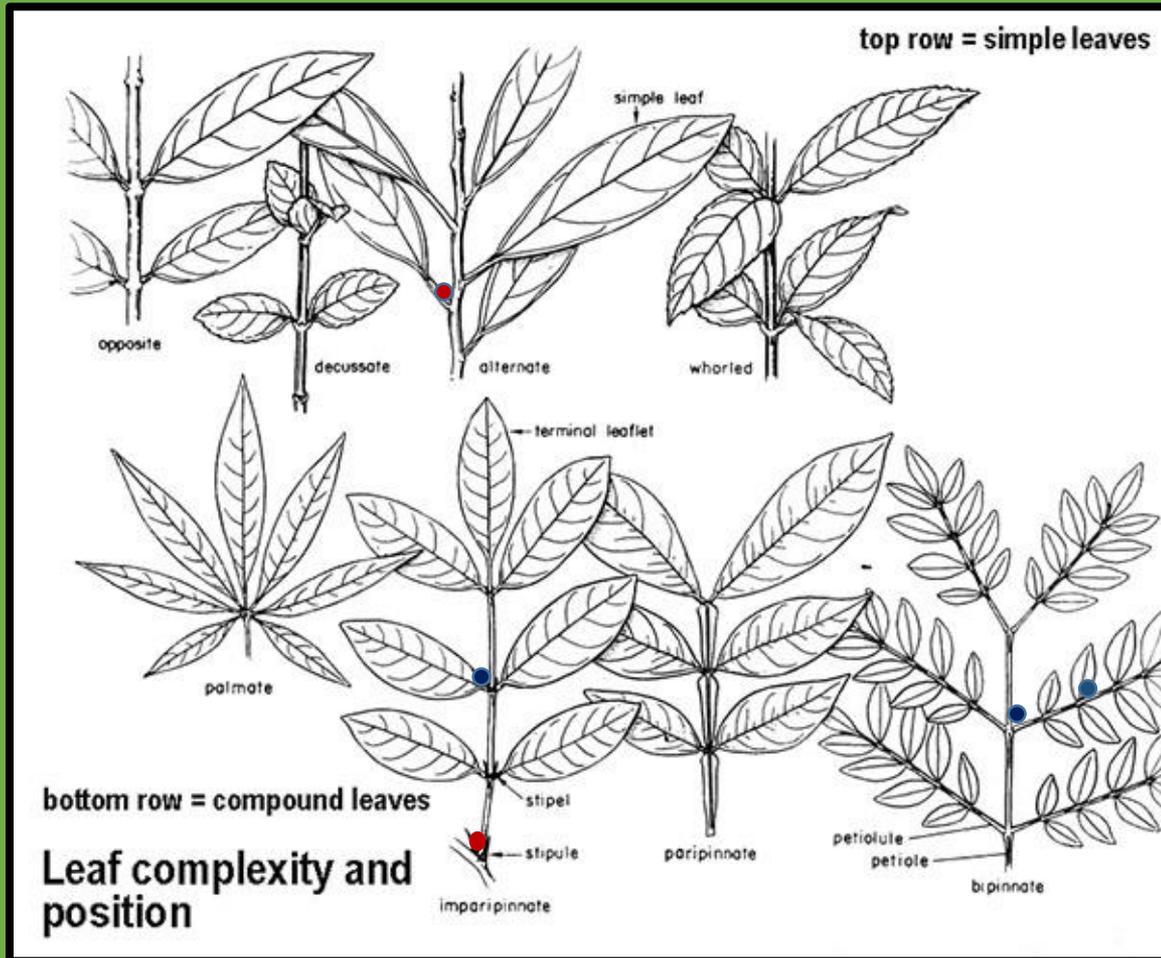


IDENTIFYING TREE SPECIES WITH PINNATELY COMPOUND LEAVES



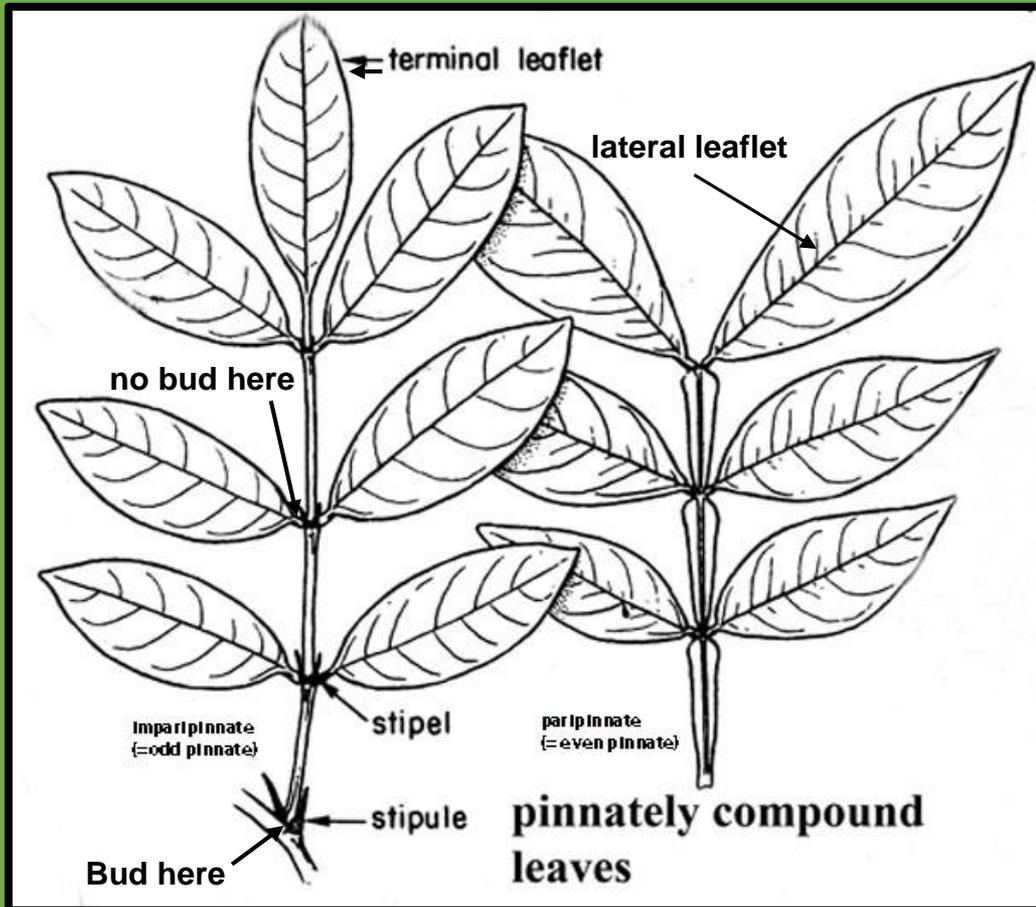
S.A. Mori, M. Rothman & R. F. Naczi

Last update: 27 March 2018

The first character used to identify trees is their leaf complexity. The top row consists of simple leaves (i.e., the leaf blades are not divided into leaflets). There are many more species with simple leaves than compound leaves in this preserve. The second character is the position of the leaf compared to other leaves. The most common type of attachment of the leaves to the stems alternate.

A leaf is defined as everything above the bud (red circles) in the axil of the petiole and the twig. In simple leaves, the leaf blades are not divided into leaflets (top row). Compound leaves are also delimited by buds in the axil of the petiole and the twig (red circle) but the leaves are divided into leaflets. There are no buds in the axils of leaflets of compound leaves (blue circles). Drawing by B. Angell in Smith et al. (2004).

TREE SPECIES WITH PINNATELY COMPOUND LEAVES IN THE PRESERVE



There are only six known pinnately compound leaved species of trees in the Preserve. A single alien plant (*Phellodendron amurense*), another single alien plant (*Ailanthus altissima*), two species of native ash (*Fraxinus*), and three species of native hickory (*Carya* spp.). All of these species consistently have an odd number of leaflets (imparipinnate or oddly pinnate) as illustrated by the leaf on the left side. Drawing by B. Angell in Smith et al. (2004).

KEY TO SPECIES WITH PINNATELY COMPOUND LEAVES IN THE PRESERVE

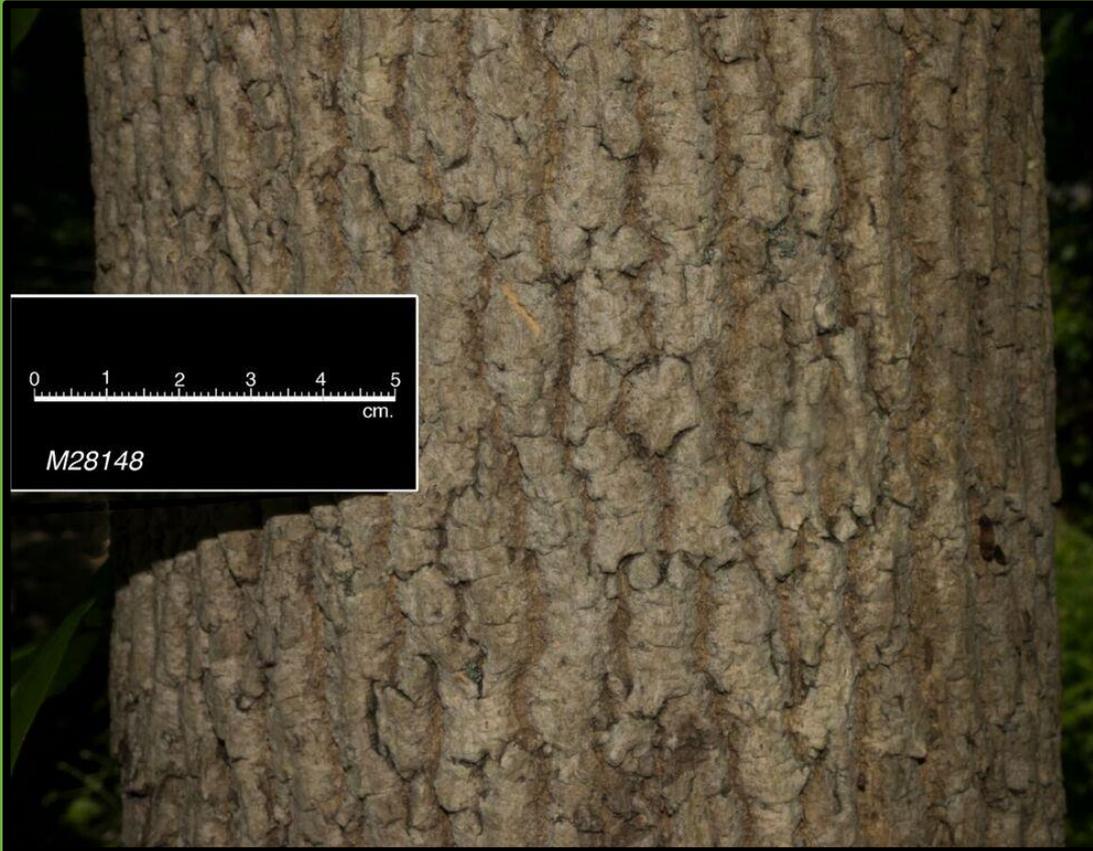
- 1. Leaves opposite.....2
- 1. Leaves alternate.....3
- 2. Leaflet apices not usually long and thin. Fruits winged.....*Fraxinus*
- 2. Leaflet apices unusually long and thin. Fruits not winged.....*Phellodendron*
- 3. Leaflets usually >9 per leaf, glands present on lower surface of leaflets. Fruits winged.....*Ailanthus*
- 3. Leaflets usually <10 per leaf, glands not present on lower surface of leaflets. Fruits not winged.....*Carya*

PINNATELY COMPOUND LEAVES OF THE WHITE ASH (*Fraxinus americana*)



Thirteen species of ash occur in eastern North America (Nelson et al, 2014). There are two species of ash in the Preserve. The leaflets are green above (adaxial) and white below (abaxial). The base of the petiole is swollen (= pulvinus).

BARK OF THE WHITE ASH (*Fraxinus americana*)

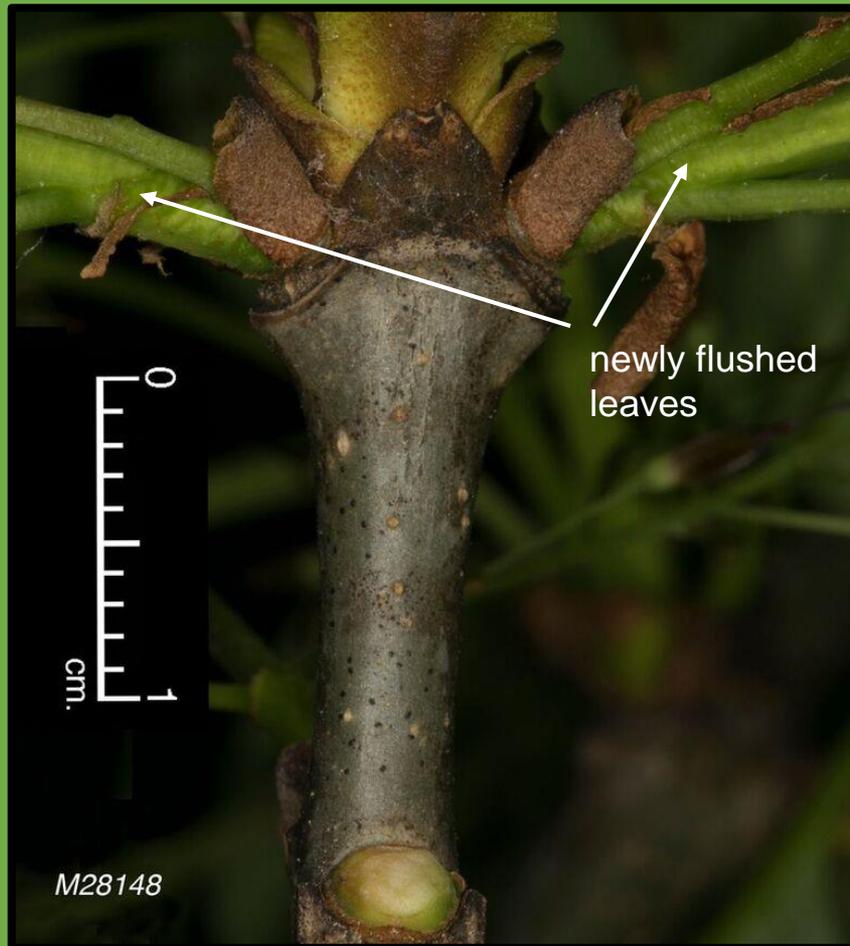


The bark of this species has shallow fissures that are vertically oriented. The major fissures undulate like a river. The ridges are frequently horizontally cracked.

Ashes are valuable timber trees best known for the manufacture of baseball bats, boat paddles, and high-quality veneer (Nelson et al., 2014)

Species of ash are sometimes mistaken for species of hickory (*Carya* spp.) but the hickories have alternate leaves, nuts as fruit, and catkins instead of panicles as inflorescences.

LEAF FLUSH OF THE WHITE ASH (*Fraxinus americana*)



Left: Flush of opposite leaves. Right: Paniculate inflorescence. The white under surfaces of this species are visible in the right hand image.

IMMATURE FRUITS OF THE WHITE ASH (*Fraxinus americana*)



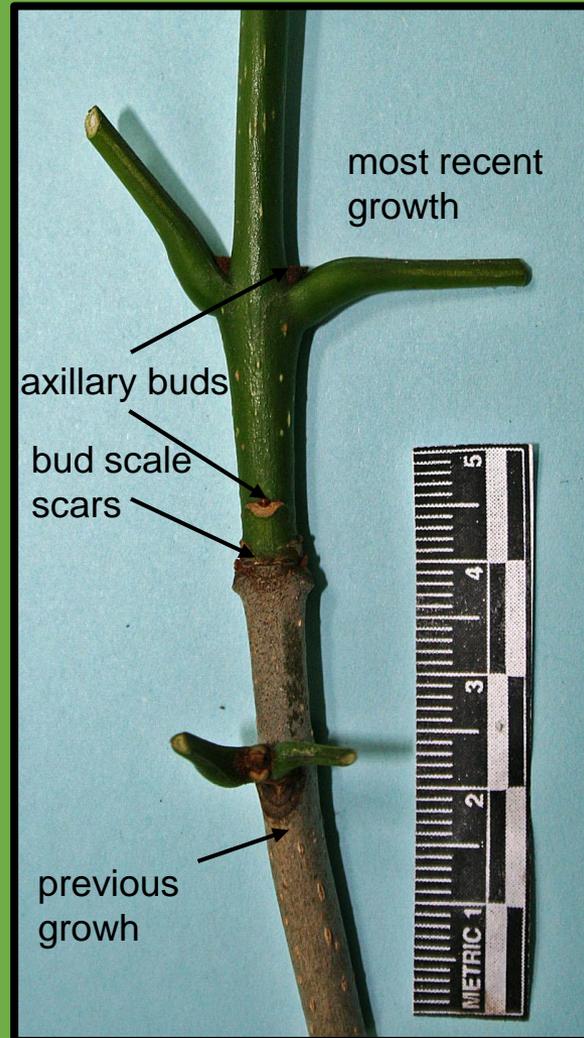
These fruits are from a superior ovary and the stigma is bifid (split into two).

LEAF AND TRUNK OF THE GREEN ASH (*Fraxinus pennsylvanica*)



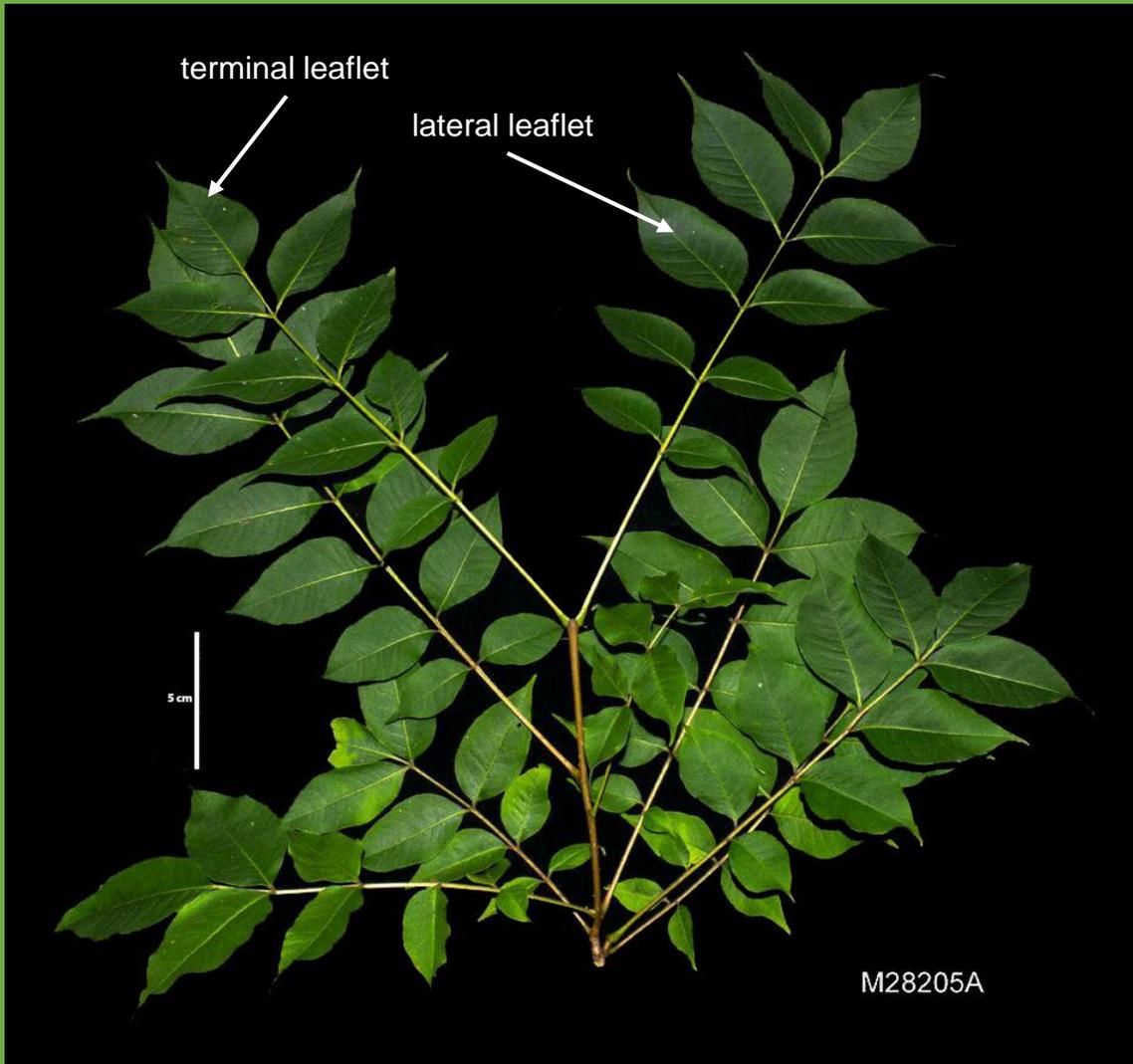
The green ash differs from the white ash by its more checkered bark caused by horizontal cracks; green instead of white underside of the leaflets; shorter leaflet apices; fewer leaflets (5 versus 9); and greater adaption to wet habitats.

BARK AND STEM OF THE GREEN ASH (*Fraxinus pennsylvanica*)



There are many details of the plants of the Preserve that we have not yet documented with images. This is especially true with flower and fruit characters. Bark characters are difficult to document because the morphology of bark changes as the bark ages.

LEAVES OF THE AMUR CORK TREE (*Phellodendron amurense*)



The amur cork tree is the only species of Rutaceae (the citrus family) found in the Preserve. It is easily identified by its oddly pinnate leaves inserted opposite another leaf. The leaves are 25 to 30 cm long and have from 5 to 11 leaflets.

This species is native to China, Korea, and Japan. It was introduced into the United States for use as an ornamental tree in around 1856.

BARK OF THE AMUR CORK TREE

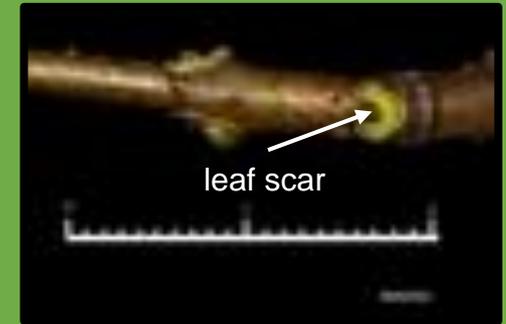
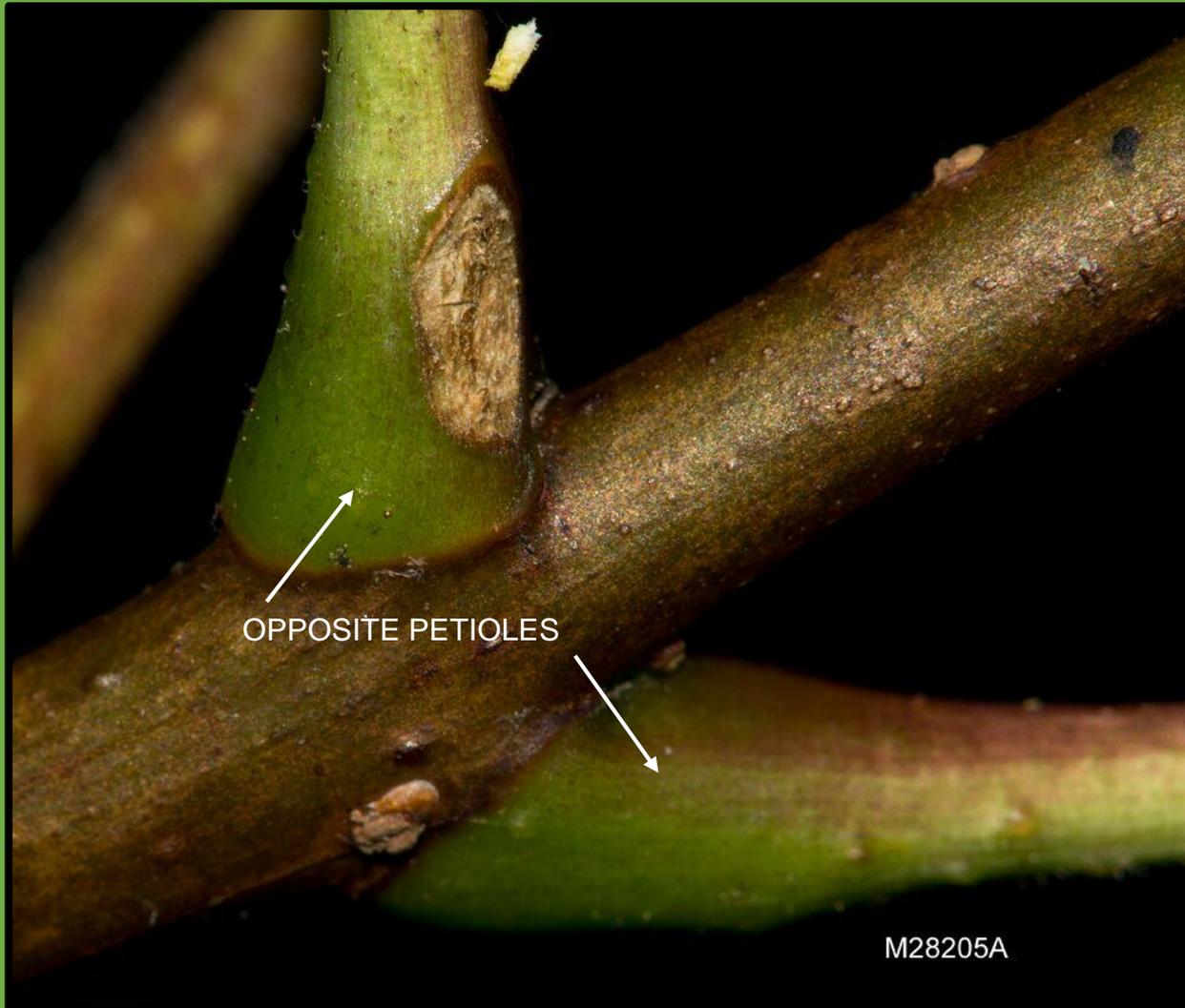


The Amur cork tree is one of the fundamental plants used in traditional Chinese medicine.

The species is dioecious (= only one sex per tree); thus, the species can only reproduce if both sexes are in the vicinity of one another.

The name *Phellodendron amurense* refers to the bark. The generic name means bark (*phellos*) tree (*dendron*) and the species epithet refers to the Amur River region in eastern Asia where it is native. The common name comes from the similarity of the bark of this species to that of *Quercus suber*, the major source of cork.

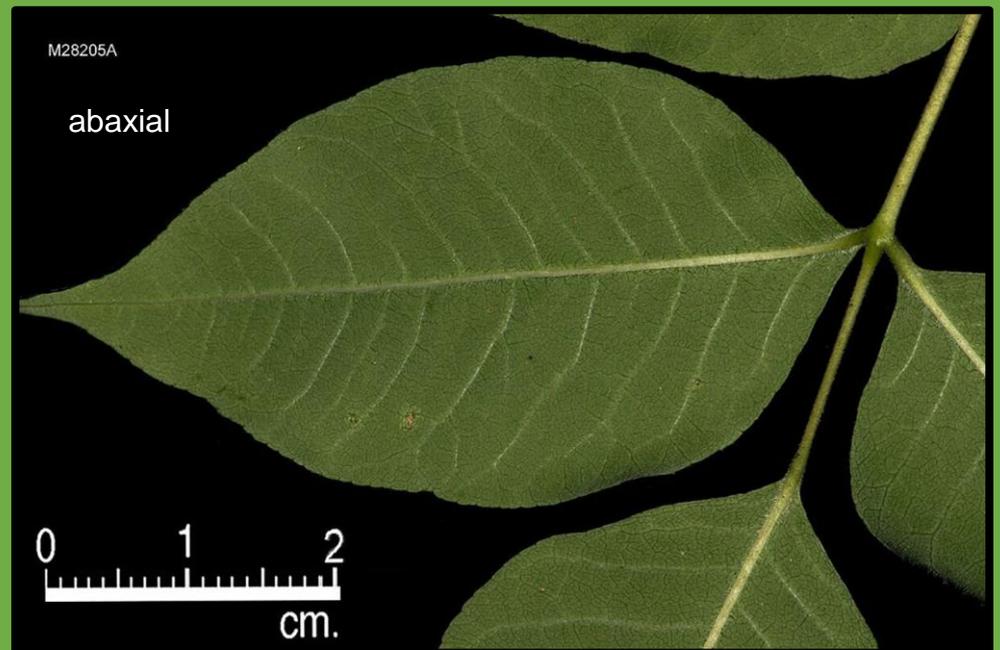
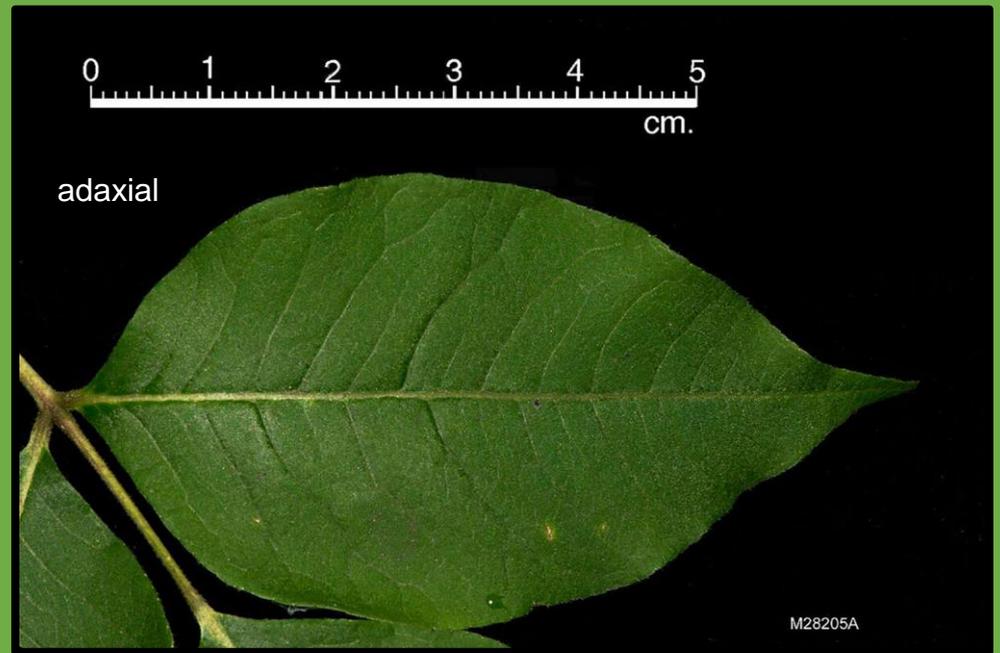
PETIOLE BASES OF THE AMUR CORK TREE



The opposite, oddly pinnate leaves; yellowish-brown twigs with inconspicuous lenticels; and smile-shaped leaf scar help in the identification of this invasive species.

LEAFLETS OF THE AMUR CORK TREE

Upper (adaxial) and lower (abaxial) views of leaflets. The leaflets are usually around 6 cm long, the margins have minute teeth, the base is obtuse, and the apex is acuminate. The overall shape of a leaflet is ovate or elliptic. The upper surface is green and the lower surface is whitish but not as white that of *Fraxinus americana*. The lower surface has white trichomes (hairs).



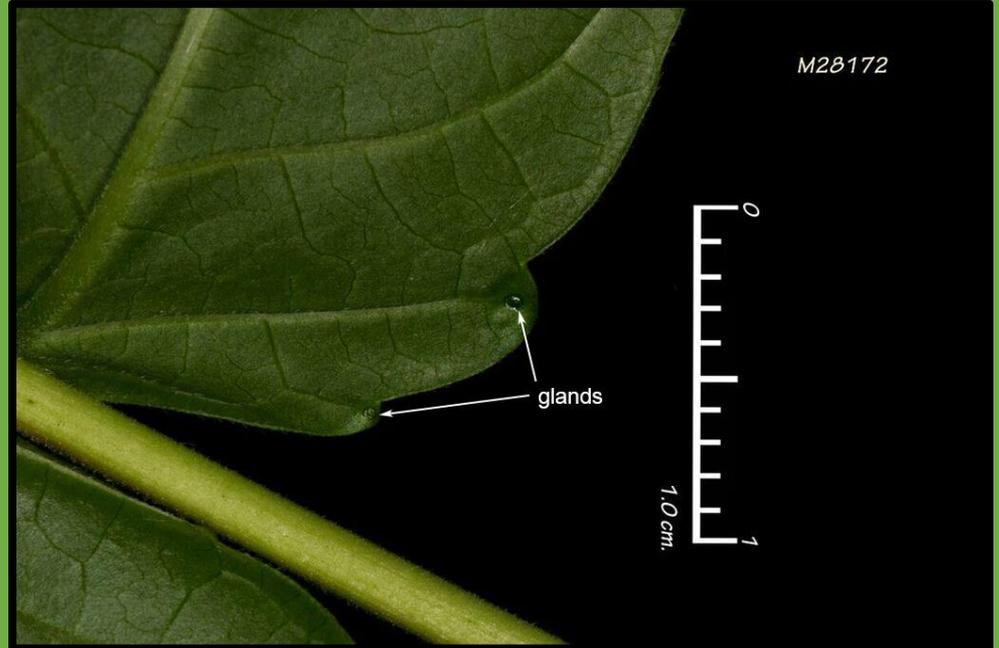
FRUITING TREE-OF-HEAVEN (*Ailanthus altissima*)



This species belongs to the Simaroubaceae, a family with centers of diversity in tropical America and tropical West Africa. In all, there are 13 genera and 130 species world wide (Thomas, 2004) . The only species of tree of this family in the northeastern United States is the tree-of-heaven which was introduced from Asia as an ornamental tree. It grows in many habitats and even thrives in cities with polluted air, soil, and water. The species is an invasive throughout most of the United States and eastern Canada (Plants, accessed 2017).

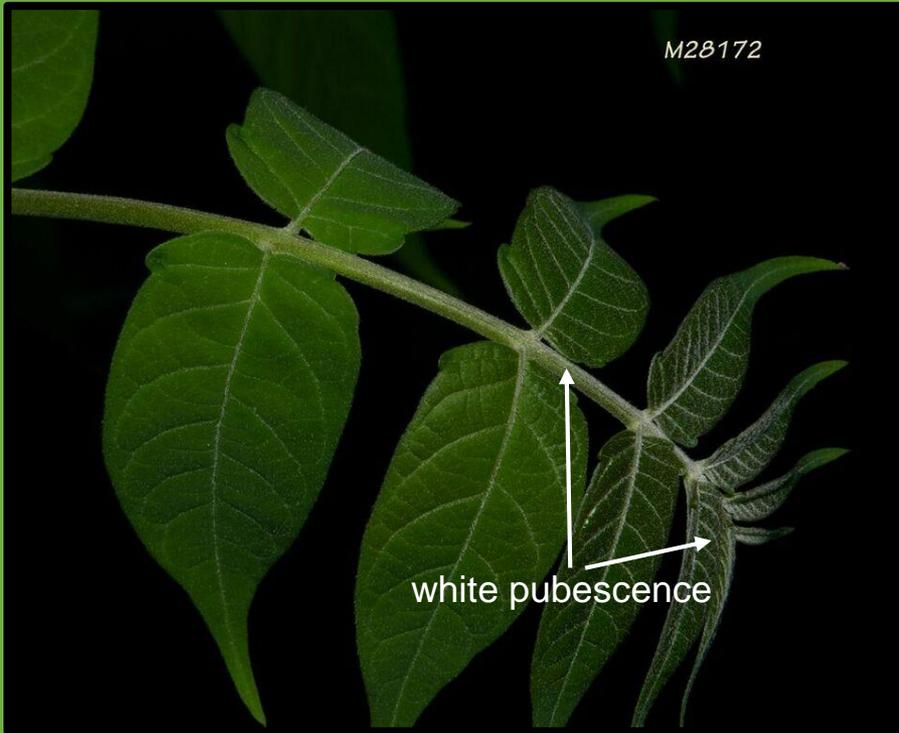
A fruiting individual is located in the center of the image. Both bisexual and unisexual flowers occur on the same tree. The fruits are first green but as they mature many of them turn red. Once established, the trees produce horizontal runners from which new trees develop from sprouts. Impressive clones of trees-of-heaven are often seen along roadsides. The reproduction by seeds and from runners makes this an efficient invasive tree difficult to control.

LEAVES OF THE TREE-OF-HEAVEN (*Ailanthus altissima*)



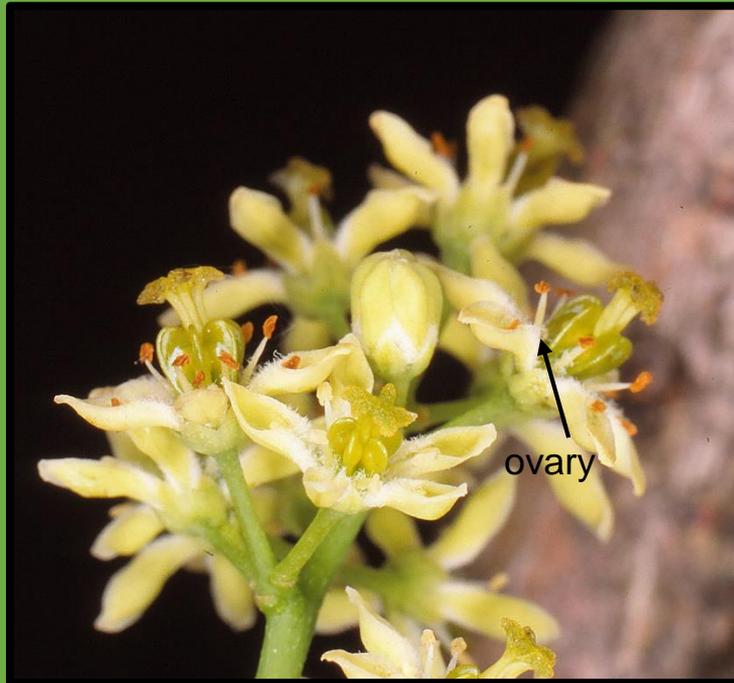
The most common habitat in our area for the tree-of-heaven is in open areas along highways. Saplings have very long leaves with up to nearly 30 leaflets. Glands are found at the base of the leaflets and the leaflets often show signs of lobes or rounded teeth at their base.

LEAVES OF THE TREE-OF-HEAVEN (*Ailanthus altissima*)



The alternate, pinnate leaves are pubescent when first flushed. This is most obvious toward the apex of the leaf shown here. The glands emit an unpleasant odor when they are crushed. The leaflets are discolorous, with the upper sides (adaxial) green and the lower sides (abaxial) white.

FLOWERS AND FRUITS OF THE TREE-OF-HEAVEN (*Ailanthus altissima*)

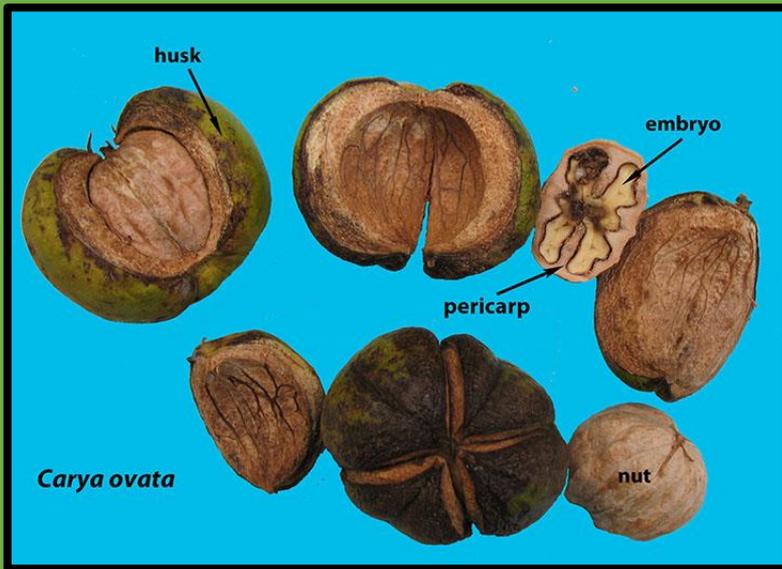


The ovary consists of five divisions. Each division can develop into a specialized fruit called a monocarp



On the left are three monocarps that developed from the original five divisions of the ovary. Normally plants produce a single fruit from a flower but in the tree-of-heaven as many as five monocarps can develop from a single flower.

SPECIES OF HICKORY (*Carya* spp.)



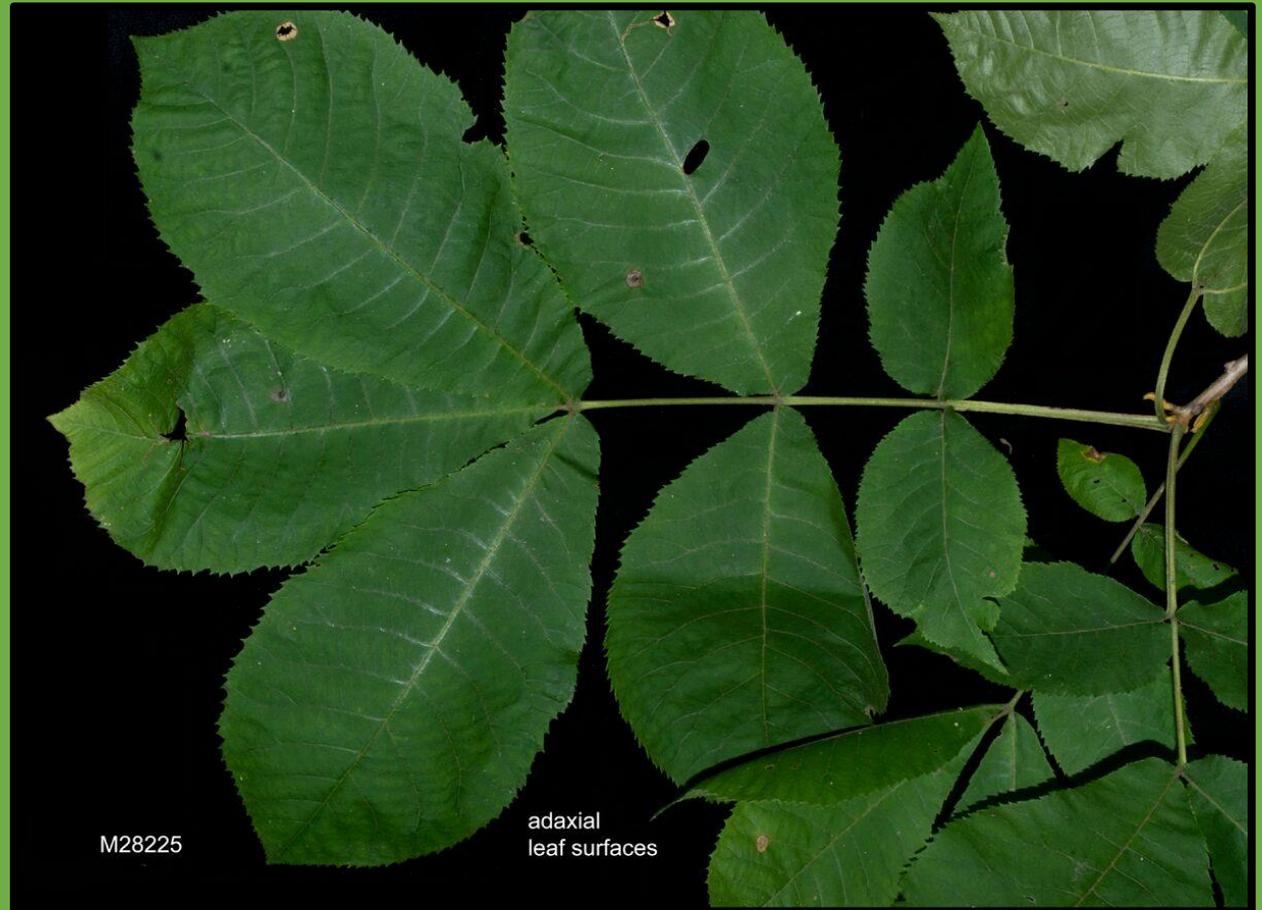
Hickories belong to the genus *Carya* of the walnut family (Juglandaceae). There are 18 species in North America, Mexico, and Asia and 11 species in eastern North America (Nelson et al., 2014). We have documented three species in the Preserve. The walnut family is best known for black walnuts (*Juglans nigra*) and pecans (*Carya illinoensis*) but we have not found them in the Preserve. The nuts also provide abundant food for animals. Black walnut is prized for its beautifully grained wood which is often used for making high quality furniture.



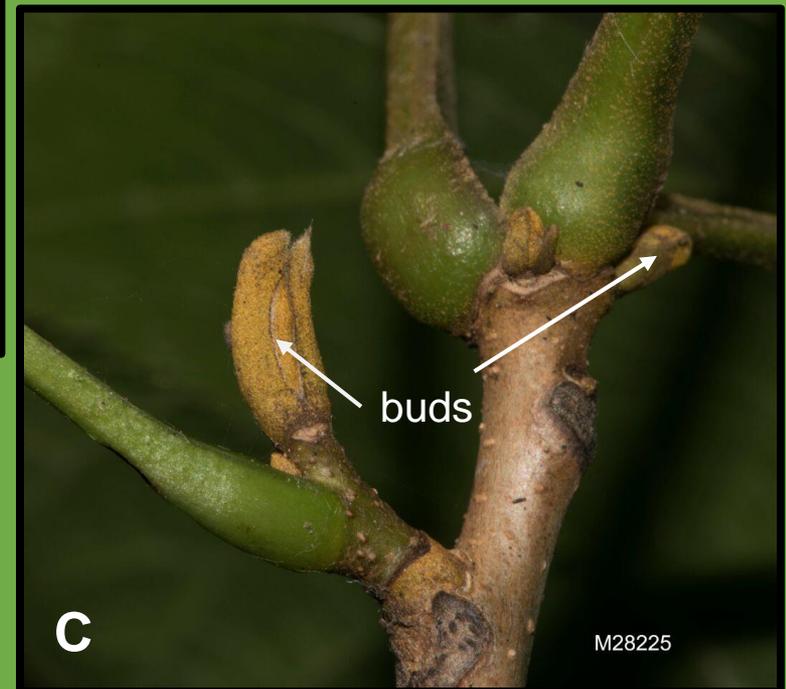
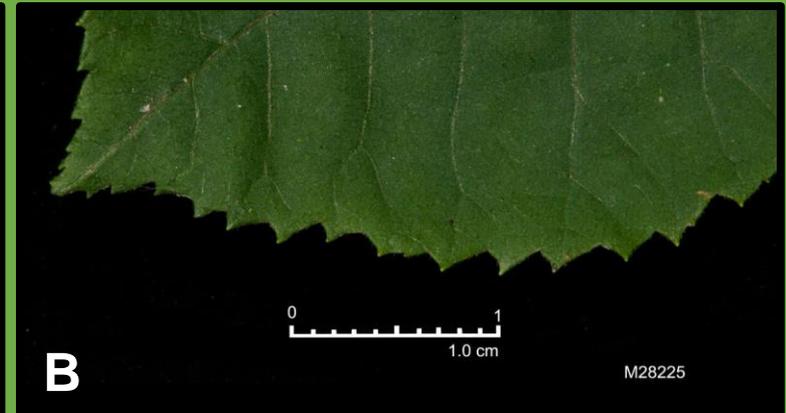
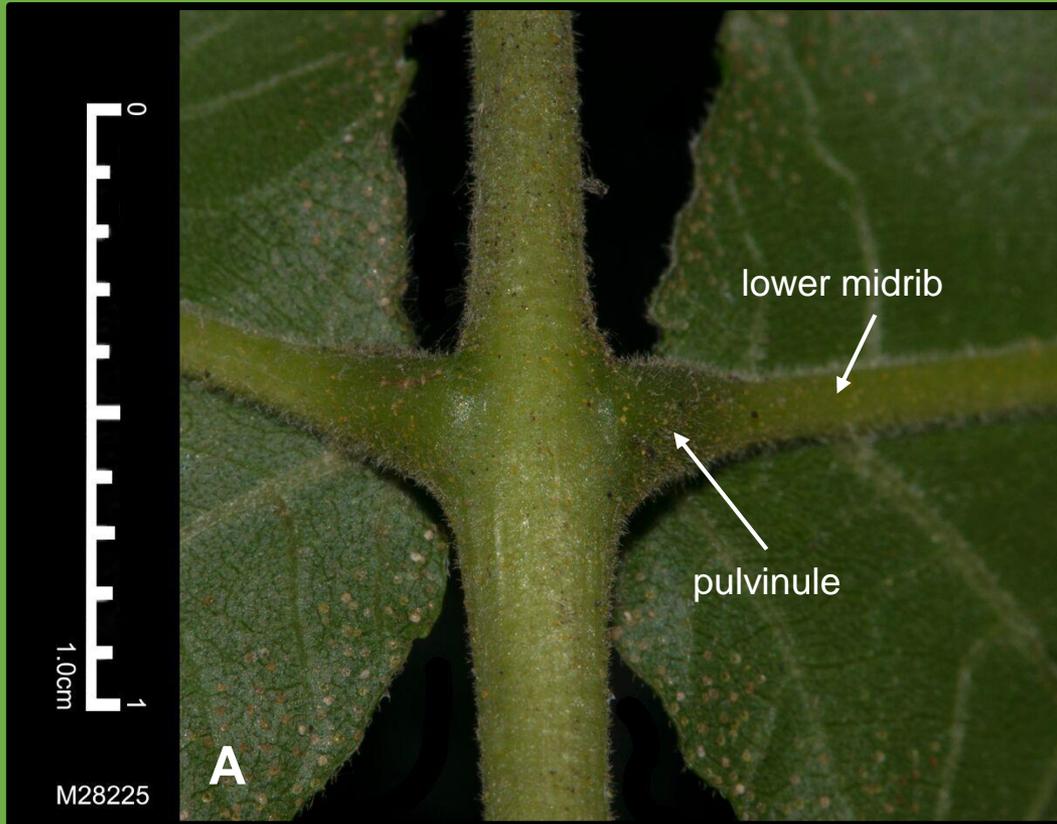
The leaves of the walnut family are oddly pinnate and alternate. Flowers are unisexual with both females and males occurring on the same tree. Male inflorescences are many-flowered catkins and females are solitary or with a few flowers at the apex of stems. The ovary is inferior. The fruit of hickories consists of two parts: 1) a husk which is derived from an involucre and dehisces into 4 valves and 2) a indehiscent nut with a very hard pericarp.

LEAF OF BITTERNUT HICKORY (*Carya cordiformis*)

An alternate, oddly pinnate leaf with seven leaflets, nearly sessile leaflets, and very well-defined dentate margins.

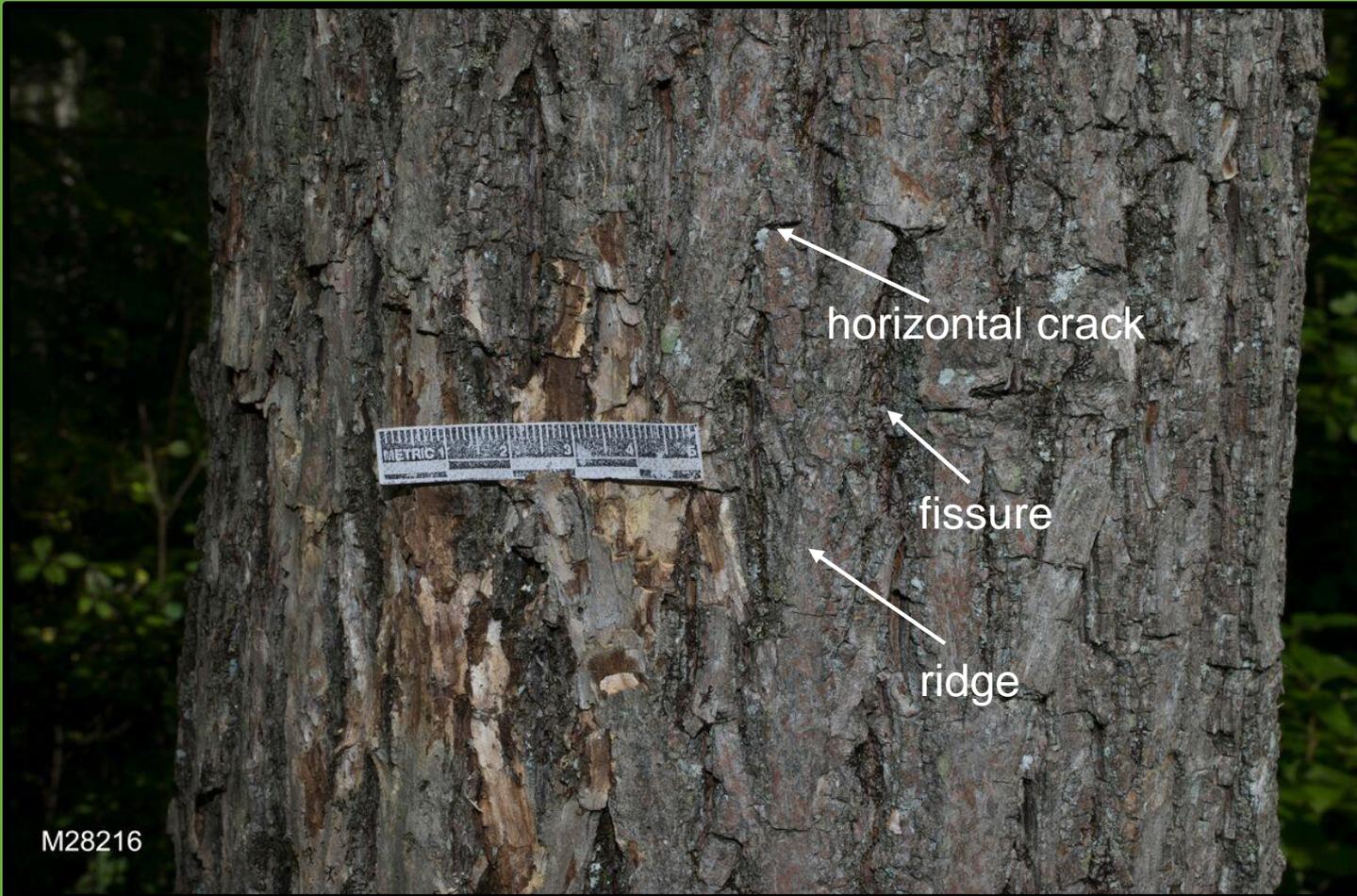


LEAF FEATURES OF BITTERNUT HICKORY (*Carya cordiformis*)



- A. Pubescent rachis, pulvinule, and midrib.
- B. Dentate leaflet margins.
- C. Yellow colored bud.

BARK OF PIGNUT HICKORY (*Carya glabra*)



Deeply fissured bark. The fissures are vertically oriented, the ridges are flat, and there are horizontal cracks. Overall, the fissures are reticulate, i.e., they are not long and straight.

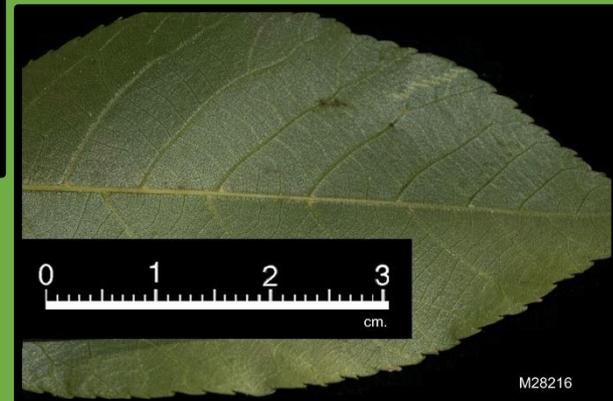
LEAF FEATURES OF PIGNUT HICKORY (*Carya glabra*)



The leaves are glabrous and often have five leaflets.

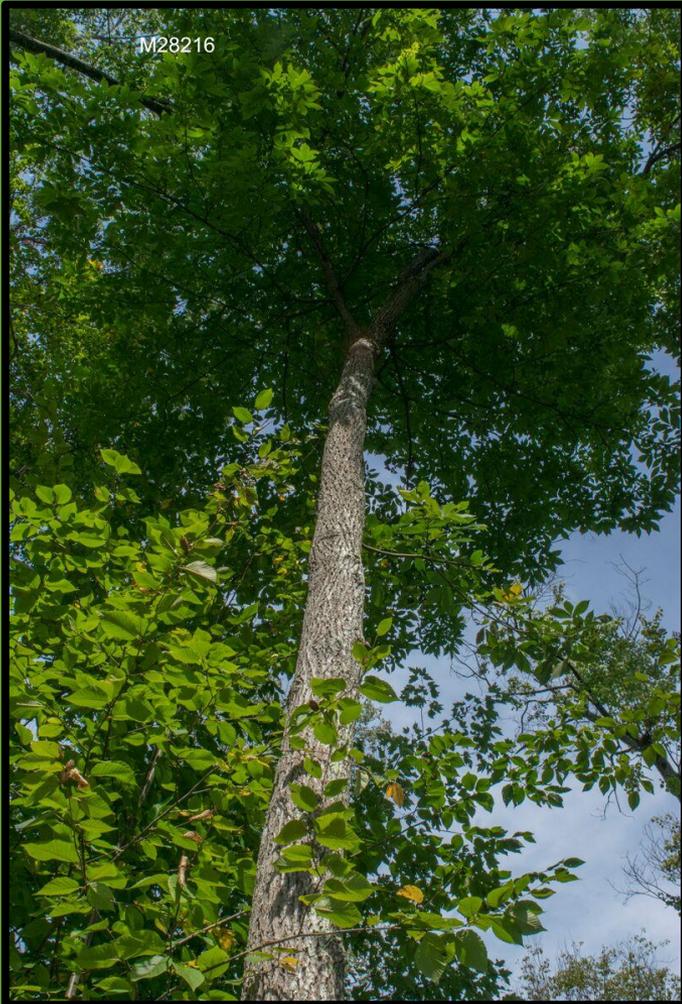


The lower (abaxial) surface of the leaflets are white.



The leaflet margins are serrate.

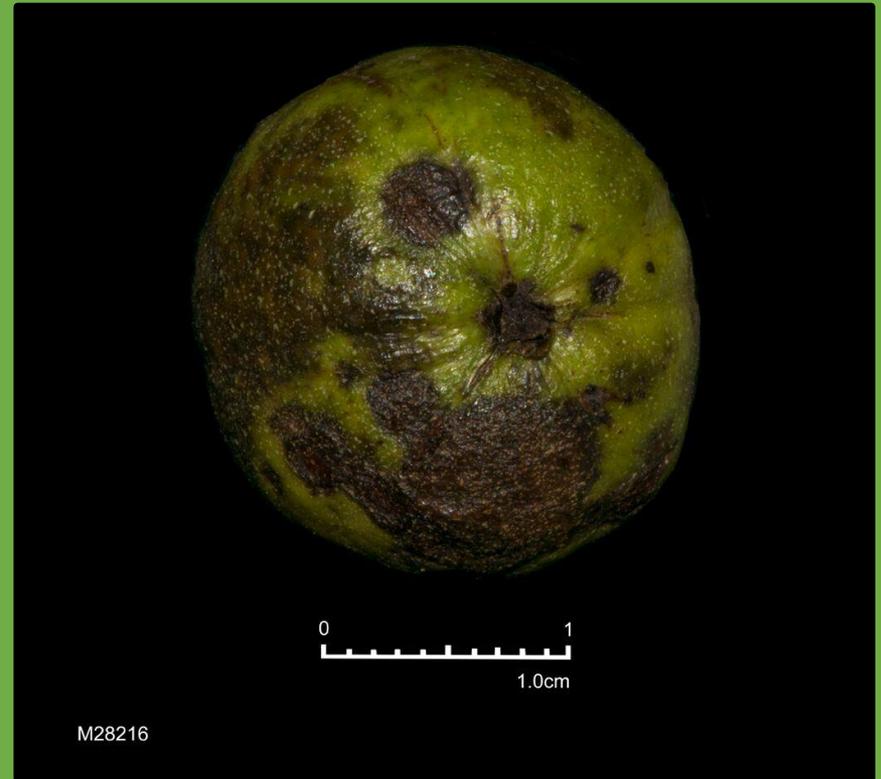
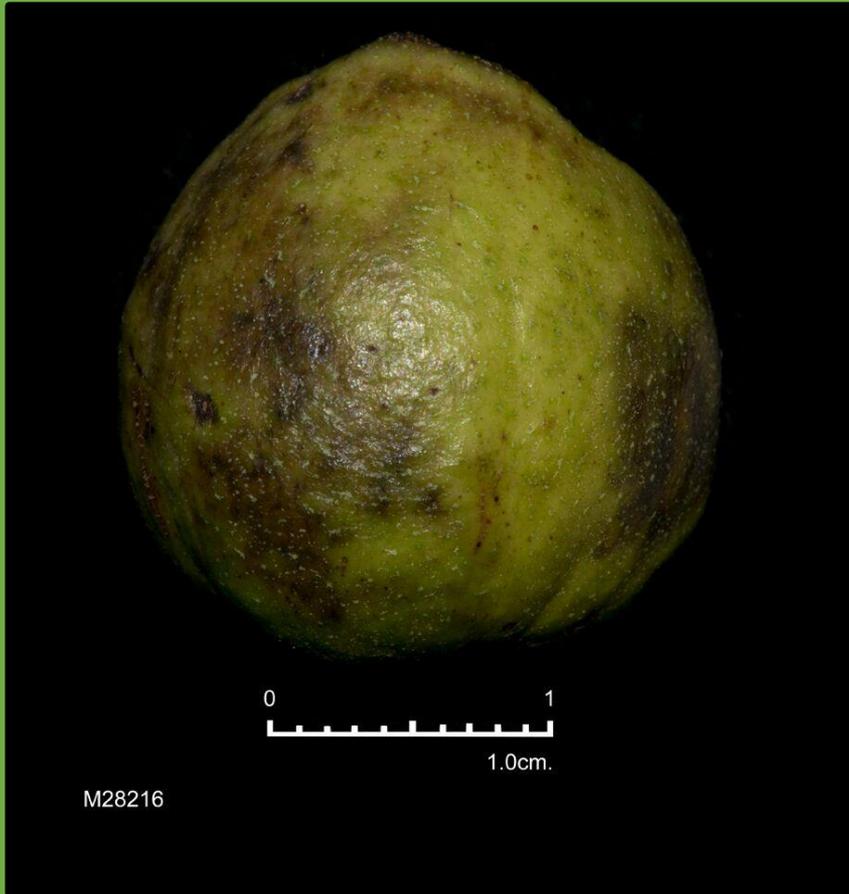
FEATURES OF PIGNUT HICKORY (*Carya glabra*)



Bud of *C. glabra*.

Trunk with fissured trunk of *C. glabra*.
The lower leaves belong to another
species.

FRUITS OF THE BITTERNUT HICKORY (*Carya glabra*)



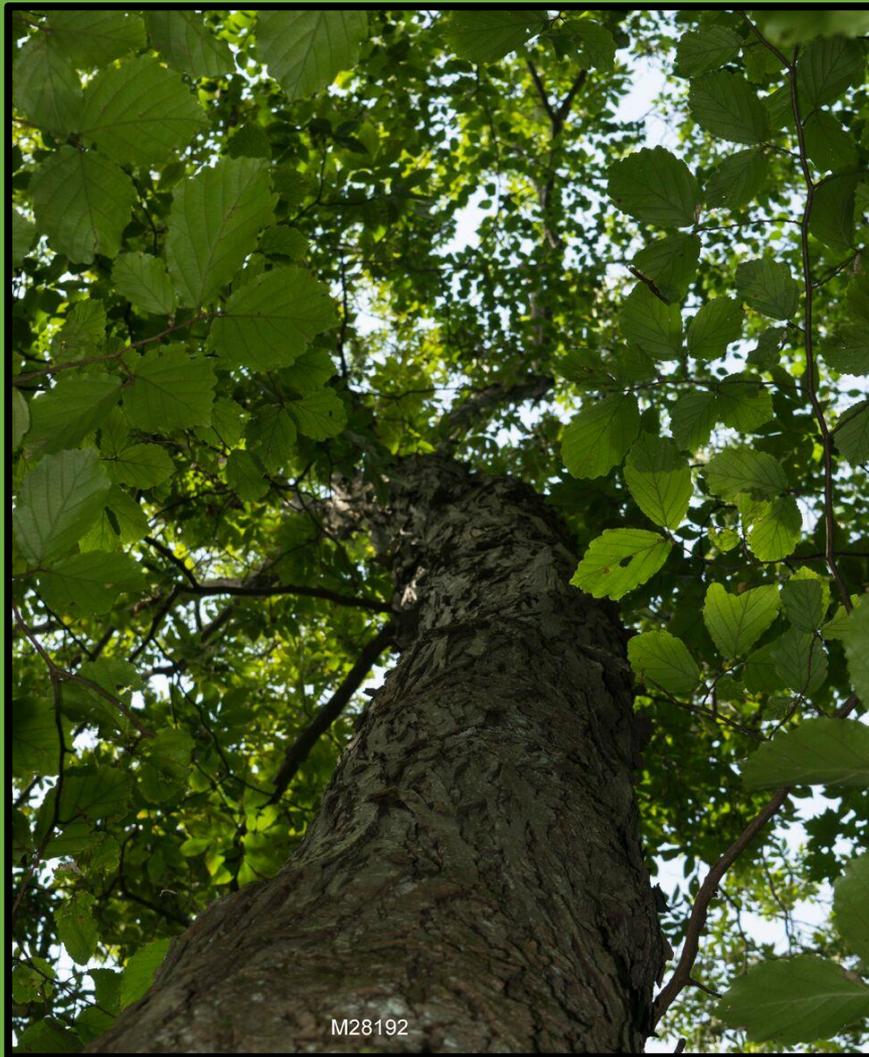
Lateral view on left side and basal view on right. There are no sign of valves and ridges on these fruits.

LEAVES OF SHAGBARK HICKORY (*Carya ovata*)



Left: lower (abaxial) side. Right: upper (adaxial) side.

BARK OF SHAGBARK HICKORY (*Carya ovata*)

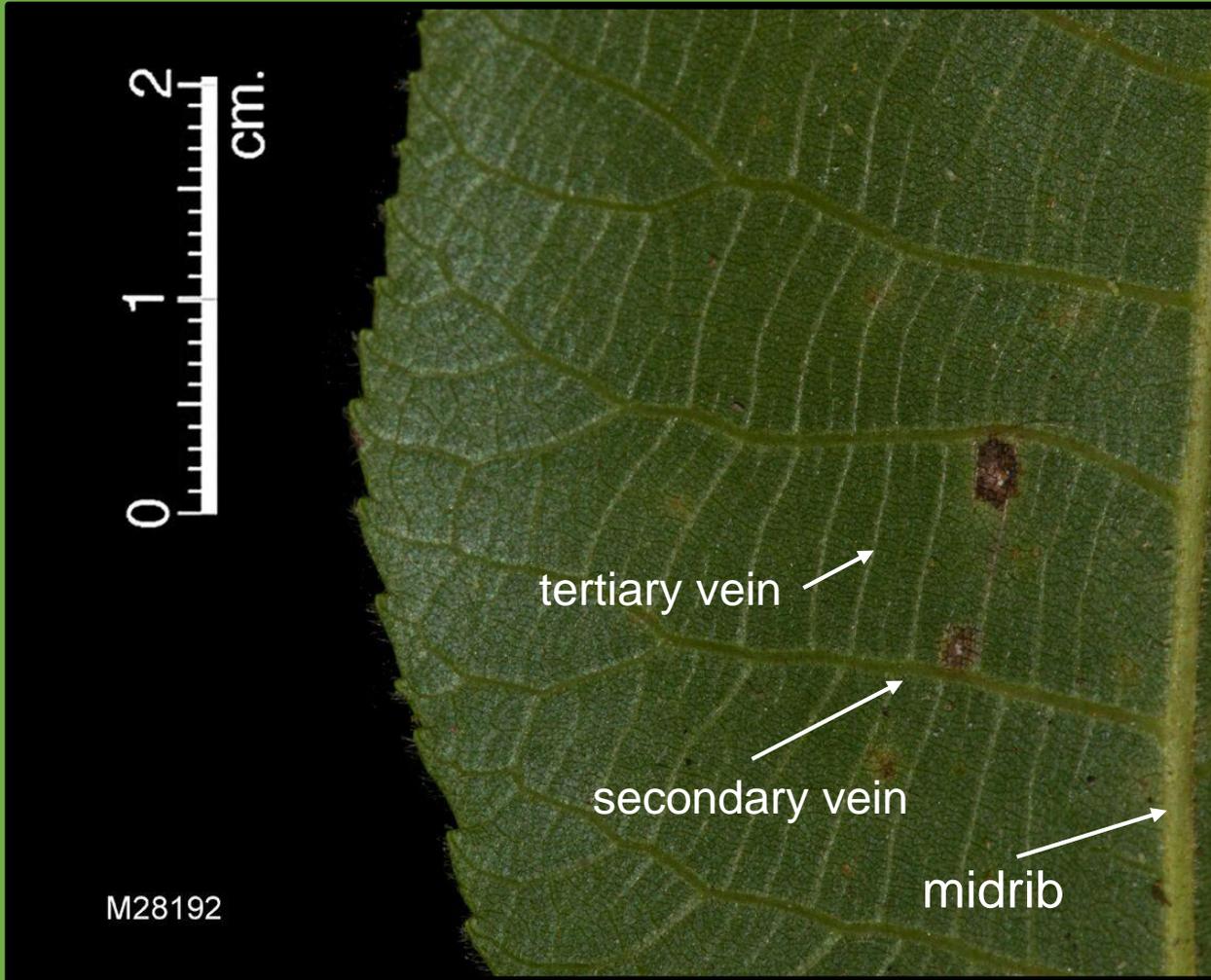


The lower leaves belong to witch hazel, not *Carya ovata*.



The bark of this species peels in large, relatively thin plates that curve away from the trunk.

ABAXIAL LEAFLET PUBESCENCE OF THE SHAGBARK HICKORY (*Carya ovata*)



The margins are serrate, the tertiary veins are percurrent, and the lower surface of the leaflet is pubescent. The lower surface of the leaflet feels velvety when it is touched.

Tertiary veins run from one to the next secondary vein without branching.

LEAVES, VEGETATIVE BUDS, AND FRUIT OF SHAGBARK HICKORY (*Carya ovata*)



This new stem bears two buds. Both are pubescent. The leaves consist of five leaflets.

FRUITS OF SHAGBARK HICKORY (*Carya ovata*)



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FRUIT OF SHAGBARK HICKORY (*Carya ovata*)



The fruits of *Carya ovata* have the thickest husk of the species of this genus found in the Preserve. The fruits were attached to leaf-bearing stems so there is no doubt that they represent the same species.