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# CYNTHIA MOTH

## (Ailanthus silkmoth; *Samia cynthia*)

**In Philadelphia in 1861, the cynthia moth was introduced into North America for the purpose of manufacturing silk, but the industry never developed, and the moth, after thriving in the wild, became extinct.**

*Figure 5.1* Cynthia moths, larvae, cocoons, and their parasites in a museum drawer of the Academy of Natural Sciences of Drexel University. All specimens are from the late nineteenth to early twentieth century. The moth is now extinct in Philadelphia. (Courtesy of the Academy of Natural Sciences of Drexel University)

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In 1862 Joseph Leidy recommended planting ailanthus trees because of their resistance to insect pests.[1] Fifteen years earlier Andrew Jackson Downing, horticultural expert, praised ailanthus trees for the same reason:

> The variety of trees for cities—densely crowded cities—is but small; and this, chiefly, because the warm brick walls are such hiding places and nurseries for insects, that many fine trees—fine for the country and for rural towns—become absolute pests in cities. Thus, in Philadelphia, we have seen, with regret, whole rows of the European Linden cut down within the last ten years, because this tree, in cities, is so infested with odious worms that it often becomes unendurable. On this account that foreign tree, the Ailanthus, the strong scented foliage of which no insect will attack, is every day becoming a greater metropolitan favorite.[2]

*Figure 5.2* Old ailanthus tree at the historic Lemon Hill mansion in Fairmount Park, Philadelphia.

## Ailanthus trees become disreputable

Leidy's advice, however, might have been controversial. By 1852 Downing had reversed his endorsement of ailanthus:

> The vices of the Ailanthus—the incurable vices of the bygone favorite—then, are two-fold. In the first place it smells horribly, both in leaf and flower—and instead of sweetening and purifying the air, fills it with a heavy, sickening odor; in the second place it suckers abominably, and thereby over runs, appropriates and reduces to beggary, all the soil of every open piece of ground where it is planted. These are the mortifications which everybody feels sooner or later, who has been seduced by the luxuriant outstretched welcome of its smooth round arms.[3]

*Figure 5.3* Colony of ailanthus saplings outside O'Connor Swimming Pool on Lombard Street. They are sprouting from roots tracking along the crack at the base of the wall.

Joseph Leidy may have favored this disreputable species out of desperation. Alternative methods for controlling infestations of insects defoliating shade trees in Philadelphia had been disappointing.

## Introduction of the ailanthus silkmoth

Leidy also may have considered a presentation made the year before at the Academy of Natural Sciences by fellow member Thomas Stewardson. In 1861 Stewardson had reported that a silkworm he had just imported into America could establish a prosperous silk industry here. After procuring eggs of this species from Paris, Stewardson succeeded in rearing the silkworms in a private garden in the city and producing eighty cocoons. At a meeting in the Academy, Stewardson exhibited a sample of cloth fabricated in France from silk of this species. He also exhibited the moth,[4] which today is called the cynthia moth (*Samia cynthia*), a strikingly colored giant silkmoth with a wingspan up to 14 centimeters (5.5 inches).[5] He displayed a live caterpillar feeding on a leaf of its food plant—*Ailanthus altissima*.[6]

Cynthia moths are native to China, where they have a long history of cultivation for commercial production of silk.[7] In China cynthia moths thrive in the wild, unlike the domesticated species of silkworm, *Bombyx mori*, which feeds on mulberry and had already been part of an ill-fated sericulture industry in Philadelphia. In 1769 Benjamin Franklin, then serving as agent of the colonies in England, had sent the American Philosophical Society a letter recommending allocation of public funds for construction of a filature (factory for producing silk thread from cocoons) to promote sericulture based on mulberry.[8] In 1771 a filature located on 7th Street between Market and Arch received over a ton of *B. mori* cocoons for processing.[9] But in 1840 the silk industry in Philadelphia collapsed due to a speculative bubble that lead to the deliberate destruction of 90 percent of the mulberry plants cultivated around Philadelphia.[10]

## Aspirations for the silk industry based on ailanthus silkmoths

News of Stewardson's presentation at the academy spread quickly and sparked unbridled enthusiasm for the future of cynthia sericulture:

> The cultivation of this worm is an employment well adapted to the poor, or the aged, or the very young who are not capable of performing any severe labor. As the worm, from the time of its exclusion from the egg to the spinning of the cocoon requires only about forty days at the furthest, an occasional supervision during eighty days (two broods are reared) of the most pleasant season of the year, is all that is required for the production of millions of cocoons, and all this can be done by a smart child of ten years of age, or an infirm or aged person. Wherever the ailanthus can grow the worm can be reared, and even in the extreme northern States [where] only one brood a year can be raised, still the profits will be large enough to justify the enterprise. With no labor worth mentioning, and with no outlay or money, a textile material, holding a middle place between the silk of the mulberry worm and other materials, as wool, hemp and cotton, can easily be raised, which will prove richly remunerative in furnishing a cheap, substantial and lasting material for apparel. The material would be cheap, and thus favorable to the poor. The coarser sorts could be manufactured into various articles of underclothing at a much less price than is now paid for them; they are tough and strong, and will wear longer than any textile material now used. It is said that garments made of it by the Chinese last through several generations of constant wearing.
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> Reliable estimates of the cost of raising a pound of this silk can only be proximately made, but under any circumstances it could not amount to one-fourth the cost of raising a pound of mulberry silk. The fact is that it would cost nothing but a little care, and as the worm is so hardy it can be left to do its work without any particular oversight. The unwinding of the

> cocoons would cost a little, but this could be done by young or aged people at very little expense. [11]

## Naturalization of cynthia moths in the eastern United States

Despite the ease of rearing cynthia larvae, Stewardson's dream of establishing a silk industry based on this insect never materialized. In the United States no practical method was found for reeling the silk off the cocoons.[12] Stewardson delegated the task of rearing the silkworms to the Academy's assistant librarian, Edward J. Nolan, who in 1863 released 200 on a large ailanthus tree growing in the yard of a laboratory of the University of Pennsylvania, then located on 9th Street just above Chestnut Street. Nolan forgot about them until the winter of 1864, when he discovered 40 cocoons on the tree. He left these undisturbed, effectively releasing them to propagate in the wild.[13]

The introduction of cynthia moths into North America bore similarities to the introduction of its host plant. In the 1780s William Hamilton imported *Ailanthus altissima* from England to his estate, Woodlands, in Philadelphia, the site of the species' first cultivation in North America.[14] Like the moth, ailanthus is native to China and had only recently been imported to Europe before its introduction here. The tree and moth escaped cultivation, naturalized, and disseminated by repeated introductions elsewhere in the United States.[15]

Initially populations of cynthia moths expanded rapidly to other urban areas. The species became established in cities in New York, New Jersey, Connecticut, and Virginia, and in Washington, DC, and later in Georgia, west to Indiana.[16] In 1881 cynthia caterpillars were observed feeding on nearly all the trees and shrubs in New York City's Central Park, but only the caterpillars feeding on ailanthus developed normally; nearly all the others died before completing their life cycles. In 1880, ichneumon parasitoids had been noted for the first time emerging from cynthia cocoons in Central Park.[17] By 1900 the population explosion of cynthia moths had abated:

> It became so common in Philadelphia and Washington, D.C. at one time as to be a pest, and threatened the destruction of the trees; but the parasites and birds seem now able to cope with it and hold it in check.[18]

## Parasites attack Samia cynthia

By the second half of the twentieth century in Philadelphia, parasitism rates were high and the moth had become uncommon, as reported by the lepidopterist Arthur Shapiro, who grew up in Philadelphia:

> The moth was apparently quite common early in the century. I heard this from old-timers when I was a kid...By the late 50's – early 60's the cocoons were not at all easy to find, but tended to be highly clumped. I found them near the Frankford Arsenal, in South Philadelphia, and along Passyunk Avenue, and occasionally at the foot of Arch Street near the river and sometimes rather commonly in the old RR yard in South Camden, behind the J. B. Van Sciver Co. warehouse. They would not be in all those places in the same year, as a rule. The tree of course is nearly ubiquitous in the city. The parasitization rate was incredible. I believe the parasite was *Spilochalcis mariae*—check on this, as I am retrieving stuff through a lot of memory!—and some whole batches were bad—certainly the average was at least 85% parasitized. I caught single adults once at International Airport, while waiting for a bus; once on

the windows of the main Lit Brothers store; and once at a shopping center near Norristown, Montgomery County, the only one I ever saw in the "country" (but downtown Norristown was pretty seedy!).[19]

Others have reported high rates of parasitism of cynthia pupae by *S. mariae.*[20] Populations of cynthia moths became limited to ailanthus's harshest urban habitats, such as railroad yards[21] and verges along major highways.[22] The species was not found on ailanthus growing in rural or suburban areas.[23] When cynthia larvae were experimentally placed on food plants in a rural area, predatory wasps destroyed them all within ten days.[24]

## Extinction of the cynthia moth in Philadelphia

The last report of the species in the wild in Philadelphia was in 1992: Christopher Cook, a moth collector, recalls finding half a dozen cynthia cocoons in southwest Philadelphia near the Eastwick SEPTA train stop. The most recent sighting before that was in 1970, when about fifty cynthia cocoons were found on a small ailanthus tree growing on the property of an American Legion Post then located at 34th and Market Streets. Cynthia moths—big, showy popular insects—have spawned a cottage industry cultivating and selling cynthia cocoons to hobbyists; accidental or intentional reintroductions could account for occasional sightings of this insect in "the wild."

A century and a half after its importation from France and its naturalization in Philadelphia, the cynthia moth is locally extinct here, despite the abundance of ailanthus. Had it been introduced as a biological control agent against ailanthus trees, it would have been deemed a failure. Twenty-five years ago, I theorized that the enemies of the moth could not tolerate gritty nineteenth-century industrial Philadelphia, which afforded it safe haven. According to this theory, as Philadelphia became less polluted and greener, predators and parasites moved into the city, which no longer served as a refuge for cynthia moths. The cynthia moth became a fugitive species with nowhere to go, a vestige of a bygone era.[25]

## Establishment of populations of parasites in Philadelphia

How did populations of parasites move into the moth's urban refuges? The cynthia parasite that Arthur Shapiro remembered, a tiny 4 millimeter wasp called the golden-yellow chalcid (*Spilochalcis mariae* [*Conura maria*]), was first found parasitizing cynthia pupae in 1881 in New York City. Museum specimens of this parasite date back to 1869, when the species was isolated from cocoons of the bagworm, the same species (*Thyridopteryx ephemeraeformis*) that plagued shade trees in Philadelphia.[26] The parasite has also been isolated from three native giant silkmoth species—*Hyalophora cecropia, Antheraea polyphemus,* and *Callosamia promethea*[27] —that I have found in Philadelphia. These hosts of the parasite could have maintained parasite populations even when cynthia populations were low or absent. In the list of species that have been identified as hosts of the chalcid parasite, the most common in downtown Philadelphia is the bagworm—which could have indirectly contributed to the cynthia moth's extirpation.

A tachinid fly, *Lespesia frenchii,* parasitized over ten times more *S. cynthia* than did the chalcid wasp in one survey.[28] A catalog of hosts of this fly lists many species common in Philadelphia. They include the tent caterpillar *(Malacosoma americana),* tiger swallowtail *(Papilio glaucus),* black swallowtail *(Papilio polyxenes),* spicebush swallowtail *(Papilio troilus),* red admiral *(Vanessa atalanta),* painted lady *(Vanessa cardui),* and cabbage white *(Pieris rapae).*[29]

The most abundant of these species in Philadelphia is the cabbage white, which in this region feeds on sixteen species of plants in the mustard family (Brassicaceae), including common weeds.[30] Like the cynthia moth, the cabbage white was introduced into North America from Europe. It was first recorded in Quebec in 1860 and spread south and west.[31] By 1908 individuals of this species were numerous in suburban Philadelphia.[32] It is possible that introduction of the cabbage white into North America provided an alternate urban host for cynthia's tachinid parasite. In Philadelphia the cabbage white, like the bagworm, may have indirectly contributed to the ailanthus silkmoth's extirpation.

*Figure 5.4* Cabbage white (*Pieris rapae*) in the community garden at 25th and Spruce Streets in Center City. It is an alternate host of a fly (*Lespesia frenchii*) that is a parasite of *Samia cynthia*. It was introduced into North America from Europe.

After the cabbage white, the most common species on the list of hosts of the tachinid fly is the red admiral, at least in Center City. Its abundance here coincides with the abundance of one of its food plants. The plant is Pennsylvania pellitory *(Parietaria pensylvanica),*[33] an inconspicuous native herbaceous weed that grows in cracks in pavement at the base of buildings. By supporting red admirals, the establishment of Pennsylvania pellitory as a weed in downtown Philadelphia could have contributed to the cynthia moth's local extinction.

*Figure 5.5* Red admiral (*Vanessa atalanta*) sunning itself on a sidewalk near 25th and Pine Streets in Center City. It is another alternate host of the cynthia parasite *Lespesia frenchii*.

*Figure 5.6* Pennsylvania pellitory (*Parietaria pensylvanica*), with small green flowers along the stem, near 25th and Pine Streets in Center City. It is a food plant of the larvae of the red admiral butterfly *(Vanessa atalanta)*. In this neighborhood, pavement cracks at the base of buildings are its favorite habitat.

*S. cynthia's* tachinid parasite, *L. frenchii,* disappeared in New England after introduction of a competing tachinid parasite, *Compsilura concinnata,* to control gypsy moths.[34] *C. concinnata* parasitizes at least 180 species and has been blamed for reductions in New England's populations of native giant silkmoths.[35] In Virginia, *C. concinnata* is itself attacked by a parasite,[36] which may explain why populations of giant silkmoths there have not declined.[37] How such complex interactions might play out over time in Philadelphia remains to be seen, but recovery of populations of cynthia moths here after an absence lasting decades would seem improbable.

## A fruitless search for cynthia cocoons on ailanthus trees

Recently Chris Cook escorted Jason Weintraub, lepidopterist at the Academy of Natural Sciences, and me on a tour of the site near the train stop in Eastwick where he had found cynthia cocoons two decades ago. The density and numbers of ailanthus trees here were greater than any I had seen elsewhere in Philadelphia. The site included highways and rail lines—ideal habitat for cynthia moths. Jason had picked the date—November 8—to maximize the likelihood of spotting any cocoons that might be present. By this date, most of the ailanthus leaflets have dropped, which would expose cocoons hanging from the main stems of the compound leaves. A few weeks later the stems and cocoons would have fallen to the ground, where they would have blended in with leaf litter. We spotted many curled up leaflets that resembled cocoons, but no cocoons.

Later Jason showed me cynthia moths in the collection in the Academy of Natural Sciences. He pulled out a glass-topped wooden drawer filled with rows of pinned specimens from the late nineteenth and early twentieth century. The drawer included specimens of the moths and their caterpillars, plus pinned specimens of their parasites. Today the last refuge of cynthia moths in Philadelphia is here, inside these museum drawers, at the same institution where in 1861 the moth, as the charismatic star of a scientific meeting, made its North American debut.

The disappearance of this moth paradoxically exemplifies increased biodiversity. As parasites and their alternate hosts populated downtown, the safe haven that protected the moth for a century in Philadelphia ended. The same forces that currently suppress outbreaks of bagworms contributed to the local extinction of the cynthia moth.