



HISTORIC GERMANTOWN SCIENCE *Sleuths*



Section 1 : AWBURY ARBORETUM

LESSON OBJECTIVE

To understand the importance of **watersheds** in maintaining balance and **biodiversity** in the environment.



The lower pond at Awbury Arboretum

Key Terms

Biodiversity

the variability (constantly changing and evolving) variety of life on earth. It can be measured in genetic variability, species diversity, and ecological diversity. Biodiversity is greatest in the tropics, because of the warm, moist climate

Watershed

an area of land that drains ("sheds") rainfall and snowmelt into streams and rivers. Every body of water has a watershed. Gravity helps to guide the path that water takes across the landscape. The area that may be covered by water when water overflows its channels (riverbanks) is called a floodplain, and is part of the watershed. To find out about your watershed, visit our local watershed experts at the Tookany-Tacony-Frankford Watershed Partnership (TTF): <https://ttfwatershed.org/our-watershed/>

Test your knowledge

Multiple choice

1. This is an element of a watershed:

- a swimming pool rain fish a floodplain

2. Pure water is:

- acidic neutral biodiverse basic

3. Sewage from a sewer pipe flowing into a river is an example of:

- a point source of pollution sediment a dispersed source of pollution runoff

4. Fertilizer from an agricultural field seeping into a river is an example of

- a point source of pollution sediment a dispersed source of pollution runoff

Match the term with its definition

- | | | |
|----------------------|-----------------------|---|
| Pathogen | <input type="radio"/> | <input type="radio"/> a common ingredient of fertilizer |
| Precipitation | <input type="radio"/> | <input type="radio"/> a microorganism that causes disease |
| Toxin | <input type="radio"/> | <input type="radio"/> water that is under the surface of the earth |
| Nitrate | <input type="radio"/> | <input type="radio"/> a poison |
| Groundwater | <input type="radio"/> | <input type="radio"/> Water that falls from the sky onto the ground |

Short Answer

1. Name two ways water goes from the ground/ocean into the atmosphere.

2. Give an example of each of these: a producer, a primary consumer, a secondary consumer, a scavenger/detritivore, and a decomposer.

Site History

Awbury Arboretum is an historic 56-acre landscape located in the Germantown neighborhood of Northwest Philadelphia, on what was once the ancestral land of the Lenape people. By the time Henry Cope, a Quaker shipping merchant and Philadelphia civic leader, bought the property in 1852, it was farmland, and the Lenape people had long since been displaced by European colonization. The Copes were shipping merchants and, while they never enslaved people nor transported enslaved peoples, they profited from the sale of goods such as cotton, tobacco, and turpentine, which resulted from the work of enslaved peoples.

Henry Cope purchased the land to provide his family a refuge in the summer from the heat and the many diseases that plagued cities at that time. He named the estate after the village of Avebury, England, from which his family originally emigrated. Awbury soon became a year-round home for members of the extended Cope-Haines family, privileged wealthy white men and their families. Various houses were built between 1860 and the 1920s. Awbury's grounds were laid out in the English picturesque landscape garden tradition with the advice of the celebrated horticulturalist (a person who specializes in the cultivation of flowers, fruits, vegetables, or ornamental plants) William Saunders. Long vistas are framed by clusters of trees and shrubs which are interwoven with open space, creating dramatic visual contrasts.



Above: View of a pasture looking towards 1011 East Washington Lane taken some time between 1880-1920. The wide-open landscape shows how the area that is now Awbury Arboretum once looked. *Gay Gilpin Johnson Archives at Awbury Arboretum.*



Above: Photograph of a painting of the Cope Ship "Monongahela". *Gay Gilpin Johnson Archives at Awbury Arboretum.*



Above: View of the pond at Awbury with two people and a dog in 1976 after an earlier reconstruction. *Gay Gilpin Johnson Archives at Awbury Arboretum.*

What to know before you go (continued)

Did you know?

In 2020-22, with funding from the Philadelphia Water Department and the Pennsylvania Dept of Community and Economic Development, Awbury undertook a complete restoration of its ponds and watercourse, adding an advanced filtration system for capturing street run-off to alleviate flooding on Washington Lane and reduce pollutants that enter the stormwater system. More than 14,000,000 gallons pass through Awbury's watercourse system annually.

Historically, the wetlands area was Wingohocking Creek (See page 7), but the current form reflects the plan of Arthur Cowell, the landscape architect. It consists of a bog and two ponds connected by a small stream. In wet periods, the overflow of water travels by way of the (channelized) Wingohocking to larger tributaries and eventually the Delaware River.

In 1916, five women from the Cope family gave most of the land to the City of Philadelphia for public use as an arboretum for the "quiet enjoyment of nature" and for educational purposes. In 1984, the not-for-profit Awbury Arboretum Association took over the day-to-day management of the arboretum from the City Parks Association.

The Arboretum is today the largest unbroken greenspace within the densely packed urban community of East Germantown. Its landscape comprises 40 acres of meadows, woodlands, ponds, wetlands, rolling lawns, a Victorian mansion, and 16 acres of agricultural land made up of farming plots, orchard, community gardens, beehives, goat paddock, and chicken coop.



Installation of the filtration system as part of Awbury's pond and watercourse restoration project. *Photo Credit - Branda O'Neil*

What to know before you go (continued)

Rachel Carson

Rachel Carson (1907-1964) started as an aquatic biologist in the US Bureau of Fisheries, became a full-time nature writer in the 1950s, and is widely considered the mother of the modern environmental movement. Late in the 1950s, Carson turned her attention to conservation (the protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water), especially to problems she believed were caused by synthetic pesticides, in her revolutionary book *Silent Spring* (1962). This groundbreaking book brought environmental concerns to the attention of the American public, not just to scientists. Carson wrote *Silent Spring* as a response to the US government's attempts to control a pest - a species of moth that was damaging crops and trees.

In 1957, the US government began spraying a toxic chemical called DDT over wide areas of land in an attempt to kill the moths. Carson spent four years gathering examples of environmental damages linked to overuse of pesticides, including a rapid decline in the bird population. Although *Silent Spring* was met with fierce opposition by the US Dept. of Agriculture and chemical companies, the book triggered great changes in national pesticide policy, eventually leading to a nationwide ban on DDT and other dangerous pesticides. It also inspired a grassroots environmental movement that led to the creation of the US Environmental Protection Agency (EPA) in 1970. President Jimmy Carter awarded Carson the Presidential Medal of Freedom posthumously in 1980.



Biologist/author Rachel Carson working with microscope at her home. Image dated September 24, 1962. Photo by Alfred Eisenstaedt via LIFE.

Key Terms

Toxin

A poison that harms you when you ingest it (eat), touch it, or get stung. Examples of natural toxins are bee venom, poison ivy oil, and poisonous mushrooms. Examples of human-made toxins are gasoline, lead paint, and pesticides. Examples of inorganic toxins are lead, arsenic, and mercury. Toxins may be poisonous to plants, animals, and/or humans.

Pathogen

An infectious organism that causes disease: a germ. It is sometimes also called an infectious agent. It can be a bacterium, a virus, a fungus, or a prion.

What to know before you go (continued)

Did you know?

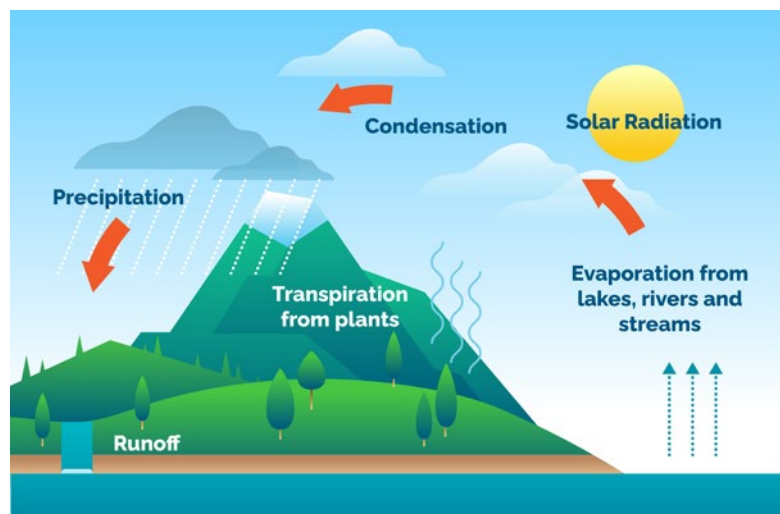
On the Earth, the primary forms of liquid water are in the oceans, lakes, rivers, and other smaller bodies of water. There are also reservoirs of water under the surface of the earth, called groundwater. The primary forms of frozen water are snow, ice, and glaciers.

In the atmosphere, the primary form of water is water vapor. Although its storage in the atmosphere is comparatively small, water vapor is extremely important in the formation of dew, frost, fog, clouds, and precipitation. Practically all water vapor in the atmosphere resides in the troposphere (the region below 6 to 8 miles altitude).

Water Cycle

Water Cycle is a term used to describe the continuous circulation of water in the system made up of the Earth and its atmosphere. Although the total amount of water within the cycle remains more or less constant, its distribution among the various processes is continually changing. Of the many processes involved in the water cycle, the most important are evaporation, transpiration, condensation, precipitation, and runoff.

The water cycle goes something like this: water from the surface (liquid) evaporates into the atmosphere; it also transpires from the pores of plants, turning into water vapor (gas). As the air reaches a maximum concentration of water vapor and the water vapor cools, the water returns to earth as precipitation, either rain (liquid), snow, or ice (solids). When the water reaches the ground, some of it infiltrates the soil, some falls back into water reservoirs, and some runs across impermeable surfaces and flows as runoff into water reservoirs, picking up soil and pollutants as it goes.



What to know before you go (continued)

The Wingohocking Creek

The Wingohocking Creek is a tributary of the Tookany/Tacony-Frankford River. The Wingohocking has been transformed by being piped underground in the late 19th century. The word “Wingohocking” may have come from the indigenous Lenape words for “favorite land for planting” or, perhaps, “crooked water.” The creek now flows in a combined sewer which carries both storm water and raw sewage.

The Wingohocking was converted to sewers beginning in the 1880s, with the final section of 21 miles of streams finally buried in 1928. A small section of Wingohocking Creek has been uncovered, or daylighted, at Awbury Arboretum (around 1916, but precise date unknown), when the Copes restored the water gardens, reversing the effects of erosion, silting, and invasive weeds. This is the only portion of the Wingohocking currently visible above ground.



Above: A section of the Wingohocking Creek sewer 17 feet in diameter. Photo taken in 1913. From Michael McShea, phillyandstuff.blogspot.com

Did you know?

The Wingohocking combined stormwater/ sewage overflows into Frankford Creek when stormwater levels are high. This is the same water we use for drinking, bathing, and cooking, although the water is sanitized for human use.

Key Terms

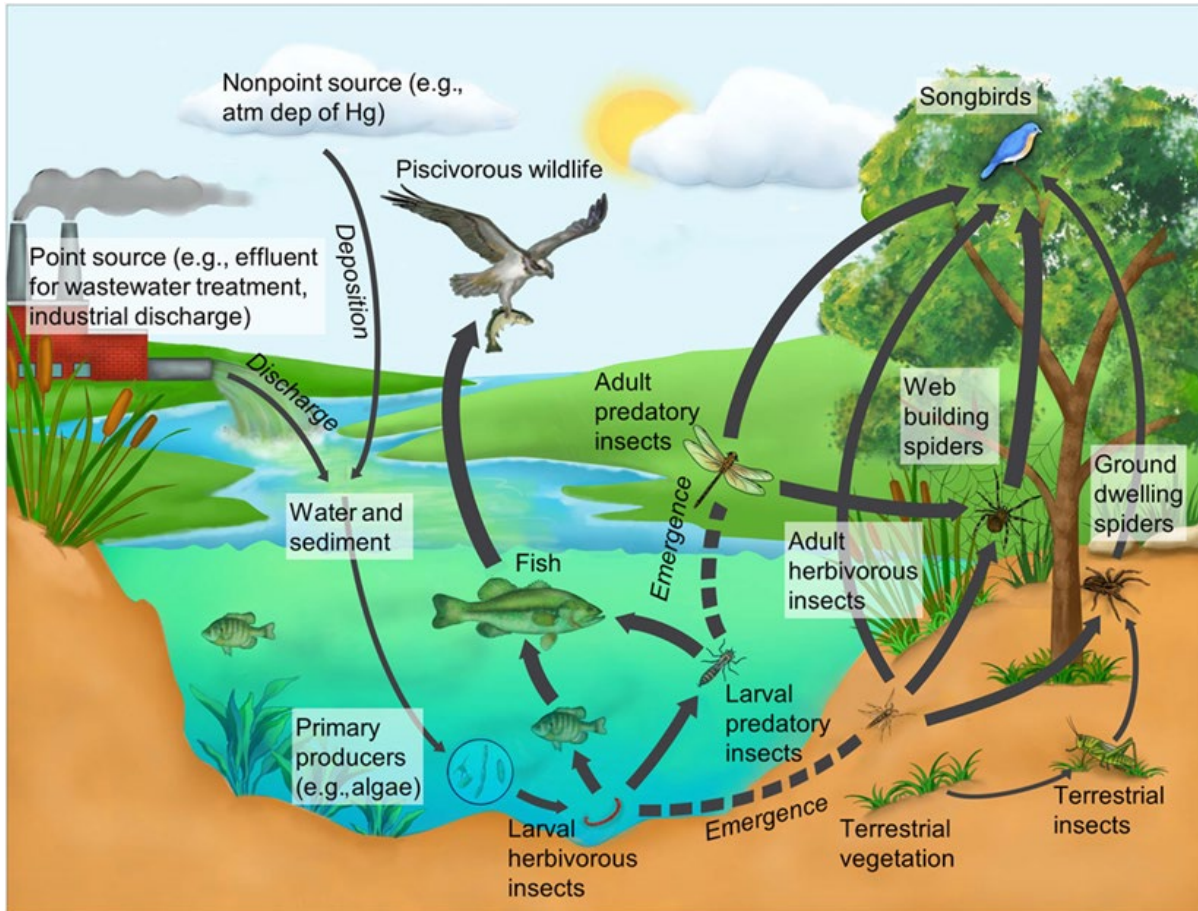
Riparian Buffer

A riparian buffer is a vegetated area near a stream, usually forested, which helps shade and partially protect the stream from the impact of nearby land uses. Buffers are important components of a healthy stream ecosystem. They provide pollution reduction, erosion control, flood protection and wildlife value. Trees keep the stream banks from eroding and releasing silt and sediment into the stream.

Tributary

a river or stream that flows into a larger body of water, like a larger river or a lake

What to know before you go (continued)



Conceptual diagram demonstrating the connections between aquatic (water) and terrestrial (land) food webs. Contaminants, such as mercury, can be taken up at the base of the aquatic food web and transferred to terrestrial ecosystems. *Source: Upper Midwest Water Science Center. Figure: Chumchal et al. 2022.*

Key Terms

Food Web

a complex network of interconnecting and overlapping food chains showing feeding relationships within an ecological community. Food webs consist of producers (plants), primary consumers (plant-eaters), secondary consumers (plant and meat eaters), detritivores and scavengers (animals that eat dead plants or animals), and decomposers (bacteria, fungi) that break down dead matter into basic materials that other organisms use to live.

Supplemental Vocabulary

Acid (acidic)	A solution with a high concentration of hydronium atoms (H_3O^+). Some common examples of acidic solutions are lemon juice, battery acid, and vinegar. Acids (the ones that are nontoxic) often taste sour.
Base (basic)	A solution with a high concentration of hydroxide ions (OH^-). Some common examples of basic solutions are baking soda and water, ammonia, and bleach. Bases (the ones that are nontoxic) often taste bitter.
Coliform bacteria	are bacillus-type bacteria commonly used as an indicator of low sanitary quality of foods, milk, and water. While coliform bacteria exist in the guts of most warm-blooded animals and are not normally causes of serious illness, their presence is used to infer that other pathogenic organisms of fecal (poop) origin may be present in a sample, or that the sample is not safe to consume.
Condensation	the change of water from the gas phase into the liquid phase, the reverse of vaporization. It is caused when water vapor comes into contact with a cold liquid or solid surface or a hyper-saturated cloud within the atmosphere.
Contaminant	anything that pollutes or makes impure. Contaminants in water can be biological (bacteria, mold, parasites, feces) or chemical (toxins, salt, fertilizers, oil, gasoline).
Dispersed source pollution	the opposite of point-source pollution, with pollutants released in a wide area. Examples of dispersed source pollution are oily, trashy runoff from city streets, animal waste, and fertilizers and pesticides from lawns and agricultural fields.
Evaporation	the process by which liquid water enters the atmosphere as water vapor without boiling. The main factors affecting evaporation are temperature (specifically, the temperature difference between the evaporating surface and the air), relative humidity, wind speed, and solar radiation.
Fauna	the animals of any given area. There are subcategories of macrofauna (animals that are one centimeter or more long but smaller than an earthworm; examples include centipedes, millipedes, slugs, snails, beetles, and spiders), and microfauna (microscopic or very small organisms, such as protozoans).
Floodplain	an area of land next to a river. Floodplains stretch from the banks of a river channel to the base of the enclosing valley, and experience flooding during periods of high precipitation, snowmelt, icemelt, or overflowing of water channels.

Supplemental Vocabulary (continued)

Flora	the plants of any given area.
Groundwater	water beneath the earth's surface, often between saturated soil and rock, that supplies wells and springs.
Infiltration	The process by which precipitation enters the soil, either directly (percolation) or indirectly (runoff). The rate of infiltration is governed by the amount of precipitation and the makeup of the land on which it falls. Infiltration is most when the soil is loosely packed and anchored by plant roots; it is least when it falls on an impermeable surface like concrete or blacktop.
Nitrate	the molecule NO_3 , derived from nitric acid, or a compound containing this group. Nitrates are common components of fertilizers and explosives. Almost all inorganic nitrates are soluble in water. Excess NO_3 in groundwater causes a variety of diseases in humans and animals but especially of concern are conditions affecting human infants.
Phosphate	a compound derived from a phosphoric acid, H_3PO_4 . It is commonly used in fertilizers. Phosphorus is an essential nutrient for plants and animals; however, too much phosphorus in surface water can cause explosive growth of aquatic plants and algae, leading to low dissolved oxygen concentrations, which can kill fish and other aquatic life by starving them of oxygen.
Point source pollution	any contaminant that enters the environment from an easily identified and confined place. Examples of point source pollution include smokestacks, sewage discharge pipes, factory discharge pipes, and toxic spills.
Precipitation	any liquid or frozen water that forms in the atmosphere and falls to earth. Common names for precipitation are rain, snow, hail, or sleet.
Runoff	when there is more water than the land can absorb, the excess liquid flows across the surface of the land and into nearby creeks, streams, or ponds. Runoff can come from both natural processes (snowmelt, for example) and human activity (soapy water from a carwash or excess fertilizer from crops, for example).
Sediment	naturally occurring material that is broken down by processes of weathering and erosion, and is transported by the action of wind, water, or ice or by the force of gravity acting on the particles. For example, sand and silt can be carried in river water and end up as sediment on the bottom of a pond.
Surface Water	water located on top of the earth, usually in bodies of water such as lakes, rivers, ponds, streams, and oceans.
Transpiration	transformation of liquid water into water vapor, especially through the tiny holes in plant tissue or the pores of animal skin (perspiration). Transpiration is basically plant sweat turned into water vapor.

Can't wait to see you at **AWBURY ARBORETUM!**



www.awbury.org



What have you learned?

Multiple choice

1. This is an element of a watershed:

- a swimming pool rain fish a floodplain

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- acidic neutral biodiverse basic

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Writing Prompt

What is the importance of water cycles in your life? What would happen to the City of Philadelphia if we could not trust that our water was clean? Use this link to read the latest report of Philadelphia water: <https://water.phila.gov/drops/2023-drinking-water-quality-report/>

Data Analysis

1. Look at the different kinds of animals you found at the pond. Now make a list of the animals you find in your school playground or the yard near your house or apartment. Compare the two lists and make some observations about what you find. As much as you are able to find out through research, draw food webs for both microbiomes. Which has a larger food web? Why is having a large food web important?
2. Look at the differences between the three water samples you collected. Make a chart with the data to compare the three types of water. Look up statistics for water samples elsewhere in the world (possible examples: Lake Erie, pig farm waste lagoons, the Ganges River, snow melt from the Himalayas). Make a chart to show the differences and write the reasons you think these different water samples contain different readings.



Additional Activities/Resources

Links to Useful Sites

[Wingohocking Creek](#)
(Wikipedia Article)

[Remembering the Wingohocking](#)

[Hiddenhydrology.org](#)

[Waterhistoryphil.org - Sewers and Drainage](#)

[Khan academy - The Water Cycle](#)

[Sciencefacts.net - water cycle](#)

[Sciencefacts.net - What is the water cycle?](#)

[Nationalgeographic.org - watershed](#)

[noaa.gov - What is a watershed?](#)

[Nationalgeographic.org - runoff](#)

[britannica.com - food web](#)

[How to Build a Model Watershed Model](#)

[Make Your Own Watershed \(Video\)](#)

Site Lesson Extensions

Create your own enviroscape out of Lego, sand, aluminum foil, or other materials. Add as many model buildings, agricultural fields, rivers, and factories as you like. Make sure there is a way to capture the water at the bottom (a tube running into a clear soda bottle is one idea). Make point sources and dispersed sources of pollution (using food coloring), spray it with water (precipitation), and capture the resulting runoff from different areas in the soda bottles. Compare the runoff color from point sources with that of runoff from dispersed sources (take equal amounts from the soda bottles and see which is darker). Based on this, make a hypothesis about which sources of pollution are worse, and how you can mitigate (improve) both kinds.



Did you know?

The Delaware river was once considered one of the most polluted waterways in the United States? During WWII, pilots reported that they could smell the stench of the river from 5,000 feet in the air, and ships docking in the waterway were stained brown. Shad fish, a migratory species that used the river as a breeding ground each spring, could not survive in the river. After the war, new clean water regulations and wastewater standards helped limit point source pollution into the river. As the Delaware's water quality improved, shad began returning for their annual spring "run" along with other species dependent on shad like bald eagles.

Watershed Specialist

A watershed specialist is a scientist who provides technical, informational, and organizational help that will improve the quality and quantity of surface and groundwater resources.

Watershed Managers are responsible for creating, developing, and implementing plans for the management of water systems. This includes water supply and sewage, but also projects related to floodwater management, crop irrigation, and street runoff. They often work alongside other professionals such as agricultural and environmental engineers. More recently, the role has expanded to include environmental justice responsibilities: access rights to water, ownership of water sources, and ensuring that all have equal access to clean water.



Dorr Lake water testing in Ocala National Forest. *US Forest Service photo by Susan Blake.*

Did you know?

More than 70% of Pennsylvania rivers, streams, and creeks contain detectable levels of PFAS.



Sign warning visitors to avoid PFAS foam on the Huron river. [License](#)

"Forever Chemicals"

The EPA (Environmental Protection Agency) has recently required public water providers across the U.S. to test their drinking water for toxic PFAS (short for per- and polyfluoroalkyl substances—widely used, long lasting chemicals, components of which break down very slowly over time), and to reduce the so-called "forever chemicals" to almost zero over the next five years. The main goal is to address increasing concerns about PFAS, a large class of chemicals found in hundreds of everyday products, such as nonstick cookware, waterproof clothing, and firefighting foam. The consequences of exposure to PFAS are serious and long-lasting — the chemicals can remain in the environment and in the human bloodstream for years and have been linked to some cancers, thyroid disease, ulcerative colitis, developmental delays in children, and other health conditions.

In January 2024, drinking water providers were required to start testing their drinking water for PFAS. Nearly 19% of the water systems tested statewide between January and March of 2024 submitted water samples that contained PFAS levels above the new federal regulations, according to newly published data of 1,059 water systems. Though the EPA states that no level of PFAS is safe, the agency has set maximum contaminant levels for two types of PFAS at 4 parts per trillion. Today's watershed specialist will need to understand how to reduce these levels, and how to keep PFAS from getting into the water system in the first place.

Acknowledgements

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Cover images include a solar microscope, bone slide with mosquito specimen, and meteorological tablets from the collection of the Wyck Association; Isaac Norris' Thirty Year Pocket Almanac from 1677 from the Stenton Collection on deposit at The Library Company of Philadelphia; and Hexamer General Survey of Wingohocking Hosiery Mills, Shoemaker Lane and Wingohocking Creek, Germantown, Philadelphia, Philadelphia County, Pennsylvania. vol.10 Plate 943, from the Free Library of Philadelphia.



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