10.4 Biological Control of Olive Fruit Fly in California – Release, Establishment and Impact of _Psyttalia lounsburyi_ and _Psyttalia humilis_

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The olive fruit fly, *Bactrocera oleae* (Rossi) (Diptera: Tephritidae), likely originated in sub-Saharan Africa, where the wild olive *Olea europaea cuspidata* L. (Wall. ex G. Don) is found and from which the domesticated olive *O. europaea europaea* L. was derived. Following the path of olive cultivation, *B. oleae* has invaded central and northern Africa, the Mediterranean basin, south-central Asia, and recently California and northwestern Mexico (Nardi et al., 2010). In California, *B. oleae* has spread to all commercial olive growing regions since first being detected in 1998. Researchers have long sought more sustainable management programs for this pest, often by using indigenous natural enemies. In the Mediterranean basin, most indigenous parasitoids found attacking *B. oleae* are generalist ectoparasitoids.

The lack of effective biological control agents attacking *B. oleae* in California led to the initiation of a classical biological control program in 2003. Parasitoids that were imported and evaluated in the University of California, Berkeley quarantine included *Bracon celer* Szépligeti, *Psyttalia humilis* Silvestri, *Psyttalia lounsburyi* (Silvestri), *Psyttalia ponerophaga* (Silvestri), and *Utetes africanus* (Silvestri) (Hymenoptera: Braconidae) (Daane et al., 2015). These parasitoids were reared from *B. oleae* collected from wild olives in Kenya, South Africa, Pakistan, or Namibia (summarized in Daane et al., 2011, 2015; Hoelmer et al., 2011). Also evaluated were the fruit fly parasitoids *Fopius arisanus* (Sonan), *Diachasmimorpha kraussii* Viereck, and *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae), each obtained from colonies in Hawaii. *P. humilis* and *P. lounsburyi* have been approved for field release in California (Daane et al., 2015). *Psyttalia ponerophaga* is still under quarantine review. Here, we report on the field release and recovery efforts for *P. lounsburyi* and *P. humilis* (mainly a Namibian strain) in California that were conducted from 2006 to 2013.

*Psyttalia lounsburyi* and *P. humilis* were supplied by the USDA-ARS European Biological Control Laboratory (EBCL) in Montferrier-sur-Lez, France (2008, 2009, and 2013), the Israel Cohen Institute of Biological Control (ICIBC) in Bet Dagan, Israel (2009–

Parasitoid releases were conducted in five California coastal counties where the summer and winter temperatures are relatively mild. Releases were also made in three inland counties where the summer temperatures are relatively warm (Napa) or hot (Butte and Yolo counties). The release sites were either clusters of ornamental trees, organic commercial olive groves, or abandoned olive groves. Typically, the trees were Manzanillo or Mission cultivars, but some sites had a mixture of cultivars. None of the release sites received insecticides, and the coastal sites were often heavily infested by *B. oleae*, making them ideal habitats for field colonization and establishment of introduced parasitoids.

Pre- and post-release samples were made at all sites. Post-release fruit samples were primarily taken in the spring and fall, when olive fruit fly densities were highest, and began 1–4 weeks after a release, depending on the availability of olives. On each sample date, olive fruit were randomly picked from trees within the release-vicinity, depending on the number of available trees and fruit at each site, resulting in fruit collections that ranged from 102–2,020 fruit per site per sample date. The collected fruit were placed in organdy covered containers, with a raised metal grid on the bottom to facilitate pre-pupal flies dropping from the fruit to be collected and reared to either adult flies or parasitoids.

From 2006 to 2013, we released a total of 40,967 female *P. humilis* and 24,402 female *P. lounsburyi* were released at both coastal and inland sites. Across all sample dates and sites, parasitism by *P. humilis* ranged from 0–25%. Recoveries of *P. humilis* were made immediately following a release date; however, *P. humilis* did not appear to successfully overwinter, and the longest period between a release and recovery date was 193 days. Parasitism by *P. lounsburyi* has ranged from 0-60% per collection. More importantly, recoveries of *P. lounsburyi* were made more than three years after the last release at some sites. Moreover, recoveries of *P. lounsburyi* have been made more than 50 km from any release site.

The field-establishment of imported biological control agents is a major step in a classical biological control program. Releases of North African populations of *P. concolor* have been numerous in Europe; however, these efforts led to *P. concolor* establishment in only southern Italy (Raspi and Loni, 1994) and southern Spain (Miranda et al., 2008). Here, we provide results from the release of sub-Saharan African populations of *P. lounsburyi* and *P. humilis*. We showed recoveries and field dispersal of both *P. humilis* and *P. lounsburyi* within the same fruit season following their releases, and the long-term establishment of *P. lounsburyi*. Many factors could have affected the California establishment of *P. humilis* and *P. lounsburyi*. Foremost was the limited number of parasitoids available to release. In California, maintaining large *B. oleae* colonies throughout the season has been difficult. For this reason, the parasitoids were reared on *C. capitata* in artificial diet, which precluded mass-rearing these parasitoid species in California, where *C. capitata* is a quarantined pest. Tolerance to extreme climatic conditions could be a key attribute influencing the establishment of introduced olive fruit fly parasitoids in California. While both introduced parasitoids were recovered within the same season as the field release, only *P. lounsburyi* appears to have survived the winter. Previous laboratory studies suggest that *P. lounsburyi* is a better match with *B. oleae*
regarding thermal performance (Daane et al., 2012; Wang et al., 2012, 2013). Field overwintering survival of both parasitoids was low in California’s interior valley, where the summer temperatures are higher and winter temperatures are colder than in coastal olive growing regions, and our results suggest that *P. lounsburyi* survival was higher than *P. humilis* survival due to temperature tolerance (Wang et al., 2013). Continued biological control efforts, therefore, must consider not only parasitoid efficacy based on laboratory trials with an abundance of host material, but on the parasitoid species inherent abilities to survive both climatic extremes as well as periods with low host densities.

References


