

Top Canadian Ornamental Plants. 17. Hydrangea

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Hydrangeas are admired for their large, long-lasting flower clusters in attractive colours. They are among the most popular of ornamental shrubs, some cultivars producing spectacular floral displays. In recent years hydrangea has also become a major potted plant, marketed in stores for holiday gifts and for use as short-term houseplants. Worldwide, hydrangeas generate hundreds of millions of dollars annually, and in Canada they are among the leading floral retail commodities. As will be noted, the determination of flower colour in some species by soil pH represents one of the most curious phenomena in nature.

Names

Scientific names: The genus name *Hydrangea* is based on Greek *hydor*, water + *angeion*, vessel or container, alluding to the shape of the mature, dehisced capsule.

Common names: Like many popular ornamentals, the common name (hydrangea) is the same as the genus name. The occasional name “hortensia” (a standard name in Europe and the French name) has the same etymological origin as *Hydrangea*. English and French common names for the five species highlighted are presented later. In warmer climates outside of Canada, “hydrangea” unqualified usually refers to *H. macrocarpa* (which is usually called “hortensia” in Europe). Since *H. paniculata* is the most widely grown species in Canada, “hydrangea” is more likely to refer to this species.

Symbolism

Hydrangeas bloom abundantly during the rainy season in Japan (June and early July), and accordingly often symbolize early summer. In Japanese tradition, hydrangea flowers represent deep or heartfelt emotion as well as a fickle or changeable heart (reflecting the instability of flower colour). In feudal Japan, warriors despised hydrangeas because changing colours came to symbolize unstable loyalty. In Western countries, hydrangeas have come to symbolize gratitude, grace and beauty on the positive side, and on the negative side vanity and boastfulness (perhaps reflective of the abundance and beauty of the flowers), and frigidity when the flowers are blue (allegedly because in Medieval times it was believed that young women who grew or picked hydrangeas would never find a husband). Alabama designated the oak-leaf hydrangea (*H. quercifolia*) as its “official state wildflower” in 1999 (camellia is the “state flower” of Alabama). Unofficially, hydrangea is considered to be the floral symbol of Brittany (France).

Wild Hydrangea species

Some taxonomists consider *Hydrangea* to include as many as 1,000 species, but most of these are usually placed in seven other genera. *Hydrangea* in a narrow sense only includes several dozen species (the exact number recognized depending on authority). Interpreting the genus in this restricted sense, it is made up of shrubs, small trees and vines.



Figure 1: *Hydrangea macrophylla* growing on a hillside by a shrine in Japan. ©Aiko Matsuoka (CC BY SA 3.0).

The species native to temperate areas of eastern Asia and North America are deciduous and the main source of the cultivars. The species native to subtropical Central America and western South America are evergreen. Five species (all deciduous) are indigenous in the US. None is native to Canada, but *H. paniculata* is introduced in Ontario, and *H. arborescens* in Ontario, New Brunswick and Nova Scotia.

Domesticated Hydrangea species

Hydrangea species have been cultivated and domesticated as ornamentals in China and Japan at least for centuries. In 1789 the famous British naturalist Sir Joseph Banks imported *H. macrophylla* into England from China, this species destined to become the predominant source of cultivars

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Figure 2: Massed blooms of *Hydrangea macrophylla*. Source: Pixabay (public domain).



Figure 3: Canadian stamps issued in 2016, showing recent hydrangea cultivars. **Left:** *Hydrangea macrophylla* 'Endless Summer'. **Right:** *H. arborescens* 'Annabelle'. © Canada Post.

in the genus. Subsequent eighteenth and nineteenth century plant collectors brought other Asian species and garden forms to Europe and North America. About the same time, the eastern North American species *H. arborescens* and *H. quercifolia* were brought to the Old World. Breeding has been continuing in both the Old and New Worlds, but to date the majority of cultivars arose in Europe and Asia.

Hydrangeas grown outdoors usually form rounded shrubs 1–3 m tall. The most common cultivated *Hydrangea* species are four deciduous shrubs: *H. arborescens*, *H. macrophylla*, *H. paniculata*, and *H. quercifolia*. Cultivars of several other species are available, but are much less significant commercially, and are not mentioned further in this review. However, the vine *H. anomala* subsp. *petiolaris* has also acquired appreciable popularity, and is discussed. The genus includes at least 1,000 cultivars (the majority in *H. macrophylla*), and some interspecific hybrids have been generated for garden cultivation. The five species mentioned here can all be grown in Canada, at least in the warmer regions, but the relatively cold-hardy *H. paniculata* is the predominant Canadian *Hydrangea*.

Hydrangeas are best known for their attractive inflorescences. Like the Asteraceae (Compositae; daisy family), these are usually made up of a combination of small, inconspicuous fertile flowers in the centre of the cluster and large, showy (pollinator-attracting) infertile flowers surrounding the central sterile ones. (Small flowers such as in the Asteraceae and Hydrangeaceae are often informally termed “florets.”) The showiness of the sterile flowers resides mostly in the petaloid sepals (an enlarged calyx is present, a corolla is not and sexual organs, if present, are rudimentary). The fertile flowers produce nectar, the infertile ones do not. Wild populations have inflorescences composed mostly or entirely of small, fertile flowers. Domestication has produced many cultivars in which most or all of the flowers are of the large, showy, sterile type. Inflorescences in which most of the flowers are large, showy and sterile and clustered into a pom-pom shape are referred to as “mopheads” and “hortensias,” in contrast to the “lacecap” category which has retained central small fertile flowers. Large, globe-shaped puffy mophead blooms (named for the alleged resemblance to a mop head) are what most people associate with hydrangeas. Lacecap inflorescences

tend to be flattened rather than spherical, and many lacecap cultivars have differently coloured fertile and sterile flowers. Lacecaps have been claimed to be named for their likeness to Colonial ladies' headcoverings. The outer flowers are often much larger than the sterile flowers, primarily made up of four or five sepals. The flowers of some cultivars have been doubled, i.e., in addition to the petaloid sepals, the true petals and stamens have been mutated to increase the number of petaloid structures. While white is the most common floral colour in wild *Hydrangea* species, in cultivars flowers may also be pink, blue, purple, red, and occasionally yellow. In some cultivars, flower colour (or at least depth of shade) changes with maturity. “Remontant” cultivars re-bloom (usually in later summer).

Hydrangea macrophylla

This, by a considerable margin the most widely cultivated species of *Hydrangea* in the world, is known as: bigleaf hydrangea, common hydrangea, florist's hydrangea (potted forms used as houseplants), French hydrangea (reflecting the importance of France in the past as a source of cultivars), garden hydrangea, hortensia (the predominant name in Europe), house hydrangea, and snowball hydrangea (French names: hortensia, hortensia à grandes feuilles). It is native to Japan and Korea, commonly growing 1–2 m (3–6 feet) in height (occasionally more than 3 m or up to 10 feet), and spreads to 2.6 m (8 feet). *Hydrangea macrophylla* subsp. *serrata* (mountain hydrangea, often separated as the species *H. serrata*) has somewhat smaller flowers and leaves.



Figure 4: The two basic inflorescence forms in *Hydrangea*. **Left:** Mophead (all florets sterile, large and showy). **Right:** Lacecap (central florets fertile, small and inconspicuous; outermost florets sterile, large and showy). Source of photos: Pixabay (public domain).



Figure 5: Cultivars of *Hydrangea macrophylla*. © Camelotrose (CC BY SA 3.0).

Hydrangea macrophylla is popular because it is easily cultivated, requires little maintenance, has few pests and diseases, is tolerant of shade and sun, can be grown in acid and slightly alkaline soil, and provides outstandingly beautiful flowers. There are many seaside biotypes in Japan that are very salt-tolerant. Unfortunately, most cultivars are insufficiently cold hardy to produce a good flowering display outdoors in most of Canada. The flower buds (produced in late summer and fall) are susceptible to low winter temperatures and are too tender when they sprout in the spring to survive heavy frosts. Planting in a sheltered location may help. Where it can be grown, pruning should be avoided or limited once flower buds begin to develop, or none will be available to bloom the next season. Several new cultivars, most notably 'Endless Summer', develop their flowers not only on old wood but also on new wood (the current year's growth), and so are not completely dependent on mild weather during both winter and spring to produce good floral displays.

Hydrangea paniculata

Known as panicle hydrangea, paniced hydrangea, PG hydrangea, and hardy hydrangea (French names: hortensia paniculé, hortensia en panicule), this species is native to cool temperate and subtropical regions of Japan, Sakhalin (Russian island north of Japan), and eastern and southern China, where it grows as a shrub or small tree as high as 8 m (26 feet). Cultivars of *H. paniculata* are usually 1–2.5 m (3–8 feet) in height, and tend to have cone-shaped inflorescences, unlike the usually spherical inflorescences of *H. macrophylla* (see figures). *Hydrangea paniculata* was collected from Japan and named in 1829 by the German physician and botanist Philipp Franz von Siebold, who was subsequently banned from the country. Thirty years later he was allowed to return, and collected the cultivar 'Grandiflora', now generally known as 'PeeGee'. Although now old-



Figure 6: Cultivars of *Hydrangea paniculata*. Left: 'Vanilla Fraise'. © Leonora (Ellie) Enking (CC BY SA 2.0). Right: 'Limelight'. © Michelle Oshen (CC BY SA 2.0).



Figure 7: *Hydrangea quercifolia*. Left: 'Snowflake'. © Krzysztof Ziarnik Kenraiz (CC BY SA 4.0). Right: Colourful foliage in autumn. © University of Washington Botanic Garden (CC BY 2.0).

fashioned, it is still the world's most popular cultivar of *H. paniculata*, and the most widespread hydrangea grown outdoors in Canada. (Because it is often used for the purpose in Canada, it has been called "cemetery flower.") Panicle hydrangea is frequently trained as a small tree. *Hydrangea paniculata* flowers on new wood developed in the spring, and may be pruned in winter or early spring. Compared to the more popular *H. macrophylla*, it is more drought-tolerant, thrives better in both full sun and partial shade, and also has a broader tolerance to soil conditions, withstanding not only acidic but somewhat alkaline soil. Most importantly insofar as Canada is concerned, *H. paniculata* is much more cold-tolerant than *H. macrophylla*, capable of surviving -30°C , and unlike *H. macrophylla* its buds are not susceptible to early spring frosts. Dirr (2004) stated that "*Hydrangea paniculata* is as easy to culture as crabgrass."

Hydrangea quercifolia

Oakleaf hydrangea (so named for the leaves which are lobed somewhat like red oaks; French names: l'hydrangea quercifolia, hortensia à feuilles de chêne) is native to the southeastern U.S. and is marginally cold-hardy. It can grow in the warmest parts of eastern Canada (it produces good flowering displays in Toronto). Unlike most cultivated hydrangeas which have uninteresting foliage colour in the autumn, *H. quercifolia* develops a striking range of reds, oranges and deep maroon leaf hues in the fall. The shrubs commonly grow 2 to 2.5 m (6–8 feet), but tend to spread wider than their height from root suckers. Large, white to cream-colored flowers are produced in early to mid-summer, these sometimes turning pink to rose with age. The flowers develop on old wood, and pruning if necessary is best done after flowering, not in late summer or fall which would remove potential buds.

Hydrangea arborescens

This species is known as seven-bark (for the layers of bark which peel away easily), smooth hydrangea, tree hydrangea, and wild hydrangea (French names: hortensia en arbre, hortensia de Virginie, hydrangelle arborescente). It is native to eastern US woodlands, and has become introduced in eastern Canada. The plants are usually 1–2 m (3–6.5 feet) tall, occasionally 3 m (10 feet). Flowering is on new wood of the current season, and so the plants can be pruned in early spring without fear of removing flower buds. The species can be grown in the warmer regions of southern Canada, including the southern Prairie Provinces. Most cultivars are white-flowered, but pink forms are available.



Figure 8: *Hydrangea arborescens*. Left: © Kor!An (CC BY SA 3.0). Right: from Curtis, W. 1799. Botanical Magazine, vol. 3, plate 437.

Hydrangea anomala subsp. *petiolaris*

Climbing hydrangea (French: hortensia grim pant) is a woody deciduous vine native to woodlands and forests of eastern Siberia, Japan, China and South Korea. It grows over shrubs and trees by twining and by aerial rootlets that develop along the stems. The rootlets can adhere to brick and vinyl siding so tenaciously that they are impossible to remove. Although slow to develop, this vine produces vigorous, sprawling growth that can be almost shrub-like. Climbing hydrangea is employed as an ornamental vine and as a groundcover. Flowering occurs on old wood, so to promote good floral displays pruning is best done after flowering. However, when growing vigorously, it is advisable to prune whenever necessary to prevent stray stems from developing where they are unwanted. Climbing hydrangea is hardy in the southernmost areas of eastern Canada. It is tolerant of different soil types but does best in well-drained substrates.

Environmental control of flower colour

One of the first chemistry lessons that students learn is that litmus paper becomes blue under alkaline conditions (pH >7.0), and red in an acidic environment (pH <7.0). Curiously, the reverse often occurs with respect to *Hydrangea* flower hues in respect to soil pH. Blue and pink are principal floral colours of *Hydrangea* cultivars, some of which are famous for having the capacity to develop one or the other colour depending on the soil in which they grow. The colour produced in such species (most notably *H. macrophylla*) has been found to be determined by a cultivar's inherent ability to produce pigment, aluminum (aluminium) availability in the soil or substrate, and the biotype's ability to uptake aluminum. Blue colour results when aluminum complexes with a pigment (the anthocyanin delphinidin 3-glucoside) in the sepals. When the pH of the growth medium is acidic



Figure 9: *Hydrangea anomala* subsp. *petiolaris*. Left: Vine climbing on a brick wall. © Leonora (Ellie) Enking (CC BY SA 2.0). Right: Close-up of flowering stems. © A. Barra (CC BY SA 3.0).



Figure 10: Potted *Hydrangea macrophylla*. Left: © Dalibri (CC BY SA 2.0). Right: © Freak222 (CC BY SA 3.0).

(4.5–5.5), flower colour tends to become blue because aluminum is generally highly available at a low pH. At pH \geq 6.0, flower colour tends to be pink. Between pH 5.5 and 6.0, the colour could be pink, blue, lavender, or a mixture of pink and blue on the same plant. However, some species, and some cultivars simply cannot be made to develop blue flowers regardless of soil pH, some will only develop scattered blue flowers within an inflorescence, and some will produce rather unattractive floral shades.

Blue is the world's most popular colour, the preference for it showing up across cultures. It is no accident that the sexist preference for baby boys is associated with blue garments, and the traditional powder blue of the majority of cultivated hydrangeas is consistent with this favouritism. Psychologists have explained the preference for blue as perhaps reflecting the calmness of blue skies and blue oceans. Nevertheless, red is the world's most "attractive" colour, consistent with lips and nipples being reddish, but so is blood, the sight of which is alarming, which may explain why pink (a softened red: attractive but not overly so) has become traditionally associated with baby girls (indeed with women).

Nursery growers have reported that they sell on average ten blue hydrangeas for every pink one, so controlling flower colour is crucial. (Nevertheless, in Asia, pink hydrangeas seem to be increasing in popularity.) For many varieties of *H. macrocarpa* grown in containers, development of blue flowers requires particular substrate conditions. Soil pH is usually maintained at 4.5 to 5.5. Some growth media may have very little aluminum, and so just influencing pH may not affect flower colour in plants potted in such material. For some biotypes, care must be taken to regulate fertilizers and water quality to avoid deficiencies of minerals such as calcium, magnesium and aluminum, and to also avoid metal toxicities. For home growers, to produce pink flowers it may suffice to simply add lime to raise soil pH, or to produce blue flowers add sulphur to lower pH. A quick-and-dirty procedure to produce blue flowers in susceptible cultivars is to drench the soil around the plant with a gallon (4 L) of water in which 1 tablespoon of alum (aluminum sulphate) has been dissolved. Or, to make flowers pink, dissolve 1 tablespoon of hydrated lime instead. Fertilizers low in phosphorus will tend to produce pink flowers, since this element ties up aluminum. Those expecting to see colour changes overnight will be disappointed: generally soil conditions must be provided well before and sometimes during flower development.



Figure 11: Painting (public domain) entitled "Young woman with hydrangeas" by the French artist Elisabeth Sonrel (1874–1953).

The cut flower industry

Hydrangea is employed as a cut flower crop, popular because of the large size of the flowers and the variety of colours available. The inflorescences are often used in bouquets and floral decorations for weddings, parties, and other events. The flowering stems have excellent vase life, and dry well for dried flower arrangements. Worldwide, about 1,200 ha have been planted to produce cut hydrangea. The most important countries of production are Colombia and The Netherlands.

Houseplants

Potted hydrangeas are increasingly being sold in supermarkets, especially for holidays. In both Europe and North America, there is high demand for potted hydrangeas at Christmas, Easter and Mother's Day. In Europe, more than 60 million pots are sold annually, with production centred in The Netherlands, Germany and France. Most of these so-called "florist hydrangeas" are *H. macrophylla*, grown to bloom very early and abundantly. They may be dwarf forms, or simply cultivated to be small. In warm regions, they can be planted outdoors once the flowers fade, but in most of Canada they will not survive winter.

Edibility and toxicity

Some species of *Hydrangea* are considered to be toxic because of the presence of cyanogenic glycosides. Hydrangeas have a very minor reputation as an intoxicant when smoked, which could simply be the result of cyanide poisoning. Hydrangeas are reportedly poisonous to dogs, cats, horses and cows.

Amacha is a Japanese beverage prepared from fermented leaves of *H. macrophylla*. A similar herbal tea, sugukcha, is available in Korea. These preparations are sweet because of the presence of phylloulcin, which is hundreds of times as sweet as table sugar, and is under investigation for control of obesity and diabetes.

Medicinal uses

Preparations of hydrangea roots and rhizomes are sometimes employed to treat kidney and bladder conditions, allegedly because of diuretic properties (which increase the flow of urine). As well, such preparations have been used to treat kidney stones and enlarged prostate. Foliage decoctions have been employed to treat intestinal ailments. These traditional herbal medicinal treatments have not been validated and should be avoided. The antimalarial potential of leaf compounds in *Hydrangea* is under investigation, as is the potential of root compounds to treat autoimmune diseases like multiple sclerosis.

Cultivation

Where winter temperatures permit, hydrangeas are not difficult to grow.

Purchasing and Propagating

Most commercial propagation of hydrangea cultivars is by stem cuttings or tissue culture. Accordingly, most plants will be purchased in the form of pot-grown specimens ready for transplanting. The hole should be excavated to be as deep as the root ball (place the root ball at the same depth as in the pot) and three times its width. Back fill with soil amended with organic matter to promote good drainage.

Soil conditions

In gardens, the best soils for hydrangeas are fertile sandy or silt loams with more than 1% organic matter, although with proper watering they will grow well in clay soils. A soil pH of 5.0–6.5 is usually recommended. Soils should be well-drained but maintained moist.

Location

Like most other shrubs, hydrangeas should be transplanted to spaces large enough to allow maximum development, to minimize pruning. In Canada, sunny or partly shady situations are suitable (shade will reduce flower display). In colder regions of Canada, locations providing protection from wind and temperature fluctuations are desirable.

Curiosities of science and technology

- Philipp Franz Balthasar von Siebold (1796–1866), a German physician and botanist who taught Western medicine in Japan, coined the scientific name of the bigleaf hydrangea as "*Hydrangea otakusa* Siebold et Zuccarini" (although the correct name is now considered to be *H. macrocarpa* (Thunb.) Ser.). The epithet *otakusa* has been interpreted as a reference to the name of the courtesan known as Kusumoto Taki who became von Siebold's mistress (marriage with foreigners was not permitted in Japan at the time). Their daughter Kusumoto Ine became the first female doctor of Western medicine in Japan.
- Portugal's Faial Island in the Azores became widely known as "Blue Island" after Portuguese poet Raul Brandão in the early 20th century marvelled at the abundant flowering hydrangeas established there.



Figure 12: Heirloom postcard (public domain) featuring hydrangea.

- According to Japanese tradition, when Buddha was born nine dragons poured amrita (nectar of immortality) over him. In commemoration of this, herbal tea made from hydrangea is ceremoniously poured over a statue of Buddha on April 8, thought to be his birthday.
- In 2009, the chef of a pricey restaurant in Japan seasoned a dish with hydrangea leaves, which as noted earlier are toxic, producing cyanide when ingested. The diners experienced severe vomiting and the chef was prosecuted (<http://blog.orienttimes.org/2011/06/hydrangea-ajisai-%E7%B4%AB%E9%99%BD%E8%8A%B1-in-japanese-history-and-culture-revisited/>).

Key publications

- Bailey, D.A. 1989. *Hydrangea* production. Timber Press, Portland, OR. 91 pp.
- Boebel, T. 2011. *Hydrangeas in the North: getting blooms in the colder climates*. CreateSpace Independent Publishing Platform (self-published by author). 120 pp.
- Bruynzeel, D.P. 1986. Allergic contact dermatitis to hydrangea. *Contact Dermatitis* 14: 128.
- Bowman, D.P. 2000. *Hydrangeas*. Friedman/Fairfax (international). 112 pp.
- Church, G. 2007. *Complete hydrangeas*. Firefly Books, Richmond Hill, ON. 144 pp.
- De Smet, Y., Granados Mendoza, C., Wanke, S., Goetghebeur, P., and Samain, M.-S. 2015. Molecular phylogenetics and new (infra)generic classification to alleviate polyphyly in tribe Hydrangeeae (Cornales: Hydrangeaceae). *Taxon* 64: 741–752.
- Dirr, M. 2004. *Hydrangeas for American gardens*. Timber Press, Portland, OR. 236 pp.
- Granados Mendoza, C., Wanke, S., Goetghebeur, P., and Samain, M.-S. 2013. Facilitating wide hybridization in *Hydrangea* s. l. cultivars: A phylogenetic and marker-assisted breeding approach. *Molec. Breed.* 32: 233–239.
- Harrison, J. 2013. *Heavenly hydrangeas: a practical guide for the home gardener*. Schiffer, Atglen, PA 144 pp.
- Haworth-Booth, M. 1984. *The hydrangeas*. 5th edition. Constable, Edinburgh. 217 pp.
- Hufford, L., Moody, M.L., and Soltis, D.E. 2001. A phylogenetic analysis of Hydrangeaceae based on sequences of

- the plastid gene *matK* and their combination with *rbcL* and morphological data. *Int. J. Plant Sci.* 162: 835–846.
- Lawson-Hall, T., and Rothera, B. 2005. *Hydrangeas: a gardener's guide*. Timber Press, Portland, OR. 176 pp.
- Mallet, C. 2008. *Hortensienatlas*. Ulmer Eugen Verlag, Stuttgart. 208 pp. (In German, with English portions; presents 1,000 illustrations.)
- Mallet, C., Mallet, R., and van Trier, H. 1992–1994. *Hydrangeas: species & cultivars*. Centre d'Art Floral, Varengeville, France, 2 vols.
- McClintock, E. 1957. A monograph of the genus *Hydrangea*. *Proc. Calif. Acad. Sci.*, ser. 4, 29: 147–256.
- Reed, S.M., and Rinehart, T.A. 2006. *Hydrangea macrophylla* and *serrata* – should we lump 'em or spit em? *SNA Research Conference* 51: 573–576. naldc.nal.usda.gov/download/45326/PDF
- Samain, M.-S., Wanke, S., and Goetghebeur, P. 2010. Unraveling extensive paraphyly in the genus *Hydrangea* s.l. with implications for the systematics of tribe Hydrangeae. *Syst. Bot.* 34: 593–600.
- Schreiber, H.D., Jones, A.H., Lariviere, C.M., Mayhew, K.M., and Cain, J.B. 2011. Role of aluminum in red-to-blue color changes in *Hydrangea macrophylla* sepals. *Biometals* 24: 1005–1015.
- Uemachi, T., Mizuhara, Y., Deguchi, K., Shinjo, Y., Kajino, E., and Ohba, H. 2014. Phylogenetic relationships of *Hydrangea macrophylla* (Thunb.) Ser. and *H. serrata* (Thunb.) Ser. evaluated using RAPD markers and plastid DNA sequences. *J. Japan. Soc. Hort. Sci.* 83: 163–171.
- Van Gelderen, C.J. and van Gelderen, D.M. 2004. *Encyclopedia of hydrangeas*. Timber Press, Portland, OR. 280 pp.
- ### Key websites
- American Hydrangea Society – americanhydrangeasociety.org/.
- Bailey, D.A. 1998. *Commercial hydrangea forcing*. North Carolina Cooperative Extension Service, Leaflet 524. content.ces.ncsu.edu/commercial-hydrangea-forcing.
- Bir, D. 2000. *Pruning hydrangeas*. www2.ca.uky.edu/HLA/Dunwell/hydprun.html.



Figure 13: “Two Little Fraid Cats,” a hand-coloured lithograph published by Currier & Ives in 1863 (public domain) showing two cats in hydrangea blooms, cowering in fear of a mouse.

- Bland, T. Hydrangeas in Newfoundland. www.mun.ca/botgarden/gardening/gardennl/Hydrangea_for_Newfoundland2013.pdf.
- Freeman, C.C. 2017. *Hydrangea*. Flora North America (online). Vol. 12. www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=115977
- Fulcher, A., Owen, J., and LeBude, A. 2016. Hydrangea production: species-specific production guide. extension.tennessee.edu/publications/Documents/PB1840-B.pdf.
- Lancaster, N. 2008. RHS Plant Trials Bulletin: *Hydrangea paniculata*. www.rhs.org.uk/plants/pdfs/plant-trials-and-awards/plant-bulletins/hydrangea-paniculata.pdf.
- Owen, J.S., Fulcher, A., and LeBude, A. 2016. Hydrangea production: cultivar selection and general practices to consider when propagating and growing hydrangea. extension.tennessee.edu/publications/Documents/PB1840-A.pdf.
- Royal Flora Holland. 2016. More production and sales of cut hydrangea worldwide. www.royalfloraholland.com/en/speciale-paginas/search-in-news/v38614/more-production-and-sales-of-cut-hydrangea-worldwide
- Schreiber, H. 2014. Curious chemistry guides hydrangea colors. *Am. Sci.* 102(6): 444. www.americanscientist.org/article/curious-chemistry-guides-hydrangea-colors.

Acknowledgements

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