

Pelargonium

Pelargonium (/ˈpɛlɑːrɡoʊniəm/)[5] is a genus of flowering plants that includes about 280 species of perennials, succulents, and shrubs,[4] commonly called geraniums, pelargoniums, or storksbills. *Geranium* is also the botanical name and common name of a separate genus of related plants, also known as cranesbills. Both genera belong to the family Geraniaceae. Carl Linnaeus originally included all the species in one genus, *Geranium*, and they were later separated into two genera by Charles Louis L'Héritier de Brutelle in 1789.

While *Geranium* species are mostly temperate herbaceous plants, dying down in winter, *Pelargonium* species are evergreen perennials indigenous to warm temperate and tropical regions of the world, with many species in southern Africa. They are drought and heat tolerant but can tolerate only minor frosts. Some species are extremely popular garden plants, grown as houseplants and bedding plants in temperate regions. They have a long flowering period, with flowers mostly in red, orange, or white, but intensive breeding has produced a huge array of cultivars with great variety in size, flower colour, leaf form and aromatic foliage.

The name *Pelargonium* is derived from the Greek *πελαργός*, *pelargós* (stork), because the seed head looks like a stork's beak. Dillenius originally suggested the name 'stork', because *Geranium* was named after a crane — "*α πελαργός*, *ciconia*, *sicuti vocamus Gerania*, *γέρανος*, *grus*" (from *pelargos*, stork, as we call the *Gerania*, *geranos*, crane).[6][7]

Pelargonium occurs in a large number of growth forms, including herbaceous annuals, shrubs, subshrubs, stem succulents and geophytes.[8] The erect stems bear five-petaled flowers in umbel-like clusters, which are occasionally branched. Because not all flowers appear simultaneously, but open from the centre outwards, this is a form of inflorescence is referred to as pseudoumbels.

The flower has a single symmetry plane (zygomorphic), which distinguishes it from the *Geranium* flower, which has radial symmetry (actinomorphic). Thus the lower three (anterior) petals are differentiated from the upper two (posterior) petals. The posterior sepal is fused with the pedicel to form a hypanthium (nectary tube). The nectary tube varies from only a few millimeters, up to several centimeters, and is an important floral characteristic in morphological classification. Stamens vary from 2 to 7, and their number, position relative to staminodes, and curvature are used to identify individual species. There are five stigmata in the style.[9] For the considerable diversity in flower morphology, see figure 1 of Röschenbleck et al. (2014)[8]

Leaves are usually alternate, and palmately lobed or pinnate, often on long stalks, and sometimes with light or dark patterns. The leaves of *Pelargonium peltatum* (Ivy-leaved Geranium), have a thick cuticle better adapting them for drought tolerance.[10]

Pelargonium is the second largest genus (after *Geranium*) within the family Geraniaceae, within which it is sister to the remaining genera of the family in its strict sense,[11] *Erodium*, *Geranium*, and *Monsonia* including *Sarcocaulon*. The Geraniaceae have a number of genetic features unique amongst angiosperms, including highly rearranged plastid genomes differing in gene content, order and expansion of the inverted repeat.[8]

The name *Pelargonium* was first proposed by Dillenius in 1732,[12] who described and illustrated seven species of geraniums from South Africa that are now classified as *Pelargonium*. [13][14] Dillenius, who referred to these seven species with apparent unique characteristics as *Geranium Africanum* (African Geranium)[15] suggested "Possent ergo ii, quibus novi generis cupido est, ea, quorum flores inaequales vel et irregulares sunt, *Pelargonia* vocare" (Those who wish a new genus can therefore call those, whose flowers are unequal or irregular, '*Pelargonia*'). [7] The name was then formally introduced by Johannes Burman in 1738. However Carl Linnaeus who first formally described these plants in 1753 did not recognise *Pelargonium* and grouped together in the same genus (*Geranium*) the three similar genera *Erodium*, *Geranium*, and *Pelargonium*. [16] Linnaeus' reputation prevented further differentiation for forty years. [14] The eventual distinction between them was made by Charles L'Héritier based on the number of stamens or anthers, seven in the case of *Pelargonium*. In 1774, *P. cordatum*, *P. crispum*, *P. quercifolium* and *P. radula* were introduced, followed by *P. capitatum* in 1790. [17][13]

Pelargonium is distinguished from the other genera in the family Geraniaceae by the presence of a hypanthium, which consists of an adnate nectar spur with one nectary, as well as a generally zygomorphic floral symmetry. [8]

De Candolle first proposed dividing the genus into 12 sections in 1824, based on the diversity of growth forms. [18] Traditionally the large number of *Pelargonium* species have been treated as sixteen sections, [9][19] based on the classification of Knuth (1912) who described 15 sections, [20] as modified by van der Walt et al. (1977-1997) who added *Chorisma*, *Reniformia* and *Subsucculentia*.

These are as follows;

All subdivision classifications had depended primarily on morphological differences till the era of phylogenetic analyses (Price and Palmer 1993). [11] However phylogenetic analysis shows only three distinct clades, labelled A, B and C. [21] In this analysis not all sections were monophyletic, although some were strongly supported including *Chorisma*, *Myrrhidium* and *Jenkinsonia*, while other sections were more paraphyletic. This in turn has led to a proposal, informal at this stage, of a reformulation of the infrageneric subdivision of *Pelargonium*.

In the proposed scheme of Weng et al. there would be two subgenera, based on clades A+B, and C respectively and seven sections based on subclades. Subsequent analysis with an expanded taxa set confirmed this infrageneric subdivision into two groups which also correspond to chromosome length ($<1.5 \mu$, $1.5-3.0 \mu$), [8] but also two subclades within each major clade, suggesting the presence of four subgenera, these correspond to clades A, B, C1 and C2 of the earlier analysis, A being by far the largest clade with 141 taxa. As before the internal structure of the clades supported monophyly of some sections (*Myrrhidium*, *Chorisma*, *Reniformia*, *Pelargonium*, *Ligularia* and *Hoarea*) but paraphyly in others (*Jenkinsonia*, *Ciconium*, *Peristera*). A distinct clade could be identified within the paraphyletic *Polyactium*, designated section *Magnistipulacea*. As a result, *Polyactium* has been split up to provide this new section, which in itself contains two subsections, *Magnistipulacea* and *Schizopetala*, following Knuth's original treatment of *Polyactium* as having four subsections. [8]

Thus Röschenbleck et al. (2014) provide a complete revision of the subgeneric classification of *Pelargonium* based on four subgenera corresponding to their major clades (A, B, C1, C2);

Sixteen sections were then assigned to the new subgenera as follows, although many species remained only assigned to subgenera at this stage

Subgenus *Magnipetala*: Corresponds to clade C1, with 24 species. Perennial to short lived, spreading subshrubs, rarely herbaceous annuals. Petals five, but may be four, colour mainly white. Mainly winter rainfall region of South Africa, spreading into summer rainfall region. One species in northern Namibia and Botswana. Two species in East Africa and Ethiopia. Chromosomes $x=11$ and 9.

Subgenus *Parvulipetala*: Corresponds to clade B, with 39-42 species. Perennials, partly annuals. Petals five and equal, colour white or pink to deep purplish red. Mainly South Africa, but also other southern hemisphere except South America. a few species in East Africa and Ethiopia. Chromosomes $x=7-19$.

Subgenus *Paucisignata*: Corresponds to clade C2, with 25-27 species. Erect sometimes trailing shrubs or subshrubs, rarely geophytes or semi-geophytes. Petals five and equal, colour pink to red sometimes white. Summer rainfall region of South Africa, spreading into winter rainfall region and northern Namibia, with a few species in tropical Africa, Ethiopia, Somalia, Madagascar, the Arabian Peninsula and Asia Minor. Chromosomes x =mainly 9 or 10, but from 4-18.

Subgenus *Pelargonium*: Corresponds to clade A, with 167 species. Frequently xerophytic deciduous perennials with many geophytes and succulent subshrubs, less frequently woody evergreen shrubs or annual herbs. Petals five, colour shades of pink to purple or yellow. Winter rainfall region of South Africa and adjacent Namibia, spreading to summer rainfall area, and two species in tropical Africa. Chromosomes $x=11$, may be 8-10.[8]

Pelargonium has around 280 species.[4][21] Röschenbleck et al lists 281 taxa.[8] There is considerable confusion as to which *Pelargonium* are true species, and which are cultivars or hybrids. The nomenclature has changed considerably since the first plants were introduced to Europe in the 17th century.[22]

Pelargonium is a large genus within the family Geraniaceae, which has a worldwide distribution in temperate to subtropical zones with some 800 mostly herbaceous species.[8] *Pelargonium* itself is native to southern Africa (including Namibia) and Australia. Southern Africa contains 90% of the genus, with only about 30 species found elsewhere, predominantly the East African rift valley (about 20 species) and southern Australia, including Tasmania.[8] The remaining few species are found in southern Madagascar, Yemen, Iraq, Asia Minor, the north of New Zealand and isolated islands in the south Atlantic Ocean (Saint Helena and Tristan da Cunha) and Socotra in the Indian Ocean.[8] The centre of diversity is in southwestern South Africa where rainfall is confined to the winter, unlike the rest of the country where rainfall is predominantly in the summer months.[8] Most of the *Pelargonium* plants cultivated in Europe and North America have their origins in South Africa.[22]

Pelargonium species are eaten by the caterpillars of some Lepidoptera species, including the noctuid moth angle shades, *Phlogophora meticulosa*. The diurnal butterflies *Cacyreus marshalli* and *C. tespis* (Lycaenidae), native to southern Africa, also feed on *Geranium* and *Pelargonium*. [23] *C. marshalli* has been introduced to Europe and can develop into a pest on cultivated *Pelargoniums*. It has naturalised along the Mediterranean, but does not survive the winter in Western Europe.[24]

The Japanese beetle, an important agricultural insect pest, becomes rapidly paralyzed after consuming flower petals of the garden hybrids known as "zonal geraniums" (*P. × hortorum*). The phenomenon was first described in 1920, and subsequently confirmed.[25][26][27][28] Research conducted by Dr. Christopher Ranger with the USDA Agricultural Research Service and other collaborating scientists have demonstrated the excitatory amino acid called quisqualic acid present within the flower petals is responsible for causing paralysis of the Japanese beetle.[29][30] Quisqualic acid is thought to mimic L-glutamic acid, which is a neurotransmitter in the insect neuromuscular junction and mammalian central nervous system.[31]

A study by the Laboratory of Apiculture & Social Insects group at the University of Sussex on the attractiveness of common garden plants to pollinators found that a cultivar of *Pelargonium × hortorum* was unattractive to pollinators in comparison to other selected garden plants such as *Lavandula* (lavender) and *Origanum*. [32]

The geranium bronze butterfly is a pest of *Pelargonium* species. The larvae of the geranium bronze bore into the stem of the host plant, causing the stem to typically turn black and die soon after. Geranium bronze are currently listed as an A2 quarantine pest by the European and Mediterranean Plant Protection Organization and can cause significant damage to *Pelargonium* species.[33]

Various types of *Pelargonium* are regular participants in flower shows and competitive events, with numerous societies devoted exclusively to their cultivation. They are easy to propagate vegetatively from cuttings.[34][35][36] It is recommended that cuttings should have at least two nodes.[37] Zonal geraniums grow in U.S. Department of Agriculture hardiness zones 9 through 12. Zonal geraniums are basically tropical perennials. Although they are often grown as annuals, they may overwinter in zones as cool as zone 7.[38]

The first species of *Pelargonium* known to be cultivated was *P. triste*, a native of South Africa. It was probably brought to the Botanical Garden in Leiden before 1600 on ships which had stopped at the Cape of Good Hope. In 1631, the English gardener John Tradescant the elder bought seeds from Rene Morin in Paris and introduced the plant to England. By 1724, *P. inquinans*, *P. odoratissimum*, *P. peltatum*, *P. vitifolium*, and *P. zonale* had been introduced to Europe.[17]

There was little attempt at any rational grouping of *Pelargonium* cultivars, the growing of which was revived in the mid-twentieth century, and the origins of many if not most were lost in obscurity. In 1916 the American botanist Liberty Hyde Bailey (1858–1954) introduced two new terms for zonal and regal pelargoniums. Those pelargoniums which were largely derived from *P. zonale* he referred to as *P. × hortorum* (i.e. from the garden), while those from *P. cucullatum* he named *P. × domesticum* (i.e. from the home).[39][40] In the late 1950s a list (the Spalding List) was produced in the United States, based on nursery listings and the 1897 list of Henri Dauthenay.[41] It described seven groups, listing each cultivar with the list of its originator, and in most cases a date. These were Species, Zonals, Variegated-Leaved, Domesticum (Regals), Ivy-Leaved, Scented-Leaved and Old. In the 1970s the British *Pelargonium* and Geranium Society produced a checklist and the Australian Geranium Society started to produce a register but it was not completed till its author, Jean Llewellyn's death in 1999. None of these were published. The most complete list in its time was the 2001 compilation by The Geraniaceae Group,[42] which included all cultivars up to 1959.[43]

Registration of cultivars is the responsibility of the *Pelargonium* & Geranium Society (PAGS):

formed in 2009 from the British Pelargonium and Geranium Society and the British and European Geranium Society)[44] which administers the International Register of Pelargonium Cultivars.[45] PAGS is the International Cultivar Registration Authority (ICRA) of the International Society for Horticultural Science for pelargoniums.[46]

Cultivated pelargoniums are commonly divided into six groups[47] in addition to species pelargoniums and primary hybrids. The following list is ordered by position in the PAGS classification.[48] Abbreviations indicate Royal Horticultural Society usage.[49]

Of these, A, U and Sc groups are sometimes lumped together as Species Derived (Sppd). This term implies that they are closely related to a species from which they were derived, and do not fit into the R, I or Z groups.[50]

In addition to the primary groups, additional descriptors are used. The Royal Horticultural Society has created description codes. These include:[49]

These may then be combined to form the code, e.g. Pelargonium 'Chelsea Gem' (Z/d/v), indicating Zonal Double with variegated foliage.[51] Crosses between groups are indicated with an x, e.g. Pelargonium 'Hindoo' (R x U), indicating a Regal x Unique cross.[52]

These are known as zonal geraniums because many have zones or patterns in the center of the leaves,[36] this is the contribution of the Pelargonium zonale parent. Common names include storksbill, fish or horseshoe geraniums.[50] They are also referred to as Pelargonium x hortorum Bailey. Zonal pelargoniums are tetraploid, mostly derived from P. inquinans and P. zonale,[53] together with P. scandens and P. frutetorum.[36][47]

Zonal pelargoniums are mostly bush-type plants with succulent stems grown for the beauty of their flowers, traditionally red, salmon, violet, white or pink.[36] The scarlet colouring is attributed to the contribution of P. inquinans.[17] Flowers may be double or single. They are the pelargoniums most often confused with genus Geranium, particularly in summer bedding arrangements. This incorrect nomenclature is widely used in horticulture, particularly in North America.[17]

Zonals include a variety of plant types along with genetic hybrids such as hybrid ivy-leaved varieties that display little or no ivy leaf characteristics (the Deacons varieties), or the Stellar varieties. Hybrid zonals are crosses between zonals and either a species or species-derived pelargonium.[50] There are hundreds of zonal cultivars available for sale,[54] and like other cultivars are sold in series such as 'Rocky Mountain',[55] each of which is named after its predominant colour, e.g. 'Rocky Mountain Orange', 'White', 'Dark Red', etc.[56]

Fancy-leaf zonal pelargoniums – besides having green leaves with or without zoning, this group also have variable coloured foliage[50] that is sometimes used in classifying for exhibition purposes, e.g. 'Bicolour', 'Tricolour', 'Bronze' or 'Gold'. Other foliage types are: 'Black' or 'Butterfly'. There are an increasing number of these plants with showy blooms;

Zonal pelargoniums have many flower types, as follows:[50]

“Zonquill” pelargoniums result from a cross between Zonal pelargonium cultivars and P. quinquelobatum.[50]

Also known as "ivy geraniums".[50] Usually of lax growth (trailing), mainly due to the long thin

stems, with thick, waxy ivy-shaped stiff fleshy evergreen leaves developed by the species *P. peltatum* to retain moisture during periods of drought. Much used for hanging pots, tubs and basket cultivation. In the UK the bulbous double-headed types are preferred whilst on the European continent the balcon single types for large-scale hanging floral displays are favoured. Ivy-leaved pelargoniums embrace all such growth size types including small-leaved varieties and genetic hybrid crosses, which display little or no zonal characteristics. May have bicolour leaves and may have flowers that are single, double or rosette. Ivy pelargoniums are often sold as series such as 'Great Balls of Fire', in a variety of colours such as 'Great Balls of Fire Burgundy'.

Additional descriptive terms include:[50]

These are large bush-type floriferous evergreen pelargoniums. In addition to "Regals" they are also known as "Show Pelargoniums". In the United States they are often known as the "Martha Washington" or "Lady Washington" pelargoniums. They are grown primarily for the beauty and richness of their flower heads, which are large. Most of those cultivars grown currently are the result of hybridization over the last 50 years. They are very short-jointed and compact, which results in their requiring very little work in order to create a floriferous and well-rounded plant.[50][48] Flowers are single, rarely double, in mauve, pink, purple or white. They have rounded, sometimes lobed or partially toothed (serrated) leaves, unlike the Zonal groups, without any type of zoning.

Additional descriptive terms include:[50]

Angel pelargoniums are similar to Regal pelargoniums but more closely resemble *P. crispum* in leaf shape and growth habit. The majority of Angel cultivars originate from a cross between *P. crispum* and a Regal variety in the early part of the 20th century. Angels have grown in popularity in the last 30 years or so due mainly to an explosion of new varieties being released by specialist nurseries resulting from the work done by dedicated amateur hybridisers. These hybridisers have managed to obtain many new flower colour breaks and tighter growth habits resulting in plants suitable for all sorts of situations. Angels basically have the appearance of a small Regal with small serrated leaves and much smaller flowers and are more compact and bushy. The group extends to include similar small-leaved and -flowered types but usually with *P. crispum* in their parentage. They are mostly upright bush-type plants but there are some lax varieties that can be used for basket or hanging pot cultivation. Often called "pansy-faced" in the US. Some varieties have bicolour foliage. Other terms include 'Langley-Smith Hybrids'.[50]

Unique in sense of not fitting into any of the above categories. The parentage of Unique pelargoniums is confused and obscure. One theory being a derivation from *P. fulgidum*, but a derivation from an older cultivar 'Old Unique', also known as or 'Rollinson's Crimson', in the mid-19th century is also claimed.[50] Unique pelargoniums resemble upright Scented Leaf pelargoniums in being shrubby and woody evergreens. They have distinctly scented leaves, and small flowers with blotched and feathered petals. They may have bicolour foliage. Some types, popularly known in the hobby as hybrid Uniques, have been crossed with Regal pelargoniums and, as a result of this cross, are much more floriferous.

Shrubby evergreen perennials grown chiefly for their fragrance, may be species or cultivars but all must have a clear and distinct scented foliage. Scent is emitted when the leaves are touched or bruised with some scents aromatic, others pungent and in a few cases, quite unpleasant. Several of the scented leaved pelargoniums are grown for the oil geraniol, which

is extracted from the leaves and is an essential oil much used commercially in perfumery. The scent of some species growing in their natural habitat, acts as a deterrent to grazing animals who appear to dislike the emitted scent. Conversely, it also attracts other insect life to visit the bloom and pollinate the plant. The scented leaves can be used for potpourri and they also have a use as flavourings in cooking. Occasionally scented types can be found in some of the other groups mentioned; for example, the Angels, having *P. crispum* in their genetic makeup, can often have a strong citrus scent. Leaves are lobed, toothed, incised or variegated. Growth habit is very variable, but the flowers are less prominent than other groups, and most closely resemble the species they originated from.[50]

These include:

The species are the forefathers of all the cultivar groups listed above. In general, the definition of a species is that it breeds true, and is to be found doing this in the "wild". Species pelargoniums have a large diversity of characteristics in habit, shape, size and colour, which probably accounts for them having retained their popularity for more than 300 years.

A primary hybrid is recognised as being the resultant plant from a first-time cross between two different known species. Examples are *P. × ardens* – from *P. lobatum* × *P. fulgidum* (1810). *P. × glauciifolium* – from *P. gibbosum* × *P. lobatum* (1822). Usually, but not always, primary hybrids are sterile.

The following is a selection of pelargoniums which have gained the Royal Horticultural Society's Award of Garden Merit:

Pelargoniums rank as one of the highest number of potted flowering plants sold and also in terms of wholesale value.[36]

Other than being grown for their beauty, species such as *P. graveolens* are important in the perfume industry and are cultivated and distilled for their scents. Although scented pelargoniums exist which have smells of citrus, mint, pine, spices or various fruits, the varieties with rose scents are most commercially important.[citation needed] Pelargonium distillates and absolutes, commonly known as "scented geranium oil" are sometimes used to supplement or adulterate expensive rose oils. The oils of the scented pelargoniums contain citronellol, geraniol, eugenol, alpha pinene and many other compounds. The edible leaves and flowers are also used as a flavouring in desserts, cakes, jellies and teas. Scented-leaved pelargoniums can be used to flavor jellies, cakes, butters, ice cream, iced tea and other dishes. The rose-, lemon- and peppermint-scents are most commonly used. Also used are those with hints of peach, cinnamon and orange. Commonly used lemon-scented culinary species include *P. crispum* and *P. citronellum*. Rose-scenteds include *P. graveolens* and members of the *P. graveolens* cultivar group. Other species and cultivars with culinary use include the lime-scented *P. 'Lime'*, the lemon balm-scented *P. 'Lemon Balm'*, the strawberry-lemon-scented *P. 'Lady Scarborough'* and the peppermint-scented *P. tomentosum*.[81] Scented leaf pelargoniums have also been historically used as toilet paper by fishermen in remote places, such as the Minquiers.[82]

In herbal medicine, Pelargonium has been used for intestinal problems, wounds and respiratory ailments, but Pelargonium species have also been used for fevers, kidney complaints and other conditions. Geranium (Pelargonium) oil is considered a relaxant in aromatherapy, and in recent years, respiratory/cold remedies made from *P. sidoides* and *P. reniforme* have been sold in Europe and the United States.[81] *P. sidoides* along with

Echinacea is used for bronchitis.[83] *P. odoratissimum* is used for its astringent, tonic and antiseptic effects.[citation needed] It is used internally for debility, gastroenteritis, and hemorrhage and externally for skin complaints, injuries, and neuralgia and throat infections. The essential oil is used in aromatherapy.[84]

According to the ASPCA, these plants are toxic to cats, dogs, and horses.[85]

Pelargonin (pelargonidin 3,5-O-diglucoside) is a petal pigment of the scarlet pelargonium.[86]

The chemist, John Dalton, realized that he was color blind in 1794 when he heard others describe the color of the flowers of the pink *Pelargonium zonale*[87] as pink or red, when to him it looked either pink or blue, having no relationship to red at all.[88]

