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Diprionid Sawflies on Lodgepole and Ponderosa Pines

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Sawflies of the family Diprionidae (Hymenoptera) are common defoliators of conifers throughout North America. Two genera, *Neodiprion* and *Zadiprion*, feed on the foliage of lodgepole pine, *Pinus contorta*, and ponderosa pine, *P. ponderosa*, in the West.

Species of the genus *Neodiprion* are the most common of the North American conifer feeding sawflies. They can reach outbreak levels and defoliate forests of true fir, pine, spruce, Douglas-fir or hemlock. Larvae feed almost exclusively on old foliage of host trees. Some 47 species and 6 subspecies are known. All but seven species, the European pine sawfly, *N. sertifer* (Geoffroy), and six species from China, are native to North America. Seven species are known to feed on the foliage of lodgepole and ponderosa pines and can occasionally become pests in western North America.

Zadiprion is a small genus, closely related to *Neodiprion*, and is composed of five pine-feeding species native to



Mature Neodiprion autumnalis larvae feeding on ponderosa pine needles.

the western United States, Mexico and Guatemala. They resemble *Neodiprion* in appearance and habits. One species, *Z. townsendi* (Cockerell), feeds on ponderosa pine.

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Sawfly outbreaks can cause growth reduction and, occasionally, tree death. In some cases, trees weakened by defoliation are subsequently attacked and killed by bark beetles. Outbreaks are of short duration, however, and usually last from two to four years. They tend to occur more frequently on poor sites, outwash plains or shallow, infertile soils. Forests most susceptible to sawfly outbreaks are open-grown stands or even-aged plantations located on poor growing sites.

Evidence of Infestation

Typically the first indication of sawfly activity is crown thinning caused by larvae feeding on older foliage (Figures 1-2). During heavy infestations or for species that feed in mid-summer, current-year's foliage can also be damaged. Closer examination may reveal the presence of colonies of feeding larvae and/or eggs



Figure 1 – Defoliation of lodgepole pine by *Neodiprion nanulus contortae*.

Figure 2 – Defoliation of ponderosa pine by *Neodiprion autumnalis*.



deposited on the needles. Early instar larvae feed only on the needle cortex, leaving the midrib remaining, while mature larvae feed on the entire needle. Pellets of frass (digested foliage) can be seen on the ground beneath heavily defoliated trees.

Species, Hosts and Distribution

Seven species of *Neodiprion* and one species of *Zadiprion* are known to defoliate lodgepole and ponderosa pines in western North America. One species feeds exclusively on lodgepole pine, one on both lodgepole and ponderosa pines and six feed on ponderosa pine (Table 1). Of the five species of *Neodiprion* that feed on ponderosa pine, some, such as *N. gillettei* (Rohwer), attack young trees and are a threat to plantations while others, such as *N. fulviceps* (Cresson), prefer either pole-sized or mature trees.

The **lodgepole sawfly, *N. burkei*** Middleton, is known from Montana and Wyoming where it feeds on the foliage of lodgepole pine. There is one generation per year, but a portion of each brood remains in the prepupal stage for 2-4 years. Winter is spent as prepupal larvae in cocoons in the litter. Between 1921 and

Table 1 – Distribution, overwintering stage and host preference for *Neodiprion* sawflies affecting lodgepole and ponderosa pines in western North America.

<i>Species</i>	<i>Distribution</i>	<i>Overwintering stage</i>	<i>Type of trees attacked*</i>
<i>N. autumnalis</i>	<u>USA</u> : Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Washington. <u>Mexico</u> – Throughout pine growing regions	Egg	Ponderosa pine: pole-sized trees
<i>N. burkei</i>	<u>USA</u> : Montana, Wyoming.	Prepupal larva in cocoon	Lodgepole pine: mature trees
<i>N. fulviceps</i>	<u>USA</u> : Arizona, California, Nevada, Wyoming. <u>Mexico</u> : Chiapas, Hidalgo, Veracruz.	Prepupal larva in cocoon	Ponderosa pine: mature trees
<i>N. gillettei</i>	<u>USA</u> : Arizona, Colorado. <u>Mexico</u> : Chihuahua, Guerrero, Michoacán.	Egg	Ponderosa pine: small trees, 3 ft tall or branches of older trees that touch the ground
<i>N. mundus</i>	<u>Canada</u> : British Columbia. <u>USA</u> : Idaho, Oregon.	Egg	Ponderosa pine: all ages and sizes
<i>N. nanulus contortae</i>	<u>Canada</u> : Alberta. <u>USA</u> : Idaho, Montana, Oregon.	Egg	Lodgepole and ponderosa pines: pole-sized to mature trees
<i>N. ventralis</i>	<u>USA</u> : Arizona, Colorado, Nebraska, North Dakota, Wyoming.	No data available	Ponderosa pine: pole-sized trees

*Mexican pine hosts are not included

1925, this sawfly, in combination with a needle tier moth, *Argyrotaenia tabulana* Freeman (Lepidoptera: Tortricidae), defoliated 80,000 acres in the upper Madison River Basin in Wyoming and Montana. The sawflies fed on the older foliage and the needle tier on new foliage. The two defoliators killed almost all of the trees on 12,000 acres

and caused severe damage on another 20,000 acres.

Neodiprion nanulus contortae Ross is a western subspecies of the red pine sawfly, *N. nanulus nanulus* Schedl. It occurs in Idaho, Montana, Oregon and adjoining portions of Alberta, Canada. Larvae feed on both lodgepole and

ponderosa pines. Winter is passed in the egg stage. Eggs hatch in early to mid-June and larvae feed until early July, then drop into the litter and upper layers of soil, spin cocoons and exist as prepupal larvae until early September when pupation occurs. Adult emergence, mating and egg deposition occurs from mid-September to mid-October. Females deposit an average of 9.49 eggs in needles of lodgepole pine and 19.15 eggs per needle on ponderosa pine.

Outbreaks have been reported from several locations. In Klamath County, Oregon, outbreaks occurred from 1941-45 and 1952-53. Some trees were killed outright by the defoliation and others succumbed to attack by other insects. Most trees recovered but suffered reduced growth. During 1959-61, an outbreak was reported near Zortman, Montana. This outbreak covered 11,000 acres before declining due to a nucleopolyhedrosis virus. In 1973 a localized outbreak occurred on portions of the Kootenai National Forest in northwestern Montana. Another outbreak occurred on several national forests in eastern Oregon in 1978 and caused over 3,000 acres of aerially visible defoliation of lodgepole pine. In 2010, a localized population was detected on lodgepole pine near Gallatin Gateway, Montana.

Neodiprion autumnalis Smith and *N. fulviceps* are two closely related species and are separated primarily on differences in their life cycles. *N. autumnalis* is the most wide-ranging of the pine sawflies that feed on ponderosa pine. This species is known to occur throughout the western United States east to western South Dakota, western Nebraska, Colorado,

western Kansas and New Mexico. It also occurs throughout the pine forests of Mexico, where it feeds on several Mexican pines. Adults emerge in fall, hence the species name *autumnalis*, and deposit eggs, which overwinter. Larvae hatch the following spring and can feed until late summer, after which they pupate. During the early 1990's outbreaks occurred in western South Dakota (3,500 acres) and eastern Wyoming (84,000 acres). Outbreaks have also occurred in the ponderosa pine-grassland transition zones in east central Colorado and north-central Arizona. Widely-spaced trees growing on dry sites with poor soils tend to be most heavily damaged. In addition to older needles being almost completely consumed, current-year needles on many trees can be clipped by mature larvae.

Neodiprion fulviceps is known from Arizona, California, Nevada and Wyoming. It is fairly widespread but not as common as *N. autumnalis*. It overwinters in cocoons as prepupal larvae and pupae in the soil. Adults emerge in mid-April to late May and lay eggs in the needles of ponderosa pine. Larvae hatch from mid-late June and feed for about four weeks before dropping to the soil to form cocoons. An outbreak of *N. fulviceps* occurred in the vicinity of Flagstaff, Arizona between 1982 and 1985.

Neodiprion gillettei occurs in Arizona, Colorado and Mexico, where it has been collected in the states of Chihuahua, Guerrero and Michoacán. This sawfly is unique in that it feeds on young trees (<2 feet tall) or branches of trees that touch the ground. Adults emerge, mate and lay eggs on pine needles in fall. Eggs hatch in spring and larvae feed

for about four weeks between April and May. Between 1967 and 1968 more than 810 acres of ponderosa pine seedlings were infested on the Sitgreaves National Forest south of Winslow, Arizona, with heavy damage on about 10% of the area.

Neodiprion mundus Rohwer occurs from the southern interior of British Columbia south to Oregon and Idaho. In British Columbia, localized outbreaks have been recorded in the Deadman River area from 1946 to 1951 and along the northern arm of Okanagan Lake in 1964. This insect has one generation per year and overwinters in the egg stage. Larvae are present from late May to June. It is a common but rarely destructive defoliator

Neodiprion ventralis Ross is a little known species found in northern Arizona, northern Colorado, southeastern Wyoming, southwestern Nebraska and the southwestern corner of North Dakota. More than 1,000 acres of ponderosa pine were defoliated by this sawfly in 2007 on the Apache-Sitgreaves National Forest between Pinedale and Overgaard, Arizona and on the San Carlos Indian Reservation. It prefers to feed on the foliage of medium or pole-sized ponderosa pines.

Zadiprion townsendi, referred to as the “bull pine sawfly,” feeds on ponderosa pine of all sizes. This sawfly is found in Arizona, Colorado, northwestern Nebraska, New Mexico, southwestern South Dakota, Utah, and the State of Chihuahua, Mexico. This species usually causes only minor

defoliation but an outbreak occurred from 1908 to 1910 in northwestern Nebraska and southwestern South Dakota.

Life Stages

Adults are small wasps with stout, thick-waisted bodies and most species are similar in appearance. In most cases, identification to species is based on females and must be made by a taxonomist. Females are larger than males. Females of the genus *Neodiprion* range from 8.5 to 10 mm (0.3 – 0.4 inches) long. Most species have two pairs of clear wings, light red to red-brown heads, serrate reddish-brown to black antennae and light brown to yellowish-green abdomens (Figure 3). Females of *N. gillettei* are entirely black. Males range from 7.5 to 8.5 mm



Figure 3. Adult female of *Neodiprion nanulus contortae*.



Figure 4. Adult male of *Neodiprion nanulus contortae*.



Figure 5. Adult female of *Zadiprion townsendi*.

(about 0.3 inches) long. They have conspicuous feathery antennae, clear wings and a shiny black body color with brown to reddish-brown legs (Figure 4). Males of *N. gillettei* are black and have darker wings than other species of *Neodiprion*.

Females of *Zadiprion townsendi* are somewhat larger and average 10.5 mm (0.4 inches) in length, with reddish brown to black antennae, a yellow head, a reddish-brown thorax, a yellow abdomen and clear wings (Figure 5). Males are about 9.5 mm (0.4 inches) long with reddish-brown to black

antennae, a black head and thorax and a yellow abdomen and legs. Eggs are small, white or pale yellow-green, and ovoid. They are deposited in niches in the upper surface of needles of host trees. They are evenly spaced along the needle and appear as spots of light brown discoloration (Figures 6-7).

Larvae of *Neodiprion* sawflies are 17 – 25 mm (0.7 – 1.0 inches) long when mature and have eight pairs of prolegs on the abdomen. Colors vary according to species. Larvae of *N. autumnalis*, *N. fulviceps* and *N. ventralis* have honey yellow to orange head capsules with a distinct black eyespot, and the body is yellow to yellow green with two darker longitudinal bands (Figure 8). Larvae of *N. burkei* have dark brown heads and a gray to green body with lighter stripes on the sides and back. Mature larvae of *N. nanulus contortae* and *N. gillettei* have shiny black head capsules with the body green to olive green with a darker green longitudinal band on the side (Figure 9). Mature larvae of *Z. townsendi* are 30-40



Figure 6 (above). Eggs of *Neodiprion nanulus contortae* deposited in needles of lodgepole pine.

Figure 7 (right). Eggs of an unidentified species of *Neodiprion* deposited in needles of ponderosa pine.



mm (1.2-1.6 inches) long with an amber or orange head and large eyespots. Body color is dark olive brown to black, mottled with white to yellow tubercles (Figure 10).

Cocoons, which contain prepupal larvae and pupae, are brown to red brown and generally range from 7.1 – 10 mm (0.3 – 0.4 inches) long.



Figure 8. *Mature larva of Neodiprion autumnnalis.*



Figure 9 (above). *Mature larvae of Neodiprion nanulus contortae*

Cocoons that produce female adults are larger than those that produce males (Figure 11). They are paper thin for species that emerge as adults in late summer/autumn and overwinter in the egg stage and somewhat thicker for those species that overwinter as prepupal larvae.

Figure 10 (right). *Larval colony of the bull pine sawfly, Zadiprion townsendi*



Figure 11 (left). *Cocoons of Neodiprion nanulus contortae. Left: females. Right: males*

Life History and Habits

Species of *Neodiprion* that feed on lodgepole or ponderosa pines have one generation per year. After mating, female adults deposit eggs individually in niches cut into the edges of needles of host trees using their sawlike ovipositor. The number of eggs deposited per needle is dependent, in part, on needle length.



Figure 12. Colony of early instar larvae of *Neodiprion nanulus contortae* feeding on a lodgepole pine needle.

Upon hatching, larvae feed in colonies until nearly mature (Figure 12). When disturbed, larvae rear their heads back and forth in unison, a behavior designed to startle and deter predators. In addition, they will regurgitate a droplet of pine resin and attempt to dab it on predators or parasites (Figure 13). Mature larvae often feed as individuals or in pairs. When feeding is completed, mature or prepupal larvae drop to the duff and upper layers of soil beneath host trees or, less frequently, on foliage, bark and other surfaces and form cocoons. Pupation takes place inside the cocoons. Extended diapause of a portion of the prepupal larvae is common.

The primary difference in the life histories of the *Neodiprion* sawflies that feed on lodgepole and ponderosa pines is that some species overwinter as eggs and others as prepupal larvae. Adults of *N. autumnalis*, *N. gillettei*, *N. mundus* and *N. nanulus contortae* emerge in late summer or fall and deposit eggs in the needles of host trees (Figure 14). Eggs overwinter and hatch the

following spring. Others, such as *N. burkei* and *N. fulviceps*, spend the winter in the litter or soil in cocoons as prepupal larvae or pupae. Adults emerge the following spring, mate and deposit eggs, which hatch within several weeks (Figure 15, Table 1).

Larvae of *Z. townsendi* feed in late summer and fall and remain on the foliage during winter in a state of semi-dormancy during which they feed on warm, sunny days. They resume

feeding in earnest in spring and are full grown by May or June. At this time, they drop or crawl to the ground, tunnel into the soil and spin a cocoon. Some larvae transform into pupae while other individuals may not pupate until late summer or even the following season.



Figure 13. Larvae of *Neodiprion autumnalis* with heads upturned in unison and a droplet of pine resin exuding from their mouths as a defense against predators.

Adults emerge a few weeks after they pupate. Females insert eggs in the needles of ponderosa pine, and they hatch between July and early fall. The life cycle may require one or two years to complete. In New Mexico, defoliation caused by this sawfly may be more

common in the lower elevation ponderosa pine forests but in Arizona, defoliation has been observed at elevations of 8000 feet (2400 meters) and higher.

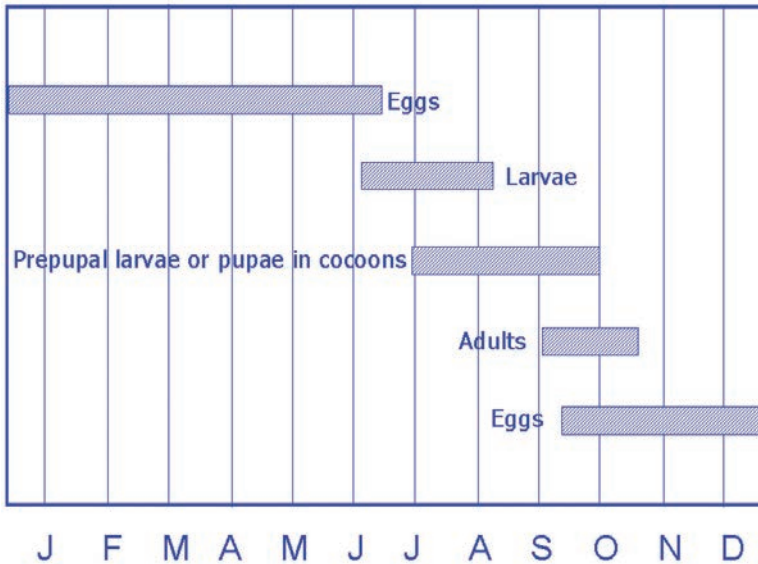


Figure 14. Generalized life cycle of a Neodiprion sawfly with eggs as the overwintering stage.

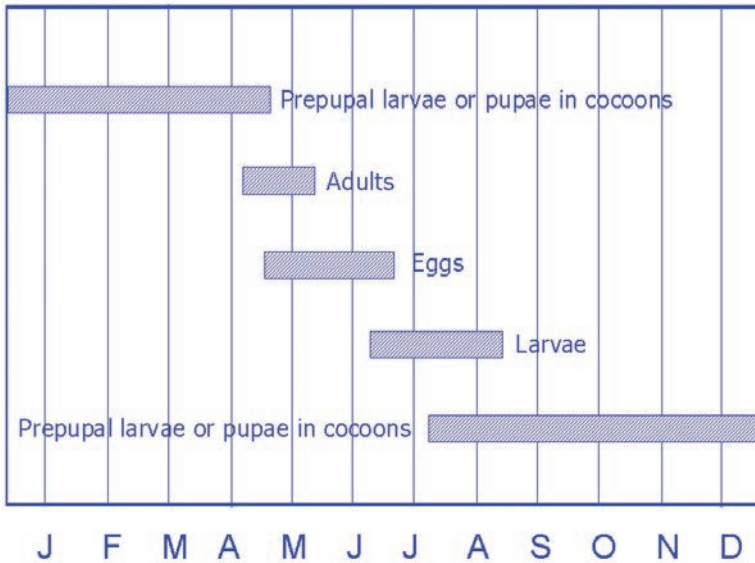


Figure 15. Generalized life cycle of a Neodiprion sawfly with cocoons containing prepupal larvae as the overwintering stage.

Natural Control

Several natural control agents and unfavorable weather, such as rain and cold temperatures when larvae are feeding, can bring about the collapse of sawfly outbreaks. Natural control agents include nucleopolyhedrosis virus diseases, parasitic wasps and flies, and predation of cocoons by mice, voles and invertebrates.

Management

Light infestations on ornamental pines can be removed by clipping infested branches and destroying the larvae. Several chemical insecticides, applied either from the ground or air, are effective direct control agents. The biological insecticide, *Bacillus thuringiensis*, which is widely used for control of defoliating caterpillars, the adults of which are moths and butterflies, is not effective against sawflies.

Photo Credits

Figure 5 - Whitney Cranshaw, Extension Entomologist, Colorado State University, Fort Collins, CO; Figure 10 - Joel McMillin, Entomologist, USDA Forest Service, Flagstaff, AZ; all other photos taken by W.M. Ciesla, FHMI, Fort Collins, CO.

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Additional Information

Private landowners can obtain more information, including currently registered and effective insecticides from County Extension Agents, State Forestry Departments, or State Agriculture Departments. Federal resource managers should contact USDA, Forest Service, Forest Health Protection (www.fs.fed.us/foresthealth/). This publication and other Forest Insect and Disease Leaflets can be found at www.fs.usda.gov/goto/fhp/fidls.

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Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels. Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues. Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container. If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly. Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides. Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place. NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

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