Biological Control

Seasonal Phenology of Leafroller Parasitoids and the Role of Alternate Hosts in Biological Control of Leafrollers in Apples

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In 1992, *Colpoclypeus florus* Walker was discovered parasitizing >80% of the leafroller *P. pyrusana* Kearfott (Lepidoptera: Tortricidae) in unsprayed apple orchards in a small area of central Washington. *P. pyrusana* and the obliquebanded leafroller *Choristoneura rosaceana* (OBLR) (both Lepidoptera: Tortricidae) are the two major leafroller pests of apples in Washington. *C. florus* is a gregarious ectoparasitic eulophid which is widely distributed in Europe where it is the most common parasitoid of tortricid leafrollers in orchards. *C. florus* was isolated to a small area in the Mid-Columbia and Wenatchee valleys until 1997-98 when, most likely as the result of releases conducted from 1994-96, it was documented to have established in several regions in eastern Washington.

Parasitoid Phenology in Apple Orchards

The observed phenology of *C. florus* parasitizing *P. pyrusana* in Washington is similar to that observed in Europe, where parasitism of the overwintering leafroller generation in late spring is extremely low or undetectable and parasitism of the summer generation ranges from 60-95%. In Washington, *C. florus* may go through 6-8 generations per year depending on temperature and host availability. However, suitable leafrollers are only available within orchards from late April to late May and again from mid-July through early August. During the periods between leafroller generations and for the 2 months after leafrollers pupate in August there have been no suitable hosts discovered within orchard systems. Although parasitism of leafrollers in the spring is low or undetectable, *C. florus* enters orchards near the end of the spring generation. After entering the orchard, *C. florus* appears to be active there through the fall. Parasitism of sentinel leafrollers in 1998 was high at all locations where *P. pyrusana* is the dominant leafroller, although parasitism did decline dramatically for a short time during late July and early August when there was a record heat wave with temperatures as high as 41°C (Fig 1). Parasitism of sentinel leafrollers in orchards during the fall when no suitable hosts are available may remain high (approaching 100%) into early October and active females have been observed as late as 10/20.

The Role of Non-orchard Habitats

It is probable that *C. florus* may survive the period between the spring and summer generations, however *C. florus* diapauses as mature larvae adjacent to a leafroller host therefore they must find suitable hosts during the early fall when no suitable leafrollers are available within orchard systems. Surveys were begun in 1996 to identify alternate hosts of *C. florus* in orchard and native habitats. When the search for alternate hosts began, there were no leafrollers known to occur in a suitable stage in the mid-September to early October period when *C. florus* enters diapause. In 1997, the first larvae supporting diapausing *C. florus* was discovered in the Squilchuck Creek valley near Wenatchee, WA, feeding on red-osier dogwood in riparian areas and has tentatively been identified as *Clepsis* sp. (possibly *viriscana)* (Lepidoptera: Tortricidae). In 1998, another tortricid *(Ancylis* sp., possibly *comptana)* which supports overwintering *C. florus* was discovered feeding on rose in the Squilchuck valley and adjacent to orchards at Orondo. While the *Clepsis* sp. is apparently rare, the *Ancylis* sp. is extremely abundant in the few locations where it has been found. In intensive sampling for alternate hosts in many habitats

throughout the apple producing region of central Washington only 2 locations have been located where there has been relatively high parasitism of leafrollers during the spring. In both cases, *C. florus* was attacking OBLR in rose at one of the locations where it has been documented entering diapause.

Due to the absence of hosts in and near the orchards in the fall, it appears that *C. florus* populations may go locally extinct each year and must recolonize each spring from overwintering sites outside the orchard. *C. florus* emerging in the spring parasitize leafrollers in non-orchard habitats near their overwintering sites and appear to move into orchards heavily during their 2nd generation. Proximity of the orchard to an overwintering site does appear to be important, as the Orondo orchard has had the highest parasitism by *C. florus* during the spring. Unfortunately, most orchards are not adjacent to these few sites and it is likely that *C. florus* must immigrate a significant distance from outside the orchard each spring. Some *C. florus* probably do survive in the orchard until the summer leafroller generation without access to hosts although parasitism of *Ancylis* sp. in rose has been observed during this period of host paucity within the orchard. In the fall both *Clepsis* sp. and *Ancylis* sp. diapause as large larvae. However, *Clepsis* sp. appears to be rare and is unlikely to contribute significantly to overwintering *C. florus* populations. *Ancylis* sp. is a smaller leafroller and is too small to support *C. florus* until mid to late September, well after adult *C. florus* would have emerged from summer leafrollers. At this time, *C. florus* populations in non-orchard habitats may be small as parasitism of *Ancylis* sp. has averaged 6% (although *Ancylis* density in infested patches of rose is high, much higher than leafrollers in apple orchards).

Potential for Improved Leafroller Biological Control

Leafrollers parasitized from mid-September into October will result in diapausing *C. florus*. Continued activity of *C. florus* in orchards in the fall suggests that *C. florus* females remain in orchards in spite of the lack of suitable hosts on which to overwinter. It is possible that *C. florus* must immigrate relatively long distances from overwintering sites into orchards each year. Separation of overwintering *C. florus* and orchards may be the critical factor preventing *C. florus* from having an impact on the overwintering leafroller generation within the orchard in the spring. Because *C. florus* must emigrate into orchards from possibly distant overwintering sites, manipulation of populations of leafrollers providing overwintering hosts for *C. florus* may improve biological control of leafrollers in orchards by improving levels of spring parasitism.

Figure 1. Parasitism of sentinel leafrollers in apple orchards and OBLR at two *C. florus* overwintering site.