# *Oriental Bittersweet* - Celastrus orbiculatus

***Celastrus orbiculatus*** is a woody vine of the Celastraceae family.[1] It is commonly called **Oriental bittersweet**.[2][3] Other common names include **Chinese bittersweet**,[2] **Asian bittersweet**,[3] **Round-leaved bittersweet**,[3] and **Asiatic bittersweet**. *Celastrus orbiculatus* was introduced into North America in 1879,[4] and is considered to be an invasive species in eastern North America. It closely resembles the native North American species, *Celastrus scandens*, with which it will readily hybridize.[5]

The defining characteristic of the plant is its vines: they are thin, spindly, and have silver to reddish brown bark. They are generally between 1 and 4 cm in diameter. When *Celastrus orbiculatus* grows by itself, it forms thickets; when it is near a tree or shrub, the vines twist themselves around the trunk. The encircling vines have been known to strangle the host tree to death, also true of the American species. The leaves are round and glossy, 2–12 cm long, have toothed margins and grow in alternate patterns along the vines. Small green flowers produce distinctive red seeds. The seeds are encased in yellow pods that break open during autumn. All parts of the plant are poisonous.[6]

## Cultivation and uses[edit]

Because of these uses and systematic disturbances to eastern forests for wood production and recreation, Oriental bittersweet has naturalized to landscapes, roadsides, and woodlands of eastern North America. In the United States it can be found as far south as Louisiana, as far north as Maine, and as far west as the Rocky Mountains.[7] It prefers mesic woods, where it has been known to eclipse native plants.[8]

## *Celastrus orbiculatus* as an Invasive Species[edit]

Oriental bittersweet is a strong competitor in its environment, and its dispersal has endangered the survival of several other species. One attribute that contributes to the success of this species is having attractively colored fruit. As a result it is eaten by mammals and birds, which excrete the seeds to different locations.
Berberis thunbergii and Euonymus alatus which have been shown to have a decreased probability of establishment when placed in environments experiencing high annual precipitation.[17] The introduction of Oriental bittersweet into new areas threatens the local flora because the native plants then have a strong competitor in the vicinity. The species is native to Eastern Asia, but was introduced to the US for aesthetic purposes.[9]

**Oriental Bittersweet**

*Celastrus orbiculatus*

**Scientific classification**

| | |
|---|---|
| Kingdom: | Plantae |
| (unranked): | Angiosperms |
| (unranked): | Eudicots |
| (unranked): | Rosids |
| Order: | Celastrales |
| Family: | Celastraceae |
| Genus: | *Celastrus* |
| Species: | ***C. orbiculatus*** |

**Binomial name**

***Celastrus orbiculatus***
Thunb.

It has been used in floral arrangements, and because of improper disposal the plant has been recklessly introduced into areas, affecting the ecology of over 33 states from Georgia to Wisconsin, and parts of the Appalachians.[9] The organism grows primarily in the perimeter of highly vegetative areas, allowing it to readily access the frontier of resources. Oriental bittersweet's ability to grow in a variety of environments has proven to be detrimental to many plant species along the Appalachian mountains and is moving more towards the West as time progresses


This map shows the identified locations of the Oriental bittersweet as of 2012 (provided by the United States Department of Agriculture).[12]

Oriental bittersweet employs multiple invasive and dispersal strategies allowing it to outcompete the surrounding plant species in non-native regions. This is a strong reason why the control of the species presents difficulties to manage.[13] The plant's invasion has created diverse ecological, managerial, and agricultural complications making it a focus of environmental conservation efforts.

### Response to Abiotic Factors[edit]

Oriental bittersweet can be found growing in areas that are high and steep. When placed in 10 different sites with varying light intensity and nitrogen concentration, Oriental bittersweet was found to have higher aboveground biomass as well as a lower mortality rate in comparison to its congener species, *Celastrus scandens* (American bittersweet). This species is able to outcompete other species by more effectively responding to abiotic conditions such as sunlight. In diverse abiotic conditions (such as varying sunlight intensity and nitrogen concentrations), Oriental bittersweet has a mortality rate of 14% in comparison to the American bittersweet, which has a mortality rate of 33%.[14] Oriental bittersweet cannot thrive as efficiently when placed in extremely wet and dry environments; however, it flourishes in moderate rainfall environments which leads to an increased growth rate.

Sunlight is one of the most vital resources for Oriental bittersweet. As demonstrated by controlled experiments, Oriental bittersweet grows more rapidly in environments that fare a higher amount of sunlight. In a study where populations received above 28% sunlight, it exhibited a higher amount of growth and biomass.[14] This study used layers of woven cloth to control the percentage of available sunlight. In this experiment, the TLL ratio (the living length of stems on each plant) increased when Oriental bittersweet was exposed to higher amounts of sunlight.[14] If Oriental bittersweet was exposed to 2% sunlight, then the TLL ratio decreased.[14] Oriental bittersweet can increase in biomass by 20% when exposed to 28% sunlight rather than 2%. The plant's strong response to sunlight parallels its role as an invasive species, as it can outcompete other species by fighting for and receiving more sunlight. Although growth ratios decrease when Oriental bittersweet is exposed to 2% sunlight (due to a decrease in photosynthetic ability), it still exhibited a 90% survival rate.[15] Experimental data has indicated that Oriental bittersweet has a strong ability to tolerate low light conditions "ranging on average from 0.8 to 6.4% transmittance".[16] In comparison to its congener American bittersweet, when placed in habitats with little light, Oriental bittersweet was found to have increased height, increased aboveground biomass, and increased total leaf mass.[15][16] Oriental bittersweet, in comparison to many other competing species, is the better competitor in attaining sunlight.

Temperature is another variable that plays a role in Oriental bittersweet's growth and development as an invasive species. Unlike other invasive species, high summer temperatures have been shown to inhibit plant growth. Oriental bittersweet has also been shown to be positively favored in habitats experiencing high annual precipitation. This is noteworthy as it contrasts sharply with other common invasive species such as Berberis thunbergii and Euonymus alatus which have been shown to have a decreased probability of establishment when placed in environments experiencing high annual precipitation.[17]

Compared to other invasive species analyzed in a recent study, Oriental bittersweet was more prevalent in landscapes dominated by developed areas.[17] Open and abandoned habitats were also found to positively influence the spread of the plant compared to other invasive species.[17] Additionally the species is heavily favored in edge habitats. This ability to live in various environmental conditions raises the concern of the plant's dispersal.

## Biotic Interactions[edit]

### *Mutualistic Interactions[edit]*

A determining factor regarding Oriental bittersweet's ability to outcompete native plant species is its ability to form mutualistic associations with mycorrhizal fungi, specifically arbuscular mycorrhizal fungi.[18] Oriental bittersweet growth is highly dependent on the absorption of phosphorus. In a recent study, growth was found to be greater when arbuscular mycorrhizal fungi were present in soil with low phosphorus concentrations, compared to when the plant was placed in an environment with high soil phosphorus concentrations with no arbuscular mycorrhizal fungi were present.[18] The results from this study show the importance of symbiotic relationships in allowing Oriental bittersweet to effectively uptake nutrients from its surroundings. Additionally, the symbiotic relationship with mycorrhizae allows this invasive species to utilize less of its energy in root biomass to absorb necessary nutrients. This may be crucial in allowing Oriental bittersweet to act as an effective invasive species as it is able to allocate more energy to its aboveground biomass instead of its belowground biomass; a significant point regarding this plant's invasiveness relies on photosynthetic ability and reproductive capacity.[18] It should be noted that the symbiotic relationship established with fungi only occurs with arbuscular mycorrhizal fungi, while no such relationship has been observed with ectomycorrhizal fungi. These studies have shown that suitable mycorrhizae are a strong determining factor regarding whether a plant can survive in its environment.[18] Studies have also shown evidence that "introduced plant species can modify microbial communities in the soil surrounding not only their own roots, but also the roots of neighboring plants, thereby altering competitive interactions among the plant species".[18] This may be a key invasive trait for Oriental bittersweet, as it allows the plant to negatively affect surrounding plant life by altering their underground symbiotic microbial relationships.[18] However, further experimentation is necessary to determine whether this organism employs this trait as an invasive strategy.

### *Competitive Interactions[edit]*

One of Oriental bittersweet's invasive characteristics is its effective utilization of energy to increase plant height, thus giving it a competitive advantage over similar plants. A study conducted in 2006 showed that, in comparison to its congener American bittersweet, Oriental bittersweet had increased height, increased aboveground biomass, and increased total leaf mass.[15] This is not to say that Oriental bittersweet outperformed American bittersweet in all criteria: in comparison to Oriental bittersweet, "American bittersweet had increased stem diameter, single leaf area, and leaf mass to stem mass ratio," suggestive that American bittersweet focused growth on ulterior portions of the plant rather than plant characteristics emphasized by Oriental bittersweet such as stem length.[15] This is significant as height plays a major role in allowing Oriental bittersweet to outcompete surrounding vegetation.[15] Focusing growth on stem length allows it to be in a strong position to absorb light, while also negatively impacting surrounding plant life by creating shade-like conditions. As a result, this surrounding plant light absorption.
The species' vine-like morphology has also been shown to have negative effects on surrounding plant life. For example, evidence suggests that this morphological characteristic facilitates its ability to girdle nearby trees, creating an overall negative effect on the trees such as making them more susceptible to ice damage or damaging branches due to the weight of the plant.[19] Additionally, studies have suggested that Oriental bittersweet is capable of siphoning away nutrients from surrounding plants. The study found this to occur in a variety of environments, suggestive of both the plant's increased relative plasticity as well as increased nutrient uptake.[16] One study observed that the presence of Oriental bittersweet increases the basicity of the surrounding soil, a characteristic of many successful invasive plant species.[19] This alters the availability of essential nutrients and hinders the nutrient uptake ability of native plants. Though the relationship between Oriental bittersweet and the basicity of the soil is consistent, there are a number of proposed mechanisms for this observation. The plant's significant above-ground biomass demands the preferential uptake of nitrate over ammonia, leading to soil nitrification. It also has a high cation-exchange capacity, which also supports the larger biomass. Either of these functions could explain the increased basicity, but further experimentation is needed to pinpoint the exact mechanism.[19]

### *Hybridization[edit]*

Another major threat posed by Oriental bittersweet is hybridization with American Bittersweet. Hybridization occurs readily between American bittersweet females and Oriental bittersweet males, though the opposite is known to occur to a lesser extent. The resulting hybrid species is fully capable of reproduction.[20] In theory, if the

Oriental bittersweet invasion continues to worsen, widespread hybridiation could genetically disrupt the entire American bittersweet population, possibly rendering it extinct.[10]

## Management[edit]

To minimize the effects of Oriental bittersweet's invasion into North American habitats, its growth and dispersal must be tightly managed. Early detection is essential for successful conservation efforts. To reduce further growth and dispersal, above-ground vegetation is cut and any foliage is sprayed with triclopyr, a common herbicide. Glyphosate is another chemical method of control. These two herbicides are usually sprayed directly on the plants in late fall to prevent other plants from being targeted. These steps must be repeated annually, or whenever regrowth is observed.[21] Triclopyr is non-toxic to most animal and insect species and slightly toxic to some species of fish, but it has a half-life of less than a day in water, making it safe and effective for field usage.[22] [21] Mechanical methods have also been used, but they are not as effective due to the difficulty of completely removing the root.[23] There is also no biological control agent available in helping control this species.[24] Mechanical and chemical methods are being used, but they are only temporarily fixing the situation.

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# *Burning Bush - Euonymus alatus*

***Euonymus alatus***, known variously as **winged spindle**, **winged euonymus** or **burning bush**, is a species of flowering plant in the family Celastraceae, native to central and northern China, Japan, and Korea.

This deciduous shrub grows to 2.5 metres (8 ft 2 in) tall, often wider than tall. The stems are notable for their four corky ridges or "wings". The word *alatus* (or *alata*, used formerly) is Latin for "winged", in reference to the winged branches. These unique structures develop from a cork cambium deposited in longitudinal grooves in the twigs' first year, unlike similar wings in other plants.[1] The leaves are 2–7 centimetres (0.79–2.76 in) long and 1–4 centimetres (0.39–1.57 in) broad, ovate-elliptic, with an acute apex. The flowers are greenish, borne over a long period in the spring. The fruit is a red aril enclosed by a four-lobed pink, yellow or orange capsule.

The common name "burning bush" comes from the bright red fall color.
It is a popular ornamental plant in gardens and parks due to its bright pink or orange fruit and attractive fall color. The species[2] and the cultivar 'Compactus'[3] have both gained the Royal Horticultural Society's Award of Garden Merit.
This plant is an invasive species of woodlands in eastern North America,[4] and its importation and sale is prohibited in the states of Massachusetts[5] and New Hampshire.[6]

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***Euonymus alatus***

## Scientific classification

| | |
|---|---|
| Kingdom: | Plantae |
| (unranked): | Angiosperms |
| (unranked): | Eudicots |
| (unranked): | Rosids |
| Order: | Celastrales |
| Family: | Celastraceae |
| Genus: | *Euonymus* |
| Species: | ***E. alatus*** |

## Binomial name

***Euonymus alatus***
(Thunb.) Siebold

Winged euonymus overgrowing a fence

fruit and attractive fall color. The species[2] and the cultivar 'Compactus'[3] have both gained the Royal Horticultural Society's Award of Garden Merit.

This plant is an invasive species of woodlands in eastern North America,[4] and its importation and sale is prohibited in the states of Massachusetts[5] and New Hampshire.[6]

# *Japanese Barberry - Berberis thunbergii*

***Berberis thunbergii*** (**Japanese barberry**,**Thunberg's barberry**, or **Red barberry**[1]) is a species of *Berberis*, native to Japan and eastern Asia, though widely naturalized in China and in North America.[2][3][4]

### Description[

It is a dense, deciduous, spiny shrub which grows 0.6 to 2.5 m (2 to 8 ft) high. It has deeply grooved, brown, spiny branches with a single (occasionally tridentine) spine (actually a highly modified leaf) at each shoot node. The leaves are green to blue-green (reddish or purple in some horticultural variants), very small, spatula to oval shaped, 12–24 mm long and 3–15 mm broad; they are produced in clusters of 2-6 on a dwarf shoot in the axil of each spine. The flowers are pale yellow, 5–8 mm diameter, produced in drooping 1-1.5 cm long umbrella-shaped clusters of 2–5; flowering is from mid spring to early summer. The edible fruit is a glossy bright red to orange-red, ovoid berry 7–10 mm long and 4–7 mm broad, containing a single seed. They mature during late summer and fall and persist through the winter.[4]

### Identification

This species is sometimes confused with *Berberis canadensis* (American barberry), *Berberis vulgaris* (European barberry), and other deciduous *Berberis* species; it is most readily distinguished by the flowers being produced in umbels, not racemes.

### Cultivation

Flowers in an umbel on naturalized *Berberis thunbergii* in the eastern United States

*Berberis thunbergii* is widely grown as an ornamental plant,[5] both in Japan and elsewhere in the temperate Northern Hemisphere. Numerous cultivars have been selected, including plants selected for yellow, dark red to violet, or variegated foliage, erect growth (for hedge use), and dwarf size.

The purple-leaved form *B. thunbergii* f. *atropurpurea* has produced numerous cultivars, of which the following have gained the award:-

- 'Atropurpurea Nana'[6]
- 'Golden Ring'[7]
- 'Harlequin'[8]
- 'Rose Glow'[9]

### Invasive species

In recent years, *Berberis thunbergii* has been recognized as an invasive species in many parts of the eastern United States.[4] The Plant Conservation Alliance's Alien Plant Working Group lists it among its "Least Wanted".[1]

This *Berberis* is avoided by deer, and has been replacing native species. Furthermore, the plant can raise the pH of the soil and affect soil nitrogen levels. Unlike *B. canadensis* and *B. vulgaris*, *B. thunbergii* does not act as a host for *Puccinia graminis* (black rust), a rust disease of wheat.[4] It is also an exceptionally favorable environment for ticks.[2]

**Berberis thunbergii**

*Berberis thunbergii* shoot with fruit

**Scientific classification**

| | |
|---|---|
| Kingdom: | Plantae |
| (unranked): | Angiosperms |
| (unranked): | Eudicots |
| Order: | Ranunculales |
| Family: | Berberidaceae |
| Genus: | *Berberis* |
| Species: | ***B. thunbergii*** |

**Binomial name**

***Berberis thunbergii***
DC.

Cultivar 'Aurea'

Cultivar 'Atropurpurea'

Naturalized *Berberis thunbergii* in Penwood State Park in Connecticut

**Japanese Knotweed**

**Scientific name**: *Fallopia japonica* (Houtt.) Ronse Decr. (ITIS)

**Synonym**: *Polygonum cuspidatum* Siebold & Zucc.; *Reynoutria japonica* Houtt.

**Common names**: Japanese knotweed, fleeceflower, Mexican bamboo, huzhang

## Selected Resources

**Native To**: Asia (Stone 2010)

**Date of U.S. Introduction**: Late 1800s (Stone 2010)

**Means of Introduction**: Introduced as an ornamental (Stone 2010)

**Impact**: Crowds out native species (Stone 2010)

**Current U.S. Distribution**:

- Invasive Species Maps
  *USDA. FS. Northern Research Station.*
  Maps are organized for 43 invasive plant species into five categories: trees, shrubs, vines, herbs, and grasses. Select the desired species to view the distribution information for northern states.
- Early Detection & Distribution Mapping System (EDDMapS) - Japanese Knotweed
  *University of Georgia. Center for Invasive Species and Ecosystem Health.*
  Provides state, county, point and GIS data. Maps can be downloaded and shared.

**Images**:

- Invasive.org - Japanese Knotweed
  *University of Georgia. Center for Invasive Species and Ecosystem Health.*
- Google Images - Japanese Knotweed
  *Google*.