Biology/Phenology

Weevils attacking fruit trees in Washington

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Abstract: Weevils currently are not considered tree fruit pests in Washington State, but attacks by weevils were mentioned as early as 1911. The advent of modern synthetic organic pesticides may have virtually eliminated weevils in commercial orchards in the intervening period. Recently several cases of weevil attacks occurred on apple and cherry in several fruit growing regions in Washington and Oregon. The first case (in April 2000) occurred in a newly planted cherry orchard near Arlington, Oregon. The buds were heavily attacked by adult weevils shortly after planting and could have caused substantial growth reduction or distortion. The weevil was identified as *Lepesoma* [=*Dyslobus*] *sp. nov.* Reports of bud feeding were made and investigated in two additional cherry orchards in Washington State in 2001. In one orchard (Quincy area) the predominant species was *Ophryastes cinerascens*, and in the other (Brays Landing area) the predominant species was *Stamoderes lanei*, with some *O. cinerascens* present. Sagebrush (*Artemisia tridentata*) is probably the native host of all three weevil species, and the common thread of the attacks was cherry orchards planted into uncultivated ground in or near sagebrush. In 2002, a severe infestation of a leaf-notching weevil species (*Otiorhynchus meridionalis*) was found in an apple orchard on Bench Rd., ca. 5 miles west of Othello. This same species was subsequently found in three other apple orchards, one in East Wenatchee near Pangborn Airport in an organic orchard, one in the Brewster-Bridgeport area and one near Vantage, WA. At the latter orchard, an isolated 1,000-acre apple ranch on the west side of the Columbia River, two additional weevil species have been problematic for a number of years. These species, tentatively identified as the strawberry root weevil (*O. ovatus*) and the black vine weevil (*O. sulcatus*), girdle the stems of developing fruit in late spring and summer. To the best of the authors' knowledge, this constitutes the first published report of the following species attacking fruit trees in North America: *Otiorhynchus meridionalis*, *O. sulcatus*, *O. rugosostriatus*, *Dyslobus sp. nov.*, and *Mesagroicus elongellus.*

Weevils (Coleoptera: Curculionidae) currently play a negligible role in tree fruit pest management in the Pacific Northwest. In a recent arthropod pest compendium(5), no weevils are listed among the 66 major and minor pest species. In nearby British Columbia, Canada, only one weevil species (apple curculio, *Anthonomus quadrigibbus* Say) is listed as a tree fruit (apple and pear) pest (57), and *Otiorhynchus cribricollis* Gyllenhal has become more important recently in California on a number of crops including tree fruits(71). There are only two tree fruit weevil

pests of importance that figure worldwide (*Conotrachelus nenuphar* (Herbst) [plum curculio] and *Anthonomus pomorum* (L.) [apple blossom weevil][6], although Alford[1] lists a number of species of local importance in Europe. However, over 50 species of Curculionidae are known to attack tree fruits in North America (Table 1).

Although minor pests in tree fruits, weevils as a group are very important agricultural pests. The family is a large one, with hundreds of species listed in the Pacific Northwest alone[39]. Crops in which they are important pests include legumes, small fruits, and stored products. While it is impossible to generalize with accuracy about so large a family, some characteristics are peculiar to a number of weevils. Some species are parthenogenetic, with males unknown in New World collections. Some are flightless, lacking hind wings. Typical adult feeding behaviors include bud feeding, leaf notching, and girdling, whereas larvae are very frequently root feeders. Two behaviors characteristic of many weevils are nocturnal feeding, spending the daytime in duff or litter around the base of the plant or some other protected place, and the propensity to "play dead" when disturbed (drop off the plant to the ground, with legs curled under the body). The latter two behaviors make sampling, detection, and control somewhat problematic, although beating trays or ground cloths are frequently useful in detection. Two curious behaviors are that adults enter houses in large numbers, causing a nuisance problem, and one species, *O. ovatus*, has been recorded as inflicting a painful bite[35, 39].

The current minor role of weevils in tree fruits was not always the case; literature from the first half of the 20th century indicates otherwise. Although sporadic, weevil damage was occasionally quite severe, both to newly planted and mature orchards[19, 75, 76, 77]. The early 20th century was a period of rapid expansion of acreage of PNW tree fruits, and virtually all expansion occurred by replacement of the native sagebrush steppe flora. Several of the weevil species that became problematic in orchards use sagebrush (*Artemisia tridentata* Nutt.) as their primary host, and it is likely that some attacks were largely opportunistic. Given the very broad host range of some species, it is possible that they adapted readily to using tree fruits as a host. This is especially true of the large group of broadnosed weevils in the subfamily Entiminae, whose larvae are root feeders.

The purpose of this paper is to review the history and status of weevils attacking tree fruits and provide an annotated compilation of species. In addition, a detailed description of several recent occurrences is given. The literature on the subject can easily be confusing to the non-specialist, because the names of the various species (and their placement in subfamilies and tribes) has changed over the years, or in some cases, reverted back to older names. In some cases, it is difficult if not impossible to trace which species the authors actually observed; *Stamoderes lanei*, found in the current study appears to have been misidentified as *Mimetes setulosus* in Yothers in 1911-12[75]. We have attempted to give the synonyms and their sources wherever possible, using the current correct name as the primary listing[52, 2]. Where a compendium summarizes information, we have given both the compendium as the source, and where possible, the original reference. It should be noted, however, that three citations in compendia may all refer back to a single reference. Since many of the species involved have little information besides a passing reference to using tree fruits as a host, a table format seemed the best way to present the information. We have defined tree fruits fairly strictly, specifically cultivated apple, pear, cherry, peach, nectarine, plum and prune. Conversely, I have defined

"attack" very broadly, that is, any stage of the weevil attacking any plant part, even if there is only a single, possibly anecdotal reference to such an attack in the literature.

History of Weevils in Washington Tree Fruits

The first mention of weevil attack in Washington tree fruits was in 1909-10 and reported on by a grower, George M. Chase, Prosser, WA, at the Annual Convention of the Washington State Horticultural Association in 1911[(19)]. The grower reports that weevils began feeding on his neighbor's apple trees in the spring of 1909 (Grandview Orchard Tracts). Specimens were sent to Pullman (presumably to Washington State College entomologists), but no identification was forthcoming. In the spring of 1910, more weevils were found in the apple trees in the Model Orchard, which Mr. Chase managed, and more samples were sent to Pullman. A. L. Melander responded (by letter) that the weevils were *Evotus nose* [sic][a]. Melander recommended that the grower shake his trees over an inverted umbrella, whereon they would drop to the ground. This control method drew laughter from the audience; western US growers, having no weevil pests, were unaware that this was a standard practice where plum curculio was common. Weevil specimens were also sent to Minnesota, with a subsequent identification by C. W. Bunn of *Anesia* [sic][b] *alternata* Horn, "closely related to the curculio" and that the "habit of attacking cultivated plants is acquired," which drew more laughter from the audience. Mr. Chase goes on to say that the beetle was threatening 16,000 trees in the Model Orchard with destruction (with a few more acerbic comments about the competence of state and local entomologists). Lead arsenate, either sprayed or painted, did not provide control, nor did Rex (spray oil). Using a control recommendation for woolly apple aphid, the grower tried a spray of 10% kerosene emulsion, which apparently was successful.

It seemed as though the public gibes drew some attention, for Melander and Yothers mention weevils in reports in 1914[(49, 74)], and Yothers published a limited study in 1916[(75)]. The latter study provided the basis for the list of tree fruit-attacking weevils in the PNW. This study was carried out in 1911 and 1912, apparently starting the spring of 1911, just weeks after Mr. Chase's mid-January talk at the Horticultural Association meeting. Study sites were carried out in Prosser, Wenatchee, Brewster, Okanogan and Omak (1911), and from Kennewick to Oroville in 1912. Despite their preliminary nature, very little further work was done; Yothers states in his opening paragraph:

> "The investigations were discontinued in 1912, when satisfactory control measures were discovered."

which, sadly, reflects an ongoing approach to tree fruit pest research. Apparently, in 1909 growers throughout the central part of the state complained of insects eating buds of young fruit trees. One orchard had half of the new trees killed, with mortality rates of 20% common. Specimens sent for identification had little or no life history information associated with them, and some of the species found were new to science. The association with sagebrush was noted, however, along with the observation that when the native plants, notably sagebrush and lupine, are removed (in preparation for planting an orchard), the weevils feed on the fruit trees because

[a] Presumably a misspelling of *naso* LeConte.
[b] Presumably a misspelling of *Amnesia*; the current name is *Dyslobus alternata* Horn.

they are the only food available. This concept was propounded for other weevil species also[59] and forms the basis for our hypothesis for several cases of weevil attacks in 2001-02.

Although Yothers[75] discusses five species of non-curculionid beetles found during his studies, we will discuss only one of these, because a closely related species of chrysomelid was found in association with one of the weevil species in the current study (*Glyptoscelis artemisiae Blake);* Yothers reported *G. alternatus* Crotch feeding on apple, peach, pear, sagebrush and sunflower[75].

Yothers[75] provides a table of control measures tried and their reported effectiveness; this apparently is anecdotal information passed on and recorded, as opposed to replicated trials. Lead arsenate and lime sulfur were considered by most to be ineffective; kerosene emulsion, Mr. Chase's prime remedy, was considered to be ineffective by every grower except Mr. Chase himself. Hand-picking was effective, although apparently only on a small scale, and the derided "shaking into an umbrella" was considered effective by the two growers who reported on it. A paper cone (around a cotton "gasket"), with the inside smeared with Tanglefoot, wrapped around the tree trunk was also found to be effective; it should be remembered that tree density was much lower in this era, and individual properties smaller, so manipulations on individual trees were in some cases feasible. The paper cone plus Tanglefoot remedy was favored as the most long-lived remedy (it lasted the whole season, unlike sprays) and served the double purpose of also preventing cutworm damage. Even in 1916, there may have been a bias toward non-insecticidal methods of control. The paper cone control method is based on the weevil's behavior of nocturnal feeding and resting at the base of the tree during the day. The last entry in the table "cover cropping" provides another insight into the essential nature of the problem. In the Hanford and White Bluffs region, cover cropping new land for two years with rye or alfalfa and turning it under was a common practice. According to Yothers[75], "Whenever this practice was followed the bud weevils did not bother." Clearly, the 2-year transition period with a non-host in place provided a sufficient temporal buffer for the weevils to either die or migrate to new hosts and thus not present a problem when the trees were planted.

One final footnote to this discussion is provided by Anderson[3], who proposes (paradoxically, in his own words) that several of the species known to attack tree fruits are candidates for listing as rare or endangered species (at least in British Columbia)[c]. Anderson also echoes the idea that these species are forced onto tree fruits through removal of their native hosts. The reverse side of this coin is the planned campaign (e.g., through pest and disease boards) to remove native or feral hosts in an effort to reduce pressure on commercial agriculture. The mind boggles, on one side, at pushing out orchards for the express ecological purpose of allowing sagebrush to re-establish, and equally ludicrous is the concept of attempting to eradicate sagebrush in central Washington for the purposes of pest control. Superimposed on this is the generally recognized precept that the density of sagebrush was caused by overgrazing of livestock in the 19th and 20th centuries and fire suppression; thus, while sagebrush is a native species, its current population levels are apparently due to perturbation by human populations.

[c] Anderson also notes that some of these "rare" weevil species are, in fact, not so much rare as they are at the northern limit of their distributional range, which speaks directly to the entire issue of what constitutes an endangered species. Certainly, some of the species in question appear to be locally abundant in central Washington.

With the control problem apparently solved, little attention was paid to weevils for the next 90 years. Yothers published two other papers on weevil pests during his career. The first was devoted to *Evotus naso* LeConte[76]. He claims this as the first report of this species attacking apple, although he mentions the earlier reference to this species by Chase[19]. Interestingly, this species is not among those documented by Yothers in his 1911-12 studies[75]. Yothers and Newcomer observed damage by *E. naso* to 3-year-old apple trees south of Yakima, WA, in late April-early May 1925. Leaf feeding was noted at the time, and bud feeding at an earlier date was presumed. A few observations of the life history are provided, but the report is quite sketchy.

The second paper by Yothers[77] on weevil pests of tree fruits concerns *Dyslobus tanneri* Van Dyke. Although published in 1941, the original observation of this species on tree fruits was made in 1916 (by Yothers); however, the species was not described by Van Dyke until 1933, hence the delay in publication. In the 1916 observation, adult weevils (all apparently female) were observed doing considerable damage to apple buds on 5-year-old trees, with up to 100 weevils found around the base of a single tree. Prune trees in the same orchard were untouched. This species appeared to be crepuscular or nocturnal in its feeding activities, lying hidden in the duff at the base of the tree during the day. The author also notes that the adults fed on alfalfa and dandelion, but a recent cultivation of the orchard floor may have driven them up into the trees in search of food.

Recent Occurrences of Weevils in the Pacific Northwest

Arlington, Oregon: This case involved a newly planted cherry orchard totaling about 20 acres south of Arlington, Oregon. The surrounding agricultural production appears to be wheat and hay, thus isolated from Oregon's primary cherry-growing district in The Dalles. The native habitat surrounding the cherry blocks was sagebrush (denser near the valley bottom) thinning to grass at the top of the slope. An area of approximately 5 acres within a larger ca. 8 acre block of 'Skeena'/Mazzard rootstock was infested by weevil adults which were destroying the buds. This section is cut off from other parts of the orchard by two gullies left in native (sagebrush) habitat. This section of the orchard had been in sagebrush the previous year; a nearby section to the north, where no weevils were observed, had been in alfalfa.

The site was visited in the spring of 2000 by personnel from the Oregon and Washington State Departments of Agriculture, the Mid-Columbia Agricultural Research and Extension Center in Hood River, and a representative from the nursery which had sold the trees to the grower. This visit was based on complaints by the grower of weevil damage, which he believed had come from the nursery on the trees. Weevils were collected and sent to Dr. Charles O'Brien of Florida A&M University for identification; the individuals were designated *Lepesoma* [=*Dyslobus*] *sp. nov.*[d] The block and the bordering sagebrush were subsequently treated twice with a pyrethroid insecticide (permethrin).

The following year, the block was revisited (25 April 2001) by several of the same persons involved in the first visit. No sign of weevils or weevil damage were found, and the trees did not appear to be stunted. Beating tray samples were taken throughout the area where weevils

[d] *sp. nov.*, new species. *Dyslobus* has been resurrected to replace *Lepesoma*.

were found the year before. In addition, the sagebrush bordering the orchard was sampled, both with beating trays and by digging through the duff at their bases; again no weevils were found. A block about a mile away belonging to the same grower, but planted the year previously, was also examined, but no weevils or damage were found. The mortality rate of trees in the affected area was low, ca. 10 trees.

There are several possible hypotheses for our inability to find weevils. One is that we were too late in the season (phenological time) and had missed the period of adult activity. A second is that the time of day in which the sampling was done (ca. noon to 3 pm) was inappropriate to maximize the chance of encountering weevils. Based on my experience at Bray's Landing the previous day, and the similar phenological stage of the cherries and time of sampling (which had produced numerous specimens), I feel these hypotheses are not likely to be true. A third hypothesis, which is my assumption at this point, is that the weevils have a patchy distribution (were not present throughout the sagebrush on the farm, but only in that one area), and the population found in 1999 in that region was extinguished by the permethrin sprays or at least brought below the point of detection.

Bridgeport, Washington: Adult weevils were found by a pest management consultant in a large commercial orchard in Douglas County, near Bridgeport, Washington. Approximately 10 acres of apples were affected to a greater or lesser extent, with foci of more intense damage (marginal leaf notching). Damage was heaviest on the root suckers, but as the season progressed, it extended well up into the tree canopy. The weevils collected on 26 April 2001 were identified as *Otiorhynchus meridionalis* Gyllenhal[e].

Quincy, Washington: The senior author investigated a block south of Quincy, Washington, in April of 2001. A report was made by a consultant that a block of newly planted cherry trees was being attacked by weevils, specifically that the buds were being destroyed. The trees had been budded in place the previous fall with the scion cultivar, thus destruction of this bud meant destruction of the entire future tree (Figs. 1, 2) Multiple species were found at this location, which were later identified as *Ophryastes cinerascens* Gyllenhal*, Stamoderes lanei* Van Dyke, and *Mesagroicus elongellus* Emden[f]. Much of the damage was near the border with the native habitat, which did not include sagebrush but did include lupine and various grasses.

Brays Landing, Washington: This site (Fig. 3) was reportedly a wheat field about 20 years ago, but had been re-invaded by sage, and in all respects resembled sage steppe common to central Washington prior to planting. Cherry trees (nursery) had been planted a few weeks before. The grower did not cultivate the plot before planting except to mow down the sage and bunch grasses and plant the trees with a tree planter (essentially a single furrow into which the tree is placed). Unlike the Quincy site, the trees had one year's strong growth of the named cultivar and were about a meter high, with perhaps 20-30 buds/tree. Thus, there was less danger of destruction of the trees at this site.

The damage was different in appearance at this site vs. the Quincy site, although this may have been due solely to differences in degree of bud development (the Quincy site was more

[e] Identification by C. W. O'Brien

[f] Replacement name for the homonym *elongatus* Buchanan (not Reitter, 1915)[(13)]as treated by Hatch[(39)].

advanced). At the Bray's Landing site, the damage ranged from neat, round holes drilled in the side of the bud (Fig. 4) to a more superficial surface feeding on the side (larger, but still roughly circular). A number of buds appeared as though just the very tips had been chewed on, although this was sometimes hard to distinguish from normal bud development. In addition, a number of weevils were found on the cut stems of the trees where they had been headed back after planting (Figs. 5, 6), apparently attracted to sap oozing from the cut.

Prior to a pesticide application scheduled for the morning of April 20, 2001, I tagged 15 trees, counted the number of weevils and damaged buds/tree, and marked one completely undamaged bud/tree to assess residual control of the pesticide application. I also circled the damaged buds with magic marker to observe the fate of the injured buds later in development. The bud development at this site was not past swollen bud (green showing), no unfolded leaves were observed; some of the trees had buds that were still quite dormant. There appeared to be a preference for weevils and feeding on the trees with swollen versus dormant buds.

Results of a brief quantitative assessment are that the trees had an average of 2 (range 0-7) weevils/tree and 5.1 (1-14) damaged buds/tree. Interestingly, no tree examined was completely free from evidence of feeding. The dominant species (77%, n=104) found in this block was *Stamoderes lanei* (Van Dyke)[g] (Fig. 6, 7) followed by a Chrysomelid beetle, *Glyptoscelis artemisiae* (Blake)[h] (15%) (Fig. 5). A second Curculionid species, *Ophryastes cinerascens* (Pierce), was found, but less commonly (8%).

A post-treatment sample (36 h) of the upper block found no live weevils, indicating good efficacy of the insecticide. I sampled the surrounding native plants with a beating tray near the southeast corner of the upper block. The dominant species were sagebrush, bitterbrush [*Purshia tridentata (Pursh*) de Canolle], lupine, arrowleaf balsamroot, phlox and grasses. The predominant species (*S. lanei*) found in the cherry block was also retrieved from the sagebrush.

On 24 April, I also examined a nearby cherry block in the process of being planted (just to the west and lower down the slope). This block had not been in sage as long as the upper block. I found only two weevils on the trees. I showed these specimens to the workers who were planting the block, and they showed me a bucket containing another six individuals of the same species that they had found on the soil surface during planting. Their inability to escape from the bucket seemed an indication of a flightless species. I found another half-dozen of the same species in the fresh soil dug up from an irrigation line trencher (Figs. 9, 10). These were later identified as *O. cinerascens,* a common inhabitant of sage lands. I also broke open four bundles of unplanted trees, and searched the root systems for any signs of weevils. None were found.

In hopes of answering the question "where did the weevils come from?" experimentally, I planted three cherry trees on 3 May 2001 ('Bing'/Mazzard) in the sagebrush about 5 m from the southeast corner of the orchard. An irrigation line was run up to them to provide water. These trees were reexamined on 7 May (Beers & Collman), but no weevils were found. Cherry may not be a preferred host, thus when sagebrush is present, they will feed on the latter. We also

[g] Identification by C. O'Brien.
[h] Identification by C. O'Brien.

sampled the sagebrush and wildflowers near the block and found a small, black, round weevil to be very abundant on both young sagebrush plants and arrowleaf balsamroot. I had not seen them on previous visits and surmised that this species (tentatively identified by S. Collman as *Omias saccatus*) was just emerging. We then looked at the cherry block, which had been free of weevils the previous week, and found more of the putative *O. saccatus*. It should be noted that *O. saccatus* was one of the species mentioned in the Yothers (1916)[(75)] paper.

I revisited this block the following spring (17 April 2002), when the buds were just beginning to open. I collected about three dozen specimens of what appeared to be *S. lanei* (based on the previous identification by C. O'Brien) from the block and evidence of feeding damage. I also examined the cherry trees planted in the sagebrush close to the southeast corner of the block the previous season. These trees were alive and budding out. I found only 1 pair of mating Chrysomelids (presumably *Glyptoscelis sp*.).

Bench Road, Othello, Washington: This mature ca. 40-acre apple orchard was the site of an experiment using Assail on codling moth; the discovery of weevils here was serendipitous. While setting up the block, I had noticed extensive leaf notching and began looking for the cause. This became readily apparent, as a brief visual examination revealed weevils hidden in the foliage during the day. The first sample was collected on 24 June 2002, and I returned with Mike Klaus to do a more extensive sample on 1 July. I had noted one area in particular as having extensive feeding damage (marginal leaf notching), and we began our samples there.

Using a 1 m^2 ground cloth, we tapped weevils from the tree. The first tap sample brought down a veritable hail of adult weevils, at least 30-40 individuals (Fig. 11). This area later proved to be the most heavily infested, but we found weevils or leaf notching (Fig. 12) throughout the orchard. The majority of the leaf notching was concentrated in the lower part of the tree, from about 2 m and lower. Most weevils we observed *in situ* were in concealed areas, e.g., in a cluster of apples (Fig. 13) or under loose bark (Fig. 14); only a few weevils were found feeding during the middle of the day (Fig. 15). These weevils exhibited the classic defensive behavior of "playing dead" (Fig. 16), usually dropping to the ground, but sometimes being intercepted by foliage.

The farm manager indicated that he had never observed any fruit damage (nor was any observed during our sampling) but that the leaf notching had been occurring for several years, at least 2001-2002. He also noted that adult weevils had invaded his house (situated near the orchard) at certain times of the year (late August, just before apple harvest), but we were not able to obtain samples.

The weevils were subsequently identified as *Otiorhynchus meridionalis*[i]. This was originally a European species, first collected in North America in central California in 1931. The first collections in the state of Washington were in Pullman (1948), Cheney/Spokane (1949) and Yakima (1958) from privet. There is also an anecdotal account of this species found damaging a commercial apple orchard in the Yakima area in 1989 (tentative identification, no specimens taken).

[i] Identification by C. W. O'Brien

Auvil/Vantage Ranch, Vantage Washington: I became aware of the weevil infestation in this orchard through the pest management consultants (Astrid Hedegaard and Steve Cockfield) working on this 1,000-acre apple ranch. The ranch is relatively isolated from the surrounding fruit growing region by the Columbia River to the east and cliffs and native habitat for many miles to the north, south and west. It is situated about 10 miles south of Vantage, WA, in Kittitas County. The nearest orchards are across the Columbia River in Grant County.

The weevil infestation had been noticed some years previously and had been identified as *Otiorhynchus ovatus* (L.), the strawberry root weevil. As more extensive samples were taken, it became apparent that multiple weevil species were involved. Samples were collected on 4 June 2002 (S. Cockfield) and 9 July 2002 (Beers & Cockfield). These specimens were subsequently identified by Dr. O'Brien. The 4 June sample contained a mixture of 3 species (*O. meridionalis*, *O. sulcatus* (black vine weevil) and *O. ovatus*; the 9 July sample were all *O. meridionalis*.

4 June 2002	9 July 2002
(8) *Otiorhynchus meridionalis* Gyllenhal	(all) *Otiorhynchus meridionalis* Gyllenhal
(1) *Otiorhynchus sulcatus* (Fabricius)	
(1) *Otiorhynchus ovatus* (Linnaeus)	

Damage from weevils in this block is of two types: marginal leaf notching (Fig. 17) and girdling the petioles of the developing apple fruits (Figs. 18, 19). (Although not observed or measured, it is assumed that weevil larvae are feeding on tree roots.) At the present time, the petiole girdling feeding is of the greatest concern, since it would likely cause either a reduction in fruit growth, premature fruit drop, or an infection court for pathogens.

For the most part, all of these weevils appear to be primarily crepuscular or nocturnal feeders. Thus, it is difficult to ascribe specific feeding behaviors to each species. At this point in time, we surmise that the petiole girdling may be ascribed to *O. sulcatus* (Fig. 20) and *O. ovatus* (Fig. 21), while *O. meridionalis* (Fig. 22) confines itself to leaf notching. Direct confirmatory observations, however, have not been made. The timing of damage appears to vary somewhat by species[j]. Damage by *O. sulcatus* occurs earlier in the season (first observed in early June), and feeding injury by this larger species may be more profound.

East Wenatchee, Washington: This organic apple orchard (mature trees) was a site for an aphid sampling experiment in the senior author's research program, and foliar samples brought into the lab revealed the characteristic marginal leaf notching damage associated with weevils. On 16 July 2002 I took beating tray samples in the block where I saw the feeding damage. Damage was mainly in the lower parts of the tree, especially the watersprouts. We recovered only 5 specimens during this trip, mainly from an area north of a farm road that divides the block approximately east-west. Of the 5 specimens (all in the genus *Otiorhynchus*), 3 were *O. meridionalis*, 1 was *O. rugosostriatus*, and 1 *O. ovatus*[k].

Control: Control of weevils in orchards poses a number of problems. Nocturnal feeders would likely be best sprayed in the evening or at night. The primary class of insecticides that is

[j] These are observations made by A. Hedegaard.
[k] Identification by C. W. O'Brien.

effective against adults is the pyrethroids, which are a poor fit with the integrated pest management programs currently used in Washington apple orchards. In addition, there is no registered pesticide treatment that would be available to reduce larval populations in the soil, assuming that most of the otiorhynchid populations are reproducing in the orchard. Investigations of such measures are needed greatly to mitigate damaging populations where they occur.

Table 1. Weevil species (Curculionidae) known to attack tree fruits in North America. First name is believed to be the current correct Latin name, names below are synonyms or combinations that have occurred over time, including some misspellings. Genera are in alphabetical order, as are species within genera. CNI indicates the source as "Common Names of Insects and Related Organisms" published by the Entomological Society of America, Lanham, MD, 1997 [(7)]. Species listed here were checked for inclusion in the web version of *Nomina Insecta Nearctica* [http://nearctica.com/nomina/nomina.htm].

Latin name, synonyms, alternative spellings	Common name(s) CNI=Common Names of Insects	Tree fruits attacked [other host plants]	Notes and references
Adaleres ovipennis Casey 1895 (*Adaleres*)		prune orchards [almond, live oak, ceanothus]	Adults normally feed on live oak and ceanothus, but can be quite destructive to buds and leaves of fruit trees [(30)]
Amotus setulosus (Schönherr) 1847 *Mimetes setulosus* Schönheer		apple peach pear [native hosts: sagebrush, *Artemisia tridentata*; arrowleaf balsam root (aka wild sunflower), *Balsamorrhiza sagittata*; lupine *Lupinus;* other cultivated hosts include blackberry, gooseberry, black walnut]	Yothers[(74, 75)] lists this species, *Mimetes setulosus,* as one of the two most injurious species of bud weevils found on tree fruits. Damage reports are from young (1- and 2-year-old) fruit trees in spring, hollowing out buds. Weevils were also feeding on cut surfaces of recently pruned shoots. There are also several contemporaneous reports of damage from British Columbia[(10, 61, 62)]. However, this species is known only from California in authoritively identified collections, and thus all citations likely involved a misidentification of *Stamoderes lanei* Van Dyke, which was not described until several decades after these observations.

Anametis granulata (Say) 1831 (*Barynotus*) *Anametis granulatus* Say *Anametis grisea* LeConte (jr. syn.)	gray snout beetle	peach apple	Adult weevil damaged buds of peach trees, destroying virtually all buds on hundreds of trees [17]. Adults are wingless, and therefore must have been on a previous host before tree planting (sod or weeds). Slight injury to a few apple orchards, eating bark of small branches and twigs. Adults exhibit "play dead" defensive behavior" [18]. A grower from Fenwick (Ontario) reports that they killed 130 young peach trees, attacking buds and bark when trees were first set out; if the bud is the scion of a budded tree, then the tree is destroyed. Habits are apparently diurnal; beetles are wingless. A colleague of Fletcher (Hamilton) reports that he has reared the beetle from the stems of ragweed, *Ambrosia trifida* [larval host] [34].
Anthonomus consors Dietz 1891 (*Tachypterus*) (NIN) *Tachypterellus consors* ssp. *cerasi* (List)			The species *T. consors* by Dietz is from a single specimen (Oregon) from the collection of G. H. Horn. List[45] gives *cerasi* as a new subspecies of *T. consors*, being different from *T. consors* in body color (brick red vs. brown), and having coarser, shorter hair, which is yellow-amber. However, there are few other references in the literature, with the exception of literature[26] and Metcalf & Metcalf [50].
Anthonomus pomorum (Linneaus) *Anthonomus pumorum* (misspelling in *Nomina Insecta Nearctica*)	apple blossom weevil	apple	Primarily a European species, it was introduced into North America (Ohio) prior to 1891[52]. Dietz[28] had one specimen from OH and hesitantly included it based on only 1 specimen. Burke (1968) (Coleop. Bull) says it is probably not established in the US.

Anthonomus quadrigibbus Say *Tachypterus quadrigibbus* *Tachypterellus quadrigibbus* *Tachypterellus quadrigibbus magna* List	apple curculio	apple pear plum peach cherry [*Amelanchier alnifolia*, (saskatoon), serviceberry, crabapple, hawthorn, quince, haw, shadblow, wild crabapple, cotton]	Although the apple curculio has never been as destructive overall as the plum curculio (even to apple), it has in the past caused considerable damage in some parts of the country (e.g., eastern US and Canada[55] [54, 15, 16, 27]. Philip & Edwards and Philip et al. (British Columbia) give one of the few contemporary references to this pest[57, 56]. Damage is somewhat similar to the plum curculio (feeding and oviposition); attacked apples may be dwarfed and misshapen. Apple curculio damage lacks the characteristic crescent-shaped scar. The subspecies *magna* was described by List[45], (and misspelled by Metcalf & Metcalf[50] as *T. q. magnus* List), is a larger form that occurs on the Great Plains centered around Iowa and Kansas. References: [64, 25, 60, 37, 70, 48, 67, 18].
Anthonomus signatus Say 1831 (Anthonomus)	strawberry bud weevil (CNI)	apple [strawberry, wild raspberry, wild blackberry, dewberry, milkweed, goldenrod, basswood, wild bergamot, mint, catnip, heal-all)	References:[18]

Cercopedius artemisiae (Pierce) 1910 *Cercopeus artemisiae* Pierce *Cryptolepidus parvulus* Van Dyke	lesser sagebrush weevil bud weevil artemisia weevil	apple peach cherry pear [adults are associated with sagebrush, *Artemisia tridentata*]	Most often associated with bud injury by adults to young fruit trees planted just after native sagebrush has been cleared off (northwestern US and southwestern Canada). It also can be found feeding on sap from newly cut shoots (heading back, or cutting off, nursery trees immediately after planting is a common practice). It is a diurnal feeder and will drop to the ground if disturbed. On sagebrush, it pierces tiny holes in the leaves. References: (8, 48) (59, 74, 75, 39, 18); suggested candidate for rare and endangered species(3).
Cleonidius canescens (LeConte) 1875 (*Cleonus*) *Cleonus canescens*		peach apple apricot	Considerable numbers on buds of peach and apple trees in 1908 and 1910 in Westlake, Utah. Like several other bud weevils, attacks were limited to young trees planted to virgin soils(75). Yothers is quoting Gillette, no citation. Essig(31) also mentions this species.
Cleonidius poricollis (Mannerhein) 1843 *Cleonus lobigerinus* (Casey) (jr. syn.)		apricot apple [lupine]	Reported as especially destructive to apricot buds in Okanogan in the spring of 1909(75).
Cleonidius quadrilineatus (Chevrolat) *Cleonus quadrilineatus* (Chevrolat)	four-lined loco weevil	apple [*Aragallus lamberti, Astragallus, Lupinus*]	Found on apple trees and lupine near Brewster, WA, in April 1912, although causing little damage to apple buds (75).

Coccotorus scutellaris (LeConte) 1858 *Coccotorus prunicida* (Walsh) *"Anthonomus(?)" prunicida* Walsh	plum gouger (CNI)	cherry plum	Adults bore round hole resembling a pin puncture; a gourd-shaped cavity is excavated underneath the skin to deposit the egg. The resulting larva bores to the stone, feeds, and eventually pupates there. Fruit punctures are made for both food and oviposition. Most of the older literature refers to this as *C. prunicida*. I have linked them through the common name and genus. References: [64, 33, 25, 31, 48, 18]
Conotrachelus anaglypticus (Say) 1831 (*Cryptorhynchus*)	cambium curculio	plum peach apple pear [hickory, slippery elm, cotton, pignut, hornbeam, sweet birch, American beech, American chestnut, white oak, chestnut oak, red oak, tulip tree, serviceberry, red maple, tupelo, flowering dogwood, sourwood]	Larvae feed under the bark (cambium) of fruit and other trees. Adults may oviposit in peach fruits, but may be limited to previously injured fruits. One specimen from black knot on plum. Distribution: MA, GA, KS, VA, TX, NJ, MI, IA, IL IN, FL[12].
Conotrachelus crataegi Walsh	quince curculio (CNI)	Pear [quince, hawthorn]	Adults damage pear fruit, although the damage is not the same as in quince; the outside of the fruit has a hard, flattened area with a central puncture[29].

Conotrachelus nenuphar (Herbst) 1797 *Curculio nenuphar* Herbst	plum curculio	apple pear apricot cherry peach plum	This pest has been known since before the turn of the 20th century and was considered one of the major pests of tree fruits (along with codling moth). It still poses problems to modern IPM programs. Adults make characteristic crescent-shaped feeding scar in fruit and oviposit there. Although especially damaging on stone fruits, it is the major curculionid pest of apple, surpassing the apple curculio in importance. It has long been a pest east of the Rocky Mountains; and although recorded from UT and WA, it currently is not considered a pest. Selected references:(64) (33, 16) (27, 48) (29, 22, 33, 25, 60, 38, 44, 18, 43)
Dyslobus luteus (Horn) 1876 (*Thricomigus*) *Lepesoma lutea* (Horn) *Melamomphus luteus* Horn *Tricomigus luteus* (Horn)		peach apple pear [raspberry]	Listed in Yothers(74, 75) as *Melamomphus luteus* Horn. While Yothers refers to the report by Chase(19) in connection with this species, Chase only refers to two species in his report: *Evotus naso*, and *Dyslobus* (*Amnesia* [sic *Anesia*]) *alternata* Horn. However, Yothers notes that the males and females differ greatly in appearance, doubtless the cause of confusion and misidentification (Horn originally placed them in different genera according to Pierce). Campbell et al.(18) give Canadian distribution as BC and SK, although their only host listing is raspberry.
Dyslobus nigrescens (Pierce) 1913 *Lepesoma nigrescens* (Pierce) *Melamomphus nigrescens* Pierce		peach apple	Listed in Yothers(74, 75) as *Melamomphus nigrescens* Pierce. Specimens were taken from Riparia, Washington, in March of 1911, reported as destroying buds of young peach and apple trees. Apparently Pierce named the new species from the Washington material.

Dyslobus tanneri Van Dyke 1933 *Lepesoma tanneri* (Van Dyke)		Apple [alfalfa, dandelion]	First found by Yothers in 1916 as an unknown weevil damaging apple buds near Yakima, WA; later named and identified[77]
Epicaerus imbricatus (Say) 1824 *Liparus imbricatus* Say	imbricated snout beetle	apple cherry peach pear plum [bean, beet, blackberry, cabbage, clover, corn, cotton, cucumber, gooseberry, muskmelon, onion, potato, radish, raspberry, strawberry, squash, tomato, watermelon]	[Adults] gnaw twigs and fruit [64]. Injures buds and newly forming fruits[59, 50].
Evotus naso (LeConte) 1857 (*Otiorhynchus*)		Apple [sagebrush]	Given as *Evotus nose* misspelling by Chase [19], who describes considerable damage caused to young apple trees near Grandview, WA; one identification by Melander was *E. naso*; a different set of specimens sent to Minnesota identified them as *Anesia alternata* Horn (probably a misspelling of *Amnesia alternata* Horn, now *Dyslobus alternata* Horn). This could have been a misidentification, or more likely there was a complex of species involved. Yothers wrote a brief paper on this species in 1928, claiming the first record of this species attacking fruit trees[76], specifically buds of apple trees. In laboratory caged tests, the adults also ate peach and pear leaves. Presumed to be a native sagebrush feeder. Other references: [3].
Magdalis aenescens LeConte	bronze appletree weevil (CNI)	apple cherry prune [alder, hawthorn]	Treherne[69] notes that this pest is associated with the canker of stems and trunks of apple trees; Brittain also associates it with injured trees[9]. Distribution is MT, WA, BC, AL, OR, CA[31, 51, 48, 18].

Magdalis gracilis LeConte 1857	black fruit tree weevil	apple apricot peach pear plum prune [willow, California Christmas berry, or rosaceous plant]	Reported injuring plum foliage in BC[18]; other hosts from Essig[31].
Mesagroicus elongellus Emden *Mesagroicus elongatus* Buchanan 1929 (not Reitter, 1915)		cherry	Current study is first known report of attacking tree fruit. From a cherry block south of Quincy, WA, adult found eating buds of newly planted trees in former sagebrush habitat[13, 39].
Naupactus cervinus (Boheman) 1840 *Pantomorus cervinus* Boheman 1840 (*Naupactus*) (NIN) *Asynonychus godmanni* Crotch (CNI) *Pantomorus godmani* (Crotch)[31] *Aramigus fulleri* Horn[31]	Fuller rose beetle (CNI) Fuller's rose beetle Fullers rose weevil	apple apricot peach pear plum prune [rose, blackberry, loganberry, strawberry (larval); abutilon, acacia, achyrantes, alfalfa, azalea, beans, begonia, camellia, canna, cape jasmine, carnation, cissus, citron, chrysanthemum, currant, deutzia, dracaena, feijoa, fuchsia, gardenia, geranium, golden glow, grapefruit, hibiscus, leadwort, lily, lemon, oak, orange, palm, penstemon, persimmon, plumbago, primrose, potato vine, raspberry, rose, scabiosa, strawberry, sugar cane, tangerine, quince (adults).	Fruit trees are not listed as larval hosts, but adults will feed on a variety of hosts including fruit trees. Adults are flightless[58, 31].

Omias saccatus (LeConte) 1857 (Ptochus) *Mylacus saccatus* (LeConte)	sagebrush weevil	apple apricot cherry peach [sagebrush, arrowleaf balsamroot aka wild sunflower, *Balsamorrhiza sagittata*]	Listed by Yothers[75] as *Mylacus saccatus*, reported as feeding on buds and leaves of 1- to 2-year-old apple trees in 1911-12, near Brewster, WA. Probably the native host is sagebrush. Distribution: WA, OR, CA, BC. Other references: [18].
Omileus epicaeroides Horn 1876		Peach [oak]	Recorded as damaging the foliage of peach trees in eastern Texas in 1904, but that the normal host was oak[58].
Ophryastes cinerascens (Pierce) 1913 *Tosastes cinerascens* Pierce		apple apricot cherry prune pear plum [adults are associated with sagebrush, *Artemisia tridentata;* balsamroot aka wild sunflower, *Balsamorrhiza sagittata;* currant, rose, grape]	Considered by Yothers [74, 75] to be the most economically damaging of the weevil species (mostly sagebrush associates) in his 1916 study. Adults feed on buds of 1- to 2-year old fruit trees. Found nearly a century later by Beers et al. (current study) feeding on newly planted cherry trees in central Washington (2 locations). Grape host record is from Klaus[42]. Suggested candidate for rare and endangered species listing[3].
Ophryastes geminatus (Horn) 1876 *Eupagoderes geminatus* Horn *Eupagoderes mortivallis* Fall (jr. syn.)	white bud weevil	fruit trees [sagebrush]	Essig[31] lists *E. geminatus* and *E. mortivallis* as separate species, although "similar in appearance and habits." Reported as normally feeding on sagebrush, but had attacked fruit trees in early spring in the eastern foothills of the Sierras (southern California).

Otiorhynchus cribricollis Gyllenhal	cribrate weevil (CNI) apple weevil apple curculio	apple apricot peach [almond, alfalfa, Maritime wormwood, *Artemisia maritima*; Chrysanthemum; *Crataegus* (hawthorn); globe artichoke; *Daucus* (carrot); *Fragaria* (strawberry); *Ilex* (holly); *Jasminium* (jasmine); *Ligustrum* (privet) *Lonicera* (honeysuckle); *Olea* (olive); citrus]	Adults are flightless, nocturnal feeders that notch leaves, ring bark on main leaders and growing shoots; larvae feed on roots[65, 71]. Distribution outside US includes southern Europe and the Mediterranean region; North Africa and Australia[4, 72]; in North America, HI, CA, WA, TX, ,AZ, NM; found feeding on apple foliage in Carlsbad, NM[72]. Other references: [32].
Otiorhynchus ligneus (Olivier) 1807 (*Curculio*)		peach [maritime wormwood, *Artemisia maritima*, Chrysanthemum sp.]	Adults may enter houses in large numbers in the fall, causing a nuisance. One of the few *Otiorhynchus* species for which males have been found in North America[72, 18].
Otiorhynchus ligustici (Linnaeus) 1758 (Curculio) *Brachyrhinus ligustici* (Linnaeus)	alfalfa snout beetle	apple [grape, alfalfa, cinquefoil, clover, dock, goldenrod, grasses, milfoil, sorrel, strawberry, wild carrot, asparagus, raspberry, rhubarb]	Originally a Palearctic species, this weevil was found in North America in the late 1800s, and the first serious outbreak (on alfalfa in New York) occurred in the 1930s. It is flightless and parthenogenetic. Adults observed feeding on apple, although alfalfa and clovers are primary hosts for reproduction[20, 18].

Otiorhynchus ovatus (Linnaeus) 1758(*Curculio*) *Curculio ovatus* Linnaeus *Brachyrhinus ovatus* (L.)	strawberry root weevil (CNI) pitchy legged Otiorhynchus strawberry crown girdler strawberry root girdler sleepy weevil graveyard bug	apple cherry peach pear [broad host range, including *Brago* (borage); *Daucus* (carrot); *Fragaria* (strawberry); *Humulus* (hops); *Juniperus* (Juniper); *Medicago sativa* (alfalfa); *Mentha* (mint); *Phaseolus* (bean); *Picea* (spruce); *Pinus* (pine); Rhododendron; rose; *Rubus* (raspberry); *Taxus* (yew); *Thuja* (arborvitae); *Trifolium pratense* (red clover); *Tsuga* (hemlock); *Vaccinium* (blueberry); *Vitis* (grape), beets; conifer seedlings]	Tree fruit pest records are from MacNay & Creelman[48] and Essig[31] (peach and cherry); also recorded in the present study. Introduced from Europe, it is a well established pest in the US, with reports as early as 1852. The most widely distributed species of *Otiorhynchus* in the US; all southern Canadian provinces, and the northern US, south to Texas, but not in the southeastern states. Adults may enter houses in large numbers in the fall, causing a nuisance; they are also reported to inflict a painful bite, as well as causing damage to "fruit in the fruitier's shop"[35]. Parthenogenetic, nocturnal [32, 72, 18].
Otiorhynchus meridionalis Gyllenhal 1834		apple [lettuce, privet, olive, lilac, forsythia, Jasmine, strawberry]	A European native, it is widely distributed in the Mediterranean region, first found in North America in California in 1931 on privet[41]. Now occurs in CA, ID, MT, NV, NM, UT, WA [72]. Adults found in large numbers (locally) notching leaves of apple in eastern Washington (present study). Other references: [32, 14].

Otiorhynchus raucus (Fabricius) 1776 (Curculio)		apple pear cherry [grape, olive; garden vegetables; arborvitae, juniper, Manitoba maple, raspberry, spruce]	Adults feed on foliage and young shoots of apple, pear and cherry (these records appear to be from Europe). Widely distributed in Europe; in North America, Ontario, Canada [72]. Adults are diurnal [18].
Otiorhynchus rugosostriatus (Goeze)	rough strawberry root weevil	[tree fruits]	Known as a pest from western Europe and Australia; in the latter, it is reported as "injurious to fruit trees." Although records of damage to tree fruits from North America are lacking, with the exception of the present study, it is well established here as a pest of strawberry. Adults may enter houses in large numbers in the fall, causing a nuisance. North American distribution (Canada): BC, NS, OT; United States: AZ, CA, CO, CT, DC, GA, ID, IN, MD, MI, MO, MT, NV, NJ, NM, NY, NC, OH, OR, PA, RI, SC, TN, UT, VA, WA, WV, WI, WY[32, 72, 18].
Otiorhynchus singularis (Linnaeus) *Otiorhynchus picipes* (Fabricius)	claycolored weevil raspberry weevil	peach (pear) apple [red raspberry, *Humulus* (hop); rose, magnolia, azalea, *Ampelopsis*, *Thuja*, conifers, beech, hazel, alder, cultivated vegetables, conifers, campanula, holly, iris, laurel, primrose, rhododendron, strawberry]	Distribution: cooler western and central regions of Europe; first report in North America from MA in 1872, also records from ME, NH, NY, PA, WA; Canada, NB, NS, OT, QB, BC [72, 18]. Adults may enter houses in large numbers in the fall, causing a nuisance. References: [32, 68].

Otiorhynchus sulcatus (Fabricius) (*Curculio*)	black vine weevil (CNI) cyclamen borer	apple [over 100 food plants, including cranberry, *Acer* (maple); *Adiantum* (maidenhair); *Celastrus* (bittersweet); Clematis; *Cordyline* (dracaena); *Crateagus* (Hawthorn); cyclamen; *Fragaria* (strawberry); *Juniperus* (Juniper); *Ligustrum* (privet); *Mentha* (mint); *Mirabilis* (four o'clock); *Polianthes tuberosa* (tuberose); Rhododendron; rose; *Rubus* (raspberry); *Solanum* sp. (nightshade); *S. tuberosum* (potato); Spirea; *Taxus* (yew); *Thuja* (arborvitae); *Vaccinium* (blueberry); *Vitis* (grape)]	Recently found on apple girdling fruit petioles (present study). Larvae feed on roots, adults on foliage. Extremely polyphagous, and well-known pest of ornamental, greenhouse, and nursery plants. Flightless, parthenogenetic, nocturnal. A European native, imported to North America perhaps as early as 1831[18]. Distribution: northern and middle Europe south to France and Italy; Australia, New Zealand, Tasmania. Notorious grape pest in Europe. Canada: BC, NB, NF, NS, QB, United States: AL, AZ, CA, CT, DC, IL, ME, MD, MA, MI, MT, NV, NH, NJ, NM, NY, NC, OH, OR, RI, TX, UT, VT, VA, WA, WI[72]. Essig[31] does not list tree fruits as hosts for this species in North America, but apples are listed as hosts in Europe.
Panscopus aequalis (Horn) 1876 (Nocheles)		apple peach [sagebrush, *Artemisia tridentata*]	Yothers[74, 75] lists this species as (adults) feeding on buds from 1-yr-old apple trees in Tonasket, WA (near Canadian border), in April of 1911 (first report; found at other sites also); in addition, it feeds on sap oozing from freshly cut shoots. Adults fall to the ground if disturbed. At least one report of feeding on fruit tree buds on land under cultivation for >7 years. Distribution: WY, UT, WA, CA (ex Yothers) BC [48]; Horn gives it as "Kansas to British Columbia"; MacNay & Creelman [48] is source of peach host information. Other references: [18].

Paraptochus sp.		cherry [or wild cherry]	MacNay & Creelman [48] only give "*Paraptochus* sp. (or near)"; however, NIN lists only three species in the genus, viz., *P. sellatus* Boheman (see below), *P. setiferus* Van Dyke, and *P. uniformis* Van Dyke. *P. setiferus* and *P. uniformis* are known only from California; thus the MacNay & Creelman reference is likely *P. sellatus*. MacNay & Creelman do not separate wild and cultivated cherry in their checklist. This information is repeated in Campbell et al. [18]
Paraptochus sellatus Boheman 1859 (*Peritelus*) *Paraptochus californicus* Seidlitz	apricot leaf weevil	apple apricot prune (other fruit trees)	Known from CA, OR, BC. Feeds on buds and leaves[31].
Pentarthrum huttoni Wollaston 1854 (*Pentarthrum*)		cherry	A pest of wood flooring, but in Europe it has also been reported from the undecayed portion of a cherry tree sawn into lumber[46].
Phyllobius oblongus (Linnaeus) 1758 (*Curculio*)		(fruit trees) [shade trees; white elm, walnut]	Distribution in Canada: BC, ON, NB, PEI[18]; MacNay also lists it from NY[46]; CT and MI [52].
Polydrusus impressifrons (Gyllenhal) 1834 (*Polydrosus*)	leaf-weevil	apple pear peach plum [birch, willow, poplar, elm, rose, linden, black locust]	Adults attack foliage, especially leaf margins; bud feeding occurs on other non-tree fruit hosts. Apple and pear are not preferred hosts; however, the listed tree fruits were larval hosts. Native to Europe [53, 18].

Pseudanthonomus crataegi (Walsh) 1867 *Anthonomus crataegi* Walsh	apple weevil	apple cherry [azalea, laurel, *Vaccinium* sp, *Amelanchier*, *Crataegus*, *Rubus*, golden currant]	Pierce[58] quotes Fred E. Brooks [11] that this species is an important apple pest in West Virginia, along with *Tachypterelllus* (*Anthonomus*) *quadrigibbus* and plum curculio. Walsh reared the beetle from a cecidomyiid gall on wild thorn[66]. Host list: [21]. Other references: [66, 73, 63]
Rhynchaenus pallicornis (Say) 1831(Orchestes) *Orchestes pallicornis* Say *Rhynchaenus pallicornis* (Say) (spelling in CNI)	apple flea weevil (CNI)	apple [wild crab, elm, hazelnut, chokecherry, quince, blackberry]	Adults of this species attack buds in the spring and chew fine holes in the undersides of leaves during the summer, the damage resembling fine birdshot; and although unusual for a curculionid attacking fruit trees, the larvae mine the leaves. An outbreak in Ohio and Illinois was documented by Flint[36]. US distribution is from Missouri and Illinois to eastern New York and southward to the Ohio river[50]. Distribution in Canada: BC, AL, MN, ON, QB NB, NS, NF [18]. Flint[36] reports that this species was erroneously reported as *Orchestes canus* by Hart. Other references: [40, 37, 48, 38, 50]. "Rynchaenus" was an incorrect original spelling emended by Fabricius 1801-438.
Sciopithes obscurus Horn	obscure root weevil (CNI)	fruit trees [ornamentals, e.g., rhododendron, azalea; mint, berry crops]	Essig[31] quotes what appears to be a personal communication from H. F. Wilson concerning damage to fruit trees in Oregon. Also known from CA, OR, WA, BC.

Sitona californicus (Fahraeus) 1840 *Sitona apacheana* Casey		apple peach [sagebrush, *Artemisia tridentata,* lupine*, Lupinus,* arrowleaf balsamroot (aka wild sunflower), *Balsamorrhiza sagittata*]	Yothers [75] lists this as *Sitona apacheana* Casey, taken on 1-year-old trees at Brewster, WA. This was also considered a variety of *S. prominens* Casey; both are now junior synonyms of *S. californicus*. Other references: [52]
Stamoderes lanei Van Dyke 1936 *Mimetes lanei* Van Dyke		cherry peach [adults are associated with sagebrush, *Artemisia tridentata*]	Recently discovered damaging buds and feeding on cut shoots of cherry in central Washington; block was newly planted (few weeks) where sagebrush had grown previously, and was immediately adjacent to large areas of sagebrush (present study); reported as a peach pest by MacNay & Creelman in British Columbia[48, 18]. Based on Hatch's[39] assessment, this was the more important species encountered by Yothers [75] in his 1916 study, but misidentified in the latter as *Mimetes setulosus* (Van Dyke did not describe *S. lanei* until 1936). Suggested candidate for rare and endangered species [3]. Note: The combination *Amotus lanei* Van Dyke in Campbell et al. 1989[18] appears to be an error. They are quoting MacNay & Creelman[48], who use *Mimetes lanei* Van Dyke.
Thricolepis inornata Horn 1876 *Tricolepis inornata* Horn (misspelling)	small gray leaf weevil prune-leaf weevil	prune plum almond peach	Cordley[23, 24] reports *Tricolepsis inornata* as a pest of prune trees in Oregon. Yothers[75] lists *Tricolepsis* sp. as stripping the foliage of young prune trees in Washougal, WA, ca. 1911 or 12. Also listed in Essig [31], known from NM, CO, AZ, UT, CA, OR, WA.

Tychius lineellus LeConte 1876		apple	Yothers[75] reports he collected this species on young apple trees, but doing "little or no damage."
Tychius picirostris Fabricius 1787 (*Curculio*)	clover seed weevil	apple [clovers, dandelion, strawberry, evergreen blackberry, salmonberry, *Spirea doulgasi*, plantain, sedge, alfalfa, willow, lodgepole pine, white pine, spruce]	Clovers are the primary hosts[18]. The one mention of attack on apple was considered non-economic[47].

Fig. 1. Weevil feeding on budded cherry. Note wrap holding bud in stem, Quincy site, 17 April 2001 (DSCN3222).

Fig. 2. Weevil and feeding damage, Quincy site, 17 April 2001 (DSCN3202).

Fig. 3. Juxtaposition of orchards and native habitat in central Washington, Bray's Landing site (DSCN 3338).

Fig. 4. Bud with feeding damage, Brays Landing site, 19 April 2001 (DSCN3322).

Fig. 5. Chrysomelid beetle (*Glyptoscelis sp.*, prob. *artemisiae*) and *S. lanei* feeding on cut stem. Notice damaged bud on right. 19 April 2001 (DSCN3325).

Fig. 6. *Stamoderes lanei* feeding on cherry stem, Brays Landing, 17 April 2002 (DSCN6184).

Fig. 7. Weevil feeding on cherry bud, *Stamoderes lanei,* Brays Landing, 17 April 2002 (DSCN6181).

Fig. 8. Weevil defensive behavior, Brays Landing, 19 April 2001 (DSCN3285).

Fig. 9. Trench dug for irrigation pipe on the eastern border the lower cherry block, Bray's Landing, WA, 24 April 2001 (DSCN3357).

Fig. 10. *O. cinerascens* found in the soil spilling out of the sides of the trench 24 April 2001 (DSCN3359).

Fig. 11. Weevils (*Otiorhynchus meridionalis*) on beating tray, Bench Rd. Orchard, 1 July 2002 (PICT1255).

Fig. 12. Leaf marginal notching by *O. meridionalis*, Bench Rd. Orchard, 1 July 2002 (PICT1154).

Fig. 13. Weevil shelter location- fruit cluster, Bench Rd. Orchard, 1 July 2002 (PICT1268).

Fig. 14. Weevil sheltering location - beneath loose bark Bench Rd. Orchard, 1 July 2002 (PICT1274).

Fig. 15. Adult weevil feeding on apple leaf, Bench Rd. Orchard, 1 July 2002 (DSCN6816).

Fig. 16. Weevil defensive behavior, Bench Rd. Orchard, 1 July 2002 (DSCN6827).

Fig. 17. Weevil damage (marginal leaf notching, Auvil Vantage Ranch, block 18 9 July 2002 (prob. *O. meridionalis*) (DSCN6902).

Fig. 18. Weevil damage (stem girdling), Auvil Vantage Ranch Block 37 'Gala', probably *O. ovatus* or *O. sulcatus*, 9 July 2002 (DSCN6912).

Fig. 19. Weevil damage (stem girdling; partial), Auvil Vantage Ranch Block 37 'Gala', probably *O. ovatus* (or *O. sulcatus*) 9 July 2002 (DSCN6915).

Fig. 20. Largest species present, ca. 11 mm; black vine weevil, *O. sulcatus*, collected from Auvil/Vantage 4 June 2002 (DSCN6901)*.

Fig. 21. Smallest species, ca 5 mm (*O. ovatus*), collected from Auvil/Vantage 4 June 2002 (DSCN6898)*.

Fig. 22. Medium sized species, ca. 9 mm (*O. meridionalis*) , collected from Auvil/Vantage 4 June 2002 (DSCN6889)*.

* Photos taken at same magnification (0.75X setting with 10x objective).

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