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Daniel G. Mosher
Michigan Department of Natural Resources

Louis F. Wilson
USDA Forest Service

SCOTCH PINE DETERIORATION IN MICHIGAN CAUSED BY PINE ROOT WEEVIL COMPLEX

Daniel G. Mosher and Louis F. Wilson[1]

ABSTRACT

Pine root tip weevil, *Hylobius rhizophagus*, and pine root collar weevil, *H. radicis*, attack certain Scotch pine stands simultaneously causing more mortality than expected from either insect alone. Recommendations for curtailing this insect complex include favoring red pine, planting Scotch pine far from brood sources, and avoiding stump culture of Christmas trees.

Scotch pine, *Pinus sylvestris* L., which is attacked by many insect species is especially susceptible to injury of the pine root tip weevil, *Hylobius rhizophagus* Millers, Benjamin and Warner, and the pine root collar weevil, *H. radicis* Buchanan. The former insect has only recently become a noteworthy pest in Scotch pine plantations in Michigan; the latter insect has been devastating Scotch pine for many years.

Currently, both species are attacking some Scotch pine stands simultaneously, causing pine deterioration. Both attack the underground portion of the tree. *H. rhizophagus* larvae feed on the root tips initially causing reduced height growth and flagged shoots, followed by mortality. *H. radicis* larvae feed on the root collar and root bases. Their feeding girdles the root collar area causing whole tree mortality or blowdown from the weakened base.

A survey was conducted in Michigan in 1976 to examine the extent and degree of injury caused by these weevils in order to determine if remedial measures will be needed. This paper is a study based on a portion of that survey.

MATERIALS AND METHODS

After examining numerous Scotch pine plantations in Michigan, 12 were selected for study from 10 counties over a wide area in the northern portion of the state's Lower Peninsula (Fig. 1). A systematic survey was conducted in each planting. Tree injury due to these two species of *Hylobius* was separated using specific symptoms for each insect. Trees attacked by *rhizophagus* flag unevenly, while trees injured by *radicis* entirely turn color at once. Trees which had been dead more than one year were entirely brown or needleless, and cause of death could not be determined.

Sample data were taken at one-chain intervals; the number of samples varied by the size of the planting. Degree of flagging was used to estimate injury from the pine root tip weevil. This was done by recording the number of flags per each of the nearest 10 trees at each stop as: none (0 flags), light (1-3 flags), moderate (4-10 flags), or heavy (>11 flags). These data were converted to a flagging index for each stand for relative comparisons. The index was calculated as follows: $I = x + 2y + 4z$, where x, y, and z are the percentages of light, medium, and heavy flagging respectively. The index varies from zero (no flagged trees) to 400 (100 percent of the trees heavily flagged).

Percentage of pine root collar weevil attacks other than mortality was determined by digging around the root collar of 5 to 10 trees per stand and searching for weevil feeding damage according to a technique developed by Kennedy and Wilson (1971).

[1]Insect and Disease Specialist, Forestry Division, Michigan Department of Natural Resources, Lansing, Michigan; and Principal Insect Ecologist, North Central Forest Experiment Station, USDA Forest Service, East Lansing, Michigan, 48824.

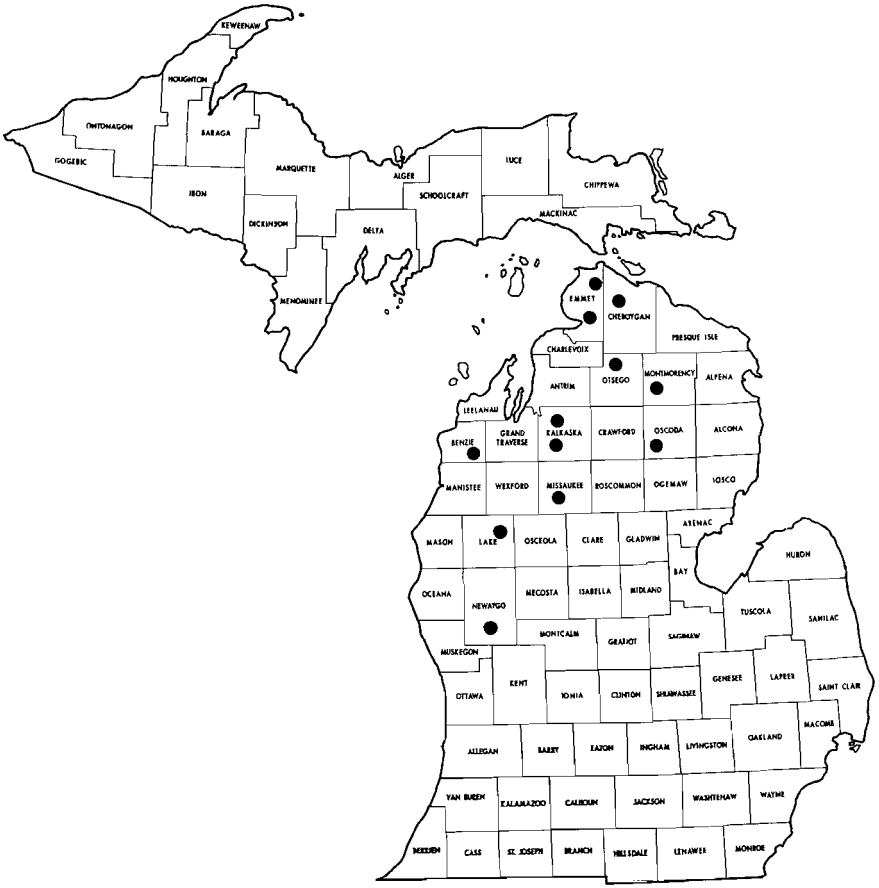

Fig. 1. Locations of Scotch pine plantations used in this study.

RESULTS AND DISCUSSION

Both weevils are now widespread and damaging numerous stands throughout the northern portion of Michigan's Lower Peninsula. All the plantations sampled in this study showed flagging symptoms of *rhizophagus* injury (Table 1). The individual stand injury indices varied from 46 to 338 (maximum is 400). This index is more sensitive to injury than percentage of trees attacked as it considers the degree of flagging. For example one stand with the index of 338 had over 99 percent of the trees injured, but 70 percent were heavily flagged.

H. radicis occurred in 10 of the 12 plantations indicating that an *Hylobius* complex was developing in Michigan. The plantings with this weevil had from 10 percent to 100 percent of the trees attacked (Table 1). The two plantations with just *rhizophagus* attacks showed the most flagging injury and lowest mortality. Those with the highest *radicis* attacks showed the most mortality (Table 1).

Each insect species is capable of killing the tree, but both attacking together appear to increase mortality. This situation seemed to occur in plantations where *radicis* attacks were

Table 1. Mortality and flagging of Scotch pine from the pine root collar weevil and pine root tip weevil in 12 plantations in Michigan, 1976.

Trees Attacked by *H. radicis* (%)	Tree Mortality (%)				*H. rhizophagus* Flagged Trees		Number of Plantations
	H. rhizophagus	*H. radicis*	Undetermined	Total	Percent	Mean Index[a]	
0	0.2	0	0.6	0.8	99.2	301	2
10	0.8	0	1.4	2.2	97.8	303	1
20	1.8	0	0	1.8	41.2	85	1
70	2.6	3.1	5.7	11.4	21.6	46	1
100	6.6	2.5	15.5	24.6	57.1	156	7

[a]Index ranges from 0 to 400. At 400 all trees would be heavily flagged.

100 percent (Table 1). But, because *rhizophagus* was not as abundant in these plantings much of the undetermined mortality could be blamed on *radicis* which readily kills Scotch pine at high population levels. The pattern of damage on several stands, however, suggests that both interact. Mortality frequently occurred in pockets in stands infested with both weevils. The oldest mortality started in the center of the pocket and spread outward. This type of mortality is indicative of *rhizophagus* (Kearby and Benjamin, 1963) but is not known for *radicis* which causes scattered mortality. *H. rhizophagus* appears to kill more slowly when alone or with low populations of *radicis*. Three of the stands had damage indices exceeding 300 and more than 97 percent had flagged trees, yet less than 1 percent had died by the time of the survey (Table 1).

There is probably little direct competition between these two insects as *rhizophagus* feeds on the roots and root tips while *radicis* feeds on the root collar and root bases. They undoubtedly compete indirectly, however, as their combined effort severely restricts nutrient uptake and transport, a situation which brings about rapid decline in Scotch pine.

The pine root tip weevil seldom injures saplings and prefers pole-sized trees (Kearby and Benjamin, 1969). However, three of the plantations in this study had trees that were notably small (average 13 ft tall) for the unusually heavy flagging from *rhizophagus* attacks. The remaining nine plantings in this study were young pole stands and averaged 22 ft tall, a size more amenable to attack. Further examination revealed that the three younger stands, and one other one, had been stump cultured 10-15 years previously so the present crop of trees were turn-ups. That is, a crop of Christmas trees had been taken out and the lower limbs left on the stump to grow into a second tree crop. Thus, these trees, though only saplings in size, had pole-sized root systems which are the size preferred by *rhizophagus*.

CONCLUSIONS AND RECOMMENDATIONS

An *Hylobius* complex was discovered between *radicis* and *rhizophagus* in the Lower Peninsula of Michigan where abundant Scotch pine is grown. Together, these weevils are becoming Michigan's most serious problem in young pole-sized and stump cultured Scotch pine plantations.

There are a few ways of potentially eliminating or at least curtailing this complex in future planting programs. For instance, planting red pine in preference for Scotch pine (or jack pine which is also a highly susceptible species), will greatly reduce the complex. Red pine, unless planted near or among Scotch or jack pine, is fairly resistant to both weevils. Resistant varieties of Scotch pine are not known as yet. If Scotch pine is planted for pulpwood or sawtimber, Michigan's Upper Peninsula would be a better location. Neither weevil is yet a pest there and Scotch pine can still be grown safely.

We do not recommend growing Scotch pine in the northern protion of the Lower Peninsula, except for Christmas trees, unless exceptional precautions are taken. We know we can plant susceptible pines far from a pine root collar weevil infestation and have a low

probability of heavy injury before maturity. This occurs because *radicis* is not a very mobile insect (Wilson, 1968). However, we do not yet know much about the mobility of *rhizophagus* and further research is needed.

Stump culture used for growing two crops of Christmas trees should be avoided as the second-crop trees with their larger root systems favor the pine root tip weevil. Stump culture also favors other insects such as the pales weevil, *H. pales* (Herbst) and the Zimmerman pine moth, *Dioryctria zimmermani* (Grote), further complicating the situation (Bell and White, 1966).

The pine root collar weevil can be managed by early basal pruning, a technique involving the removal of a few of the lower whorls of branches and needle litter around the base of the tree (Wilson and Miller, 1968; Wilson and Rudolph, 1970). This treatment should be started before trees reach pole size and can be used as either a preventive or control measure.

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