Incidence and severity of Melampsora leaf rust of poplar grown under controlled conditions

*K.F. Chang[1], S.F. Hwang[2] and **M.E.** Neuwirth[2]*

Poplar leaf rust caused by *Melampsora occidentalis* was epidemic in a nursery near Edmonton, Alberta in 1988. All six poplar clones grown under controlled conditions suffered, to varying degrees, from Melampsora rust. Average percent incidence and disease severity were 79% and 1.22 (on a scale of 0-4), respectively.

Can. Plant Dis. Surv. 69:2, 121-124, 1989.

En 1988, on a observe un foyer d'infection de la rouille des feuilles du peuplier causee par *Melampsora occidentalis* dans une pepiniere situee pres d'Edmonton (Alberta). Les six clones de peupliers cultivés dans des conditions contrôlées ont été attaques par la rouille causee par *Melampsora* à des degres divers. Le pourcentage moyen d'incidence et la gravité de la rnaladie ont été respectivement de 79 % et 1,22 (selon une echelle de 0 a 4).

Introduction

Poplar leaf rust caused by species of *Melampsora* Cast. is one of the most serious foliage diseases of poplar *(Populus* spp.) (2, 12). Heavy rust infections not only cause premature defoliation and growth suppression of the poplar, but also predispose it to cold injury and secondary pathogens such as *Cytospora* and *Dothichiza* (2, 4, 6, 7).

When poplar seedlings are grown in protected environments such as a lathhouse or intensively managed nurseries, natural selection due to disease is often precluded (7). However, in 1988, Melampsora rust was epidemic on some poplar clones grown in a nursery near Edmonton, Alberta. Studies were therefore undertaken to determine the identity, incidence and severity of Melampsora rust on various clones of poplar and hybrids.

Materials and methods

All six clones of poplars used in this investigation were established with stem cuttings collected in the early winter of 1987 (9). In May 1988, seedlings of *P. trichocarpa* Torr. and Gray, and *P. balsamifera* L. clones were grown in a lathhouse in 15-cm-diameter plastic pots containing a peatmoss and perlite mixture (1:1, vlv) with the following ingredients: lime (1.5 g/L), calcium carbonate (0.5 g/L), gypsum (1.6 g/L), super phosphate (1.36 g/L), potassium nitrate (0.11 g/L), potassium bicarbonate (1.5 g/L), chelated micronutrients (0.06 g/L) and iron (0.07 g/L). Seedlings of the remaining four clones – *P. deltoides* Bartr., *P. deltoides* x *P. balsamifera* cv. Northwest, *P. deltoides* x *P. petrowskyana* Brooks No. 1 and No. 6 – were planted in the field. Fifty rows of each clone were planted in separate plots 110 m wide by 20 m long. Seedlings were placed 20 cm apart in the rows spaced 40 cm apart. Plots were separated by a 10 m strip that was kept harrowed throughout the growing season.

Using a W-pattern transect through the lathhouse and each clone plot, 10 seedlings at each of 10 sites were visually assessed for disease incidence. Ten leaves from the middle portions of the hundred seedlings of each clone were evaluated for severity of Melampsora rust. Severity ratings were assigned based on a scale of 0 to 4 where 0 = clean, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76-100% of leaf area infected with rust (Figs. 1-4).

Species determinations were carried out by examining morphological characteristics of urediniospores. Leaf segments with uredinial pustules were fixed in 2% glutaraldehyde in 0.1 M cacodylate buffer at pH 7.2 for 16 h, washed in 0.1 M cacodylate buffer pH 7.2, and postfixed in 1% osmium tetroxide in the same buffer for 4 h. The samples were then dehydrated through an ethanol series, critical point dried (using liquid CO_2 as transitional fluid), and affixed to metal stubs with silver paint. The specimens were sputter coated with gold (15 nm thick) and examined and photographed with a Hitachi S510 SEM.

Results and discussion

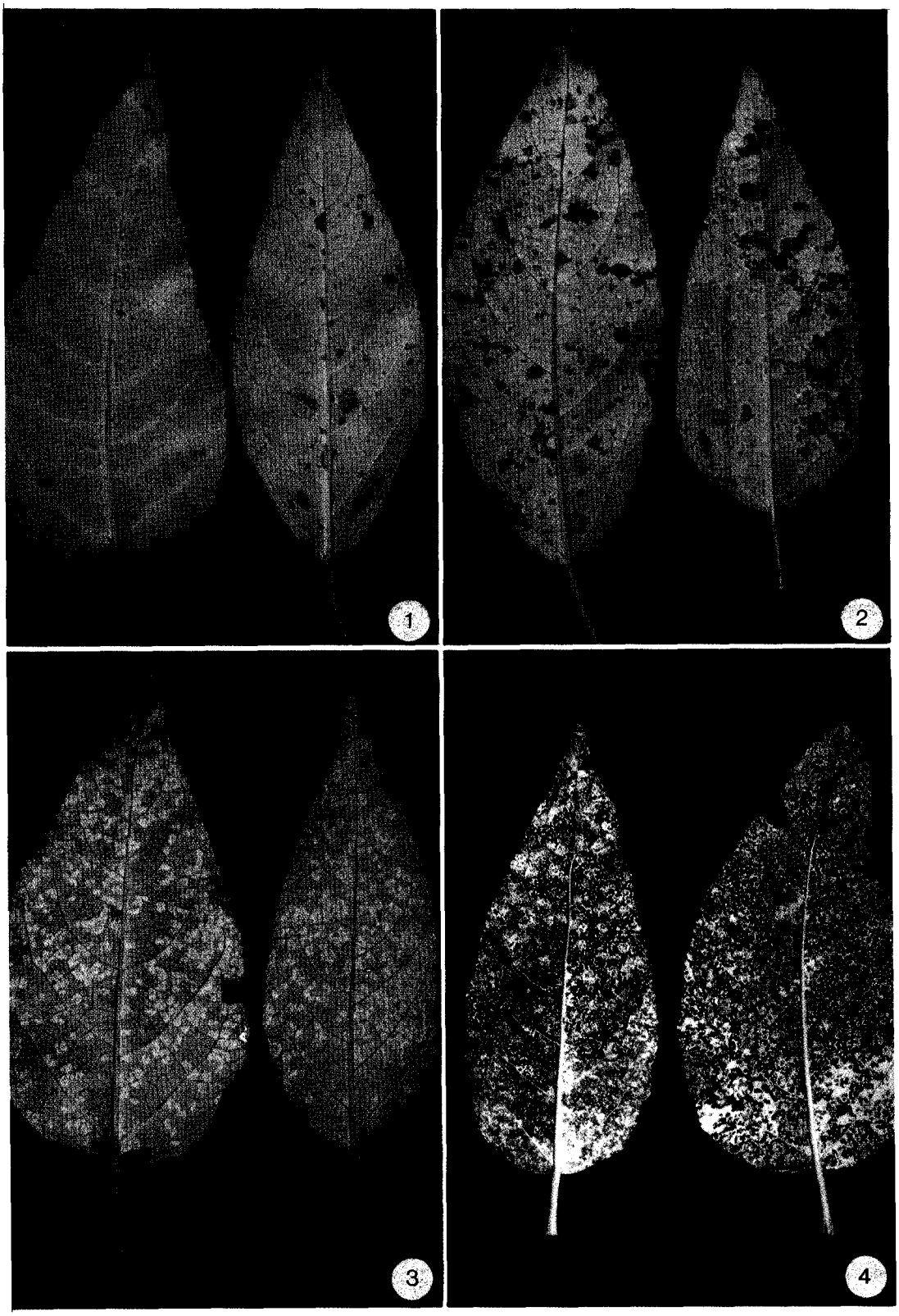
Uredinial pustules on leaves were first noticed in July 1988, and the level of rust infection of poplar clones was low. By Sept. 1988, all six clones of poplars suffered, to varying degrees, from Melampsora rust (Table 1). ***P. deltoides* x** *P. petrowskyana* Brooks No. 1 and No. 6 had the least disease with percent incidence and severity ratings of 38% and 0.38, and 50% and 0.51, respectively, whereas *P. balsamifera* and *P. trichocarpa* had the most at 100% and 2.35, and 100% and 1.91, respectively. Overall, disease incidence and severity of Melampsora rust averaged 79% and 1.22 (on scale of 0-4), respectively.

Poplar leaf rust was easily recognized throughout most of the growing season by the bright orange-yellow urediniospores, which appeared as powdery masses on the lower surface of infected leaves. Very few uredinia developed on the upper surface of leaves. Urediniosporeswere produced in uredinia which had broken through the leaf epidermis (Fig. 5). Uredinia were mainly hypophyllous and were often in clusters. Mature urediniospores were covered with minute spines, most of which were perpendicular to the spore surface, although

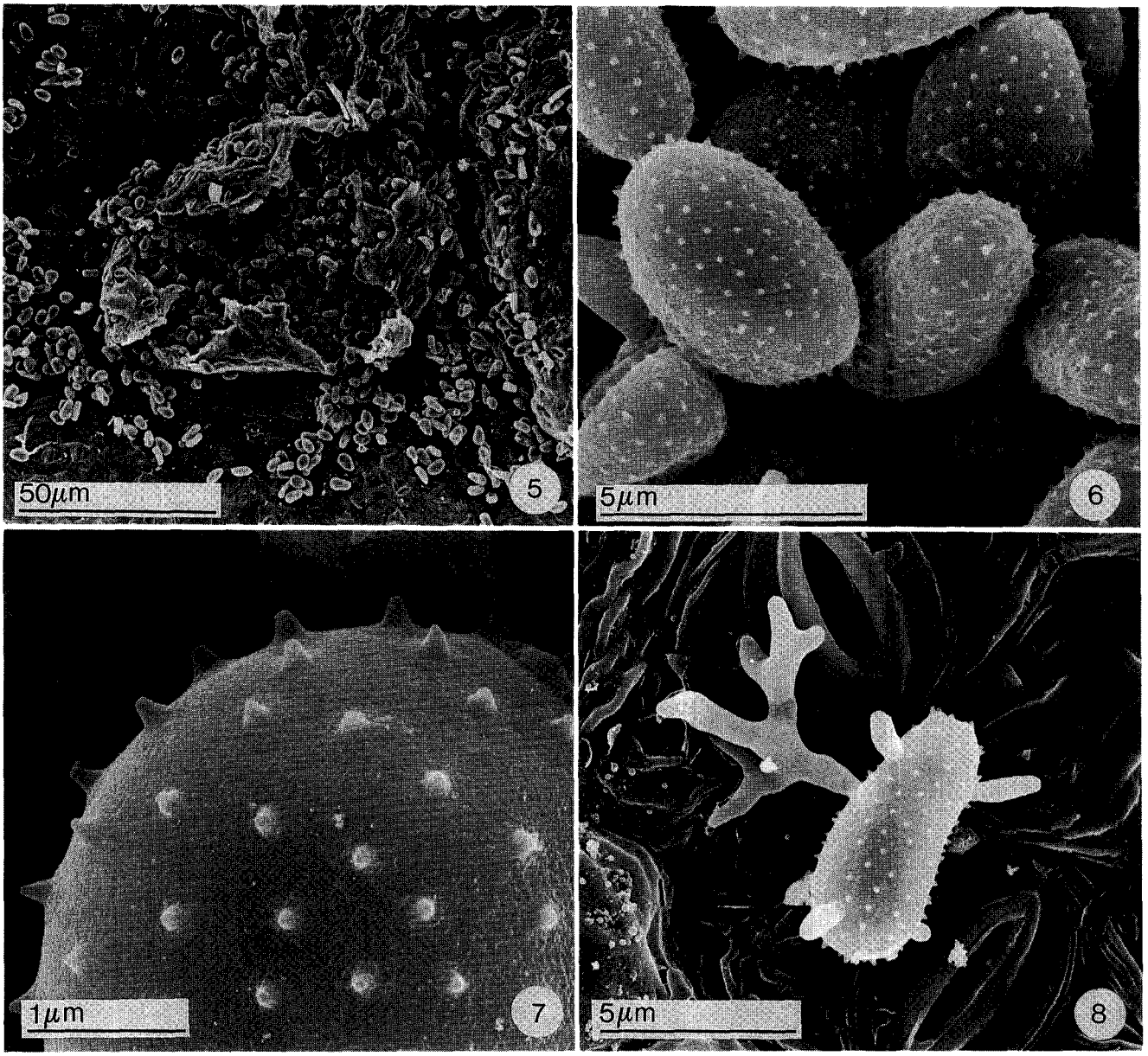
[1] *Alberta Tree Nursery and Horticulture Centre, R.R. **6,** Edmonton, Alberta, Canada T5B 4K3.*

[2] *Alberta Environmental Centre, Vegreville, Alberta, Canada TOB 4LO.*

Accepted for publication February 14, 1989.



Figs. 1-4. Disease severity ratings of 0-4 of *Melampsora occidentalis* on the lower surface of the leaves of *Populus balsamifera* where *0* = clean, 1 = 1-25% (Fig. 1), 2 = 26-50% (Fig. 2), 3 = 51-75% (Fig. 3), and 4 = 76-100% (Fig. 4) of the leaf area rusted.



Figs. 5-8. Uredinial state of *Melampsora occidentalis*.

Fig. 5. Mature uredinia on leaf surface. Note hundreds of urediniospores within the uredinia. x600

Fig. 6. Mature urediniospores covered with spines. x8000

Fig. 7. Higher magnification of the mature urediniospore covered with spines. x24000

Fig. 8. The mature urediniospore showing the germ tubes. x6000

Table 1. Disease incidence and severity of 'Melampsora rust on different clones of poplar.

Clone	Incidence %	Severity Rating*
Populus balsamifera	100	2.35
P. trichocarpa	100	1.91
P. deltroides x *P. balsamifera* cv. Northwest	99	1.26
P. deltroides	84	0.92
P. deltroides x *P. petrowskyana*		
Brooks No. 1	38	0.38
Brooks No. 6	50	0.51
Average	79	1.22

*Melampsora rust severity rating scale: 0 = clean, 1 = 1–25%. 2 = 26–50%, 3 = 51–75%, and 4 = 76–100% of the leaf area rusted.

some extended at various angles (Fig. 6). The spines were evenly distributed over the entire spore surface (Fig. 7). Germ pores were not observed, but germ tubes were seen from scattered points on the spore surface (Fig. 8). Dark brown to black telia were also observed on hanging or fallen leaves in late fall and early winter.

Based on the morphological characteristics of urediniospores (14), *M. occidentalis* Jacks. was the only species of Melampsora found in the nursery. This confirms an earlier study (14) which indicated two species of Melampsora occur in Canada: M. *occidentalis* in the west, and M. medusae in the east. The very high incidence and severity of Melampsora rust on some poplar clone seedlings grown in the nursery confirms earlier reports that high-density planting can lead to more severe rust infestations (7). As a precaution, poplar seedlings should not be planted too densely. M. *occidentalis* has been reported to have a wide host range and occurs only in areas where its alternate coniferous hosts grow (9, 11, 13). It has been suggested that poplar plantations should be no closer than 0.8 km to the nearest alternate host (7).

Clones of *P.* deltoides x *P. petrowskyana* Brooks No. 1 and No. 6 were resistant while clones *P.* balsamifera, *P.* trichocarpa, and *P.* deltoides x *P.* balsamifera cv. Northwest were highly susceptible. On the resistant clones, fewer sori developed and defoliation was not as severe as on the susceptible clones. These results confirm previous studies that poplar clones vary in their resistance to Melampsora leaf rust (6, 8). Moreover, resistance of poplars to Melampsora rust has been reported to be under strong genetic control and not to be readily overcome in genetically uniform plantations (1, 3, 7). Since the use of rust-resistant poplar clones offers the most promising means of controlling the disease (1, 6, 7), selection and breeding programs should emphasize not only rapid height and diameter growth, but also rust resistance. Because different leaf rust species and biotypes exist in various regions (5, 10, 14), leaf rust resistance must be evaluated on a regional basis.

Acknowledgements

We thank Mr. G. Grainger and Mr. H. Philip for their valuable suggestions on the manuscript.

Literature cited

1. Hsiang, T., and B.J. van der Kamp. 1985. Variation in rust virulence and host resistance of *Melampsora* on black cottonwood. Can. J. Plant Pathol. 7:247-252.
2. Hubbes, M., R.S. Jeng, and L. Zsuffa. 1983. Melampsora rust in poplar plantations across southern Ontario. Plant Dis. 67:217-218.
3. Jokela, J.J. 1966. Incidence and heritability of Melampsora rust in *Populus deltoides* Bartr. Pages 111-117 *In*: Breeding pest-resistant trees. H.D. Berhold, E.J. Schreiner, R.E. McDermott, and J.A. Winieski., eds., Pergamon Press, New York.
4. Nagel, C.M. 1949. Leaf rust resistance within certain species and hybrids of *Populus*. Phytopathology 39:16.
5. Prakash, C.S., and B.A. Thielges. 1987. Pathogenic variation in *Melampsora medusae* leaf rusts of poplars. Euphytica 36:563-570.
6. Schipper, A.L. Jr., and D.H. Dawson. 1974. Poplar leaf rust — a problem in maximum wood fiber production. Plant Dis. Reptr. 58:721-723.
7. Schipper, A.L. Jr. 1976. Foliar diseases of periodic importance to *Populus deltoides* and its hybrids. Pages 234-244 *In*: Proceedings: symposium on eastern cottonwood and related species. B.A. Thielges and S.B. Land Jr., eds., Louisiana State Univ. Press, Baton Rouge, Louisiana.
8. Shain, L. 1976. Etiology, epidemiology and control of Melampsora rust of cottonwood. Pages 189-198 *In*: Proceedings: symposium on eastern cottonwood and related species. B.A. Thielges and S.B. Land Jr., eds., Louisiana State Univ. Press, Baton Rouge, Louisiana.
9. Shain, L. 1988. A search for aecial hosts of *Melampsora medusae* among some conifers grown in the eastern United States. Plant Dis. 72:904-906.
10. Sharma, J.K., and W.A. Heather. 1977. Infection of *Populus alba* var. *hickeliana* by *Melampsora medusae* Thum. Eur. J. For. Pathol. 7:119-124.
11. Sinclair, W.A., H.H. Lyon, and W.T. Johnson. 1987. Diseases of trees and shrubs. Cornell Univ. Press, Ithaca and London.
12. Toole, E.R. 1967. *Melampsora medusae* causes cottonwood rust in lower Mississippi Valley. Phytopathology 57:1361-1362.
13. Walker, J., D. Hartigan, and A.L. Bertus. 1974. Poplar rusts in Australia with comments on potential conifer rusts. Eur. J. For. Pathol. 4:100-118.
14. 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.