A Search for Aecial Hosts of *Melampsora medusae* Among Some Conifers Grown in the Eastern United States

LOUIS SHAIN, Department of Plant Pathology, University of Kentucky, Lexington 40546-0091

ABSTRACT

Shain, L. 1988. A search for aecial hosts of *Melampsora medusae* among some conifers grown in the eastern United States. Plant Disease 72:904-906.

Epidemics of cottonwood leaf rust, caused by *Melampsora medusae*, occur annually in the central and southern United States at great distances from tamarack (*Larix laricina*), the recognized native aecial host in eastern North America. Eight conifer species (*Larix decidua, Pinus echinata, P. rigida, P. strobus, P. sylvestris, P. taeda, P. virginiana,* and *Tsuga canadensis*) grown in the eastern United States were planted around enclosures containing telia-laden, overwintered cottonwood leaves to determine if they could provide primary inoculum for southern epidemics by serving as aecial hosts. Aecia were observed annually on *L. decidua* during a 5-yr test period, but not at all on the other conifers tested. Previous reports on the occurrence of overwintered urediospores in Texas and of different physiological races of *M. medusae* in the north and south suggest that primary inoculum may be produced locally in areas far removed from tamarack. Species of larch planted in the central and southern states can provide some of this inoculum.

Melampsora medusae (Thüm.), a cause of poplar leaf rust, is a heteroecious, macrocyclic fungus that produces its uredial and telial stages on eastern cottonwood (*Populus deltoides* Bartr. ex Marshall) and trembling aspen (*Populus tremuloides* Michx.). Basidiospores, produced in the spring on germinated telia on overwintered poplar leaves, infect the coniferous, aecial host. Tamarack (*Larix laricina* (Du Roi) K. Koch) appears to be a favored aecial host of this native pathogen where this conifer shares an extensive common range with trembling aspen across northern North America, and a limited common range with eastern cottonwood. Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) is another favored aecial host in western North America (17). After the discovery of *Melampsora* rust on seedlings of *Pinus ponderosa* Douglas ex P. Lawson & Lawson in a tree nursery in British Columbia (7), Ziller (16) screened 21 conifers in six genera for their susceptibility to several *Melampsora* rusts, including *M. medusae*, by basidiospore inoculation of greenhouse seedlings. With the exception of *Pinus sylvestris* L., which is of European origin, and two exotic species of larch, all were native to northern or western North America. Aecia were produced on many of the western conifers and *P. sylvestris* as a result of these inoculations. The establishment of host ranges by greenhouse inoculations, however, should be viewed with caution because some plants that do not normally serve as hosts under natural conditions may do so in greenhouse tests (1). Two conifers native to the northeastern United States, *Pinus banksiana* Lamb. and *Pinus resinosa* Ait. also served as aecial hosts after inoculation of potted seedlings with basidiospores of *M. albertensis* Arth. (7) = *M. medusae* (16).

Leaf rust occurs on eastern cottonwood at great distances from known aecial hosts. Rust epidemics occur annually, for example, near the Gulf of Mexico (approximate latitude 30° N) (14) which is about 1,400 km south of the natural

range of tamarack (4). The source of primary inoculum for these epidemics is uncertain. Chitzanidis and Van Arsdel (3) suggested that urediospores are reintroduced annually from the north, but aeciospores were trapped at about the same time in the spring in Madison, WI, as they were in Yoakum, TX (6). Different physiological races of the pathogen, furthermore, were found in the central and southern portions of the natural range of eastern cottonwood (9,11). This would not be expected if urediospores introduced from the north were the only source of primary inoculum.

Overwintered urediospores are another possible source of primary inoculum for southern epidemics. Such urediospores were found in the Texas coastal plain (3), but sought for four years and not found near Stoneville, MS (14).

Conifers grown in the central and southern United States also may provide primary inoculum by serving as aecial hosts of *M. medusae*. Bald cypress (*Taxodium distichum* (L.) Rich.), a native of the lower Mississippi valley, did not serve as an aecial host in a previous greenhouse inoculation (14). *P. sylvestris*, however, was implicated as a host (16) and is grown in this area as an ornamental and in Christmas tree plantations. Many other conifers not included in previous tests occur naturally. The objective of this study, therefore, was to determine if some of these conifers can serve as aecial hosts under field conditions.

MATERIALS AND METHODS

Three enclosures were constructed to contain telia-laden leaves of eastern cottonwood. Each enclosure was a cube, 1.2 m on each side, constructed of lumber that supported a wide-mesh (approximately 5 × 8 cm) screen. Enclosures were positioned 1.2 m apart and filled to a depth of about 15 cm with fallen leaves collected in the late autumn from a cottonwood planting highly infected with leaf rust. Seedlings were planted around these structures before needle emergence in the spring at a spacing of 15 cm in rows at 30, 60, and 90 cm from each enclosure. The conifers included in this test were *L. decidua* Mill., *P. echinata* Mill., *P. rigida* Mill., *P. strobus* L., *P. sylvestris* L., *P. taeda* L., *P. virginiana* Mill., and *Tsuga canadensis* (L.) Carr. At least one row of each species, consisting of nine seedlings, was planted on one side of each enclosure, with the exception of *P. rigida*, which was planted in two rows for a total of 18 seedlings.

Three-month-old seedlings (germlings) of *L. decidua* and *P. sylvestris* were susceptible to *M. medusae* on the basis of previous greenhouse inoculations (16) and were considered as positive checks. *Tsuga canadensis*, an aecial host of *M. abietis-canadensis* (2), was not tested

previously as a host of *M. medusae*. Aecia, however, were produced on germlings of *T. mertensiana* (Bong.) Carr. upon inoculation with basidiospores of *M. medusae* (16).

Seedlings were examined for the presence of aecia several times after the emergence of current needles in the spring over a 5-yr period. Enclosures were replenished each autumn with infected cottonwood leaves from the same planting.

RESULTS AND DISCUSSION

Caeomatoid aecia were observed each year in late April/early May on the foliage of *L. decidua*. Inoculation of eastern cottonwood leaf tissue (12) with aeciospores collected from *L. decidua* resulted in the production of uredia and urediospores typical of *M. medusae* (2). Similar aecia were not seen during the 5 yr of observation on any of the other conifers in this test. Aecia of *Coleosporium solidaginis* (Schw.) Thüm., however, were observed during the fourth and fifth growing seasons on the previous years' foliage of *P. taeda*.

Germlings (16) and potted seedlings (13,14) of *L. decidua* served as hosts to *M. medusae* in previous inoculation studies. This appears to be the first report of *L. decidua*, a native of northern Europe, serving as an aecial host to this pathogen beyond the seedling stage (i.e., up to age 6 yr). Perhaps this is not surprising, as *L. decidua* is an aecial host for several European *Melampsora* spp. (8) and *Larix* is phylogenetically considered the favored genus for *Melampsora* among the recent genera of Abietaceae (5).

In other tests, *P. sylvestris*, like most other pines, served as a host as a germling (7,16), but, for the most part, not as a third-year seedling. For example, in one test, aecia were produced on juvenile needles of an adventitious shoot on a 3-yr seedling (7). If some species of pine can serve as a host only during a short juvenile period, it is not surprising that aecia were not found on the pines in the current study because seedlings were flushing into their second year at the beginning of this test. Observations at conifer nurseries near eastern cottonwood may resolve the susceptibility of germlings. I have not yet seen *Melampsora* aecia on germlings in my limited observations in such nurseries.

This study, therefore, did not uncover an obvious new aecial host among some conifers native to central and southern United States. It is possible, but perhaps unlikely, that such hosts exist on the basis of the representative conifers now tested.

The origin of primary inoculum for southern epidemics remains unclear. Even though urediospore transport over substantial distances has been documented (10), it seems unlikely that inoculum originating from northern areas, where

larch and cottonwood are sympatric, is totally responsible. Some southern movement would be expected and has been reported (6,15). The occurrence of uredia in the south at or before aecia appear in the north (6), as well as the occurrence of separate races in the north and south, argues against northern inoculum as the only source. It is conceded, however, that different races could become predominant as urediospores cycle on different host genotypes in a changing environment during a southern migration.

A case, nonetheless, can be made for a local contribution of primary inoculum in areas far removed from tamarack. Overwintered urediospores were reported in Texas (3) and may occur elsewhere. Larch are planted as ornamentals at a considerable distance south of the natural range of tamarack. In Lexington, KY, about 300 km south of this range (4), for example, an ornamental larch is within 30 m of an ornamental cottonwood. Aecia were observed on this larch followed by uredia on this cottonwood before rust was observed in a cottonwood planting about 15 km north. The race of *M. medusae* that occurred on the ornamental cottonwood and in the cottonwood planting was the same during several years of testing (Shain, *unpublished*). The frequency of this occurrence and its impact on available primary inoculum in the central and southern United States is uncertain, but may be significant.

LITERATURE CITED
1. Anikster, Y. 1984. The *formae speciales*. Pages 115-130 in: The Cereal Rusts. Vol. 1. Origins, Specificity, Structure, and Physiology. W. R. Bushnell and A. P. Roelfs, eds. Academic Press, Orlando, FL. 546 pp.
2. Arthur, J. C. 1934. Manual of the rusts in United States and Canada. Purdue Research Foundation, Lafayette, Indiana.
3. Chitzanidis, A., and Van Arsdel, E. P. 1970. Autumn introduction and winter survival of poplar rust on the Texas coastal plain. (Abstr.) Phytopathology 60:582.
4. Fowells, H. A. 1965. Silvics of forest trees of the United States. USDA Agric. Handb. 271. 762 pp.
5. Leppik, E. E. 1953. Some viewpoints on the phylogeny of rust fungi. I. Coniferous rusts. Mycologia 45:46-74.
6. McCracken, F. I., Schipper, A. L., and Widin, K. D. 1984. Observations on occurrence of cottonwood leaf rust in central United States. Eur. J. For. Pathol. 14:226-233.
7. Molnar, A. C., and Sivak, B. 1964. *Melampsora* infection of pine in British Columbia. Can. J. Bot. 42:145-158.
8. Peace, T. R. 1962. Pathology of trees and shrubs. Clarendon Press, Oxford. 753 pp.
9. Prakash, C. S., and Thielges, B. A. 1987. Pathogenic variation in *Melampsora medusae* leaf rusts of poplars. Euphytica 36:563-570.
10. Roelfs, A. P. 1985. Epidemiology in North America. Pages 403-434 in: The Cereal Rusts. Vol. II. Diseases, Distribution, Epidemiology, and Control. A. P. Roelfs and W. R. Bushnell, eds. Academic Press, Orlando, FL. 606 pp.

11. Shain, L. 1978. Mechanisms of resistance in forest trees to pathogenic fungi. Pages 132-133 in: Kentucky Agric. Exp. Stn. Rep. 1977.

12. Shain, L., and Cornelius, P. L. 1979. Quantitative inoculation of eastern cottonwood leaf tissue with *Melampsora medusae* under controlled conditions. Phytopathology 69:301-304.

13. Spiers, A. G. 1975. Species of *Melampsora* infecting conifers in New Zealand. Plant Dis. Rep. 59:486-488.

14. Toole, E. R. 1967. *Melampsora medusae* causes cottonwood rust in lower Mississippi valley. Phytopathology 57:1361-1362.

15. Widen, K. D., and Schipper, A. L., Jr. 1980. Epidemiology of *Melampsora medusae* leaf rust of poplars in north central United States. Can. J. For. Res. 10:257-263.

16. Ziller, W. G. 1965. Studies of Western Tree Rusts (VI). The aecial host ranges of *Melampsora albertensis*, *M. medusae*, and *M. occidentalis*. Can. J. Bot. 43:217-230.

17. Ziller, W. G. 1974. The tree rusts of western Canada. Can. For. Serv. Publ. 1329. 272 pp.