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# Can we save our horse chestnut trees?

Horse chestnut trees were planted in parks and village greens for their attractive shape and beautiful flowers. We noticed there was extensive early browning of the trees in our school grounds, which we found was caused by the horse-chestnut leaf-miner, *Cameraria ohridella* (see Catalyst Volume 25 issue 4, April 2015). Both the horse chestnut tree and the *Cameraria ohridella* moth are invasive species but we consider the moths to be pests because they harm the trees that we chose to plant.

We investigated several possibilities of control: natural predators (parasitoid wasp and blue tit); burning or burying fallen leaves in autumn to destroy the overwintering pupae; pheromone traps that attract and kill male moths. We also considered spraying and root/soil treatment with insecticide.

Most caterpillars eat the leaves from the outside. However leaf miner moth caterpillars live, tunnel and feed between the two layers of the leaf. There can easily be three generations of moths per year. Severely damaged leaves shrivel and turn brown in late summer and fall prematurely.

*Adult* Cameraria ohridella *moth*

## Food web

The horse chestnut leaf (producer) is consumed by the horse chestnut moth larvae (primary consumer), which in turn is predated by the blue tit (secondary consumer). Competing with the blue tits are a number of parasitoid wasps. A parasitoid is an animal that lives inside its host (like a parasite), but always kills its host (like a predator does, but unlike parasites). The parasitoid wasp has a long ovipositor which she uses to insert a single egg through the leaf cuticle into the larva of the moth. The wasp larva feeds within the moth larva, eventually killing it.

By counting the number of the leaf miners in a small section of the tree and then scaling up, we estimated that there were 250 000 – 500 000 leaf miners per tree in July.

**Key words**

invasive species

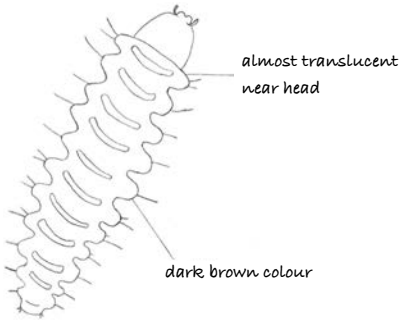
food web

insect control

parasitoid

*Progress of infestation (19th July and 2nd September respectively)*

Brown leaf mines were obvious in July and by early September there was substantial browning of the leaves. The leaf miners (caterpillars) are small, with an obvious mouth part and deep indented segments. Mining gives them some protection from natural enemies and the physical environment.




*Leaf-miner larvae are translucent and can be seen when a leaf is held against the light.*

## Natural control

We investigated the effectiveness of the different types of natural control of the leaf miner, starting with parasitic wasps. Infested leaves were stored in zip-lock bags for two weeks. The Conker Tree Website's insect identification chart was used to record what hatched (Catalyst April 2015).

We found 723 adult *Cameraria ohridella* moths. There were 171 wasps altogether indicating that 171 horse chestnut tree leaf miner larvae were killed by the larvae of the parasitic wasps, so there would have been a total 894 leaf miners on 16 leaves. The rate of parasitism by the wasps was only 19%.

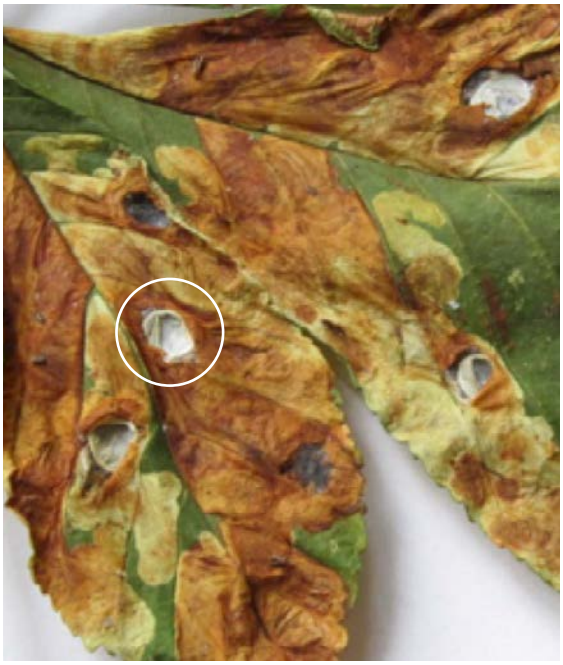
*LSU students examine leaves*

## Natural control by birds

Caterpillars are an important food source for blue tits, which feed them to their young. It's not clear how many leaf miner caterpillars are being eaten by the birds, but if they were to start eating a substantial number it would help the horse chestnut tree.

The majority of the accessible leaves did not have any V-shaped tears indicating bird attack. However a more secluded tree showed these tears (mean = 25; range = 0 – 57) for seven leaves in September.

It was difficult to estimate the contribution that birds were making to control of the numbers of leaf miners because we only looked at a small sample of leaves.



*V-shaped tear on a mine indicating predation by birds e.g. blue tit*

## Pheromone traps

The main component of the sex attractant (pheromone) released by the females has been identified as (E,Z)-8,10-tetradecadienal. We used pheromone traps to catch male moths. This reduces mating and therefore egg laying. We weighed the content of the trap and estimated that 30 000 moths had been captured over a period of two months (8 July - 9 September). This is about a tenth of the number we had estimated on each tree in July after the first generation.

## Removing leaf litter

Early in the season (July), we noticed that the browning of the leaves is more prominent at the base of the tree. This is consistent with the moths emerging from fallen leaves and spreading upwards to the lower leaves. We collected leaves from the base of the tree and estimated that there were 100 pupae per leaf.

In the spring there can easily be at least 100 fallen leaves near the tree, each containing 100 pupae. In this case potentially 10 000 moths could emerge and be waiting to infect the tree in early summer. If half of these are females we could expect 150 000 eggs. Furthermore, if we assume that all the eggs from the first generation survived and 150 000 moths hatched, and if half of these are female we would expect 2 250 000 eggs in the second generation.

In reality the number will be smaller because not all pupae, moths or eggs will survive. Nonetheless the number of potential moths is formidable bearing in mind that the calculation is based on just a hundred leaves. By removing the fallen leaves in autumn and early spring, the pupae of *Cameraria ohridella* hibernating in the leaf mines are also removed, and consequently the number of adults emerging in the following spring will be reduced.

*Sweeping up leaves*

## Red or white?

Unlike the common horse chestnut (*Aesculus hippocastanum*), the red-flowering hybrid (*Aesculus* × *carnea*) is very resistant. Leaves of the red flowered horse chestnut tree are glossier, tougher, more crinkled and darker green when compared to the white flowered tree. We cut equal sized strips from the leaves of the two types of trees and compared their masses. We avoided the thick mid vein and any areas with leaf mines. The mass of the red flowered horse chestnut trees was approximately twice that of the white flowered trees regardless of whether we looked at wet (0.35 *vs* 0.19 g/strip) or dry weight (0.14 *vs* 0.06 g/strip) indicating the leaves were thicker or denser.

*Leaf mines in leaves of red (left) and white flowered horse chestnut tree (right)*

In late summer red flowered trees that were near white flowered trees had short mines. Close examination showed that the caterpillars had died. The caterpillars seem unable to feed successfully on these leaves. It is possible that when the *Aesculus hippocastanum* trees have been decimated, the leaf miner moths may adapt to feed on the *Aesculus carnea*. The present leaf miner problem only became apparent in the 1980s and it is thought *Cameraria ohridella* switched host trees at that time.

## Discussion

Unfortunately neither the parasitoid wasps nor the blue tits are able to control the number of leaf miners or their effects on the tree. Without an efficient predator for horse chestnut leaf miner, the tree's future is in jeopardy.

Pheromone traps and insecticides may help, but treatment of 0.5 million trees in this way would be an unsustainable financial burden for the UK. The cost of one pheromone trap treatment per tree per year is about £20. The numbers of moths trapped indicate that this method alone is insufficient.

The control of the leaf miner with chemical products is very difficult since it lives inside the leaf mines during most of its life cycle. Spraying large trees with insecticides is not a viable option in urban areas. One effective chemical control measure is the injection of insecticide imidacloprid ('Admire') in the trunk or soil. However, the cost of systemic soil/root treatment is about £300 per tree per year. This may be more effective than the traps but is not without its problems not least the cost.

## A possible solution

Trees that were planted for their attractiveness are looking withered. The horse chestnut tree has had to contend with bleeding canker as well as leaf miner disease and so is at serious risk. Nurseries have stopped planting horse chestnut saplings. Replacement of horse chestnut trees with other trees will be very costly. We also have the possibility that *Cameraria ohridella* may switch host trees.

The UK could follow Berlin's example where it is considered every citizen's civic duty to participate in the clearing of every single horse chestnut tree leaf. Involving the community in this way may have many social benefits encouraging social interaction, interest and responsibility for the environment.


*A poster from Berlin – Save our chestnut trees, stop moths, gather leaves!*

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