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Identification and Status of the Introduced Black Pine, *Pinus nigra*, and Mugo Pine, *Pinus mugo*, in Ontario

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Recent reference texts and other sources are contradictory regarding the spread of *Pinus nigra* and *Pinus mugo* from cultivation in Ontario. Both species have reproduced from plantings along roadsides but neither has been observed to occupy habitats in Ontario to the substantial reduction or exclusion of native species, or to substantially invade natural habitats. The more widely planted Black Pine has been recorded spreading at 24 localities throughout the eastern part of southern Ontario. Mugo Pine is reported spreading at 18 locations. Although evidently much less aggressive than Scots Pine (*Pinus sylvestris*), both Black and Mugo pines have a potential for negative impact on biodiversity in dry, rocky or sandy habitats, especially in connection with extensive plantings. A key for the identification of two-needle pines is included. Both *P. nigra* and *P. mugo* are highly variable and reported to hybridize extensively with other species.

Key Words: Black Pine, Austrian Pine, *Pinus nigra*, Mugo Pine, *Pinus mugo*, Scots Pine, *Pinus sylvestris*, spreading, invading, alien, naturalized, woody plants, Ontario.

Introduced woody plants are increasingly a source of questions relating to identification, status, distribution, and general biology. In many cases, authoritative answers to the questions are not readily available. Accurate information is important because invasive alien woody plants are a major threat to Canadian native biodiversity (Catling 1997). Some are also of importance with respect to agriculture, horticulture and/or forestry. The introduced Black Pine (*Pinus nigra* Arnold) and Mugo Pine (*Pinus mugo* Turra) provide a good example. They are both important, particularly in landscaping, but their current status, potential to spread from cultivation and their distinguishing features are not well known.

Status of Black Pine and Mugo Pine in North America

A tree to 30 m high with a rounded crown, Black Pine, also called Austrian Pine, is native to Eurasia and north Africa from Spain and Morocco east to eastern Turkey and north to Austria (Dallimore et al. 1966; Farjon 1984; Mirov 1967, map). It has been planted in North America for dune stabilization, forestry and horticultural purposes (Burns and Honkala 1990), and is currently one of the most common introduced ornamentals in the United States (van Haverbeke 2002*).

Kral (1993) does not include Black Pine in the key and species accounts in his recent work on North American pines, but he does make reference to it being naturalized in Illinois and notes characteristic features under general notes on the genus. Gleason and Cronquist (1991) do not include Black Pine in their key, but allude to it as a local escape under Red Pine. Farrar (1995) indicates that it is not spreading in Canada. Black Pine is actually much more widely escaped than these standard references suggest (Figure 1). It is naturalized throughout the Great Lakes states (e.g., Burns and Honkala 1990; Swink and Wilhelm 1994; Mitchell and Tucker 1997; Parfitt and Wade 2000; Leege and Murphy 2001) and in New England (e.g., Haines and Vining 1998, van Haverbeke 2002*), in the Pacific Northwest (Petrides and Petrides 1998) and it has been listed as an invading species in Canada (Catling 1997).

Mugo (Mugho) Pine, also known as Mountain Pine, is native to the mountains of central Europe and the Balkan peninsula. It is not included in the North American flora by Kral (1993), presumably because it had not been reported as spreading. It is widely used in landscaping and in stabilization of steep slopes. However, it was listed as spreading in Canada (Catling 1997) based on observations in Ontario.

The Ontario plant list (Newmaster et al. 1998) gives the status of both Black Pine and Mugo Pine as "ornamental", there defined as "plants that have escaped from gardens" (page 18), but this category has evidently been applied to plants that persist after cultivation in Ontario, as well as to those that spread. The authors were unaware of any case of these pines spreading (personal communication). Thus the 5-20 occurrences suggested by the provincial rank of "SE2" and "SE1" for Black Pine and Mugo Pine (respectively) refer to populations persisting after cultivation since the number of locations of plantings in Ontario is certainly in the many hundreds for both species.

Even when included in texts the two species have not been adequately compared with similar species. For example, both Japanese Black Pine (*P. thunbergii* Parlatore) and Japanese Red Pine (*P. densiflora* Siebold & Zuccarini) have escaped from cultivation in

FIGURE 1. A ten-year-old Black Pine (*Pinus nigra*) spread from a 30-year-old roadside planting along highway 7 in Hastings County, Ontario, Canada. Photo by P. M. Catling.

northeastern North America, and both could be confused with Black Pine but are not included in available keys.

A continuing assessment of the impact of these two alien pines in Ontario is desirable since they are currently being planted widely in North America. For example several million trees of Black Pine are produced annually in the United States (van Havenbeke 2002*). Assessment of impact is dependent upon a better understanding of both status and identification. The following work addresses these needs.

Methods

Literature on Black and Mugo Pines was reviewed in order to place occurrence and status within Ontario in a global context, and to provide information for identification. An identification key was prepared based on published studies and examination of specimens.

Locations in Ontario where young trees of Black Pine and Mugo Pine were growing near older plantings were recorded. Voucher specimens were collected and deposited in the Agriculture and Agri-Food Herbarium (DAO) in Ottawa.

Curators of various herbaria with significant Ontario collections including CAN, DAO, HAM, OAC, QK, TRT, TRTE, UWO, and WAT (acronyms from Holmgren et al. 1990), were contacted with a request to examine their holdings and databases for information on Black Pine spreading from cultivation. Field botanists and natural resource biologists were also contacted to find out if they had observed escaping populations.

Results and Discussion

(1) Beneficial and detrimental aspects

Beneficial Aspects

Both Black and Mugo Pines are widely recognized as valuable ornamental plantings due to resistance to pollution and high tolerance of de-icing salt spray along roadsides. Black Pine may be the most pollution-tolerant species of pine (Earle 2001*). Both species have also been recommended for use as windbreaks and as bioindicators of environmental pollution (Micieta and Murin 1998). Black Pine has also been recommended as a useful tree for tracking climatic change on a local scale (Levanic 1999; Collins et al. 2000).

Forestry Importance

Black Pine is the primary host of *Diplodia* tip rust in parts of the Great Lakes region (Vujanovic et al. 2000; Michigan State University http://www.msue.msu.edu/msue/imp/mod03/01701195.html). This rust infects native pines and other conifers. Among the recommended control measures is the use of native plantings instead of exotic plantings.

Biodiversity Importance

In Allegan County, Michigan, where 26 000 Black Pine trees were planted in a dune system between 1956 and 1972, and where the trees are now reproducing and spreading, the pine stands have been associated with a reduced cover of dune vegetation and depressed species richness (Leege and Murphy 2001). There was also evidence for modification of dune habitats at this site and the stands of introduced pines appeared to be functionally different from native tree stands. "Reproduction and naturalization of this tree in large numbers" has occurred in Illinois Beach State Park, Lake County, Illinois (Swink and Wilhelm 1994). An impoverished native seedbank has been reported in soils under Black Pine planted in natural dolomite grasslands in Hungary (Csontos et al. 1997).

Alien conifers replacing natural plant communities are a major problem in New Zealand (Hunter and Douglas 1984) where a recent study found that control of Black Pine required greater herbicide applications than were required to control other spreading conifers (Langer 1992). Both Mugo Pine and Black Pine are alien species of major concern to the conservation of natural habitats in New Zealand and extensive control programs are in effect (e.g. New Zealand Department of Conservation 2002*).

(2) General Survey Results

Both Black Pine and Mugo Pine were found to have spread from cultivation at a number of sites (Figures 2 and 3). There was no recent evidence of planting or cultivation in any of these areas. Most of these sites were old field or woodland edge habitats along roads. At many locations the young trees were of different ages from 1 to 20 years. They were not equidistant, but in patches and/or close together and near the putative parent. These observations support the conclusion that they had spread naturally from the plantings.

Remarkably, there was not a single herbarium specimen of either Black Pine or Mugo Pine in any of the collections surveyed that had a label suggesting escape. The potential for trees to be invasive is not immediately apparent because of the time that it takes to reach reproductive maturity. In the case of Black Pine, trees can reproduce as early as 15-20 years of age, or can delay until much later (Vidakovic 1974). It appears that spread of Black Pine in Ontario has occurred only over the past few decades. Good seed production in Black Pine occurs every 3-5 years (Kerr 2000). The delay as well as periodicity in ample seed production, may partially explain the lack of herbarium collections.

Nevertheless, the lack of observation, considering that many established trees that had evidently spread from plantings were over 10 years of age, suggests that invasive species are easily overlooked, and that the manpower available to document invasion is limited. Although invasive plants are a serious ecological problem, much more effort is currently devoted to documentation of rare native species.

(3) Occurrence of Black Pine in southern Ontario

Spread of Black Pine, although not frequent, has occurred over an extensive area of southern Ontario (Figures 1 and 2). The vouchers and most other trees examined were referable to var. *nigra*, which is to be expected since most of the North American plants originate from seeds collected in Austria (van Haverbeke 2002*). Those records for which vouchers are available include:

ONTARIO: HASTINGS: Hwy 7 at Madoc turnoff, 44.5250°N, 77.4176°W, old trees of similar age (30 years) and 20 young trees 2-8 years old, 22 Oct. 2001, *P. M. Catling 2001-4* (DAO); Hwy 7, E of Madoc turnoff, 44.5036°N, 77.5071°W, at this site there were about 30 old trees of similar age (30 years) and 10 young trees 1-8 years old, 22 Oct. 2001, *P. M. Catling 2001-5*, (DAO); Hwy 7 near Black River, 44.5395°N, 77.3711°W, 6 year old tree escaped from roadside plantings, 22 Oct. 2001, *P. M. Catling* (DAO). Hwy 7 near Madoc, 44.4943°N, 77.6405°W, at least 50 young plants, many seedlings, within 30 m of a large planted tree, 22 Oct. 2001, *P. M. Catling 2001-10* (DAO). OTTAWA-CARLETON: Hwy 417 and Boundary Road, 1 km S of Vars, 45.3379°N, 75.3447°W, 16 May 2002, *P. M. Catling & V. R. Brownell* (DAO). UNITED COUNTIES OF STORMONT, DUNDAS, AND GLENGARRY: S side of hwy 401 W of Cornwall, 45.0556°N, 74.8006°W, two 3-year-old seedlings under seven 30 year old planted trees, 29 Sept. 2001, *P. M. Catling* (DAO); Hwy 43, 3 km W of Avonmore, 45.1613°N, 75.0214°W, 15 May 2002, *P. M. Catling & V. R. Brownell* (DAO).

In addition to these vouchered observations, 17 sight records of young trees spread from cultivation are plotted on the accompanying map (Figure 2).

(4) Occurrence of Mugo Pine in southern Ontario

Although it is widely cultivated and capable of reproducing when only 10 years of age, there are relatively few records of Mugo Pine escaping from cultivation in Ontario (Figure 3). All three subspecies are represented by escapes in Ontario. Those records for which vouchers are available include:

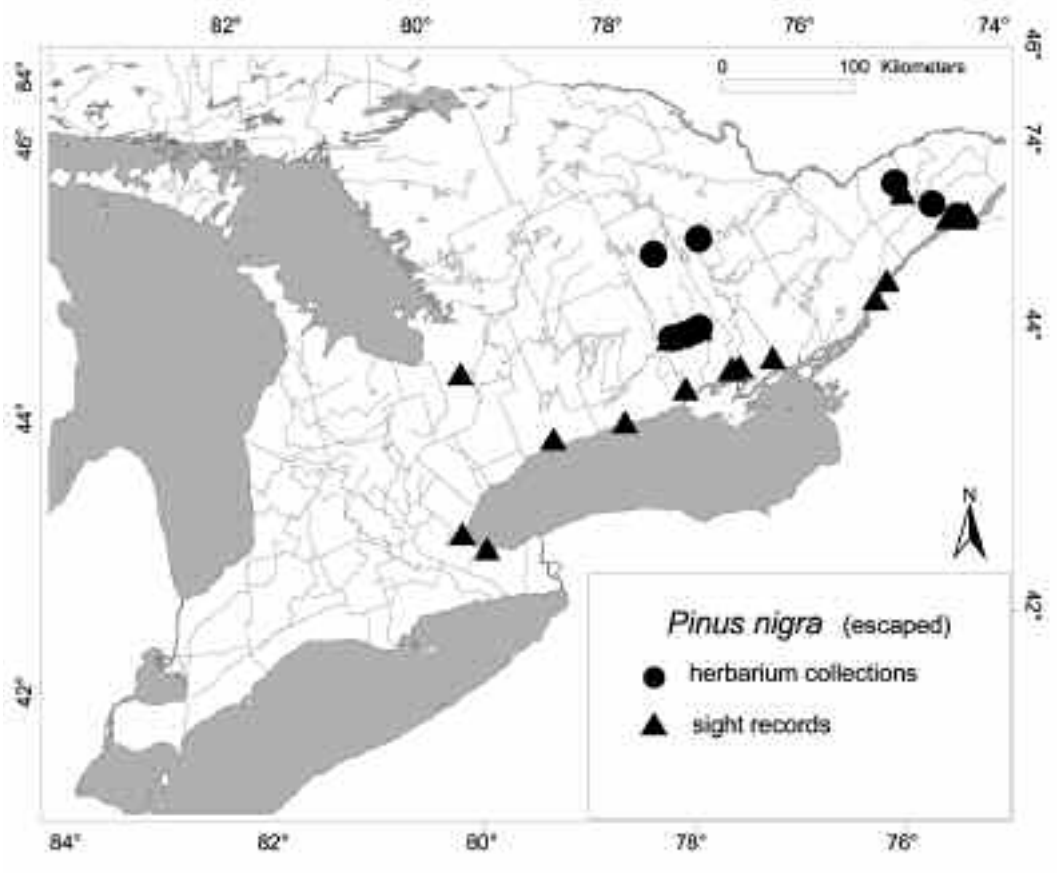

FIGURE 2. Central and eastern portions of southwestern Ontario showing locations where Black Pine (*Pinus nigra*) has escaped from cultivation. Escaped occurrences supported by herbarium specimens at DAO, Agriculture and Agri-food Canada, Ottawa, are indicated with a solid dot. Sight records of the author are indicated by solid triangles.

ONTARIO: HASTINGS: Hwy 7 east of Marmora, 44.4943°N, 77.6566°W, escaped from plantings, 22 Oct. 2001, *P. M. Catling 2001-20* (DAO *sub* subsp. *mugo*); Hwy 7 east of Marmora, 44.4943°N, 77.6566°W, from a 10 year old escaped plant with cones with apophysis hooked and recurved, accompanied by seedlings beneath a plant referable to subsp. *uncinata*, 22 Oct. 2001, *P. M. Catling 2001-11* (DAO *sub* subsp. *uncinata*); 13 km east of Marmora along Hwy 7, 44.5033°N, 77.5116°W, this branch collected from a small sapling ½ m tall, evidently escaped from planted shrubs 5 m tall within 20 m, many young plants 1-10 years old, 22 Oct. 2001, *P. M. Catling 2001-8-2* (DAO *sub* nothosubsp. *rotundata*); Hwy 7 east of Marmora, 44.4943°N, 77.6566°W, ½ year old plant, escaped from roadside plantings, 22 Oct. 2001, *P. M. Catling 2001-11*, (DAO *sub* nothosubsp. *rotundata*); UNITED COUNTIES OF LEEDS AND GRENVILLE: 2 km NE of Brockville, 44.6263°N, 75.6608°W, shrub approx. 10 years old, escaped from plantings, 27 April 2002, *P. M. Catling* (DAO *sub* subsp. *mugo*).

In addition to these vouchered observations, 13 sight records of young trees spread from cultivation are plotted on the accompanying map (Figure 3).

(5) Identification

Not all pines are easily identified. The most useful texts for identification are Shaw's (1914) well-illustrated compendium and the classic handbook by Dallimore et al. (1966). Cope (1986) also provides a key to all of the species cultivated in the northeast and a list of cultivars and their characteristics. Different authors have used different characters to distinguish the Asian species, and a comprehensive taxonomic study is needed. The following provisional key, derived from both previously published work and examination of specimens, will help to distinguish Black and Mugo Pines from similar two-needle pines including some that may have been overlooked.

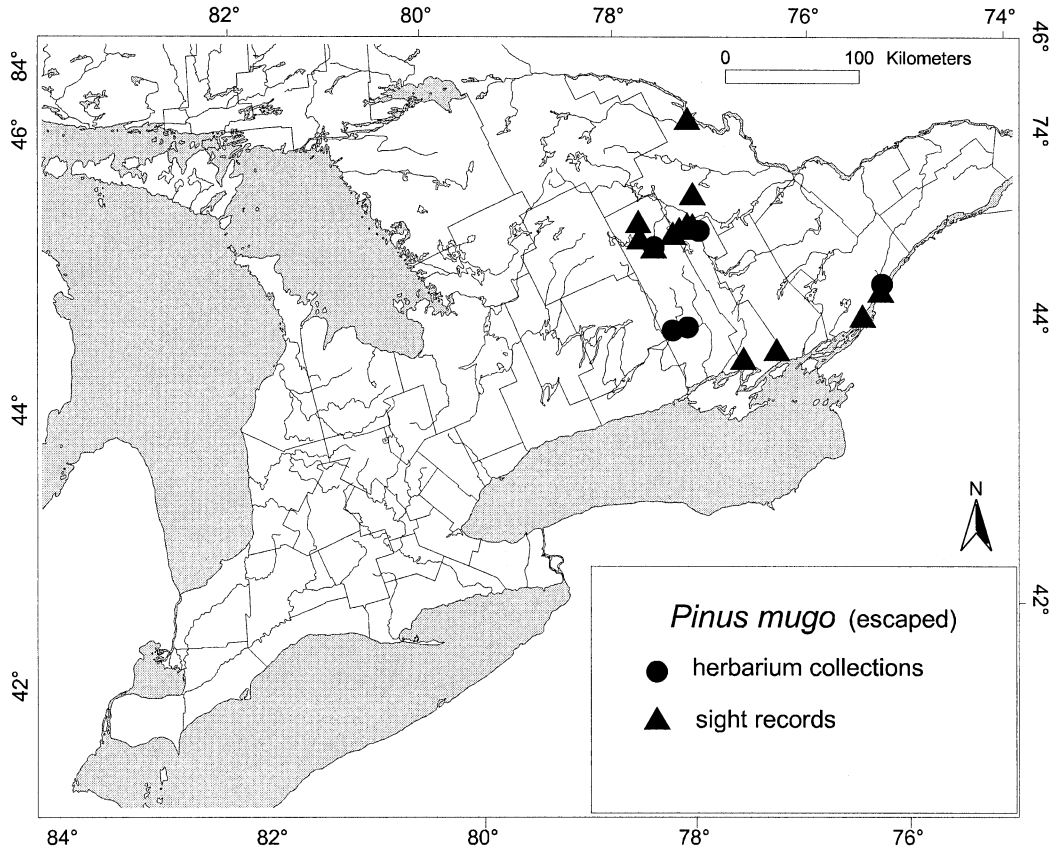

FIGURE 3. Central and eastern portions of southwestern Ontario showing locations where Mugo Pine (*Pinus mugo*) has escaped from cultivation. Escaped occurrences supported by herbarium specimens at DAO, Agriculture and Agri-food Canada, Ottawa, are indicated with a solid dot. Sight records of the author are indicated by solid triangles.

1a. Leaves 7.5-18 cm long . . . . . 2.
2a Needles snap when bent 180° (at least in *P. resinosa*); cones with or without prickles (recurved hook at centre of umbo[2]) on subterminal scales (Figure 4); resin canals marginal[4]; winter buds more or less reddish-brown . . . . . 3.
3a. Twigs glaucous; cones usually with prickles (recurved hook at centre of umbo[2]) on subterminal scales; . . . . . *Pinus densiflora* Siebold & Zuccarini, JAPANESE RED PINE
3b. Twigs not glaucous; cones without prickles (recurved hook at centre of umbo[2]) on subterminal scales . . . . . *Pinus resinosa* Ait., RED PINE
2b. Needles do not snap when bent 180°, but simply fold and either crease and remain somewhat folded, or regain their original straight appearance upon release; cones with prickles (recurved hook at centre of umbo[2]) on subterminal scales (Figure 4); resin canals median[3]; winter buds pale silvery . . . . . 4.
4a. Seed cones sessile with rounded base; terminal bud resinous; basal leaf sheath ending in a single elongated tip; scales of winter buds reddish-brown with white edges . . . . . *Pinus nigra* Arnold, BLACK PINE
4b. Seed cones with stalks and truncate at the base; terminal bud not resinous; basal leaf sheath ending in two long filaments; scales of winter buds white . . . . . *Pinus thunbergii* Parlatore, JAPANESE BLACK PINE
1b. Leaves relatively short, 2-7.5 cm long . . . . . 5.
5a. Resin canals median[3] (Figure 5) . . . . . *Pinus nigra* Arnold, BLACK PINE
5b. Resin canals marginal or submarginal[4] (Figure 5) . . . 6.
6a. Needles blue-green, often twisted; cones straight; upper bark orange-brown; twigs pale yellowish or greenish . . . . . *Pinus sylvestris* L., SCOTS PINE
6b. Needles green, not twisted; cones straight or curved; upper bark brown; twigs dark brown or greenish . . . . 7.
7a. Needles twisted; cones curved . . . . . *P. banksiana* Lamb., JACK PINE
7b. Needles not twisted; cones straight . . . . . 8.
8a. Leaf margins long-tapered and pointed at the apex; leaf sheaths early deciduous leaving pale leaf bases on older branches; seeds not winged . . . . . *P. edulis* Engelmann, NUT PINE
8b. Leaf margins abruptly tapered and somewhat rounded at the apex; leaf sheaths persistent and therefore bases not pale; seeds winged . . . . . 9.

9a. Cones 2-5 cm long, symmetrical at the base; apophysis[1] flat or slightly elevated but not recurved and hooked (Figure 6) . . . . . *P. mugo* Turra subsp. *mugo* DWARF MUGO (MOUNTAIN) PINE

9b. Cones 2.5-7 cm long, oblique at the base; apophysis prominently recurved and hooded or hooked (Figure 6) . . . . . 10.

10a. Apophysis[1] on basal part of outer side of cone hooked and recurved . . . . *P. mugo* Turra subsp. *uncinata* (Ramond) Domin, SWISS MUGO (MOUNTAIN) PINE

10b. Apophysis[1] rounded and hooded . . . . . *P. mugo* Turra nothosubsp. *rotundata* (Link) Janchen & Neumayer, HYBRID MUGO (MOUNTAIN) PINE

[1] The apophysis is the part of the seed scale that is exposed in a mature closed cone.

[2] The umbo is a protuberance on the exposed part of the scale (in an unopened cone) representing the apex of the growth of the first year. Cones of most pines take two years to mature.

[3] in middle of mesophyll between hypodermis and endodermis.

[4] outer edge of mesophyll adjacent to epidermis and hypodermis.

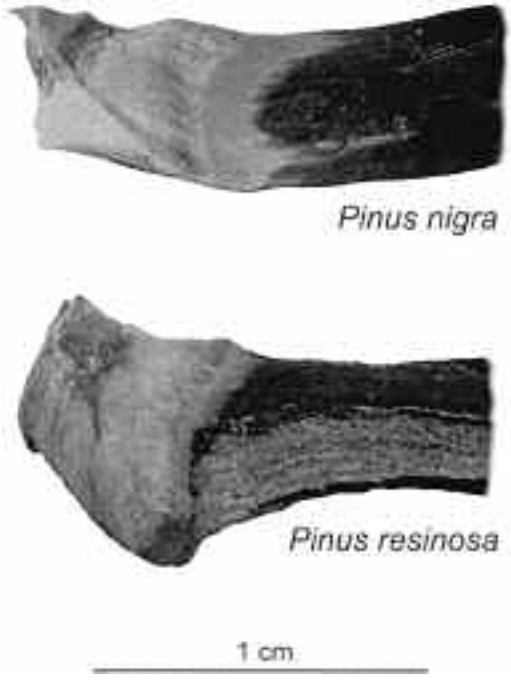

FIGURE 4. Middle cone scales of pines. Above, *Pinus nigra* cone showing terminal prickle on the umbo which is the protuberance on the scale representing the apex of first year growth, in this case elevated and pyramidal (*Kleinfeld 1774*, DAO). Below, *Pinus resinosa* cone lacking a prickle and with the umbo flattened except for small points on its lateral edges (*Marcoux s. n.*, DAO 40745). Photos by P. M. Catling.

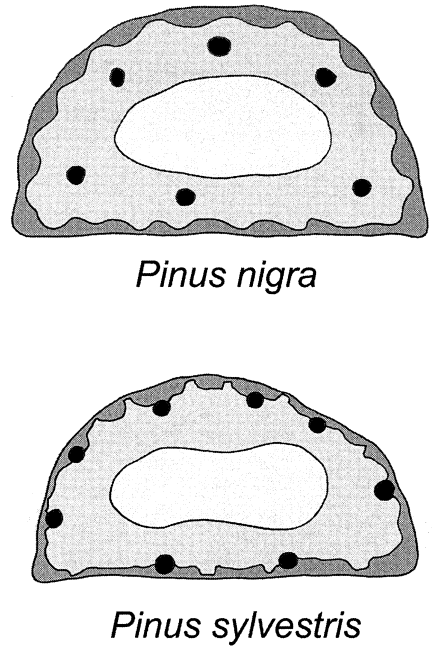

FIGURE 5. Diagrammatic cross sections of pine needles showing position of resin canals (blackened). Above, *Pinus nigra* with median resin canals. Below, *Pinus sylvestris* with resin canals submarginal and very near to or touching the epidermal tissue. Redrawn by P. M. Catling from Shaw (1914).

(6) Additional notes on identification and occurrence

1. Pinus mugo ssp. *mugo,* ssp. *uncinata* and nothossp. *rotundata* (*P. montana* Miller)

Pinus uncinata Miller ex Mirbel is sometimes placed in synonymy with *Pinus mugo* Turra, or treated as a variety (*Pinus mugo* var. *rostrata* Hoopes), but it has most recently been treated as a subspecies. It grows as a tree to 25 m tall with cones 5-7 cm long. The tree (ssp. *uncinata*) and shrub (ssp. *mugo*) have hybridized extensively (Gaussen et al. 1964) and the hybrids have been referred to *P. mugo* nothossp. *rotundata* (Link) Janchen & Neumayer. Apart from forms only the three infraspecific taxa (*mugo, uncinata* and *rotundata*) are recognized in Christensen's (1987) classification which reduced *P. mugo* from 16 species with 91 varieties.

The cones of *P. mugo* are essentially sessile whereas those of *P. sylvestris* are stalked. *Pinus mugo* and *Pinus sylvestris* hybridize in their native range to produce *Pinus* ×*rhaetica* Brügger (Christensen 1987). Since both occur together as escapes along roadsides in Ontario, there is a possibility for this hybrid to occur here as well. It possesses characters of *P. sylvestris*

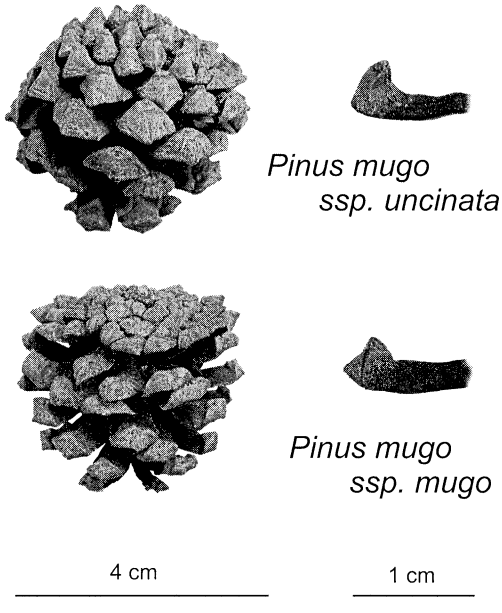

FIGURE 6. Cones and cone scales of *Pinus mugo* showing apophyses (exposed portion of seed scale). Above, ssp. *uncinata* cone (left) and lateral view of scale (right) showing hooked and recurved apophyses (*Catling 2001-11*, DAO). Below, ssp. *mugo* cone (left) and lateral view of scale (right) showing apophyses elevated but not recurved and hooked (*Catling 2002-1*, DAO). Photos by P. M. Catling.

including the peeling bark, but the bark is more greyish-brown than orange and the leaves may be either bright green as in *P. mugo*, or glaucous green as in *P. sylvestris*. As in *P. mugo* the umbo is bordered by a black, grey or dark brown ring (Christensen 1987).

2. Pinus nigra

Pinus nigra has been more divided into infrataxa (e.g., Bailey 1948; Vidakovic 1974) than other pines with similar levels of variability (Earle 2001*). The major pattern of variation in Eurasia involves eastern and western groups (e.g., Dallimore et al. 1966; Scaltsoyiannes et al. 1994):

1a. Needles stout and rigid, 1.5-2 mm thick . . . . . subsp. *salzmannii* (Dunal) Franco (eastern)
1b. Needles slender and flexible, 0.8-1.5 mm thick . . . . . subsp. *nigra* (western)

The western ssp. *nigra* includes 3 varieties (Earle 2001):

1a. Needles 6-14 cm; bark on old trees greyish var. *nigra*, AUSTRIAN PINE
1b. Needles 8-18 cm; bark on old trees orange-pinkish . . . . . 2.
2a. Cones yellowish, 5-10 cm long . . . var. *caramanica* (Loudon) Rehder, TURKISH PINE
2b. Cones greyish, 7-12 cm long . . . . . var. *pallasiana* (Lambert) Aech. & Graebn., CRIMEAN PINE

Plants of *Pinus nigra* that are 1-4 years old have needles that are much shorter, often 4-6 cm long, than those of older plants, which are usually over 7.5 cm long. Consequently *P. nigra* appears twice in the preceding key to species where the first couplet distinguishes species on the basis of needle length. Among the few and rather rare dwarf forms of *P. nigra* is cv. *hornibrookiana*, a shrubby plant with stiff lustrous dark needles less than 6 cm long (illustrated by Bailey 1948, plate IX). The median resin canals readily separate the latter cultivar or a young short-needled plant of *P. nigra* from *P. mugo*.

The needles of the Black Pine group that do not snap when bent and the presence of spines on the cone scales readily distinguish it from Red Pine with which it is most likely to be confused. With respect to its separation from *P. thunbergii*, different authors have emphasized different characters. Earle (2001*) suggests that the tomentum on the young elongating shoots is distinctive in *P. thunbergii*, but Dallimore et al. (1966) describe the young shoots as glabrous. Young plants of Black Pine with relatively shorter needles can still be distinguished from other short-needled species by the position of the resin canals as indicated in the key. In the eastern part of their natural range *P. nigra* and its relatives (including *P. thunbergii*) require more taxonomic study. *Pinus ponderosa* Douglas (Ponderosa Pine) is sometimes sold and planted in Ontario as *P. nigra*, but the former is readily distinguished by leaves usually in fascicles of 3 and by the much more prominent prickles (1-2 mm in length) on the middle and upper cone scales.

Natural hybridization between Black and Japanese Red pines has been reported in southern Michigan (Wright et al. 1969). The hybrids were reported to grow more rapidly than either parent. At age 4 years they could be identified by needles of intermediate stiffness and sharpness (between the stiff, sharp needles of *P. nigra* and the flexible, more blunt needles of *P. densiflora*). Presence of 3-needled fascicles was also characteristic of the hybrid. The young hybrid trees are also identifiable by their terminal buds which are darker brown than in Black Pine, and by intermediacy in position of resin ducts. The Black-Japanese Red pine hybrid is considered commercially valuable for both timber and roadside planting. In Europe natural hybrids have formed with *P. mugo* and *P. sylvestris* (e.g., Vidakovic 1958). Many other hybrids have been produced to create superior trees for lumber production (van Haverbeke 2002*).

Trees of *Pinus nigra* reach 6-10 m in height and 10-15 cm dbh when 15-20 years of age and many produce seed as early as age 15. They are reported to have growth rates similar to that of the more widely planted and native *P. resinosa* on some sites (van Haverbeke 2002*). They are not necessarily superior to *P. resinosa* outside of the special circumstances of roadsides (Morrow 1975). *Pinus nigra* has been recommended as an

alternative to *P. resinosa*, where the latter is particularly subject to European pests (Wright and Bull 1962).

3. Pinus edulis

Also treated as *Pinus cembroides* var. *edulis*, this taxon is culitivated for its edible seeds often called "piñons". It is widely cultivated outside its native range which is the semi-desert of the southeastern United States. The native range includes climatic zones similar to those of southern Ontario. It is occasionally introduced into remote natural settings such as the Kaladar Jack Pine barrens in Ontario (approximately 44.5333°N, 77.1500°W). Trees begin to bear cones when 25 years old and 3 m tall.

4. Pinus resinosa

Red Pine is native to southeastern Canada and the adjacent United States. It is one of the most widely planted pines in Ontario, as individual trees, in small plots and in plantations. It spreads readily from plantings, but to a much lesser extent than *Pinus sylvestris*. In addition to the key characters, the reddish flaky bark is distinctive.

5. Pinus sylvestris

Scots Pine, also called Scotch Pine, is native to Eurasia. It frequently spreads from cultivation in Ontario forming dense stands that exclude native species. The yellowish or light brown branches and glaucous needles of young trees are distinctive. The orange bark of the upper trunk and outer branches are distinctive in older trees.

6. Pinus densiflora

A tree to 40 m tall, *P. densiflora* is native to Japan, Korea, China and Russia. It is very similar to *P. sylvestris* from which it can be distinguished by longer, dull green (but not glaucous) leaves, glabrous branchlets and larger cones. The conelets of *P. densiflora* are erect instead of reflexed as in *P. sylvestris* (Shaw 1914). The 2-4-year-old branches are without exfoliating scales unlike those of *P. nigra*, *P. resinosa* and *P. thunbergii* (Bailey 1948). *Pinus densiflora* is now widely planted in Europe and North America.

7. Pinus thunbergii

A tree to 43 m tall, *P. thunbergii* is native to Japan and southern Korea. Its pale and rigid leaves are useful in identification. The fresh cones are brown in *P. thunbergii* instead of brownish-yellow as in *P. nigra* (Shaw 1914). *Pinus thunbergii* also has fewer and larger cone scales than *P. nigra*, but is apparently closely related to the latter species. It has also been separated from *P. nigra* by its tendency to have yellow or orange twigs (as in *P. resinosa*), instead of brown or dark grey twigs (e.g., Bailey 1948).

8. Pinus banksiana

A tree to 30 m tall, *P. banksiana* is native to the boreal and mixed forest regions of Canada excepting the western cordillera. It is readily distinguished by crooked branches, relatively short needles and curved cones. It has been frequently established in plantations on dry sites.

(7) Prospects

At the present time neither Black or Mugo pines are seriously affecting native biodiversity. Naturally established individuals often exist in small numbers and mostly along roadsides and in vegetation comprised of other alien species. Although evidently less aggressive than the introduced Scots Pine (*Pinus sylvestris*), both Black and Mugo pines have a potential for negative impact on biodiversity in dry, rocky or sandy habitats, especially in connection with extensive plantings. Black Pine in particular has been shown to grow better in North America than in its native range, to reduce native biodiversity and cover, and requires relatively high levels of herbicide application to control. As a result of its superficial similarity to native species, it may be overlooked as a problem, thus leading to management difficulties that would not exist if it was identified as a risk at an early stage.

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