Gouty Pitch Midge

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The gouty pitch midge, *Retinodiplosis inopis* (O.S.), is a native enemy of pine forests in eastern and western United States. In the West, where it is called the "ponderosa pine resin midge," or sometimes the "birds-eye pine midge,"[3] it is especially injurious in ponderosa pine forests. The damage that it causes in western forests has been attributed until recently to an unidentified species of *Retinodiplosis,* known only by common name. In 1957, it was learned that the so-called ponderosa pine resin midge of the West and the gouty pitch midge of the East were the same species.[4]

This insect belongs to one of the larger families of flies—the gall midges, so called because many members of the family cause galls on plants which they attack. Some of its relatives are important pests of cones and seeds of forest trees, but this species is noted for its damage to twigs. Although not a true gall producer, it causes swellings and other malformities in twig growth. Prolonged, severe infestations usually deform or stunt the crowns, and occasionally kill trees (fig. 1).

The insect at times has been very abundant in the Eastern States, but it is best known in California, where it is a pest of long standing. Symptoms of its work there were noted as early as 1913. It is more injurious to planted trees than to those established naturally. In the 1930's it cropped up as a serious enemy of pine plantations at the Institute of Forest Genetics, Placerville, Calif., where superior strains of trees for reforestation were being studied. Damage like that encountered at the Institute has occurred

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[3] This name was coined in the belief that the midge causes imperfections in wood which produce a "birds-eye" effect in the grain. "Birds-eye" grain is highly prized in finished lumber. Imperfections of this type can be demonstrated in twigs that have been damaged by the midge, but they do not always go back to the 1-year wood, the part attacked. Moreover, the stem of the tree, except in its very earliest stage as a terminal shoot, is not attacked. Attributing "birds-eye" in lumber to this species of midge, therefore, seems to be a misconception; however, it does not preclude the possibility that some other midge may cause this defect.

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in plantations at Mt. Shasta, Calif., and elsewhere.

In northern New York, the insect was very abundant from 1911 to 1913, reducing the vitality of the affected trees. In a ponderosa pine plantation on Pilgrim Creek near Noxon, Mont., midges killed so many of the new shoots for several successive years in the late 1930's that in some places the trees died. In natural stands of the upper Rogue River and upper Klamath River drainages in southern Oregon, and in the upper reaches of California's Sacramento River drainage, midge epidemics have recurred repeatedly and at times have been severe.

Ordinarily, few trees die from midge attacks, but extensive killing of branch and leader terminals over a period of years reduces tree growth sharply. In also prolongs the time required for trees to reach merchantable size. Although these effects have not been considered serious in natural stands, their economic significance has been recognized where the damage has been prevalent in plantations, or where ornametal trees have been affected.

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Figure 1.—Ponderosa pine stunted in growth and near death from repeated midge attacks.

Range

The distribution of the gouty pitch midge is transcontinental (fig. 2). The midge is most common, however, in the North Atlantic, Inland Empire, and Pacific Coast States within the range of its principal hosts. Damage symptomatic of *Retinodiplosis inopis* (O.S.) has been observed frequently in parts of western Montana, northern Idaho, northeastern Washington, southern Oregon, and northern and central California. Outside California this species has not been widely recorded from many western areas where it is thought to occur. The damage usually has been attributed to an undescribed species identified simply as *Retinodiplosis* sp. or *R.* sp. near *inopis* (O.S.).

Hosts

In eastern United States, pitch pine (*Pinus rigida* Mill.) is the principal host. Virginia pine (*P. virginiana* Mill.) and jack pine pine (*P. banksiana* Lamb) are also attacked. In the West the chief host is ponderosa pine (*P. ponderosa* Laws.), typically the Pacific coast form. The midge breeds readily in the Rocky Mountain variety (*P. ponderosa* var. *scopulorum* Engelm.), but seldom has been recorded in the natural range of this variety. It also breeds in Jeffrey pine (*P. jeffreyi*

Grev. & Balf.) when this tree species grows near infested ponderosa pine. Damage symptomatic of the gouty pitch midge has been reported on lodgepole pine (*P. contorta* Dougl.).

In the arboretum of the western Institute of Forest Genetics at Placerville, the midge occasionally infests two southwestern pines that are exotics in California. These are Arizona pine (*P. ponderosa* var. *arizonica* (Engelm.) Shaw), and Apache pine (*P. engelmannii* Carr.). Whether these two species are hosts in their native habitat is not known.

Only living trees serve as hosts to this insect, and attacks on these are restricted to the current year's shoots. The younger age classes—saplings and poles 4 to 16 feet in height—are most heavily infested. Trees under 3 years in age ordinarily escape injury. On young trees 50 percent of the new shoots often die as a result of outbreaks. Older individuals are sometimes attacked, but usually only in the lower part of the crown.

Evidence of Infestation

Dead needles, dead or dying twigs, and distorted, twisted terminal growth are the general earmarks of gouty pitch midge activity. Most prominent in the early stages of damage are dead needles on the current shoot growth. The needles die in tufts and as they die they droop, turn yellow, and later reddish brown. Heavily infested twigs, on which all of the needles are killed, show up as sprigs of dead foliage, or "flags." These usually are scattered over part or all of the crown (fig. 3). Flags due to the midge begin to appear in the summer, but are most conspicuous in the late winter or early spring of the year following attack. Later they break off and fall to the ground. Extensive twig-killing, stunted or distorted growth, and sparse, off-colored foliage are symptoms of persistent heavy infestations.

Certain twig beetles and scale insects cause damage that superficially resembles the work of

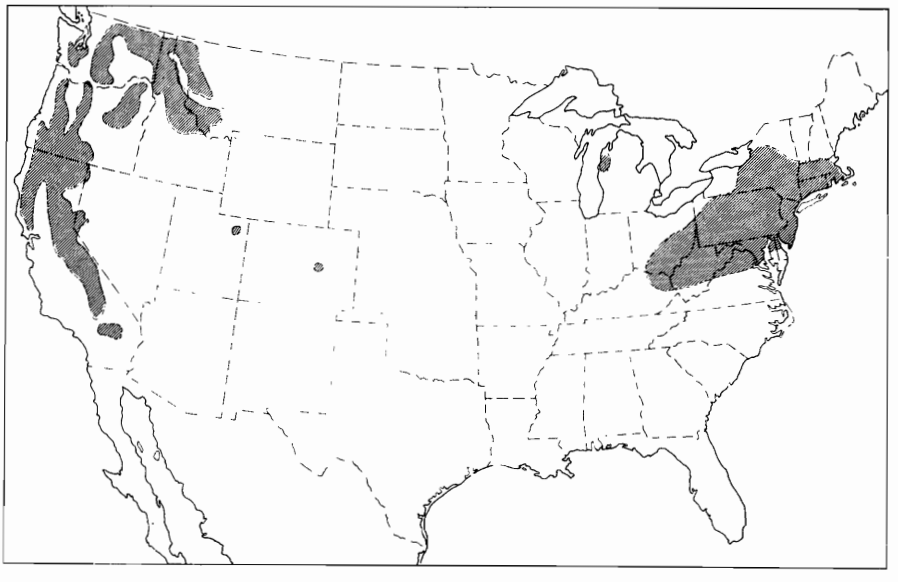

Figure 2.—Distribution of the gouty pitch midge in United States.

midges. However, midge larvae injure the shoot in a distinctive manner. These injuries show up as slight swellings on the surface of the shoot. Each swelling encloses a larval feeding pit—a tiny pocket about 4 mm. long and 3 mm. wide, in the vascular tissue, containing a larva immersed in fluid resin (fig. 4, *A*). The resin infiltrates the wood around the pits and at times exudes over the surface of the twig.

Two or three pits have no noticeable effect on the tree, but as the number increases the normal processes of conduction and growth are disrupted. The needles around the pits start to die, and growth deformities begin to appear. Flagging results when the pits are numerous enough to girdle the shoot. Frequently, pits are distributed along only one side of a shoot; then growth is greatly reduced along the infested side, the unaffected side grows normally, and the shoot is twisted. If the infested tip does not die, the pits eventually heal over, and in a few years become covered by a rough, corky scar. The distortion, of course, remains throughout the life of the injured branch or leader.

Midge infestions are seldom uniformly distributed throughout the stand. Trees, in some spots, may be heavily infested, while others a short distance aways are not. Even on individual, heavily attacked trees, some shoots may escape injury. In plantations and in clear-cut areas that are fairly well restocked, infestations tend to be more regular than elsewhere, but still far from uniform. The spotty distribution is due in part to differences in the susceptibility of the trees.

Life Stages

The adult midge (fig. 5, *A*) is a small, delicate fly, resembling a mosquito in many respects. It is about 3.5 millimeters long, and has a wing span of 4.5 millimeters. The body color in both sexes is dark gray to brown, except for the abdomen which is crimson. The wings are transparent.

The egg (fig. 5, *B*) is minute, its length being only about 0.4 millimeter and its width 0.1 millimeter. It is ellipsoid in shape, but tapers slightly more at one end than at the other. When the egg is first laid its color is crimson, but it becomes pink during incubation.

The larva (fig. 5, *C*), a typical fly maggot, is flattened dorsoventrally and tapers at both ends. It has two rows of bilobed tubercles along its dorsal surface. In the first stage of development, the larva is scarcely larger than the egg and its color is pink. When full-grown it is 4–5 millimeters long and its color ranges from bright orange to red. The body is usually coated with fluid resin, so that it appears shiny or varnished.

The pupa (fig. 5, *D*) differs markedly from the larva in shape and appearance. It is shorter and stouter, and on its head bears a pair of hornlike protuberances. The head and thoracic segments in this stage are blackened, but the abdomen remains reddish as in the larva. The pupa is encased in a white or translucent, beaked cocoon (fig. 6), much like a moth cocoon. This casing is about the thickness and consistency of lens paper, and is composed of long fibers felted together. The outside is covered with a thin coating of brittle, resinlike material, giving the surface a lacquered appearance.

Habits

Pitch midge adults are active during the spring months. In the warmer parts of the range, the Sierra Nevada foothills, adults be-

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Figure 3.—Dead twig tips or "flags" on ponderosa pine caused by the gouty pitch midge.

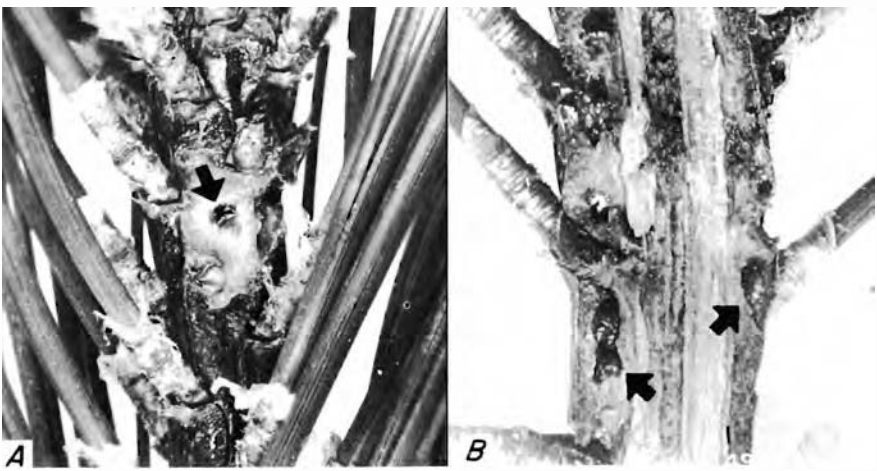

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Figure 4.—Larvae embedded in vascular tissue of current year's shoots: *A*, Single larva in its resinous pit; *B*, longitudinal section showing larvae in a heavily infested shoot.

gin to emerge and start their attacks toward the end of March. They are most abundant during April, but can be found until early in May. In more rigorous climates, emergence may be a month or more later. Like most gnats, the adults can fly; and although they are not strong fliers, it is by this means that they spread. Because of their fragility and small size, they seldom attract attention.

Individual adults live only 5 to 12 days. During this short period they are active chiefly in the afternoon when the air is comparatively calm and the temperature between 65° and 85° F. In the forenoon they mostly remain quietly hidden among the foliage, even though wind and temperature conditions are favorable. At night they are inactive.

Both sexes are fully developed when they emerge, the females each containing 80 to 100 well-formed eggs. Mating takes place almost immediately after emergence, and within a day or two the females begin to oviposit. The eggs are laid on expanding branch and leader tips of the host trees during the period of rapid spring shoot growth. They are deposited singly or in groups of up to four eggs. Most eggs are placed behind the bud scales or needle bases, but some are laid on roughened parts of the shoot. They are not forced into the tissue, but are simply placed on the surface.

On the fourth day after they are laid, the eggs become lighter in color; on the sixth day they hatch. Each larva immediately crawls to a natural crease or depression in the shoot and slowly bores through the surface. Four to six days later they are completely embedded in the vascular

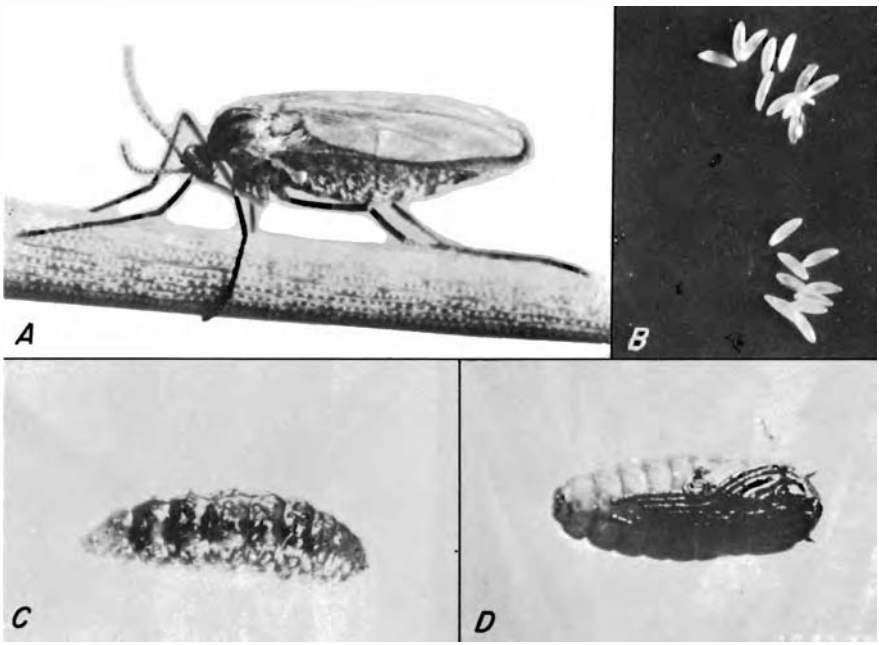

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Figure 5.—Life stages of the gouty pitch midge: *A*, adult female; *B*, eggs; *C*, mature larva; *D*, pupa.

tissue. There, surrounded by fluid resin, which fills the cavities that they hollow out, the larvae feed until the following spring. One or more larvae may occupy a single feeding pit (fig. 4, *B*). The surface swellings that mark these pits develop as the tree attempts to heal the injury.

When the larvae are mature, they work themselves to the surface of the shoot and leave their feeding pits to pupate. This emigration occurs in late winter and early spring. It is attended by copious exudations of resin which pour from the pits as the larvae exit. Most of the insects crawl out onto the needles, but an occasional one may settle on the twig or bud. The second day after it settles, each larva constructs its cocoon by lining with fibers the thin coating of resin on its body. About one week later it pupates. The dark color of the imaginal head and thorax is visible through the cocoon at the end of the second week.

The pupal period lasts from 10 to 14 days. Toward the end of this time, the pupa cuts a cap out of the pointed end of the cocoon, aided by its "horns" and by rotating its body. It then works itself through the opening until its body extends two thirds of the way out. When the adult emerges it leaves behind the empty pupal skin projecting from the cocoon (fig. 6).

There is but one generation per year.

Control

Gouty pitch midge populations fluctuate markedly. The insect may be extremely abundant one year, and scarce the next. High populations for several successive years are the exception rather than the rule. Natural controls usually regulate the midge's abundance and keep it from becoming more numerous and destructive than it is. Natural enemies, host resistance, and weather are the main factors that keep the insect in check. The effects of weather have not been studied, but the effects of the other two factors are partly understood.

The midge is host to several parasitic insects. The principal ones are three species of tiny wasps: *Platygaster diplosidis* (Ashm.), an egg parasite; *Eurydinota rufiventris* Gir., a parasite of the prepupal larva and pupa; and *Amblymerus* sp., a pupal parasite. The first two species have been reared from the midge in the East and the West; the third only in the West. *P. diplosidis* is the most abundant, perhaps because as many as 14 individuals can develop within a single host. This parasite has been observed to oviposit without mating, and to oviposit several times in a single host egg. *E. rufiventris* has somewhat similar potentialities; from 6 to 10 individuals have been reared from a single host cocoon.

These parasites are important in controlling infestations, particularly in naturally established stands where they sometimes kill 50 percent or more of the midge population. They do not seem to be quite as effective against infestations in plantations. The incidence of parasitism in plantations studied did not exceed 25 percent, even in heavy infestations that persisted over 7 years.

In ponderosa pine marked differences in the susceptibility of different trees have been observed. These differences are related to the character of the surface of the new shoots. Trees with shoots having sticky, resinous surfaces are more prone to injury than those with shoots that are either dry and smooth, or covered with a waxy bloom. The midge is capa-

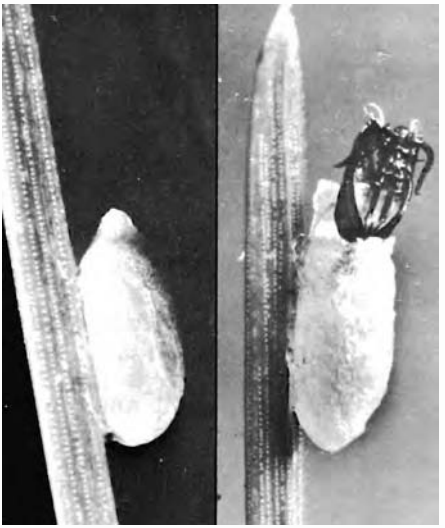

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Figure 6.—Cocoons on pine needles before and after the adult emerges.

ble of developing in all three types, but shoots with sticky surfaces seem to be the most attractive to ovipositing females. Host vigor in ponderosa pine seems to have very little to do with susceptibility to attacks by this insect; vigorous, rapidly growing trees are as readily infested as those that are not. However, the slower growing trees are more adversely affected.

Midge damage can be minimized in growing ponderosa pine by practices that will reduce the number of susceptible trees in the stand. Seed trees selected to provide seed for nurseries or natural regeneration, for restocking areas where the midge is a serious pest, should be those having shoots that are either dry and smooth, or covered with a waxy bloom. In forest nurseries where ponderosa pine seedlings are grown to the age of 3 years or more, the character of the shoots can also be used to select planting stock least likely to be attacked. Where thinning operations are necessary in young planted or natural stands, the hazard of midge damage can be reduced by removing trees with sticky, resinous shoots. Ordinarily, these comprise about one-third of the stand.

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