Bagrada Bug News

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Walking Behavior of Food-Deprived Bagrada Bug

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In the Central Coast, growers of cruciferous crops usually have problems with bagrada bug starting in late July, and problems can extend into late November. Usually, bagrada bug populations build up on common cruciferous weeds such as shortpod mustard and perennial pepperweed in the general landscape surrounding the agricultural fields.

We hypothesize that bagrada bug move from those infested weeds and invade newly planted crucifer crops when quality of the weeds deteriorate (see photo next page) likely due to water stress or summer heat. At this time bagrada bug are susceptible to food deprivation and starvation.

We conducted experiments to determine if the degree of starvation has an effect on bagrada bug walking movement using mobility tracking software. Nymphal stages (younger nymphs: 2^{nd}-3^{rd} and older nymphs: 4^{th}-5^{th} instars) and adults (females and males) were starved in the laboratory for up to three days. In general, all bagrada bug life stages travelled farther and faster when starved in the laboratory.

In the field, walking pattern of starved bugs was not consistent with laboratory results because the bugs were exposed to varied environmental conditions, especially temperatures. It appears that only starved bugs moved farther as temperatures increased. Walking behavior of non-starved bugs did not appear to change with increase in field temperatures.

If weed quality declines in late summer or early fall, bagrada bugs are likely to travel longer distances for food.

We also examined if starved bugs oriented more strongly to food than non-starved bugs. We used broccoli crowns as food and provided a choice between food and nothing. It appears that both females and males chose broccoli over nothing

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Dead, dry weeds cause bagrada bugs to seek other food sources, such as brassica crops.

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when they were starved. Non-starved adults did not show preference for either broccoli or nothing.

This study suggests that bagrada bugs are likely to leave the weeds when their quality deteriorates. In the Central Coast, quality of the weeds in the agricultural landscape depends on sustained but intermittent winter rain events or how quickly weeds senesce in the heat of summers. These weeds have fairly deep root systems which can help them to stay alive beyond mid-summer. If the infested weeds dry early, it is likely that bagrada bug will appear early in the agricultural fields. Also, based on the data, if the weed quality is declining during the warmer time of the year (as in late summer or early fall), bagrada bugs are likely to travel longer distances.

Report from Abroad: Preliminary Results on the Geographic Origin of Bagrada

By Marie Claude Bon, René F.H. Sforza, and Lincoln Smith

USDA-ARS European Biological Control Laboratory

Marie Claude Bon (European Biological Control Laboratory, EBCL) has analyzed DNA from a variety of bagrada bug (*Bagrada hilaris*) specimens with the goal of determining the region of origin of the pest. Such information helps direct where to search for prospective biological control agents. A genetic "barcode" (a short sequence from a standard genetic locus of mitochondrial DNA, named *CO1* and commonly used for species identification) was sequenced to determine the relatedness of various populations of bagrada bug. We analyzed specimens from bagrada bug colonies provided by Darcy Reed, Brian Hogg, and Charlie Pickett that originated from Riverside, Coachella Valley, Davis, Gustine, and Monterey, CA, as well as specimens collected by Centre for Agriculture and Biosciences International (CABI) cooperators in Pakistan and by René Sforza (EBCL) in Morocco and South Africa. We compared these barcode sequences with those obtained from public databases such as the *BOLD* DNA Barcode Reference Library and the *GenBank* sequence database provided by the National Center for Biotechnology Information (NCBI), which included barcodes from Pakistan, Kenya, and Mexico.

It appears that all bagrada bugs in USA belong to one haplotype.

All the bagrada bug specimens from the USA share the same barcode sequence (haplotype). A similar pattern was observed with nine additional genes sequenced by Blake Bextine's group at University of Texas. Thus it appears that all bagrada bugs in USA belong to one haplotype. This haplotype is most closely related to one of the most prevalent haplotypes recovered from Pakistan (see figure). Specimens

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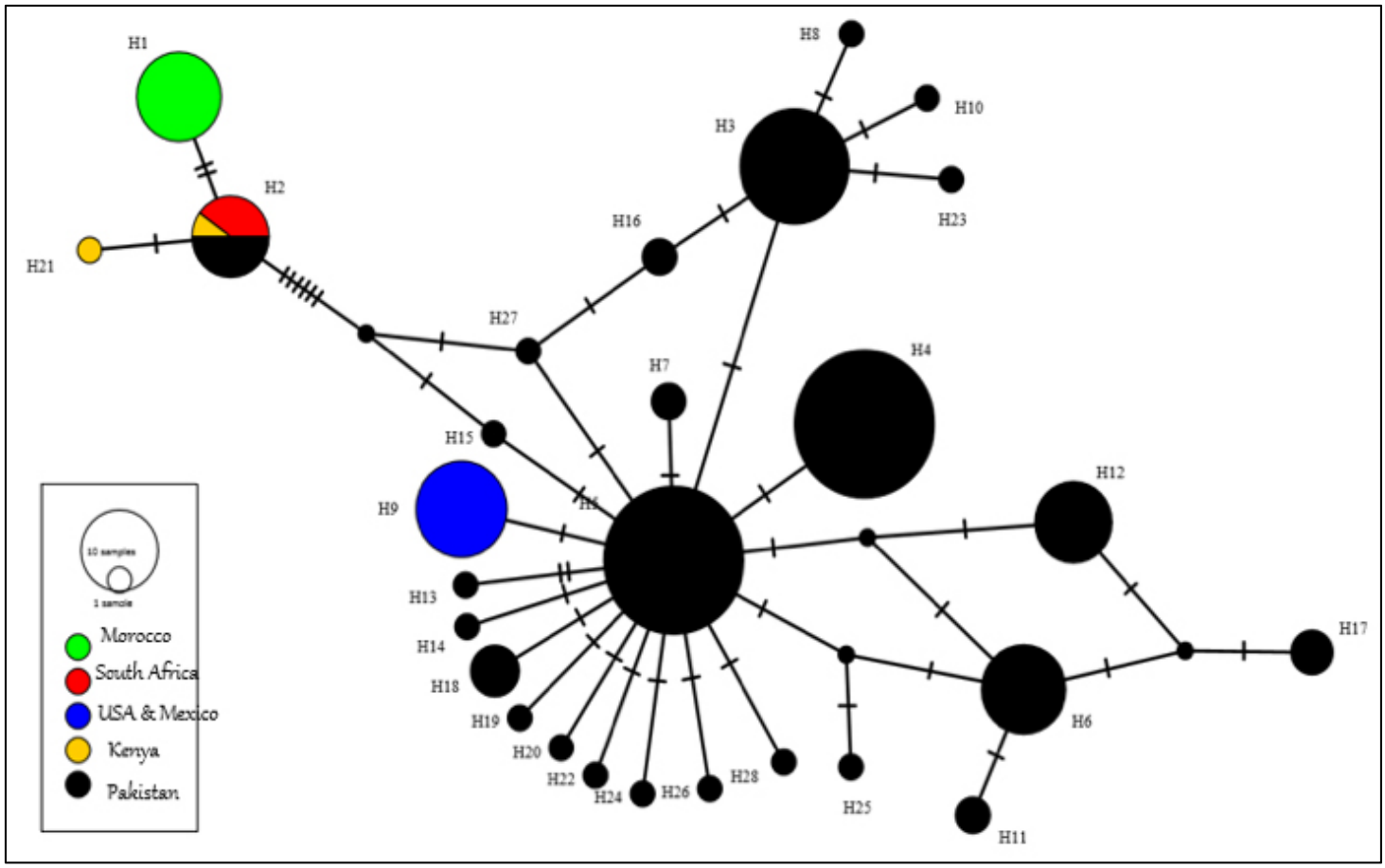

Evolutionary network depicting genetic relatedness among barcode haplotypes recovered from *Bagrada hilaris*. Each circle represents a different haplotype, the color corresponds to country, the diameter is proportional to abundance, and the cross hatches indicate the number of mutations (nucleotide changes) between haplotypes.

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from Kenya, South Africa, and Morocco are more distantly related to the USA specimens.

The present results suggest that the invasive populations in the USA originated from one population in the Pakistan region. We have yet not examined Indian samples, which might be similar to those from neighboring Pakistan. In any case, Pakistan appears to have a high genetic diversity, which further suggests that this would be a likely region for finding prospective biological control agents. The two species of parasitoids collected from Pakistan this year, *Trissolcus hyalinipennis* and *Gryon sp.*, should be prime candidates for host specificity testing.

California Bagrada Bug Scouting Report

By C.H. Pickett[1], B.N. Hogg[2], and K. Stokes[2]

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Work began in summer and fall 2016 to survey natural enemies of bagrada bug that may already be present in California. The major focus of our work was to develop a sentinel egg "trap" to identify parasitoids attacking bagrada bug eggs. Traps consisted of killed (frozen) bagrada bug eggs glued to waterproof index cards, which were placed on the ground, where bagrada bug lays most of its eggs, in organic cole crop fields and patches of known weedy hosts of bagrada bug (primarily shortpod mustard and perennial pepperweed).

From late July to October 2016, researchers at USDA-ARS and California Department of Food and Agriculture placed sentinel egg traps at a total of 18 sites in northern

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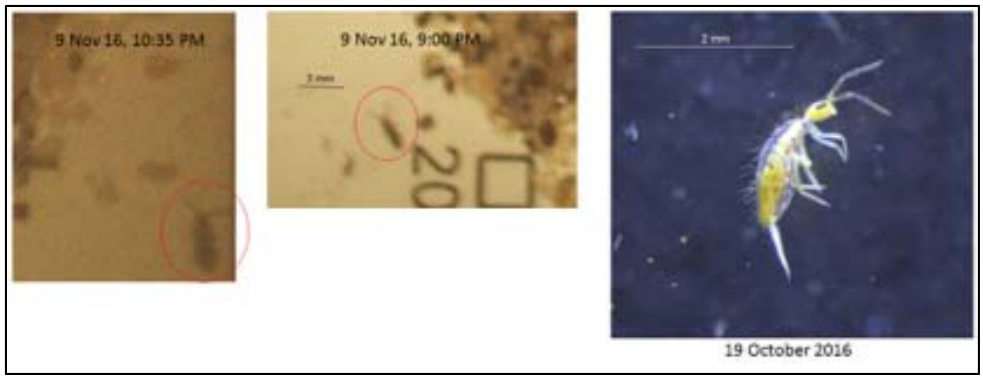

Soil Born Farms, Collembola in sentinel traps. Images to left from field camera, and to right collected species imaged through microscope.

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California in these counties: Monterey, San Benito, Fresno, Merced, San Joaquin, Marin, Sonoma, Contra Costa, Yolo, and Sacramento. Bagrada bug numbers were generally low in 2016; only eight of our sites (six cole crop fields and two weed patches) had significant bagrada bug populations.

We found four sites with high numbers of bagrada bugs in the Sacramento region where cole crops were being grown. Two were operated by Soil Born Farms, a non-profit educational organic production operation, and two sites managed by Terra Firma farms in Yolo and Solano counties, also organic production. Brown marmorated stink bug (BMSB) (*Halyomorpha halys*) pheromone-baited AgBio traps were set up to provide some baseline information on the relative size of the bagrada bug population. We know from having used this trap throughout California for monitoring BMSB that it also readily attracts bagrada bug.

We also sampled for bagrada bug by sweeping strips of alyssum at the two Terra Firma farms. They interplant alyssum strips with their cole crops for aphid control. This non-crop plant appears to be highly preferred by bagrada bug.

Sentinel bagrada bug eggs were readily fed on by predators. A time-lapse field camera was tested at one site for identification of predators that could be feeding on the sentinel eggs, although problems with fogging of the camera lens precluded its use at multiple sites. The organisms most commonly observed near sentinel egg cards were springtails (Collembola: most likely Isotomidae). See above image.

The creatures enclosed with a red circle in this image are probably Collembola (an order previously in Insecta).

Many species of Collembola are scavengers, but some are known to feed on other Collembola. In general there is very little known about these animals. Ants were also observed at several sites and are likely to prey on bagrada bug eggs.

Our traps sat just on top of the soil, however, and bagrada bugs lay the majority of their eggs just below the soil surface, where many predators may not find them.

Although we found no parasitism of sentinel bagrada bug eggs, no conclusions regarding findings can be made until season-long monitoring has taken place at multiple locations.

Update on Bagrada Bug Populations in Non-Crop Areas of the Salinas Valley

By Ian Grettenberger[1], Larry Godfrey[1], and Shimat V. Joseph[2]

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Here in the Salinas Valley, we have reached the end of our approximately two-year effort tracking bagrada bug populations in non-crop habitat. Countable populations have neared (or stayed at) zero at most of our sampling sites on the last sampling date the last week of November 2016. It is a good time to summarize what we have seen this year and how it compares to last year. Our assessments of bagrada bugs on weeds matches up with what we have heard in the Valley about populations in crops.

As a reminder, we have been following bagrada bug popula-tions at sites located in non-crop areas. These sites contained key cruciferous weeds, which were

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primarily shortpod mustard or perennial pepperweed, with some containing perennial wall-rocket. The sites we added at the inception of this study were chosen based on a previous history of bagrada bug infestations in nearby fields. The additional sites we added this year were chosen based on our knowledge that bagrada bugs had been on the weeds or simply based on habitat (i.e., great-looking weeds).

At the sites we have monitored for two years, populations were definitely lower than last year. We did still find bagrada bugs and saw populations tick up at some of the sites. However, these spikes were lower than last year. This seemed to be especially true for the nymphs. At our pepperweed sites that were monitored for two years (three sites), we found bagrada bugs both years, even if populations were a bit lower in 2016 than 2015.

Our two-year shortpod mustard sites were a bit different. A few of the sites had bagrada bug populations develop, although they didn't reach the size of populations in 2015. Notably, we did not find any bagrada bugs at a large number of these sites. This included sites that had fairly high populations of adults and/or nymphs in 2015. Shortpod mustard plants were present and looked healthy, but the insects were not.

We cannot compare populations in 2016 to those last year at the sites that were first scouted in 2016, although we do see some interesting trends when we look at the overall data for our study. Consistent with the general distribution of the weeds in the Valley, most of the sites were dominated by shortpod mustard versus pepperweed. None of the sites reached population levels that we saw at the two-year sites in 2015, although we did find decent populations at some of them.

Interestingly, while adult populations were not that much lower overall this year compared to last year (at new and old sites), nymph populations were much lower across sites both on shortpod mustard and pepperweed. A number of the shortpod mustard sites had very high spikes in populations of nymphs in 2015 (30-140 nymphs per plant), but our site with the most nymphs in 2016 (a new site) only had a maximum of 40 per plant. This suggests that either reproduction or mortality for nymphs was different between years. However, we don't have any evidence for what drove this pattern.

The complete lack of bagrada bugs (and damage on weeds) at some of the sites also shows how variable populations can be. The variation in bagrada bug populations between years could result from abiotic (temperature, precipitation) or biotic (weed hosts, predators) factors.

It remains to be seen what will happen with populations next year in both non-crop areas and in fields. It doesn't seem like we have high populations of bagrada bugs going into the winter. However, we will have to wait until the temperatures start to rise in late spring and early summer before we start to get a handle on what populations will look like in 2017. 

About the Bagrada Bug News

Numerous agencies are cooperating in the effort to discover effective organic management and biocontrol of bagrada bug. Please refer any questions about this newsletter to editor Jane Sooby, jsooby@ccof.org. Design by Sarah Watters, CCOF.