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ALTERNATE HOST OF JACK PINE NEEDLE RUST IN NORTHERN MINNESOTA

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ABSTRACT.—The pine needle rust of jack pine on the Little Sioux Burn in northeastern Minnesota infected large-leaf aster but not goldenrod. The rust was most severe when asters were abundant on the plots. Less than 10 percent of the jack pine were infected over a 3-year period when asters were more than 10 feet (3.05 m) from the mil-acre plots.

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Early literature, including Arthur (1934), indicates that both goldenrod, *Solidago* sp., and aster, *Aster* sp., are alternate hosts for the pine needle rust, *Coleosporium asterum* (Diet.) Syd. After inoculating alternate host plants of both genera, Hedgcock and Hunt (1922) suggested that, in the eastern United States *Coleosporium solidaginis* (Schw.) Thum (*C. asterum*) either included two races each infecting only one of the alternate host genera or else should be considered as two species of rust. In the western United States, however, Weir and Hubert (1916) obtained infection of both alternate host genera from single sources of inoculum and Weir (1925) repeatedly transferred the rust from *Aster* to *Solidago* and from *Solidago* to *Aster* by means of urediospores. Apparently no further attention was given to this problem until the studies by Nicholls *et al.* (1968) in Wisconsin. They suggest that there are at least three forms or races of *C. asterum,* one specific to *Solidago,* another specific to *Aster,* a third occurring on some species of both genera. They also suggest that infection of red pine, *Pinus resinosa* Ait., jack pine, *P. banksiana* Lamb., and Austrian pine, *P. nigra* Arnold, in Wisconsin is limited to the form or race of the rust found on *Solidago* sp.

Our purpose here is to identify the alternate host of the needle rust on jack pine on the "Little Sioux Burn" in northeastern Minnesota and to present further evidence suggesting that *C. asterum* is composed of a complex of races or forms.

In May 1971, a large fire, the Little Sioux Fire, burned several thousand acres on the Superior National Forest in northeastern Minnesota. On those sites occupied by jack pine or aspen, *Populus tremuloides* Michx., abundant natural regeneration occurred. In the summer of 1972, experiments were set up to determine the

influence of diseases on jack pine seedling survival on the burn. Two sites were selected for study, one a good jack pine site on deep sandy soil, the other a poor site on very shallow soil overlying bed rock. On each site 100 mil-acre sample plots were set up along a transect, across the site, approximately one-fourth mile in length. Plots were examined in June 1973, 1974, and 1975.

Needle rust infection was abundant on both sites. This posed two interesting questions: Although *Aster macrophyllus* L. was abundant on both sites, no *Solidago* sp. were found on any of the plots. A reconnaissance of both sites in the vicinity of the plots also failed to reveal any *Solidago* sp. This suggested that *Solidago* was not involved and that *Aster* was the alternate host, contrary to Nicholls *et al.* (1968) in Wisconsin. It was also noted that the needle rust infection was not distributed at random. Instead, it was severe on some plots and absent on others.

An analysis was made to determine whether there was any correlation between local abundance of *A. macrophyllus* on and in the immediate vicinity of individual plots and the prevalence of *C. asterum* infection of jack pine on the plots. The results, essentially identical for both sites, suggest a close relation between the presence of aster and prevalence of needle rust on jack pine (table 1). They also indicate that aster must be abundant within a few feet of the jack pine seedlings to cause heavy infection, at least under the conditions that prevailed on the Little Sioux Burn.

Table 1.—*Prevalence of needle rust infection in relation to presence and abundance of aster*

(In percent)

Presence and abundance of aster	Jack pine infected		
	1973	1974	1975
Abundant on plots	40	85	80
Moderately abundant on plots	41	80	73
Rare on plots	10	44	37
None on plots, but present within 10 feet	7	34	41
None within 10 feet of plots	6	10	9

The information obtained in the field suggested that it would be desirable to follow-up with a greenhouse inoculation study using inoculum collected from several locations in the Lake States region. *Aster macrophyllus* and *Solidago* sp. were potted in the fall of 1974 and held over winter in the greenhouse. Pine needles bearing needle rust aeciospores were collected from several locations in early June 1975; three jack pine and one red pine collections were used.

Five aster and five goldenrod plants were inoculated from each aeciospore collection, and incubated. Five aster and five goldenrod plants were incubated without inoculation to serve as controls. The test was repeated a second time using the same aeciospore inoculum and a third time using urediospores produced in the first test. No infection occurred on any of the control plants, and all the results were identical for all three tests on all collections.

Inoculations from two of the jack pine collections (one from the Little Sioux Burn in northeastern Minnesota and the other from a Washburn area in northern Wisconsin) infected aster but not goldenrod. Inoculations from the third jack pine collection (from the Beltrami Island area in northwest Minnesota) infected goldenrod but not aster. The red pine aeciospore collection (from the Chippewa National Forest in north-central Minnesota) also infected goldenrod but not aster.

These results support the conclusion that large-leaf aster is the alternate host for the jack pine needle rust on the Little Sioux Burn. They also indicate that both aster and goldenrod serve as alternate hosts for needle rust on jack pine, but that different forms or races of the rust are involved on each of these alternate host genera. Beyond this, because of the small number of collections tested, more questions are raised than answered.

Are there forms or races of the pine needle rust that can infect eastern species of pines and both genera of alternate hosts as was indicated in the West by Weir and Hubert (1916)? There appears to be no reason why, on some sites, a mixture of forms or races, one on goldenrod the other on aster, could not result in mixed infection on a single pine or even a single needle. Proof would

require alternate host inoculation studies with aeciospore in oculum form single aecium sources on pine needles to avoid mixed inoculum and assure that the rusts tested are in fact pathogenic on pine. Uredia arising from successful inoculations should then be tested for transfer between alternate host genera as was done by Weir (1925) in the West.

Are there forms or races of the pine needle rust occuring on red pine that use aster as an alternate host? The single red pine isolate tested in this study, plus those by Nicholls *et al.* (1968), are too limited a sample. Testing results from a large number of inoculum sources would be needed to answer this question.

The needle rust fungus has developed forms or races that differ on the alternate hosts. Does it also differ on the pine hosts, i.e., do the races or forms infecting jack pine also infect red pine and the other hard pine species susceptible to needle-rust infection? If the rust called *C. asterum* is composed of "forms or races" that differ, not only in the genera of alternate hosts infected but also in the pine species infected, then it would seem questionable to regard the rust as a single species, unless the various races could interbreed and change. Attempts to answer this question would require pine host range inoculation studies using inoculum originating from known pine and alternate host sources.

To complicate the picture further, it has been shown that *Coleosporium viburni,* which causes a needle rust of jack pine indistinguishable in the field from *C. asterum,* has as its alternate host the Arrow-wood, *Viburnum cassinoides* L., Ouellette (1966).

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