

## Crassulaceae

Perennial or rarely annual or hapaxanthic herbs, subshrubs to shrubs (rarely aquatics, or tree-like, or epiphytic, or scandent), usually with succulent **L**, sometimes with succulent stems or underground caudices; **L** opposite and decussate or alternate and spiral, frequently aggregated into **Ros**, simple, usually entire, or crenate to lobed, glabrous or tomentose; stipules absent; **Inf** lateral or terminal many-flowered spikes or panicles, rarely few- to 1-flowered and axillary; **Fl** bisexual or unisexual (then plants  $\pm$  dioecious), actinomorphic (except *Tylecodon grandiflorus*), frequently 5-merous but varying from 3- to 32-merous; **Sep** free or basally united; **Pet** free or basally united to form a short to long **Cl** tube; **St** as many or  $2\times$  as many as **Pet**, free or fused to them; **Ca** as many as **Pet**, superior, free or almost so, basally with a small to conspicuous **NSc**, gradually tapering into short to long **Sty**, with few to many ovules; **Fr** usually dehiscent follicles, capsular; **Se** smallish, to 1.5 - 3 mm, elongate, smooth, papillate to longitudinally ridged, mostly brownish.

**Distribution:** Worldwide but esp. N hemisphere and S Africa.

**Literature:** Berger (1930); 't Hart (1995); Eggli & al. (1995).

The family counts  $\pm$  1400 species in 33 genera here accepted. It is here treated in its entirety, adopting the consensus classification proposed by Eggli & al. (1995), but modified to accept the additional genera *Afrovivella*, *Phedimus* and *Prometheum*, and subsuming *Bryophyllum* under *Kalanchoe*, and *Jovibarba* under *Sempervivum*. The family has no important crop plants, with the exception of numerous taxa of horticultural interest, mainly as hardy perennials for rock gardens, and – more recently – for establishing green ‘living’ roofs. *Hylotelephium spectabile* is sometimes used in the cut-flower trade. Numerous species from almost all genera are popular in succulent plant collections.

Due to numerous suspected parallel developments, the classification of the family has been difficult, and the identification of species is often problematical because of hybridization (to a limited extent natural, and almost without limits in cultivation, esp. amongst genera in Group F). The traditional circumscription of 6 subfamilies by Berger (1930) was known to be artificial for some time. Recently, a revised classification was proposed by 't Hart (1995), based on molecular and morphological data:

Subfamily **Crassuloideae** A. Berger 1930: **Fl** haplostemonous (**St** as many as **Pet**): *Crassula*.

Subfamily **Sedoideae** A. Berger 1930: **Fl** obdiplostemonous (**St**  $2\times$  as many as **Pet**) (with few exceptions):

– Tribe **Kalanchoeae** 't Hart 1995: **L** decussate or alternate, flat (rarely terete), crenate or dentate (rarely entire); **Fl** 4- or 5-merous; **Pet** united to form a distinct tube; **Se** costate:

**Group A:** **L** alternate: *Adromischus*, *Tylecodon*.

**Group B:** **L** decussate: *Cotyledon*, *Kalanchoe*.

– Tribe **Sedeeae** 't Hart 1995: **L** mostly alternate, thick, entire (if decussate **Pet** free and **Se** costate); **Fl** (3- to) 5- to 32-merous; **Se** costate, (multi-) papillate or reticulate:

- Subtribe *Telephinae* 't Hart 1995: Stems often basally woody, tuberous or sympodial or monopodial rhizomes; **L** usually alternate, flat, dentate or crenate (rarely decussate, terete or entire); **Fl** 5-merous (if polymeric then **L** flat, opposite or whorled); **Sep** basally connate; **Pet** usually free (if connate then **Se** multipapillate); **Se** costate or multipapillate: *Hylotelephium*, *Hypagophytum*, *Orostachys*, *Perrierosedum*, *Phedimus*, *Pseudosedum*, *Rhodiola*, *Umbilicus*.

- Subtribe *Sedinae* 't Hart 1995: Stems herbaceous, rarely woody or rhizomatous; **L** often rosulate or subrosulate, terete or semiterete, or flat and/or dentate-serrate and/or decussate; **Fl** 4- or to 32-merous; **Sep** basally connate or free; **Pet** usually free and stellately patent, rarely united; **Se** reticulate, papillate or costate:

**Group C:** Plants various; **L** in **Ros** or scattered, glabrous or glandular-hairy; **Inf** terminal or lateral: *Pistorinia*, *Prometheum*, *Rosularia*, *Sedum*.

**Group D:** Plants rosulate, from Europe, W Asia, the Caucasus or Macaronesia, mostly glandular-hairy; **Inf** mostly terminal; **Fl** mostly > 5-merous: *Aeonium*, *Aichryson*, *Monanthes*, *Sempervivum*.

**Group E:** N American rosulate plants, glabrous but often farinose; **Inf** lateral; **Fl** 5-merous: *Dudleya*.

**Group F:** American plants, mostly with well-defined **Ros**, hairy or glabrous; **Inf** lateral or rarely terminal; **Fl** mostly 5-merous: *Echeveria*, *Graptopetalum*, *Lenophyllum*, *Pachyphytum*, *Thompsonella*, *Villadia*.

### Key to the genera:

- 1 **Fl** with **St** as many as **Pet** (haplostemonous): 2
- **Fl** with **St**  $2\times$  as many as **Pet** (obdiplostemonous): 8
- 2 **Fl** often (2- to) 4-merous or more rarely 10- to 12-merous (predominantly in Africa; extra-African taxa dwarf minute ephemeral herbs with 2- to 4-merous **Fl**): 3
- **Fl** usually 5-merous (outside Africa): 4

- 3 Perennial herbs with underground tuber or tuberous rhizome; stems deciduous; **L** ternate; **Fl** 10- to 12-merous; **Ca** 2-seeded, follicles opening transversally (Ethiopia): **Hypagophytum**  
 – Not as above; **Ca** with > 2 **Se**, follicles opening apically: **Crassula**
- 4 Plants with persistent or monocarpic, dense to lax **Ros**: **5**  
 – Plants annual or perennial herbs without obvious **Ros**: **7**
- 5 Monocarpic **Ros**-forming herbs (Europe and Asia): **6**  
 – Perennial shrublets with lax **Ros** at the stem tips (Mexico): **Graptopetalum pentandrum**
- 6 **Inf** flat-topped (corymbose): **Sinocrassula**  
 – **Inf** thyrsoide-elongate: **Orostachys** p.p.
- 7 Annual to perennial herbs; **Fr** many-seeded follicles opening along the ventral side (Europe and Asia): **Sedum** p.p. (e.g. *S. rubens*)  
 – Annual minute ephemeral herbs; **Fr** indehiscent and nutlet-like, each follicle with a single seed (USA: California): **Sedella** p.p.
- 8 Perennial plants, stems perennating but with annually deciduous **L**, or stems annually deciduous: **9**  
 – Annual (to biennial) plants, or perennial plants with at least some perennating **L**: **14**
- 9 Stems obviously succulent, perennating; **L** crowded at branch tips (S and SW Africa): **Tylecodon**  
 – Stems not succulent and regularly deciduous and plants perennating with underground root stocks or small caudex (mostly outside of Africa): **10**
- 10 **L** usually distinctly peltate; **Inf** terminal racemes or panicles (Asia and E Africa): **Umbilicus** p.p.  
 – **L** flat, never peltate; **Inf** usually cymes or corymbs,  $\pm$  flat-topped (outside of Africa): **11**
- 11 Plants with tuberous caudex and annually deciduous stems; **L** alternate; **Fl** 4- to 6-merous, often unisexual (plants monoecious or dioecious): **Rhodiola**  
 – Plants with or without thickened roots but never with a caudex; **L** opposite, alternate or rarely verticillate; **Fl** various but plants never dioecious: **12**
- 12 **L** flat: **13**  
 – **L** terete-subulate: **Villadia** p.p.
- 13 **R** thickened, fusiform, and stems annually deciduous; or **R** fibrous and stems perennial, woody, forming dwarf shrublets: **Hylotelephium**  
 – **R** fibrous; stems annually deciduous: **Phedimus**
- 14 Plants with perennial monocarpic **Ros**: **15**  
 – Plants annual (to biennial), or perennial but then not with monocarpic **Ros**: **21**
- 15 **NSc** conspicuous, broader and more obvious than the insignificant **Pet** (Canary and Selvagen Islands): **Monanthes** p.p.  
 – **NSc** inconspicuous, much narrower than the showy **Pet**: **16**
- 16 **Fl** 5- (to rarely 6-) merous; **Inf** corymbose to much elongated and spike-like: **17**  
 – **Fl** 6- to 32-merous; **Inf** corymbose to dome-shaped, never much elongated: **20**
- 17 **Inf** flat-topped, corymbose or cymose, few-flowered: **18**  
 – **Inf** elongate, many-flowered: **19**
- 18 **Pet** 2.5 - 4 mm, ascending, white (E Asia): **Meterostachys**  
 – **Pet** > 4 mm, ascending to spreading, whitish, yellowish, red or pink (E Mediterranean, W Asia): **Prometheum**
- 19 **Br** of the **Inf** helicoid (Turkey, Iraq, Turkmenistan): **Rosularia elymaitica**  
 – **Br** of the **Inf** never helicoid (C to E Asia): **Orostachys** p.p.
- 20 **Ros** sessile, usually < 10 cm  $\varnothing$ ; **Fl** 6- to 18-merous, often in shades of pink and purple, rarely white or yellow: **Sempervivum**  
 – **Ros** sessile or often with a conspicuous and sometimes branched stem, often > 10 cm  $\varnothing$ ; **Fl** (6- to) 10- to 32-merous, often in shades of yellow but also whitish, more rarely reddish: **Aeonium**
- 21 **L** decussate throughout the whole length of the stems: **23**  
 – **L** verticillate or alternate at least in the upper stem parts, or in **Ros**: **22**
- 22 **L** verticillate (Africa): **Sedum** p.p. (e.g. *S. epidendrum*)  
 – **L** alternate at least in the upper stem parts, or in **Ros**: **30**
- 23 Annual to biennial glabrous to glandular-hairy herbs to 15 cm; **Fl** (4- to) 5-merous, white, pink or purplish; **Pet** 4 - 5 mm (Mediterranean): **24**  
 – Perennial herbs (sometimes monocarpic), or shrubs or small trees, or lianas; **Fl** 4- to 6-merous; **Pet** > 5 mm, in various colours: **25**
- 24 Annual glabrous herbs; **Inf** to 5 cm tall: **Phedimus stellatus**  
 – Annual to biennial glandular-hairy herbs; **Inf** to 60 cm tall: **Sedum** p.p. (e.g. *S. cepaea*)
- 25 **Fl** 4-merous; herbs (sometimes monocarpic) to shrubs or small trees, or lianas (Africa, Madagascar, Asia, neophytes world-wide): **Kalanchoe**  
 – **Fl** 5- or 6-merous; shrublets or herbs: **26**
- 26 **Fl** 5-merous, not white (Africa, Caucasus, N America): **28**  
 – **Fl** (5- to) 6-merous, erect, white: **27**
- 27 Shrubby to 80 cm tall (Madagascar): **Perrierosedum**  
 – Dwarf herbs to 10 cm tall (Europe and N Africa): **Sedum** p.p. (e.g. *S. dasphyllum*)

- 28 Herbs with creeping stems; **L** flat and rather thin-textured; **Inf** arching; **Fl** yellow, narrowly urceolate (Caucasus): **Umbilicus oppositifolius**  
 – Not with this combination of characters: 29
- 29 Plants shrubby, often > 50 cm tall; **L** not easily detached; **Fl** conspicuous, campanulate, 2 - 3 cm long, **Pet** basally connate, in various shades of orange to red or rarely yellowish (Africa, Arabia): **Cotyledon**  
 – Herbs, 10 - 30 (-50) cm tall; **L** often easily detached; **Fl** small, to 1 cm long, yellow or yellowish; **Pet** free to the base (USA, Mexico): **Lenophyllum**
- 30 Perennial plants with sessile **Ros**, or shrubby with lax **Ros** at the stem tips or **L** scattered along the length of the stems, or stems short with short internodes and few crowded **L**: 31  
 – Annual (to biennial) plants, or perennial plants, neither with conspicuous **Ros** nor shrubby: 46
- 31 **NSc** conspicuous and more obvious than the insignificant **Pet**: 32  
 – **NSc** inconspicuous, much smaller than the showy **Pet**: 33
- 32 **Fl** (5- to) 6- to 9-merous (Canary Islands): **Monanthes** p.p.  
 – **Fl** 5-merous (Mexico): **Sedum longipes**
- 33 Plants shrubby; **L** scattered along the length of the stems, never forming well-defined **Ros** (Americas): 34  
 – Plants not shrubby, or if shrubby then stems with terminal **Ros**: 35
- 34 Stems slender to wiry and not distinctly succulent: **Villadia** p.p.  
 – Stems distinctly succulent, with  $\pm$  flaking papery bark: **Sedum** p.p. (e.g. *S. frutescens*)
- 35 **Ros** ill-defined, i.e. **L** crowded and stems with very short inconspicuous **Int**; **Inf** terminal spike-like thyrses; **Fl** 5-merous; **Sep** very short; **Cl** tubular (Africa): **Adromischus**  
 – **Ros**  $\pm$  well-defined; **Inf** lateral; **Fl** 5-merous (rarely 4- or 6- to 10-merous); **Sep** usually conspicuous; **Cl** tubular or stellate: 36
- 36 **Ros** to 5 cm  $\varnothing$ ; **Fl** white or pale yellowish/reddish (Europe, W and E Asia): 37  
 – **Ros** usually > 5 cm  $\varnothing$ : 38
- 37 **Fl** white (Europe, E Asia): **Meterostachys** + **Sedum** p.p.  
 – **Fl** white or pale yellow/reddish (W Asia, E Mediterranean): **Prometheum** p.p.
- 38 Dwarf shrublets with glandular-hairy **L** in terminal **Ros**; **Fl** yellow, 7- to 8-merous (Canary Islands): **Aichryson** p.p.  
 – Not with this combination of characters: 39
- 39 **Ros** stemless, offsetting with brittle runners; **L** margins conspicuously ciliate; **Fl** 5- to 7-merous, white tinged reddish (Ethiopia): **Afroviella**  
 – Not with this combination of characters: 40
- 40 **Ros** stemless; **Fl** 5- to 9-merous,  $\pm$  cup-shaped to  $\pm$  urceolate to saucer-shaped, white, whitish, pinkish or pink but never in bright colours, never long-tubular, not very fleshy: 41  
 – Not with this combination of characters (America): 42
- 41 **Fl** 5-merous, white; **Pet** basally free or almost so (Mexico): **Sedum** p.p. (*S. suaveolens*)  
 – **Fl** 5- to 9-merous, white to pinkish or pink, **Pet** basally united (E Mediterranean, Asia Minor to E Asia): **Rosularia** p.p.
- 42 Glabrous shrublets with thickish stems; **L** mostly very thick; **Inf** scape basally  $\pm$  **L**-less, usually unbranched; fertile **Bra** large, overlapping and  $\pm$  hiding the **Fl**; **Fl** 5- to 6-merous; **Pet** with a basal scale on each margin (Mexico): **Pachyphytum**  
 – Not with this combination of characters; **Bra** never hiding the **Fl**: 43
- 43 **Pet** free to the base or slightly connate; **Fl** (4- to) 5- (to 10-) merous, long petiolate; **Pet** usually pale cream with red cross-bands or blotches, or bright pink, stellately spreading (S USA, Mexico): **Graptopetalum**  
 – **Pet** slightly to distinctly connate; **Fl** 5-merous, coloration not as above: 44
- 44 Plants never shrubby but old **Ros** sometimes with short thick stems, sometimes branching dichotomously; **Bra** semi-amplexicaul, never spurred, not easily detached; **Pet** hardly to distinctly united, tubular to stellately spreading (W USA and Baja California): **Dudleya**  
 – Plants shrubby or with sessile solitary or offsetting **Ros**, never dichotomously branching; **Bra** not semi-amplexicaul, spurred or not: 45
- 45 **Inf** narrow thyrses or spicate, erect, with 10 - 70 1- to 12-flowered cincinni; **Sep** subequal in size; **Pet** shortly connate, thin-textured, upper  $\frac{1}{2}$  stellately spreading (Mexico): **Thompsonella**  
 – **Inf** racemose, cymose-paniculate or rarely spicate; **Sep** often strongly unequal in size; **Pet** basally distinctly connate, usually distinctly fleshy, often bright pink to red (S USA to Argentina): **Echeveria**
- 46 (from 30) Minute annual herbs; **Fl** 6- to 7-merous, dirty white; **NSc** conspicuously broader than the small **Pet** (Canary Islands): **Monanthes ictERICA**  
 – Annual to perennial herbs; **Fl** 5- to 12-merous; **NSc** inconspicuous and never broader than the **Pet**: 47
- 47 Annual herbs; **Fl** 5- to 12-merous: 48  
 – Annual or perennial herbs; **Fl** 5- to 6-merous; **Pet** free to distinctly united, in various colours: 50
- 48 **Fl** 6- to 12-merous; **Pet** completely free, yellow (Canary Islands): **Aichryson** p.p.  
 – **Fl** 5- to 9-merous; **Pet** hardly to distinctly connate, not yellow: 49

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