22

RED BACK SALAMANDER

(*Plethodon cinereus*)

Abundant prey and a strictly terrestrial life cycle helped this non-amphibious amphibian adapt to Center City, Philadelphia.

Figure 22.1 Red back salamander (*Plethodon cinereus*), discovered on a sidewalk in Fitler Square. It was headed away from an enclosed garden, shown in figure 22.3.

From Ecology of Center City, Philadelphia by Kenneth D. Frank. Published in 2015 by Fitler Square Press, Philadelphia, PA.

At a meeting of the Academy of Natural Sciences of Philadelphia in May 1818, Jacob Green named what he thought was a new species of salamander.[1] Green, then a chemist practicing law in Philadelphia,[2] did not know that two months earlier Constantine Samuel Rafinesque had described and named the same species.[3] Green's naming has endured, even though Rafinesque's has priority.[4] Rafinesque coined the salamander's current vernacular name: *red back salamander.*[5]

Green stated that this salamander is common in New Jersey,[6] while Rafinesque placed it in the highlands of New York.[7] In 1842 John Edwards Holbrook ranked it the most common salamander in the eastern United States from Maryland to Vermont. He was the first to report that it is abundant in Philadelphia.[8] For the next century and a half, a succession of herpetologists noted its presence in Philadelphia.[9] It was recorded in many other cities: lawns in Bethlehem, Pennsylvania, and urban forests in Indianapolis, Montréal, and Cleveland.[10]

Urban dryness hostile to amphibians

Cities typically degrade wetlands, home to many amphibians; and downtown Philadelphia fits this mode. Two rivers border Center City and adjacent neighborhoods, but bulkheading and fill along riverbanks have destroyed all traces of marsh and riparian habitat. Asphalt, concrete, and other impervious material cover most of downtown; runoff from rain drains mostly into sewers. The landscape downtown is dry except after rain or snow. Center City would appear to be among the worst places for amphibians.

Records of amphibians in Philadelphia a century or more ago might be from habitats since destroyed or from remnants of wetland currently protected, as in Fairmount Park or the John Heinz National Wildlife Refuge—far from the urban core. In 1917, Henry Weed Fowler at the Academy of Natural Sciences reported the distribution of red back salamanders within Philadelphia; he listed Fairmount Park and Wissahickon Creek, but also Germantown, Frankford, Holmesburg, Rowlands, La Grange, and "Philadelphia."[11]

Within the barren terrain of downtown are irrigated gardens and parks. In the garden in our backyard, which we water, small animals vulnerable to desiccation thrive. Examples are snails, slugs, earthworms, millipedes, and isopods (such as pillbugs). In experiments conducted in litter from an urban forest near Cleveland, red back salamanders consumed isopods and millipedes.[12] Other studies have shown that this salamander eats introduced earthworms,[13] including *Lumbricus terrestris*,[14] a species common in our garden. Might gardens downtown support amphibians?

Amphibians like the American toad (*Bufo americanus*) require both land and bodies of water. Some salamanders have aquatic and terrestrial stages like those of American toads, whose larvae (tadpoles) have gills, live in water, and metamorphose into adults that live on land.[15] The life cycles of most species of salamanders, in contrast, are strictly terrestrial,[16] even though all salamanders belong to the taxonomic class Amphibia and are called amphibians. The red back salamander exemplifies a non-amphibious amphibian in the sense that its life cycle does not include an aquatic or larval stage. What hatches from its egg is a miniature version of a fully formed, exclusively terrestrial adult, except for vestigial gills that shrivel up and disappear in a day.[17]

Figure 22.2 Bullfrog (*Rana catesbeiana*) in a flooded trench below Boathouse Row. Its dependence on open water limits its distribution in Philadelphia.

Red back salamander's habits adapted to urban gardens

Both Rafinesque and Green noted that the red back salamander is found under stones. In 1961 Frieda B. Taub at Rutgers University discovered that most red back salamanders in a forest lived in soil to a depth of at least 30 centimeters. They preferred moist soil that was not inundated.[18] To nest underground, they burrow, particularly in response to desiccation.[19] Individuals hide under cover during the day and emerge at night.[20]

The red back salamander's secretive behavior makes it easy to overlook. Its habits—predacious, subterranean, and nocturnal—resemble those of firefly larvae (*Photinus pyralis*), which I have never found, even though fireflies flash here every summer. But on October 20, 2012, around 9 a.m., I observed a red back salamander scurrying across a sidewalk in Fitler Square, a neighborhood park occupying less than a square block in Center City. It was headed toward the curb, away from a naturalized garden in the square. This garden is irrigated and has abundant leaf litter. Plantings include old London plane trees, wild ginger, ferns, Virginia bluebells, and oak-leaf hydrangea. A metal fence around it excludes people and dogs.

Figure 22.3 Naturalized habitat surrounded by a fence, located in Fitler Square. The fence, sprinklers, and leaf litter create conditions that resemble the wooded habitat of red back salamanders.

Conceivably this particular red back salamander was searching for a mate. In a study in Rochester, New York, in 1929, the mating period for red back salamanders ranged from October 7 to 16.[21] Red back salamanders are territorial and evict intruders.[22] The salamander on the sidewalk may have been fleeing a rival or a predator, or foraging, driven by hunger and scarcity of prey. Red back salamanders have been found to disperse through open terrain, such as fields.[23]

I found no published reports of red back salamanders colonizing downtown habitats. The naturalized garden in Fitler Square beside the sidewalk where I found the salamander occupies only about 1/100 of a hectare (0.025 acre). What is the smallest habitat that can support a population of red back salamanders? At a meeting of conservation biologists in 2000, Elke Wind considered this question for amphibians generally. In no case could she could find data that provided a definitive answer.[24]

Fragments of habitat may be too small to contain amphibians even though they provide ample food and shelter, as exemplified by species that migrate to ponds and streams for breeding. The red back salamander's nonmigratory life cycle[25] allows it to confine its movement to small areas. One study found that red back salamanders were less likely than migratory amphibians to travel to edges of forest.[26] Another study embedded radioactive tags in red back salamanders and used radiation de-

tectors to monitor their movements. It found that on average red back salamanders traveled less than half a meter a day. Home ranges averaged just over 24 square meters for females and about half that for males.[27] From year to year, the average distance red back salamanders dispersed was less than 2 meters.[28]

Benefits of staying put

Sedentary life cycles can help populations survive in cities. The annual weed *Crepis sancta* produces two kinds of seeds, dispersing and nondispersing. For plants growing in cracks in sidewalks, natural selection favors nondispersing seeds, which are more likely than are dispersing seeds to fall in cracks near their parents and to germinate. Plants in these cracks produce seeds that are predominantly nondispersing, in contrast to dispersing seeds produced by plants growing outside of cracks.[29]

The giant Canada goose (*Branta canadensis maxima*) that populates urban areas along the Atlantic flyway is sedentary compared to long-distance migrant subspecies of Canada geese that overwinter in the same region.[30] In the last half of the twentieth century, the range of this subspecies of Canada goose expanded to cities and suburbs throughout the country.[31] Its urban habitats are safe havens from hunters and predators such as bobcats[32] and wolves,[33] and abandonment of long-distance migration saves the goose energy and avoids the hazards of prolonged flight.

Figure 22.4 Giant Canada geese (*Branta canadensis maxima*) behind the Philadelphia Museum of Art. Their sedentary behavior keeps them within an urban safe haven, protected from hunters and wild predators.

Bedbugs (*Cimex lectularius*) are wingless but belong to a suborder (Heteroptera) of insects whose members, with rare exceptions, are winged, like stinkbugs.[34] Bedbugs likely evolved in caves with bats and later expanded their hosts to include people.[35] The evolutionary loss of wings served the bedbug's need to stay close to its host.

Figure 22.5 Bedbug (*Cimex lectularius*) crawling off a penny. A patient who lives in Philadelphia brought it to me for identification. All bedbugs are wingless—an adaptation that serves their need to remain close to their victims.

Adaptations for an all-terrestrial life cycle

In his description of the red back salamander in 1818, Jacob Green noted its strictly terrestrial life and classified it as a "land salamander." In 1908 W. H. Piersol described its development in eggs. He referred to the embryo as a "larva," due to its resemblance to salamander larvae that develop in water. He noted that mothers care for their offspring for several weeks after they hatch out.[36] More recent observations have shown that mothers brood their eggs before the eggs hatch;[37] and that females take two years to produce eggs with yolks sufficiently large to nurture the salamander's extensive embryonic development.[38] The embryos need the big yokes because they cannot feed on algae and other pond life that nurtures salamander larvae in ponds and streams.

Maternal behavior and big yolks helped liberate red back salamanders from dependence on open water and migratory travel.[39] These traits may have evolved 200 million years ago when the red back salamander's taxonomic family (Plethodontidae) first appeared,[40] but the traits fortuitously prepared this salamander for life in the city.

The six- to eight-month interval between mating in the fall and laying eggs in the spring[41] gives fertilized female red back salamanders an opportunity to disperse and found colonies alone. A tiny isolated urban habitat fragment like the one in Fitler Square might serve as a dispersal site following importation of females in topsoil or root balls.

Urban opportunity and vulnerability

I captured the salamander at the curb and released it into our backyard, which offers an abundance of possible prey, including isopods, millipedes, and earthworms, but also slugs and snails.[42] Among the inhabitants of our garden soil, it could become top predator. Red back salamanders eat arthropods that are predators, including spiders, centipedes, and firefly larvae.[43] If this salamander happened to be a mated female, her release in our backyard may found a new colony, extending the range of this species downtown.

Despite the potential of this species for dissemination downtown, my rescue of this salamander on the sidewalk highlights why in Center City this animal is rare compared to earthworms. Unlike earthworms, red back salamanders cannot disperse independently as eggs in soil; the eggs[44] and hatchlings[45] of red back salamanders require maternal care. Unlike reproduction in earthworms, which are hermaphroditic or parthenogenetic,[46] reproduction in red back salamanders requires mating with members of the opposite sex.[47] And while earthworms on sidewalks are vulnerable to accidental trampling, the rapid crawling of the red back salamander, as on the sidewalk at Fitler Square, attracts attention, inviting attack by birds and people.