

ELEMENT STEWARDSHIP ABSTRACT
for

Celastrus orbiculata

Asiatic Bittersweet

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Authors of this Abstract:
Glenn D. Dreyer

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1815 North Lynn Street, Arlington, Virginia 22209 (703) 841 5300

The Nature Conservancy
Element Stewardship Abstract
For *Celastrus orbiculatus* Thunb. (*C. articulatus*)

I. IDENTIFIERS

Common Name: asiatic bittersweet, oriental bittersweet

General Description:

Celastrus orbiculatus is a deciduous woody vine which climbs by means of twining about a support. The branches are round, glabrous, light to darker brown, usually with noticeable lenticels. The outer surface of its roots are characteristically bright orange. Individuals have been found climbing to heights up to 18 m in the Great Smoky mountains (Langdon 1993). Plants with stems 5 cm diameter at breast height are common and some reach 13 cm dbh.

Axillary buds are 1-3 mm long, rounded, with outer scales sometimes becoming spine-like. Leaves are glabrous, alternate in arrangement and extremely variable in size and shape, from broadly oblong-obovate to suborbicular, 2 -12 cm long and 1.5 to 8 cm wide. Leaf margins are crenate-serrate and leaf base cuneate to obtuse, tip acute to rounded. Petioles are 1-3 cm long.

Inflorescences are axillary cymes, usually containing 3 - 7 flowers. However inflorescences are sometimes terminal in male plants. Flowers are small, greenish-yellow, and usually become unisexual by abortion or reduction of male or female parts, thus the plants are usually dioecious (Brizicky 1964). Occasional vines develop both unisexual and perfect flowers and are then termed polygamo-dioecious (Gleason and Cronquist 1991). Another reported variation is occasional monoecious plants, i.e. with both male and female flowers on the same vine (Hou 1955).

The flowers have 5 sepals and 5 petals. Male flowers contain 5 stamens which are about as long as the petals and inserted at the edge of a cup-shaped disk around a vestigial pistil. Female flowers have vestigial stamens, a 3-lobed stigma, columnar style and well a developed superior ovary, sometimes embedded in the disk (Gleason and Cronquist 1991).

The fruit are globose, loculicidal capsules, 6 to 8 mm in diameter, which change in color from green to bright yellow as they mature. The capsules are three valved with each valve (locule) containing one or two brown seeds completely enclosed in a fleshy red aril. Upon ripening, the yellow outer covering splits open to reveal the red aril, thus presenting a brightly bicolored "dispersal flag".

This species can be reliably distinguished from the native *Celastrus scandens* only by the location of female flowers and fruit. In *C. orbiculatus* they are borne in clusters of 3 - 7 in the axils of leaves. *Celastrus orbiculatus* fruit are never arranged in terminal clusters. In contrast the flowers and fruit of *C. scandens* are borne in terminal panicles which may contain numerous flowers or fruits. A second, less reliable, difference is the yellow color of the outer fruit covering in *C. orbiculatus* vs. the orange color of *C. scandens* outer fruit cover.

The color of the inner aril is red in both species. Identification by leaf shape or size, or by male inflorescence type is not reliable. Illustrations showing the differences between the two species can be found in Gleason (1952) and McNab and Meeker (1987).

The primary taxonomic reference for this section is Hou (1955).

Diagnostic Characteristics:

Celastrus orbiculatus is an invasive, non-native woody vine. It is particularly troublesome in natural areas in coastal Connecticut and New York state and in the southern Appalachians but may be found growing wild from Maine to Louisiana and the southeastern Great Plains. It may severely damage desirable plants by strangling and/or overtopping them and may blanket entire stands. Upland meadows, thickets, young forests, and beaches are most vulnerable to Asian bittersweet invasion and dominance.

The species may be distinguished from its native congener *C. scandens* by the location of its fruit - *C. orbiculatus* has small clusters in the leaf axils while *C. scandens* has clusters at its branch tips. The two species may be capable of hybridizing and since the native is relatively rare it is possible that its distinct genetic identity is threatened.

Little research has been conducted on *C. orbiculatus* control but low-growing populations have been successfully treated by cutting and applying triclopyr herbicide to the regrowth about a month later. Larger vines may be cut and the stump treated immediately with triclopyr herbicide. Unfortunately, Asian bittersweet is frequently cultivated and its fruits are gathered for decorative use, which will make preventing further spread and reinfestation all the more difficult. For this reason it is of the utmost importance that land managers, naturalists, botanists, students, horticulturists, gardeners, retailers, etc. learn to distinguish between the native and the introduced bittersweet vine. The seriousness of the problem must be communicated to those in areas where *C. orbiculatus* either has not yet reached or is not well established.

II. STEWARDSHIP SUMMARY

III. NATURAL HISTORY

Range:

Celastrus orbiculatus is native to temperate east Asia, including central and northern Japan, Korea, and China north of the Yangtze River.

The exact date of *Celastrus orbiculatus* introduction to eastern North America is obscure, but appears to have been before 1879 (Patterson 1974). Patterson (1974) stated that *C. orbiculatus* has become "naturalized" in 21 of the 33 states in which it is cultivated. By the early 1970's it was naturalized north to central Maine, through New England, New York, Ohio and west to Iowa, south to Louisiana and Georgia. It was considered weedy in all of New England and most of the Atlantic Coast States by 1971. It is especially troublesome in the southern Appalachians and is considered epidemic in the vicinity of Asheville, NC (Langdon 1993). Patterson (1974) also found it cultivated in the three Pacific Coast states,

but it has not been reported "naturalized" there. It is reasonable to assume the vine has expanded its North American range in the twenty years since Patterson completed his research.

The western-most citation of naturalized populations found was for the "southeastern Great Plains" (Great Plains Flora Assoc. 1986). In southern Illinois, it is sometimes found in woodlands (Mohlenbrock and Voigt 1974), while the authors of "Plants of the Chicago Region" call it "an aggressive weed which gives every indication of being a future problem in the area" (Swink and Wilhelm 1979). *C. orbiculatus* is also "sometimes found in semi-natural situations, as in woods" in southern Ontario (Soper and Heimbürger 1985).

Habitat:

Celastrus orbiculatus habitat on its native continent of Asia is said to be lowland slopes or thickets at altitudes from 100 to 1,400 m. The vine is widely distributed in northern and central Japan and Korea. In China it is found primarily in provinces north of the Yangtze River (Hou 1955).

Its North American habitat preferences are wide but seem to be exclusively terrestrial. It is variously described as occupying open woods and thickets (Gleason and Cronquist 1991), roadsides, fence-rows, and thickets (Fernald 1970), alluvial woods, roadsides and thickets (Radford et al. 1968).

Reproduction:

Flowers bloom in late May to early June in Connecticut. Fruit ripens in September and remains on the vine through much of the winter. Brizicky (1964) notes that hymenopterous insects, especially bees, are its main pollinators, but Wyman (1950) also found wind pollination to be effective. Wyman also states *C. orbiculatus* and *C. scandens* can pollinate each other, and White and Bowden (1947) created a fertile hybrid through a controlled breeding program. No naturally occurring hybrid plants have been reported in the literature. However, Dreyer et al, (1987) reported two distinct sizes of pollen grains on certain individuals, tentatively identified as *C. orbiculatus*, growing in close proximity to *C. scandens*. They speculated that these plants may be hybrids.

Fruit dispersal is generally thought to be by birds and small mammals. In an unpublished undergraduate study in Connecticut, removal of fruit from seven species of woody plants by birds was observed during fall and winter (Wheeler 1987). *C. orbiculatus* was considered an important winter food, and was comparable in lipid and sugar content to the fruit of other species, but was not taken at all by animals in the fall. Black-capped Chickadees, Northern Mockingbirds, European Starlings and Blue Jays all fed on *C. orbiculatus* during the winter months.

Humans are also important dispersal agents. Fruiting stems are collected for dried flower arrangements, and are soon disposed of on compost and brush piles. The vine is highly attractive, easy to grow and propagate, and available at many nurseries, where it is often mislabeled as *C. scandens*. It was, and still may be, planted extensively in highway

landscaping and for "conservation" plantings for wildlife food and cover, and erosion control, both as itself or mistakenly for *C. scandens*.

Seed germination is generally high in *C. orbiculatus*, particularly when compared to *C. scandens*. Patterson (1974) conducted a wide variety of germination tests with seed from 4 eastern US states and found between 30 and 95% germination. He also noted that the highest germination rates occurred at low light intensities. Dreyer et al. (1987) confirmed the ability to germinate at low light levels and reported germination from 59 to 82%. Also in Connecticut, Clement et al. (1991) found *C. orbiculatus* produced 4.2 viable seed per fruit compared to 3.2 in *C. scandens*. Mean germination rates for *C. orbiculatus* were 70% compared to 20 % for *C. scandens*.

In field experiments Clement et al (1991) found that *C. orbiculatus* photosynthetic rates increased with increasing light intensity. In contrast, *C. scandens* photosynthetic rates at the same sites, tended to reach a plateau beyond which additional light had no significant effect. The ability of *C. orbiculatus* to acclimate to a variety of irradiance levels may be one of the factors which has allowed it to spread rapidly.

C. orbiculatus rootsuckers prolifically, especially after the main vine is damaged or cut. Rootsuckering is a common occurrence and results in large clones or patches which often spread from one or a few original plants which originated as seedlings.

Patterson (1974) noted the scarcity of other plants under dense canopies of *C. orbiculatus*, but could not attribute this to soil moisture, soil nutrients, precipitation interception or temperature changes. However, shading by the *C. orbiculatus* canopy was considered a potentially significant factor.

IV. CONDITION

V. MANAGEMENT/MONITORING

Management Requirements:

Celastrus orbiculatus poses a serious threat to individual plants and plant communities due to its high reproductive rate, long range dispersal, ability to rootsucker, and rapid growth rates. Individual plants can be severely damaged and even killed by the aggressive growth habits of this vine. Tree and shrub stems are weakened and killed by the twining and climbing growth which twists around and eventually constricts solute flow (as shown by Lutz, 1943 for *C. scandens*). Trees with girdled stems and large amounts of vine biomass in their canopies are more susceptible to damage by wind, snow and ice storms (Siccama, et al. 1976, Langdon 1993). All types of plants, and even entire plant communities, can be over-topped and shaded by the vine's rapid vegetative growth. Nearly pure stands of this vine are not uncommon in affected areas. Upland meadows, thickets and young forests, both natural and managed, appear to be most vulnerable to *C. orbiculatus* dominance.

Langdon (1993) notes that many of the rarest plants in the southeastern U.S. require a natural disturbance regimen of a certain quality and frequency. Because many of these processes

have been altered some of these species are now relegated to roadway and utility corridors which provide exactly the sort of habitat most often invaded and dominated by *C. orbiculatus*. Langdon (1993) also points out that the region's old growth forests such as cove hardwood stands lose 1-2% of their canopy each year which may provide *C. orbiculatus* with opportunities to invade. Fortunately, it has not yet been found in virgin forests in the Smokies.

Beaches are also open to invasion. In Connecticut, TNC is managing a *C. orbiculatus* infestation in sand dunes adjacent to a Piping Plover nesting area on Long Island Sound. The managers are concerned that the vines will either spread into actual nesting areas or alter the dynamics of dune formation and erosion (Lapin 1992). In either case, they could interfere with the reproduction of a bird officially listed as a Threatened Species by the State of Connecticut. Very vigorous patches of *C. orbiculatus* have also been observed growing in pure sand in coastal Rhode Island (Dreyer, pers. obser.).

It is considered of particular concern to forestry programs in some parts of the southern U.S. (McNab and Meeker 1987). The problems throughout the East are most noticeable along roadsides where vegetation is blanketed by bittersweet in a way reminiscent of Kudzu infested areas of the Southeastern U.S.

Given the fact that hybrids with *C. scandens* are clearly possible, and that *C. scandens* appears to be less common than in the recent past (Dreyer et al. 1987, Mehrhoff, 1986) the potential for introgressive hybridization, resulting in the loss of *C. scandens* genetic identity, is possible. Connecticut has recently listed *C. scandens* as a Species of Special Concern, i.e. one for which more information on distribution and abundance is needed. In Great Smoky Mountains National Park *C. scandens* is restricted to circumneutral soils and is considered a non-reproducing rare plant (Langdon 1993).

Recovery of natural areas highly infested with *C. orbiculatus* is unpredictable. Previous natural vegetation structure and function are often severely altered, although remnants of the flora may persist. Removal methods often further disrupt remnants of previous plant communities. A number of workers report that even with complete removal and rootkill of *C. orbiculatus*, substantial seedling regeneration occurs in following years, probably due to a persistent soil seed bank. Langdon (1993) stresses that individual clones are difficult to kill. For example, one 5m x 5m clone treated with triclopyr in 1986 has produced 50+ sprouts each year since. The sprouts are hand-pulled but often break and resprout later. Fortunately, the six years of work at this site appear to have nearly exhausted the seed bank. In cases where all nearby seed sources cannot be eliminated, however, reinfestation is a continual possibility.

Due to the ease of and apparent interest in cultivating *C. orbiculatus* in the eastern half of the U.S. and elsewhere, a very large geographic area is potentially threatened. The spread of the vine from coastal States westward should be monitored. In addition, the status of *C. scandens* populations, especially in east coast States, should be evaluated.

Langdon (1993) strongly suggests that natural areas be scouted for infestations about 2 weeks after the autumn foliage peak. In the Smokies this falls around November 10. By this time other native deciduous plants drop almost all of their leaves while *C. orbiculatus* leaves turn lemon- to golden-yellow making the plants easy to identify even at a distance or from a vehicle at moderate speeds. Since individual plants are usually exclusively male or female and the seeds may disperse a kilometer or more these types of searches are essential to locate individuals that have recently become established in previously uninfested areas. If carried out conscientiously, such searches will enable managers to implement control programs that contain infestations to particular areas and prevent them from spreading.

The following individuals have experience monitoring and controlling *Celastrus orbiculatus*:

Glenn Dreyer
The Connecticut College Arboretum
270 Mohegan Avenue
New London, CT 06320

Lise Hanners
Devil's Den Preserve
P.O. Box 1162
Weston, CT 06883
203 226 4991

Keith Langdon
Great Smokey Mt. National Park
107 Park Headquarters Road
Gatlinburg, Tenn. 37738
615 436 1218

W. Henry McNab
USDA Forest Service
SE Forest Experiment Station
Asheville, NC 28806

David Patterson
USDA Ag. Research Service
Botany Department
Duke University
Durham, NC 27706

Paula Piehl
Potomac State College
West Virginia University
Keyser, West Virginia 26726

Effective biological and additional effective chemical/mechanical control methods are needed. Education of nursery growers, retailers and the gardening public is also needed to reduce the demand for and the dissemination of the vine and its fruit.

HERBICIDES:

A successful control technique was developed by Dreyer (1988) for dense, low patches of *C. orbiculatus* where herbicide use is appropriate. Vegetation in the entire area is cut to the ground early in the growing season and allowed to resurge. Approximately one month later, foliar applications of an herbicide containing triclopyr (Garlon 4, a triclopyr ester, or Garlon 3A, a triclopyr salt) mixed at 1% to 2% in water and applied by backpack sprayer result in essentially 100% rootkill of *C. orbiculatus*. No off-target damage or root uptake by adjacent plants has been noted in over four years of using this technique. The same study found foliar applications of glyphosate (Roundup, Rodeo) and amitrole (Amitrol, Weedazol) were both ineffective in rootkilling *C. orbiculatus*.

Another advantage to using triclopyr instead of glyphosate is that it does not kill monocots. Thus grasses, sedges, liliaceous plants, etc., will not be killed and will remain to prevent soils from being completely exposed. These remaining plants often dominate sprayed sites a year after treatment. Triclopyr is also the active ingredient, in relatively dilute form, in the Ortho product Brush-B-Gone which, unlike Garlon, is not a restricted use chemical.

Hutchison (1992) reports foliar applications of a 2,4-D and triclopyr mixture (Crossbow) to *C. orbiculatus* will effectively "reduce the population" when applied in mid to late October.

In locations where large vines climb high into trees, cutting and treating the vine stump surface with a triclopyr-containing herbicide is a logical procedure. The vine stems hanging in the trees will decompose and fall within two to three years. Hutchison (1992) recommends cut surface treatment with "100% Roundup" (presumably undiluted with water) applied at the time of the last killing frost, but he included no data concerning the effectiveness of this technique.

MOWING:

Regular, weekly mowing will exclude *C. orbiculatus*. However, less frequent mowing, eg. 2-3 mowings per year, stimulates rootsuckering (Dreyer, pers. obs.).

CONTACTS WITH ADDITIONAL INFORMATION ON CONTROL:

In addition to the Connecticut College Arboretum program described above, the following organizations have some type of *C. orbiculatus* control programs or experience:

Connecticut DOT
Contact: James Stotler
Conn. DOT
24 Wolcott Hill Rd., Drawer A
Wethersfield, CT 06109)

Great Smokey Mountains National Park (Contact is Keith Langdon, see MONITORING PROJECTS section above for address)

Max Hutchison
Cache River Wetlands Project
The Nature Conservancy
Route 1, Box 53E
Ullin, Illinois, 62992
618 634 2524

Southeastern Forest Experiment Station (contact is W. Henry McNab, see MONITORING PROJECTS section above for address)

VI. RESEARCH

Management Research Programs:

Researchers at the Connecticut College Arboretum and the College's Botany and Zoology Departments (Dreyer, Clement, Wheeler, etc.) have pursued various aspects of the problem. No projects are currently underway. Future research will probably continue to examine the comparative species biology of *C. scandens* vs. *C. orbiculatus*.

No other active research programs are known.

Management Research Needs:

Research in species biology is needed in the following areas: pollination ecology; extent of natural hybridization with *C. scandens*; mechanisms of seed dispersal; annual vegetative growth rates; mechanisms of rootsucker induction; possible allelopathic effects on other species; seed bank dynamics.

Research is also needed to define the current range of *C. orbiculatus* and to monitor subsequent spread.

Work on biological control methods is apparently completely lacking. Langdon (1993) located an ornamental planting of *C. orbiculatus* in north Georgia that was losing vigor due to an infestation of *Euonymus* scale (*Unaspi euomyi*) and suggests this lead should be followed. The little published on chemical and mechanical control indicates further work in these areas would also be fruitful.

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

Bibliography:

Brizicky, G. 1964. The genera of Celastrales in the Southeastern United States. *Journal of the Arnold Arboretum* 45:206-218.

Clement, C., R. Warren, G. Dreyer and P. Barnes. 1991. Photosynthesis, water relations and fecundity in the woody vines American and Oriental bittersweet (*Celastrus scandens* and *C. orbiculatus*). Annual Meeting Botanical Society of America, Poster Abstract in American Journal of Botany 78(6 suppl.):134-135.

Dreyer, G., L. Baird and C. Fickler. 1987. *Celastrus scandens* and *Celastrus orbiculatus*: Comparisons of reproductive potential between a native and an introduced woody vine. Bulletin of the Torrey Botanical Club 114(3):260-264.

Dreyer, G. 1988. Efficacy of triclopyr in rootkilling Oriental Bittersweet and certain other woody weeds. Proceedings of the Northeastern Weed Science Society Vol. 42: 120-121.

Fernald, M. 1970. Gray's Manual of Botany, Eighth Edition. Corrected Printing. D. Van Nostrand Company, New York. 1632 pgs.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence, Kansas. 1392 pgs.

Gleason, H. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada, Volume 2. The New York Botanical Garden and Hafner Press, New York. 655 pgs.

Gleason, H. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Second Edition. The New York Botanical Garden, Bronx, NY. 910 pgs.

Hou, D. 1955. A revision of the genus *Celastrus*. Annals of the Missouri Botanical Garden 42:215-302.

Hutchison, M. 1992. Vegetation Management Guideline: Round-leaved Bittersweet (*Celastrus orbiculatus* Thunb.) Natural Areas Journal 12(3):161.

Lapin, B.P. 1992. Biological Monitoring and Management Specialist, Connecticut Field Office, The Nature Conservancy, telephone conversation with Glenn Dreyer 1992.

Langdon, K. 1993. Natural Resource Specialist, Great Smoky Mountains National Park, letter to John Randall, TNC Weed Specialist, dated 26 August 1993. on file at TNC Exotic Species Program.

Lutz, H. 1943. Injury to trees caused by *Celastrus* and *Vitis*. Bulletin of the Torrey Botanical Club 70(4):436-439.

Mehrhoff, L. 1986. Notes on the Connecticut Flora - IV. The genus *Celastrus* (Celastraceae) in Connecticut. Newsletter of the Connecticut Botanical Society 14(1):4-5.

McNab, W. and M. Meeker. 1987. Oriental bittersweet: a growing threat to hardwood silviculture in the Appalachians. *Northern Journal of Applied Forestry* 4:174-177.

Mohlenbrock, R., and J. Voigt. 1974. *A Flora of Southern Illinois*. Southern Illinois University Press. Carbondale and Edwardsville. 390 pgs.

Patterson, D. 1974. The ecology of Oriental bittersweet, *Celastrus orbiculatus*, a weedy introduced ornamental vine. Ph.d. Dissertation, Department of Botany, Duke University. 252 pgs. (available from University Microfilms International).

Radford, A., H. Ahles and C. Bell. 1968. *Manual of the vascular flora of the Carolinas*. The University of North Carolina Press, Chapel Hill. 1183 pgs.

Siccama, T. G. Weir and K. Wallace. 1976. Ice damage in a mixed hardwood forest in Connecticut in relation to *Vitis* infestation. *Bulletin of the Torrey Botanical Club* 103:180-183.

Soper, J. and M. Heimburger. 1985. *Shrubs of Ontario*. Life Sciences Miscellaneous Publications. The Royal Ontario Museum, Toronto. 495 pgs.

Swink, F. and G. Wilhelm. 1979. *Plants of the Chicago Region*. Revised and Expanded Edition. The Morton Arboretum, Lisle, Illinois. 922 pgs.

Wheeler, L. 1987. Oriental bittersweet: avian dispersal in winter in relation to other species of fruiting plants. Undergraduate Individual Study Report. Zoology Department, Connecticut College. Unpublished.

White, O. and W. Bowden. 1947. Oriental and American bittersweet hybrids. *Journal of Heredity* 38(4):125-127.

Wyman, D. 1950. Fruiting habits of certain ornamental plants. *Arnoldia* 10(13):81-85.

IX. DOCUMENT PREPARATION & MAINTENANCE

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Contributing Author(s): Glenn D. Dreyer, edited by: John M. Randall.