CHAPTER 16

Successful Suppression of the Birch Leafminer, *Fenusa pumila,* in the Northeastern United States

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NON-TECHNICAL SUMMARY

Historically, the uncontrolled international movement of plants allowed pests to enter the United States at a rapid rate. U.S. plant importations were first regulated by the 1912 Plant Quarantine Act, and since then, restrictions and inspections have slowed the accidental introduction of plant-feeding pests, even though some new introductions still happen. Among the pests that invaded the United States in the early 1900s was the birch leafminer, *Fenusa pumila* (Hymenoptera: Tenthredinidae). Established in Connecticut sometime before 1924, this pest spread from New England to Alaska, causing annual defoliation of white and gray birches in urban and forest landscapes for over 60 years before being brought under biological control in the 1980s.

In the 1970s, the birch leafminer was identified as a good candidate for classical biological control (as defined and described in Chapter 1), and specialized natural enemies that hold this pest in check in Europe were introduced into the United States by USDA scientists. Of these imported beneficial insects, *Lathrolestes nigricollis* (Hymenoptera: Ichneumonidae) proved most successful. It readily established and spread naturally through forests and urban landscapes, eventually lowering birch leafminer numbers across the region. By 2000, birch leafminer was reduced to a non-pest in at least the northeastern United States, eastern Canada, and Alberta. No harmful effects occurred from this introduction, and its benefits were more attractive birch trees in the landscape, reduced need for pesticides around homes, and healthier birches in the forest.

HISTORY OF INVASION AND NATURE OF PROBLEM

The Species Invasion

Fenusa pumila (Hymenoptera: Tenthredinidae) (**Fig. 1**), formerly called *Fenusa pusilla*, is distributed from Ireland through Siberia, China, and Japan (Digweed et al., 2009). It was first found in North America in

Van Driesche, R. G. and R. A. Casagrande. 2022. Successful suppression of the birch leafminer, *Fenusa pumila*, in the northeastern United States, pp. 173–178. *In:* Van Driesche, R. G., R. L. Winston, T. M. Perring, and V. M. Lopez (eds.). *Contributions of Classical Biological Control to the U.S. Food Security, Forestry, and Biodiversity.* FHAAST-2019-05. USDA Forest Service, Morgantown, West Virginia, USA. https://bugwoodcloud.org/resource/files/23194.pdf

Connecticut in the early 1920s, and by 1931 it was present throughout New England, as well as New York, New Jersey, and the Canadian province of New Brunswick (Friend, 1931). It now occurs from Newfoundland south to Maryland, and west to Alberta, the Great Lake States, and Iowa, with isolated populations in Oregon, Washington, British Columbia, and Alaska (Drooz, 1985; Snyder et al., 2007; Digweed et al., 2009).

In the northeastern United States, it most commonly attacks gray birch (*Betula populifolia*) and paper birch (*Betula papyrifera*). In Europe, the native silver birch (*Betula pendula*) is a key host. *Betula pendula* is also a host in North America where it has been introduced as an ornamental (Fuester et al., 1984), and this may have been how the leafminer reached North America.

Figure 1. Adult birch leafminer (*Fenusa pumila*). (Andrey Ponomarev, iNaturalist.org CC BY-NC 4.0)

NATURE OF THE PROBLEM

While the extensive damage caused by birch leafminer (**Fig. 2a**) has long been recognized, there are no specific studies of the consequences of its feeding on the health of birch trees. Birch leafminer does not kill trees, but its leaf-mining (akin to defoliation) destroys much of the photosynthetic tissue of the plant (**Fig. 2b**), especially on the new shoots which are the preferred oviposition site. Damage occurs early in the season (mid-May to mid-June in Massachusetts). In the northeastern United States, moderate to heavy mining of leaves of gray and white birch (**Fig. 2c**) occurred in many areas, year after year from the 1930s through at least the 1980s (Fuester et al., 1984). While not studied specifically for this leafminer, insect defoliation or leaf-mining can reduce tree growth, accelerate die-back, and reduce reproductive output (Rose, 1958; Kulman, 1971; Long, 1988; Muzika & Liebhold, 2001; Thalmann et al., 2003).

WHY CONTROL THIS INVASIVE SPECIES?

Compared to gypsy moth, *Lymantria dispar*, which can defoliate whole forests over hundreds of thousands of acres, birch leafminer is a relatively unimportant forest pest. Its damage, usually most intense along forest edges, is too limited to merit control in commercially managed forests. The leafminer's damage typically produces a general browning of birches in June (in Massachusetts) when the first generation of mining larvae mature and consume the foliage. The poor appearance of heavily mined trees along city streets, in private yards, and in commercial nurseries led to regular use of many pesticides for control of birch leafminer, including foliar applications (Schread, 1954; Nielsen and King, 1992), soil applications (Cheng and LeRoux, 1968, Scheer and Johnson, 1970), and tree injection (Marion et al., 1990). Biological control of this species was intended to reduce pesticide use and improve the appearance of white birch in the suburban landscape.

In addition to landscape uses, gray and white birch are important pioneer species that are among the first trees to establish in abandoned fields or forest openings. Also, in Pennsylvania and other coal-mining areas, gray birch often revegetates strip-mined areas, and it can be planted to speed up recovery of such sites (Anon., 1975; Davidson, 1977, 1979).

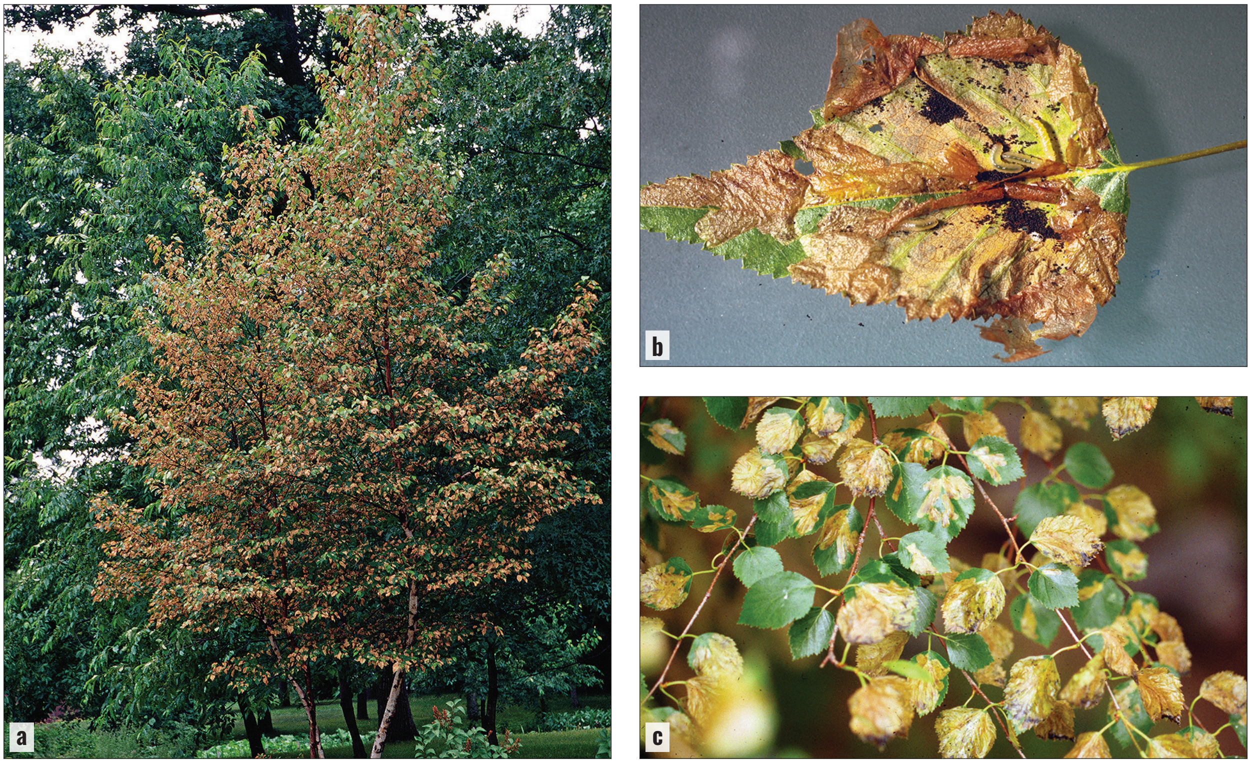

Figure 2. (a) Birch leafminer (*Fenusa pumila*) damage at the whole tree level; (b) heavily mined birch leaf with mature larvae exiting the leaf; (c) moderate to heavy damage to individual birch leaves. (a: Steven Katovich; b: E. Bradford Walker, Vermont Department of Forests, Parks and Recreation; c: Whitney Cranshaw, Colorado State University; a–c: Bugwood.org CC BY-NC 3.0 US)

THE ECOLOGY OF THE PROBLEM

Immature leafminers are found within leaves, and small larvae or lightly infested plants can escape detection by horticultural inspectors. The pupae are in the soil, which allows for easy movement of the pest if trees are shipped in other than a bare root condition. Movement of nursery stock was likely the route of invasion for *F. pumila* into North America, and indeed, all but one of the *Fenusa* species found in North America are invasive European species (Eichhorn and Pschorn-Walcher, 1973).

Populations of many leafminers are strongly suppressed by specialized natural enemies called parasitoids (e.g., Andersen et al., 2021). In small samples, such as plants with only a few leafminers, parasitoids may be present or absent, by chance. When such plants are moved overseas, leafminers, unrestrained by specialized parasitoids, may reach outbreak populations unless controlled by local natural enemies or the co-invasion of their own specialist enemies (Kirichenko et al., 2019). When the birch leafminer was accidentally introduced into North America, its native (European) parasitoids were left behind. While later surveys in North America found 15 species of local generalist parasitoids attacking *F. pumila* in Quebec, they collectively caused <10% mortality (Cheng and LeRoux, 1969). In Europe, 17 parasitoid species are found attacking *F. pumila*, but larval parasitism was much higher (38–47%). The most effective species causing most of the mortality were not present in North America (Eichhorn and Pschorn-Walcher, 1973; Digweed et al., 2009). In Europe, these more effective species not only caused high mortality, they also attacked few if any other leafminer species (Eichhorn and Pschorn-Walcher, 1973). Such specialized species are unlikely to harm populations of native leafminers in North America, where there is only one native *Fenusa* species, which attacks a rose (Smith and Eiseman, 2017).

The key steps needed to suppress *F. pumila* to much lower levels were to select the most promising parasitoids (based on their abundance and wide distribution in Europe), and then release them to determine if one or more were able to thrive under North American climatic conditions. Climates in North America differ from those of Europe in various ways because the Gulf Stream warms western Europe to much higher latitudes than in North America. This changes the relationship between photoperiod and temperature in ways that can be damaging to parasitoids adapted to European conditions.

PROJECT HISTORY THROUGH AGENT ESTABLISHMENT

Efforts to suppress the birch leafminer in eastern North America started in 1968, when the Canadian Forest Service requested the Commonwealth Institute of Biological Control (an international organization dedicated to biological control) to begin surveys in Europe for parasitoids of *F. pumila* (Eichhorn and Pschorn-Walcher, 1973). Those surveys took place in Switzerland, Germany, Austria, France, and Denmark. While many species of parasitoids were found attacking *F. pumila* in its native range, two wasps, *Lathrolestes nigricollis* (**Fig. 3**) and *Grypocentrus albipes* (both Hymenoptera: Ichneumonidae), were selected for introduction to North America because they caused high rates of mortality and were widely distributed in Europe (Eichhorn and Pschorn-Walcher, 1973). Host-ranges of these parasitoids were estimated from observations made in field surveys of various species of leafminers on birch or alder in Europe. Those field observations only recorded *G. albipes* from *F. pumila*, while *L. nigricollis* seemed also to only attack *F. pumila* or perhaps some other species of *Fenusa*.

Figure 3. *Lathrolestes nigricollis* on a mined leaf. (R.A. Casagrande, University of Rhode Island)

Releases of *L. nigricollis* and *G. albipes* in Canada were made in Newfoundland and Labrador (1973), then Quebec (1974–1978), and Alberta (1994–1996) (Digweed et al., 2009). Releases in the Mid-Atlantic U.S. states (especially Pennsylvania) were made in 1976–1982 (Fuester et al., 1984). *Lathrolestes nigricollis* was moved from Pennsylvania to Massachusetts and Rhode Island in 1979 (as adults) and then again (as parasitized larvae) in 1989–1990 (Van Driesche et al., 1997).

In Canada, *G. albipes* became established near Quebec City (Quednau, 1984) and in Alberta (Langor et al., 2000, 2002), but in general did not quickly increase in abundance (Quednau, 1984). Similarly, in the United States, *G. albipes* was rarely recovered (Fuester et al., 1984). In contrast, *L. nigricollis* established quickly at most locations and spread rapidly (Van Driesche et al., 1997; Digweed et al., 2009).

HOW WELL DID IT WORK

Following the release and rapid spread of *L. nigricollis* in New England and parts of Canada, the level of damage from *F. pumila* (as % leaves mined) declined dramatically. In the United States, intensive follow-up studies were done in Massachusetts (Van Driesche et al., 1997) and Rhode Island (Casagrande et al., 2009). At the release site in Amherst, Massachusetts, the percentage of leaves mined by *F. pumila* declined from 50–54% in 1979 (the year of the first release of *L. nigricollis*) to 1–3% in 1990–1995. Concurrently, parasitism rates at the release site increased from undetectable in 1979–1980 to 30–80% in 1990–1995 (Van Driesche et al., 1997). In Massachusetts in this same study, it was observed that by 1995, parasitism within

4 km (2.5 mi) of the original release site was 28% compared to only 14% at sites 15–20 km (9–12 mi) away, and this difference in parasitism rate was associated with an increase in damage from 6% near the release site to 33% at sites 15–20 km away. Within 4 km of the original release site, leaf-mining had been reduced to inconsequential levels by 1995 (Van Driesche et al., 1997). Similar events were also observed at a release site in Rhode Island, where the percentage of leaves mined fell from 87% in the 1990s to about 3% in 2004–2008, as parasitism by *L. nigricollis* rose from 6% in the 1990s to 38% in 2004 (Casagrande et al., 2009).

To learn if control had also occurred at a much larger scale over the northeastern United States, a survey was conducted in 2007 at 183 sites spread out over seven states (Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware). This survey found that birch leaf miner levels (as % of leaves mined in spring) had declined to barely detectable levels in five states (Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania) but was still at damaging levels in southern New Jersey (ca 50% leaves mined) despite high parasitism levels; this area was near the southern limit of white and gray birch (Casagrande et al., 2009).

These findings were further corroborated by work in Canada. In Alberta, the same two parasitoids (*L. nigricollis* and *G. albipes*) were released against *F. pumila* in 1994–1996 in Edmonton. Five years after the parasitoids' introduction, at a location where establishment of *L. nigricollis* had occurred, 78% of the larvae of the spring generation were parasitized (Langor et al., 2000). Later, surveys across Canada found that *F. pumila* was rare or absent at most locations visited (Digweed et al., 2009).

BENEFITS OF BIOLOGICAL CONTROL OF BIRCH LEAFMINER

Defoliation of gray and white birch in the northeastern United States is now uncommon, instead of being the norm. The benefits of this change include a general lack of any need for pesticide treatment of yard or street white birch for leafminer control. Also, white birch around homes, along streets, or trees used for landscaping at commercial sites now have increased aesthetic value because they no longer turn brown each spring. Forest stands of white and gray birch may have improved growth rates compared to years with defoliation because the stress of defoliation, which forced trees to grow a new set of leaves just a month after production of spring leaves, has been removed. This should lead to healthier trees being able to grow quicker and better perform their normal ecological functions in regional forests.

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