

Gormanian

Sedum is a large genus of flowering plants in the family Crassulaceae, members of which are commonly known as stonecrops. The genus has been described as containing up to 600 species, subsequently reduced to 400–500. They are leaf succulents found primarily in the Northern Hemisphere, but extending into the southern hemisphere in Africa and South America. The plants vary from annual and creeping herbs to shrubs. The plants have water-storing leaves. The flowers usually have five petals, seldom four or six. There are typically twice as many stamens as petals. Various species formerly classified as *Sedum* are now in the segregate genera *Hylotelephium* and *Rhodiola*.

Well-known European species of *Sedum* are *Sedum acre*, *Sedum album*, *Sedum dasyphyllum*, *Sedum reflexum* (also known as *Sedum rupestre*) and *Sedum hispanicum*.

Sedum is a genus that includes annual, biennial, and perennial herbs. They are characterised by succulent leaves and stems.[2] The extent of morphological diversity and homoplasy make it impossible to characterise *Sedum* phenotypically.[3]

Sedum was first formally described by Carl Linnaeus in 1753, with 15 species.[4] Of the genera encompassed by the Crassulaceae family, *Sedum* is the most species rich, the most morphologically diverse and most complex taxonomically. Historically it was placed in the subfamily Sedoideae, of which it was the type genus. Of the three modern subfamilies of the Crassulaceae, based on molecular phylogenetics *Sedum* is placed in the subfamily Sempervivoideae. Although the genus has been greatly reduced, from about 600[5] to 420–470 species,[6] by forming up to 32 segregate genera,[7] it still constitutes a third of the family and is polyphyletic.[8]

Sedum species are found in four of six major crown clades within subfamily Sempervivoideae of Crassulaceae and are allocated to tribes, as follows:[9]

Clades containing *Sedum*, shown in blue

In addition at least nine other distinct genera appear to be nested within *Sedum*. However the number of species found outside of the first two clades (Tribe Sedeae) are only a small fraction of the whole genus. Therefore the current circumscription, which is somewhat artificial and catch-all must be considered unstable.[8] The relationships between the tribes of Sempervivoideae is shown in the cladogram.

Telephieae

Umbilicieae

Semperviveae

Aeonieae

Sedeae (*Leucosedum*+*Acre*)

There are now thought to be approximately 55 European species. *Sedum* demonstrates a

wide variation in chromosome numbers, and polyploidy is common. Chromosome number is considered an important taxonomic feature.[10]

Earlier authors placed a number of *Sedum* species outside of these clades, such as *S. spurium*, *S. stellatum* and *S. kamtschaticum* (*Telephium* clade),[11] that has been segregated into *Phedimus* (tribe *Umbiliceae*).[9][12][13][14] Given the substantial taxonomic challenges presented by this highly polyphyletic genus, a number of radical solutions have been proposed for what is described as the "Sedum problem", all of which would require a substantial number of new combinations within *Sempervivoideae*. Nikulin and colleagues (2016) have recommended that, given the monophyly of *Aeonieae* and *Semperviveae*, species of *Sedum* outside of the tribe *Sedeae* (all in subgenus *Gormanina*) be removed from the genus and reallocated. However this does not resolve the problem of other genera embedded within *Sedum*, in *Sedeae*. [8] In the largest published phylogenetic study (2020), the authors propose placing all taxa within *Sedeae* in genus *Sedum*, and transferring all other *Sedum* species in the remaining *Sempervivoideae* clades to other genera. This expanded *Sedum* s.l. would comprise about 755 species.[15]

Linnaeus originally described 15 species, characterised by pentamerous flowers, dividing them into two groups; *Planifolia* and *Teretifolia*, based on leaf morphology. with 15 species, and hence bears his name as the botanical authority (L.).[16] By 1828, de Candolle recognized 88 species, in six informal groups.[17] Various attempts have been made to subdivide this large genus, in addition to segregating separate genera, including creation of informal groups, sections, series and subgenera. For an extensive history of subfamily *Sedoideae*, see Ohba 1978.

Gray (1821) divided the 13 species known in Britain at that time into five sections; *Rhodiola*, *Telephium*, *Sedum*, (unnamed) and *Aizoon*. [18] In 1921 Praeger established ten sections; *Rhodiola*, *Pseudorhodiola*, *Giraldiina*, *Telephium*, *Aizoon*, *Mexicana*, *Seda Genuina*, *Sempervivoides*, *Epeteium* and *Telmissa*. [19] This was later revised in what is the best known system, that of Berger (1930), who defined 22 subdivisions, which he called *Reihe* (sections or series). [20] Berger's sections were:

A number of these, he further subdivided. [20] In contrast, Fröderströmm (1935) adopted a much broader circumscription of the genus, accepting only *Sedum* and *Pseudosedum* within the *Sedoideae*, dividing the former into 9 sections. [21] Although this was followed by numerous other systems, the most widely accepted infrageneric classification following Berger, was by Ohba (1978). [22] Prior to this most species in *Sedoideae* were placed in genus *Sedum*. [12] Of these systems, it was observed "No really satisfactory basis for the division of the family into genera has yet been proposed". [23]

Some other authors have added other series, and combined some of the series into groups, such as sections. [24] In particular *Sedum* section *Sedum* is divided into series (see Clades) [8][2] More recently, two subgenera have been recognised, *Gormanina* and *Sedum*. [8]

Subgenus *Sedum* has been considered as three geographically distinct, but equal sized sections: [25]

S. sect. Sedum includes 54 species native to Europe, which Berger classified into 27 series. [25]

Species and series include [26][27][28][11][9][8][7][29]

Of about 80 Eurasian species, series *Rupestris* forms a distinct monophyletic group of about ten taxa, which some authors have considered a separate genus, *Petrosedum*.^{[31][32][33]} It was series 20 in Berger's classification. Native to Europe it has escaped cultivation and become naturalized in North America.^[34]

Embedded within series *Monanthoidea* are three Macaronesian segregate genera, *Aichryson*, *Monanthes* and *Aeonium*.^[9]

In the Levant, one species of this succulent (*S. microcarpum*) covers the stony ground like a carpet where the soil is shallow, growing no higher than 5–10 cm. At first, the fleshy leaves are a light green, but as the season progresses, the fleshy leaves turn red.

Embedded within the *Leucosedum* clade are the following genera: *Rosularia*, *Prometheum*, *Sedella* and *Dudleya*.^[9] *Rosularia* is paraphyletic, and some *Sedum* species, such as *S. sempervivoides* Fischer ex M. Bieberstein are assigned by some authors to *Rosularia*, as *R. sempervivoides* (Fischer ex M. Bieberstein) Boriss.^[36]

Embedded within the *Acre* clade are the following genera: *Villadia*, *Lenophyllum*, *Graptopetalum*, *Thompsonella*, *Echeveria* and *Pachyphytum*.^[9] The species within *Acre*, can be broadly grouped into two subclades, American/European and Asian.^{[37][11]}

Distributed in mainly in temperate to subtropical climates the Northern hemisphere, extending to the Southern hemisphere in Africa and South America,^[6] being most diverse in the Mediterranean,^[28] Central America, Himalayas, and East Asia.^[2] In this respect, the two subgenera differ. Subgenus *Sedum* having a centre of diversity in Mexico, and *Gormania* in Eurasia with a secondary centre in N America. ^[28]

Sedum species are used as food plants by the larvae of some Lepidoptera species including the grey chi moth. In particular, *Sedum spathulifolium* is the host plant of the endangered San Bruno elfin butterfly of San Mateo County, California.^[citation needed] *Sedum lanceolatum* is the host plant of the more common *Parnassius smintheus* found in the Rocky Mountains.^[38] As well as *Sedum spathulifolium*, many other species of *Sedum* serve the environmental role of host plants for butterflies. For example, the butterfly *Callophrys xami* uses several species of *Sedum*, such as *Sedum allantoides*, for suitable host plants.^{[39][40]}

Many sedums are cultivated as ornamental garden plants, due to their interesting and attractive appearance and hardiness. The various species differ in their requirements; some are cold-hardy but do not tolerate heat, some require heat but do not tolerate cold.

Numerous hybrid cultivars have been developed, of which the following have gained the Royal Horticultural Society's Award of Garden Merit:^[b]

The leaves of most stonecrops are edible,^[45] excepting *Sedum rubrotinctum*, although toxicity has also been reported in some other species.^[46] The juice from the stems and leaves may irritate skin if handled excessively.^[47]

Sedum reflexum, known as "prickmadam", "stone orpine", or "crooked yellow stonecrop", is occasionally used as a salad leaf or herb in Europe, including the United Kingdom.^[48] It has a slightly astringent sour taste.

Sedum divergens, known as "spreading stonecrop", was eaten by First Nations people in

northwest British Columbia. The plant is used as a salad herb by the Haida and the Nisga'a people. It is common in the Nass Valley of British Columbia.[49]

Biting stonecrop (*Sedum acre*) contains high quantities of piperidine alkaloids (namely (+)-sedridine, (–)-sedamine, sedinone and isopelletierine), which give it a sharp, peppery, acrid taste and make it somewhat toxic.

Sedum can be used to provide a roof covering in green roofs,[50][51] where they are preferred to grasses.[52] Examples include Ford's Dearborn, Michigan Truck Plant, which has a living roof with 454,000 square feet (42,200 m²) of *sedum*. [53] The Rolls-Royce Motor Cars plant in Goodwood, England, has a 242,000 square feet (22,500 m²) roof complex covered in *Sedum*, the largest in the United Kingdom.[54] Nintendo of America's roof is covered in some 75,000 square feet (7,000 m²) of *Sedum*. [55] The Javits Center in New York City is covered with 292,000 square feet (27,100 m²) of *Sedum*. [56]

Berlin's Prenzlauer Allee,[57] Le Mans, and Warsaw, for example, plant *sedum* in between rails of some tramways as a low maintenance alternative to grass. This provides beautification, a permeable surface for water management, and noise reduction.[58]

Sedum acre

Sedum dendroideum

Sedum glaucophyllum

Sedum ochroleucum

Sedum spathulifolium

Sedum stenopetalum

Sedum lanceolatum

Sedum lineare

