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2011 International Activities Team:
Goldspotted oak borer and forest health surveys in southern Mexico
(Year 2 of proposed two year project)

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Abstract

The main objective of this trip was to obtain additional populations of *Agrilus coxalis* from southern Mexico for genetic analyses and conduct surveys for associated natural enemies. Less than a week was spent in mid-April 2011 sampling for *A. coxalis* populations in Chiapas, Mexico. Populations of *A. coxalis* were discovered in nine recently cut oak stumps in Teopisca. A total of 208 specimens were collected for genetic analyses aimed at determining the origin of California's invasive population. The straw itch mite, *Pyemotes tritici* LaGrèze-Fossat & Montagné, was found infesting adults, pupae, and larvae of *A. coxalis* in the cut stumps. This is the first record of any mite preying on *A. coxalis* in southern Mexico. The initial parasitism rate of *P. tritici* on *A. coxalis* populations was determined at 11%.

Introduction

The goldspotted oak borer (GSOB), *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae), continues to kill coast live oak, *Quercus agrifloia* Née and California black oak, *Q. kelloggii* Newb., in San Diego County, California (Coleman et al. 2011). Since 2002, tree mortality has been continuous and is spreading from southern parts of San Diego County. The goldspotted oak borer is exotic to California and represents a new threat to native oak woodlands (Coleman and Seybold 2008). *Agrilus auroguttatus* is native to southeastern Arizona and southern Baja California Sur, Mexico with a similar congener, *A. coxalis*, native to southern Mexico and Guatemala (Hesphenheide and Bellamy 2009, Hesphenheide et al. 2011)

Tree mortality in California spans all land ownerships and is impacting land management objectives. Insecticide treatments are currently being developed for high-value oaks, but are limited in scale, costly, and are at best short term control options. Biological control is being considered as an option for reducing GSOB associated tree mortality that can provide long term and widespread control.

Although the two *Agrilus* spp. were once synonymized based on morphology, recent genetic work suggests that the two GSOB populations from California, Arizona, and southern Mexico are distinct species (CA/AZ: *A. auroguttatus*; MX: *A. coxalis*) (Coleman et al. *in review*). Initial IAT surveys for *A. coxalis* conducted in 2010 in Chiapas and Oaxaca in southern Mexico contributed to this work and laid the foundation for these genetic comparisons. Despite the separate speciation of the two species, an "extraordinary" parasitoid guild may be desirable for controlling *A. auroguttatus* in California and could be comprised of natural enemies from the

Arizona and Mexico *Agrilus* populations. This approach would develop a diverse natural enemy complex for GSOB in California. No parasitoids were discovered in 2010 in Chiapas and Oaxaca, Mexico with *A. coxalis* populations.

Methods

In 2010, 12 *Quercus peduncularis* were girdled in an oak-dominated woodland south of Teopisca, Chiapas where *A. coxalis* populations were previously active. The 12 trees were split into two equal groups each spanning approximately 1/10 acre. Trees were girdled at the root collar on 3 April 2010. Girdling removed the bark, phloem, and outer xylem in an approximate 3″ band around the tree.

The girdled oaks were revisited on 19 April 2011 and inspected for symptoms of *A. coxalis* injury, including D-shaped exit holes, bark staining, and crown thinning. The bark was removed from the lower portion of the bole on the north and south sides to inspect for *A. coxalis* life stages and larval feeding galleries.

Additional tree felling of *Q. peduncularis* had occurred in the area since the 2010 visit. Eleven cut stumps in very close proximity to girdled trees were inspected for injury symptoms and life stages of *A. coxalis* during the same period as the girdled tree sampling. If *A. coxalis* life stages were present or larval feeding was encountered, the bark was collected from the stump and returned to the field laboratory in San Cristobal de las Casas, Chiapas.

Bark sampled from stumps was cut and shaved into smaller pieces (<1″) to look for *A. coxalis* life stages. All life stages were noted, extracted, and preserved in 95% ethanol for genetic analyses. Presence of other arthropods was also noted and collected if believed of significance.

Results

Agrilus coxalis injury and populations were not observed or sampled from the girdled trees. No evidence of any wood boring injury was evident on these trees. All eleven trees were flushing new foliage and had not died from the girdling event.

Eight recently cut stumps were positive for active *A. coxalis* populations (Fig. 1.A-B). Three of the stumps possessed minor feeding from *A. coxalis* larvae, but active populations were not seen in the phloem. A total of 208 specimens of *A. coxalis* were sampled from the eight stumps. Sixty-one adults, 70 pupae, and 77 larvae were collected from the phloem of cut stumps (Fig. 1.C-F). Adults were observed quiescent in the bark, seen chewing out of the bark, or newly emerged in sampling containers. Three stumps sprouted from the root collar following the tree felling.

The straw itch mite, *Pyemotes tritici* LaGrèze-Fossat & Montagné (Acarina: Pyemotidae), was the only natural enemy observed parasitizing *A. coxalis* life stages collected from cut stumps. An initial infestation rate of 11% was determined from collected samples (10 infested larvae, 8 infested pupae, and 5 infested adults). The majority of the mites were identified on *A. coxalis* specimens by the presence of the gravid females (Fig. 2.A-E), but males were also collected and used for identification (John Moser, personal communication). Hundreds of males and thousands of females were recovered in the samples. These have been preserved in 95% ethanol for DNA analyses and comparison with other populations of *P. tritici*.

Conclusion

The 2011 surveys to southern Mexico were very beneficial for furthering our understanding about *A. coxalis* biology and life history information. In Teopisca, the life cycle of *A. coxalis* was accelerated from what has been recorded for GSOB (*A. auroguttatus*) in southern California. Adult emergence was beginning to occur in Chiapas in April 2011, whereas adult emergence does not begin until late May in San Diego County (Coleman and Seybold 2010). This same trend was seen previously in Chiapas where mature larvae, pupae, and an adult were collected during 28 March to 10 April 2010.

These observations represent the first report of *A. coxalis* infesting recently cut stumps. The stumps were likely cut mid-summer 2010 during the adult flight period. Larval feeding was prolific on the bark surface from beneath the root collar to several inches below the cut margin. Feeding was likely limited in this zone due to the desiccated phloem.

Girdled oaks, or "trap trees," in the same vicinity were unsuccessful for luring populations of *A. coxalis*. The girdling did not kill the trees and likely was not a good point source of volatiles to attract infestations of *A. coxalis*, or was not a suitable host for larval development because trees were still too healthy. The close proximity of the recently cut stumps probably produced a substantial amount of volatiles to mask the girdled trees and reduced attractiveness to *A. coxalis* infestation. These observations of *A. coxalis* attacking recently cut stumps have spawned new directions for GSOB surveys in southeastern Arizona where cut stumps are being used as trap trees and compared to girdled trees to investigate whether or not *A. auroguttatus* behaves similarly to *A. coxalis* with respect to preferences for stumps vs. girdled oaks.

Pyomotes tritici is considered a "tramp" species that has a wide host range, but commonly parasitizes insects associated with stored grain (Hoschele and Tanigoshi 1993; Moser 1975; Oliveria et al. 2003). The mite can also cause severe dermatitis in humans (Rosen et al. 2002). The species is commonly associated with humans and considered a cosmopolitan species, but it is also found in dry regions such as Magdalena, Sonora, Mexico, which is in close proximity to native populations of GSOB in southeastern Arizona. This same species is likely present on GSOB populations in southeastern Arizona.

Pyomotes tritici has been considered for biological control of *Dendroctonus*, *Ips*, and *Scolytu*s spp. bark beetles (Coleoptera: Scolytidae), red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), and Mediterranean flour moth, *Anagasta kuehniella* Zeller (Lepidoptera: Pyralidae) (Hoschele and Tanigoshi 1993; Moser 1975; Williams et al. 2003). The mite was considered a promising candidate for biological control due to its high reproductive potential, wide host range, unusual life cycle, and availability (Hoschele and Tanigoshi 1993). Because *P. tritici* is infesting all life stages, it is believed that the species is not phoretic on the adults (Moser 1975). The discovery of *Pyemotes tritici* on *A. coxalis* represents the first known report for this wood borer species.

The numerous *A. coxalis* specimens collected will contribute to defining the origin of California's exotic population, provide a comparison of genotypes from other areas collected in 2010 in Chiapas, and determine the variance among cut stumps at a single site. These Mexico surveys have also provided insight to new directions of work for GSOB in California and Arizona.

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Additional work

This work supported by IAT has been presented at two nation meetings (North American Forest Insect Work Conference 2011 and Entomological Society of America 2010) and numerous regional meetings. Two manuscripts have also incorporated data from these two trips.

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impacts from the goldspotted oak borer, *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae), in introduced and native oak woodlands. Targeted Journal: Forest Ecology and Mangement.

Figure 1. Oak stumps of *Quercus peduncularis* sampled for *Agrilus coxalis* populations in Chiapas, Mexico. A stump sampled by Mark Hoddle for *A. coxalis* populations (A) and a cut stump showing signs of larval injury from *A. coxalis* (B). Adults of *A. coxalis* (C, D), mature larva (E), and pupae (F) recovered from the cut stumps.

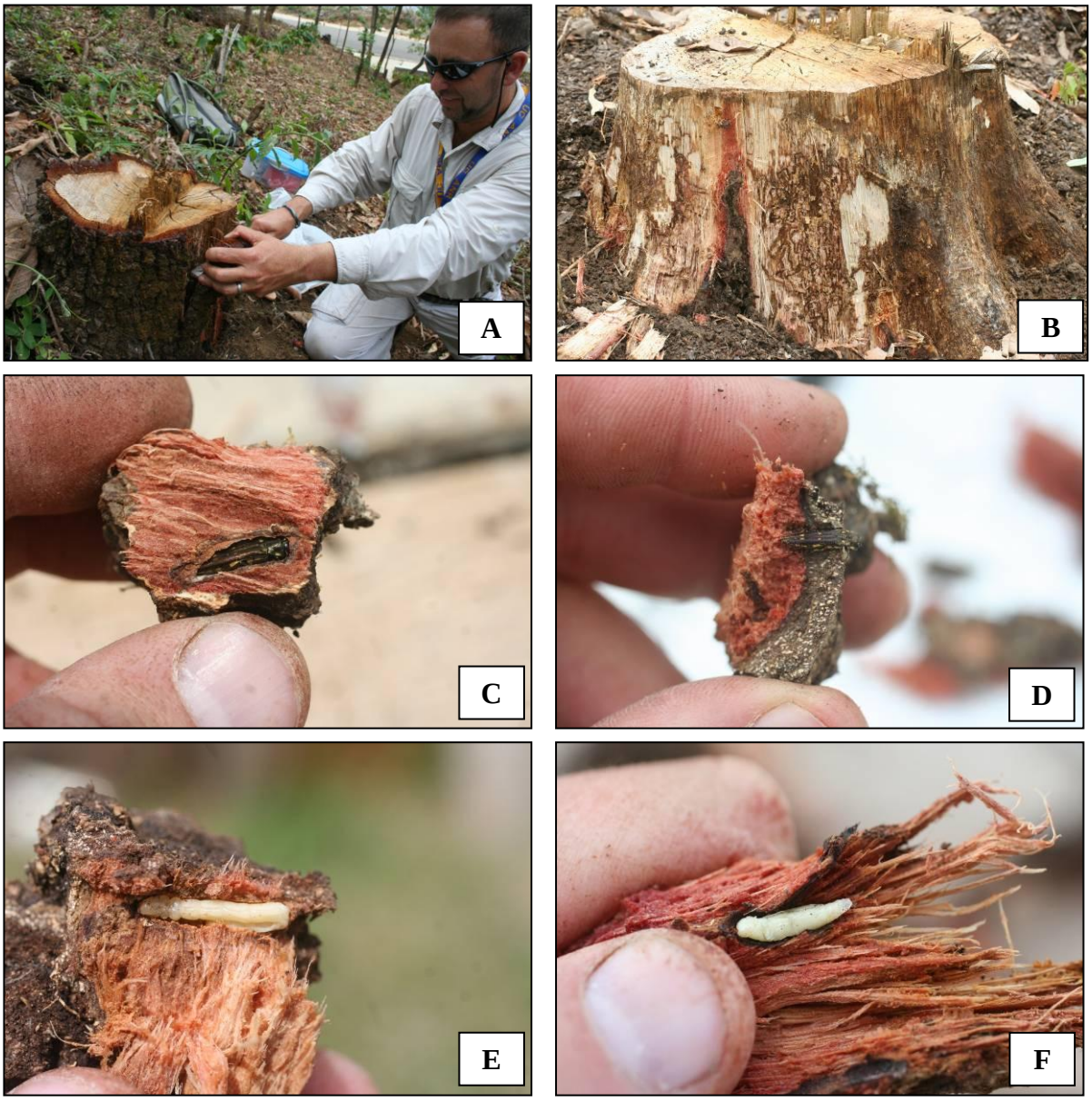

Figure 2. Infested *Agrilus coxalis* sampled from stumps of *Quercus peduncularis* south of Teopisca, Chiapas, Mexico. Gravid females of *Pyemotes tritici* discovered on a mature larva (A), seen infesting larvae in the phloem (B), and *P. tritici* females on a pupa (C), underneath the elytra of an adult (D), and on an adult (E).