog egg masses are not enclosed in a firm matrix that helps the egg mass retain its shape. Wood frog egg masses are large, soft, and shapeless. Often wood frogs will deposit their eggs in communal nesting areas, creating large expansive egg masses. Like the salamander egg masses, wood frog egg masses often turn green from algae. The eggs develop for roughly 20 days, dependent upon temperature. Tadpoles are in the water for 80 to 115 days, emerging from the water in July and August (Hulse et al. 2001).

This brief article details the specialized adaptations for six organisms endemic to these often overlooked pools. Specialized niches are central to biological diversity. Preserving biological diversity is a primary focus of the Litchfield Land Trust. If you live close to one of the land trust many properties, go seek out the elusive dwellers of those wicked big puddle.

Cowardin et al 1979 National Wetland Inventory http://www.fws.gov/wetlands/Data/Wetland-Codes.html

Hulse, A. C., C. J. McCoy, and E. Censky. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University

Peckarsky, B., Fraissinet, P., Penton, M., & Conklin, D. (1990). Ch 15 Freshwater Crustacea. In Freshwater Macroinvertebrates of Northeastern North American (1st ed.). (pp. 268-289). Ithaca, NY: Cornell University Press.

Shaffer, H.B., J.M. Clark, and F. Kraus. 1991. When molecules and morphology clash: A phylogenetic analysis of the North American ambystomatid (Caudata:Ambystomatidae) salamanders. Systematic Zoology 40(3): 284-303.