Psyllid Field Studies from the Pacific Northwest to the Home of Smokey Bear

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Since the arrival of zebra chip (ZC; caused by a bacterium that is vectored by potato psyllid) in the Northwest in 2011, psyllids in general have become more interesting. Psyllids (a.k.a. jumping plant lice) are small insects related to aphids (a.k.a. plant lice). Most psyllids are much less and ¼" long. Psyllid immature stages include the egg and 5 nymphal stages; nymphs are flattened and resemble scale insects or whitefly nymphs. For a representative psyllid size reference, see Figure 1.

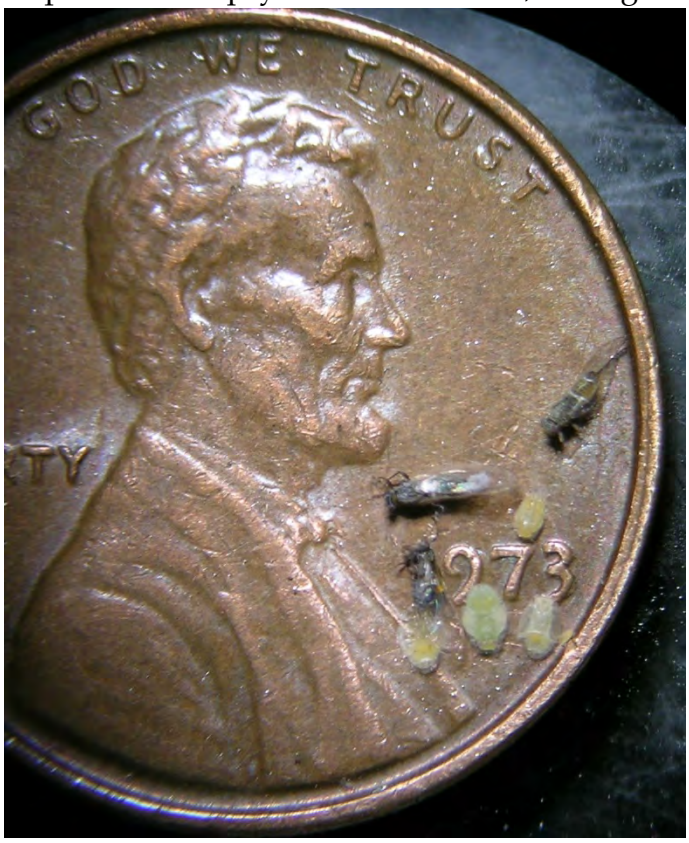

Figure 1. Potato psyllid adults and nymphs on a penny for size reference.

During the past three seasons, much yellow sticky card trapping has been undertaken in potato fields across the region. From these traps it is clear that many species of psyllids inhabit our states. Partly in response to questions about what those non-potato psyllid species were, and partly in response to my own curiosity, I started collecting psyllids in all sorts of habitats and from many host plants. My hobby is aphid collecting, identification (& naming of new species, i.e. taxonomy), and field natural history (I call myself 'taxonomist and natural historian'), so it was easy to add

psyllids to my target list. When beginning my field work on psyllids, I had a few main objectives:

- Learn about common psyllids in agricultural areas;
- Collect fresh material of as many psyllid species as possible and document which species found;
- Learn about psyllid field biology and patterns of adaptation;
- See what unexpected finds emerge.

The Tools

My insect collecting tools are very simple; the basic technique is a beating sheet method using a piece of thin plywood instead of a beating sheet. Of course I also keep an eye out on plants as I walk by, often spotting aphids and psyllids on the plants before sampling using my board and stick. See Figure 2 for my collecting tools.

Figure 2. Psyllid collecting tools.

When I find a plant of interest, the plywood is slipped under or into the foliage, which is then struck vigorously several times with the stick. Small insects are dislodged

onto the board for observation and collection. Psyllids are usually very cooperative in being collected, despite being able to jump and fly readily. Normally after being shaken onto the board, psyllids will stand quietly for several seconds at least, during which time I can recognize them from among the other insects. A psyllid is then collected by inverting the board and moving an open vial or jar up to it, then jostling the psyllid with the rim of the vial or jar. The psyllid will then cooperatively jump into the container.

Once at home and preserved in ethanol for several weeks, all my specimens are put through a chemical treatment process called 'clearing' that removes the internal fluids and soft tissues. Following this, the specimens are preserved permanently in Canada balsam on microscope slides (Figure 3).

Figure 3. Potato psyllids preserved on a microscope slide.

Many Places Visited

For recreation and leisure time we do a lot of travel and camping in the western U.S. and Canada. Everywhere I go I collect aphids and psyllids. To address the questions listed above for my psyllid natural history work, I collected in many places. Figure 4 shows some of the locations, marked with yellow pins, that I collected psyllids since 2011. Figure 5 shows many more places all over the West.

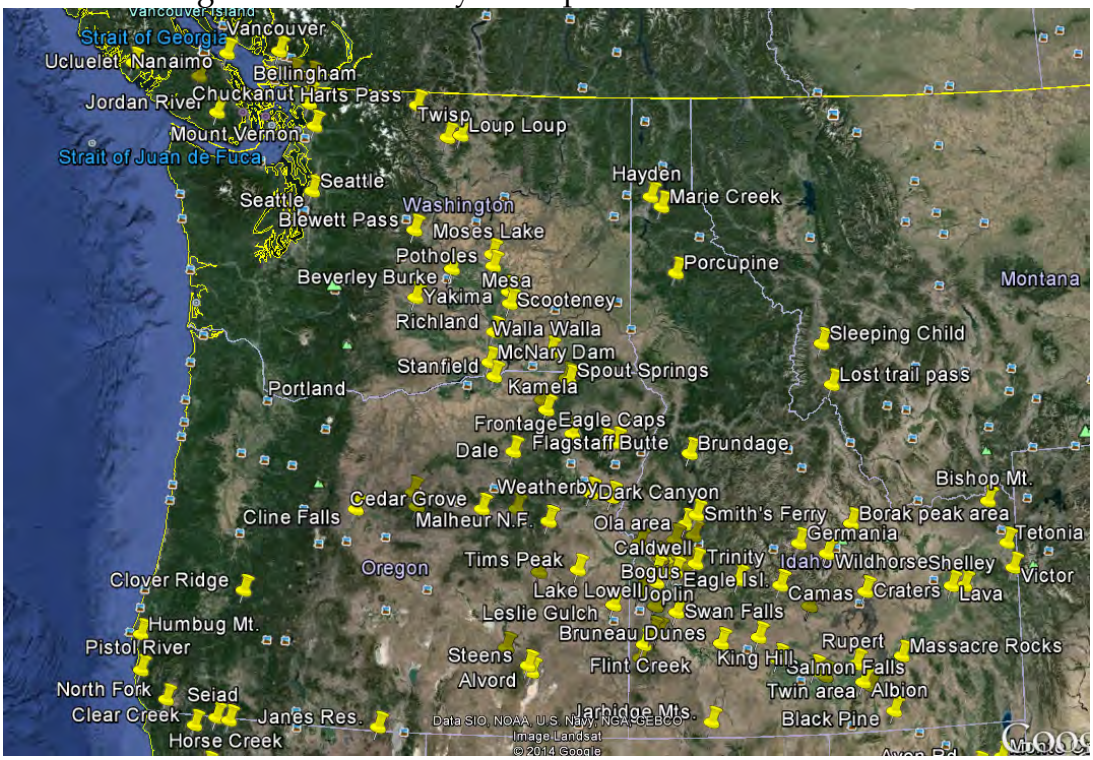

Figure 4. Some locations in the Northwest where psyllids were collected since 2011.

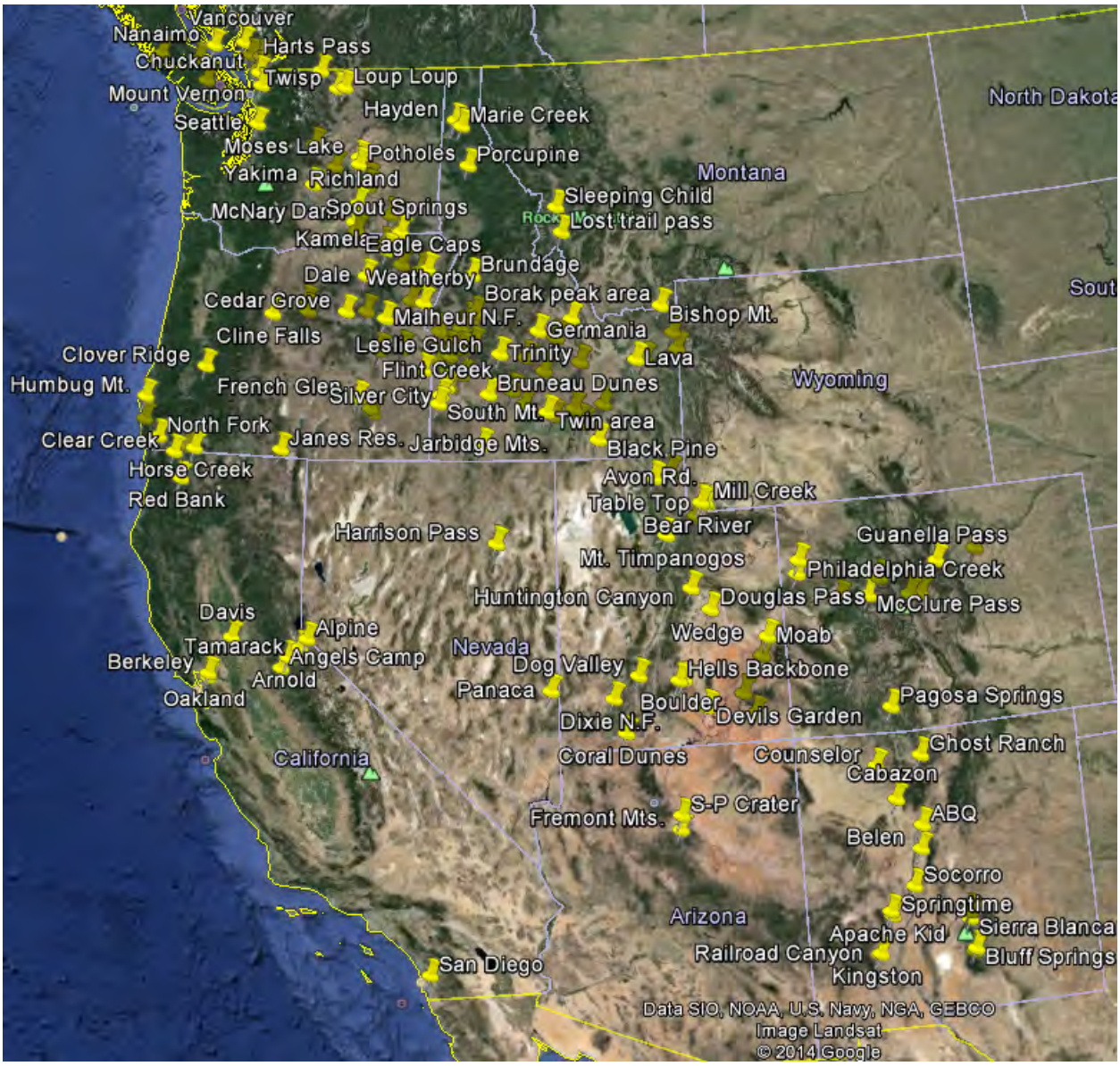

Figure 5. Many of the sites where psyllids were collected since 2011 all over the West.

After collecting psyllids in so many habitats, from ocean beaches to mountain tops, I have seen many species. Psyllids come in a wide range of shapes, sizes, and colors. See Figure 6 for just a few examples. Some of the common plants I have collected psyllids from include, willows (*Salix* spp.), bindweed (*Convolvulus arvensis*), golden currant (*Ribes aureum*), alder (*Alnus* spp.), sagebrush (*Artemisia* spp.), hawthorn (*Crataegus* spp.), and a weed much like lambsquarters in the genus *Atriplex*. It is critical to realize that the psyllids living on such plants are extremely host-specific. The vast majority of psyllid species can reproduce on only one or a few species of plants.

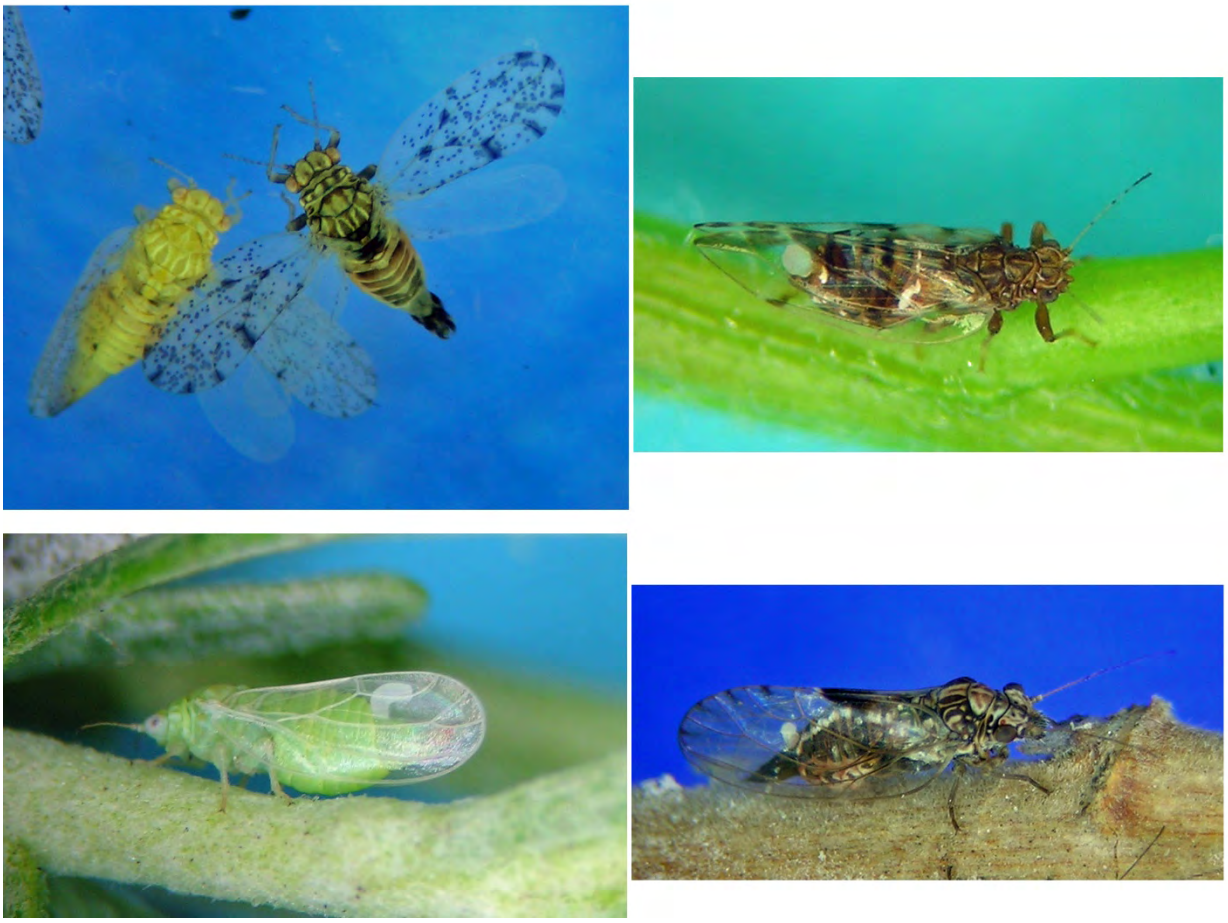

Figure 6. Four species of native psyllids, showing some of the variety of the group.

Results: Information about Commonly Trapped Psyllids in Potatoes

One the original goals of my psyllid natural history work was to learn more about the biology and source of a few common psyllids on our yellow sticky traps in the Northwest. We have known for many years that psyllids matching the description of the specimens shown in Figure 7 are common on our sticky traps. Much collecting in the field, and some tips from colleagues about identification, led to the following conclusions:

- There are a few species at least in Northwest agricultural areas that look more or less like the reddish-orange psyllid in Figure 7. These species feed on plants in the family Polygonaceae, mostly plants generally known as 'dock' (*Rumex*). They belong to the genus *Aphalara*. In addition to our agricultural areas, I have seen several species of *Aphalara* psyllids from ocean coast to the highest mountain habitats.

Figure 7. Two commonly caught psyllids.

- The psyllid on the bottom of Figure 7, which is sometimes caught by the hundreds per trap in and near potato fields, turns out to feed on plants in the genus *Atriplex* in our region. These plants are very similar to lambsquarters (Figure 8). I have tentatively identified this as *Heterotrioza chenopodii*, a species apparently accidentally introduced from Europe. However, my inexperience with psyllids brings me pause as to the correct identification of this species.

Figure 8. *Atriplex* herb from Eagle Island, Idaho.

Results: A Story from the Homeland of Smokey Bear

Every September our travels take us to the Southwest, driving through Utah or Nevada to Arizona and New Mexico. As usual, I collect aphids and psyllids at every stop along the highway, and at every overnight camping location. In 2013 I made the first collections of what became an interesting story about potato psyllid. The first find was on rabbitbrush (*Chrysothamnus* sp.) in the Dixie National Forest in southwestern Utah. At the time of this collection I did not recognize the psyllids I collected as potato psyllid, but simply collected them as a matter of course in my normal work with the aphids on this shrub. A few days later we were in Arizona, on the northern slopes of the San Francisco Mountains north of Flagstaff. Rabbitbrush was present but not common in this area. I sampled from it as usual. In two separate places I found several adult potato psyllids per rabbitbrush plant. This was in the last week of September. The psyllids were apparently using rabbitbrush as a 'shelter plant' (a term used for plants that psyllid adults rest on while not reproducing, and on which the nymphs cannot develop). These finds puzzled me because there is no agriculture within many miles of this area.

The story became much clearer in 2014. We spent a few nights in Alamogordo, New Mexico in late September, and I spent a few days collecting in the mountains east of town in the Lincoln National Forest (incidentally, this is the mountain range where Smokey Bear was born and where he became famous). The forests of these mountains are very similar in general appearance to forests of the interior mountains of Idaho, Oregon, and Washington, but as you'll see, there are some interesting differences. On the upper slopes of Nogal Peak on the first day of my field work, I took a wrong turn

from the main trail and found myself in an oak thicket. To my surprise, I noticed potato plants growing under the oaks – this was about 8,000 feet elevation. The following day I was more tuned into looking for potatoes, and on the slopes near Bluff Springs potatoes were found growing under many trees. On those potatoes in several sites I found potato psyllid late instar nymphs and a few adults. Upon returning to the motel that night, I looked up the latest field research on wild potatoes in the Southwest, and found that two very similar species of totally wild potato are known from many mountainous sites in Arizona, New Mexico, Texas, Utah, Colorado, and even as far north as Nebraska (Bamberg et al., 2003). It was one of these wild potatoes that I had found, and that potato psyllid was happily developing on at elevations of about 8,000 feet. The thing that struck me the most about these potatoes was just how normal they look (Figure 9). The larger plants looked just like modest-sized commercial potato plants.

Figure 9. Leaves of wild potato from Lincoln National Forest. Each had several potato psyllids on it. The board is 1X1 foot, for size reference.

For me as a natural historian, this find connected to the rabbitbrush finds of 2013. Why? Because in these mountain regions of the Southwest, rabbitbrush is commonly found in the mid-elevation transition zone from mountain forests to desert. So, I surmise that the potato psyllids found on rabbitbrush in 2013 had recently migrated down-slope from the adjacent mountains to find shelter plants on which to spend the winter. Or, perhaps the shelter plants like rabbitbrush are simply mid-elevation stop-overs for the psyllids as they move to overwinter on desert-inhabiting Solanaceae in the lowlands. It has been observed for many years that potato psyllid disappears from agricultural land in Texas in the summer months. Much of the speculation as to where the psyllids go has assumed a northward migration to other potato producing areas. While such migration in modern times is likely, as a natural historian I think it important to consider what a native insect like potato psyllid did prior to modern human agriculture. My guess is that potato psyllid typically carried out relatively local movement, from summer on potatoes in the mountains, to shelter plants and possibly desert Solanaceae in the fall, winter, and spring, followed by re-migration to potatoes in the mountains. This kind of elevation-gradient migration is common in native aphids

such as potato aphid (*Macrosiphum euphorbiae*) and sunflower aphid (*Aphis carduella*), and is therefore no surprise to me.

My hypothesis based on natural history field work is that the advent of potato (and other solanaceous crops) production in the winter and spring in Texas, and neighboring states where native potatoes live, gave potato psyllid the opportunity to not just survive the winter in the lowlands, but to thrive and build huge populations. Such huge numbers of psyllids could then provide adequate migrants to reach far northern locales as an artefact of natural migratory flights originally aimed at re-colonizing the mountains of the Southwest each summer.

Concluding Remarks

The information presented here is based on simple field work, studying plants and insects in the wild – this is called natural history. While in a strict sense such observational information-gathering may not be science (i.e. there are no experiments, no 'scientific method' is followed), it is nonetheless important. In the case of potato psyllid and zebra chip, it was natural history field work that first discovered the link between bittersweet nightshade (*Solanum dulcamara*) and potato psyllid overwintering in the Northwest (Jensen, 2013). It was also what led to the recent discovery of matrimony vine as an important host of potato psyllid in some developed areas of the Northwest (see Thinakaran et al., in these Proceedings). Some of the most important scientific advances in history have begun from observations of nature, and as an old-school natural historian, I hope the practice of such observational science is not lost.

Reference

J. Bamberg, A. del Rio, Z. Huaman, S. Vega, M. Martin, A. Salas, J. Pavek, S. Kiru, C. Fernandez, and D. Spooner. 2003. A Decade of Collecting and Research on Wild Potatoes of the Southwest USA. *American Journal of Potato Research* 80: 159-172.

Jensen, A.S. 2013. Potato Psyllid Overwintering and Identification on Yellow Sticky Traps. Proceedings of the Washington - Oregon Potato Conference: 20-26.