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OVERVIEW

Populations of wild plants and animals in Center City have had to cope with conditions that were never part of their evolutionary past. Those that adapted, or that were preadapted, survived; and those that benefited multiplied. Others dwindled or went locally extinct, sometimes reappearing a century or more later, after hardships had abated.

Figure 28.1 Triangulate cobweb spider (*Steatoda triangulosa*) wrapping silk around a multicolored Asian lady beetle (*Harmonia axyridis*) snared in the spider's web, which was anchored to a door lamp outside our house at night. The beetle had flown and crawled toward the lamp's light. Both species were introduced into North America.[1]

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The preceding chapters examined Center City's plants and animals from diverse points of view: geologic time; pollution; prejudice; persecution; populations; habitats; evolution; and conservation. This chapter will explore each of these viewpoints separately, integrating observations from earlier chapters. It will omit references previously cited. The goal is to present an overview of the ecology of Center City.

Geologic time

The oldest tree on record in Center City grew when the area was a cypress swamp. The time was a warm interglacial period in the Pleistocene more than 36,000 years ago—the age of the Subway Tree, a bald cypress unearthed here in 1931 during excavation for a tunnel. Glacial meltwater flooded the swamp and buried it in sediment. Twenty thousand years ago the last glaciation in this region reached its maximum. It stopped 100 kilometers north of what is now Philadelphia.

Permafrost extended south of the glacier along the coastal plain to southern Delaware and Maryland. It wiped out all terrestrial isopods (pillbugs and sow bugs) outside of caves and seashores. Isopods did not repopulate the area until Europeans introduced them, probably incidentally in garden soil.

Around 6,000 years ago, Native Americans built houses upon which the black and yellow mud dauber constructed its nest. In 1745 John Bartram described this wasp making nests under the eaves of his house in Philadelphia. In Philadelphia the black and yellow mud dauber continues to produce nests—exclusively on man-made structures, including John Bartram's house and buildings and bridges in Center City.

Most preadaptations to Center City can only be inferred. An example is the predilection of the American robin to forage near houses and gardens. The affinity of this bird for human habitation dates to our earliest records of its behavior in Pennsylvania. The robin displayed this trait even when people hunted it and sold it as a delicacy in markets. It probably exhibited the trait around gardens of Native Americans before European settlement of North America. The red-tailed hawk, in contrast to the American robin, avoided people until persecution abated late in the twentieth century.

Preadaptation to downtown habitats typically evolved long before people or human disturbance. The red back salamander was able to inhabit Fitler Square in Center City in part because it is a non-amphibious amphibian. Evolution to an all-terrestrial life cycle liberated it from dependence on open water such as ponds and streams. Its ancestors evolved the capacity to live exclusively on land early—perhaps 200 million years ago, around the beginning of the Jurassic period.

Air pollution

The end of the eighteenth century marked the beginning of what has been dubbed the *Anthropocene*, a term for a geologic epic Paul J. Crutzen popularized in a paper called "The Geology of Mankind," published in Nature in 2002. *Anthropocene* is derived from *anthros*, Greek for "human," and *cene*, meaning "new." Crutzen dated the onset of his Anthropocene to the late eighteenth century, when concentrations of carbon dioxide and methane began increasing in air trapped in polar ice.[2]

In Philadelphia, the beginning of Crutzen's Anthropocene coincided with the Industrial Revolution, which exposed plants and animals to conditions that they had never before encountered and that were never part of their evolutionary history. Industrial air pollution is one example.

Tree mosses in the genus *Orthotrichum* are exquisitely vulnerable to sulfur dioxide in air. Published studies of mosses in the early twentieth century reported no tree mosses in New York City and Philadelphia. At that time, air pollution caused by combustion of coal contained sulfur dioxide in high concentrations. Levels of sulfur dioxide in Philadelphia have since reverted to levels not toxic to mosses. I recently discovered the tree moss *Orthotrichum pumilum* growing on trunks of street trees in Center City. Published records indicate that Thomas Potts James, who was born just outside Philadelphia in 1803 and died at age 79,[3] was the last person before me to have found this moss in Philadelphia.[4]

Figure 28.2 Cemetery at Old Pine Street Church. Burials began here in 1764. Acid rain accelerates natural weathering of marble and limestone. The acidity is due to sulfuric acid and nitric acid from sulfur dioxide and nitrogen oxides in air pollution,[5] which improved in Philadelphia in the 20th century after reduction in the burning of coal.

The rise of industrial pollution of air in Philadelphia preceded introduction of methodical monitoring of air quality, but historic collections of moths provide objective evidence of it. In Britain, the peppered moth (*Biston betularia*) has melanic (black) forms that increased in frequency when soot in air pollution turned tree bark black. When soot subsided, the abundance of melanic forms decreased. The phenomenon, called industrial melanism, offered a textbook case of evolution in action. As in Britain, industrial melanism showed up in populations of the peppered moth in Philadelphia, and subsequently abated in Pennsylvania as the quality of air improved.

Water pollution

Shad, initially abundant in the tidal Schuylkill River in Philadelphia, disappeared by 1914, the year Henry Fowler at the Academy of Natural Sciences in Philadelphia produced an inventory of fish collected in the polluted Schuylkill River.[6] Like tree mosses and light-colored peppered moths, shad returned when pollution abated. Construction of a fish ladder at the Fairmount Dam in Philadelphia and, later, release of shad fry upstream supported the recovery.

In the nineteenth and twentieth centuries the native, pollution-tolerant brown bullhead catfish inhabited the Schuylkill River, whose pollution probably protected the fish from pollution-sensitive enemies such as tapeworms. The brown bullhead disappeared from inventories of fish in the Schuylkill River below the Fairmount Dam in the twenty-first century after pollution declined and nonnative competitors and predators, such as flathead and channel catfishes, established abundant local populations.

In nineteenth-century Philadelphia pollution-tolerant freshwater sponges such as *Spongilla* (*Eunapius*) *fragilis* were abundant in the polluted Schuylkill River. They tolerate pollution better than do specialized predators such as the spongillafly, *Climacea areolaris* (order Neuroptera), a flying insect whose aquatic larvae feed exclusively on freshwater sponges. In Center City spongillaflies fly to light in our backyard, a few blocks from the river. Their presence implies that the river here continues to support freshwater sponges.

Thermal pollution

Temperatures typically run from 1.7 to 3.3°C (3 to 6°F) higher in Center City than in surrounding suburbs, and on clear, calm winter nights they often exceed those in nearby rural areas by 5.6 to 11°C (10 to 20°F).[7] Philadelphia's urban heat island is due to passive trapping of solar energy plus active production of heat, such as that released into the environment by gasoline engines, electric motors, computers, and furnaces. In the winter, man-made sources of heat are estimated to account for 2–3°C of Philadelphia's nighttime heat island.[8]

Philadelphia's heat island advances the onset of leafing out in the spring. This shift is superimposed on advances due to global warming. Satellite imaging of the Washington-Philadelphia-New York corridor in 2001 showed that leafing out occurred almost nine days earlier inside urban zones compared to 8–10 kilometers outside these zones.[9]

Thermal mapping graphically displays geographic differences in temperature within Center City's heat island. Shaded by trees, Rittenhouse Square stands out as a "cool island" during the day within the heat island.[10] Studies performed in Raleigh, North Carolina, demonstrated the ecological importance of temperature differences within an urban heat island. In Raleigh, higher temperatures drove the abundance of a scale insect (order Hemiptera: *Parthenolecanium quercifex*) that infests willow oak trees. The study controlled for confounding variables such as parasitism and habitat. Abundance of the scale insect in Raleigh was thirteen times greater in hot areas compared to cooler areas.[11]

In Center City, animals vulnerable to desiccation from heat limit their activities to the night; during the day they find shelter underground or beneath leaf litter or stones. Examples include pillbugs, slugs, millipedes, and the red back salamander. Pillbugs and slugs avoid desiccation by bunching together. The silvergreen bryum moss (*Bryum argenteum*), a common moss in Center City, tolerates desiccation.[12]

In theory, Center City's heat island might attract birds such as American robins that overwinter here but also migrate south. Against this theory are William Bartram's detailed records of robins around his home in Philadelphia during frigid spells in January in the early nineteenth century, long before one would expect development of a significant urban heat island effect. In the winter of 2012, the number of silver-haired bats people discovered in Center City and transported to a local animal rehabilitation clinic totaled six. Theoretically Center City's heat island offered these bats thermal protection during winter hibernation.

Pumps serving power plants at Christian Street draw cooling water from the Schuylkill River, circulate it around the plants, and discharge heated water into the river. The average volume of water they draw from the river has exceeded the river's historic minimum rate of flow by more than fourfold. The river here is tidal, so that the Atlantic Ocean maintains water levels in the river close to sea level despite the withdrawals. The thermal plume of the power plants' heated discharge could point upstream toward Center City, depending on the plant's discharge rate, river discharge rate, and tidal flow.

In 1962 at the annual conference of the American Water Works Association in Philadelphia, Gerald E. Arnold, superintendent of the Philadelphia Water Department, presented a paper on industrial thermal pollution. It reported results of studies on the Allegheny, Monongahela, and Ohio Rivers in the vicinity of Pittsburgh. Among the findings: as the temperature of water rises, water holds less dissolved oxygen, and dissolved oxygen required by aquatic organisms increases. A reduction in dissolved oxygen reduces the upper temperatures that fish can tolerate. As temperatures rise, bacteria deplete dissolved oxygen. Some fish swimming into hot water are killed, while fish acclimated to warm water are rapidly killed when they swim into cold water. Elevated temperature disturbs activity, feeding, growth, and spawning of fish; and it acts as a force repelling or attracting them. Lethal high temperatures vary according to species, developmental stage, and rate of temperature change.[13] Arnold added a worrisome caveat:

> Water temperatures do not have to reach lethal levels in order to wipe out a species. Temperatures which favor competitors, predators, parasites, and diseases can destroy a species at levels far below those which are lethal.[14]

I have found no ecological reports on thermal discharges into the Schuylkill River from the power plants just below Center City.

One of these power plants cogenerates electricity and steam. Customers in Center City and University City, located across the river, purchase the steam for heating. The power plant's capacity is 170 MW of electricity plus 1.5 million lb/hr of steam, which it distributes through steam pipes.[15] In theory, heat in the form of steam piped to customers reduces heat in the form of hot water discharged into the Schuylkill River.

Light pollution

At the beginning of the twentieth century, powerful arc lamps mounted on top of City Hall Tower disoriented nocturnal migrating birds, which collided with the building. After storms, hundreds of dead and wounded birds accumulated below City Hall Tower, which has since stopped producing the bright light.

Later in the twentieth century and into the twenty-first, windows and glass facades of tall buildings in Philadelphia compounded the danger of collisions due to artificial light. Birds fail to recognize transparent or reflective glass as a barrier, and fatally collide with it. Annually, the number of birds killed in collisions with buildings in just two locations in Philadelphia has been estimated at over 2,000.

When municipal electric lighting was first introduced to big cities at the end of the nineteenth and the beginning of the twentieth century, it attracted entomologists because of the rich assortment of insects that flew to the lamps. Today, in comparison, urban lamps are among the worst places to look for insects. Paradoxically, light pollution downtown can reduce attraction of insects to light. By increasing background light, it decreases contrast between light sources and their backgrounds. Insects downtown still fly to lamps surrounded by relative darkness, as in our backyard garden, which is shielded from streetlights. From the perspective of moths, outdoor electric lighting in Center City may be viewed as a double-edged sword, disturbing or protecting them depending on circumstances.

Bridge spiders (*Larinioides sclopetarius*) have colonized lamps along the east bank of the Schuylkill River in Center City. In the nineteenth century this spider was observed capturing prey in its web primarily during the day, but now in Center City the spider captures prey at electric lamps at night. Lamp fixtures along the river offer the bridge spider shelter and aquatic insects, and they distance the spider from a predator, the black and yellow mud dauber.

The common eastern firefly (*Photinus pyralis*) appears in June and July in Center City. It flies at dusk despite exposure to streetlamps. Center City endows this firefly with a safe haven from its usual predator, femme fatale fireflies (*Photuris*). Femme fatales emit flashes that lure in male common eastern fireflies, which the femme fatales overpower and devour. The reason these predatory fireflies are absent from Center City is unknown; they are present in Philadelphia's suburbs. One hypothesis is that femme fatale fireflies are more vulnerable than their victims to light pollution.

Intense light pollution was found to advance the onset of early-morning singing by American robins (*Turdus migratorius*) in Pennsylvania; the shift averaged 107 minutes. In urban areas in Britain, the European robin (*Erithacus rubecula*) has shifted its song from day to night; but noise pollution, rather than light pollution, caused the shift. In Center City, noise and light pollution theoretically could act together to advance the time in the morning when American robins begin singing.

Sound (noise) pollution

Noise from interstate highways surrounds Center City on three sides. Within Center City's commercial core, vehicular noise peaks at rush hour. Intermittent sources of noise downtown are geographically scattered, and include car alarms, sirens, air conditioners, street cleaners, helicopters, freight trains, and amplified music. A city ordinance defines limits of lawful noise.[16]

Noise pollution may protect house finches (*Haemorhous mexicanus*), which are common at our backyard feeder. In an experimental study in New Mexico, house finches preferred to nest in a noisy habitat compared to a control habitat that was similar but quiet. Its enemies, jays and cowbirds (nest predators and parasites, respectively), avoided the noisy habitat.[17]

Urban noise can interfere with communication among songbirds. House finches studied in Mexico City increased the minimal acoustic frequency (pitch) of their songs according to the level of background urban noise.[18] This capability has been postulated to explain the house finch's success in colonizing cities.[19] American robins and cardinals (*Cardinalis cardinalis*) also modulate the pitch of their songs according background noise.[20]

Mourning doves (*Zenaida macroura*), like house finches, are frequent visitors to our backyard, where they forage for seed on the ground. In contrast to house finches, mourning doves in the experiments in New Mexico preferentially nested in the habitat that was less noisy.[21]

In Center City, common insects that sing include cicadas, crickets, and katydids. The response of these insects to man-made noise has not been studied, but in Germany, the maximum pitch of songs of grasshoppers was tested under standard background noise in the laboratory. The maximum pitch of grasshoppers from noisy roadside habitats was higher than that of grasshoppers of the same species from relatively quiet habitats.[22]

Mouse-eared bats, which find food by passively listening for rustling sounds of prey on vegetation, avoid foraging near highway noise.[23] Using an ultrasonic monitor, I observed bats emitting ultrasonic sounds as they foraged for insects flying in Schuylkill River Park, well within human earshot of the noisy Schuylkill Expressway across the river.

Persecution

In Center City green space is scarce and manicured. Wild plants colonize vulnerable sanctuaries like pavement cracks, strips along curbs, and untended borders of parking lots or playgrounds.

Wild plants successful at escaping persecution are those that colonize small spaces, mature quickly, keep a low profile, and are hard to pull up. Tall, broad-leaved perennials that occupy more than a few square centimeters of ground are attractive targets for removal; an example is common milkweed (*Asclepias syriaca*), recently extirpated from Center City.

Persecution downtown takes aim against habitat as well as particular plants. Outside Center City, a fern called purple-stemmed cliffbrake (*Pellaea atropurpurea*) thrives in cracks in old mortar that has weathered. Downtown, the fern and its habitat are both absent, casualties of property maintenance such as painting and repairing of masonry. An old granite masonry pier supporting the Chestnut Street Bridge is an exception. In an inaccessible refuge near the top of this stone structure is a colony of ebony spleenwort (*Asplenium platyneuron*), another fern with an affinity for old masonry. Ferns have populated old inaccessible masonry retaining walls around the Fairmount Water Works, but they have disappeared from nearby rocky cliffs scoured by maintenance crews with weed whackers.

Figure 28.3 Community of wild ferns on an old stone retaining wall near Fairmount Water Works. It contains ebony spleenwort (*Asplenium platyneuron*), purple-stemmed cliffbrake (*Pellaea atropurpurea*), and bladder fern (*Cystopteris*). So far, inaccessibility has protected this wall from weeding.

Persecution in Center City targets animals as well as plants. Property owners try to rid facades of unsightly nests of black and yellow mud dauber wasps. Positioned in inaccessible nooks high on exterior walls below eaves, these nests often defy removal. The nest of the organ pipe mud dauber, in contrast, is more vulnerable, because this mud dauber positions its nest lower, and the male hangs around loudly buzzing—although it cannot sting. I have yet to find the organ pipe mud dauber downtown, although I have found it under suburban railroad trestles. Mud daubers are solitary and less aggressive than paper wasps, which also build nests under eaves.

Prejudice

In 1808 Alexander Wilson puzzled over why people persecute the American robin less than other birds. He suggested that people like this bird because they associate its song with spring and its name with the European robin, a traditional English favorite. Popular affection for the American robin endures even though the bird strips ornamental berries off garden shrubbery; harbors deer ticks and the pathogen for Lyme disease; and is a reservoir for West Nile virus, an introduced cause of human encephalitis.

In Center City animus toward the Norway rat has been constant since earliest records, while historical attitudes toward the gray squirrel and house sparrow have shifted according to circumstances. The status of the Canada goose reversed as the bird changed from migratory icon to perennial nuisance. Love for the ailanthus tree turned to hate as people discovered its invasiveness. When first described in Philadelphia in 1819, the brown bullhead was esteemed as dinner fare, but dismissed as a game fish; in Center City it has disappeared, and so is no longer a game fish, and in Philadelphia's Darby Creek, where it can still be found, PCB contamination has spoiled its status as fine fare.

Downtown, rats, geese, sparrows, and squirrels have all survived bad reputations, which may, paradoxically, serve the animals better than do good reputations. For example, in the winter, well-meaning people pick egg cases of Chinese mantids and bring them indoors, where they hatch prematurely, before the hatchlings can survive outdoors. Chinese mantids, which have reputations as "beneficial," have become scarce downtown compared to Carolina mantids, whose egg cases are smaller and better camouflaged.

Populations

People

Center City's high density of buildings and streets fosters an illusion that the city is insulated from disruptive forces of nature except for geophysical disturbances such as hurricanes, floods, and heat. In 1793 an epidemic of yellow fever swept through Philadelphia and killed a tenth of the population. Nearly half of the people in the city fled. Yellow fever epidemics in Philadelphia recurred six times until the final one in 1805.[24]

The yellow fever virus and its mosquito vector (*Aedes aegypti*) have not re-established themselves in Philadelphia since the last epidemic, but a close relative, the Asian tiger mosquito (*Aedes albopictus*), was discovered here in 2000 for the first time.[25] In other parts of the world, this mosquito has been a vector for viruses causing dengue and Chikungunya fever,[26] while in the Philadelphia region it carries West Nile virus. [27]

Public surveillance programs in Philadelphia are finding West Nile virus most often in two other mosquitoes, *Culex pipiens* and *Culex restuans*.[28] From 1999 to 2012, West Nile virus caused over 37,000 cases of encephalitis nationwide[29] and over a thousand deaths.[30] A state-sponsored program to control this disease in Philadelphia uses trucks to spray insecticide against populations of mosquitoes found to be infected with the virus.[31]

Figure 28.4 Asian tiger mosquito (*Aedes albopictus*) on the stucco rear wall of our row house. A recently introduced vector for viral pathogens, it is spreading globally, and elsewhere has caused outbreaks of dengue and Chikungunya fever.

Bagworms

Diverse forces have shaped populations of plants and animals downtown over the past 200 years. In public squares in mid-nineteenth-century Philadelphia, plagues of insects attacked municipal shade trees. One of the pests was the bagworm. Its populations are controlled primarily by parasitic wasps, which take time to establish numbers sufficient to suppress infestations. In disturbed habitats, this grace period offers bagworms windows of opportunity, which bagworms likely exploited in the nineteenth century as Philadelphia expanded its plantings of trees in public spaces. At that time, the absence of flowerbeds and flowering shrubs in public squares may have contributed to population explosions of bagworms: parasitic wasps whose larvae eat bagworms feed on nectar and pollen of flowers. Use of insecticides against bagworms may have disrupted parasitic control and paradoxically prolonged infestations.

House sparrows

Populations of some introduced species exploded initially, only to taper off with the passage of time and loss of favorable conditions. In 1869 the City of Philadelphia released 1,000 house sparrows imported from England to prey on insects infesting municipal shade trees. Numbers of house sparrows at first multiplied exponentially, but lately their numbers have been declining. Hypotheses to explain the decline have cited many factors: exotic ornamental plants resistant to insects have reduced the house sparrow's supply of insect prey; destruction of weeds has reduced availability of both seeds and insects; parasites of insect pests reduced the house sparrow's prey; predation by raptors and cats increased house sparrow mortality; introduction of house finches has increased competition; the design of new buildings denies house sparrows suitable nesting sites. Since 1966 numbers of house sparrows have declined in Pennsylvania by 62 percent, and nationally by 85 percent.

Yellowjackets

Changes in abundance of some species downtown are shrouded in mystery. Populations of yellowjackets in Center City exploded in the late 1990s. During this period a series of papers in medical and veterinary journals documented yellowjacket stings in Philadelphia, but the outbreak was neither formally monitored nor evaluated, and the causes for its onset and remission remain unknown. Its geographic distribution was never mapped. During the outbreak, which peaked annually in late August and September, yellowjackets would swarm around food and drink of people dining outdoors; meat, fruit, and sweet beverages would attract yellowjackets within minutes. In recent years, yellowjackets downtown have been rare or absent. Spikes in abundance of yellowjackets have recurred for reasons unknown in England and the Pacific Northwest..

Geese

Canada geese outside of captivity never bred in Pennsylvania until the twentieth century. In 1814 Canada geese were selling in Philadelphia markets for seventy-five cents to a dollar per bird. Hunters kept captive flocks of decoy geese to lure in wild Canada geese as they migrated overhead. Over generations, these captive geese lost

their migratory behavior, which is learned rather than innate. With their migratory habits broken, captive Canada geese nested and reproduced locally, even when freed. After use of decoy flocks for hunting geese was outlawed, hunters released their semidomesticated Canada geese or turned them over to state game managers, who in turn transplanted them throughout Pennsylvania, unintentionally unleashing the current proliferation of urban Canada geese. The Canada geese game managers distributed in Pennsylvania were giant Canada geese of Midwestern stock.

Stink bugs

In Center City accidental introduction of pests continues to occur. In 1996 the brown marmorated stink bug showed up for the first time in North America in Allentown, Pennsylvania, 79 kilometers outside of Philadelphia. This bug had been known as an agricultural pest in Asia. By 2010 the stink bug had reached our house in Center City. In Pennsylvania it has proved damaging to crops and difficult to control with insecticides and parasites. A sand wasp discovered in Pennsylvania in 1823 is a predator of stink bug nymphs, including those of the brown marmorated stink bug. In Logan Circle it drags prey down holes to its underground nests. This wasp has so far not controlled the outbreak of stink bugs.

Evolution

Industrial melanism demonstrated the power of big cities like Philadelphia to generate selective forces strong enough to drive evolution, as in the case of the melanic (black) form of the peppered moth. Cities also drive evolution by importing foreign strains; hosting genetic mixing; and subjecting hybrids to new selective pressure.

Mugwort naturalized in New England and Canada after Jesuits introduced it into North America from Europe in the sixteenth century. Around Philadelphia, populations of mugwort stayed quiescent or disappeared until the latter half of the nineteenth century, when sailing ships deposited it in ballast dumps in the city. These dumps allowed strains of mugwort imported from around the world to hybridize. The plant evolved competitive strains whose populations exploded out of port cities. Today this perennial populates pavement cracks and edges of gardens and parking lots throughout Center City. It forms dense monocultures that exclude other plants.

Habitats

Row house courtyards

A habitat characteristic of Center City and surrounding neighborhoods is the courtyard behind a row house. Courtyards have graced the rear of Center City's row houses since they were built in the nineteenth century. Even when not cultivated, rear courtyards function as refuges for wild plants and animals, especially invertebrates, in a downtown otherwise saturated with buildings and pavement.

The longevity of Center City's courtyards allowed time for introduction and establishment of populations of earthworms, which may in part explain the abundance here of fireflies, whose larvae prey on earthworms. Longevity also contributed to

the diversity of isopods such as pillbugs, which support pillbug hunters, spiders that specialize in consuming them. The abundance of soil invertebrates attracts American robins, which in turn harbor parasitic worms that infect pillbugs, which transmit the worms back to robins.

The community of animals on the ground in our garden decomposes leaf litter and aerates the soil. Although most of them are introduced, some are native, such as fireflies, or support species that are native, such as American robins. In a pristine habitat, exotic animals such as those in Center City courtyards might be condemned as invasive or destructive, but here they inhabit territory long ago stripped of endemic flora and fauna.

Sidewalk cracks

In Center City sidewalk cracks are the only places where I have found some plants, like lawn pennywort (*Hydrocotyle sibthorpioides*), which leafs out and produces flowers and seed entirely within cracks between the pavers of brick walkways. Sidewalk cracks are the predominant habitat for Japanese mazus (*Mazus pumilus*), whose flowers barely poke above the pavement surface in zones that are heavily trampled. Cracks at the juncture of sidewalks and buildings are the most common location for Pennsylvania pellitory (*Parietaria pensylvanica*), a tall, upright native annual. On the paved island in the middle of Broad Street, fine cracks between snugly fitted pavers accommodate plants with stems that are thin, as exemplified by lovegrasses (*Eragrostis pectinacea* and *E. spectabilis*). Between the pavers of brick sidewalks on the south side of east-west streets, mosses flourish—beneficiaries of shade cast by row houses.

Plants in sidewalk cracks in Center City contribute not only to botanical diversity, but also to the city's hydrology. Center City's sewage system, a legacy of infrastructure dating back 200 years, drains storm water and sewage through a single pipe rather than through two separate pipes, the standard in modern municipal drainage systems. Ordinarily Center City's sewers direct their flow to treatment plants. During heavy storms, however, surface runoff overwhelms the system, and the overflow containing raw sewage mixed with storm water spills into the Schuylkill River. By impeding storm runoff and directing it into cracks, plants growing in pavement cracks retard the flow of storm water into the sewers. They also soak up storm water and divert it into the ground. Wide, deep cracks with thick vegetation offer the most effective barriers.

A common inhabitant of sidewalk cracks is purslane (*Portulaca oleracea*). Leroy G. Holm and his colleagues highlighted it in *The World's Worst Weeds.* They rank weeds according to type and number of published reports in agricultural literature. Among the world's seventy-six worst weeds, purslane ranked number nine. It infests the earth's major crops: corn, wheat, rice, potatoes, sugarcane, linseed, safflower, sugar beets, sorghum, bananas, citrus, millet, peanuts, vineyards, cotton, vegetables, and coffee. It poisons and kills livestock and is an alternative host of harmful agricultural viruses, nematodes, and insects.[32] In Center City, it is an attractive, maintenance-free, compact flowering succulent that tolerates harsh conditions on pavement.

Figure 28.5 Purslane (*Portulaca oleracea*) in bloom at curb on Spruce Street. Here it impedes storm runoff that pollutes the Schuylkill River, although wider cracks with thicker vegetation offer more protection. Agronomists have ranked purslane number nine among the world's worst weeds.

Five of the world's ten worst weeds as cited by Holm et al. inhabit Center City's sidewalk cracks. They are Bermuda grass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-galli*), goose grass (*Eleusine indica*), lambsquarters (*Chenopodium album*), and purslane. House sparrows, which are declining in Pennsylvania, feed on the seeds of common wild plants such as these. Flora in sidewalk cracks may degrade pavement and impede foot traffic even as it supports wildlife and enriches urban vegetation.

Tidal alluvial mudflat

Specialized habitats downtown include an artificially created tidal alluvial mudflat in an 8-meter gap in the bulkheading along the Schuylkill River just below the Walnut Street Bridge. Here wild purple loosestrife (*Lythrum salicaria*) quickly overran a garden of carefully selected plants native to Pennsylvania wetlands. The Pennsylvania Department of Agriculture has posted this notice online:[33]

> **Purple Loosestrife Alert**
>
> **An Attractive but Deadly Threat to Pennsylvania's Wetlands and Waterways**
>
> Purple loosestrife is an aggressive plant that is invading our wetlands, replacing valuable wetland plants; eliminating food and shelter for wildlife; and choking waterways.

Figure 28.6 Purple loosestrife (*Lythrum salicaria*) an exotic species growing wild in tidal alluvial mud below the Walnut Street Bridge along the east bank of the Schuylkill River. It attracts native bees, as shown in Figure 29.1. It has replaced native wetland flora that had been planted in a garden here several years before.

In this site along the Schuylkill River, purple loosestrife has colonized former wharves and industrial property, now a recreational park. It attracts honeybees and native pollinators such as bumblebees, to the admiration of visitors in the park. It deters children from wandering into the river. It is care free. Occupying but a small patch of ground, it belongs to a lush community of wild plants in fierce competition. Such a botanical spectacle flourishing unfettered in Center City is unique.

Just outside Center City, north of Chinatown and the Vine Street Expressway, are more extensive communities of wild plants. They inhabit the Reading Viaduct, an abandoned elevated commuter railway operational from 1893 to 1984. When trains ran here, the railroad used herbicide and maintenance crews to suppress vegetation, but now trees, shrubs, and herbaceous annuals and perennials thrive along the tracks high above city streets. Common milkweed (*Asclepias syriaca*), recently extirpated from Center City, thrives here. Conversion of the Reading Viaduct into a public park would inevitably transform these botanical communities.

Figure 28.7 Reading Viaduct, December 11, 2011. Elevated above city streets, it carried trains into Reading Terminal Station from to 1893 to 1984. In 1894, 290 trains on thirteen sets of tracks were scheduled to run daily from this station onto tracks such as those that once ran here.[34]

Center City as beneficiary of environmental protection

In Center City, the tree moss *Orthotrichum pumilum* returned to Philadelphia after disappearing over a century earlier. It embodies the triumph of campaigns for clean air. Its counterparts among animals include the American shad, which returned with restoration of clean water, and the red-tailed hawk, once a victim of DDT and persecution. Center City is no Wilderness Area, but environmental activism has nevertheless rewarded it.

Downtown the fate of populations of plants and animals attracts interest either when it defies human control and comprehension, or when it appears, directly or indirectly, to affect people. The attraction may also come from what E. O. Wilson calls *biophilia*—the human bond with other species.[35] In Center City, accounts of the journeys of populations of plants and animals out of the past—documented in publications and museums and linked to familiar streets and buildings—illuminate the present and introduce the future.