

## ELEMENT STEWARDSHIP ABSTRACT

for

*Dioscorea oppositifolia* L.  
*syn. Dioscorea batatas* (Decne)

Chinese yam, cinnamon vine

To the User:

Element Stewardship Abstracts (ESAs) are prepared to provide The Nature Conservancy's Stewardship staff and other land managers with current management related information on target species and communities that are most important to protect or threats that are most important to control. The abstracts organize and summarize data from many sources including literature and from researchers and managers actively working with the species or community.

We hope, by providing this abstract free of charge, to encourage users to contribute their information to the abstract. This sharing of information will benefit all land managers by ensuring the availability of an abstract that contains up-to-date information on management techniques and knowledgeable contacts. Contributors of information will be acknowledged within the abstract.

For ease of update and retrievability, the abstracts are stored on computer at The Nature Conservancy. Anyone with comments, questions, or information on current or past monitoring, research, or management programs for the species described in this abstract is encouraged to contact The Nature Conservancy's Wildland Invasive Species Team.

This abstract is a compilation of available information and is not an endorsement of particular practices or products.

Please do not remove this cover statement from the attached abstract.

Author of this Abstract: Mandy Tu, The Nature Conservancy's Wildland Invasive Species Team, Dept. of Vegetable Crops & Weed Sciences, University of California, Davis, CA 95616. Phone: (530) 754-8891.

Written: August 2002

THE NATURE CONSERVANCY

4245 North Fairfax Drive, Arlington, Virginia 22203-1606 (703) 841-5300  
**SCIENTIFIC NAME**

*Dioscorea oppositifolia* L.

The genus name “*Dioscorea*” is from Dioscoride, a Greek physician and naturalist. The species epithet “*oppositifolia*” refers to the opposite arrangement of its leaves. The other species epithet (synonym) commonly used for this species “*batatas*” means potato (Bailey 1949).

### **SYNONYMS**

There is confusion regarding the correct taxonomy of *Dioscorea oppositifolia*. *Dioscorea batatas* (Decne) is the most common synonym for this species. Gleason and Cronquist’s (1991, 1998 update) Manual of Vascular Plants of the Northeastern U.S. and Adjacent Canada as well as the Missouri Botanical Garden’s VAST (VAScular Tropicos) nomenclatural database, use *D. batatas* (TROPICOS 2001).

Kartesz (1999) however, in his Synthesis of the North American Flora and the PLANTS database (USDA, NRCS 2001), uses *D. oppositifolia* and notes that many floras in the U.S. also use this name. *D. oppositifolia* L. is the oldest name, and therefore, is the proper name for this species (E. Dean, pers comm.).

### **COMMON NAMES**

Chinese yam and cinnamon vine are frequently used common names for *D. oppositifolia*. Chinese yam refers to its origin from China where the tuber was regularly eaten for starch. The name cinnamon vine is attributed to the cinnamon-like fragrance of *D. oppositifolia* flowers. This cinnamon fragrance and showy flowers also contribute to *D. oppositifolia*’s attractiveness for horticultural use.

### **DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS**

*Dioscorea oppositifolia* is a perennial twining vine in the Dioscoreaceae (yam family). Underground, it has a deep, persistent, root-like tuber up to 1.0 m (3 ft) long that resprouts annually. Aboveground, it has round slender stems that twine dextrorsely (from left to right, counterclockwise), upwards. The leaves are usually arranged oppositely, although they may be alternate in the upper nodes, and are occasionally arranged ternately in whorls of 3 (Gleason & Cronquist 1991). Leaves of *D. oppositifolia* are simple, 7 to 9-nerved (veined), 4 to 8 cm (1.5 to 3 inches) long, and are typically ovate, hastate, or sagittate in shape. Leaves generally have a deeply lobed base, an acuminate tip, and are reddish-purple colored along the leaf margins, petioles, and stems (Bailey 1949; Bailey & Bailey 1949). New leaves often display a distinctive bronze-colored tint (Beyerl 2001).

Flowers of *D. oppositifolia* are small, white (greenish-yellow), and have a cinnamon fragrance. The flowers are unisexual (plants dioecious) and arise from the leaf axils in spike or panicle inflorescences. Fruits of *D. oppositifolia* are membranous, three-angled capsules (Gleason & Cronquist 1991).

*D. oppositifolia* can reproduce both sexually (via production of seeds) as well as asexually through the production of axillary tubers, called bulbils. Although *D. oppositifolia* has not been documented to reproduce sexually in North America, it is able to rapidly expand its range by the proliferation of its bulbils, which resemble small potatoes (Beyerl 2001).

### **STEWARDSHIP SUMMARY**

*D. oppositifolia* is a fast-growing, twining vine that is able to climb on and over adjacent vegetation, forming a thick blanket of leaves that shades out other plant species. It is able to exclude almost all short-statured plants, and when it climbs into large trees, may eventually become heavy enough to bend and break the stems of small trees. It spreads rapidly by vegetative reproduction of its axillary tubers (bulbils).

In small isolated patches, good control may be achieved by the manual removal of the entire tuber. Hand-pulling the newly sprouted bulbils, making sure to remove the entire bulbil, can also provide good control, but these manual methods are extremely time and labor intensive. In large infestations, repeated cutting may provide good control, but will require several years of follow-up treatment. Herbicides currently provide the easiest method for the control of *D. oppositifolia*. Triclopyr (Garlon 4<sup>®</sup>) or glyphosate (RoundUp<sup>®</sup> or Rodeo<sup>®</sup>) herbicides applied as a foliar spray, will kill bulbils, suppress further bulbil production, and work towards killing mature vines depending on the timing of application.

### **RANGE**

*D. oppositifolia* is native to China and was introduced into North America as an ornamental vine. In 1970, it had not yet been documented as escaping from cultivation. By 1986 however, Mohlenbrock (1970, 1986) reports that it had become naturalized and was observed in areas outside of cultivation (Beyerl 2001).

In North America, *D. oppositifolia* is currently present in: Alabama, Arkansas, Connecticut, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, and West Virginia (USDA, NRCS 1999). Beyerl (2001) reports that it has now also been documented from Florida.

*D. oppositifolia* is currently listed in the Southeast Exotic Pest Plant Council's Invasive Exotic Pest Plant List for Tennessee as a Rank 1-Severe Threat species, indicating that it is an exotic species that possesses characteristics of an invasive species and could spread easily into native plant communities and displace native vegetation (SE EPPC 2001).

### **IMPACTS AND THREATS POSED BY *DIOSCOREA OPPOSITIFOLIA***

*D. oppositifolia* is a fast growing twining vine that has escaped from cultivation, and has the ability to rapidly invade pristine habitats, especially riparian corridors. Due to its swift rate of vegetative growth and prolific rate of asexual reproduction via bulbils, it has the potential to become a major pest plant in the eastern and central United States.

In infested areas, *D. oppositifolia* lowers native species richness and abundance by outcompeting and eliminating native plant species. It does this by quickly outgrowing the native herbs and seedlings, thickly blanketing all adjacent vegetation, and competitively excluding light. *D. oppositifolia* may also weight-down and break branches of large trees and shrubs (similar to kudzu – *Pueraria montana*).

Peter Whan of TNC's Edge of Appalachia Preserve System reports that entire stands of native shrubs may become covered by *D. oppositifolia*, and that it shades and eventually kills those shrubs. It is also able to completely cover the ground, so that all native herbaceous ground cover is excluded. Whan reports that he has observed infestations up to 1.2 hectares (3 acres) in size, and has seen little use of *D. oppositifolia* by wildlife.

## **HABITAT**

*D. oppositifolia* can survive in a number of different habitats and environmental conditions, but is most commonly found at the edges of rich, mesic bottomland forests, along streambanks and drainageways, and near fencerows (Yayskievych 1999). Initial infestations of *D. oppositifolia* are generally associated with human-caused disturbances, such as near old homesites and along roadways. From these areas, *D. oppositifolia* can easily spread into nearby riparian swaths and undisturbed habitats.

## **BIOLOGY AND ECOLOGY**

### **Light and Soils**

*D. oppositifolia* can tolerate light levels ranging from full sun to full shade, but mostly grows at intermediate light levels along forest edges. Since *D. oppositifolia* is often associated with riparian habitats, it is typically found in silty loam soils, which are typical of alluvial habitats (Beyerl 2001). It also prefers soils that are relatively rich in nitrogen. Silty loams tend to be high in total nitrogen, and *D. oppositifolia* is well adapted to exploit any increase in soil nutrient levels, making it an excellent competitor for soil resources (Beyerl 2001).

### **Reproduction**

*D. oppositifolia* can reproduce both sexually and asexually. Although it is capable of sexual reproduction, *D. oppositifolia* has not been documented to reproduce sexually in North America. This could be because it is a dioecious species, and female (pistillate) plants have not been observed in the wild.

*D. oppositifolia* does, however, reproduce vigorously asexually, via the production of small potato-like axillary bulbils. These bulbils exhibit a relatively low rate of survival in the field (versus in the greenhouse), but plants apparently produce adequate numbers of bulbils to more than compensate for their low rate of survival (Beyerl 2001).

Each vine is capable of producing an average 20 bulbils per year, and bulbils have been observed sprouting new shoots within 2 weeks of formation. Fragmented or broken bulbils are also capable surviving and sprouting into new vines. Thus, even partially

eaten bulbils (rodents will chew on them), or bulbils chopped apart by a tiller, are still capable of producing healthy plants (Beyerl 2001).

### **Dispersal**

*D. oppositifolia* bulbils are dispersed primarily by gravity. Most bulbils are deposited within 10 m of the source population, although some bulbils may be dispersed farther by water or by animals. Bulbils might be carried by rodents (who eat and gather them) from nearby ornamental gardens (Beyerl 2001).

### **ECONOMIC USES**

Both the tuber and bulbils of *D. oppositifolia* are edible, although the bulbils are generally not collected and used as food. The edible tuber, which can measure up to 1 m (3 ft) long and weigh up to 2 kg (4.5 lbs) or more if grown in deep loam soils, is flavorful and nutritious. The flavor, according to Plants for a Future (1997), is between a sweet potato and a regular potato. The tuber contains about 20% starch, 75% water, 0.1% vitamin B1, and 10 to 15 mg Vitamin C. It also contains mucilage, amylase, amino acids, and glutamine.

The tuber is sometimes used as an herbal tonic. It stimulates the stomach and spleen and has an effect on the lungs and kidneys. The tuber has been eaten for the treatment of poor appetite, chronic diarrhea, asthma, dry coughs, frequent or uncontrollable urination, diabetes, and emotional instability. Externally, the tuber has also been applied to ulcers, boils and abscesses. It contains allantoin, a cell-proliferant that speeds up the healing process (Plants for a Future 1997).

Leaf juice from *D. oppositifolia* can be used to treat snakebites and scorpion stings. Its roots contain diosgenin, which is a compound often used in the manufacture of progesterone and other steroid drugs. *D. oppositifolia* has also been used traditionally as a contraceptive and in the treatment of various disorders of the genitry (genital?) organs as well as for asthma and arthritis (Plants for a Future 1997).

*D. oppositifolia* has been, and is still frequently planted for its ornamental value. The flowers smell like cinnamon and the twining vine is attractive for arbors, trellises, and along porches (Illinois DNR).

### **MANAGEMENT**

#### **Potential for Restoration of Invaded Sites**

As with all prolific invaders, the key to the successful control of *D. oppositifolia* is to prevent new infestations or to control them as soon as possible. Especially since *D. oppositifolia* appears to have a limited range of dispersal, be aware of any new infestations that might arise from nearby planted vines. *D. oppositifolia* has a wide range of environmental adaptability and few pests and predators in North America. It has a high degree of asexual reproductive vigor, and is difficult to manage once firmly established. If controlled during the early stages of invasion, the potential for successful

management is high. The potential for large-scale restoration of wildlands where *D. oppositifolia* has become established is probably moderate.

Although there is not much conclusive evidence on how best to manage *D. oppositifolia* in wildlands, control efforts for this species may be similar to those used for *Dioscorea bulbifera* (air-potato), another highly invasive non-native plant to North America from the same genus. Currently, the best control of *D. oppositifolia* will likely occur with the use of an integrated management approach. The use of manual and mechanical methods followed by another control technique (for example, periodic herbicide sprays to control for new bulbil recruitment and root sprouts) for several years should be accompanied by active restoration efforts to obtain desired results.

### **Manual and Mechanical Control**

Manual and/or mechanical methods of plant removal can effectively control small isolated patches of *D. oppositifolia*. These methods, however, are extremely time and labor-intensive, as the large deep tuber make manual removal very difficult. All pieces of the tuber must carefully be removed or resprouting may occur. Populations will also need to be monitored for several years following plant removal as bulbils in the soil may germinate over several years. There is currently no information on how long these bulbils remain viable.

Peter Whan of TNC's Edge of Appalachia Preserve System in southern Ohio reports that constant mowing or clipping *D. oppositifolia* at the base of the vine (top of the tuber) appears to eventually kill it. How often the shoots must be clipped and for how long of a duration, in order to kill the underground tuber, still remains to be determined. This removal of aboveground biomass appears to eventually exhaust the tuber, and indicates that perhaps a management regime of repeated grazing or burning may also work to kill the plant. These other methods, however, have not been tried.

Manually picking the aerial bulbils off the vines will not kill the plant, but will prevent the further spread of *D. oppositifolia* for a growing season (C. Chapman, pers. comm.). Once the bulbils have dispersed, hand-pulling the young germinating bulbils from soil can be an effective control measure if the entire bulbil is removed (K. Johnson, pers. comm.).

### **Chemical Control**

Herbicide application appears to be the most effective means to control *D. oppositifolia* in large infestations. One application of some herbicides can effectively kill all new germinating bulbils, but repeat treatments are probably necessary to completely kill large underground tubers that originally supported large mature vines.

The herbicides glyphosate or triclopyr have been the most successful at killing *D. oppositifolia*. Beyerl (2001) reports in her greenhouse study, that untreated bulbils had 100% germination, while treated bulbils (using glyphosate) had only 30% germination. Glyphosate also significantly lowered rates of plant growth from germinated bulbils as measured by stem length and numbers of leaves.

Dr. Tom Mueller, a professor at the University of Tennessee, recommends treating *D. oppositifolia* with either triclopyr (Garlon 4<sup>®</sup>) in a 4% solution (4 parts Garlon<sup>®</sup> + 96 parts water or 3 quarts per acre) or with glyphosate (RoundUp Ultra<sup>®</sup>) in a 4 to 6% solution. He adds that no additional surfactant is needed with either herbicide for good (95%) control of *D. oppositifolia*.

Kristine Johnson, the Supervisory Forester at the Great Smoky Mountains National Park in Tennessee, reports that using triclopyr (Garlon 4<sup>®</sup>) applied at 2% with an adjuvant, either Big-Sur<sup>®</sup> or Activate-Plus<sup>®</sup>) worked well to control *D. oppositifolia*. She adds that the timing of herbicide application is very important, as early season spraying when vines are small and young is not effective, but spraying later in the season on foliage was, apparently because at this time of year significant amounts of the herbicide were translocated to the tuber.

Beyerl (2001) however, reports that glyphosate (Rodeo<sup>®</sup>) applied to mature vines early in the growing season (May in Illinois) prevented the production of bulbils. It is unknown if Rodeo<sup>®</sup> would effectively prevent established tubers from resprouting. She adds that applying a herbicide that is not active or persistent in the soil (such as glyphosate) to bulbils during the dormant season can reduce risks to non-target species.

Cliff Chapman, a regional ecologist for Indiana DNR-Division of Nature Preserves uses glyphosate, RoundUp Pro<sup>®</sup> at 5% with 0.5% NuFilm IR<sup>®</sup> surfactant on infestations in low quality areas, and reports moderate success.

### **Prescribed Fire**

Although there are no conclusive results reported from long-term fire effects on *D. oppositifolia* yet, Kristine Johnson of the Great Smoky Mountains National Park has noted that sites burned in a wildfire from the previous fall, had reduced amounts the following year.

### **Biocontrol**

There are currently no available biocontrol agents for *D. oppositifolia*. Snails and caterpillars have been observed browsing on leaves of this species, but do not appear to damage the plants significantly. Rodents and other small mammals also consume the bulbils, but the degree of consumption and damage to the plants have not been quantified (Beyerl 2001). The exact species of these consumers have not been determined, nor has it been elucidated if they are specifically feeding on *D. oppositifolia* or are only generalist feeders.

### **Restoration/Competition**

None tried yet.

## **EXAMPLES OF MANAGEMENT PROGRAMS FOR *DIOSCOREA* *OPPOSITIFOLIA***

Peter Whan, TNC-Program Manager for the Edge of Appalachia Preserves in southeastern Ohio, has tried a variety of methods to control *D. oppositifolia*. He reports controlling it with constant mowing. He has not had good success using foliar sprays of 10% RoundUp<sup>®</sup>, and has found *D. oppositifolia* coming back two years after a 50% RoundUp<sup>®</sup> application. He is unsure whether this was from rootstock or from new bulbils. He has also tried a 7% solution of Garlon 3A<sup>®</sup>, but had no results to report at the time of this writing. He adds that manual removal of the tuber is nearly impossible at his site, as the roots are too deep.

Kristine Johnson, the Supervisory Forester at the Great Smoky Mountains National Park in eastern Tennessee and western North Carolina, reports that the herbicide Garlon 4<sup>®</sup> applied at 2% with an adjuvant, worked well to control *D. oppositifolia*. She adds that the timing of application is very important, with the best control achieved by spraying late in summer on foliage. Follow-up treatment is necessary, and herbicide or hand-pulling of young germinants from bulbils works well if the entire bulbil is removed. Johnson has also noted a marked decrease in the amount of *D. oppositifolia* following a fall burn.

### **CONTACTS**

Kristine Johnson, Supervisory Forester  
Great Smoky Mountains National Park  
E-mail: kris\_johnson@nps.gov

Dr. Tom Mueller, Professor  
Dept. of Plant Sciences and Landscape Systems  
University of Tennessee  
E-mail: tmueller@utk.edu

Peter Whan, Program Manager  
The Nature Conservancy - Edge of Appalachia Preserve System  
3223 Waggoner Riffle Rd.  
West Union, OH 45693  
Phone: 937-544-2188  
E-mail: pwhan@tnc.org

### **MONITORING**

Ideally, monitoring should occur both prior to and following control efforts to determine the effectiveness of the control treatments. In most cases, however, only post-treatment monitoring data are available, and should be continued for several years if possible. At a minimum, data on *D. oppositifolia* abundance (percent cover and/or density) should be collected in a sampling design adequate to allow significant changes in the species abundance (e.g.  $\pm 25\%$ ) with time or treatments. Information on changes in the abundance of desirable native species may also be valuable. Monitoring the status of other conservation targets, such as the growth and survival of restoration plantings, the



regeneration of native species, invertebrates, and mammals, may be important indicators of ecosystem health. In general, the objectives of monitoring should track those of management.

Following initial control treatments, further monitoring and control efforts are needed (at least) annually for a minimum of 3 to 5 years due to the ability of *D. oppositifolia* to resprout from tubers or from bulbils remaining in the soil, or from an influx of new bulbils carried in by gravity, rodents or flowing water.

Where practical, monitoring for changes, or lack thereof, of *D. oppositifolia* abundance in control (untreated) areas can be an effective way of assuring that any changes detected in treated areas are actually the result of management actions and not from other factors.

### **Research Needs**

Very little is currently known regarding specific impacts *D. oppositifolia* on native species, communities and ecological processes or on how to control it. The following research topics need attention to determine when it is important to control this species and how to effectively do so with a minimum of damage to native species:

1. Does *D. oppositifolia* significantly reduce abundances of native species (plants and animals) in otherwise intact forest and riparian communities?
2. What are the mechanisms of *D. oppositifolia* invasion and spread in a variety of landscapes?
3. How does native species competition and shading affect the growth, survival, and reproduction of *D. oppositifolia*?
4. Which if any biocontrols are effective in the native ranges of *D. oppositifolia*?
5. Is prescribed fire an effective management tool for the control of *D. oppositifolia*?
6. What integrated management approach will best control *D. oppositifolia*?

### **REFERENCES**

- Bailey, L.H. 1949. Manual of Cultivated Plants. The MacMillan Company, New York.
- Bailey, L.H. and E.Z. Bailey. 1949. Hortus Second: A Concise Dictionary of Gardening and General Horticulture. The MacMillan Company, New York.
- Beyerl, T. 2001. Habitat and life history characteristics of *Dioscorea oppositifolia*, an invasive plant species in southern Illinois. M.S. Thesis, Southern Illinois University, 104pp.
- Dean, E.A. 2002. Director/Curator of U.C. Davis Herbarium, Personal Communication.
- Gleason, H.A. and A. Cronquist. 1991 (1998 update). Manual of Vascular Plants of Northeastern United States and Adjacent Canada. The New York Botanical Garden, Bronx.

Illinois Department of Natural Resources. Chinese Yam Alert! The Natural Areas Association Issues.

Johnson, K. 2002. Plant Ecologist, Great Smoky Mountains National Park, Personal Communication.

Kartesz, J.T. 1999. A Synonymized Checklist and Atlas with Biological Attributes for the Vascular Flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Mueller, T. 2002. University of Tennessee, Professor. Personal communication.

Ott, M. 2001. Cinnamon vine or air potato: A problem by any name. Marietta Natural History Society, Fall 2001, pg. 5.

SE EPPC 2001. Southeast Exotic Pest Plant Council's Invasive Exotic Pest Plants in Tennessee (<http://www.exoticpestplantcouncil.org/states/TN/TNList.html>). Research Committee of the Tennessee Exotic Pest Plant Council.

TROPICOS. 2002. The Missouri Botanical Garden's VAST (VAscular Tropicos) nomenclatural database. (<http://mobot.mobot.org/W3T/Search/vast.html>).

USDA, NRCS. 2001. The PLANTS Database, Version 3.1 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Whan, P. 2002. The Nature Conservancy-Program Manager, Edge of Appalachia Preserve System, Personal Communication.

**AUTHORED BY:** Mandy Tu, The Nature Conservancy's Wildland Invasive Species Team, Dept. of Vegetable Crops & Weed Sciences, University of California, Davis, CA 95616, phone: (530) 754-8891.

**EDITED BY:** John M. Randall & Tunyalee Martin, The Nature Conservancy's Wildland Invasive Species Team, Dept. of Vegetable Crops & Weed Sciences, University of California, Davis, CA 95616

August 2002