Biology and Behavior of Codling Moth

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Management of Our Key Pest – Codling Moth

Developing a Realistic, Practical Plan to Control Codling Moth on Your Site.

Codling moth (CM), *Cydia pomonella* L., is the key pest of pome fruit in most areas where it is grown for commercial use. It is native to Asia but occurs in most areas of the world. In the Pacific Northwest CM can cause the loss of up to 80% of an apple and 50% of a pear crop if uncontrolled.

Hosts: Pome fruit (apple, pear, quince, asian pear, crab apple, and large fruited hawthorne) the primary host for CM. Smaller fruited crab polinizers are not acceptable hosts for CM. Other hosts include walnut and prune or plum. These latter hosts are as suitable, that is there is more natural mortality, as most pome fruit but high infestations can occur. Cherry is listed as a host in some literature but infestations only seem to occur if CM is forced to use them as a host and "natural" infestations do not occur.

Life Cycle: The CM spends the winter as a mature larva spun up in a cocoon that is located on protected areas on the tree (bark crevices or cracks), which is the preferred location (Fig. 1a), or at the base of the tree in ground litter. In modern high density apple orchards there are very few cocooning sites on trees because of the smooth bark. Pupae form in the cocoon spun by the mature larva.

The adult stage (moth; Fig. 1b) emerges from the pupal case and after a short period to harden the exoskeleton it flies into the tree. Most literature indicates that moth activity occurs in the upper third of the tree canopy. Adults are active at dusk for a couple hours with an average activity threshold of between 60-62°F (range of 55-65F). Mating usually occurs on the host. The female emerges with eggs already developed so she can lay eggs as soon as mating occurs. It is possible on warm evenings for a female moth to emerge, mate, and lay eggs in a two-day period. A CM moth can live over 20 days under ideal conditions but in the field it is likely they survive a much shorter time, especially in the heat of summer. A female moth can lay up to 100 eggs but the actual fecundity in the field is likely much less and most are laid in the first few days after emergence and mating.

Eggs are laid individually on the upper surface of the leaf, on twigs or on fruit. In the first generation eggs are laid only on leaves until about two weeks after fruit have set when the fuzziness of the fruit wares off. In the second generation about 65% of the eggs are laid on leaves but these are usually very close to a fruit. Eggs are creamy white when first laid, have a red-ring mid-way though development and when near hatch the black head capsule can be seen (Fig. 1c-e).

A newly hatched larva wander until they locate a fruit. It chews through the skin and feeds on the apple flesh beneath the skin for a few days (Fig. 1g). In the process of chewing through the skin and feeding beneath the larvae pushes frass out the entry area (Fig. 1g). There is often a red ring surrounding the entry, especially in young fruit (Fig. h). After the larva molts to the next stage it bores toward the core where it will feed on seeds until mature (Fig. 1f). When nearly mature the larva will make a tunnel from the

core to the exterior of the apple and will plug the hole with frass (excrement) and silk (Fig. 1g). When ready to spin a cocoon the larva leaves the fruit, wondering across the tree or dropping to the ground on a silk thread, and finds a protected location.

Life History in Washington: There are two complete generations in Washington and a partial third generation in some of the warmer areas most years. Flight activity begins in mid-April to early May. The 30-year average in Wenatchee for the beginning of activity is April 28. This activity usually coincides with full bloom of Red Delicious. The second generation activity begins in late June or early July and the proportion of larvae that complete the second generation prior to mid-August will emerge as moths of the third generation (Fig. 2). In Wenatchee the 30-year degree day accumulation average suggests 15% of the second generation would emerge as a third generation. The third generation is a suicidal event since none of the larvae entering the fruit will mature enough to survive winter.

Codling moth behavior: Male CM have been recovered several miles from sources of release and it is generally known that males will travel further than females. Information on female CM behavior is more limited but in general they seem only to move about 100 yards. Most of female moths will move much less distance than this, probably only 20 to 30 yards, especially if there is fruit available (Fig. 3a). However, if moths emerge from a site that is highly infested (bin pile or abandoned orchard – Fig. 3b) and there is an open field between the source and the nearest orchard, then the females will fly much further to the nearest orchard edge. In this scenario it is likely that females arriving from distant sources would be mated and ready to lay eggs. Moths tend to be in higher densities at orchard edges and at tops of slopes or in high places in the orchard. This is especially true in orchards using mating disruption and is accentuated because pheromone concentrations are lower in these areas relative to the rest of the orchard.

Population biology: There is a high potential for a CM population to increase in an apple orchard. Increases from one generation to another of between 10 and 20 times without controls being applied has been observed. For example, in an orchard that had only 0.2% injury at harvest in year-one could have 2 to 4% fruit injury after the first generation in year-two and by harvest could have 20 to 30% fruit injury. There are several natural controls identified for CM but none would be expected to provide adequate commercial suppression of CM populations. Cold and wet weather are known to increase mortality of CM eggs and young larvae. Very cold winter temperatures will reduce overwintering CM populations. In nature one of the most important regulator of CM populations is the bi-annual bearing nature of host trees. In order to maintain the CM population in the orchard at the same level suppression of each generation must be 95% or more.

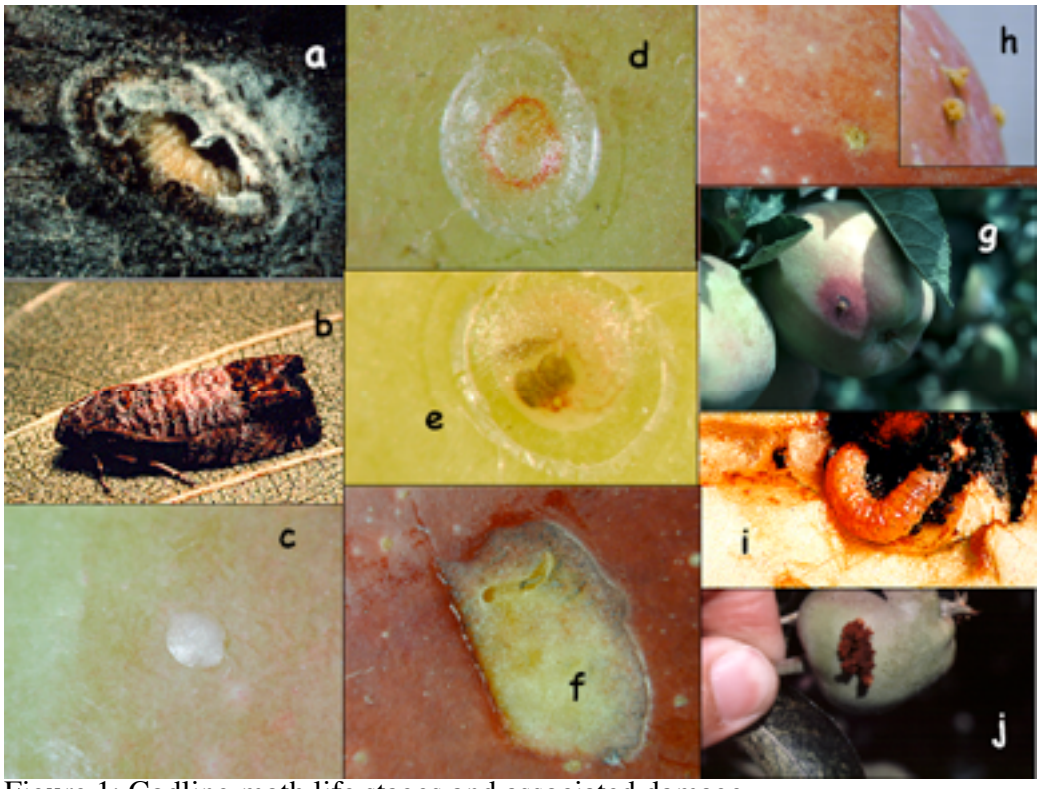

Figure 1: Codling moth life stages and associated damage.

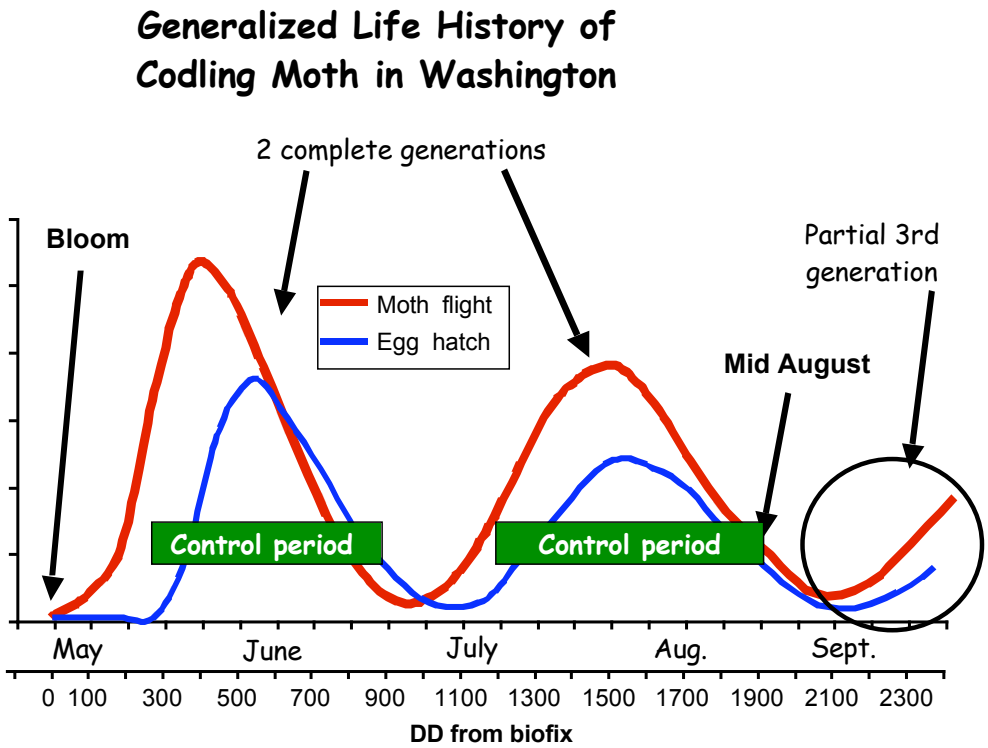

Figure 2: Codling moth life history as described by degree-day model

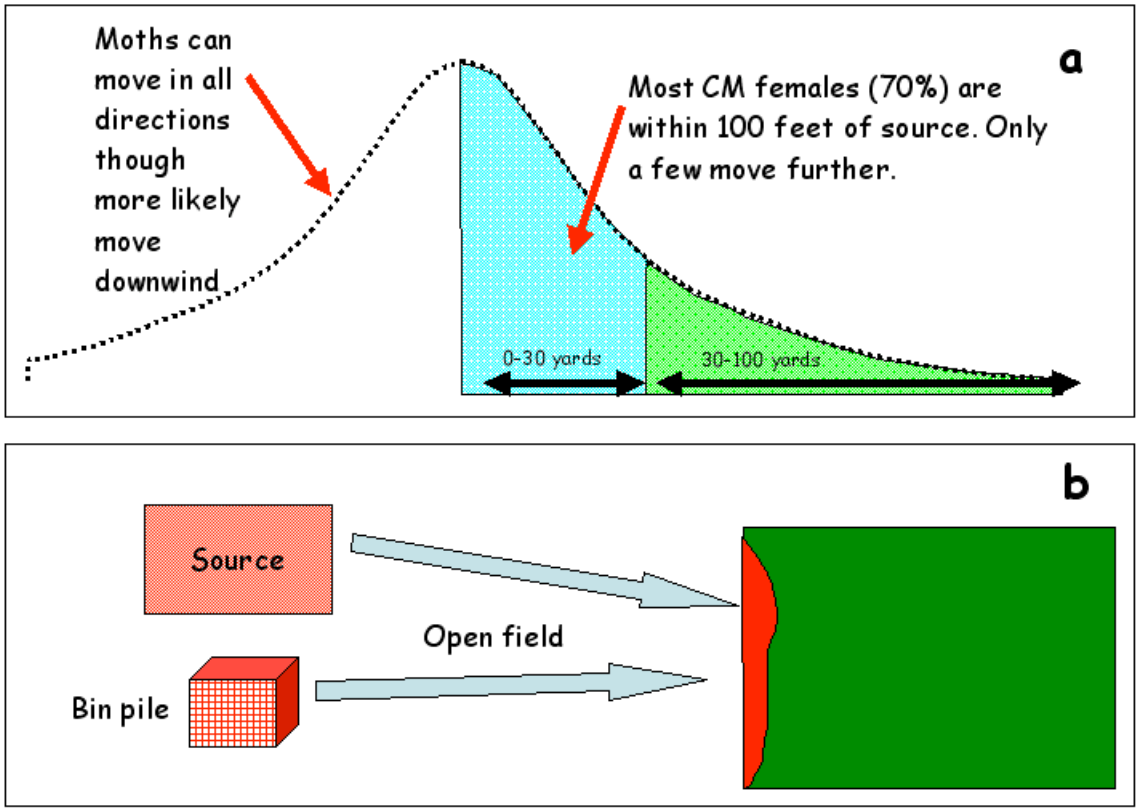

Figure 3: Potential impact of an external codling moth source.