



**Fig. 20.** An old EAB gallery that was walled off from the rest of the cambium with callus tissue. More recent galleries surround the old gallery.

the rural and urban landscape in Canada. It is essential that all survey staff be able to distinguish ash from other species that can look similar and be able to identify ash trees to species.

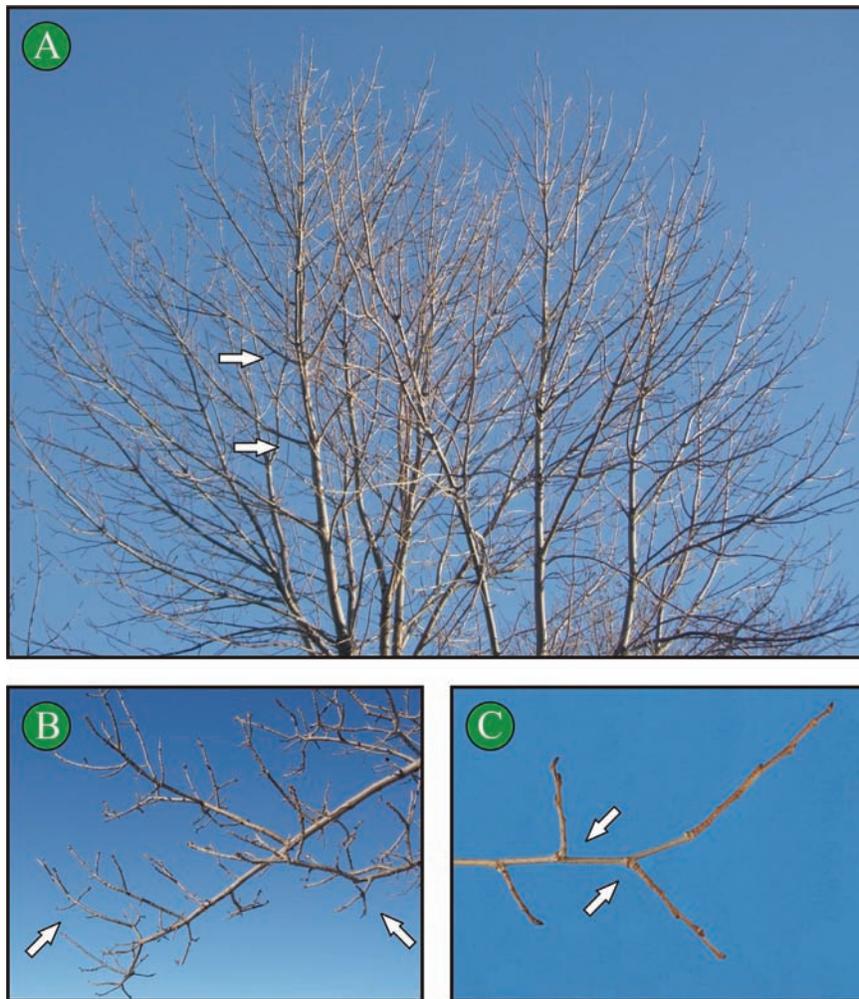
This part of the manual is divided into four sections. Section 6.1 provides a general description of trees that are similar to ash trees and how to distinguish ash from these similar trees. Section 6.2 provides a tree identification key to distinguish ash trees from other trees. In section 6.3, the distinctive features of different ash species (native and many of the introduced species) are described. Section 6.4 provides a tree identification key to distinguish the ash species from one another. Survey staff should use these sections together with a tree identification book, such as “Trees in Canada” (Farrar 1995), to aid in identification.

## 6.1 IDENTIFYING ASH TREES

Trees are broadly distinguished from each other according to whether the tree’s leaves are opposite or alternate, and simple or compound. Using these characteristics allows for the differentiation of ash from many other tree species.

Twigs and branches can be used in winter to help identify trees. Ashes (*Fraxinus* spp.), maples (*Acer* spp.), catalpas (*Catalpa* spp.), horsechestnuts (*Aesculus* spp.), elders (*Sambucus* spp.), viburnum (*Viburnum* spp.), common lilac (*Syringa vulgaris*), amur corktree (*Phellodendron amurense*) and dogwoods (*Cornus* spp.) are deciduous trees with buds and branches in an opposite arrangement (Fig. 21A and B). Other tree species have buds and branches arranged alternately (Fig. 21C).

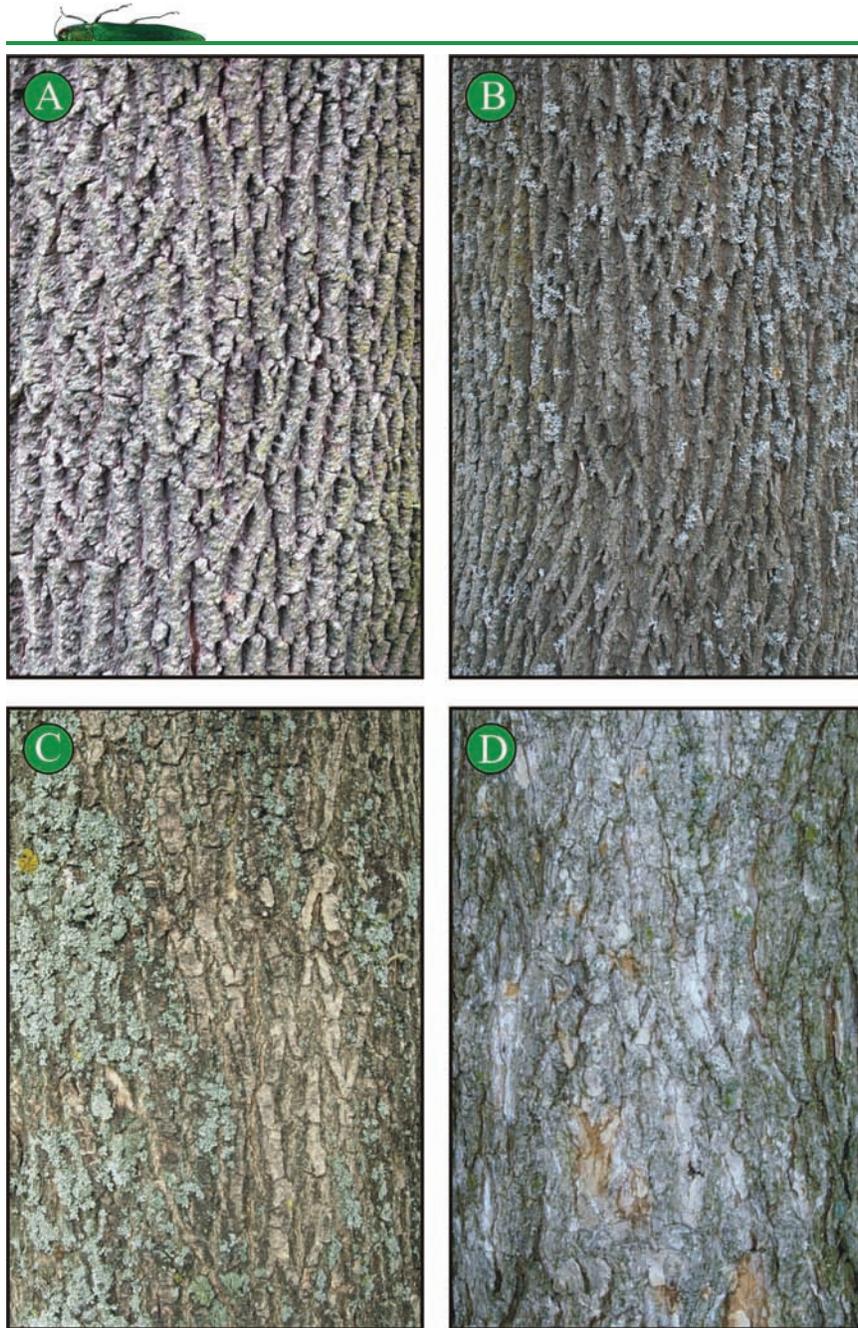
Ashes have blunt buds, stout twigs, and an upright growth habit with long branches. The branch tips look like tridents (3-pronged fork). Bark (Fig. 22) is variable and thus is not a feature upon which identification should be based. Maple buds are covered by folded scales and the twigs are more slender (Fig. 23A). Horsechestnuts have darker bark than ashes, large terminal buds that are dark and sticky. Catalpas, lilac and corktree have no true terminal bud and usually retain seeds into winter unless they are pruned off.



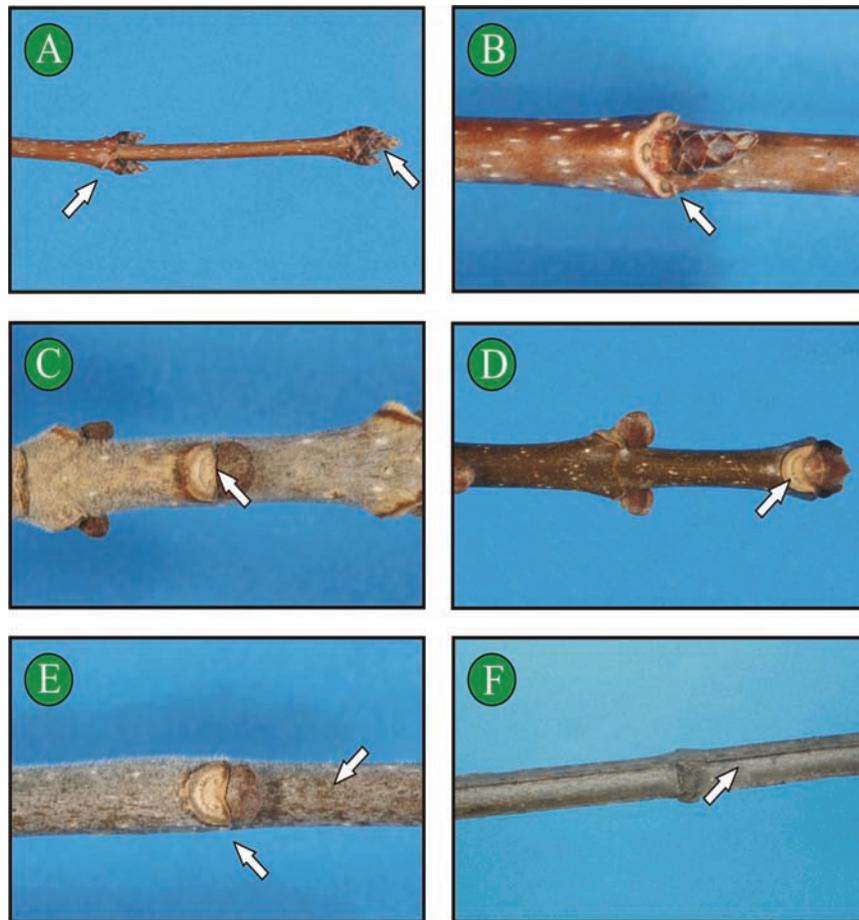
**Fig. 21.** A) Opposite branching on green ash, B) opposite twig structure on green ash and C) alternate twig structure on white elm.

In the winter, the tree species most commonly confused with ash are Norway maple (*Acer platanoides*), Manitoba maple (*A. negundo*) and black walnut (*Juglans nigra*). Norway maple is most often planted as a landscaped tree and must be examined closely. Norway maple has

mahogany-coloured twigs, black branch collars and larger terminal buds than ash. The buds are a distinct red colour and covered by folded bud scales. The most reliable identifying feature is to find maple keys persisting on the tree.



**Fig. 22.** Mature bark of A) green/red ash, B) white ash, C) black ash, and D) blue ash.



**Fig. 23.** A) Twig with buds of sugar maple, B) leaf scar on sugar maple, C) green/red ash buds and leaf scar, D) white ash buds and notched leaf scar, E) leaf scar and hairy twig of black ash, and F) square twig of blue ash.

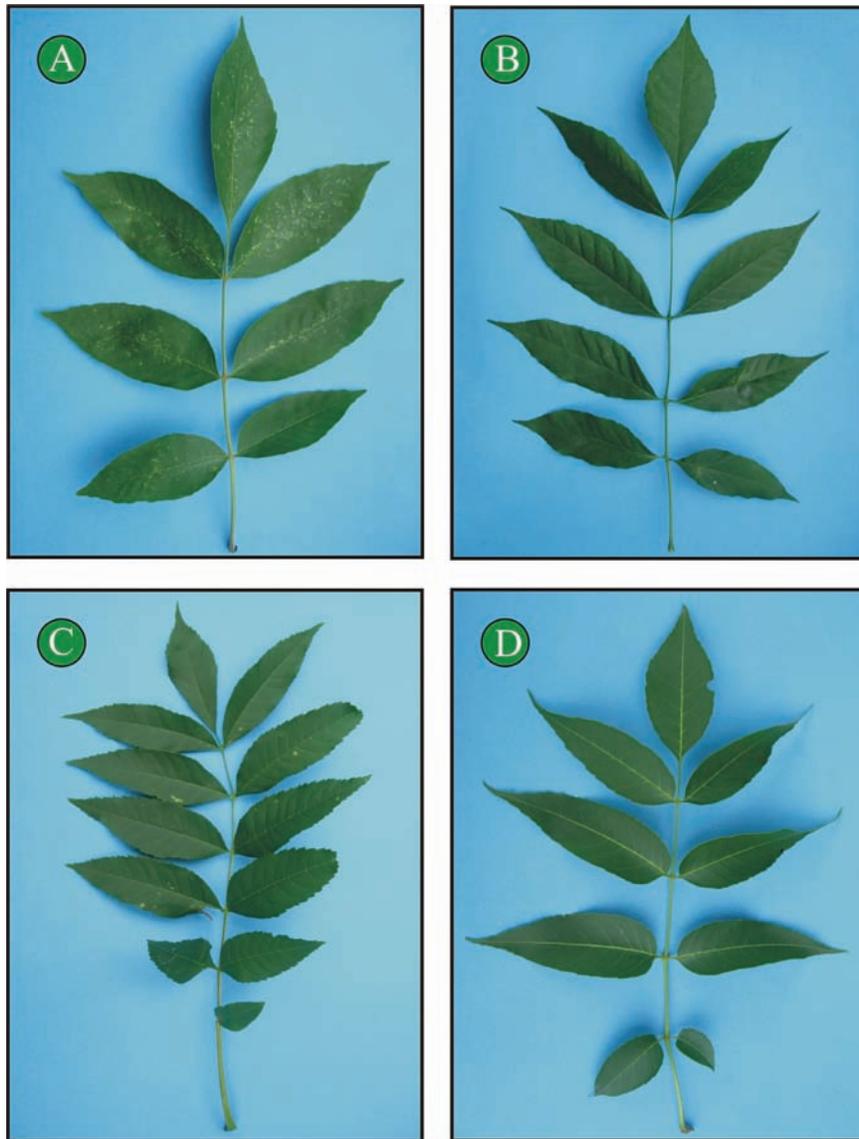
Manitoba maple has grey buds on slender twigs that look relatively large. The twigs are purple and are coated with a white waxy powder that can be rubbed off. Manitoba maple has a crooked form. It is most easily identified when it retains its clusters of maple keys. From a distance, with their stout branches and form, black walnut,

butternut, hickories (*Carya* spp.), cottonwood/poplar (*Populus* spp.), and tulip-tree (*Liriodendron tulipifera*) appear ash-like but all have alternately oriented branches and buds like white elm (Fig. 21C). The tulip-tree may still have its seed cones in the winter, and there is white dotting on the bark.



Some tree species, such as ash, have compound leaves (Fig. 24), that is two or more leaflets on a single leaf stalk and each leaf

forms a bud at its base. Other trees such as maple, oak (*Quercus* spp.), elm (*Ulmus* spp.), poplar and beech (*Fagus* spp.)



**Fig. 24.** Compound leaves of A) green/red ash, B) white ash, C) black ash, and D) blue ash.

have simple leaves (Fig. 25). If it does not have a compound leaf, it is not an ash.

Ash leaves (Fig. 24) usually have 5 - 9 finely-toothed leaflets (occasionally 11) of roughly equal size with the lowest (basal) two leaflets being slightly smaller than the other leaflets. Ash seeds are attached to a wing called samaras, which droop towards the ground and turn from green to brown throughout the summer.

Manitoba maple is the only native maple with a compound leaf. Manitoba maple generally has 3-5 leaflets (occasionally 7) with slight lobes, crooked form, and clusters of maple keys. Amur corktree is an uncommon tree species. Fruits are grape-like clusters of berries turning green to purple. Amur

corktree has spongy-textured bark. Elder is a shrub-sized plant with hollow, easily breakable stems. The fruits are flat clusters of small berries turning from green to red or nearly black, depending on the species.

The following trees have an alternating leaf and bud arrangement (Fig. 21C) as their main difference from ash (Fig. 23). Walnut and butternut have more than nine leaflets. Nuts develop inside of a large green husk on these trees. Leaves have a distinct citrus smell when crushed. Hickory leaves have a shiny upper surface and are aromatic when crushed. The terminal leaflet is much larger than the basal leaves. Honey locust (*Gleditsia triacanthos*) and black locust (*Robinia pseudoacacia*) have more than nine small leaflets of equal size. These are leguminous trees that develop seed pods. Mountain-ash, which are in the rose family, are not true ashes. Leaves of these species have distinct teeth. Showy white flowers on these trees develop into clusters of bright orange berries. The introduced ornamental, tree-of-heaven (*Ailanthus altissima*) has many more than nine leaflets.



**Fig. 25.** The simple leaf of white elm.

## 6.2 A KEY TO DISTINGUISH ASH FROM OTHER TREES

These simple keys will help you separate ash trees from other trees that have a similar appearance.



Trees can be identified in the summer using the leaves (Summer Key) or in the winter using the twigs and bark (Winter Key). It is more difficult to distinguish between tree species in the winter, so it takes some practice to become proficient. Twigs are used to identify trees without leaves. Make sure the twig examined does not have missing buds and is alive. We strongly advise that you examine at least two or three samples at each step of the key to be sure the decision is correct and to familiarize you with the variation that occurs within and among trees. Do not use the leaves and twigs from epicormic branches.

### Summer Key

**Step 1:** Look at a branch in a tree where the branches are easy to see. Are the branches directly opposite (across from each other) (Fig. 21A), or are the branches alternate (staggered and not directly across from each other) (Fig. 21C)?

If the branches are alternate, it is not an ash tree.

If the branches are opposite, go to Step 2.

**Step 2:** Is the leaf a single blade (**Simple Leaf** – Fig. 25) joined by its stem to a woody branch, or does

the leaf have many leaflets (**Compound Leaf** – Fig. 24) attached to a single leaf stem?

If the leaf is simple, then the tree is not an ash tree.

If the leaf is compound, go to Step 3.

**Step 3:** Does the leaf have 3 to 5 (rarely more) leaflets that are irregular in shape and with coarse teeth?

If yes, it is a Manitoba maple (boxelder).

If not, go to Step 4.

**Step 4:** Does the leaf have 5 to 9 (usually 7) leaflets arranged like the fingers in a hand (palmate), with the leaflets bigger above the middle and ending with a small point?

If yes, it is a horsechestnut or a buckeye.

If not, go to Step 5.

**Step 5:** Are the leaves covered with translucent dots (glands)? Are they fragrant, and do the twigs have prominent lenticels?

If yes, it is likely an Amur corktree, which is com-



monly planted in urban areas and looks a lot like ash.

If not, go to Step 6.

**Step 6:** Does the leaf have 5 to 11 leaflets all about the same size (the terminal leaflet can sometimes be slightly larger) and is the edge (margin) of each leaflet smooth or with small teeth (Fig. 24)?

If yes, it is likely an ash tree. Go to Sections 6.3 & 6.4 to distinguish the different species of ash.

### Winter Key

**Step 1:** Look at a branch in a tree where the branches are easy to see. Are the branches directly opposite (across from each other) (Fig. 21A & B), or are the branches alternate (staggered and not directly across from each other) (Fig. 21C)?

If the branches are alternate, it is not an ash tree.

If the branches are opposite, go to Step 2.

**Step 2:** Are the twigs very stout with very large and sometimes sticky terminal buds with large

shield-shaped leaf scars?

If yes, it is likely a horsechestnut or a buck-eye.

If not, go to Step 3.

**Step 3:** Are the twigs slender, with three distinct vein (bundle) scars inside the crescent-shaped leaf scar (Fig. 23B)?

If yes, it is likely a maple.

If not, and the leaf scar has many (5 or more) small vein scars (Fig. 23C-E), it is likely an ash tree. Go to Section 6.3 & 6.4 to distinguish the different species of ash.

### 6.3 IDENTIFYING ASH SPECIES

There are five native species (green/red, white, black, blue and pumpkin ash) of ash in eastern Canada and several more species that are introduced and planted as landscape ornamentals. What is known as red ash (*Fraxinus pennsylvanica*) in Canada, is called green ash in the United States. To make matters somewhat more confusing, in Canada, there are two varieties of red ash, the northern red ash (*Fraxinus pennsylvanica* var. *austini*) and the green ash (*Fraxinus pennsylvanica* var. *subintegerrima*). Green ash has become the predominant common



name in Canada in association with the emerald ash borer. Pumpkin ash is extremely rare and occurs in a few locations in southeastern Ontario near Lake Erie. Similarly, blue ash is also a rare tree but can easily be distinguished from the other ash trees by its four sided twigs. In urban areas, European ash and its golden twig cultivar, and sometimes Manchurian ash and its hybrids can also be encountered.

The description for individual species contains the characteristics of that species that allows for specific identification.

### 6.3.1 GREEN/RED ASH (*FRAXINUS PENNSYLVANICA*)

**Key Features:** In the spring and summer, twigs (Fig. 23C), buds and leaves on red ash (green ash is the hairless variety of red ash) are very pubescent, but in the fall, they are only slightly fuzzy. Twigs are less stout than in white ash (Fig. 23D). The outer bark (epidermis) does not flake or peel on older twigs like those on white ash.

**Bud:** The pubescent buds are raised on the leaf scar (Fig. 23C).

**Leaf:** Leaves (Fig. 24A) have 5-9 leaflets (most often 7) that are serrated (toothed) beyond the middle of the leaflet. Leaflets are attached to the leaf stalk by a short petiole.

**Seed:** The wing of the samara covers about half of the seed. The seed cavity is relatively thin and narrow.

**Bark:** Mature trees have an irregular diamond-shaped bark pattern (Fig. 22A). The bark on twigs often has a reddish tinge to it.

### 6.3.2 WHITE ASH (*FRAXINUS AMERICANA*)

**Key Features:** The buds are set into the leaf scar (Fig. 23D). This is the only ash that may turn purple in the fall. Twigs are stouter than those on green/red ash and exhibit a purple-grey colour. The growth habit is neat and upright giving the terminal leaders the shape of a trident.

**Bud:** The lateral buds are all set into a notch in the leaf scar (Fig. 23D). Leaf scars are raised giving the twig a knobby appearance.

**Leaf:** Leaves (Fig. 24B) have 5-9 hairless leaflets (most often 7). The leaflets are mostly smooth-edged, often with rounded serrations. The leaves are dark green above, but much paler on the under side. The leaflets are attached to the leaf stalk by a petiole that is slightly longer than those in *F. pennsylvanica*.

**Seed:** The wing of the samara covers only the tip of the seed. The seed cavity is relatively plump.

**Bark:** The bark has a distinct diamond-shaped pattern on mature specimens (Fig. 22B).

### 6.3.3 BLACK ASH (*FRAXINUS NIGRA*)

**Key Features:** This is the only native ash that has its uppermost lateral buds spaced distinctly be-



low the terminal bud so that one can see bark between the two. The terminal twigs are stout. The species is rarely found on upland sites.

**Bud:** The very dark brown buds are raised above the leaf scar (Fig. 23E).

**Leaf:** Of the 7-11 leaflets, only the terminal leaflet has a petiole, the rest are sessile (attached directly to the leaf stalk) (Fig. 24C). Leaves are serrated along the margins.

**Seed:** The wing of the samara is wider than those on white or green/red ash, covering nearly all of the seed. The wing is notched at the end.

**Bark:** The bark (Fig. 22C) is corky and when cut into is tight to the sapwood.

#### 6.3.4 BLUE ASH (*FRAXINUS QUADRANGULATA*)

**Key Features:** This is the only ash species with 4-sided (square) twigs (Fig. 23F). The bark on a mature tree is scaly as opposed to the diamond-shaped bark of other *Fraxinus* spp. This is a medium-sized tree found on upland sites. The tree is often planted as an ornamental due to its rarity in Ontario.

**Bud:** The lateral buds are set above the leaf scar, which has the shape of a narrow crescent.

**Leaf:** The 5-11 leaflets (most often 9) are coarsely serrated with asymmetrical bases (Fig. 24D). The leaflets are attached to the leaf stalk by a short petiole.

**Seed:** The wing of the samara is

broad, covering the whole, relatively flat seed. The samara is twisted in appearance and has a notched tip.

**Bark:** The bark (Fig. 22D) is distinctly grey and scaly.

#### 6.3.5 PUMPKIN ASH (*FRAXINUS PROFUNDA*)

**Key Features:** This species has many similar features as white and red ash, but much larger features than any other native *Fraxinus* spp. On more mature specimens the base will be buttressed and swollen to look like a pumpkin. The species is rare in Ontario and is only found in moist bottomlands.

**Bud:** The buds are very pubescent and set into the leaf scar.

**Leaf:** The leaves are very long with 7-9 leaflets each one being 10-25 cm long (other *Fraxinus* spp.: 7-15 cm). The petiolules are relatively long (1 cm). Leaflets have rounded serrations and are pubescent underneath, with the midrib being densely hairy.

**Seed:** The wing of the samara is very broad and much longer than other *Fraxinus* spp. (5-8 cm) and covers most and in some cases, all of the seed cavity.

#### 6.3.6 EXOTIC ASHES

Many species of ash in eastern Canada have been planted outside of their native range. The two most common species are Manchurian and European ash. The following is a list of some of the more common species of exotic



ashes that may be encountered during surveys with brief descriptions of their diagnostic characteristics.

#### *F. excelsior* (European Ash)

**Key Features:** The buds of this species are jet black. Twigs and upper branches may be yellow on some cultivars and the bark is often smooth, lacking the deep fissures of native species.

#### *F. mandshurica* (Manchurian Ash)

**Key Features:** The 11 lance-shaped leaflets have sunken veins, are coarsely toothed, and are hairy on both the upper and lower surfaces. Several Manchurian-black ash hybrids have been planted in Canada for their fall foliage.

#### *F. ornus* (Flowering Ash)

**Key Features:** This species has showy fragrant white flowers.

#### *F. angustifolia* (Narrow-leafed Ash)

**Key Features:** The three buds are arranged in a whorled fashion on the twig.

#### *F. bungeana* (Bunge's Ash)

**Key Features:** Leaves and flowers are downy when first emerging. This species is a small tree or shrub.

#### *F. chinensis* (Chinese Ash)

**Key Features:** The eight egg-shaped leaflets are downy beneath.

#### *F. latifolia* (Oregon Ash)

**Key Features:** This species is found in British Columbia. The twigs and buds are pubescent. The tips of the leaflets are pointed.

### 6.4 A KEY TO DISTINGUISH ASH SPECIES

This simple key will help you separate the five native species of ash and a common introduced ornamental (European ash) found in Eastern Canada.

#### Summer Key

**Step 1:** Does the leaf have smooth margins or a few rounded teeth along the edges (margin)?

If yes, and the twigs are hairless and stout (Fig. 23D) and the leaflets (5-9) are hairless below (except along the veins), the tree is a **White Ash (*Fraxinus americana*)**. The seed wing is tapered and surrounds only the tip of the seed case.

If yes, and the twigs are hairy and stout and the leaflets are hairy, large,



thick and with 1 cm long stems, it is a **pumpkin ash (*Fraxinus profunda*)**. The seed wing is widest at or above the middle.

If not, go to Step 2.

**Step 2:** Does the leaf have toothed margins and are the leaflets directly attached (without a stem) to the central leaf stalk (Fig. 24C)?

If yes, and there are 7-11 leaflets with dense tufts of reddish-brown hair near where the leaflet attaches to the central leaf stalk (Fig. 24C), the tree is a **Black Ash (*Fraxinus nigra*)**. The seed wing is often twisted and surrounds the seed case and sometimes has a small notch at the tip.

If yes, and there 9-15 leaflets that do not have tufts of hair where the leaflet attaches to the central leaf stalk, the tree is an **European ash (*Fraxinus excelsior*)**. The seed wing is wide, flat and surrounds the seedcase.

If not, go to Step 3.

**Step 3:** Does the leaf have toothed margins and are

the leaflets attached by a small stem (petiole) to the central leaf stalk (Fig. 23A & C)?

If yes, and the twig has four prominent corky ridges, giving it a four-sided appearance (Fig. 23F), and the leaflets are asymmetrical at the base, the tree is a **blue ash (*Fraxinus quadrangulata*)**. The seed wing is broad and twisted and surrounds the flat seedcase.

If yes, and the twig lacks ridges and is round in cross section and the leaflets are symmetrical at the base (Fig. 24A), the tree is the **green/red ash (*Fraxinus pennsylvanica*)**. The seed wing is flat, sometimes with a small notch at the tip and surrounds about one-half of the seed case and stays on the tree almost all winter.

### Winter Key

**Step 1:** Does the twig have four prominent corky ridges giving it a four-sided appearance (Fig. 23F)?

If yes, the tree is a **blue ash (*Fraxinus quadrangulata*)**.

If not, go to Step 2.



**Step 2:** Are the twigs round?

If yes, and the buds are noticeably deep inky black in colour, the tree is an **European ash (*Fraxinus excelsior*)**.

If yes, but the buds are reddish to dark brown, go to Step 3.

**Step 3:** Are the terminal buds conical and dark brown to black, and is there bark clearly visible between the terminal buds and the first pair of lateral buds just below?

If yes, and the twig is smooth with corky purplish lenticels, the tree is a **black ash (*Fraxinus nigra*)**.

If not, go to Step 4.

**Step 4:** Do the leaf scars underneath the buds have deeply U- or V-shaped notches and are the lateral buds set close up against the terminal buds leaving no visible bark between (Fig. 23D)?

If yes, and the twig is smooth, the tree is a **white ash (*Fraxinus americana*)**.

If not, go to Step 5.

**Step 5:** Is the tree in a very wet site with a swollen trunk (looks like a pumpkin) at the base, and are the twigs densely hairy?

If yes, the tree is a **pumpkin ash (*Fraxinus profunda*)**.

If not, the tree will be **green/red ash (*Fraxinus pennsylvanica*)**. The leaf scar underneath the bud will have a straight edge at the top and will look like the letter D when turned on its side (Fig. 23C). The twigs will be hairy to smooth or nearly so and tend to be somewhat flattened.

## 7. EXAMINATION METHODS

Visual surveys can be conducted year round but slightly different methods are used in different seasons. The best time of year to see all or most of the symptoms is during late summer and fall.

From late July until leaf-drop in the fall is when the trees begin to show signs of stress due to the heaviest larval feeding activity. Epicormic shoots and thinning crowns start to become very evident during this period. This time period is best for observing all of the EAB signs and symptoms. Bark deformities are easiest to observe when the leaves are off the trees (October/November to