

Euonymus atropurpurea var. *atropurpurea*

Wahoo

Celastraceae



2005 © Peter M. Dziuk

Euonymus atropurpurea var. *atropurpurea* by Peter M. Dziuk, 2005

Euonymus atropurpurea var. *atropurpurea* Rare Plant Profile

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
Forests & Natural Lands
Office of Natural Lands Management
New Jersey Natural Heritage Program

501 E. State St.
PO Box 420
Trenton, NJ 08625-0420

Prepared by:
Jill S. Dodds
jsdodds@biostarassociates.com

October, 2025

For:
New Jersey Department of Environmental Protection
Office of Natural Lands Management
New Jersey Natural Heritage Program
natlands@dep.nj.gov

This report should be cited as follows: Dodds, Jill S. 2025. *Euonymus atropurpurea* var. *atropurpurea* Rare Plant Profile. New Jersey Department of Environmental Protection, State Parks, Forests & Historic Sites, Forests & Natural Lands, Office of Natural Lands Management, New Jersey Natural Heritage Program, Trenton, NJ. 18 pp.

Life History

Euonymus atropurpurea var. *atropurpurea* (Wahoo) is a deciduous shrub or small tree in the bittersweet family that can occasionally reach heights of up to 8 meters. The other accepted variety, var. *cheatumii*, is only known from a single site in Texas and it may now be extirpated (NatureServe 2025, POWO 2025). *Euonymus atropurpurea* can reproduce vigorously via rhizomatous growth so it sometimes forms large colonies. The species has sturdy branches and smooth, green twigs. The leaves are opposite, stalked, elliptic, and finely toothed; their lengths may vary from 5–16 cm. The inflorescence is a cluster of 7–20 small flowers with four sepals, four dark purple petals, and four stamens. A detailed description of floral anatomy is available from Berkeley (1953). The fruits of *E. atropurpurea* are smooth, pink-purple capsules with four lobes that are often unequal in size. When the mature capsules dehisce they expose the seeds, which are completely encased in scarlet arils. (See Andrew 1846, Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1991, Ma 2001, Ma and Moore 2004, Ma and Levin 2020).

Euonymus atropurpurea can flower from May through July, with the fruits maturing from August through October (Andrew 1846, Stiles 1980, Ma 2001, Rhoads and Block 2007, Weakley et al. 2024, Zasada and Rudolf 2008). A population observed by Robertson (1929) remained in flower for about a month, and the average interval between blooming and fruit maturity is 100 days (Gorchov 1987). In New Jersey the species usually blooms between mid-May and mid-June (Hough 1983): Some plants observed during 2007 were still in tight bud on May 14 (NJNHP 2024). Fruits have been observed in the state from early August through late October (Lorimer and Moore 2019, NJNHP 2024). In the autumn the leaves may turn yellow, orange, pink, or scarlet, and once they have fallen the brightly colored fruits and seeds can make the plants particularly conspicuous (Ma and Moore 2004, Leopold 2005, NSAP 2020). Later in the season the color of the capsules changes to brown but the arils remain bright (Willson and Thompson 1982). During the winter months, the contrast between the green twigs and the gray-brown bark can help to identify *E. atropurpurea*. The opposite petiole scars on the twigs are rounded below but somewhat squared-off above, and the vascular bundles are often arranged in a semicircle (Foerste 1892).



Left: Britton and Brown 1913, courtesy USDA NRCS 2025a. Center and Right: Courtesy of R. W. Smith (2012) and Brenda K. Loveless (2014), Lady Bird Johnson Wildflower Center.

Euonymus is a fairly large genus but only a few species occur in New Jersey. *E. atropurpurea* is diploid while the only other native species in the state—*E. americanus*—is polyploid (Nath and Clay 1972). *E. americanus* can be separated from all of the others by its five-parted flowers and its spiny capsules. The introduced *Euonymus* species have four-parted flowers but *E. europaeus* has white or yellow flowers and yellow to orange arils, and corky-winged branches of *E. alatus* can distinguish it at any time of year. *Euonymus fortunei* (sometimes classified as *Elaeodendron fortunei*) is a vine (Kartesz 2015, Ma and Levin 2020).

Euonymus atropurpurea has a long history of cultivation (Zasada and Rudolf 2008) as well as medicinal usage (Andrew 1846). The primary active ingredient obtained from the bark, euonymin, is a potentially deadly toxin so its use for medical purposes declined during the twentieth century (Blakelock 1951). In addition to the bark, the seeds and other vegetative organs of *E. atropurpurea* are also reportedly poisonous (Brizicky 1964a).

Pollinator Dynamics

The flowers of *Euonymus atropurpurea* produce nectar and they are visited by a wide variety of flies as well as by some short-tongued bees, beetles, and butterflies (Robertson 1929, Pierce et al. 2016, Hilty 2020). It was previously thought that fertilization was effected by Hymenoptera, or possibly wind (Ma and Moore 2004), but a recent study of populations in Illinois determined that the primary pollinators were fungus gnats. Acetoin is the dominant component of floral scent in *E. atropurpurea* and also in other red-flowered, gnat-pollinated members of the genus. The insects feed on floral nectar and carry pollen on their coxae (Mochizuki et al. 2023). According to Gavrilova et al. (2018), a pollen grain diameter of about 24 μm is typical for *E. atropurpurea*.

No information was found regarding self-compatibility in *Euonymus atropurpurea*. Low levels of fruit set following self-pollination were recorded in an Indian species with small maroon flowers (Devy and Davidar 2006). *E. americanus* is self-compatible but appears to require insects to transport pollen between flowers (Wyatt et al. 2023). In contrast, *E. fortunei* is highly apomictic and about half of its seeds are produced without any fertilization (Elam et al. 2025).

Seed Dispersal and Establishment

Within each lobe of a *Euonymus atropurpurea* fruit is a cavity that usually contains two seeds (Fernald 1950). Some other *Euonymus* species have been known to produce seeds with multiple embryos. Although polyembryony was not observed in *E. atropurpurea* by Brizicky (1964b) he noted the need for further investigation. The seeds are mainly dispersed by birds, although some distribution may also be facilitated by small mammals (Blakelock 1951, Gorchoff 1987, Ma and Moore 2004). Both migrant and resident birds may play a role in dispersing *E. atropurpurea* propagules. The mature capsules often dehisce and present their brightly-colored seeds at the peak of the fall migration period, creating a chance for dispersal over greater distances, but seeds that remain on the plants until late autumn or early winter are likely to be distributed more locally (Thompson and Willson 1979, Stiles 1980, Willson and Thompson 1982, Johnson et al. 1985, Hilty 2020).

Most *Euonymus* seeds are dormant at the time of dispersal and require a period of stratification before they can germinate (Brizicky 1964a). *E. atropurpurea* needs at least 60 days of cold stratification (Rounsaville et al. 2018), but two months of warm stratification followed by three months of cold stratification appears to be optimal (Leopold 2005). It is not clear whether *E. atropurpurea* maintains a seed bank, although the seeds of some other *Euonymus* species can remain viable for up to seven years under the right conditions (Zasada and Rudolf 2008).

Habitat

Euonymus atropurpurea can grow in sun or shade (Leopold 2005, NSAP 2020) but the species appears to have a strong preference for shaded sites (Weakley et al. 2024). It can tolerate a variety of moisture conditions and has been found in wet, moist, and well-drained soils (Hough 1983, Leopold 2005, Mattingly et al. 2016). Adams and Anderson (1980) reported that *E. atropurpurea* achieved maximum success on wet-mesic sites. While it is not associated with any particular type of substrate it is often found on deep, loose, rich soils (Andrew 1846, Geis and Boggess 1970, Nelson 1986, Morris et al. 1993, Rhoads and Block 2007, Mattingly et al. 2016, NSAP 2020, Weakley et al. 2024).

Euonymus atropurpurea has been recorded at elevations ranging from 0–400 meters above sea level (Ma and Levin 2020). It typically occurs in woods and thickets—frequently along river or stream banks and on floodplains but sometimes on sloping hillsides or bluffs (Andrew 1846, Brizicky 1964a, Morris et al. 1993, Ma and Moore 2004, Rhoads and Block 2007, Weakley et al. 2024). The canopy in sites utilized by *E. atropurpurea* is usually made up of deciduous trees and may include species of *Acer*, *Aesculus*, *Carya*, *Celtis*, *Fraxinus*, *Juglans*, *Prunus*, *Quercus*, *Salix*, or *Ulmus* although the dominant species can vary depending on the relative wetness of the soils (Nelson 1986, Breden et al. 2001, Zasada and Rudolf 2008, Mattingly et al. 2016). Some scattered conifers are present at one New Jersey site (NJNHP 2024). *Lindera benzoin*, *Asimina triloba*, *Xanthoxylum americanum*, or *Cercis canadensis* may co-occur with *E. atropurpurea* in the shrub layer (Geis and Boggess 1970, Hoyer et al. 1979).

In some communities *Euonymus atropurpurea* has only been represented in a single age class. In one Illinois preserve, Edgin (2003) found the species in both upland and floodplain forests and seedlings were numerous but no small or large saplings were present. At another location, *E. atropurpurea* was present in the sapling layer but no seedlings or mature shrubs were noted (Ebinger et al. 1997). There appear to be few records of the species establishing on disturbed substrates, but an exception was noted in Kansas where it was one of the most commonly encountered plants on the spoil bank of an abandoned strip-mine (Giacomelli 2016).

Wetland Indicator Status

The U. S. Army Corps of Engineers divided the country into a number of regions for use with the National Wetlands Plant List and portions of New Jersey fall into three different regions (Figure 1). *Euonymus atropurpurea* has more than one wetland indicator status within the state. In the Atlantic and Gulf Coastal Plain region it is a facultative species, meaning that it is equally likely

to occur in wetlands or nonwetlands. In the rest of the state it is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands (U. S. Army Corps of Engineers 2022).

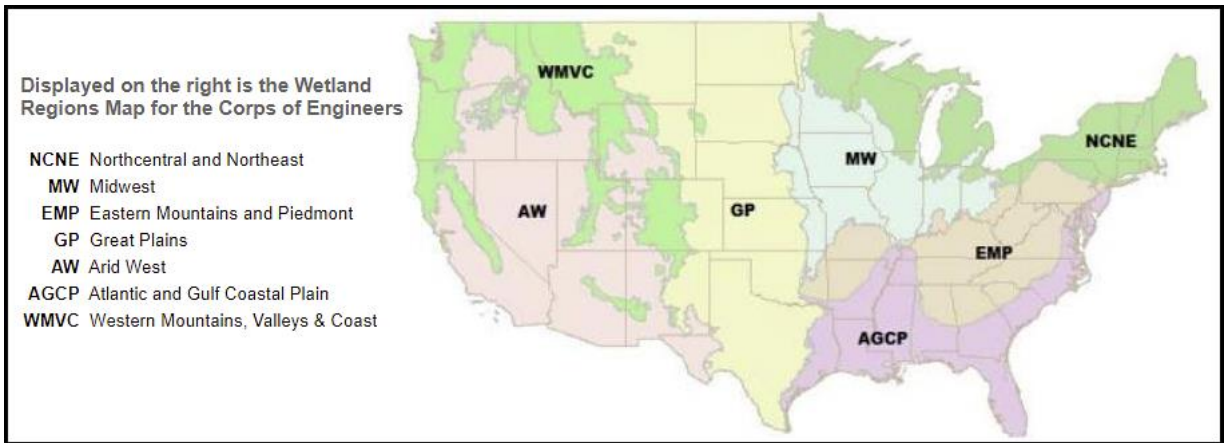


Figure 1. Mainland U. S. wetland regions, adapted from U. S. Army Corps of Engineers (2022).

USDA Plants Code (USDA, NRCS 2025b)

EUATA2

Coefficient of Conservancy (Walz et al. 2020)

CoC = 8. Criteria for a value of 6 to 8: Native with a narrow range of ecological tolerances and typically associated with a stable community (Faber-Langendoen 2018).

Distribution and Range

Euonymus atropurpurea is native to the central and eastern United States and southern Ontario. It is introduced in Tadjhikstan (POWO 2025). The map in Figure 2 depicts the extent of the species in North America.

The USDA PLANTS Database (2025b) shows *Euonymus atropurpurea* var. *atropurpurea* in 16 New Jersey counties: Bergen, Burlington, Camden, Cape May, Cumberland, Hunterdon, Mercer, Middlesex, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, and Warren (Figure 3). There are also records from Atlantic, Gloucester, and Monmouth counties (Ma 2001, Mid-Atlantic Herbaria 2025). The data include historic observations and do not reflect the current distribution of the species.

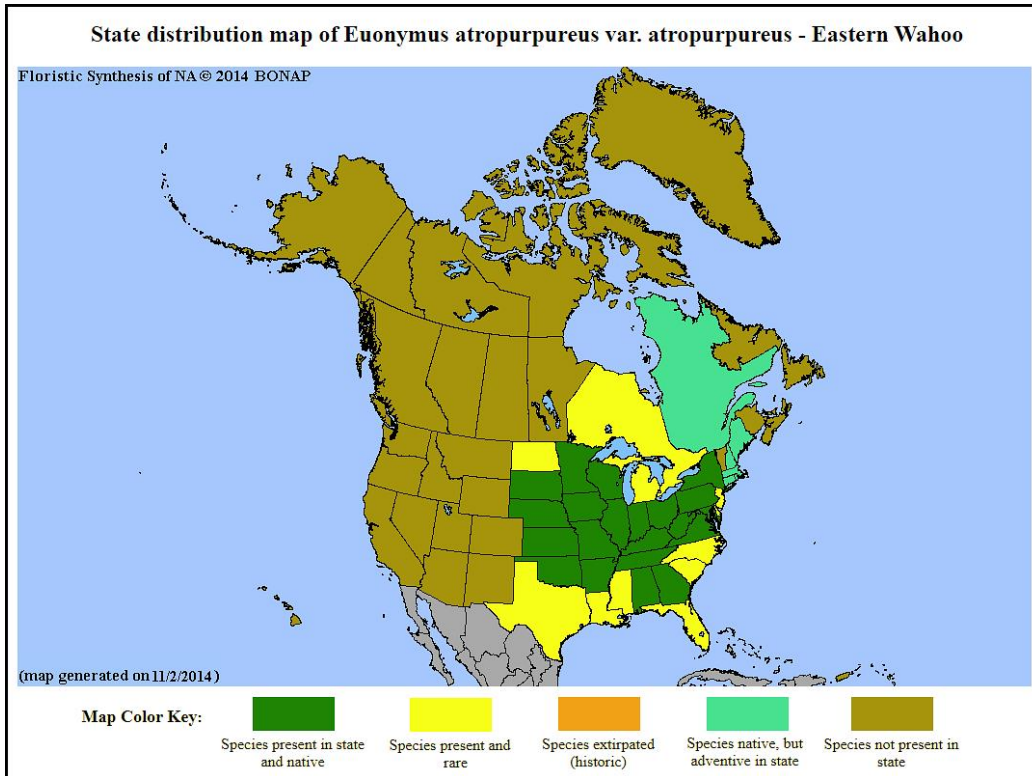


Figure 2. Distribution of *E. atropurpurea* var. *purpurea* in North America, adapted from BONAP (Kartesz 2015).

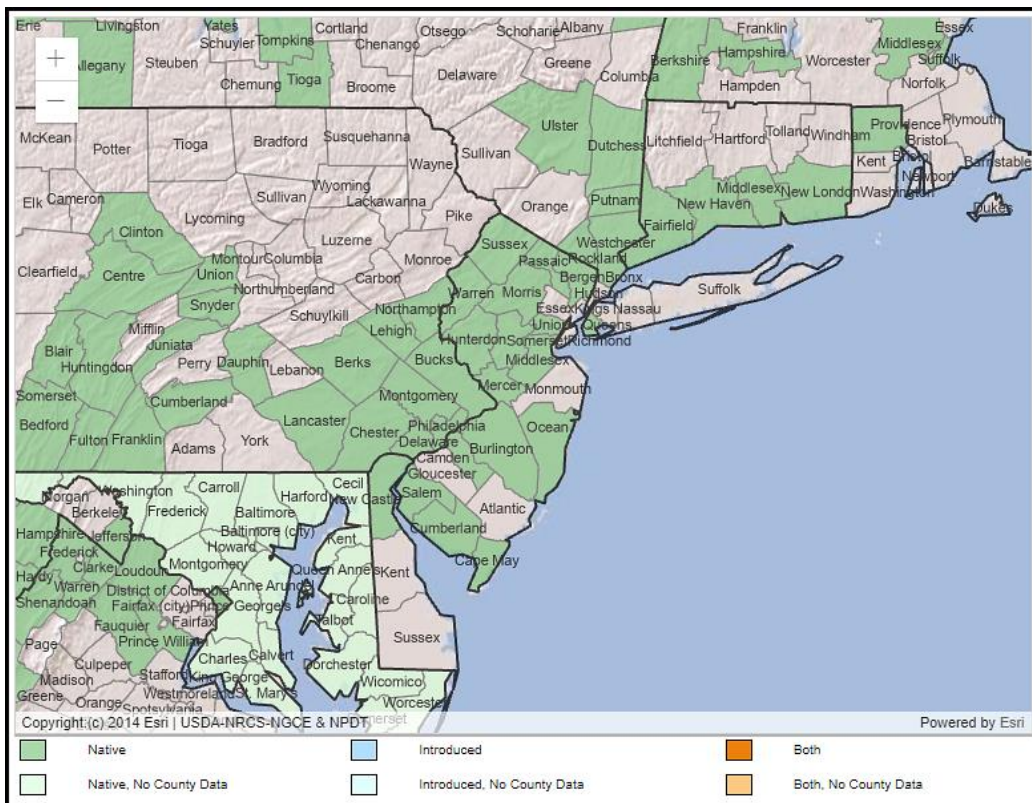


Figure 3. County records of *E. atropurpurea* in New Jersey and vicinity (USDA NRCS 2025b).

Conservation Status

Euonymus atropurpurea var. *atropurpurea* is considered globally secure. The G5T5 rank means the variety has a very low risk of extinction or collapse due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats (NatureServe 2025). The map below (Figure 4) illustrates the conservation status of *E. atropurpurea* throughout its native range. Wahoo is shown as vulnerable (moderate risk of extinction) in four states and one province, imperiled (high risk of extinction) in three states, and critically imperiled (very high risk of extinction) in three states. In many of the places where it occurs the species is secure, apparently secure, or unranked, and it is considered introduced in New York and the New England states.

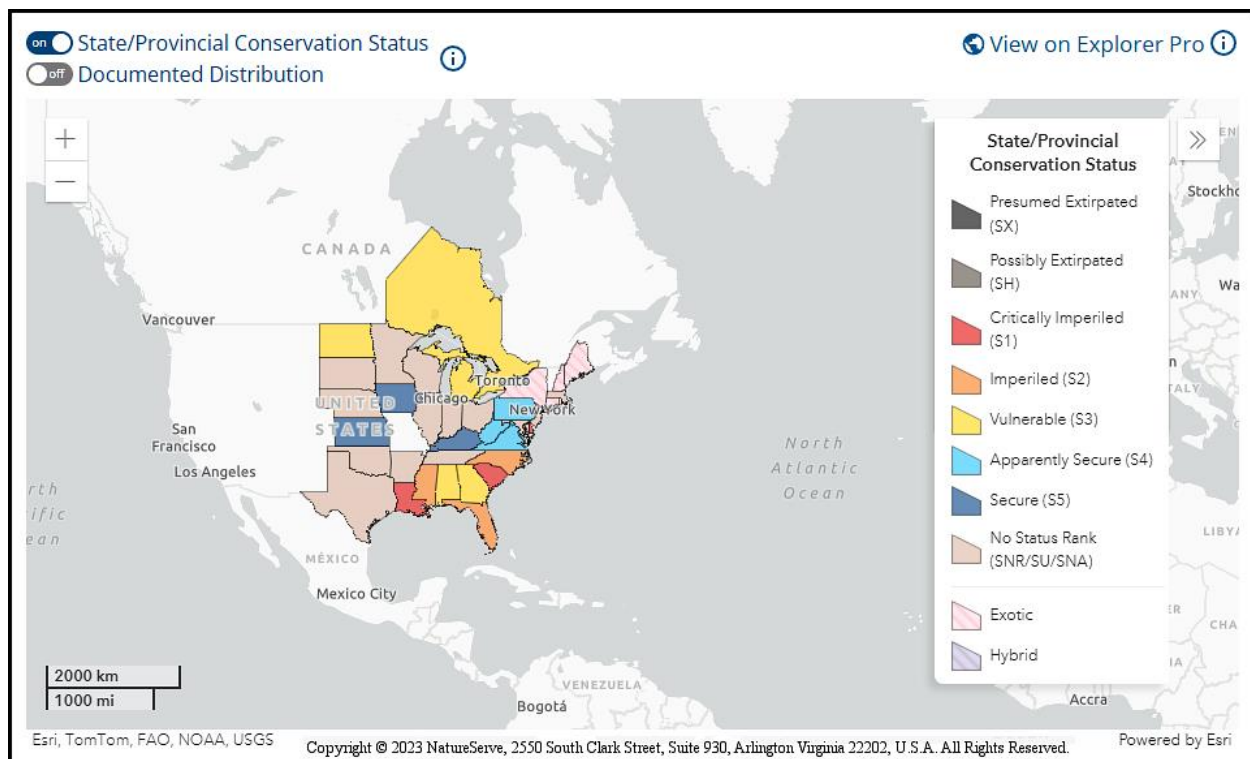


Figure 4. Conservation status of *E. atropurpurea* in North America (NatureServe 2025).

The New Jersey status is not shown in Figure 4 due to a nomenclatural discrepancy but *Euonymus atropurpurea* var. *atropurpurea* is listed as critically imperiled in the state (NJNHP 2024). The S1 rank signifies five or fewer occurrences. A species with an S1 rank is typically either restricted to specialized habitats, geographically limited to a small area of the state, or significantly reduced in number from its previous status. *E. atropurpurea* var. *atropurpurea* has also been assigned a regional status code of HL, signifying that the species is eligible for protection under the jurisdiction of the Highlands Preservation Area (NJNHP 2010).

Euonymus atropurpurea was once fairly common in New Jersey: It was recorded from one end of the state to the other and it was said to be particularly frequent in the Delaware River Valley (Willis 1874, Britton 1889, Stone 1911, Taylor 1915). Hough (1983) indicated that the species was still present in Hunterdon County and had been collected in a number of other South Jersey

counties during the five preceding decades, although at that time it was already being used for horticultural purposes in the state (e.g. Leonard 1964) so some records may have been based on planted specimens. *E. atropurpurea* was initially listed as historical in New Jersey but the status was revised to S1 after a population was documented in Warren County (NJONLM 1992, 1997; NJNHP 2024). That occurrence may no longer be extant, although another small colony has since been found in Morris County. Those are the only two populations currently tracked by the Natural Heritage Program. *E. atropurpurea* is also present in Cumberland County but the extant plants might have originated from horticultural material (Moore et al. 2016, Lorimer and Moore 2019).

Threats

It is not clear why *Euonymus atropurpurea* has become so scarce in New Jersey although competition, overbrowsing, fungal diseases, and insect pests could all have contributed to the species' decline. Most of the recent threats noted to populations in the state were due to competition with invasive plants, including *Berberis thunbergii*, *Lonicera japonica*, *Rosa multiflora*, and *Rubus phoenicolasius*. In one location where *E. atropurpurea* could no longer be found it appeared to have been overrun by its congener, *E. alatus*. Evidence of deer browse was also observed at one site (NJNHP 2024). Deer herbivory has been identified as a threat to *Euonymus atropurpurea* in other parts of its range (Miller et al. 1992, Hilty 2020) and *E. americanus* is also highly utilized by deer, especially during the spring and summer months (Warren and Hurst 1981).

A leaf spot fungus, *Ramularia euonymi*, was documented on *Euonymus atropurpurea* by Kellerman and Carleton (1886). Members of the genus are generally susceptible to a wide assortment of fungal infections. Common diseases of *Euonymus* that are known to occur in New Jersey include a form of anthracnose (*Colletotrichum griseum*), a bacterial crown gall (*Agrobacterium tumefaciens*), a root rot (*Fusarium scirpi*), and two powdery mildews (*Microsphaera alni*, *Oidium euonymi-japonici*) (Horst 2013).

Many generalist insect pests occasionally feed on the leaves of *Euonymus atropurpurea* (Hilty 2020) but one that specializes on *Euonymus* is the Black Bean Aphid, *Aphis fabae*. Aphid activity can reduce plant vigor, promote the development of mold, and transmit plant viruses. *Aphis fabae* typically alternates between winter and summer hosts, but its primary (winter) host plant is usually a *Euonymus* species. After the winged females mate they seek out *Euonymus* plants and lay their eggs, which hatch in the spring and give rise to a generation of wingless females. That generation reproduces parthenogenetically, yielding a winged generation that migrates to the summer host plants. However one subspecies, *A. fabae evonymi*, does not use an alternate host and remains on *Euonymus* year-round (Blakelock 1951, Fischer et al. 2005, Chaker et al. 2021). Leonard (1964, 1972) recorded *Aphis fabae* on *E. atropurpurea* at two different sites in New Jersey. Although he did not make note of a subspecies, both of the observations took place during the month of May.

An introduced moth may be an emerging threat to *Euonymus* plants in the eastern United States. *Pryeria sinicia* (also known as the *Euonymus* Defoliator) was first found in Fairfax Virginia in

2002 and it has since spread to a number of other sites in Virginia and Maryland. The larvae feed gregariously on the foliage of *Euonymus* and *Celastrus* species and they can strip entire shrubs when they are abundant (Raupp 2012, BugGuide 2025, NAMPG 2025). *Bacillus thuringiensis* appears to be an effective tool for control of the moth (Farrar et al. 2011) but if its spread isn't contained the insect is likely to reach New Jersey before long.

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Euonymus atropurpurea* populations to climate change. The species was assigned a rank from NatureServe's Climate Change Vulnerability Index using the associated tool (Version 3.02) to estimate its exposure, sensitivity, and adaptive capacity to changing climactic conditions in accordance with the guidelines described by Young et al. (2016) and the state climactic computations by Ring et al. (2013). Based on available data *E. atropurpurea* was assessed as Moderately Vulnerable, meaning that it is likely to show some decrease in abundance or range extent in New Jersey by 2050.

Some of the effects of climate change in New Jersey include rising temperatures, a longer growing season, and shifting precipitation patterns that have increased the frequency and intensity of both droughts and floods (Hill et al. 2020). *Euonymus atropurpurea* is generally viewed as a drought-tolerant species (NSAP 2020). It is also considered hardy in Zones 4–9 and New Jersey falls into the middle of that range, which suggests that established plants could withstand warmer conditions. However, recent winters in the state have been punctuated by spells of unseasonably warm weather which may interfere with the cold stratification periods required for seed germination. Summer weather influences the development of flower buds for the following year (Zasada and Rudolf 2008), so lengthy droughts during that period might also curtail sexual reproduction. There is potential for climate-induced stress to increase the species' susceptibility to disease or insect damage, and the spread of invasive plants—already identified as a threat to New Jersey populations—is likely to be exacerbated by changing climactic conditions (Bellard et al. 2013, Salva and Bradley 2023).

Management Summary and Recommendations

Notes made during monitoring visits to New Jersey's two extant *Euonymus atropurpurea* populations indicate that the control of invasive species should be a management priority, and that some protection from deer may also be necessary. Updated assessments of population status and threats are needed at both sites. A statewide review of historic records of *E. atropurpurea* is also recommended.

It is somewhat perplexing that a plant which was once noted as "not rare" (Willis 1874) or "not uncommon" (Taylor 1915) throughout the state and "frequent" in parts of Hunterdon County (Britton 1889) has become so scarce in New Jersey. *Euonymus atropurpurea* does not have any readily apparent barriers to reproduction or dispersal, nor does it have exceptionally narrow

habitat requirements. Identification of the factors that have contributed to its decline would be a critical step toward the development of a meaningful conservation plan for *E. atropurpurea*.

Synonyms

The New Jersey accepted botanical name of the species is *Euonymus atropurpurea* Jacq. var. *atropurpurea*, although Jacquin (1772) initially published the name as *Euonymus atropurpureus* and that form was used by many current references (e.g. Kartesz 2015, Ma and Levin 2020, Weakley et al. 2024, ITIS 2025, POWO 2025, USDA NRCS 2025b). The rules for botanical nomenclature require the gender of a specific epithet to match that of the genus; however there is longstanding disagreement as to whether *Euonymus* is masculine or feminine due to conflicting traditions. Linnæus (1753) identified the taxon as masculine, spelling it *Evonymus*.^{*} Proponents for the masculine form of the species name (*E. atropurpureus*) argue that the gender assigned by the original author should be maintained and that shrub genera ending in *-us* are traditionally treated as masculine, but advocates for the feminine form (*E. atropurpurea*) point out that the genus name was derived from the Greek word euōnymos—which is a feminine noun (Danser 1935, Sprague 1935, Paclt 1998, Ma and Moore 2004). Some additional synonyms and common names are listed below.

* The American Code of Botanical Nomenclature (1907) cited the genus as an example of spelling that should be corrected (from *Evonymus* to *Euonymus*) in order to agree with modern usage, but the use of both spellings persisted so Zijlstra and Tolsma (1991) proposed that the updated version be formally adopted.

Botanical Synonyms

Euonymus atropurpureus Jacq. var. *atropurpureus*
Evonymus atropurpureus
Euonymus atropurpureus var. *grandifolius* Raf.
Euonymus atropurpureus var. *latifolius* Raf.
Euonymus atropurpureus var. *oblongifolius* Raf.
Euonymus caroliniensis Marshall
Euonymus latifolius Marshall
Euonymus tristis Salisb.

Common Names

Wahoo
Eastern Wahoo

References

Adams, Dwight E. and Roger C. Anderson. 1980. Species response to a moisture gradient in central Illinois forests. *American Journal of Botany* 67(3): 381–392.

American Code of Botanical Nomenclature. 1907. *Bulletin of the Torrey Botanical Club* 34(4): 167–178.

Andrew, Ellwood. 1846. An essay on the therapeutic virtues of the *Euonymus atropurpureus* or Wahoo: Written for the degree of Doctor of Medicine in the “Rush Medical College”. Illinois and Indiana Medical and Surgical Journal 1(1): 15–22.

Bellard, C., W. Thuiller, B. Leroy, P. Genovesi, M. Bakkenes, and F. Courchamp. 2013. Will climate change promote future invasions? *Global Change Biology* 19(12): 3740–3748.

Berkeley, Edmund. 1953. Morphological studies in the Celastraceae. *Journal of the Elisha Mitchell Scientific Society* 69(2): 185–208.

Blakelock, R. A. 1951. A synopsis of the genus *Euonymus* L. *Kew Bulletin* 6(2): 210–290.

Breden, Thomas F., Yvette R. Alger, Kathleen Strakosch Walz, and Andrew G. Windisch. 2001. Classification of Vegetation Communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry, NJ Department of Environmental Protection, Trenton, NJ. 230 pp.

Britton, N. L. 1889. Catalogue of plants found in New Jersey. Geological Survey of New Jersey, Final Report of the State Geologist 2: 27–642.

Britton, N. L. and A. Brown. 1913. An Illustrated Flora of the Northern United States and Canada in three volumes: Volume II (Amaranth to Polypremum). Second Edition. Reissued (unabridged and unaltered) in 1970 by Dover Publications, New York, NY. 735 pp.

Brizicky, George K. 1964a. The genera of Celastrales in the southeastern United States. *Journal of the Arnold Arboretum* 45(2): 206–234.

Brizicky, George K. 1964b. Polyembryony in *Euonymus* (Celastraceae). *Journal of the Arnold Arboretum* 45(2): 251–259.

BugGuide. 2025. An online resource for identification, images, and information about insects, spiders and their kin in the United States and Canada. Site hosted by Iowa State University Department of Entomology. Available at <https://bugguide.net/node/view/15740>

Chaker, Bennour, Ben Belgacem Ali, and Ben Nasr Hmed. 2021. A review of the management of *Aphis fabae* Scopoli (Hemiptera: Aphididae). *Journal of Oasis Agriculture and Sustainable Development* 3(1): 32–44.

Danser, B. H. 1935. Grammatical objections to the international rules of botanical nomenclature adopted at Cambridge in 1930. *Blumea* 1: 295–304.

Devy, M. Soubadra and Priya Davidar. 2006. Breeding systems and pollination modes of understory shrubs in a medium elevation wet evergreen forest, southern Western Ghats, India. *Current Science* 90(6): 838–842.

Dziuk, Peter M. 2005. Cover photo of *Euonymus atropurpureus*. Image courtesy of Minnesota Wildflowers, <https://www.minnesotawildflowers.info/shrub/eastern-wahoo> licensed by <https://creativecommons.org/licenses/by-nc-nd/3.0/>.

Ebinger, John, Daniel O'Connell, Steve Turner, Floyd Catchpole, and William McClain. 1997. Vegetation survey of Elkhart Woods, Logan County, Illinois. *Castanea* 62(2): 74–81.

Edgin, Bob. 2003. Vascular flora of Big Creek Woods Memorial Nature Preserve, Richland County, Illinois. *Transactions of the Illinois State Academy of Science* 96(3): 179–192.

Elam, Robert, Eleanor Jacobs, Caitlin Barilleaux, Becca Erikson, Gwendalyn Culley, and Theresa Culley. 2025. Reproductive mode and mating system in the invasive wintercreeper vine (*Euonymus fortunei*) in southwestern Ohio: Polyembryony, apomixis, selfing, and outcrossing. Preprint of article accepted for publication in *Invasive Plant Science and Management*.

Faber-Langendoen, D. 2018. Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments. NatureServe, Arlington, VA. 52 pp.

Farrar, Robert R., Phyllis A. Martin, and Michael B. Blackburn. 2011. Activity of *Bacillus thuringiensis* against *Pryeria sinicia* (Lepidoptera: Zygaenidae), an invasive pest of *Euonymus*. *Journal of Entomological Science* 46: 148–151.

Fernald, M. L. 1950. *Gray's Manual of Botany*. Dioscorides Press, Portland, OR. 1632 pp.

Fischer, Melanie K., Wolfgang Völkl, and Klaus H. Hoffmann. 2005. Honeydew production and honeydew sugar composition of polyphagous Black Bean Aphid, *Aphis fabae* (Homoptera: Aphisidae) on various host plants and implications for ant-attendance. *European Journal of Entomology* 102: 155–160.

Foerste, Aug. F. 1892. The identification of trees in winter. *Botanical Gazette* 17(6): 180–190.

Gavrilova, O. A., D. A. Britski, V. V. Grigorieva, V. F. Tarasevich, A. E. Pozhidaev, and V. M. Leunova. 2018. Pollen morphology of the genus *Euonymus* (Celastraceae). *Turczaninowia* 21(4): 188–206.

Geis, James W. and William R. Boggess. 1970. Soil-vegetation relationships in a prairie grove remnant. *Bulletin of the Torrey Botanical Club* 97(4): 196–203.

Giacomelli, Fabio. 2016. The Richness and Relative Abundance of Small Mammals in Old Surface Coal-mined Sites in Crawford and Cherokee Counties, Kansas. *Pittsburg State University, Pittsburg, KS*. 113 pp.

Gleason, H. A. 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 pp.

- Gorchov, David L. 1987. Sequence of fruit ripening in bird-dispersed plants: Consistency among years. *Ecology* 68(1): 223–225.
- Hill, Rebecca, Megan M. Rutkowski, Lori A. Lester, Heather Genievich, and Nicholas A. Procopio (eds.). 2020. New Jersey Scientific Report on Climate Change, Version 1.0. New Jersey Department of Environmental Protection, Trenton, NJ. 184 pp.
- Hilty, John. 2020. *Euonymus atropurpureus*. Illinois Wildflowers. Accessed September 30, 2025 at <https://www.illinoiswildflowers.info/trees/plants/wahoo.htm> and https://www.illinoiswildflowers.info/flower_insects/plants/wahoo.htm
- Horst, R. Kenneth. 2013. Field Manual of Diseases on Trees and Shrubs. Springer Science & Business Media, Dordrech. 207 pp.
- Hough, Mary Y. 1983. New Jersey Wild Plants. Harmony Press, Harmony, NJ. 414 pp.
- Hoye, Martha, Janice V. Perino, and Charles H. Perino. 1979. Secondary vegetation and successional sequences within Shawnee Lookout Park, Hamilton County, Ohio. *Castanea* 44(4): 208–217.
- ITIS (Integrated Taxonomic Information System). Accessed August 25, 2025 at <http://www.itis.gov>
- Jacquín, Nicolai Josephi. 1772. Hortus Botanicus Vindobonensis, Vol. II. Vindobonae: Typis Leopoldi Joannis Kaliwoda, aulae imperialis typographi.
- Johnson, Robert A., Mary F. Willson, John N. Thompson, and Robert I. Bertin. 1985. Nutritional values of wild fruits and consumption by migrant frugivorous birds. *Ecology* 66(3): 819–827.
- Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (<http://www.bonap.net/tdc>). Chapel Hill, NC. [Maps generated from Kartesz, J. T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].
- Kellerman, W. A. and M. A. Carleton. 1886. Second list of Kansas parasitic fungi, together with their host-plants. *Transactions of the Annual Meetings of the Kansas Academy of Science* 10: 88–99.
- Leonard, Mortimer D. 1964. Additional records of New Jersey aphids. *Journal of the New York Entomological Society* 72(2): 79–101.
- Leonard, Mortimer D. 1972. Aphids of New Jersey, a few more records (Homoptera: Aphididae). *Journal of the New York Entomological Society* 80(4): 182–194.

- Leopold, Donald J. 2005. Native Plants of the Northeast: A Guide for Gardening and Conservation. Timber Press, Portland, OR. 308 pp.
- Linnæus, Carl. 1753. Species Plantarum: Exhibentes plantas rite cognitatas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas. Vol. 1. Holmiæ, Impensis Laurentii Salvii. 560 pp.
- Lorimer, Uli and Gerry Moore. 2019. 2015–2016 field trips. *Bartonia* 70: 99–130.
- Loveless, Brenda K. 2014. Photo of *Euonymus atropurpureus* fruits and seeds. Courtesy of the Lady Bird Johnson Wildflower Center, <https://www.wildflower.org/>. Used with permission.
- Ma, Jin Shuang. 2001. A revision of *Euonymus* (Celastraceae). *Thaiszia* 11: 1–264.
- Ma, Jinshuang and Gerry Moore. 2004. *Euonymus atropurpureus* Jacq. In John K. Francis (ed.), Wildland Shrubs of the United States and Its Territories: Thamnic Descriptions: Volume 1. USDA General Technical Report IITF-GTR-26. 830 pp.
- Ma, Jinshuang and Geoffrey A. Levin. Page updated November 5, 2020. *Euonymus atropurpureus* Jacquin. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed September 30, 2025 at https://floranorthamerica.org/Euonymus_atropurpureus
- Mattingly, Kali Z., Ryan W. McEwan, Robert D. Paratley, Sarah R. Bray, and James R. Lempke. 2016. Recovery of forest floor diversity after removal of the nonnative, invasive plant *Euonymus fortunei*. *The Journal of the Torrey Botanical Society* 143(2): 103–116.
- Mid-Atlantic Herbaria. 2025. Accessed at <https://midatlanticherbaria.org/portal/index.php> on September 30, 2025.
- Miller, Scott G., Susan P. Bratton, and John Hadidian. 1992. Impacts of White-tailed Deer on endangered and threatened vascular plants. *Natural Areas Journal* 12(2): 67–74.
- Mochizuki, Ko, Tomoko Okamoto, Kai-Hsiu Chen, Chun-Neng Wang, Matthew Evans, Andrea T. Kramer, and Atsushi Kawakita. 2023. Adaptation to pollination by fungus gnats underlies the evolution of pollination syndrome in the genus *Euonymus*. *Annals of Botany* 132(2): 319–333.
- Moore, Gerry, Renée Brecht, and Dale Schweitzer. 2016. Additions and corrections to the checklist of vascular plants of Cumberland County, New Jersey. *Bartonia* 68: 1–59.
- Morris, Michael Wayne, Charles T. Bryson, and Randy C. Warren. 1993. Rare vascular plants and associate plant communities from the Sand Creek Chalk Bluffs, Oktibbeha County, Mississippi. *Castanea* 58(4): 250–259.

NAMPG (North American Moth Photographers Group at the Mississippi Entomological Museum, at Mississippi State University). 2025. Digital Guide to Moth Identification. Available online at <http://mothphotographersgroup.msstate.edu/>

Nath, Joginder and Susan N. Clay. 1972. Cytogenetic studies on some species of *Euonymus*. *Caryologia* 25(4): 417–427.

NatureServe. 2025. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed September 30, 2025 at <https://explorer.natureserve.org/>

Nelson, John B. 1986. The Natural Communities of South Carolina: Initial Classification and Description. South Carolina Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries. 64 pp.

NJNHP (New Jersey Natural Heritage Program). 2010. Explanation of Codes Used in Natural Heritage Reports. Updated March 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2024. Biotics 5 Database. NatureServe, Arlington, VA. Accessed March 15, 2024.

NJONLM (New Jersey Office of Natural Lands Management). 1992. Special Plants of New Jersey. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Trenton, NJ. 22 pp.

NJONLM (New Jersey Office of Natural Lands Management). 1997. Special Plants of New Jersey. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Trenton, NJ. 21 pp.

NSAP (Nebraska Statewide Arboretum Publications). 2020. A collection of articles published by the Nebraska Arboretum including "Plains-hardy Shrubs for Fall Color" by Jim Locklear, "Fall Color in Shrubs" by Bob Henrickson, "Have a Berry Christmas!" by Karma Larson, and "Wahoo for the Wahoo!" by Sue Kohles. DigitalCommons@University of Nebraska, Lincoln, NE.

Paclt, J. 1998. (1351) Proposal to amend the gender of *Euonymus*, nom. cons. (Celastraceae), to feminine. *Taxon* 47(2): 473-474.

Pierce, Robert A., Charles Nilon, Nadia Navarrete-Tindall, Sarah Denkler, and Eric Fishel. 2016. Improving Habitats for Wildlife in Your Backyard and Neighborhood. University of Missouri Extension, g9500. 10 pp.

POWO. 2025. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed August 25, 2025 at <http://www.plantsoftheworldonline.org/>

Raupp, Michael J. 2012. Yet another exotic invader: *Euonymus* Leaf Notcher, *Pryeria sinicia*. University of Maryland Extension. Accessed October 3, 2025 at <https://bugoftheweek.com/blog/2013/1/27/yet-another-exotic-invader-euonymus-leaf-notcher-ipryeria-siniciai>

Rhoads, Ann Fowler and Timothy A. Block. 2007. *The Plants of Pennsylvania*. University of Pennsylvania Press, Philadelphia, PA. 1042 pp.

Ring, Richard M., Elizabeth A. Spencer, and Kathleen Strakosch Walz. 2013. Vulnerability of 70 Plant Species of Greatest Conservation Need to Climate Change in New Jersey. New York Natural Heritage Program, Albany, NY and New Jersey Natural Heritage Program, Department of Environmental Protection, Office of Natural Lands Management, Trenton, NJ, for NatureServe #DDCF-0F-001a, Arlington, VA. 38 pp.

Robertson, Charles. 1929. *Flowers and Insects: Lists of Visitors of Four Hundred and Fifty-three Flowers*. Science Press Printing Company, Lancaster, PA. 221 pp.

Rounsaville, Todd J., Carol C. Baskin, Edward A. Roualdes, Rebecca L. McCulley, and Mary A. Arthur. 2018. Seed dynamics of the liana *Euonymus fortunei* (Celastraceae) and implications for invasibility. *Journal of the Torrey Botanical Society* 145(3): 225–236.

Salva, Justin D. and Bethany A. Bradley. 2023. High-impact invasive plants expanding into mid-Atlantic states: Identifying priority range-shifting species for monitoring in light of climate change. *Invasive Plant Science and Management* 16: 197–206.

Smith, R. W. 2012. Photo of *Euonymus atropurpureus* flower. Courtesy of the Lady Bird Johnson Wildflower Center, <https://www.wildflower.org/>. Used with permission.

Sprague, T. A. 1935. The gender of generic names: A vindication of Art. 72 (2). *Bulletin of Miscellaneous Information* 6/9: 545–557.

Stiles, Edmund W. 1980. Patterns of fruit presentation and seed dispersal in bird-disseminated woody plants in the eastern deciduous forest. *The American Naturalist* 116(5): 670–688.

Stone, Witmer. 1911. *The Plants of Southern New Jersey*. Quarterman Publications, Boston, MA. 828 pp.

Taylor, Norman. 1915. *Flora of the vicinity of New York - A contribution to plant geography*. *Memoirs of the New York Botanical Garden* 5: 1–683.

Thompson, John N. and Mary F. Willson. 1979. Evolution of temperate fruit/bird interactions: Phenological strategies. *Evolution* 33(3): 973–982.

U. S. Army Corps of Engineers. 2022. National Wetland Plant List, version 3.6. <https://nwpl.sec.usace.army.mil/> U. S. Army Corps of Engineers Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2025a. *Euonymus atropurpureus* illustration from Britton, N. L. and A. Brown, 1913, An illustrated flora of the northern United States, Canada and the British Possessions, 3 vols., Kentucky Native Plant Society, New York, Scanned By Omnitek Inc. Image courtesy of The PLANTS Database (<http://plants.usda.gov>). National Plant Data Team, Greensboro, NC.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2025b. PLANTS profile for *Euonymus atropurpureus* var. *atropurpureus* (Eastern Wahoo). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed February 6, 2025 at <http://plants.usda.gov>

Walz, Kathleen S., Jason L. Hafstad, Linda Kelly, and Karl Anderson. 2020. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera (update to 2017 list). New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ.

Warren, R. C. and G. A. Hurst. 1981. Rating of Plants in Pine Plantations as White-tailed Deer Food. Mississippi Agricultural & Forestry Experiment Station Information Bulletin 18, Mississippi State, MS. 14 pp.

Weakley, A. S. and Southeastern Flora Team. 2024. Flora of the Southeastern United States. Edition of March 4, 2024. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC. 2203 pp.

Willis, O. 1874. Catalogue of Plants Growing in the State of New Jersey. J. W. Schermerhorn, New York, NY. 92 pp.

Willson, Mary F. and John N. Thompson. 1982. Phenology and ecology of color in bird-dispersed fruits, or why some fruits are red when they are "green". Canadian Journal of Botany 60(5): 701–713.

Wyatt, Robert, Bethany D. Beliveau, and Graham E. Wyatt. 2023. Reproductive biology of *Euonymus americanus* (Celastraceae): Pollination by ants and cockroaches. The Journal of the Torrey Botanical Society 150(4): 538–548.

Young, Bruce E., Elizabeth Byers, Geoff Hammerson, Anne Frances, Leah Oliver, and Amanda Treher. 2016. Guidelines for Using the NatureServe Climate Change Vulnerability Index, Release 3.02, 1 June 2016. NatureServe, Arlington, VA. 65 pp.

Zasada, John C. and Paul O. Rudolf. 2008. *Euonymus* L. In F. T. Bonner and R. P. Karrfalt (eds.), The Woody Plant Seed Manual, Agriculture Handbook 727, USDA Forest Service, Washington D. C.

Zijlstra, G. and J. Tolsma. 1991. (1997) Proposal to conserve the spelling of 4618 *Euonymus* (Celastraceae). Taxon 40(1): 137–139.