58. Ivy (Hedera species) – virtues and vices of the world’s most popular ornamental vine

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Introduction
Ivies (species of Hedera) were universally admired ornamental vines until several decades ago, and to this day most horticulturists continue to defend their use. However, Ivies have escaped in widespread areas of the world, where they have become significant alien invasives, condemned by many ecologists. Two acrimonious debates have developed: are Ivies bad for biodiversity, even in their native areas, or do they contribute significantly to ecosystem functions? Second, do Ivies planted on buildings and other structures physically deteriorate them, or are there insulation benefits that contribute to energy efficiencies and planetary climate control? This review analyses the comparative damages and benefits of one of human-kind’s principal plant companions.

Vines: a brief review of what they are and how they affect trees
The dominant feature of Ivy species is that they are vines, and so background on the role of climbing plants in nature is in order. In some parts of the world, such as the UK, the term ‘vine’ often refers specifically to the grapevine (especially the Wine Grape, Vitis vinifera). In general, however, ‘vines’ are any of numerous plants that have long but relatively weak and flexible stems which either climb upon self-supporting tall plants, natural physical objects (such as rocks and cliffs) or human-made structures (such as fences, power posts and houses) or simply sprawl over the ground. Unlike ‘epiphytes’ (plants which entirely or mostly live on trunks or canopies of trees, but rarely grow in the ground), vines root permanently in soil. ‘Climber’ is a general term for vines that grow from lower to higher levels, often employing twining, tendrils or special attachments (which may be modified roots, leaves or hairs). ‘Creeper’ is applied to plants that trail along the ground, but some so-called creepers also climb on objects, including trees, if they encounter them. Ecologists often restrict the word ‘liana’ to woody, large vines that grow in the Tropics, applying ‘vine’ to herbaceous plants (Rowe 2018). For a more detailed classification of vines, see Gentry (1991).

There are thousands of vine species, because there are innumerable trees providing habitat upon which they can prosper. The more than 60,000 tree species (Beech et al. 2017) represent 20% of all ‘vascular plants’ (plants with internal conducting tissues, including angiosperms, gymnosperms, ferns and allies). The world currently has over three trillion trees, although 12,000 years ago, before the advent of agriculture, there were twice as many (Crowther et al. 2015). Trees invest considerable energy into producing woody trunks to elevate their foliage so that they can outcompete smaller plants for sunlight. Rather than employing their own resources to produce sturdy stems for mechanical support, vines are ‘structural parasites’ which simply grow up and over trees to reach sunlight, an exploitive relationship pointed out long ago by Charles Darwin (1865). Vines harm trees by outcompeting them for sunlight (they have also been termed ‘light parasites’). Since they root beside trees, they also compete with them for water and nutrients from the soil. (Numerous parasitic animals and a few plant parasites directly penetrate host tissues to extract food, but vines rob nourishing chemicals from their hosts indirectly). Sometimes vines physically damage trees by abrasion, and they can even topple a tree by weighing it down.

Vines play critical roles in regulating forest biodiversity, affecting different species differently, including trees (Schnitzer and Bongers 2002; Schnitzer 2015). Vines are a common component of forests worldwide and they contribute to forest ecology, diversity and dynamics (Schnitzer et al. 2014). They
can have both positive and negative effects in forests. Vines can be an important resource for animals, as food (in the form of nectar, pollen, fruits, leaves or sap), providing nesting sites, shelter and, by climbing among many tree crowns, they can also provide aerial highways for many arboreal animal species. By contrast, vines also compete intensively with trees, reducing tree recruitment, growth, reproduction and survival, as well as tree diversity and forest-level carbon sequestration.

Many ornamental species have been introduced into foreign lands, and have proven to be so invasive in some locations that they are now major pests, often endangering native biodiversity and degrading ecosystems (Niemiera and Von Holle 2008). North America in particular appears to be the victim of invasive vines (Leicht-Young and Pavlovic 2014). In addition to Ivies, notable invasive vines in North America include Kudzu (*Pueraria montana* var. *lobata*), Japanese Honeysuckle (*Lonicera japonica*), Mile-a-Minute (*Polygonum perfoliatum*), Oriental Bittersweet (*Celastrus orbiculatus*), Porcelain Berry (*Ampelopsis brevipedunculata*), Bigleaf Periwinkle (*Vinca major*) and Dog-Strangling Vines (Swallowworts; *Vincetoxicum* species).

**Classification of Ivies**

There are many plant species known as ‘Ivy’ (e.g. Poison Ivy, German Ivy, Swedish Ivy, Boston Ivy), but the name is most widely understood to apply to species of the genus *Hedera*, especially English Ivy (*H. helix*; Figure 1). *Hedera* consists of a dozen or more species, but its classification is problematical, and the taxonomy of the genus requires considerable study (Strelau et al. 2018). Some of the recognised species are difficult to distinguish (Ackerfield and Wen 2002). *Hedera helix* is widely considered to be the most important species, but it is poorly separable by appearance from *H. hibernica*, and the two are widely confused in the commercial trade. Both (and sometimes other species) are commonly known as ‘English Ivy’, but *H. hibernica* is also called Irish Ivy and Atlantic Ivy. On the West Coast of North America, *H. hibernica* is the most common invasive species (Murai 1999; Green, Ramsey, and Ramsey 2013), while in eastern North America *H. helix* is more frequent (Clarke, Reichard, and Hamilton 2006). *Hedera helix* is also called ‘True Ivy’ and ‘Common Ivy’. Algerian Ivy (*H. algeriensis*) and Canary Island Ivy (*H. canariensis*) are additional closely related species believed to also appear in cultivation. When the name ‘Ivy’ is used alone it usually refers to *H. helix*. Most cultivars of *Hedera* are identified as *H. helix*.

**Ecology**

*Hedera* species are native to Asia, Europe, North Africa and Macaronesia (Ackerfield and Wen 2003). Ivies tolerate a wide array of soils, dry and moist sites, frost and deep shade, and can outcompete many plants. During the past several centuries, Ivies have expanded considerably along the Pacific and Atlantic coasts of North America, and in New Zealand, Australia, South Africa, Brazil and Hawaii (Strelau et al. 2018). They have also been introduced to South Africa, India, Mexico and other countries (Waggy 2010). In nature, Ivies are common in forests, starting growth on the ground and climbing up trees. Ivies also scramble up rocks and cliffs, and if they do not encounter objects on which to grow they simply scatter laterally to produce a prostrate dense cover on the ground. Whether deliberately planted or not, Ivies are also found on the walls of buildings, fences, posts, hedges, shrubs and trees. The plants may be very long-lived, sometimes reaching an age of over 400 years (Invasive Species Compendium 2018). The seeds are spread particularly by birds, but
also by other animals. Humans often accidentally transport vegetative parts, which are capable of establishing Ivies in unintended places. In the native European areas, some deer species graze on Ivy vines, although in North America Ivies are considered deer- and rabbit-resistant. Most domesticated mammals (including cattle and sheep) avoid Ivies, although goats have been observed to consume the foliage and have even been employed as a control measure (Ingham and Borman 2010). As noted later, Hedera species contain toxic compounds.

**Appearance**

Hedera species are woody, perennial, branching vines, sometimes growing to lengths (or heights) of over 30 m (100 feet). Old stems can attain diameters greater than 10 cm (reportedly, even more than 30 cm), and may develop short trunks (Figure 2). In initial growth, germinated seeds produce stems which scramble laterally over the soil surface, and roots develop at the stem nodes (where leaves originate), anchoring the horizontally growing stems to the ground. These roots absorb minerals and water. When the horizontally-growing stems contact above-ground objects like trees, rocks or man-made objects, they climb vertically. Numerous ‘adventitious rootlets’ (Figure 3) develop on the vertically growing stems. (In botany, ‘adventitious’ means growing in an unusual place; in this case the rootlets (small roots) grow out of stems that are remote from the soil where normal roots are located). Because the adventitious rootlets develop from aerial stems they are also termed ‘aerial rootlets’. Unlike underground roots, these are unbranched, permanently slim, and do not absorb water and nutrients. Instead, the aerial rootlets anchor the vines to surfaces, clinging with the aid of an adhesive that they produce from a dense covering of very short, tiny root hairs (Xia et al. 2011; Melzer et al. 2012). The evergreen foliage is deep green, leathery, glossy, and often lobed. The stems trailing on the ground are non- flowering, and tend to produce ‘juvenile’ leaves that are noticeably lobed, while climbing and flowering stems produce less-lobed or unlobed leaves. Most cultivated selections are based on the juvenile form, and these may not develop flowers

![Figure 2](image2.png) An old vine of English Ivy (Hedera helix) growing against the ruin (bombed during the Second World War) of the Tempelherrenhaus (House of the Templers) in Weimar, Germany. Notice the impressive thickness of the woody stem at its base. Photo by ArtMechanic (CC BY SA 3.0).

![Figure 3](image3.png) Adventitious roots covering stems of English Ivy (Hedera helix). Photo by Bialowieza 2005 (CC BY SA 3.0).
Figure 4. Variation in foliage of domesticated English Ivy (*Hedera helix*). (a) Photo by Magpie Ilya (CC BY SA 3.0). (b) Variegated leaves of cultivar ‘Adam’. Photo by Agnieszka Kwiecien, Nova (CC BY SA 4.0).

Figure 5. Flowering branches of English Ivy (*Hedera helix*). Photo by Jan Samanek, Bugwood.org (CC BY 3.0).

Figure 6. Fruiting branches of Atlantic or Irish Ivy (*Hedera hibernica*). Photo by Michael Maggs (CC BY SA 2.5).
even when climbing upwards (Pennisi et al. 2009). The hundreds of cultivars include forms with variegated foliage (with whitish areas) and different leaf sizes and shapes have been selected (Figure 4). The veins of the leaves are often whitish, contributing to their attractiveness. Pierot (1974) classified Ivy cultivars into eight categories based simply on leaf shape and variegation. After about 10 years of age, upright vines may produce small, yellowish-green flowers in clusters (Figure 5), and these mature into small purplish or black (occasionally yellowish or orange) berries 5–10 mm wide (Figure 6). The degree to which given species and cultivated forms develop physical and physiological characteristics differs appreciably. For example, some kinds of Hedera are non-climbing.

Horticultural values

The American Ivy Society provides an online site (http://www.ivy.org/index.html) presenting information on horticultural aspects of Ivies. The attractive, evergreen, lustrous foliage (turning red in the autumn in some selections) and the ability to climb smooth surfaces to considerable heights have resulted in Ivies becoming very popular outdoor ornamentals (McAllister and Marshall 2017). Although not particularly cold-tolerant (Castagneri, Garbarino, and Nola 2013), Hedera species are hardy in warm temperate areas, very vigorous, easily propagated, drought-tolerant and shade-tolerant. They grow best in full sun, but can survive in as little as 3% of sunlight (Metcalfe 2005). Ivies can be trained to grow on structures, and are often used in topiary; Ivy growing over wire frames in the shape of animals is particularly attractive.

Ivies are popular houseplants (Figure 7), often grown in hanging baskets (Figure 8) and in planters with mixed species. Cultivated forms with short internodes (the portion of stem between nodes, where leaves are attached) are particularly suitable for indoor cultivation. If indoor plants are neglected, one may find Ivy vines covering venetian blinds or even attached to wallpaper. Grown indoors, Ivies are very tolerant of shade, but although durable, they should not be over- or under-watered. Ivies are reputed to improve air quality by removing volatile organic compounds (Yang et al. 2009). Formaldehyde is the most common volatile organic compound emitted in households, and potted ivy has been demonstrated to significantly decrease its concentration (Lin, Chen, and Chuah 2017).

Ivies are also used by the florist industry as greenery in floral arrangements. Fake (i.e. plastic) ivy vines for indoor display are often encountered, although true lovers of plants should regard artificial plants as abominations.

Ivies are very attractive, cheap, and require little maintenance, but if not kept in check they can become invasive. The invasive potential is a major impediment to the industry. In the US, over eight million pots annually were marketed a decade ago (Green, Ramsey, and Ramsey 2011), but sales have decreased in recent years.

Aesthetic improvement of property

Ivies are widely used in landscaping. English poet William Cowper wrote ‘Creeping ivy clings to wood or stone, And hides the ruin that it feeds upon.’ In a similar vein, American architect Frank Lloyd Wright said: ‘Physicians can bury their mistakes, but an architect can only advise his clients to plant vines.’ Unsightly fences and barriers can be transformed into beautiful vertical walls by Ivy. Ivy also makes a superb groundcover (Figure 9). Large Ivy-covered

Figure 7. English Ivy (Hedera helix) cultivated indoors in pots. (a) Public domain photo from Pixabay. (b) Bonsai. Photo by Jerry Norbury (CC BY ND 2.0).
buildings are particularly attractive (Figure 10). However, Boston Ivy (*Parthenocissus tricuspidata*) instead of English Ivy is often employed; numerous houses pictured on the Internet, allegedly covered by English Ivy, are in fact decorated with Boston Ivy. Ivy-covered houses are attractive, although if the vines are allowed to grow unchecked the effect can be excessive. Ivy coverings on large buildings can be expensive to maintain.

Figure 8. Drawing (public domain) of a hanging basket of English Ivy (*Hedera helix*). Source: Blakelee (1889).

Figure 9. English Ivy (*Hedera helix*) employed as a ground cover in Germany. Photo by Presse03 (CC BY SA 3.0).

Figure 10. English Ivy (*Hedera helix*) covering house in Weener, Germany. Photo by Frank Vincentz (CC BY SA 3.0).

**Are Ivies good or bad for human-built structures?**

Ivy-covered buildings are icons of upper-class status and quality. Nevertheless, Ivies are one of the vines thought to endanger buildings, especially those of historical value (Mishra, Jain, and Garg 1995; Bartoli, Romiti, and Caneva 2017; Figure 11(a)). The adventitious roots that are produced by ivies to anchor them to objects can penetrate cracks in brick and stone walls, expanding openings to allow penetration by water (and ice), insects and moulds. High-climbing vines can block gutters and lift roof tiles. Potentially serious structural faults can be hidden by Ivy, delaying needed repairs. When Ivy vines are removed, they can leave unsightly remains on exterior walls, necessitating expensive resurfacing. Neglected graveyards can become quite unsightly when overrun by Ivy (Figure 11(b)). Unwelcome pests can nest in Ivy.

However, some have alleged that Ivy (and other vines) growing on walls protects buildings from excessive sun, rain, temperature fluctuations, chemicals, and other environmental stresses (Rose 1996; Sternberg et al. 2010). Ivy-covered walls of residences can be cooler in the summer because of intercepted sunlight (Cuces 2017), and warmer in the winter because of the insulating effect of the vegetation (Sternberg, Viles, and Cathersides 2011). It appears that the insulating effect of Ivy can protect masonry from damaging frosts (Coombes, Viles, and Zhang 2018).

Sulgrove (2002) provided a list of publications contending that Ivies are either good or bad for structures, and it appears that there is by no means a unanimous viewpoint on this subject.
Medicinal uses

All parts of Ivies are toxic to humans when consumed, and contact with skin can produce dermatitis in sensitive individuals (De Smet 1993; Paulsen, Christensen, and Andersen 2010), but reports of negative reactions by people are uncommon (Burrows and Tyrl 2013). Cows, sheep and dogs have been poisoned by consuming the stems and/or foliage, although Ivies are not considered to be a significant danger to domesticated animals. Despite the toxicity, Ivy preparations have been employed in herbal medicine, both internally (especially for respiratory conditions) and externally (especially for skin conditions), to treat a wide variety of disorders (Lutsenko et al. 2010; Al-Snafi 2018). Ivy continues to be used as a natural remedy for respiratory illness (Rehman et al. 2017), although the efficacy has been challenged (Holzinger and Chenot 2011).

Miscellaneous uses

Bees visiting Ivy flowers produce an excellent honey which is apparently non-toxic (Invasive Species Compendium 2018). Secondary compounds in the foliage are potential natural product pesticides for insects. Ivy has been employed to control soil erosion along highway embankments and medians (Strelau et al. 2018), but while it quickly provides cover, the shallow roots are not efficient at retaining the ground. Moreover, invasive Ivy may actually increase erosion in some circumstances.
when native species with superior soil-binding properties are displaced. Ivy wood has been used to fashion curios, but is too limited to be significant.

**Biodiversity virtues**

Although *Hedera* species contain toxins, they are nevertheless commonly employed by wildlife. As noted earlier, there is limited consumption of the foliage by wild mammals. However, a wide variety of insects visit the flowers for nectar and pollen (Figure 12). The berries are bitter and poisonous to humans but are extensively consumed by birds (Figure 13(a)). Indeed, the seeds usually need to be abraded by passing through a bird’s digestive system before they will germinate (Reichard 2000). Well-developed leafy vines can provide nesting habitat for birds (Figure 13(b)) and rodents.

**Biodiversity vices**

*Hedera* species are considered detrimental to forests, especially in non-native areas (Castagneri, Garbarino, and Nola 2013; Invasive Species Compendium 2018; Strelau et al. 2018). They ‘smother’ trees (Figure 14), reducing their survival, and are especially harmful to deciduous trees as the vines can carry on photosynthesis while the trees are dormant, thereby growing faster. When vines develop mainly on one side of trees, the trees become susceptible to wind fall from the uneven distribution of weight (Ivy vines can weigh as much as a tonne). Ivies invade urban natural areas, woodlands, the sides of stream corridors, and semi-open and deeply shaded forests (Strelau et al. 2018). It has been suggested that in North America the weight of water and/or ice on the evergreen Ivy leaves may increase storm damage (Reichard 2000). The dense Ivy cover sometimes formed either over open ground or in forests can reduce native biodiversity, and such areas have been termed ‘Ivy deserts’ (Okerman 2000; Strelau et al. 2018). In California, invasive Ivy harms the Northern Spotted Owl (*Strix occidentalis caurina*, ‘endangered’ or ‘threatened’ in some jurisdictions; Armanino 2017) by so densely covering the ground that prey are hard to find. In North America, invasive Ivy serves as a reservoir for Bacterial Leaf Scorch (*Xylella fastidiosa*), a pathogen that harms Elms, Oaks, Maples and other native plants. Rodents commonly nest in dense Ivy vines on the ground, which is fine for the rodents, but considered objectionable when this occurs near buildings.

![Figure 12. English Ivy (*Hedera helix*) as food for wildlife. (a) Red Admiral butterfly (*Vanessa atalanta*) feeding on Ivy flowers in Great Britain. Photo by Andrew Curtis (CC BY SA 2.0). (b) The Ivy Bee (*Colletes hederae*) feeding on Ivy flowers in Germany. This European solitary bee forages mainly on nectar and pollen from Ivy flowers. Photo by Pjt56 (CC BY SA 4.0).](image1)

![Figure 13. Birds associating with Ivy. (a) Woodpigeon (*Columba palumbus*) feeding on Ivy berries. Photo by MPF (CC BY SA 3.0). (b) A Blackbird (*Turdus merula*) nest in Ivy vines. Photo (public domain) by Max Pixel.](image2)
Controlling the detrimental effects of invasive Ivies

Destruction of Ivy that has become established in areas as an invasive is difficult. Biological control measures are not practical because they would affect cultivated Ivies. The most common eradication technique is simply removal by hand (Figure 15), which is effective with small patches, but is very labour-intensive, expensive and difficult in large infestations. Ivies intimately intertwine with shrubs and tree branches, and the vines are time-consuming to locate. Sometimes plants will re-sprout from the remaining roots, and stems that have been cut off are capable of re-growing roots if left on the ground. Transport of Ivy trimmings and logs bearing Ivy stems can introduce the plant to new regions. Chemical control is also employed, but the wax layer on the leaves reduces entry of some foliar-applied herbicides (even when a surfactant is used to promote penetration). Recommendations for removing invasive Ivy are provided by Soll (2005) and McQueeney (2018).

The seeds of Ivies are easily spread by birds. However, some cultivars have been bred that are sterile. Normally, Ivies have either 48 or 96 chromosomes. Hybrids between forms with different chromosome numbers tend to have an intermediate (‘triploid’) number of chromosomes (72). These hybrids are sterile – unable to produce viable seeds, reducing invasiveness (but hybrids often are exceptionally vigorous and reproduce well vegetatively). Many cultivars, especially those with variegated leaves, are relatively slow growers, and so also have less invasive potential (Clarke, Reichard, and Hamilton 2006; Reiss 2008).

Figure 14. Vines of Ivy (*Hedera* species) smothering trees. (a) In Jungfernheide, a former forest and heathland located in Berlin, Germany. Photo by Rolf Dietrich Brecher (CC BY SA 2.0). (b) On a leafless tree in Connecticut. Photo by Leslie J. Behrhorff (CC BY 3.0).
In some jurisdictions, sale of Ivy for outdoor planting is banned, but introducing such legislation has been opposed by the nursery and landscape industries, since Ivy is a staple for them.

Believe it or not

- In the United Kingdom, the Victorian era refers to the period of Queen Victoria’s reign, 1837–1901, while the Edwardian period denotes the reign of King Edward VII, 1901–1910, sometimes expanded to include the 1890s to the First World War. During those times, plants were widely assigned sentimental meanings. Clinging Ivy was often symbolically associated specifically with women (who passionately cling to their families), and more generally with close interpersonal relationships (Figure 16). At weddings, Ivy is said to symbolise fidelity.

- The ‘Ivy League’ is a collegiate athletic conference made up of eight private universities in the northeastern United States. The phrase also refers to these eight schools as a group. They include Brown University, Columbia University, Cornell University, Dartmouth College, Harvard University, the University of Pennsylvania, Princeton University and Yale University. ‘Ivy League’ has come to suggest academic excellence, selectivity in admissions, privileged lifestyle and social elitism. The name traces to the widespread use of ‘ivy’ on old college buildings,

Figure 15. Removing invasive ivy (identified as ‘probably Hedera hibernica’) near Seattle, Washington. Photo by Everyguy (released into the public domain).

Figure 16. Four ‘True Friendship’ cards (public domain), produced about 1910, indicating that Ivy symbolises lasting closeness.
and indeed a custom at some universities of students ceremoniously planting ivy. The usual ivy planted is Boston Ivy (Parthenocissus tricuspidata), which is generally more cold-tolerant than Hedera species, but loses its foliage in the autumn.

- How popular is your given name? Estimations of the popularity of names in the United States can be found at http://www.mynamenstats.com/. In the US, 'Ivy' is used as a girl's name 93% of the time. There are only eight persons named Ivy for every 100,000 Americans.

- Vincent van Gogh (1853–1890), one of the world’s most influential artists, prepared over 2000 paintings, including one of Ivy in a forest (Figure 17(a)). Ironically, his grave is covered by Ivy (Figure 17(b)).

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Disclosure statement

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Figure 17. Vincent van Gogh (1853–1890) and Ivy (public domain images). (a) His painting of Ivy scrambling up and between trees (1889; housed in the Van Gogh Museum, Amsterdam). (b) Headstones and graves of Vincent van Gogh and his younger brother Theodorus, whose support allowed Vincent to devote his life to painting. Located in the French town of Auvers-sur-Oise, in the north-western suburbs of Paris, the graves receive over one-quarter million visitors yearly.
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