Summary of Utah CLB Biocontrol Efforts

Surveys of cereal leaf beetles (CLB) and efforts to establish parasitoids in Utah were led by Jay B. Karren (Utah State University Extension and Department of Biology) from 1984 (the year in which the CLB first appeared in the state) through 2004. Donald W. Davis (USU Department of Biology) worked with Jay from 1984-1990 on efforts to introduce parasitoids of CLB to Utah. The CLB parasitoid work has been continued from 2005 on by Edward W. Evans (USU Department of Biology). The State of Utah Department of Agriculture and Food now conducts yearly censuses for CLB in counties throughout the state.

The first discovery of CLB in Utah was in Morgan County in June, 1984. In the first few years thereafter, the state responded to CLB infestations with a massive county-wide spray program with Malathion applied 2-3 times in a growing season on a cost-share basis. Although the spraying appeared to be very effective in reducing CLB numbers, the beetle nonetheless spread over the next decade to also infest Box Elder, Cache, Rich, Weber, Summit, Davis, Salt Lake, Utah, Juab, Sanpete, Wasatch and Uintah Counties. By 2006, it had been detected in Tooele, Sevier, and Carbon counties as well. As of 2008, consistently heaviest infestations occur in Cache County, and to a lesser degree in Box Elder and Weber Counties, although scattered instances of heavy CLB damage have occurred at times in other counties as well.

The larval parasitoid *Tetrastichus julis* was introduced to Morgan County in 1985, following the discovery of CLB. Individuals of this parasitoid were obtained from APHIS (collected in New Jersey and Virginia), as were individuals of the egg parasitoid
*Anaphes flavipes* as well as a few individuals of *Diasparsis* sp. (these latter two parasitoids species were also released in 1985 in Morgan County). In 1986-1990, *T. julis* was repeatedly recovered from CLB near the release site, but not very far away. No *A. flavipes* were ever recovered. A second field insectary for *T. julis* was established in Kaysville (Davis County) with two releases in 1992. A third field insectary was established in Richmond (Cache County) in 1993.

In 1996, Jay Karren and field assistants surveyed 165 grain fields throughout the state (28 counties) for both CLB and parasitoids. Nineteen samples of CLB larvae from grain fields in Cache, Davis, Morgan, Utah, Wasatch and Weber Counties with suspected parasitism were shipped to Niles, Michigan, for evaluation of establishment of *T. julis*. The parasitoid was confirmed to be present in all but Davis County. Periodic sampling of CLB larvae at the two insectaries in Richmond and Kaysville consistently revealed rates of parasitism by *T. julis* of 50-70%. To increase genetic diversity of *T. julis* at these insectary sites, nine new releases were made. As large shipments of parasitoids were received from Niles (APHIS), additional grain fields in Cache County were used as release sites. In total in 1996 in Cache County, 800 adult specimens of *T. julis* and *Diaparsis* sp. (never recovered) were released.

Sampling of grain fields throughout Utah continued in subsequent years, and parasitized CLB larvae were introduced to grain fields of cooperating growers to further the spread of *T. julis*. In 2000, 353 sites among the 361,000 acres of grain planted throughout the state were surveyed for CLB and parasitoids by Jay Karren and field assistants. Most sites surveyed in Cache, Box Elder and Weber Counties now had established populations of *T. julis* (the only CLB parasitoid to establish in Utah).
Infestations of CLB were judged to be either decreasing in severity at individual sites and/or in the number of sites in Davis, Wasatch, Utah, Unita, Tooele, Sevier, San Pete, Rich, Morgan, and Juab counties.

Repeated weekly sampling (May-July) of multiple fields throughout Cache County was initiated in 2000 to determine the phenology and abundance of CLB and T. julis. This effort was expanded in 2001 to also include Box Elder and Weber counties. A total of 147 fields was monitored weekly on farms of 58 cooperating growers in 2001. This effort resulted in identification of individual fields with high rates of parasitism. This in turn enabled USU to redistribute approximately 28,000 CLB larvae (with rates of parasitism by T. julis of 40% or more) within grain fields in Cache County, or to other counties in Utah (Sevier and Weber) and other states (Idaho, Oregon and Washington). Releases in previous years of the egg parasitoid A. flavipes in Cache County were successful only in release fields (with no spread beyond) and only during release years (with no carry-over to the next year). A new release of 396 adults of A. flavipes from Missouri was made in mid-June 2001 in College Ward, Cache County, but this release also failed to result in establishment and no adults of this parasitoid were recovered at the release site in 2002.

The weekly sampling program for CLB and parasitoids continued in 2002, and an additional 16,000 parasitized CLB larvae were harvested in Cache County and redistributed within the county or to Box Elder, Davis, Utah, and Weber Counties, and to Oregon. In addition, fields were identified in Weber, Davis and Cache Counties in which adults of T. julis had established on their own, without human assistance. In 2003, nearly 80,000 parasitized CLB larvae were redistributed within Cache County or in Utah County,
or to Colorado and Oregon (75,000 larvae were sent to APHIS in Ontario, Oregon). Additional releases of nearly 38,000 eggs of CLB parasitized by *A. flavipes* or emerging adults of this parasitoid (obtained from APHIS in Niles, Michigan) were made in eight fields in Cache County, but again these releases did not result in establishment. More releases of the egg parasitoid in Utah have not been made since 2003. In 2005, rearing efforts for additional releases of *A. flavipes* in other western states were shifted from APHIS at Niles, Michigan, to the Colorado Department of Agriculture at Palisade, CO. To support egg parasitoid rearing efforts, USU shipped CLB adults (5,000 in both 2005 and 2006, 12,000 in 2007, 5,000 in 2008) collected from grain fields in Cache County to the insectary at Palisade.

The larval parasitoid *T. julis* is the only biocontrol agent so far established in Utah against CLB. The weekly sampling program of grain fields in Cache and adjacent counties initiated in 2000 and continuing to the present has provided a clear picture of the phenologies of CLB and *T. julis* in northern Utah, and of the interaction between the parasitoid and its host. Larvae of CLB first appear in May, with peak infestation typically occurring in early to mid June. Parasitism by overwintering females of *T. julis* is highest among earliest developing beetle larvae. Thereafter, rates of parasitism fall to low levels (5-10% or less) by the latter half of June, when heat accumulation has reached 280-350 degree-days (based on a minimum threshold of 8.9 °C). With the emergence of second generation parasitoids, rates of parasitism rise to levels widely approaching 100% among the relatively few late-developing CLB larvae in individual fields. Clear and consistent differences over the years have not been apparent among different crops of small grains (barley, wheat, or oats) either in the phenology and intensity of beetle
infestation, or in the rate of parasitism of beetle larvae. This reflects in part the variation among growers in when crops in individual fields are planted. Overall, surveys indicate that the parasitoid has become well-established and appears to be continuing to increase in its impact on CLB in northern Utah despite a relatively hostile environment of crop management, wherein most fields are plowed and disked annually (see also Evans, E.W., Karren, J.B., and Israelson, C.E. 2006. Journal of Economic Entomology 99: 1967-1973).