

## **A taxonomic backbone for the global synthesis of species diversity in the angiosperm order Caryophyllales**

Authors: Hernández-Ledesma, Patricia, Berendsohn, Walter G., Borsch, Thomas, Mering, Sabine Von, Akhani, Hossein, et al.

Source: Willdenowia, 45(3) : 281-383

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: <https://doi.org/10.3372/wi.45.45301>

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PATRICIA HERNÁNDEZ-LEDESMA<sup>1,2</sup>, WALTER G. BERENDSOHN<sup>1</sup>, THOMAS BORSCH<sup>1,3</sup>, SABINE VON MERING<sup>1</sup>, HOSSEIN AKHANI<sup>4</sup>, SALVADOR ARIAS<sup>5</sup>, IDELFONSO CASTAÑEDA-NOA<sup>6</sup>, URS EGGLI<sup>7</sup>, ROGER ERIKSSON<sup>8</sup>, HILDA FLORES-OLVERA<sup>9</sup>, SUSY FUENTES-BAZÁN<sup>1</sup>, GUDRUN KADEREIT<sup>10</sup>, CORNELIA KLAK<sup>11</sup>, NADJA KOROTKOVA<sup>1,3</sup>, RETO NYFFELER<sup>12</sup>, GILBERTO OCAMPO<sup>13</sup>, HELGA OCHOTERENA<sup>9</sup>, BENGT OXELMAN<sup>8</sup>, RICHARD K. RABELER<sup>14</sup>, ADRIANA SANCHEZ<sup>15</sup>, BORIS O. SCHLUMPBERGER<sup>16</sup> & PERTTI UOTILA<sup>17</sup>

## A taxonomic backbone for the global synthesis of species diversity in the angiosperm order *Caryophyllales*

### Abstract

Hernández-Ledesma P., Berendsohn W. G., Borsch Th., Mering S. von, Akhani H., Arias S., Castañeda-Noa I., Egli U., Eriksson R., Flores-Olvera H., Fuentes-Bazán S., Kadereit G., Klak C., Korotkova N., Nyffeler R., Ocampo G., Ochoterena H., Oxelman B., Rabeler R. K., Sanchez A., Schlumpberger B. O. & Uotila P.: A taxonomic backbone for the global synthesis of species diversity in the angiosperm order *Caryophyllales*. – Willdenowia 45: 281–383. 2015. – Version of record first published online on 11 September 2015 ahead of inclusion in December 2015 issue; ISSN 1868-6397; © 2015 BGBM Berlin.

DOI: <http://dx.doi.org/10.3372/wi.45.45301>

The *Caryophyllales* constitute a major lineage of flowering plants with approximately 12500 species in 39 families. A taxonomic backbone at the genus level is provided that reflects the current state of knowledge and accepts 749 genera for the order. A detailed review of the literature of the past two decades shows that enormous progress has been made in understanding overall phylogenetic relationships in *Caryophyllales*. The process of re-circumscribing families in order to be monophyletic appears to be largely complete and has led to the recognition of eight new families (*Anacampserotaceae*, *Kewaceae*, *Limeaceae*, *Lophiocarpaceae*, *Macarthuraceae*, *Microteaceae*, *Montiaceae* and *Talinaceae*), while the phylogenetic evaluation of generic concepts is still well underway. As a result of this, the number of genera has increased by more than ten percent in comparison to the last complete treatments in the “Families and genera of vascular plants” series. A checklist with all currently accepted genus names in *Caryophyllales*, as well as nomenclatural references, type names and synonymy is presented. Notes indicate how extensively the respective genera have been studied in a phylogenetic context. The most diverse families at the generic level are *Cactaceae* and *Aizoaceae*, but 28 families comprise only one to six genera. This synopsis represents a first step towards the aim of creating a global synthesis of the species diversity in the angiosperm order *Caryophyllales* integrating the work of numerous specialists around the world.

Additional key words: flowering plants, *Caryophyllales* network, checklist, phylogeny, taxon concept, genus, World Flora Online, EDIT Platform for Cybertaxonomy

General e-mail address for correspondence: [caryophyllales@bgbm.org](mailto:caryophyllales@bgbm.org)

- 1 Botanic Garden and Botanical Museum Berlin (BGBM), Freie Universität Berlin, Königin-Luise-Str. 6–8, 14195 Berlin, Germany.
- 2 Current address: Laboratorio de Genética Molecular y Ecología Evolutiva, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Campus Aeropuerto, Querétaro, Qto. 76140, Mexico.
- 3 Institut für Biologie, Systematische Botanik und Pflanzengeographie, Freie Universität Berlin, Altensteinstr. 6, 14195 Berlin, Germany.
- 4 Department of Plant Sciences, School of Biology, College of Science, University of Tehran, P.O. Box 14155-6455, Tehran, Iran.
- 5 Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Circuito exterior s.n., Ciudad Universitaria, Ap. postal 70-614, México D.F. 04510, Mexico.
- 6 Jardín Botánico de Villa Clara, Universidad Central “Marta Abreu” de Las Villas, Facultad de Ciencias Agropecuarias, Carretera de Camajuaní km 5½, Santa Clara, Cuba.
- 7 Sukkulenten-Sammlung Zürich, Mythenquai 88, CH-8002 Zürich, Switzerland.
- 8 Department of Biological and Environmental Sciences, University of Gothenburg, Box 461, SE-40530 Göteborg, Sweden.
- 9 Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Circuito exterior s.n., Ciudad Universitaria, Ap. postal 70-614, México D.F. 04510, Mexico.

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## Introduction

### Background

Recent years have yielded a wealth of new informatics tools and infrastructures to facilitate working with taxonomic data. Searching and accessing the necessary literature and type specimens has become much faster and easier, thus stimulating research in plant systematics. Modern monographic work synthesizes knowledge on a group of organisms and generates, manages, and publishes high quality data as needed for a variety of applications. To be biologically meaningful and to allow correct identification especially at the species level, the entities recognized such as species or genera should as much as possible reflect the latest understanding provided by phylogenetic and evolutionary approaches (Marhold & al. 2013; Borsch & al. 2015; Naciri & Linder 2015). In order to achieve this, an integration of the ever-increasing number of phylogenetic and evolutionary studies and the data generated by them with formal monographic work is imperative. This requires the research process to be organized in a way that explicitly links data on characters and specimens with evolutionary results and taxon concepts, and that allows for continuous updating to reflect the continuous generation of knowledge (Borsch & al. 2015). At the same time there is now an increased awareness for the need of a comprehensive assessment of the species diversity on our planet as a basis for conservation and sustainable use (Lughada & Miller 2009; Paton 2009; Hendry & al. 2010).

### The *Caryophyllales* Global Synthesis Initiative

We have started a joint initiative entitled “Global synthesis of species diversity in the angiosperm order *Caryophyllales*”. The idea was to develop a practical model for integrative monographic work that is based on a sizable group of world-wide occurring organisms. Our approach is to develop a network and an internet portal based on a collaborative approach of institutions and individual researchers studying various aspects of the diversity and evolution of the *Caryophyllales*. Major partners will function as focal points with a long-term institutional commitment that ensures sustainability of the initiative. At the moment the core partnership consists

of: the Instituto de Biología, Universidad Nacional Autónoma de México – UNAM (Mexico); the Instituto de Botánica Darwinion (Argentina); and the Botanic Garden and Botanical Museum Berlin – BGBM (Germany). The BGBM is committed to support the coordination of the initiative and will provide the biodiversity informatics infrastructure. Apart from aiming at satisfying the general scientific and applied need for quality data, we specifically envision the application of the Synthesis in the context of plant conservation. One of the immediate outputs of the *Caryophyllales* synthesis will be an up-to-date taxonomic backbone for the World Flora Online as called for by the Convention on Biological Diversity’s Conference of the Parties (2012). Considering the enormous progress on understanding and describing *Caryophyllales* diversity that has been made in the past two decades and will continue into the future, and also the need to have full coverage of the diversity for the users, the approach will entail a mechanism to integrate new results as they become available (Borsch & al. 2015) and therefore to present the best possible treatment for any given taxon. A comprehensive review and treatment at the generic level is an important step that will then be extended to the species level and be complemented by descriptive and other information.

### *Caryophyllales* as a model group

Reasons for choosing *Caryophyllales* as model group are diverse. The group is one of the major lineages of angiosperms with about 12 500 species. It is strongly supported as monophyletic by several molecular phylogenetic studies (Savolainen & al. 2000; Soltis & al. 2000; Cuénoud & al. 2002; Hilu & al. 2003; Brockington & al. 2009; Schäferhoff & al. 2009; Qiu & al. 2010; Soltis & al. 2011; Crawley & Hilu 2012).

The *Caryophyllales* are of great ecological and evolutionary interest because they show multiple origins of specialized morphological, anatomical, and biochemical traits. The order for example comprises the highest diversity of species with C<sub>4</sub> photosynthesis after the grasses (Sage & al. 2011). Several lineages are highly specialized with adaptations to extreme habitats such as xeric conditions, salinity, or nitrogen-poor soils, and thus the group includes many succulent, halophytic, gypsophilous and

(Addresses continued from previous page)

- 10 Institut für Allgemeine und Spezielle Botanik, Herbarium MJG, Anselm-Franz-von-Bentzelweg 9a, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany.
- 11 Bolus Herbarium, Department of Biological Sciences, University of Cape Town, 7701 Rondebosch, South Africa.
- 12 Institut für Systematische Botanik, Universität Zürich, Zollikerstrasse 107, CH-8008 Zürich, Switzerland.
- 13 Departamento de Biología, Centro de Ciencias Básicas, Universidad Autónoma de Aguascalientes, Avenida Universidad 940, Ciudad Universitaria, C.P. 20131, Aguascalientes, Ags., Mexico.
- 14 University of Michigan Herbarium-EEB, 3600 Varsity Drive, Ann Arbor, MI 48108-2228, U.S.A.
- 15 Facultad de Ciencias Naturales y Matemáticas, Programa de Biología, Universidad del Rosario, Carrera 24 No. 63C-69, Bogotá D.C., Colombia.
- 16 Herrenhäuser Gärten, Herrenhäuser Str. 4, 30419 Hannover, Germany.
- 17 Botanical Museum, Finnish Museum of Natural History, P.O. Box 7, FI-00014 University of Helsinki, Finland.

carnivorous plants. The *Caryophyllales* are the order with the highest number of halophytes containing more than 21 % of all halophytic species (Flowers & al. 2010) and with the evolutionary oldest halophyte lineages (e.g. Kadereit & al. 2012a). The anatomy of *Caryophyllales* is also interesting because there are many wood features that are difficult to interpret (e.g. successive cambia, vessel elements perforation plates, ray anatomy, and raylessness; Carlquist 2010). In several families, pollen has evolved complex architectures and ultrastructures, based on the tricolpate pollen of the eudicots (Skvarla & Nowicke 1976; Nowicke 1994) with several *Amaranthaceae* exhibiting strongly derived metareticulate pollen with the highest number of apertures known in angiosperms (Borsch 1998; Borsch & Barthlott 1998). *Caryophyllales* are characterized by a unique phenomenon of petal loss and repeated reinvention (Brockington & al. 2012; Ronse De Craene 2013).

Furthermore, the order is relevant in the context of the Global Strategy for Plant Conservation and CITES by including groups of plants with many endangered species (e.g. Hunt 1999), most importantly *Cactaceae*, *Droseraceae* and *Nepenthaceae*. Species of economic importance include cereals and green vegetables (e.g. amaranth, quinoa, spinach, sugar beet), ornamentals (e.g. many *Cactaceae* and *Caryophyllaceae* species, carnivorous groups), noxious weeds (e.g. *Alternanthera philoxeroides* (Mart.) Griseb., *Amaranthus spinosus* L. and *Mirabilis* and *Opuntia* species), and of medical importance (mainly allergens; e.g. *Amaranthus retroflexus* L., *Atriplex* species, *Kali turgidum* (Dumort.) Guterm.).

The rapidly increasing number of fully sequenced genomes (currently five: two *Chenopodiaceae*, two *Amaranthaceae* and one *Caryophyllaceae*; <http://www.ncbi.nlm.nih.gov/genome>) and transcriptomes (66 species of *Caryophyllales* are included in the 1KP initiative; <https://sites.google.com/a/ualberta.ca/onekp/home>) opens new exciting opportunities for evolutionary studies in this order.

### Circumscription and phylogenetic relationships of *Caryophyllales*

For many decades the order just included the taxa characterized by a free central placentation (= *Centrospermae*), perisperm and curved embryos (Bittrich 1993a). Based on phylogenetic analyses, the *Caryophyllales* are now understood in a wider sense as also including *Polygonales*, *Nepenthales* and smaller lineages that were distantly placed in earlier classification systems, such as *Rhabdodendron* or *Simmondsia* (APG 1998; Cuénoud & al. 2002). This concept of the order is also basically followed here. We will summarize the changes in the classification of *Caryophyllales* and the different families below. This will help to understand the changes during the long transition phase from pre-cladistic to phylogeny-based taxonomy.

Several pre-cladistic classification systems were proposed for the *Caryophyllales* (for a review until the 1990s see Cronquist & Thorne 1994). Rodman & al. (1984) were the first to evaluate the classification of *Caryophyllales* based on a cladistic analysis of morphological characters. They reasserted the monophyly of the group and produced one of the first classifications based on a phylogenetic hypothesis (Table 1), even though this study was questioned with respect to its methodology and character selection (Gianassi & al. 1992). Subsequently, early molecular systematic studies (i.e. Rettig & al. 1992; Downie & Palmer 1994; Downie & al. 1997; Lledó & al. 1998) indicated the close relationship of the members of subclass *Caryophyllidae* (i.e. *Caryophyllales*, *Plumbaginales* and *Polygonales* sensu Cronquist 1981). Further studies (e.g. Albert & al. 1992; Chase & al. 1993) showed close phylogenetic relationships of *Caryophyllidae* with the carnivorous lineages *Droseraceae* and *Nepenthaceae* (*Nepenthales* sensu Cronquist 1981). Morton & al. (1997) found that the Madagascan *Asteropeiaceae* (*Theales* sensu Takhtajan 1987) and *Physenaceae* (described by Takhtajan 1985, but placed in *Sapindales*) both belong to *Caryophyllales*. This placement of *Asteropeiaceae* was further supported by a morphological cladistic analysis (Luna & Ochoteren 2004). Other studies (e.g. Fay & al. 1997) clarified the placement of *Rhabdodendraceae* (*Rosales* sensu Cronquist 1981), *Simmondsiaceae* (previously placed in either *Euphorbiaceae* or *Buxaceae*; Tobe & al. 1992), *Tamaricaceae* and *Frankeniaceae* (*Violales* sensu Cronquist 1988). The suggested affinities of all these groups to *Caryophyllales* were examined by Nandi & al. (1998), with respect to the fit of morphological characters, who adopted the concept of “caryophyllids s.l.” for a clade including *Caryophyllales* sensu Cronquist (1981) plus most of the taxa mentioned above. Nandi & al. (1998) further showed that the *Dioncophyllaceae* (*Theaneae* sensu Takhtajan 1987) and *Ancistrocladaceae* (*Theales* sensu Cronquist 1981) also belong to the carnivorous clade within the caryophyllids.

Based on a review of published molecular phylogenetic studies, the Angiosperm Phylogeny Group (APG 1998) considered 26 families to constitute the *Caryophyllales* with an expanded taxon concept. In this concept the order included all the families of the caryophyllids s.l. (Nandi & al. 1998) plus several family segregates such as *Achatocarpaceae* and *Stegnospemataceae* (segregated from *Phytolaccaceae*), *Drosophyllaceae* (segregated from *Droseraceae*) and *Sarcobataceae* (segregated from *Chenopodiaceae*). A molecular study by Savolainen & al. (2000) tested this circumscription and retrieved a well-supported clade. On their trees the authors annotated the families *Halophytaceae* (segregated from *Chenopodiaceae*) and *Petiveriaceae* (segregated from *Phytolaccaceae*).

Since then, further studies have improved the understanding of the phylogenetic relationships within

the expanded *Caryophyllales*. The study by Cuénoud & al. (2002) based on 18S rDNA, *rbcL*, *atpB*, and partial *matK* sequences, was relevant in terms of its sampling, which included most of the families treated by Kubitzki & al. (1993) and Mabberley (1997), including *Agdestidaceae*, *Barbuiaceae* and *Gisekiaceae* (segregated from *Phytolaccaceae*). Cuénoud & al. (2002) retrieved a well-supported *Caryophyllales* clade in most of their analyses, and one of their most relevant results was the detection of major subclades: the “core *Caryophyllales*” and “non-core *Caryophyllales*”. The core *Caryophyllales* included the traditionally recognized *Caryophyllales* (Cronquist 1981) and their segregated families; within this clade two subclades were recovered, one is the “lower core *Caryophyllales*” including *Achatocarpaceae*, *Amaranthaceae* s.l. (including *Chenopodiaceae*), *Asteropeiaceae* and *Caryophyllaceae*, and the other is the “higher core *Caryophyllales*” including the rest of the traditional *Caryophyllales* and their segregated families. Within the “higher core *Caryophyllales*”, *Corbichonia* and *Lophiocarpus* (*rbcL*+*matK* analysis) were considered as separate lineages within *Molluginaceae* and *Phytolaccaceae*, respectively. The “non-core *Caryophyllales*” clade also included two major subclades: one including *Frankeniaceae*, *Plumbaginaceae*, *Polygonaceae* and *Tamaricaceae*, and the other consisting of the carnivorous families *Ancistrocladaceae*, *Dioncophyllaceae*, *Droseraceae* and *Nepenthaceae*. The analysis of Cuénoud & al. (2002) resulted in inconclusive positions for *Rhabdodendraceae* and *Simmondsiaceae*. In their combined tree, *Rhabdodendraceae* were recovered as sister to all *Caryophyllales* (100% Bootstrap; BS), and *Simmondsiaceae* as sister to the core *Caryophyllales* (moderate BS), while in the analysis of *matK* (low BS), both taxa as sisters were recovered as sister to the core *Caryophyllales*.

The study by Hilu & al. (2003) based on *matK* also retrieved two moderately supported major clades: “*Caryophyllales* I” and “*Caryophyllales* II”, the former including the core *Caryophyllales* plus *Simmondsiaceae* and *Rhabdodendraceae* (expanded core *Caryophyllales*). Within this clade two sister groups were recovered, “higher core I” and “higher core II”, one comprising *Aizoaceae*, *Nyctaginaceae* and relatives and the other *Cactaceae*, *Portulacaceae*, and relatives. The “*Caryophyllales* II” corresponded to the non-core *Caryophyllales* of Cuénoud & al. (2002).

Schäferhoff & al. (2009) employed sequence data of the *petD* group II intron and *matK* and recovered the “caryophyllids” and “polygonids” as major clades with high confidence. The caryophyllids include the expanded core *Caryophyllales*, which in general correspond to the “*Caryophyllales* I” of Hilu & al. (2003). The polygonids correspond to the non-core *Caryophyllales* of Cuénoud & al. (2002) and *Caryophyllales* II of Hilu & al. (2003). Furthermore, Schäferhoff & al. (2009) described the *Microteaceae* (segregated from *Phytolaccaceae*) with the

sole genus *Microtea*, which they sampled for the first time in any molecular study. The study underscored the importance of a representative taxon sampling because *Microtea* was identified based on just two markers as an isolated lineage that together with the *Simmondsiaceae* is the successive sister to the rest of the caryophyllids.

Other recent authors mainly increased the number of characters analysed from the chloroplast. Brockington & al. (2009) using nine plastid genes from the single-copy region, the inverted repeat, and two nuclear genes, recovered the non-core *Caryophyllales* and core *Caryophyllales* clades with *Rhabdodendraceae* followed by *Simmondsiaceae* plus the clade *Asteropeiaceae*–*Physenaceae* as successive sisters of the rest of the core *Caryophyllales*. Within the core *Caryophyllales*, the authors designated the “globular inclusion” clade as the clade that corresponds to the “higher core *Caryophyllales*” of Cuénoud & al. (2002). Within this clade, they referred to the clade containing *Cactaceae*, *Portulacaceae*, and relatives as the “portulacaceous cohort” (an earlier-suggested name by Rodman & al. 1984, “cohort Portulacares”) and the lineage including *Aizoaceae*, *Nyctaginaceae*, and most parts of *Phytolaccaceae* possessing raphides as the “raphide clade”. Soltis & al. (2011) used 17 genes (representing the three plant genomes) and came to results very similar to those of Schäferhoff & al. (2009) and Brockington & al. (2009).

Several phylogenetic studies have focused on the *Portulacineae* (= *Cactineae*/Portulacaceous cohort) (Applequist & Wallace 2001; Nyffeler 2007; Nyffeler & al. 2008; Ocampo & Columbus 2010). The most recent study by Nyffeler & Eggli (2010a) resulted in the disintegration of *Portulacaceae*, recognizing eight monophyletic families including the newly described *Anacampserotaceae* (segregated from *Portulacaceae*), the concept of *Portulacaceae* s.str. as a monotypic family, changes of the circumscription of some families (*Didiereaceae*), and the re-establishment and change of concept of others (*Montiaceae* and *Talinaceae*).

The family names *Limeaceae* and *Lophiocarpaceae* were published in 2005 (Hoogland & Reveal 2005) and 2008 (Doweld & Reveal 2008), respectively, based on phylogenetic data (e.g. Cuénoud & al. 2002) that were confirmed in later works (e.g. Schäferhoff & al. 2009; Brockington & al. 2009). In a similar way the *Kewaceae* were validated (Christenhusz & al. 2014) to accommodate the second lineage of the biphyletic genus *Hyperbelia* that had been found outside of *Molluginaceae* s.str. (Schäferhoff & al. 2009; Brockington & al. 2011; Christin & al. 2011) but in an isolated position sister to the raphide clade. The genus *Macarthuria* that was resolved in an isolated position as sister to the remainder of the core *Caryophyllales* (Brockington & al. 2011; Christin & al. 2011) was accommodated in the new family *Macarthuraceae* (Christenhusz & al. 2014).

In summary, our concept of *Caryophyllales* includes 39 families (Fig. 1; Table 1, 2). It is in line with the fami-

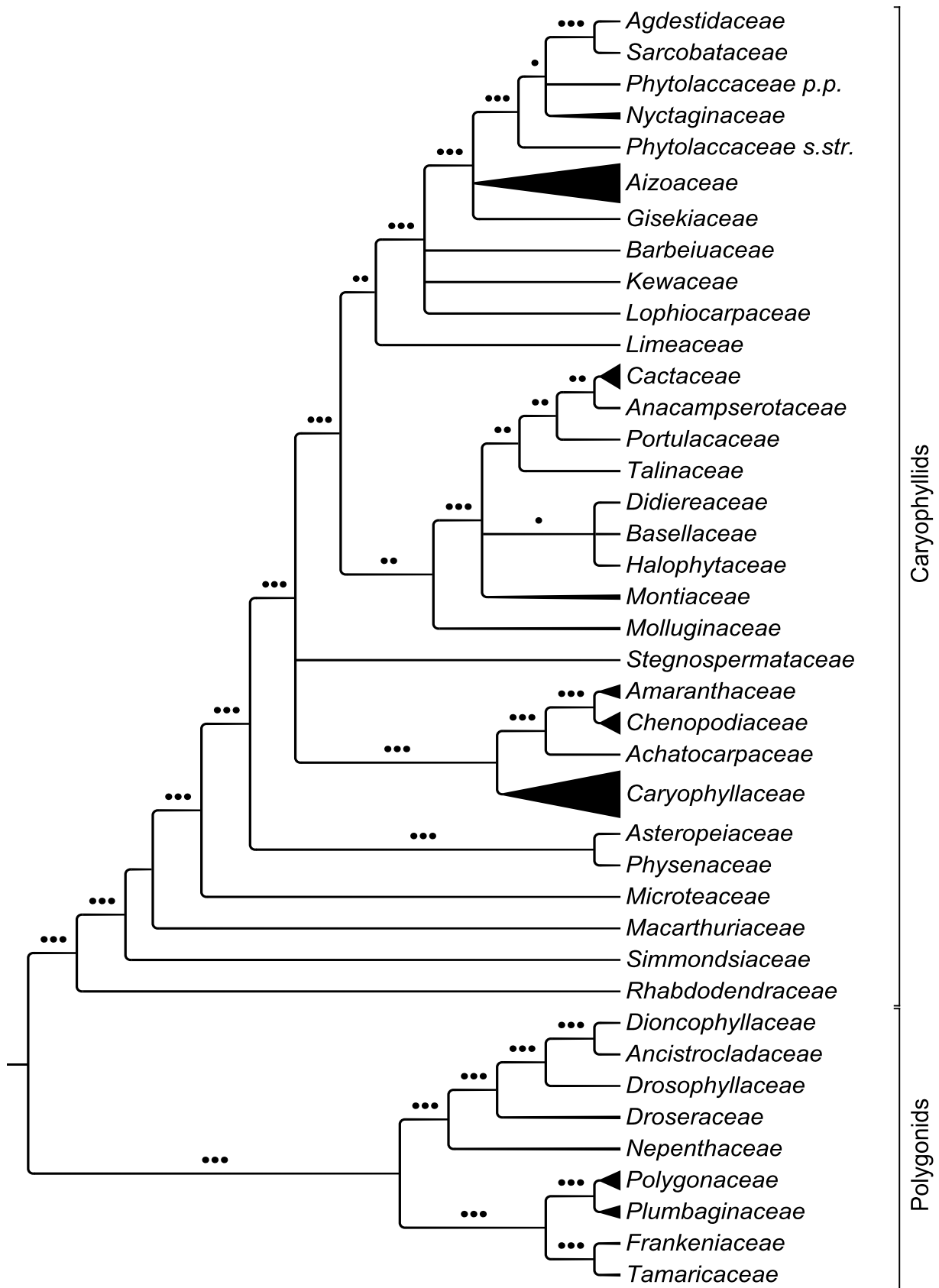


Fig. 1. Summary of the current knowledge on phylogenetic relationships in the *Caryophyllales*. Based on Cúenod & al. (2002), Brockington & al. (2009) and Schäferhoff & al. (2009). Branch widths shown as triangles indicate species richness in these clades. – ●●● = high support (95-100 BS/JK/PP), ●● = medium support (75-94 BS/JK/PP), ● = low support (50-74 BS/JK/PP).

Table 1. Circumscription of *Caryophyllales* in a phylogenetic context according to different authors. The names in bold represent changes in comparison to the previous concept. \* = not at family level in APG; \*\* = different concept from APG III (2009) and Stevens (2001 onwards).

<i>Centrospermae</i> (Rodman & al. 1984)	<i>Caryophyllidae</i> (Chase & al. 1993; Morton & al. 1997; Fay & al. 1997)	<b>Expanded <i>Caryophyllales</i></b> (APG 1998)	<b>Expanded <i>Caryophyllales</i></b> (Savolainen & al. 2000; Cuénoud & al. 2002; APG II 2003)	<b>Current <i>Caryophyllales</i></b> (Brockington & al. 2009; Schäferhoff & al. 2009; APG III 2009; Stevens 2001 onwards; Nyffeler & Eggli 2010a; Christin & al. 2011; Christenhusz & al. 2014)
		<b><i>Achatocarpaceae</i></b>	<i>Achatocarpaceae</i>	<i>Achatocarpaceae</i>
			<b><i>Agdestidaceae</i>*</b>	<i>Agdestidaceae</i> *
<i>Aizoaceae</i>	<i>Aizoaceae</i>	<i>Aizoaceae</i>	<i>Aizoaceae</i>	<i>Aizoaceae</i>
<i>Amaranthaceae</i>	<i>Amaranthaceae</i>	<i>Amaranthaceae</i>	<i>Amaranthaceae</i>	<i>Amaranthaceae</i> **
				<b><i>Anacampserotaceae</i></b>
	<b><i>Ancistrocladaceae</i></b>	<i>Ancistrocladaceae</i>	<i>Ancistrocladaceae</i>	<i>Ancistrocladaceae</i>
	<b><i>Asteropeiaceae</i></b>	<i>Asteropeiaceae</i>	<i>Asteropeiaceae</i>	<i>Asteropeiaceae</i>
			<b><i>Barbeuiaceae</i></b>	<i>Barbeuiaceae</i>
<i>Basellaceae</i>	<i>Basellaceae</i>	<i>Basellaceae</i>	<i>Basellaceae</i>	<i>Basellaceae</i>
<i>Cactaceae</i>	<i>Cactaceae</i>	<i>Cactaceae</i>	<i>Cactaceae</i>	<i>Cactaceae</i>
<i>Caryophyllaceae</i>	<i>Caryophyllaceae</i>	<i>Caryophyllaceae</i>	<i>Caryophyllaceae</i>	<i>Caryophyllaceae</i>
<i>Chenopodiaceae</i>	<i>Chenopodiaceae</i>	<i>Caryophyllaceae</i>	<i>Caryophyllaceae</i>	<i>Chenopodiaceae</i> **
<i>Didiereaceae</i>	<i>Didiereaceae</i>	<i>Didiereaceae</i>	<i>Didiereaceae</i>	<i>Didiereaceae</i>
	<b><i>Dioncophyllaceae</i></b>	<i>Dioncophyllaceae</i>	<i>Dioncophyllaceae</i>	<i>Dioncophyllaceae</i>
	<b><i>Droseraceae</i></b>	<i>Droseraceae</i>	<i>Droseraceae</i>	<i>Droseraceae</i>
	<b><i>Drosophyllaceae</i></b>	<i>Drosophyllaceae</i>	<i>Drosophyllaceae</i>	<i>Drosophyllaceae</i>
	<b><i>Frankeniaceae</i></b>	<i>Frankeniaceae</i>	<i>Frankeniaceae</i>	<i>Frankeniaceae</i>
			<b><i>Gisekiaceae</i></b>	<i>Gisekiaceae</i>
			<b><i>Halophytaceae</i></b>	<i>Halophytaceae</i>
				<b><i>Kewaceae</i></b>
				<b><i>Limeaceae</i></b>
				<b><i>Lophiocarpaceae</i></b>
				<b><i>Macarthuraceae</i></b>
				<b><i>Microteaceae</i></b>
<i>Molluginaceae</i>	<i>Molluginaceae</i>	<i>Molluginaceae</i>	<i>Molluginaceae</i>	<i>Molluginaceae</i>
				<b><i>Montiaceae</i></b>
	<b><i>Nepenthaceae</i></b>	<i>Nepenthaceae</i>	<i>Nepenthaceae</i>	<i>Nepenthaceae</i>
<i>Nyctaginaceae</i>	<i>Nyctaginaceae</i>	<i>Nyctaginaceae</i>	<i>Nyctaginaceae</i>	<i>Nyctaginaceae</i>
			<b><i>Petiveriaceae</i></b>	
	<b><i>Physenaceae</i></b>	<i>Physenaceae</i>	<i>Physenaceae</i>	<i>Physenaceae</i>
<i>Phytolaccaceae</i>	<i>Phytolaccaceae</i>	<i>Phytolaccaceae</i>	<i>Phytolaccaceae</i>	<i>Phytolaccaceae</i>
	<b><i>Plumbaginaceae</i></b>	<i>Plumbaginaceae</i>	<i>Plumbaginaceae</i>	<i>Plumbaginaceae</i>
	<b><i>Polygonaceae</i></b>	<i>Polygonaceae</i>	<i>Polygonaceae</i>	<i>Polygonaceae</i>
<i>Portulacaceae</i>	<i>Portulacaceae</i>	<i>Portulacaceae</i>	<i>Portulacaceae</i>	<i>Portulacaceae</i>
	<b><i>Rhabdodendraceae</i></b>	<i>Rhabdodendraceae</i>	<i>Rhabdodendraceae</i>	<i>Rhabdodendraceae</i>
		<b><i>Sarcobataceae</i></b>	<i>Sarcobataceae</i>	<i>Sarcobataceae</i>
	<b><i>Simmondsiaceae</i></b>	<i>Simmondsiaceae</i>	<i>Simmondsiaceae</i>	<i>Simmondsiaceae</i>
		<b><i>Stegnospermataceae</i></b>	<i>Stegnospermataceae</i>	<i>Stegnospermataceae</i>
				<b><i>Talinaceae</i></b>
	<b><i>Tamaricaceae</i></b>	<i>Tamaricaceae</i>	<i>Tamaricaceae</i>	<i>Tamaricaceae</i>

lies recognized by the APG III (2009) and Stevens (2001 onwards) but separates *Agdestidaceae* from *Phytolaccaceae* and *Chenopodiaceae* from *Amaranthaceae* and is updated by adding *Kewaceae* and *Macarthuraceae*. In APG III (2009) *Agdestis* was included within *Agdestidoideae* (*Phytolaccaceae*) although its position as sister of *Sarcobataceae* obtained by Cuénoud & al. (2002) and

Schäferhoff & al. (2009) supports the acceptance of the family described by Nakai (1942). APG III (2009) also recognized the *Sarcobataceae*. The *Amaranthaceae* are treated in a very wide sense in APG III (2009) including all *Chenopodiaceae*, merely reflecting that the two families form a monophyletic group (Cuénoud & al. 2002; Kadereit & al. 2003; Müller & Borsch 2005a), while the

Table 2. Comparison of the current treatment with the two volumes edited by Kubitzki & al. (1993) and Kubitzki & Bayer (2003) representing the so far most inclusive generic treatment of the *Caryophyllales*.

Family	No. of genera (Kubitzki & al. 1993; Kubitzki & Bayer 2003)	No. of genera (present publication)
<i>Achatocarpaceae</i>	2	2
<i>Agdestidaceae</i>	n.a.	1
<i>Aizoaceae</i>	127	125
<i>Amaranthaceae</i>	69	79
<i>Anacampserotaceae</i>	n.a.	3
<i>Ancistrocladaceae</i>	1	1
<i>Asteropeiaceae</i>	1	1
<i>Barbeuiaceae</i>	n.a.	1
<i>Basellaceae</i>	4	4
<i>Cactaceae</i>	98	139
<i>Caryophyllaceae</i>	87	101
<i>Chenopodiaceae</i>	98	104
<i>Didiereaceae</i>	4	6
<i>Dioncophyllaceae</i>	3	3
<i>Droseraceae</i>	3	3
<i>Drosophyllaceae</i>	1	1
<i>Frankeniaceae</i>	2	1
<i>Gisekiaceae</i>	n.a.	1
<i>Halophytaceae</i>	1	1
<i>Kewaceae</i>	n.a.	1
<i>Limeaceae</i>	n.a.	1
<i>Lophiocarpaceae</i>	n.a.	2
<i>Macarthuraceae</i>	n.a.	1
<i>Microteaceae</i>	n.a.	1
<i>Molluginaceae</i>	13	10
<i>Montiaceae</i>	n.a.	13
<i>Nepenthaceae</i>	1	1
<i>Nyctaginaceae</i>	31	31
<i>Physenaceae</i>	1	1
<i>Phytolaccaceae</i>	17	12
<i>Plumbaginaceae</i>	27	29
<i>Polygonaceae</i>	43	55
<i>Portulacaceae</i>	29	1
<i>Rhabdodendraceae</i>	1	1
<i>Sarcobataceae</i>	n.a.	1
<i>Simmondsiaceae</i>	1	1
<i>Stegnospermataceae</i>	1	1
<i>Talinaceae</i>	n.a.	3
<i>Tamaricaceae</i>	4	5
incertae sedis	5	1
<b>Total</b>	<b>675</b>	<b>749</b>

relationships of the major groups of *Chenopodiaceae* are still under debate. In this case, a merger resulting in a shift of family assignment for a major lineage of plants with many genera appearing in numerous studies in ecology, agriculture, and conservation had been promoted without robust phylogenetic data (see also respective family treatments).

For ease of recognition, we distinguish the two major *Caryophyllales* clades as caryophyllids and polygonids following Schäferhoff & al. (2009). The caryophyllids are the larger clade and include *Simmondsiaceae* and/

or *Rhabdodendraceae* along with the core *Caryophyllales* (= *Centrospermae*). The polygonids include the “carnivorous clade” with *Ancistrocladaceae*, *Dioncophyllaceae*, *Droseraceae*, *Drosophyllaceae* and *Nepenthaceae* plus the *Frankeniaceae* + *Tamaricaceae* and *Plumbaginaceae* + *Polygonaceae* subclades (Fig. 1).

### Rationale for a revised generic classification

More than twenty years have passed since the publication of the comprehensive treatment of the centrospermous families of *Caryophyllales* by several authors in “Families and genera of vascular plants” (Kubitzki & al. [eds.] 1993). There, 15 families are recognized in the order (*Achatocarpaceae*, *Aizoaceae*, *Amaranthaceae*, *Basellaceae*, *Cactaceae*, *Caryophyllaceae*, *Chenopodiaceae*, *Didiereaceae*, *Halophytaceae*, *Hectorellaceae*, *Molluginaceae*, *Nyctaginaceae*, *Phytolaccaceae*, *Portulacaceae* and *Stegnospermaceae* [= *Stegnospermataceae*]). Ten years later the treatment was completed with the publication by Kubitzki & Bayer (2003), where the concept of “expanded *Caryophyllales*” was adopted, by now also treating *Ancistrocladaceae*, *Asteropeiaceae*, *Dioncophyllaceae*, *Droseraceae*, *Drosophyllaceae*, *Frankenia-*

*ceae*, *Nepenthaceae*, *Physenaceae*, *Rhabdodendraceae*, *Simmondsiaceae*, and *Tamaricaceae*. In addition to the treatments of these families, Cuénoud (2003) discussed the circumscription of the expanded *Caryophyllales* including *Plumbaginaceae* and *Polygonaceae* previously considered as separate orders by Kubitzki (1993b) and Brandbyge (1993), respectively. The two volumes edited by Kubitzki & al. (1993) and Kubitzki & Bayer (2003) represented the most inclusive generic treatment of the *Caryophyllales* with 675 genera in 27 families. In addition, there are even more comprehensive family-wide



treatments including all genera and even species for the *Aizoaceae* (Hartmann & al. 2001a, b), *Basellaceae* (Eriksson 2007), *Cactaceae* (Hunt 2006) and *Portulacaceae* (Eggl 2002).

The amount of new data accumulated in the past two decades has considerably improved our understanding about the *Caryophyllales* and marks a major transition from a pre-phylogenetic to a largely phylogeny-based classification. Several molecular phylogenetic studies have evaluated the intrafamilial classifications adopted by various authors in Kubitzki & al. (1993), Hartmann & al. (2001a, b) and Hunt (2006), for example: *Aizoaceae* (Hassan & al. 2005; Klak & Bruyns 2012; Klak & al. 2003a, b, 2007, 2013; Bohley & al. 2015), *Amaranthaceae* (Kadereit & al. 2003; Müller & Borsch 2005a, b; Sánchez-del Pino & al. 2009; Masson & Kadereit 2013), *Cactaceae* (Arias & al. 2005; Butterworth 2006; Ritz & al. 2007, 2012; Butterworth & Edwards 2008; Griffith & Porter 2009; Ocampo & Columbus 2010; Korotkova & al. 2010, 2011; Bárcenas & al. 2011; Calvente & al. 2011a, b; Demaio & al. 2011; Hernández-Hernández & al. 2011; Majure & al. 2012; Franck & al. 2013a, b; Vázquez-Sánchez & al. 2013), *Caryophyllaceae* (Oxelmann & al. 2001; Fior & al. 2006; Harbaugh & al. 2010; Greenberg & Donoghue 2011), *Chenopodiaceae* (Kadereit & al. 2003, 2006a, b, 2010; Kapralov & al. 2006; Akhani & al. 2007; Zacharias & Baldwin 2010; Kadereit & Freitag 2011; Fuentes-Bazán & al. 2012a, b), *Didiereaceae* (Applequist & Wallace 2000), *Nyctaginaceae* (Levin 2000; Douglas & Manos 2007), *Plumbaginaceae* (Lledó & al. 1998, 2001, 2005), *Polygonaceae* (Sanchez & Kron 2008, 2009; Burke & al. 2010; Burke & Sanchez 2011; Sanchez & al. 2011; Schuster & al. 2011; Kempton 2012; Sun & Zhang 2012).

These and other molecular phylogenetic studies have resulted in the confirmation or rejection of monophyly in several taxa, and consequently in changes of their circumscription or status. Some of the re-established taxa are for example *Lymanbensonia*, *Nyctocereus* (*Cactaceae*, Korotkova & al. 2010, Arias & al. 2005, respectively); *Atocion*, *Eudianthe*, *Heliosperma* (= *Ixoca*), *Viscaria* (*Caryophyllaceae*, Oxelman & al. 2001); *Lipandra*, *Oxybasis* (*Chenopodiaceae*, Fuentes-Bazán & al. 2012b); and *Afrobrunnichia* (*Polygonaceae*, Sanchez & Kron 2009).

Taxa for which the circumscription had, or has, to be changed in order to accept them as monophyletic groups are for example: *Arenaria* (*Caryophyllaceae*, Harbaugh & al. 2010), *Atocion* (*Caryophyllaceae*, Frajman & al. 2009b), *Atraphaxis* (*Polygonaceae*, Schuster & al. 2011a, b), *Austrocylindropuntia* (*Cactaceae*, Ritz & al. 2012), *Bassia* (*Chenopodiaceae*, Kadereit & Freitag 2011), *Beta* (*Chenopodiaceae*, Kadereit & al. 2006b), *Brunnichia* (*Polygonaceae*, Sanchez & Kron 2009), *Chenopodium* (*Chenopodiaceae*, Fuentes-Bazán & al. 2012b), *Echinopsis* (*Cactaceae*, Schlumberger & Renner 2012), *Ferocactus* (*Cactaceae*, Vázquez-Sánchez

& al. 2013), *Grayia* (*Chenopodiaceae*, Zacharias & Baldwin 2010), *Hatiara* (*Cactaceae*, Korotkova & al. 2011), *Limoniastrum* (*Plumbaginaceae*, Lledó & Crespo 2000), *Lychnis* (*Caryophyllaceae*, Oxelman & al. 2001; Popp & al. 2008), *Mammillaria* (*Cactaceae*, Bárcenas & al. 2011; Hernández-Hernández & al. 2011), *Mesembryanthemum* (*Aizoaceae*, Klak & al. 2007), *Minuartia* (*Caryophyllaceae*, Dillenberger & Kadereit 2014), *Moehringia* (*Caryophyllaceae*, Fior & Karis 2007), *Opuntia* (*Cactaceae*, Majure 2012), *Pachycereus* (*Cactaceae*, Arias & Terrazas 2009), *Peniocereus* (*Cactaceae*, Arias & al. 2005), *Pfeiffera* (*Cactaceae*, Korotkova & al. 2010), *Polycarpon* (*Caryophyllaceae*, Kool & al. 2007), *Silene* (*Caryophyllaceae*, Oxelman & al. 2001), *Suaeda* (*Chenopodiaceae*, Schütze & al. 2003), and *Viscaria* (*Caryophyllaceae*, Frajman & al. 2009b).

In addition, molecular phylogenies also have resulted in the identification and description of new taxa at all levels, for example: *Anacampserotaceae* (Nyffeler & Eggl 2010a); *Microteaceae* (Schäferhoff & al. 2009); *Didiereoideae*, *Portulacarioideae* (*Didiereaceae*, Applequist & Wallace 2003); *Blossfeldieae* (*Cactaceae*, Butterworth 2006); *Caribeeae* (*Nyctaginaceae*, Douglas & Spellenberg 2010); *Eremogoneae* (*Caryophyllaceae*, Harbaugh & al. 2010); *Gymnopodieae*, *Leptogoneae* (*Polygonaceae*, Burke & Sanchez 2011); *Chenopodiastrium* (*Chenopodiaceae*, Fuentes-Bazán & al. 2012b); and *Surreya* (*Amaranthaceae*, Masson & Kadereit 2013).

The new data also demonstrate that developing a classification system for the order is a dynamic process. An updated backbone at the generic level serves to present the current state of knowledge. We believe that this is an important step because many projects or researchers are specifically dealing with certain genera. Building upon a generic-level backbone will increase the efficiency of implementing the next steps towards a synopsis at species level. For example, Oxelman & al. (2013) keep a dynamically updated classification of *Sileneae* online. The long-term aim is to provide a portal where taxonomic, chorologic, nomenclatural, and phylogenetic information can be retrieved, along with literature, DNA sequences and images. This resource can be a valuable subproject for infrageneric and species-level taxonomy, and also for various other biological research projects where there is a strong need for a solid taxonomy based on phylogenetic relationships in *Sileneae* (e.g. Bernasconi & al. 2009). Such initiatives will be strongly supported by the *Caryophyllales* network, also by providing a sustained informatics infrastructure and a joint concept for future monographic work (Borsch & al. 2015). The published treatment of the genera of *Caryophyllales*, produced directly from an EDIT-Platform database, will provide a stepping stone for further refinement, also to encourage further research and participation in the network. Members of the *Caryophyllales* network will be able to correct and add to the information presented as it



Fig. 2. A: *Achatocarpaceae*: *Phaulothamnus spinescens* A. Gray, U.S.A., Texas, 22 Aug 2001, *Borsch & al. 3446* (B, ISC), photo by T. Borsch. – B–D: *Aizoaceae*: B: *Tetragonia decumbens* Mill., South Africa, Cape Town, Muizenberg, 1 Mar 2015, photo by P. Bruyns. – C: *Cheiridopsis robusta* N. E. Br., South Africa, Richtersveld, north of Port Nolloth, Sep 1991, photo by W. Barthlott. – D: *Braunsia apiculata* (Kensit) L. Bolus, South Africa, Witteberg, 6 Aug 2013, photo by P. Bruyns. – E & F: *Amaranthaceae*: E: *Gomphrena haenkeana* Mart., Bolivia, Santa Cruz, 6 Apr 2003, *Borsch & Ortuño 3627* (B, LPB), photo by T. Borsch. – F: *Pleuropetalum sprucei* (Hook. f.) Standl., Germany, Botanischer Garten Berlin, photo by T. Borsch.



Fig. 3. A: *Amaranthaceae*: *Tidestromia lanuginosa* (Nutt.) Standl., U.S.A., Texas, Borsch & al. 3439 (B, ISC, MEXU), photo by T. Borsch. – B–D: *Cactaceae*: B: *Carnegiea gigantea* (Engelm.) Britton & Rose, U.S.A., Arizona, Organ Pipe Cactus National Monument, 11 Apr 1992, photo by W. Barthlott. – C: *Opuntia ficus-indica* (L.) Mill., Spain, Canarias, Tenerife, near Orotava, Feb 1989, photo by W. Barthlott. – D: *Pereskia aculeata* Mill., Monaco, Jardin Exotique de Monaco, Jun 1998, photo by W. Barthlott. – E–G: *Caryophyllaceae*: E: *Arenaria cretica* Spreng., Greece, Mt Olimbos, 29 Jul 2005, photo by N. Turland. – F: *Bolanthus creutzburgii* subsp. *zaffranii* Phitos & al., Greece, Kriti, Paleochoira, 31 Mar 2009, Turland & al. 1841 (MO, PAL, UPA), photo by N. Turland. – G: *Silene virginica* L., U.S.A., Tennessee, Great Smoky Mountains National Park, 25 Jun 2012, photo by N. Turland.



Fig. 4. A: *Caryophyllaceae*: *Dianthus androsaceus* (Boiss. & Heldr.) Hayek, Greece, Mt Taigetos, 14 Jul 2007, photo by N. Turland. – B–D: *Chenopodiaceae*: B: *Allenrolfea occidentalis* (S. Watson) Kuntze, U.S.A., Texas, 23 Aug 2001, Borsch & al. 3447 (B, ISC), photo by T. Borsch. – C: *Chenopodium quinoa* Willd., Bolivia, Departamento de La Paz, Altiplano, 2010, photo by T. Borsch. – D: *Chenopodium vulvaria* L., Germany, Botanischer Garten der Universität Mainz, Aug 2015, photo by G. Kadereit. – E & F: *Didieriaceae*: E: *Alluaudia ascendens* (Drake) Drake, Germany, Botanische Gärten der Universität Bonn, 2010, photo by N. Korotkova. – F: *Portulacaria namaquensis* Sond., Namibia, W of Aussenkehr, 5 Jul 2013, photo by P. Bruyns. – G: *Dioncophyllaceae*: *Triphyophyllum peltatum* (Hutch. & Dalziel) Airy Shaw, Côte d'Ivoire, Parc National de Tai, north of Mt Niénokoué, 1998, photo by W. Barthlott.



Fig. 5. A & B: *Droseraceae*: A: *Drosera cistiflora* L., Germany, Botanische Gärten der Universität Bonn, Jan 2001, photo by W. Barthlott. – B: *Drosera cuneifolia* L. f., South Africa, Cape Town, Table Mountain, 6 Jan 2008, photo by N. Turland. – C: *Halophytaceae*: *Halophytum ameghinoi* (Speg.) Speg., ex Sukkulente-Sammlung Zürich, photo by T. Borsch. – D: *Montiaceae*: *Claytonia virginica* L., U.S.A., Missouri, Rockpile Mountain Wilderness, 10 Apr 2010, photo by N. Turland. – E–G: *Nyctaginaceae*: E: *Bougainvillea spectabilis* Willd., Germany, Botanische Gärten der Universität Bonn, Oct 1990, photo by W. Barthlott. – F: *Guapira rufescens* (Heimerl) Lundell, Cuba, Holguín, 1 Mar 2010, *Borsch & al.* 4273 (B, HAJB), photo by T. Borsch. – G: *Pisonia aculeata* L., Cuba, Holguín, 27 Feb 2010, *Borsch & al.* 4229 (B, HAJB), photo by T. Borsch.



Fig. 6. A & B: *Phytolaccaceae*: A: *Rivina humilis* L., Germany, Botanische Gärten der Universität Bonn, Borsch 3542 (BONN), photo by T. Borsch. – B: *Trichostigma octandrum* (L.) H. Walter, Cuba, Villa Clara, 1 Mar 2012, Borsch & al. 5265 (B, HAJB), photo by T. Borsch. – C & D: *Plumbaginaceae*: C: *Acantholimon androsaceum* (Jaub. & Spach) Boiss., Greece, Kriti, Lefka Ori, 13 Jul 2006, photo by N. Turland. – D: *Armeria maritima* (Mill.) Willd. subsp. *maritima*, U.K., Devon, Foreland Point, 20 May 2008, photo by N. Turland. – E–G: *Polygonaceae*: E: *Coccoloba shaferi* Britton, Cuba, Holguín, 1 Mar 2010, Borsch & al. 4270 (B, HAJB) photo by T. Borsch. – F: *Coccoloba uvifera* (L.) L., Cuba, Holguín, 1 Mar 2010, photo by T. Borsch. – G: *Triplaris americana* L., Peru, San Martín, Río Huallaga, 27 Jun 2009, photo by A. Sanchez.



Fig. 7. A: *Sarcobataceae*: *Sarcobatus vermiculatus* (Hook.) Torr., Germany, Botanischer Garten Berlin, 29 Aug 2015, photo by N. Turland. – B: *Tamaricaceae*: *Tamarix ramosissima* Ledeb., Azerbaijan, *Borsch & al. 5461* (B, BAK), photo by T. Borsch.

is databased. Once published, the continuously updated dynamic treatment will also be available as a freely accessible online data portal (<http://caryophyllales.org/>).

## Revised generic classification of *Caryophyllales*

### Methodology and content

The names of genera listed follows the rules of nomenclature (McNeill & al. 2012) and the family assignments adhere to APG III (2009) and Stevens (2001 onwards), if not noted otherwise. Notes are added to many genera providing information about the current state of knowledge in terms of monophyly or phylogenetic relationships. The data management is effected by means of the EDIT Platform for Cybertaxonomy software suite (Berendsohn 2010; Berendsohn & al. 2011). In a first step, data from Names in Current Use 3 (Greuter & al. 1993) were imported. Additions and corrections were then incorporated particularly from Bittrich 1993b–d; Bittrich & Kühn 1993; Brandbyge 1993; Carolin 1993; Endress & Bittrich 1993; Kubitzki 1993a, b; Kühn 1993; Rohwer 1993; Sperling & Bittrich 1993; Townsend 1993; Dickison 2003; Gaskin 2003; Kubitzki 2003a–e; Porembski 2003; Porembski & Barthlott 2003; Prance 2003, and for *Aizoaceae* and *Cactaceae*, corrections were incorporated from Hartmann (2001a, b) and Hunt (2006) respectively; if not noted otherwise. Data cited include the

generic name, its author citation and its nomenclatural reference, the name of the type species, selected synonyms (including all names listed in NCU-3; Greuter & al. 1993), and later publications with their respective nomenclatural data.

Author names are abbreviated in conformity with Brummitt & Powell (1992) and its updates online; titles of serials in the nomenclatural reference citations are abbreviated in conformity with Bridson & al. (2004) and the titles of monographs are abbreviated in conformity with Stafleu & Cowan (1976–1988) and their successors, except that all components start with capital letters.

The name of the type species follows NCU-3 (Greuter & al. 1993); for genera not treated there, the names were obtained from reviewing protologues, Index Nominum Genericorum (ING; Farr & Zijlstra 1996+), Tropicos (undated), or The International Plant Names Index (IPNI 2004+). To denote the taxon concept followed in the present publication, a “sec.” (secundum, following, according to; Stearn 1992) reference is given (see, e.g., Berendsohn 1997; Franz & Cardona-Duque 2013). This is a bibliographic citation of a (recent) paper or work giving the circumscription of the taxon (by means of a description, synonymy and/or details of the relationship to other taxa). In some cases, this is further discussed in a note, particularly with reference to the authors mentioned in the previous paragraph and later publications. The text of the following section, Classification, consists of direct output from the EDIT-Platform database.

## Classification

The families and genera are listed in alphabetical order, with a single incertae sedis genus at the very end of the list. Each accepted name is given in bold and includes the standardized information mentioned above. The homotypic and heterotypic synonyms are listed according to the conventions in *Willdenowia*. Many names are followed by notes as mentioned above.

### **Achatocarpaceae** Heimerl sec. APG (2009).

A small family comprising two genera and 16 species occurring in tropical America, from southeastern United States to South America (Medina 2009). Traditionally, the family has been included in *Phytolaccaceae* s.l., but its position as an independent lineage has been well supported by several molecular phylogenetic studies (Hilu & al. 2003; Schäferhoff & al. 2009; Brockington & al. 2009, 2011), which also showed that the family is more closely related to the *Amaranthaceae/Chenopodiaceae* clade rather than to *Phytolaccaceae*. *Achatocarpaceae* are characterized by having unisexual flowers, the gynoeceum with two connate carpels, unilocular ovaries with two styles and a single ovule, berrylike fruits and pollen with obscure pores (Martínez-García 1985; Lipscomb 2003).

**Achatocarpus** Triana in Ann. Sci. Nat., Bot., ser. 4, 9: 45. 1858 sec. Bittrich (1993b). – Type: *Achatocarpus nigricans* Triana

**Phaulothamnus** A. Gray in Proc. Amer. Acad. Arts 20: 293. 1885 sec. Bittrich (1993b). – Type: *Phaulothamnus spinescens* A. Gray – Fig. 2A.

### **Agdestidaceae** Nakai sec. Cuénoud & al. (2002).

A monotypic family distributed from southern United States to Nicaragua (Rohwer 1993a), introduced and naturalized in Florida and the Antilles and cultivated as ornamentals in South America (Rzedowski & Calderón 2000). Traditionally, *Agdestis* was placed in *Phytolaccaceae*, subfamily *Agdestioideae* (e.g. Rohwer 1993a; Stevens 2001 onwards; Nienaber & Thieret 2003), but several molecular phylogenetic studies have shown that it represents a well-supported independent lineage (Cuénoud & al. 2002; Hilu & al. 2003; Schäferhoff & al. 2009). These studies also showed a close but only moderately supported relationship of the family with *Sarcobataceae*. *Agdestidaceae* are climbers and characterized by paniculate inflorescences, semi-inferior ovaries and cypselas crowned by winglike sepals (Nienaber & Thieret 2003).

**Agdestis** Moc. & Sessé ex DC., Syst. Nat. 1: 511, 543. 1817 sec. Rohwer (1993a). – Type: *Agdestis clematidea* Moc. & Sessé ex DC.

Monotypic; southern United States, Mexico, and Central America.

### **Aizoaceae** Martinov sec. APG (2009).

The *Aizoaceae* have a worldwide distribution throughout the tropics and subtropics (Hartmann 2001a, b).

However, the centres of diversity are in the south-western part of Africa (Bittrich 1986; Jürgens 1986; Hartmann 1991). Relatively few genera occur outside of southern Africa, mainly those from subfamilies *Aizoioideae*, *Sesuvioideae* and *Tetragonioideae*. In contrast, *Mesembryanthemoideae* and *Ruschioideae* are largely restricted to southern Africa with few species found outside of this area (e.g. *Mesembryanthemum crystallinum* L., *M. nodiflorum* L. and *Carpobrotus*, *Delosperma*, *Disphyma* and *Sarcozona* species) (Hartmann 2001a, b). The family consists predominantly of succulent (mostly leaf succulent), annual to perennial herbs, subshrubs or shrubs, with undifferentiated perianth or biseriate with petals of staminodial origin, with mostly hygrochastic loculicidal fruits.

**Acrodon** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001a). – Type: *Acrodon bellidiflorus* (L.) N. E. Br.

**Acrosanthes** Eckl. & Zeyh. in Enum. Pl. Afric. Austral. [Ecklon & Zeyher]: 328. 1837 sec. Hartmann (2001a). – Type: *Acrosanthes anceps* Sond.

= *Aizoon* subg. *Acrosanthes* (Eckl. & Zeyh.) D. Dietr., Syn. Pl. 3: 130. 1842.

= *Didaste* E. Mey. ex Harv. & Sond., Fl. Cap. 2: 472. 1862, nom. nud.

**Aizoanthemum** Dinter ex Friedrich in Mitt. Bot. Staatssamml. München 2: 343. 1957 sec. Hartmann (2001a). – Type: *Aizoanthemum membrum-connectens* Dinter ex Friedrich

**Aizoon** L., Sp. Pl. 1: 488. 1753 sec. Hartmann (2001a) = *Veslingia* Heist. ex Fabr., Enum.: 201. 1759. – Type: *Aizoon canariense* L.

**Aloinopsis** Schwantes in Z. Sukkulente. 2: 177. 1926 sec. Hartmann (2001a) = *Acaulon* N. E. Br. in J. Bot. 66: 76. 1928 = *Aistocaulon* Poelln. ex H. Jacobsen, Succ. Pl.: 123. 1935. – Type: *Aloinopsis aloides* (Haw.) Schwantes

The *Aloinopsis* clade includes several small genera (ranging from one to six species), i.e. *Aloinopsis*, *Deilanthe*, *Nananthus*, *Pleiospilos*, *Prepodesma*, *Rabiea* and *Tanquana* (Klak & al. 2013). The group is found outside the winter-rainfall region of South Africa. The status and generic placement of numerous species in this group has been subject to many changes. For example, the monotypic *Prepodesma* has been included in five different genera by different taxonomic treatments. *Aloinopsis*, *Nananthus* and *Rabiea* are particularly poorly known in terms of species delimitation.

**Amphibolia** L. Bolus in J. S. African Bot. 31: 169. 1965 sec. Hartmann (2001a). – Type: *Amphibolia maritima* L. Bolus

**Antegibbaeum** Schwantes ex C. Weber in Bailey 16: 10. 1968 sec. Hartmann (2001a). – Type: *Antegibbaeum fissoides* (Haw.) C. Weber

A monotypic genus, which is endemic to the Little Karoo, South Africa. The placement of this genus as



- sister to *Cylindrophyllum* remains statistically poorly supported (Klak & al. 2013).
- Antimima** N. E. Br. in Gard. Chron., ser. 3, 87: 211. 1930 sec. Hartmann (2001a). – Type: *Antimima dualis* (N. E. Br.) N. E. Br.  
A large genus of 96 species, which has never been revised. Most species were previously placed in *Ruschia*, but separated from the latter based on fruit characters. Hartmann (2001a) recognized five subgenera within *Antimima*, but did not indicate which species belong to which subgenus. The molecular study by Klak & al. (2013) suggests that *Antimima* is not monophyletic in its current circumscription. A detailed morphological and molecular study is needed to establish generic boundaries within the *Antimima* clade, in which several other smaller genera such as *Braunsia*, *Hammeria*, *Smicrostigma* and *Zeuktophyllum* take part (Klak & al. 2013).
- Apatesia** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001a). – Type: *Apatesia pillansii* N. E. Br.
- Arenifera** A. G. J. Herre in Sukkulenten. 2: 35. 1948 sec. Hartmann (2001a). – Type: *Arenifera pillansii* (L. Bolus) A. G. J. Herre  
There are four species included in *Arenifera* (Hartmann 2001a). Since this group was not sampled by Klak & al. (2013), its phylogenetic position within the tribe *Ruschieae* remains uncertain.
- Argyroderma** N. E. Br. in Gard. Chron., ser. 3, 71: 92. 1922 sec. Hartmann (2001a). – Type: *Argyroderma testiculare* (Aiton) N. E. Br.  
= *Roodia* N. E. Br. in Fl. Pl. South Africa 2: 78. 1922.
- Astridia** Dinter in Gard. Chron., ser. 3, 80: 430. 1926 sec. Hartmann (2001a). – Type: *Astridia velutina* Dinter
- Bergeranthus** Schwantes in Z. Sukkulenten. 2: 179. 1926 sec. Hartmann (2001a). – Type: *Bergeranthus scapigerus* (Haw.) Schwantes
- Bijlia** N. E. Br. in J. Bot. 66: 267. 1928 sec. Hartmann (2001a). – Type: *Bijlia cana* (Haw.) N. E. Br.  
= *Bolusanthemum* Schwantes in Gartenwelt 32: 514. 1928.
- Braunsia** Schwantes in Gartenwelt 32: 644. 1928 sec. Hartmann (2001a). – Type: *Braunsia nelii* Schwantes – Fig. 2D.  
= *Echinus* L. Bolus in Fl. Pl. South Africa 7: 266. 1927, nom. illeg.
- Brianhuntleya** Chesselet, S. A. Hammer & I. Oliver in Bothalia 33: 161. 2003 sec. Chesselet & al. (2003). – Type: *Brianhuntleya intrusa* (Kensit) Chesselet, S. A. Hammer & I. Oliver  
A monotypic genus, from the Worcester-Robertson Karoo (South Africa). Its sister relationship to *Bijlia* (two species) remains poorly supported (Klak & al. 2013).
- Calamophyllum** Schwantes in Z. Sukkulenten. 3: 15, 28. 1927 sec. Hartmann (2001a). – Type: *Calamophyllum teretifolium* (Haw.) Schwantes  
A mysterious genus including three species. These were described by Haworth between 1795 and 1812. However, for two of the names no types have been selected yet, whereas for the third a drawing by Duncanson serves as a lectotype (Hartmann 2001a). The distribution of the genus is uncertain.
- Carpanthea** N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925 sec. Hartmann (2001a). – Type: *Carpanthea pomeridiana* (L.) N. E. Br.  
= *Macrocaulon* N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927.
- Carpobrotus** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a) = *Abryanthemum* Neck., Elem. Bot. 2: 82. 1790, nom. inval. – Type: *Carpobrotus edulis* (L.) L. Bolus
- Carruanthus** (Schwantes) Schwantes in Z. Sukkulenten. 3: 106. 1927 sec. Hartmann (2001a) = *Bergeranthus* subg. *Carruanthus* Schwantes in Z. Sukkulenten. 2: 180. 1926. – Type: *Carruanthus caninus* (Lam.) Schwantes  
= *Tischleria* Schwantes in Sukkulenten. 4: 78. 1951.
- Cephalophyllum** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Cephalophyllum tricolorum* (Haw.) N. E. Br.
- Cerochlamys** N. E. Br. in J. Bot. 66: 171. 1928 sec. Hartmann (2001a). – Type: *Cerochlamys trigona* N. E. Br.
- Chasmatophyllum** Dinter & Schwantes in Z. Sukkulenten. 3: 14, 17. 1927 sec. Hartmann (2001a). – Type: *Chasmatophyllum musculinum* (Haw.) Dinter & Schwantes
- Cheiridopsis** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Cheiridopsis tuberculata* (Mill.) N. E. Br. – Fig. 2C.  
*Cheiridopsis* was found to be closely related to *Ihlenfeldtia* and *Odontophorus* (Klak & al. 2013). In addition, one of the three subgenera of *Cheiridopsis*, *C.* subg. *Odontophoroides*, could be more closely related to *Odontophorus* than to the remainder of *Cheiridopsis* (Hartmann 2001b). Although *Cheiridopsis* and *Odontophorus* were revised at species level (Hartmann 1976; Hartmann & Dehn 1987), their generic limits need to be reinvestigated.
- Circandra** N. E. Br. in Gard. Chron., ser. 3, 87: 126. 1930 sec. Hartmann (2001a). – Type: *Circandra serrata* (L.) N. E. Br.  
A monotypic genus; its only species was already known to Linnaeus as *Mesembryanthemum serratum* L. The area where it was previously recorded has been subject to extensive cultivation, so the species had been thought to be extinct. However, it was rediscovered in 2007 and is currently considered as critically endangered (Klak & Low 2007). The hypanthium found in the flowers suggests a close relationship with *Erepsia*, where this species had been included previously (as *E. serrata* (L.) L. Bolus).
- Cleretum** N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925 sec. Klak & Bruyns (2012). – Type: *Cleretum papulosum* (L. f.) L. Bolus

- = *Dorotheanthus* Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 283. 1927.
- = *Aethephyllum* N. E. Br. in Möller's Deutsche Gärtn.-Zeitung 43: 400. 1928.
- = *Pherolobus* N. E. Br. in Möller's Deutsche Gärtn.-Zeitung 43: 400. 1928.
- = *Sineoperculum* Van Jaarsv. in J. S. African Bot. 48: 5. 1982.
- Conicosia** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Conicosia pugioniformis* (L.) N. E. Br.
- = *Herrea* Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 436. 1927.
- Conophytum** N. E. Br. in Gard. Chron., ser. 3, 71: 19. 1922 sec. Hammer (2001). – Type: *Conophytum minutum* (Haw.) N. E. Br.
- = *Derenbergia* Schwantes in Z. Sukkulantenk. 2: 137. 1925.
- = *Ophthalmophyllum* Dinter & Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 64. 1927.
- = *Herreanthus* Schwantes in Gartenwelt 32: 514. 1928.
- = *Berresfordia* L. Bolus, Notes Mesembryanthemum 2: 313. 1930.
- Corpuscularia** Schwantes in Z. Sukkulantenk. 2: 185. 1926 sec. Hartmann (2001a) ≡ *Schonlandia* L. Bolus in Fl. Pl. South Africa 7: 259. 1927. – Type: *Corpuscularia lehmannii* (Eckl. & Zeyh.) Schwantes  
The genus includes eight species and is endemic to the Eastern Cape, South Africa. Its phylogenetic position near *Delosperma* has been confirmed (Klak & al. 2013), but the genus lacks a taxonomic revision.
- Cylindrophyllum** Schwantes in Z. Sukkulantenk. 3: 15, 28. 1927 sec. Hartmann (2001a). – Type: *Cylindrophyllum calamiforme* (L.) Schwantes  
*Cylindrophyllum* includes five species (Hartmann 2001a), but lacks a taxonomic revision.
- Cypselea** Turpin in Ann. Mus. Natl. Hist. Nat. 7: 219. 1806 sec. Hartmann (2001a) ≡ *Radiana* Raf., Specchio Sci. 1: 88. 1814. – Type: *Cypselea humifusa* Turpin
- = *Millegrana* Juss. ex Turpin in Ann. Mus. Natl. Hist. Nat. 7: 220. 1806, nom. nud.  
*Cypselea* includes three species (Hartmann 2011a) and is nested within *Sesuvium* (Bohley & al. 2015; Hassan & al. 2005; Thulin & al. 2012). Two of the species are endemic to Paraguay and Cuba, respectively (Hartmann 2011a).
- Deilanthe** N. E. Br. in Gard. Chron., ser. 3, 88: 278. 1930 sec. Hartmann (2001a). – Type: *Deilanthe peersii* (L. Bolus) N. E. Br.
- Delosperma** N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925 sec. Hartmann (2001a). – Type: *Delosperma echinatum* (Lam.) Schwantes  
A large genus of 142 species, which has never been revised. The study by Klak & al. (2013) suggests that *Delosperma* is not monophyletic in its current circumscription. A detailed morphological and molecular study is needed to establish generic boundaries within the *Delosperma* clade, in which several other smaller genera, including *Corpuscularia*, *Ectotropis*, *Frithia*, *Mestoklema* and *Trichidiadema* take part (Klak & al. 2013).
- Dicrocaulon** N. E. Br. in J. Bot. 66: 141. 1928 sec. Ihlenfeldt (2001a). – Type: *Dicrocaulon pearsonii* N. E. Br.
- Didymaotus** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Didymaotus lapidiformis* (Marloth) N. E. Br.  
The phylogenetic position of this monotypic genus remains largely unresolved (Klak & al. 2013).
- Dinteranthus** Schwantes in Z. Sukkulantenk. 2: 184. 1926 sec. Hartmann (2001a). – Type: *Dinteranthus microspermus* (Dinter & Derenb.) Schwantes
- Diplosoma** Schwantes in Z. Sukkulantenk. 2: 179. 1926 sec. Ihlenfeldt (2001b). – Type: *Diplosoma retroversum* (Kensit) Schwantes
- = *Maughania* N. E. Br. in J. Cact. Succ. Soc. Amer. 2: 389. 1931.
- = *Maughaniella* L. Bolus in J. S. African Bot. 28: 264. 1962.
- Disphyma** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Disphyma crassifolium* (L.) L. Bolus
- Dracophilus** Dinter & Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 187. 1927 sec. Hartmann (2001a) ≡ *Juttadinteria* subg. *Dracophilus* Schwantes in Z. Sukkulantenk. 2: 183. 1926. – Type: *Dracophilus delaetianus* (Dinter) Dinter & Schwantes
- Drosanthemum** Schwantes in Z. Sukkulantenk. 3: 14, 29. 1927 sec. Hartmann (2001a). – Type: *Drosanthemum hispidum* (L.) Schwantes  
A large genus of 107 species, which has only partly been revised. With the exception of few misplaced species, the genus is thought to be monophyletic (Klak & al. 2003b; Klak & al. 2013). Hartmann (2007) recognized eight subgenera in *Drosanthemum* and also provided a key to the subgenera with a list of species included for each of them. Although also distribution maps were included for all eight subgenera, no vouchers were cited (Hartmann 2007), so that it remains uncertain on which material the maps were based. In addition, only one of the eight subgenera has so far been revised in part (Hartmann 2008). Since many species are threatened by agriculture or urban expansion, the genus is in urgent need of revision.
- Eberlanzia** Schwantes in Z. Sukkulantenk. 2: 189. 1926 sec. Hartmann (2001a). – Type: *Eberlanzia clausa* (Dinter) Schwantes  
*Eberlanzia* includes eight species (Hartmann 2001a). However, the two species sampled by Klak & al. (2013) do not group together, suggesting that the genus is not monophyletic in its current circumscription.
- Ebracteola** Dinter & Schwantes in Z. Sukkulantenk. 3: 15, 24. 1927 sec. Hartmann (2001a). – Type: *Ebracteola montis-moltkei* (Dinter) Dinter & Schwantes

- Ectotropis** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001a). – Type: *Ectotropis alpina* N. E. Br.
- Enarganthe** N. E. Br. in Gard. Chron., ser. 3, 87: 71. 1930 sec. Hartmann (2001a). – Type: *Enarganthe octonaria* (L. Bolus) N. E. Br.  
A monotypic genus, which is endemic to Namaqualand. Relationships to other members in the *Conophytum* clade remain uncertain.
- Erepsia** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001a). – Type: *Erepsia inclaudens* (Haw.) Schwantes  
= *Piquetia* N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925, nom. illeg.  
= *Semnanthe* N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927.  
= *Kensitia* Fedde in Repert. Spec. Nov. Regni Veg. 48: 11. 1940.
- Esterhuysenia** L. Bolus in S. African J. Bot. 33: 308. 1967 sec. Hartmann (2001a). – Type: *Esterhuysenia alpina* L. Bolus  
A small genus with five species endemic to the Cape region of South Africa. See further notes under *Hammeria*.
- Faucaria** Schwantes in Z. Sukkulantenk. 2: 176. 1926 sec. Groen & Hartmann (2001). – Type: *Faucaria tigrina* (Haw.) Schwantes
- Fenestraria** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001b). – Type: *Fenestraria aurantiaca* N. E. Br.  
A monotypic genus from Namaqualand. See further notes under *Cephalophyllum*.
- Frithia** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001b). – Type: *Frithia pulchra* N. E. Br.  
This bitypic genus was found to be closely related to *Delosperma* (Klak & al. 2013). See further remarks under *Delosperma*.
- Galenia** L., Sp. Pl. 1: 359. 1753 sec. Hartmann (2001b). – Type: *Galenia africana* L.  
= *Kolleria* C. Presl., Symb. Bot. 1: 23. 1831.  
= *Sialodes* Eckl. & Zeyh., Enum. Pl. Afric. Austral. 3: 329. 1837.  
= *Tephros* E. Mey. ex Harv. & Sond., Fl. Cap. 2: 477. 1862.
- Gibbaeum** Haw. ex N. E. Br. in Gard. Chron., ser. 3, 71: 129. 1922 sec. Hartmann (2001b). – Type: *Gibbaeum pubescens* (Haw.) N. E. Br.  
= *Rimaria* N. E. Br. in Gard. Chron., ser. 3, 78: 413. 1925.  
= *Argeta* N. E. Br. in Gard. Chron., ser. 3, 82: 113. 1927.  
= *Imitaria* N. E. Br. in J. Bot. 65: 348. 1927.  
= *Mentocalyx* N. E. Br. in Gard. Chron., ser. 3, 81: 251. 1927.  
= *Muiria* N. E. Br. in Gard. Chron., ser. 3, 81: 116. 1927.  
The monotypic *Muiria* was placed in *Gibbaeum*, as *G. hortenseae* (N. E. Br.) Thiede & Klak, sec. Goldblatt & Manning (2000). The species was confirmed to be closely related to *Gibbaeum*, but its relationship to other species in the genus remains unresolved (Klak & al. 2013).
- Glottiphyllum** Haw. ex N. E. Br. in Gard. Chron., ser. 3, 70: 311. 1921 sec. Hartmann (2001b). – Type: *Glottiphyllum linguiforme* (L.) N. E. Br.
- Gunniopsis** Pax, Nat. Pflanzenfam. 3(1b): 44. 1889 sec. Hartmann (2001b) ≡ *Aizoon* subg. *Gunniopsis* Pax & K. Hoffm. in J. S. African Bot. Soc. 25: 30. 1959. – Type: *Gunniopsis quadrifaria* Pax  
= *Gunnia* F. Muell., Rep. Pl. Babbage's Exped.: 9. 1859, nom. illeg.  
= *Neogunnia* Pax & K. Hoffm., Nat. Pflanzenfam. (ed. 2) 16c: 225. 1934.  
The genus is endemic to Australia.
- Hallianthus** H. E. K. Hartmann in Bot. Jahrb. Syst. 114: 167. 1992 sec. Hartmann (2001b). – Type: *Hallianthus planus* (L. Bolus) H. E. K. Hartmann
- Hammeria** Burgoyne in Cact. Succ. J. (Los Angeles) 70(4): 204. 1998 sec. Hartmann (2001b). – Type: *Hammeria salteri* (L. Bolus) Burgoyne  
A small genus consisting of only three species. The two species included in the molecular study by Klak & al. (2013) were not resolved as sisters. However, they were shown to group with other small genera such as *Braunsia* and *Esterhuysenia* in the *Antimima* clade (Klak & al. 2013).
- Hartmanthus** S. A. Hammer in Haseltonia 3: 79. 1995 sec. Hartmann (2001b). – Type: *Hartmanthus pergamentaceus* (L. Bolus) S. A. Hammer
- Hereroa** (Schwantes) Dinter & Schwantes in Z. Sukkulantenk. 3: 15, 23. 1927 sec. Hartmann (2001b) ≡ *Bergeranthus* subg. *Hereroa* Schwantes in Z. Sukkulantenk. 2: 180. 1926. – Type: *Hereroa puttkammeriana* (Dinter & Berger) Dinter & Schwantes  
*Hereroa* includes 27 species but lacks a taxonomic revision. The study by Klak & al. (2013) reveals *Rhombophyllum* (five species) and *Bergeranthus* (ten species) as its closest relatives. Denser sampling may in addition show that *Hereroa* is not monophyletic, with *Rhombophyllum* likely to be nested within it. On account of the close morphological resemblance between these genera, generic limits need to be critically reinvestigated.
- Hymenogyne** Haw., Revis. Pl. Succ.: 192. 1821 sec. Hartmann (2001b). – Type: *Hymenogyne glabra* (Aiton) Haw.  
= *Thyrasperma* N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925.
- Ihlenfeldtia** H. E. K. Hartmann in Bot. Jahrb. Syst. 114: 47. 1992 sec. Hartmann (2001b). – Type: *Ihlenfeldtia excavata* (L. Bolus) H. E. K. Hartmann  
The two species currently included in *Ihlenfeldtia* were previously included in *Cheiridopsis*. However,

the two species were moved each into their own genus and thought to be closely related to *Tanquana* (three species) and *Vanheerdi* (two species), based on characters of the fruits (Hartmann 1992). However Klak & al. (2013) confirmed the previous position of *Ihlenfeldtia* as a close relative of *Cheiridopsis*, which is supported by characteristics of the leaves (Hartmann 1992). See further notes under *Cheiridopsis*.

**Jacobsenia** L. Bolus & Schwantes, Notes Mesembryanthemum 3: 255. 1954 sec. Ihlenfeldt (2001c). – Type: *Jacobsenia kolbei* (L. Bolus) L. Bolus & Schwantes  
= *Anisocalyx* L. Bolus, Notes Mesembryanthemum 3: 385. 1958, nom. illeg.

= *Drosanthemopsis* Rauschert in Taxon 31: 555. 1982.  
Although *Jacobsenia* currently includes only three species, they were shown not to be monophyletic (Klak & al. 2013).

**Jensenobotrya** A. G. J. Herre in Sukkulantenk. 4: 79. 1951 sec. Hartmann (2001b). – Type: *Jensenobotrya lossowiana* A. G. J. Herre

**Jordaniella** H. E. K. Hartmann in Biblioth. Bot. 136: 57. 1983 sec. Hartmann (2001b). – Type: *Jordaniella clavifolia* (L. Bolus) H. E. K. Hartmann

**Juttadinteria** Schwantes in Z. Sukkulantenk. 2: 182. 1926 sec. Hartmann (2001b). – Type: *Juttadinteria kovisimontana* (Dinter & A. Berger) Schwantes

**Khadia** N. E. Br. in Gard. Chron., ser. 3, 88: 279. 1930 sec. Hartmann & Chesselet (2001). – Type: *Khadia acutipetala* (N. E. Br.) N. E. Br.

**Knersia** H. E. K. Hartmann & Liede in Bradleya 31: 126. 2013 sec. Hartmann & Liede-Schumann (2013). – Type: *Knersia diversifolia* (L. Bolus) H. E. K. Hartmann & Liede

A monotypic genus, which was recently erected to accommodate a species previously misplaced in *Drosanthemum* (Klak & al. 2013; Hartmann & Liede-Schumann 2013).

**Lampranthus** N. E. Br. in Gard. Chron., ser. 3, 87: 71. 1930, nom. cons. sec. Hartmann (2001b). – Type: *Lampranthus multiradiatus* (Jacq.) N. E. Br.

= *Aristanthus* Schwantes in Z. Sukkulantenk. 3: 28. 1827.

= *Mesembryanthus* Necker ex Rothm. in Notizbl. Bot. Gart. Berlin-Dahlem 15: 413. 1941, nom. inval.

*Lampranthus* is a large genus of 194 species, which has never been revised. A molecular study of the *Lampranthus* group identified a core of closely related species, which makes up the current genus (Klak & al. 2003a). Groups of species not closely related to *Lampranthus* s.str. were placed in other genera, with some placed in new genera (Klak 2005).

**Lapidaria** (Dinter & Schwantes) N. E. Br. in Gard. Chron., ser. 3, 84: 472. 1928 sec. Hartmann (2001b) ≡ *Dinteranthus* subg. *Lapidaria* Dinter & Schwantes in Möller's Deutsche Gärt.-Zeitung 42: 223. 1927. – Type: *Lapidaria margaretae* (Schwantes) N. E. Br.

A monotypic genus, which was shown to be sister to *Dinteranthus* (Klak & al. 2013), where it had been placed previously. The two genera form a clade together with *Lithops* and *Schwantesia* (Klak & al. 2013).

**Leipoldtia** L. Bolus in Fl. Pl. South Africa 7: t. 256. 1927 sec. Hartmann (2001b). – Type: *Leipoldtia constricta* (L. Bolus) L. Bolus

= *Rhopalocyclus* Schwantes in Gartenwelt 32: 599. 1928.

**Lithops** N. E. Br. in Gard. Chron., ser. 3, 71: 44. 1922 sec. Cole & Cole (2001). – Type: *Lithops lesliei* (N. E. Br.) N. E. Br.

*Lithops* is one of the best-known genera among collectors of succulents. Species and subspecies are largely distinguished by the colour and markings present on the flattened leaf tops. The genus was shown to be closely related to *Dinteranthus*, *Lapidaria* and *Schwantesia* by Klak & al. (2013). In view of the close morphological resemblance between the four genera in terms of fruit and floral characters, it needs to be reinvestigated whether all of the genera should be maintained.

**Machairophyllum** Schwantes in Möller's Deutsche Gärt.-Zeitung 42: 187. 1927 sec. Hartmann (2001b). – Type: *Machairophyllum albidum* (L.) Schwantes

= *Perissolobus* N. E. Br. in Gard. Chron., ser. 3, 88: 278. 1930.

**Malephora** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001b). – Type: *Malephora mollis* (Aiton) N. E. Br.

= *Crocanthus* L. Bolus in Fl. Pl. South Africa 7: 255. 1927.

= *Hymenocyclus* Schwantes in Möller's Deutsche Gärt.-Zeitung 42: 27. 1927.

The genus includes 16 species, but lacks a taxonomic revision. Since the group is rather homogenous, further sampling is likely to confirm the monophyly of the genus with the species currently included.

**Marlothistella** Schwantes in Gartenwelt 32: 599. 1928 sec. Hartmann (2001b). – Type: *Marlothistella union-dalensis* Schwantes

**Mesembryanthemum** L., Sp. Pl. 1: 480. 1753, nom. cons. sec. Klak & al. (2007). – Type: *Mesembryanthemum nodiflorum* L.

= *Brownanthus* Schwantes in Z. Sukkulantenk. 3: 14, 20. 1827 ≡ *Trichocyclus* N. E. Br. in Bothalia 1(3): 151. 1922, nom. illeg.

= *Aptenia* N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925.

= *Aridaria* N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925.

= *Aspazoma* N. E. Br. in Gard. Chron., ser. 3, 78: 413. 1925.

= *Dactylopsis* N. E. Br. in Gard. Chron., ser. 3, 78: 413. 1925.

= *Phyllobolus* N. E. Br. in Gard. Chron., ser. 3, 78: 413. 1925.

- = *Prenia* N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925.
- = *Psilocaulon* N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925.
- = *Sceletium* N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925.
- = *Synaptophyllum* N. E. Br. in Gard. Chron., ser. 3, 78: 412. 1925.
- = *Pseudobrownanthus* Ihlenf. & Bittrich in Bot. Jahrb. Syst. 105: 319. 1985.
- = *Caulipsolon* Klak, Ill. Handb. Succ. Pl. *Aizoaceae* A–E: 103. 2002.
- = *Volkeranthus* Gerbault in Bradleya 30: 196. 2012.  
A new infrageneric classification has been proposed by Klak & Bruyns (2013). A broad generic circumscription for *Mesembryanthemum* has been reaffirmed and *Mesembryanthemum* subdivided into five subgenera, with all five shown to be monophyletic. Two species were recently reinstated and shown to form part of subgenus *Volkeranthus*, which is sister to the remainder of *Mesembryanthemum* (Klak & al. 2014). Thus, *Mesembryanthemum* currently includes 105 species.
- Mestoklema** N. E. Br. ex Glen in Bothalia 13: 454. 1981 sec. Hartmann (2001b). – Type: *Mestoklema tuberosum* (L.) N. E. Br. ex Glen  
See notes under *Delosperma*.
- Meyerophytum** Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 436. 1927 sec. Ihlenfeldt (2001d). – Type: *Meyerophytum meyeri* (Schwantes) Schwantes
- = *Depacarpus* N. E. Br. in Gard. Chron., ser. 3, 87: 71. 1930.
- Mitrophyllum** Schwantes in Z. Sukkulente. 2: 181. 1926 sec. Hartmann (2001b). – Type: *Mitrophyllum mitratum* (Marloth) Schwantes
- = *Conophyllum* Schwantes in Z. Sukkulente. 3: 321. 1928.
- = *Mimetophytum* L. Bolus, Notes Mesembryanthemum 3: 252. 1954.
- Monilaria** Schwantes in Gartenwelt 33: 69. 1929 sec. Ihlenfeldt (2001e). – Type: *Monilaria chrysoleuca* (Schltr.) Schwantes
- Mossia** N. E. Br. in Gard. Chron., ser. 3, 87: 71. 1930 sec. Hartmann (2001b). – Type: *Mossia intervallis* (L. Bolus) N. E. Br.
- Namaquanthus** L. Bolus, Notes Mesembryanthemum 3: 257. 1954 sec. Hartmann (2001b). – Type: *Namaquanthus vanheerdei* L. Bolus
- Namibia** Dinter & Schwantes in Z. Sukkulente. 3: 106. 1927 sec. Hartmann (2001b) ≡ *Juttadinteria* subg. *Namibia* Schwantes in Z. Sukkulente. 2: 184. 1926. – Type: *Namibia cinerea* Dinter & Schwantes
- Nananthus** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001b). – Type: *Nananthus vitatus* (N. E. Br.) Schwantes
- Nelia** Schwantes in Möller's Deutsche Gärtn.-Zeitung 43: 92. 1928 sec. Hartmann (2001b). – Type: *Nelia meyeri* Schwantes
- = *Sterropetalum* N. E. Br. in Gard. Chron., ser. 3, 83: 266. 1928.
- Neohenricia** L. Bolus in J. S. African Bot. 4: 51. 1938 sec. Hartmann (2001b) ≡ *Henricia* L. Bolus, Notes Mesembryanthemum 3: 39. 1936. – Type: *Neohenricia sibbettii* (L. Bolus) L. Bolus  
A small genus including only two species. See further remarks under *Stomatium*.
- Octopoma** N. E. Br. in Gard. Chron., ser. 3, 87: 72. 1930 sec. Hartmann (2001b). – Type: *Octopoma octojuge* (L. Bolus) N. E. Br.  
*Octopoma* has been recognized by several authors (Hartmann 2001b) and Klak & al. (2013). However, the two infrageneric groups distinguished on account of differences in fruit morphology (Hartmann 2001b) were not confirmed by Klak & al. (2013).
- Odontophorus** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001b). – Type: *Odontophorus marlothii* N. E. Br.  
See remarks under *Cheiridopsis*.
- Oophytum** N. E. Br. in Gard. Chron., ser. 3, 78: 413. 1925 sec. Ihlenfeldt (2001f). – Type: *Oophytum oviforme* (N. E. Br.) N. E. Br.
- Orthopterum** L. Bolus in S. African Gard. 17: 281. 1927 sec. Hartmann (2001b). – Type: *Orthopterum waltoniae* L. Bolus  
*Orthopterum*, comprising two species, is closely allied to *Faucaria* (Klak & al. 2013), from which it mainly differs by the repeatedly opening and closing fruits (Hartmann 2001b).
- Oscularia** Schwantes in Möller's Deutsche Gärtn.-Zeitung 42: 187. 1927 sec. Hartmann (2001b). – Type: *Oscularia deltoides* (L.) Schwantes
- Ottosonderia** L. Bolus in Notes Mesembryanthemum [H. M. L. Bolus] 3: 292. 1958 sec. Hartmann (2001b). – Type: *Ottosonderia monticola* (Sond.) L. Bolus  
A monotypic genus from Namaqualand, which was shown to be closely allied to *Jordaaniella* and to *Ruschia sandbergensis* L. Bolus (Klak & al. 2013). However, relationships to other members of the xeromorphic winter-rainfall clade remain in many parts poorly resolved.
- Peersia** L. Bolus in Fl. Pl. South Africa 7: t. 264. 1927 sec. Hartmann (2001b). – Type: *Peersia macradenia* (L. Bolus) L. Bolus  
A small genus of only three species, which was shown to be closely allied to *Rhinephyllum* (Klak & al. 2013), where all three species were previously placed.
- Phiambolia** Klak in Bradleya 21: 112. 2003 sec. Klak (2003). – Type: *Phiambolia hallii* (L. Bolus) Klak
- Pleiospilos** N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925 sec. Hartmann (2001b). – Type: *Pleiospilos bolusii* (Hook. f.) N. E. Br.
- = *Punctillaria* N. E. Br. in Gard. Chron., ser. 3, 78: 433. 1925.
- Plinthus** Fenzl in Nov. Stirp. Dec.: 52. 1839 sec. Hartmann (2001b). – Type: *Plinthus cryptocarpus* Fenzl

- Polymita** N. E. Br. in Gard. Chron., ser. 3, 87: 72. 1930 sec. Hartmann (2001b). – Type: *Polymita pearsonii* N. E. Br.  
A small genus including only two species. It is closely allied to *Schlechteranthus* (Klak & al. 2013), which also only incorporates two species. As indicated by the molecular analysis by Klak & al. (2013), the generic limits need to be critically reinvestigated.
- Prepodesma** N. E. Br. in Gard. Chron., ser. 3, 88: 279. 1930 sec. Hartmann (2001b). – Type: *Prepodesma orpenii* (N. E. Br.) N. E. Br.
- Psammophora** Dinter & Schwantes in Z. Sukkulantenk. 2: 188. 1926 sec. Hartmann (2001b). – Type: *Psammophora nissenii* (Dinter) Dinter & Schwantes
- Rabiea** N. E. Br. in Gard. Chron., ser. 3, 88: 279. 1930 sec. Hartmann (2001b). – Type: *Rabiea albinota* (Haw.) N. E. Br.
- Rhinephyllum** N. E. Br. in Gard. Chron., ser. 3, 82: 92. 1927 sec. Hartmann (2001b). – Type: *Rhinephyllum muirii* N. E. Br.  
= *Neorhine* Schwantes in Monatsschr. Deutsch. Kakteen-Ges. 2: 22. 1930.
- Rhombophyllum** (Schwantes) Schwantes in Z. Sukkulantenk. 3: 16, 23. 1927 sec. Hartmann (2001b) ≡ *Bergeranthus* subg. *Rhombophyllum* Schwantes in Z. Sukkulantenk. 2: 180. 1926. – Type: *Rhombophyllum rhomboideum* (Salm-Dyck) Schwantes
- Ruschia** Schwantes in Z. Sukkulantenk. 2: 186. 1926 sec. Hartmann (2001b). – Type: *Ruschia rupicola* (Engl.) Schwantes  
A large genus including 206 species, for which no taxonomic revision has been compiled. Dehn (1993) recognized nine subgenera, of which only one has been studied further, *Ruschia* subg. *Spinosa* (Salm-Dyck) Dehn (Hartmann & Stüber 1993). However, it has since been established that *Ruschia* is not monophyletic in its current circumscription (Klak & al. 2013). The clade in which species of *Ruschia* s.str. are found is still poorly resolved, so that relationships of species groups of current *Ruschia* remain uncertain. In addition, much denser sampling is required to establish monophyly and relationships of the subgenera of *Ruschia* and their relationship to other members of the xeromorphic winter-rainfall clade (Klak & al. 2013).
- Ruschianthus** L. Bolus in J. S. African Bot. 27: 62. 1960 sec. Hartmann (2001b). – Type: *Ruschianthus falcatus* L. Bolus  
A monotypic genus, which resolved within the *Conophytum* clade (Klak & al. 2013).
- Ruschiella** Klak in Bradleya 23: 100. 2005 sec. Hartmann (2001b). – Type: *Ruschiella argentea* (L. Bolus) Klak
- Saphesia** N. E. Br. in Gard. Chron., ser. 3, 91: 205. 1932 sec. Hartmann (2001b). – Type: *Saphesia flaccida* (Jacq.) N. E. Br.  
Monotypic. *Saphesia* is an insufficiently known genus that needs further study to clarify its identity (Klak & al. 2015).
- Sarcozona** J. M. Black in Trans. & Proc. Roy. Soc. South Australia 58: 176. 1934 sec. Hartmann (2001b). – Type: *Sarcozona pulleinei* (J. M. Black) J. M. Black  
The genus consists of only two species, which are endemic to Australia.
- Schlechteranthus** Schwantes in Monatsschr. Deutsch. Kakteen-Ges. 1: 16. 1929 sec. Hartmann (2001b). – Type: *Schlechteranthus maximiliani* Schwantes  
A small genus of two species, which is endemic to Namaqualand. See further remarks under *Polymita*.
- Schwantesia** Dinter in Möller's Deutsche Gärtner-Zeitung 42: 234. 1927 sec. Hartmann & Zimmermann (2001). – Type: *Schwantesia ruedeuschii* Dinter
- Scopelogenia** L. Bolus in J. S. African Bot. 28: 9. 1962 sec. Hartmann (2001b). – Type: *Scopelogenia verruculata* (L.) L. Bolus  
A small genus with two species, which was placed in a clade with two species of the polyphyletic *Ruschia* (Klak & al. 2013). A comprehensive revision of *Ruschia* should therefore also address the generic delimitation of *Scopelogenia*.
- Sesuvium** L., Syst. Nat., ed. 10: 1052, 1058, 1371. 1759 sec. Hartmann (2001b) ≡ *Halimus* Rumph. ex Kuntze, Revis. Gen. Pl. 1: 263. 1891, nom. illeg. ≡ *Halimum* Loef. ex Hiern. in Cat. Afr. Pl. 1: 411. 1898. – Type: *Sesuvium portulacastrum* (L.) L.  
= *Diplochonium* Fenzl, Nov. Stirp. Dec.: 57. 1839.  
= *Pyxypoma* Fenzl in Ann. Wiener Mus. Naturgesch. 2: 293. 1840.  
= *Psammanthe* Hance in Ann. Bot. Syst. 2: 659. 1851.  
The genus includes about 15 species; the exact number, however, is unknown and a taxonomic treatment is needed. *Sesuvium* contains an African clade consisting of C<sub>4</sub> species and an American clade consisting of *Cypselea* (also C<sub>4</sub>) and a C<sub>3</sub> *Sesuvium* clade (Bohley & al. 2015). *Sesuvium portulacastrum* (L.) L., which belongs to the American clade, is found along tropical and subtropical coasts.
- Skatophytum** L. Bolus in S. African Gard. 17: 435. 1927 sec. Hartmann (2001b) ≡ *Gymnopoma* N. E. Br. in Gard. Chron., ser. 3, 83: 194. 1928. – Type: *Skatophytum tripolium* (L.) L. Bolus  
= *Caryotophora* Leistner, Notes Mesembryanthemum 3: 289. 1958.  
*Skatophytum* forms part of the tribe *Apatesieae*, which consists of only 11 species. The tribe is considered to be monophyletic (Ihlenfeldt & Gerbaulet 1990; Klak & al. 2003b; Klak & al. 2015). *Skatophytum* includes only three species, which are endemic to the south-western Cape region of South Africa (Klak & al. 2015). Based on a recent phylogenetic study, Klak & al. (2015) proposed that the monotypic *Caryotophora* Leistner should be considered part of *Skatophytum*. In addition, it was shown that the lec-

- totype and protologue of *Mesembryanthemum flaccidum* Jacq. did not correspond to the species currently associated with this name, which was described as *S. flaccidifolium* Klak (Klak & al. 2015). The type of the monotypic *Saphesia*, which is *M. flaccidum*, was found to be an insufficiently known species.
- Smicrostigma** N. E. Br. in Gard. Chron., ser. 3, 87: 72. 1930 sec. Hartmann (1993). – Type: *Smicrostigma viride* (Haw.) N. E. Br.  
A monotypic genus, which was shown to be closely related to *Zeuktophyllum* (two species) and *Octopoma* p.p. (Klak & al. 2013). All three taxa are endemic to the Little Karoo, South Africa. The overall similarity between these taxa suggests that a broader generic concept should be adopted for this group of species.
- Stayneria** L. Bolus in J. S. African Bot. 27: 47. 1960 sec. Hartmann (2001b). – Type: *Stayneria littlewoodii* L. Bolus  
A monotypic genus, which was found to be closely allied to parts of the polyphyletic genus *Ruschia* (Klak & al. 2013).
- Stoeberia** Dinter & Schwantes in Z. Sukkulantenk. 3: 14, 17. 1927 sec. Hartmann (2001b). – Type: *Stoeberia beetzii* (Dinter) Dinter & Schwantes  
= *Ruschianthemum* Friedrich in Mitt. Bot. Staatssamml. München 3: 563. 1960.  
Hartmann (2001b) treated *Ruschianthemum* as a distinct genus with *R. gigas* (Dinter) Friedrich as the only species. However, the species had already previously placed in *Stoeberia* because of strong similarities; it differs mostly in its fruit morphology, which has traditionally played an important role in delimiting genera in *Aizoaceae*. However, fruit characters have recently been shown to be far more homoplasious than previously expected (Klak & al. 2013), suggesting that fruit morphology on its own does not justify the recognition as a distinct genus. Given the large overall similarity in all other morphological characters to *Stoeberia*, this species has been reinstated as a member of *Stoeberia* by Cheslet & van Wyk (2002), based on very similar arguments.
- Stomatium** Schwantes in Z. Sukkulantenk. 2: 175. 1926 sec. Hartmann (2001b). – Type: *Stomatium suaveolens* Schwantes  
= *Agnirictus* Schwantes in Monatschr. Deutsch. Kakteen-Ges. 2: 21. 1930, nom. inval.  
*Stomatium* currently includes 39 species, but lacks a taxonomic revision. It was shown to be closely related to *Chasmatophyllum* (eight species), *Mossia* (one species), *Neohenricia* (two species), *Peersia* (three species) and *Rhinephyllum* (11 species) by Klak & al. (2013). Both *Chasmatophyllum* and *Rhinephyllum* also lack a taxonomic revision. All of these genera occur outside the winter-rainfall region of South Africa. The group shares a similar floral morphology, i.e. yellow or more rarely cream-coloured petaloid staminodes, absence of filamentous staminodes and a concavely shaped ovary wall. Over the past decades species have been shifted between genera since generic boundaries are poorly circumscribed.
- Tanquana** H. E. K. Hartmann & Liede in Bot. Jahrb. Syst. 106: 479. 1986 sec. Hartmann (2001b). – Type: *Tanquana archeri* (L. Bolus) H. E. K. Hartmann & Liede  
Based on differences in fruit morphology, Hartmann & Liede (1986) excluded three species from *Pleiospilos* and established a new genus for them, *Tanquana*. However, its previously recognized close relationship to *Pleiospilos* was confirmed by Klak & al. (2013), and is also corroborated by leaf-morphological characters (Hartmann & Liede 1986).
- Tetragonia** L., Sp. Pl. 1: 480. 1753 sec. Hartmann (2001b) = *Ludolfia* Adans., Fam. Pl. 2: 244. 1763 = *Tetragonocarpus* Hassk. in Flora 40: 99. 1857. – Type: *Tetragonia fruticosa* L. – Fig. 2B.  
= *Demidovia* Pall., Enum. Hort. Demidof: 150. 1781.  
= *Tetragonella* Miq. in Lehm. Pl. Preiss. 1: 245. 1845.  
= *Anisostigma* Schinz in Bull. Herb. Boissier 5 App. 3: 78. 1897.
- Titanopsis** Schwantes in Z. Sukkulantenk. 2: 178. 1926 sec. Hartmann (2001b). – Type: *Titanopsis calcarea* (Marloth) Schwantes  
= *Verrucifera* N. E. Br. in Gard. Chron., ser. 3, 88: 278. 1930.
- Trianthema** L., Sp. Pl. 1: 223. 1753 sec. Hartmann (2001b) = *Reme* Adans., Fam. Pl. 2: 245. 1763 = *Portulacastrum* Juss. ex Medik., Philos. Bot.: 99. 1789. – Type: *Trianthema portulacastrum* L.  
= *Papularia* Forssk., Fl. Aegypt.-Arab.: 69. 1775.  
= *Meridiana* L. f., Suppl. Pl.: 248. 1782.  
= *Ancistrostigma* Fenzl in Ann. Wiener Mus. Naturgesch. 2: 293. 1840.  
The genus belongs to *Sesuvioideae* and comprises about 28 species in two monophyletic clades, *T.* subg. *Trianthema* and *T.* subg. *Papularia* (Bohley & al. 2015). The latter has been revised by Hartmann & al. (2011). Nearly all species are C<sub>4</sub> plants: an exception is the C<sub>3</sub> species *T. ceratosepala* Volkens & Irmsch.
- Tribulocarpus** S. Moore in J. Bot. 59: 228. 1921 sec. Thulin & al. (2012). – Type: *Tribulocarpus dimorphantha* (Pax) S. Moore  
*Tribulocarpus* belongs to the *Sesuvioideae* (Klak & al. 2003; Thulin & al. 2012) and is sister to the remaining genera of the subfamily, i.e. *Sesuvium* (incl. *Cypselea*), *Trianthema* and *Zaleya*. It is the only genus in the *Sesuvioideae* that includes only C<sub>3</sub> species.
- Trichodiadema** Schwantes in Z. Sukkulantenk. 2: 187. 1926 sec. Niesler (2001). – Type: *Trichodiadema stelligerum* (Haw.) Schwantes  
The genus includes 32 species and is divided into two subgenera (Hartmann & Niesler 2013). The latter study as well as earlier studies appear to be largely based on the types of *Trichodiadema* (Niesler 1997),

since very little additional material (none from a South African herbarium) is cited as the basis for their taxonomic conclusions. Distribution ranges for the recognized species remain uncertain due to the lack of cited vouchers. In addition, monophyly of the genus needs to be reinvestigated in view its having been found nested among species of *Delosperma* (Klak & al. 2013).

**Vanheerdea** L. Bolus ex H. E. K. Hartmann in Bradleya 10: 15. 1992 sec. Hartmann (2001b). – Type: *Vanheerdea roodiae* (N. E. Br.) L. Bolus ex H. E. K. Hartmann

**Vanzijlia** L. Bolus in Fl. Pl. South Africa 7. t. 256: 262. 1927 sec. Hartmann (2001b). – Type: *Vanzijlia annulata* (A. Berger) L. Bolus

**Vlokia** S. A. Hammer in Cact. Succ. J. (Los Angeles) 66: 256. 1994 sec. Hartmann (2001b). – Type: *Vlokia ater* S. A. Hammer

**Wooleya** L. Bolus in J. S. African Bot. 27: 48. 1960 sec. Hartmann (2001b). – Type: *Wooleya farinosa* L. Bolus

A monotypic genus from the coast of Namaqualand. Its phylogenetic position within the xeromorphic winter-rainfall clade remains unresolved (Klak & al. 2013).

**Zaleyia** Burm. f. in Fl. Indica (N. L. Burman): 110. 1768 sec. Hartmann (2001b). – Type: *Zaleyia decandra* Burm. f.

= *Rocama* Forssk., Fl. Aegypt.-Arab.: 71. 1775.

The genus is monophyletic and belongs to *Sesuvioideae*, where it is sister to *Sesuvium* (Bohley & al. 2015). *Zaleyia* is a C<sub>4</sub> genus and distributed in eastern Africa, southern Asia and Australia. It contains seven species (Hartmann 2011b).

**Zeuktophyllum** N. E. Br. in Gard. Chron., ser. 3, 81: 12. 1927 sec. Hartmann (2001b). – Type: *Zeuktophyllum suppositum* (L. Bolus) N. E. Br.

### **Amaranthaceae** Juss. sec. Müller & Borsch (2005).

*Amaranthaceae* belong to a clade together with *Chenopodiaceae*. Support for the monophyly of the “*Amaranthaceae*–*Chenopodiaceae* alliance” is found consistently in all molecular phylogenetic analyses (Manhart & Rettig 1994; Downie & al. 1997; Cuénoud & al. 2002; Kadereit & al. 2003; Müller & Borsch 2005a; Schäferhoff & al. 2009; Brockington & al. 2009). The family circumscription of the *Amaranthaceae* in the sense of Schinz (1893) was upheld by Townsend (1993) and confirmed as monophyletic with high statistical confidence by Kadereit & al. (2003) and Müller & Borsch (2005a). Following this concept the *Amaranthaceae* predominantly occur in tropical and subtropical regions with most of the species diversity in the Neotropics, eastern and southern Africa and Australia (Müller & Borsch 2005a, b; Sánchez-del Pino & al. 2009). Subfamily *Gomphrenoideae* has been revealed as monophyletic and nested within the *Amaranthoideae* and is characterized by unilocular anthers (Sánchez-del Pino & al. 2009) and metareticulate pol-

len (Borsch & Barthlott 1998; in core *Gomphrenoideae* except *Irenella*, *Iresine* and *Woehleria*). In contrast, subfamily *Amaranthoideae* is largely paraphyletic. The genera *Bosea* and *Charpentiera* were found as successive sisters to the remainder of the *Amaranthaceae* (Müller & Borsch 2005a). The *Celosioidae* (corresponding to the celosoid clade) are the only natural tribe in the pre-phylogenetic classification of the family and further major lineages are constituted by the amaranthoid clade (*Amaranthus*, *Chamissoa* and relatives), the aervoid clade (*Aerva*, *Ptilotus* and relatives) and the achyranthoid clade (*Achyranthes*, *Centemopsis*, *Cyathula*, *Pupalia*, *Sericocoma* and many other African genera; Müller & Borsch 2005b). The Angiosperm Phylogeny Group (APG 1998) proposed to apply the name *Amaranthaceae* to the complete *Amaranthaceae*–*Chenopodiaceae* alliance, essentially adopting the family concept of Baillon (1887) and Mallinson (1922). The broad family circumscription was also adopted in subsequent versions of the APG classification (APG II 2003; APG III 2009). However, since recent phylogenetic analyses rather indicate the monophyly of the core *Chenopodiaceae* but are not yet conclusive about the position of the subfamily *Polycnemoideae*, the widely used family name *Chenopodiaceae* is maintained (see introduction to the family *Chenopodiaceae*). The four genera of the well-supported polycnemoid lineage (*Hemichroa*, *Nitrophila*, *Polycnemum*, *Surreya*) that corresponds to the subfamily *Polycnemoideae* share petaloid tepals, two large bracteoles supporting the flower, an androecium that is basally united into a tube and bilocular anthers with the *Amaranthaceae* sensu Schinz (1893), Masson & Kadereit (2013). We are therefore provisionally treating this subfamily under the *Amaranthaceae* along with Endlicher (1841), Moquin-Tandon (1849) and Scott (1977).

**Achyranthes** L., Sp. Pl. 1: 204. 1753, nom. cons. prop. sec. Townsend (1993). – Type: *Achyranthes aspera* L.

**Achyropsis** Benth. & Hook. f., Gen. Pl. 3(1): 36. 1880 sec. Townsend (1993) ≡ *Achyranthes* sect. *Achyropsis* Moq. in Candolle, Prodr. 13(2): 310. 1849. – Type: not designated.

**Aerva** Forssk. in Fl. Aegypt.-Arab.: 170. 1775, nom. cons. sec. Townsend (1993). – Type: *Aerva tomentosa* Forssk.

The genus may not be monophyletic and includes two principal lineages (Thiv & al. 2006). One of these was shown as sister to the remainder of the aervoid clade (represented by *A. javanica* Juss.; Müller & Borsch 2005a) and the other (represented by *A. leucura* Moq.; Müller & Borsch 2005b) as sister to *Ptilotus*. Further study of the aervoid clade is needed to clarify generic concepts.

**Allmania** R. Br. ex Wight in J. Bot. 1: 226. 1834 sec. Townsend (1993). – Type: *Allmania nodiflora* (L.) R. Br. ex Wight

**Allmaniopsis** Suess. in Mitt. Bot. Staatssamml. München 4. 1952 sec. Townsend (1993). – Type: *Allmaniopsis fruticulosa* Suess.



- Alternanthera*** Forssk., Fl. Aegypt.-Arab.: 28, 59. 1775 sec. Townsend (1993). – Type: *Alternanthera achyranthes* Forssk.  
 = *Telanthera* R. Br., Observ. Congo. 1818.  
 = *Brandesia* Mart., Nov. Gen. Sp. Pl. 2: 25. 1826.  
 = *Buchholzia* Mart., Nov. Gen. Sp. Pl. 2: 49. 1826.  
 = *Mogiphanes* Mart., Nov. Gen. Sp. Pl. 2: 29. 1826.  
 The genus *Alternanthera* is well supported as monophyletic in the current circumscription and is characterized by the presence of capitate stigmas and in most species also distinct androecial appendages that alternate with the filaments. The previously recognized genera do not represent natural entities except *Mogiphanes*, which is nested within one of the two major subclades of *Alternanthera* (Sánchez-del Pino & al. 2012).
- Amaranthus*** L., Sp. Pl. 1: 989. 1753 sec. Townsend (1993). – Type: *Amaranthus caudatus* L.  
 = *Acnida* L., Sp. Pl. 2: 1027. 1753 = *Amaranthus* subg. *Acnida* (L.) Aellen ex K. R. Robertson in J. Arnold Arbor. 62(3): 283. 1981.  
 = *Albersia* Kunth, Fl. Berol. 2: 144. 1838 = *Amaranthus* subg. *Albersia* (Kunth) Gren. & Godr., Fl. France 3: 3. 1856.  
 = *Acanthochiton* Torr., Rep. Exped. Zuñi & Colorado Rivers: 170. 1853 = *Amaranthus* sect. *Acanthochiton* (Torr.) Mosyakin & K. R. Robertson in Ann. Bot. Fenn. 33: 277. 1996.  
 = *Goerziella* Urb., Repert. Spec. Nov. Regni Veg. 20: 301. 1924 = *Amaranthus* sect. *Goerziella* (Urb.) Mosyakin & K. R. Robertson in Ann. Bot. Fenn. 33: 280. 1996.  
 The genus, with its more than 75 currently recognized species, is monophyletic and constitutes a C<sub>4</sub> lineage (Sage & al. 2007) within the otherwise completely C<sub>3</sub> amaranthoid clade (Müller & Borsch 2005b) of subfamily *Amaranthoideae*. The current infrageneric system of the genus (Mosyakin & Robertson 1996, 2003), recognizing three subgenera (*A.* subg. *Acnida* (L.) Aellen ex K. R. Robertson, *A.* subg. *Albersia* (Kunth) Gren. & Godr. and *A.* subg. *Amaranthus*) and several sections, was developed before the advent of molecular phylogenetic methods and is now in need of revision. *Amaranthus* subg. *Acnida*, represented by dioecious species currently placed in three sections, seems to be non-monophyletic, since dioecy in *Amaranthus* probably developed independently at least twice (Mosyakin 2005). Surprisingly, no comprehensive molecular phylogenetic study of *Amaranthus* has been done yet, despite the economic importance of the genus, containing some pseudocereal and green crops, popular ornamentals, and noxious weeds.
- Arthraerua*** (Kuntze) Schinz, Nat. Pflanzenfam. 3(1a): 109. 1893 sec. Townsend (1993) = *Aerva* sect. *Arthraerua* Kuntze in Jahrb. Königl. Bot. Gart. Berlin 4: 272. 1886. – Type: *Arthraerua leubnitziae* (Kuntze) Schinz
- Bosea*** L., Sp. Pl. 1: 225. 1753 sec. Townsend (1993). – Type: *Bosea yervamora* L.
- Calicorema*** Hook. f., Gen. Pl. 3(1): 34. 1880 sec. Townsend (1993). – Type: *Calicorema capitata* (Moq.) Hook. f.  
 The genus is not monophyletic as currently circumscribed because its two species, *Calicorema capitata* and *C. squarrosa* (Schinz) Schinz, appear in two completely different lineages of the achyranthoid clade (Müller & Borsch 2005a, b). Correct generic assignment has to await a comprehensive analysis of the achyranthoid clade.
- Celosia*** L., Sp. Pl. 1: 205. 1753 sec. Townsend (1993). – Type: *Celosia argentea* L.
- Centema*** Hook. f., Gen. Pl. 3(1): 31. 1880 sec. Townsend (1993). – Type: *Centema angolensis* Hook. f.
- Centemopsis*** Schinz in Vierteljahrsschr. Naturf. Ges. Zürich 56: 242. 1911 sec. Townsend (1993). – Type: not designated.  
 The genus is probably monophyletic considering phylogenetic trees of Müller & Borsch (2005b) and Sage & al. (2007).
- Centrostachys*** Wall., Fl. Ind., ed. 1820: 497. 1824 sec. Townsend (1993). – Type: *Centrostachys aquatica* (R. Br.) Wall.
- Chamissoa*** Kunth in Nov. Gen. Sp. [H. B. K.] 2: 196, t. 125. 1818, nom. cons. sec. Townsend (1993). – Type: *Chamissoa altissima* (Jacq.) Kunth
- Charpentiera*** Gaudich. in Voy. Uranie, Bot.: 444, t. 48. 1826 sec. Townsend (1993). – Type: *Charpentiera obovata* Gaudich.
- Chionothrix*** Hook. f., Gen. Pl. 3(1): 33. 1880 sec. Townsend (1993). – Type: *Chionothrix somalensis* (S. Moore) Hook. f.
- Cyathula*** Blume in Bijdr. Fl. Ned. Ind. 11: 548. 1826 sec. Townsend (1993). – Type: *Cyathula prostrata* (L.) Blume
- Cyphocarpa*** (Fenzl) Lopr. in Bot. Jahrb. Syst. 27: 42. 1899 sec. Townsend (1993) = *Sericocoma* subg. *Kyphocarpa* Fenzl in Linnaea 17: 324. 1843. – Type: *Cyphocarpa trichinioides* (Fenzl) Lopr.
- Dasyphaera*** Volkens ex Gilg, Nat. Pflanzenfam. Nachtr. 2-4, 1: 153. 1897 sec. Townsend (1993). – Type: not designated.
- Deeringia*** R. Br., Prodr. Fl. Nov. Holland.: 413. 1810 sec. Townsend (1993). – Type: *Deeringia celosioides* R. Br.  
 = *Dendroportulaca* Egli in Adansonia, sér. 3, 19: 49. 1997.  
*Celosieae*. *Dendroportulaca* (formerly placed in *Portulacaceae*) has been shown to be referable to *Deeringia* and the only species, *Dendroportulaca mirabilis* Egli, has been transferred there (Applequist & Pratt 2005).
- Digera*** Forssk. in Fl. Aegypt.-Arab.: 65. 1775 sec. Townsend (1993). – Type: *Digera arvensis* Forssk.
- Eriostylos*** C. C. Towns. in Kew Bull. 46: 237. 1991

- sec. Townsend (1993). – Type: *Eriostylos stefaninii* (Chiov.) C. C. Towns.
- Froelichia** Moench, *Methodus*: 50. 1794 sec. Townsend (1993). – Type: *Froelichia lanata* Moench
- Froelichiella** R. E. Fr. in *Ark. Bot.* 16(13): 3. 1921 sec. Townsend (1993). – Type: *Froelichiella grisea* (Lopr.) R. E. Fr.
- Gomphrena** L., *Sp. Pl.* 1: 224. 1753 sec. Townsend (1993). – Type: *Gomphrena globosa* L. – Fig. 2E.
- Gossypianthus** Hook. in *Icon. Pl.*: 251. 1840 sec. Clemants (2003). – Type: *Gossypianthus rigidiflorus* Hook. Close relationships between *Gossypianthus* and *Guilleminea* and a merger of both genera were long-disputed (Mears 1967; Eliasson 1988). Phylogenetic analysis of plastid (Sánchez-del Pino & al. 2009) and nuclear sequences (T. Ortuño & T. Borsch, unpubl. data) show that they are more distantly related and do not form sister groups.
- Guilleminea** Kunth, *Nov. Gen. Sp.* (quarto ed.) 6: 40, pl. 518. 1823 sec. Clemants (2003) = *Brayulinea* Small, *Fl. S. E. U. S.*: 394. 1903. – Type: *Guilleminea illecebroides* Kunth  
See notes under *Gossypianthus*.
- Hebanthe** Mart., *Beitr. Amarantac.*: 96. 1825 sec. Borsch & Pedersen (1997). – Type: not designated.  
The genus was resurrected based on its very distinctive flower and pollen morphology by Borsch & Pedersen (1997) and also appears to be monophyletic based on molecular phylogenetic analysis (Sánchez-del Pino & al. 2009; Borsch & al. 2011).
- Hebanthodes** Pedersen in *Bonplandia* (Corrientes) 10: 102. 2000 sec. Pedersen (2000). – Type: *Hebanthodes peruviana* Pedersen  
Monotypic and known from a single historical specimen (Pedersen 2000). Affinities are unclear but a placement within the gomphrenoid clade of *Gomphrenoideae* (Sánchez-del Pino & al. 2009) is certain, where it shares a pollen morphology similar to *Pfaffia*.
- Hemichroa** R. Br., *Prodr. Fl. Nov. Holland.*: 409. 1810 sec. Masson & Kadereit (2013). – Type: *Hemichroa pentandra* R. Br.  
*Polycnemoideae*. *Hemichroa* consists of only one species; two further species have been segregated as *Surreya* (see there for details; Masson & Kadereit 2013). The succulent halophyte *H. pentandra* R. Br. is endemic to Australia. It is sister to *Surreya* (Masson & Kadereit 2013).
- Henonia** Moq. in *Candolle, Prodr.* 13(2): 237. 1849 sec. Townsend (1993). – Type: *Henonia scoparia* Moq.
- Herbstia** Sohmer in *Brittonia* 28: 448. 1977 sec. Townsend (1993). – Type: *Herbstia brasiliiana* (Moq.) Sohmer
- Hermbstaedtia** Rchb. in *Consp. Regn. Veg.*: 164. 1828 sec. Townsend (1993). – Type: *Hermbstaedtia glauca* (J. C. Wendl.) Steud. ex Rchb.
- Indobanalia** A. N. Henry & B. Roy in *Bull. Bot. Surv. India* 10: 274. 1969 sec. Townsend (1993) = *Banalia* Moq. in *Candolle, Prodr.* 13(2): 278. 1849, nom. illeg. – Type: *Indobanalia thyrsiflora* (Moq.) A. N. Henry & B. Roy
- Irenella** Suess. in *Repert. Spec. Nov. Regni Veg.* 35: 318. 1934 sec. Townsend (1993). – Type: *Irenella chryso-tricha* Suess.
- Iresine** P. Browne in *Civ. Nat. Hist. Jamaica*: 358. 1756, nom. cons. sec. Townsend (1993). – Type: *Iresine dif-fusa* Humb. & Bonpl. ex Willd.  
= *Dicraurus* Hook. f., *Gen. Pl.* 3(1): 42. 1880.  
The genus is monophyletic (Sánchez-del Pino & al. 2009; Borsch, Flores Olvera, Zumaya & Müller, in review) with approximately 45 species all of which are characterized by *Iresine*-type pollen (Borsch 1998). The two species formerly classified as *Dicraurus* on the base of alternate and not opposite leaves are nested within the *Iresine* clade, confirming the merger by Henrickson & Sundberg (1986). Their dense indumentum with branched trichomes appears to be an adaptation to the dry habitats of northern Mexico.
- Lagrezia** Moq. in *Candolle, Prodr.* 13(2): 252. 1849 sec. Townsend (1993). – Type: *Lagrezia madagascariensis* (Poir.) Moq.  
= *Apterantha* C. H. Wright in *Bull. Misc. Inform. Kew* 1918: 202. 1918.
- Leucosphaera** Gilg, *Nat. Pflanzenfam. Nachtr.* 2–4, 1: 152. 1897 sec. Townsend (1993). – Type: *Leucosphaera bainesii* (Hook. f.) Gilg
- Lithophila** Sw., *Prodr.* [O. P. Swartz]: 1, 14. 1788 sec. Townsend (1993). – Type: *Lithophila muscoides* Sw.
- Lopriorea** Schinz in *Vierteljahrsschr. Naturf. Ges. Zürich* 56: 251. 1911 sec. Townsend (1993). – Type: *Lopriorea ruspolii* (Lopr.) Schinz
- Marcellipsis** Schinz, *Nat. Pflanzenfam.*, ed. 2, 16c: 48. 1934 sec. Townsend (1993) = *Marcellia* Baill. in *Bull. Mens. Soc. Linn. Paris* 1(79): 625. 1886, nom. illeg. – Type: *Marcellia mirabilis* Baill.
- Mechowia** Schinz in *Nat. Pflanzenfam.* 3(1a): 110. 1893 sec. Townsend (1993). – Type: *Mechowia grandiflora* Schinz
- Nelsia** Schinz in *Vierteljahrsschr. Naturf. Ges. Zürich* 56: 247. 1912 sec. Townsend (1993). – Type: *Nelsia quadrangula* (Engl.) Schinz
- Neocentema** Schinz in *Vierteljahrsschr. Naturf. Ges. Zürich* 56: 248. 1911 sec. Townsend (1993). – Type: not designated.
- Nitrophila** S. Watson in *Botany [Fortieth Parallel]*: 297. 1871 sec. Masson & Kadereit (2013) = *Banalia* sect. *Idiopsis* Moq. in *Candolle, Prodr.* 13(2): 279. 1849. – Type: *Nitrophila occidentalis* (Moq.) S. Watson  
*Polycnemoideae*. *Nitrophila* consists of four (to eight) species distributed in western North America and South America, and the genus represents a classical example of an amphitropical desert disjunction (Masson & Kadereit 2013). *Nitrophila* shows leaf anatomical adaptations to physiological drought.

- Nothosaerva** Wight in Icon. Pl. Ind. Orient. [Wight] 6: 17. 1853 sec. Townsend (1993). – Type: *Nothosaerva brachiata* (L.) Wight
- Nototrichium** W. F. Hillebr. in Fl. Hawaiian Isl.: 372. 1888 sec. Townsend (1993). – Type: not designated.
- Nyssanthes** R. Br., Prodr. Fl. Nov. Holland.: 418. 1810 sec. Townsend (1993). – Type: not designated.
- Pandiaka** Hook. f., Gen. Pl. 3(1): 35. 1880 sec. Townsend (1993) = *Achyranthes* sect. *Pandiaka* Moq. in Candolle, Prodr. 13(2): 310. 1849. – Type: *Pandiaka involucrata* (Moq.) B. D. Jacks.
- Pedersenia** Holub in Preslia 70: 181. 1998 sec. Holub (1998). – Type: *Pedersenia argentata* (Mart.) Holub  
The genus was resurrected by Pedersen (1997) under *Trommsdorffia* Mart., a later homonym of *Trommsdorffia* Bernh. (*Compositae*; Holub 1998). *Pedersenia* is well supported as monophyletic (Borsch & al. 2011).
- Pfaffia** Mart., Beitr. Amarantac.: 103. 1825 sec. Townsend (1993). – Type: *Pfaffia glabrata* Mart.  
= *Sertuenera* Mart., Nov. Gen. Sp. Pl. 2: 36. 1826.
- Philoxerus** R. Br., Prodr. Fl. Nov. Holland.: 416. 1810 sec. Bao & al. (2003). – Type: *Philoxerus conicus* R. Br.  
= *Blutaparon* Raf., New Fl. 4: 45. 1838.  
The genus name was lectotypified by Standley (1917) using an Australian species, *P. conicus* R. Br. (= *Gomphrena conica* (R. Br.) Spreng.). Palmer (1998) accepted *G. conica* along with the other Australian species of *Gomphrena* and indicated that this is a rare species that grows in sandy soils close to coasts. Considering this, *Philoxerus* would have to be a synonym of *Gomphrena*. The problem is that Hooker (1880, Genera plantarum) kept the genus name *Philoxerus* separate from *Gomphrena* and, rather than using morphological characters, applied a genus concept for *Philoxerus* to comprise *Gomphrena* species of coastal habitats in America, Africa and Australia. This is practically upheld in the genus concept of *Blutaparon* Raf. (Townsend 1993), with four coastal species, although Townsend did not even cite the name *Philoxerus*. Mears (1982a, b) argued that *Philoxerus* had been used for the American coastal species, so he actually looked for a name that would define a genus of coastal species based on the American coastal plants originally described by Linnaeus as *G. vermicularis*. What Mears overlooked is that *G. conica* also appears to be a coastal plant (Palmer 1998), so that Bentham's 1880 generic concept of a gomphrenoid genus of coastal plants under the name *Philoxerus* would actually have been correct with five and not four species. Strictly applying such a genus concept to formal nomenclature, *Blutaparon* is a synonym of *Philoxerus*. However, in the course of analysing evolutionary relationships it will have to be seen if the adaptation to coastal habitats correlates with other characters that could provide synapomorphies for circumscribing and maintaining a genus *Philoxerus*, and if these synapomorphies are shared by *P. conicus* and the other coastal species.
- Pleuropetalum** Hook. f. in London J. Bot. 5: 108. 1846 sec. Townsend (1993). – Type: *Pleuropetalum darwinii* Hook. f. – Fig. 2F.  
*Pleuropetalum* is a member of *Amaranthoideae*. The genus is unusual in the family because of a higher stamen and carpel number (Eliasson 1988; Ronse De Craene & al. 1999).
- Pleuropterantha** Franch., Sert. Somal.: 59 (t. 5). 1882 sec. Townsend (1993). – Type: *Pleuropterantha revoilii* Franch.
- Polycnemum** L., Sp. Pl. 1: 35. 1753 sec. Masson & Kaderleit (2013). – Type: *Polycnemum arvense* L.  
= *Selago* Adans., Fam. Pl. 2: 268. 1763, nom. illeg.  
= *Rovillia* Bubani, Fl. Pyren. 1: 182. 1897.  
*Polycnemoideae*. The genus comprises six species distributed in Eurasia and northwestern Africa. It is sister to the rest of *Polycnemoideae* (Masson & Kaderleit 2013).
- Polyrhabda** C. C. Towns. in Kew Bull. 39: 775. 1984 sec. Townsend (1993). – Type: *Polyrhabda atriplicifolia* C. C. Towns.
- Pseudogomphrena** R. E. Fr. in Ark. Bot. 16(13): 17. 1920 sec. Townsend (1993). – Type: *Pseudogomphrena scandens* R. E. Fr.
- Pseudoplantago** Suess. in Repert. Spec. Nov. Regni Veg. 35: 334. 1934 sec. Townsend (1993). – Type: *Pseudoplantago friesii* Suess.
- Pseudoseriocoma** Cavaco in Mém. Mus Hist. Nat., Paris, Ser. Bot., 13: 66. 1962 sec. Townsend (1993). – Type: *Pseudoseriocoma pungens* (Fenzl) Cavaco
- Psilotrichopsis** C. C. Towns. in Kew Bull. 29 (3): 464. 1974 sec. Townsend (1993). – Type: *Psilotrichopsis curtisii* (Oliv.) C. C. Towns.
- Psilotrichum** Blume, Bijdr. Fl. Ned. Ind. 11: 544. 1826 sec. Townsend (1993). – Type: *Psilotrichum trichotomum* Blume  
The genus is highly polyphyletic (Müller & Borsch 2005a, b). Correct generic assignment has to await a comprehensive analysis of the achyranthoid clade.
- Ptilotus** R. Br., Prodr. Fl. Nov. Holland.: 415. 1810 sec. Townsend (1993). – Type: not designated.  
= *?Dipteranthemum* F. Muell. in South Sc. Record. 3: 281. 1883.  
*Ptilotus* has been recovered as monophyletic in the current circumscription, with the species diversity the result of a rapid diversification in Australia (Hammer & al. 2015).
- Pupalia** Juss. in Ann. Mus. Natl. Hist. Nat. 2: 132. 1803, nom. cons. sec. Townsend (1993). – Type: *Pupalia lappacea* (L.) Juss.
- Quaternella** Pedersen in Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 12: 92. 1990 sec. Pedersen (2000). – Type: *Quaternella confusa* Pedersen
- Rosifax** C. C. Towns. in Kew Bull. 46: 101. 1991 sec.

- Townsend (1993). – Type: *Rosifax sabuletorum* C. C. Towns.
- Saltia** R. Br. ex Moq. in Candolle, Prodr. 13(2): 325. 1849 sec. Townsend (1993). – Type: *Saltia papposa* (Forssk.) Moq.  
= *Psilodigera* Suess. in Mitt. Bot. Staatssamml. München 4: 109. 1952.
- Sericocoma** Fenzl in Endlicher, Gen. Pl. Suppl. 2: 33. 1842 sec. Townsend (1993). – Type: *Sericocoma trichinioides* Fenzl
- Sericocomopsis** Schinz in Bot. Jahrb. Syst. 21: 184. 1895 sec. Townsend (1993). – Type: *Sericocomopsis hildebrandtii* Schinz
- Sericorema** Lopr. in Bot. Jahrb. Syst. 27: 39. 1899 sec. Townsend (1993) = *Sericocoma* sect. *Sericorema* Hook. f., Gen. Pl. 3(1): 30. 1880. – Type: *Sericorema remotiflora* Lopr.
- Sericostachys** Gilg & Lopr. ex Lopr. in Bot. Jahrb. Syst. 27: 50. 1899 sec. Townsend (1993). – Type: not designated.
- Siamosia** K. Larsen & Pedersen in Nordic J. Bot. 7: 271. 1987 sec. Townsend (1993). – Type: *Siamosia thailandica* K. Larsen & Pedersen
- Stilbanthus** Hook. f. in Hooker's Icon. Pl. 13: 67. 1879 sec. Townsend (1993). – Type: *Stilbanthus scandens* Hook. f.
- Surreya** R. Masson & G. Kadereit in Taxon 62: 109. 2013 sec. Masson & Kadereit (2013). – Type: *Surreya diandra* (R. Br.) R. Masson & G. Kadereit *Polycnemoideae*. The Australian *Surreya* comprises two species of subshrubs (Masson & Kadereit 2013).
- Tidestromia** Standl. in J. Wash. Acad. Sci. 6: 70. 1916 sec. Townsend (1993) = *Alternanthera* sect. *Cladothrix* Moq. in Candolle, Prodr. 13(2): 359. 1849 = *Cladothrix* (Moq.) Nutt. ex Benth. & Hook. f., Gen. Pl. 3(1): 37. 1880, nom. illeg. – Type: *Tidestromia lanuginosa* (Nutt.) Standl. – Fig. 3A.  
The genus is monophyletic (Sánchez-del Pino & al. 2009).
- Trichuriella** Bennet in Indian J. Forest. 8: 86. 1985 sec. Townsend (1993) = *Trichurus* C. C. Towns. in Kew Bull. 29(3): 466. 1974, nom. illeg. – Type: *Trichuriella monsoniae* (L. f.) Bennet
- Volkensinia** Schinz in Vierteljahrsschr. Naturf. Ges. Zürich 57: 535. 1912 sec. Townsend (1993). – Type: *Volkensinia prostrata* (Volkens ex Gilg) Schinz
- Woehleria** Griseb., Abh. Königl. Ges. Wiss. Göttingen. 9: 11. 1860 sec. Townsend (1993). – Type: *Woehleria serpyllifolia* Griseb.
- Xerosiphon** Turcz. in Bull. Soc. Imp. Naturalistes Moscou 16: 55. 1843 sec. Pedersen (1990). – Type: *Xerosiphon gracilis* Turcz.  
A well-circumscribed monophyletic genus with two species that was long treated as part of a widely circumscribed genus *Gomphrena* Mart. but resurrected by Pedersen (1990) because of its morphological distinctness (gamopetalous perianth, cauline leaves reduced to scales). Molecular phylogenetic analyses (Sage & al. 2007; Sánchez-del Pino & al. 2009) depicted *Xerosiphon* as an isolated lineage in the gomphrenoid clade of subfamily *Gomphrenoideae*.
- Anacampserotaceae** Egli & Nyffeler sec. APG (2009).  
A family with three genera and around 36 species mainly distributed in the southern and eastern parts of Africa, but also found in North America, South America, and Australia (Nyffeler & Egli 2010a). The species of this family are traditionally considered members of *Portulacaceae*; however, molecular phylogenetic studies have shown that the traditional *Portulacaceae* are not monophyletic (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001; Nyffeler 2007; Nyffeler & Egli 2010a; Ocampo & Columbus 2010). Nyffeler & Egli (2010a) proposed the segregation of the traditional *Portulacaceae* into four families (*Anacampserotaceae*, *Montiaceae*, *Portulacaceae* and *Talinaceae*) based on morphological and molecular data. In this context, the *Anacampserotaceae* are recognized by their capsules with loculicidal dehiscence, endocarp valves forming a basket-like structure and seeds with testa layers separate from each other (Nyffeler & Egli 2010a).
- Anacampseros** L., Opera Var.: 232. 1758, nom. cons. sec. Nyffeler & Egli (2010a). – Type: *Anacampseros telephiastrum* DC.  
= *Talinaria* Brandege in Zoe 5: 231. 1908.  
= *Xenia* Gerbaulet in Bot. Jahrb. Syst. 113: 552. 1992.  
= *Avonia* (E. Mey. ex Fenzl) G. D. Rowley in Bradleya 12: 111. 1994.  
*Anacampseros* with c. 34 herbaceous species distributed in Africa, Australia, North and South America, is the most diverse genus of *Anacampserotaceae* (Nyffeler & Egli 2010a). Phylogenetic analyses recover this lineage as a derived monophyletic group with moderate statistical support (Nyffeler & Egli 2010a).
- Grahamia** Gillies ex Hook. & Arn. in Bot. Misc. 3: 331. 1833 sec. Carolin (1993). – Type: *Grahamia bracteata* Gillies
- Talinopsis** A. Gray in Smithsonian Contr. Knowl. 1: 14. 1852 sec. Carolin (1993). – Type: *Talinopsis frutescens* A. Gray  
Phylogenetic analyses recover the North American *Talinopsis frutescens* A. Gray, the only member of the genus, as the most basal member of *Anacampserotaceae* (Nyffeler & Egli 2010a; Ocampo & Columbus 2010).
- Ancistrocladaceae** Planch. ex Walp. sec. APG (2009).  
A monogeneric family comprising 18 species with a disjunct paleotropical distribution in western and central Africa and southeastern Asia (Rischer & al. 2005). The family includes only non-carnivorous plants characterized by having nuts, ruminant endosperm and a gynoeceium partly inferior with a single ovule (Heubl & al. 2006).

Traditionally, the family was placed either in the order *Theales* (e.g. Thorne 1992) or *Dilleniales* (e.g. Thorne 2000). However, the position of the family within *Caryophyllales* and its close relationship with the “partially carnivorous” *Dioncophyllaceae* (see there) was shown by the early molecular phylogenetic study of Nandi & al. (1998). These results were confirmed by subsequent studies (e.g. Meimberg & al. 2000; Cuénoud & al. 2002; Hilu & al. 2003; Brockington 2009, 2011; Schäferhoff & al. 2009; Renner & Specht 2011), which have also shown, with high support, that both *Ancistrocladaceae* and *Dioncophyllaceae* are part of the “carnivorous clade” of the *Caryophyllales*. Other studies focusing on the evolution of carnivory and relationships within this clade (e.g. Heubl & al. 2006; Renner & Specht 2011) suggest that the absence of carnivory in *Ancistrocladaceae* can be explained as a complete secondary loss of this character.

***Ancistrocladus*** Wall., Numer. List: 1052. 1829, nom. cons. sec. Porembski (2003). – Type: *Ancistrocladus hamatus* (Vahl) Gilg

***Asteropeiaceae*** Takht. ex Reveal & Hoogland sec. APG (2009).

A monogeneric family with eight species endemic to Madagascar (Kubitzki 2003). The genus was traditionally placed in *Theales*, either in its own family (e.g. Takhtajan 1987; Thorne 1992) or within *Theaceae* (e.g. Cronquist 1988). However, early molecular phylogenetic studies have shown the affinities of *Asteropeiaceae* within *Caryophyllales* and the close relationship with *Physenaceae* (e.g. Morton & al. 1997). These results were confirmed by subsequent studies (e.g. Cuénoud & al. 2002; Brockington 2009, 2011; Soltis & al. 2011). The clade *Asteropeiaceae*–*Physenaceae* is also well supported by wood-anatomical characters (e.g. Miller & Dickison 1992; Dickison & Miller 1993; Carlquist 2006); some member species (with small circular alternate pits on vessels, vascentric tracheids plus fibre tracheids, abaxial confluent diffuse parenchyma and predominantly uniseriate rays) have been proposed as synapomorphies to the family (e.g. Carlquist 2006).

***Asteropeia*** Thouars, Hist. Vég. Isles Austral. Afriq.: 51–52, pl. 15. 1805 sec. Kubitzki (2003a). – Type: *Asteropeia multiflora* Thouars

***Barbeuiaceae*** Nakai sec. APG (2009).

A monotypic family restricted to Madagascar (Rohwer 1993). The family is characterized by ovaries consisting of two united carpels with two locules and by capsules (Rohwer 1993). Traditionally, the family was placed in *Phytolaccaceae* subfamily *Barbeuioidae*, but its position as an independent lineage has been supported by several molecular phylogenetic studies (Cuénoud & al. 2002; Hilu & al. 2003; Schäferhoff & al. 2009).

***Barbeuia*** Thouars in Gen. Nov. Madagasc.: 6. 1806 sec. Rohwer (1993a). – Type: *Barbeuia madagascariensis* Steud.

***Basellaceae*** Raf. sec. APG (2009).

*Basellaceae* are a small tropical and subtropical family native to the Americas, southeastern Africa, Madagascar and possibly Asia. The centre of diversity is in the Andes of northwestern South America, but the centre of origin may very well be in Africa. At present, four genera (*Anredera*, *Basella*, *Tournonia*, *Ullucus*) with a total of 19 species are recognized, most of them succulent vines occurring in dry habitats. Some species are cultivated, and one (*Ullucus tuberosus* Caldas) is an important high-Andean crop grown for its edible tubers.

***Anredera*** Juss., Gen. Pl.: 84. 1789 sec. Eriksson (2007) ≡ *Clarisia* Abat in Mem. Acad. Real Soc. Med. Sevilla 10: 418. 1792. – Type: *Anredera spicata* J. F. Gmel.  
= *Boussingaultia* Kunth, Nov. Gen. Sp. (quarto ed.) 7: 194 t. 645. 1825.

= *Tandonia* Moq. in Candolle, Prodr. 13(2): 226. 1849 ≡ *Boussingaultia* sect. *Tandonia* (Moq.) Volkens, Nat. Pflanzenfam. 3(1a): 128. 1893 ≡ *Anredera* sect. *Tandonia* (Moq.) Steenis, Flora Malesiana, ser. 1, 5: 302. 1957.

= *Boussingaultia* sect. *Moquiniella* Hauman in Anales Mus. Nac. Buenos Aires 33: 351. 1925.

= *Boussingaultia* sect. *Euboussingaultia* Volkens, Nat. Pflanzenfam. 3(1a): 128. 1893, nom. inval.

= *Siebera* C. Presl in Isis (Oken) 21: 275. 1828, nom. nud.

= *Beriesa* Steud., Nomencl. Bot., ed. 2, 1: 199. 1840, nom. nud.

A monophyletic group of species in *Anredera* corresponds to the previously recognized taxon *Tandonia*, but a formal recognition of *Tandonia* would make the remaining *Anredera* paraphyletic (Eriksson 2007).

***Basella*** L., Sp. Pl. 1: 272. 1753 sec. Eriksson (2007). – Type: *Basella rubra* L.

= *Gandola* Raf., Sylva Tellur.: 60. 1838.

One species, *B. paniculata* Volkens, is morphologically deviating in *Basella*, and may be better placed in a genus of its own. A phylogenetic analysis based on morphological data gave inconclusive results regarding its placement (Eriksson 2007).

***Tournonia*** Moq. in Candolle, Prodr. 13(2): 221, 225. 1849 sec. Eriksson (2007). – Type: *Tournonia hookeriana* Moq.

***Ullucus*** Caldas in Seman. Nuev. Granad.: 185. 1809 sec. Eriksson (2007). – Type: *Ullucus tuberosus* Caldas

= *Melloca* Lindl. in Gard. Chron. 42: 685. 1847.

***Cactaceae*** Juss. sec. APG (2009).

*Cactaceae* comprise about 120 to 130 genera and some 1450 to 1870 species (Hunt 2006; Nyffeler & Eggl 2010b). Most species are highly modified perennial stem succulents which conserve water to survive temporary dry periods. Only some two dozen species of the genera *Pereskia*, *Peresklopsis* and *Quiabentia* have a shrubby or tree-like habit with more or less fleshy leaves. All species of the family bear characteristic spine clusters (i.e.

areoles), representing short shoots with leaves transformed into spines already at the stage of primordia. Some taxa are spineless and even lack areoles at maturity but all species bear areoles as seedlings. This characteristic is a true synapomorphy of the entire family. Cacti are native to the Americas, except for the widely distributed *Rhipsalis baccifera* (Sol.) Stearn that also occurs in tropical Africa, Madagascar, and on islands in the Indian Ocean. Several species from different lineages have been introduced worldwide as crop plants or ornamentals and have become naturalized, and are classified as invasive aliens in several areas, including Australia, southern Africa, and the Mediterranean. For a long time in the past, the classification into genera and suprageneric groups was based on form characteristics of vegetative and reproductive structures, culminating in the fine-grained classifications of Backeberg (1958–1962, 1966) or Buxbaum (1962) and Endler & Buxbaum (1974). Many of the highly modified structural features are associated with the succulent life strategy (e.g. Nyffeler & al. 2008), and hence provide particular challenges in the interpretation of a classification based on purported relationships. The consensus classification initiative as reported by Hunt & Taylor (1986) and subsequent papers helped to overcome the deviating systems used in the second part of the 20<sup>th</sup> century, but also fell short in not being based on further and expanded data sets of comparative data for reconstructing relative relationships. However, the molecular phylogenetic studies (see the introduction and Nyffeler & Egli (2010b) provide the base for an increasingly stable backbone classification for major suprageneric clades. At the same time, unexpected novel placements are suggested by such studies for several species or genera, such as *Blossfeldia* (Nyffeler 2002) or *Lymanbensonia* (Korotkova & al. 2010), while long-established genera, such as *Echinocactus* and *Ferocactus* but also *Mammillaria* have been found to be polyphyletic (Bárcenas & al. 2011; Hernández-Hernández & al. 2011; Vázquez-Sánchez & al. 2013). To use these findings for updating the generic classification of the family is a pronounced challenge (Hunt 2006; Nyffeler & Egli 2010b).

**Acanthocereus** (Engelm. ex A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 432. 1909 sec. Hunt (2006) = *Cereus* subsect. *Acanthocereus* Engelm. ex A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 77. 1905. – Type: *Acanthocereus baxaniensis* (Karw.) Borg

= *Monvillea* Britton & Rose, Cactaceae 2: 21. 1920. Currently accepted as monotypic with *A. tetragonus* (L.) Britton & Rose (Hunt 2006), whereas all other names suggested in this genus are of uncertain application or were wrongly assigned to *Acanthocereus*. The molecular phylogenetic study of Arias & al. (2005) showed that *Acanthocereus* would need to be expanded to include *Peniocereus* subg. *Pseudoacanthocereus* Sánchez-Mej., but no new combinations have yet been published.

**Acharagma** (N. P. Taylor) Glass in Guía Identif. Cact. Amenazadas México 1: [Ac/Ag]. 1997 sec. Vázquez-Sánchez & al. (2013) = *Escobaria* sect. *Acharagma* N. P. Taylor in Kakteen And. Sukk. 34: 185. 1983. – Type: *Acharagma roseanum* (Boed.) E. F. Anderson *Acharagma* includes only two species that were found well-supported as sister to each other by Vázquez-Sánchez & al. (2013).

**Ariocarpus** Scheidw. in Bull. Acad. Roy. Sci. Bruxelles 5: 491. 1838 sec. Vázquez-Sánchez & al. (2013). – Type: *Ariocarpus retusus* Scheidw.

= *Neogomesia* Castañeda in Cact. Succ. J. (Los Angeles) 13: 98. 1941.

= *Roseocactus* A. Berger in J. Wash. Acad. Sci. 15: 45. The monophyly of *Ariocarpus* was repeatedly confirmed (Butterworth & al. 2002; Bárcenas & al. 2011; Hernández-Hernández & al. 2001; Vázquez-Sánchez & al. 2013). Recent traditional treatments by Anderson & Fitz Maurice (1998) and Lüthy & Moser (2002).

**Armatocereus** Backeb. in Blätt. Kakteenf. 1938(6): [21]. 1938 sec. Hunt (2006). – Type: *Armatocereus laetus* (Kunth) Backeb.

**Arrojadoa** Britton & Rose, Cactaceae 2: 170. 1920 sec. Hunt (2006). – Type: *Arrojadoa rhodantha* (Gürke) Britton & Rose

= *Pierrebraunia* Esteves in Cact. Succ. J. (Los Angeles) 69: 296. 1997.

= *Arrojadoopsis* Guiggi in Cactology 1: 26. 2007. Recent floristic treatment by Taylor & Zappi (2004).

**Arthrocareus** A. Berger in Kakteen: 146, 337. 1929, nom. cons. sec. Hunt (2006). – Type: *Cereus damazioidi* K. Schum.

**Astrophytum** Lem., Cact. Gen. Sp. Nov.: 3-6. 1839 sec. Vázquez-Sánchez & al. (2013). – Type: *Astrophytum myriostigma* Lem.

= *Digitostigma* Velazco & Nevárez in Cact. Suc. Mex. 47: 79. 2002, nom. inval. Confirmed as monophyletic, including *Digitostigma*; therefore the transfer of *Digitostigma* to *Astrophytum*, as suggested by Hunt (2003), is justified.

**Austrocactus** Britton & Rose, Cactaceae 3: 44. 1922 sec. Hunt (2006). – Type: *Austrocactus bertinii* (Cels) Britton & Rose

**Austrocyliindropuntia** Backeb. in Blätt. Kakteenf. 6: 21. 1938 sec. Ritz & al. (2012). – Type: *Austrocyliindropuntia exaltata* (A. Berger) Backeb.

= *Andinopuntia* Guiggi, Cactology 2(Suppl.): [1]. 2011.

= *Bañiopuntia* Guiggi, Cactology 2(Suppl.): [1]. 2011.

= *Peruviopuntia* Guiggi, Cactology 2(Suppl.): [1]. 2011.

= *Trichopuntia* Guiggi, Cactology 2(Suppl.): 2. 2011. *Austrocyliindropuntia* as originally treated in Hunt (2006) was found as not monophyletic by Ritz & al. (2012). *Austrocyliindropuntia lagopus* (K. Schum.) F. Ritter was found sister to the remaining species of *Austrocyliindropuntia* and *Cumulopuntia* and was

- therefore segregated as a monotypic genus *Punotia* D. R. Hunt; see also there.
- Aylostera** Speg. in *Anales Soc. Ci. Argent.* 96: 75. 1923 sec. Ritz & al. (2007). – Type: *Aylostera pseudominuscula* (Speg.) Speg.
- = *Mediolobivia* Backeb. in *Blätt. Kakteenf.* 1934(2): 1934.
- = *Digitorebutia* Frič & Kreuz. ex Buining in *Succulenta* (Netherlands) 22. 1940.
- See notes under *Rebutia*. According to the molecular phylogenetic study of Mosti & al. (2011), *Aylostera* falls in two clades, *Aylostera* s.str. and *Mediolobivia* (incl. *A. einsteinii* (Frič ex Kreuz. & Buining) Mosti & Papini), which were recognized as subgenera by these authors. The genus is an excellent example for the notorious oversplitting prevalent in many cacti: Hunt (2006) (as *Rebutia* subg. *Rebutia*) accepted ten species, while Mosti & al. (2011) argued for 110 species.
- Aztekium** Boed. in *Monatsschr. Deutsch. Kakteen-Ges.* 1: 52. 1929 sec. Vázquez-Sánchez & al. (2013). – Type: *Aztekium ritteri* (Boed.) Boed.
- The genus contains only three species; two of them (*A. ritteri* and *A. hintonii* Glass & W. A. Fitz Maur.) have been found well supported as sisters to each other (Vázquez-Sánchez & al. 2013).
- Bergerocactus** Britton & Rose in *Contr. U. S. Natl. Herb.* 12: 435. 1909 sec. Hunt (2006). – Type: *Bergerocactus emoryi* (Engelm.) Britton & Rose
- Blossfeldia** Werderm. in *Kakteenkunde* 1937: 162. 1937 sec. Hunt (2006). – Type: *Blossfeldia liliputana* Werderm.
- The monotypic peculiar genus *Blossfeldia* is found as sister to the rest of the *Cactoideae* (Nyffeler 2002; Butterworth 2006).
- Borzicactus** Riccob. in *Boll. Reale Orto Bot. Palermo* 8: 261. 1909 sec. Hunt (2012b). – Type: *Borzicactus ventimigliae* Riccob.
- = *Clistanthocereus* Backeb. in *Cactaceae* (Berlin) 1937(1): 24. 1937.
- = *Seticereus* Backeb. in *Kakt. And. Sukk.* 1937: 37. 1937.
- = *Akersia* Buining in *Succulenta* (Netherlands) 1961: 25. 1961.
- = *Borzicactella* H. Johnson ex F. Ritter, *Kakteen Südamerika* 4: 1385. 1981.
- Borzicactus* is reinstated based on the results of Schlumpberger & Renner (2012). Its circumscription has been the subject of some debate, as summarized by Bregman (1992). The exact delimitation of *Borzicactus* and the genera currently included or considered related to it is still unclear.
- Brachycereus** Britton & Rose, *Cactaceae* 2: 120. 1920 sec. Hunt (2006). – Type: *Brachycereus nesioticus* (K. Schum.) Backeb.
- Brasilicereus** Backeb. in *Blätt. Kakteenf.* 1938(6): 22. 1938 sec. Hunt (2006). – Type: *Brasilicereus phaeacanthus* (Gürke) Backeb.
- = *Bragaia* Esteves, Hofacker & P. J. Braun in *Kakteen And. Sukk.* 60(12): 328. 2009.
- Recent floristic monograph by Taylor & Zappi (2004).
- Brasiliopuntia** (K. Schum.) A. Berger, *Entwicklungslin. Kakt.* 17, 18: 94. 1926 sec. Majure & al. (2012) ≡ *Opuntia* subg. *Brasiliopuntia* K. Schum., *Gesamtbeschr. Kakt.* 1898. – Type: *Brasiliopuntia brasiliensis* (Willd.) A. Berger
- Originally monotypic with *B. brasiliensis*. Majure & al. (2012) found good support for a sister-group relation of *Opuntia schickendantzii* F. A. C. Weber., and transferred this species to *Brasiliopuntia*.
- Browningia** Britton & Rose, *Cactaceae* 2: 63. 1920 sec. Hunt (2006). – Type: *Browningia candelaris* (Meyen) Britton & Rose
- = *Gymnanthocereus* Backeb. in *Blätt. Kakteenf.* 1937(8): Nachtr. 15 [2]. 1937.
- = *Azureocereus* Akers & H. Johnson in *Cact. Succ. J.* (Los Angeles) 21: 133. 1949.
- = *Gymnocereus* Backeb., *Cactaceae Handb. Kakteen. Pereskioideae Opuntioideae* 2: 920. 1959, nom. illeg.
- Calymmanthium** F. Ritter in *Kakteen And. Sukk.* 13: 25. 1962 sec. Hunt (2006). – Type: *Calymmanthium substerile* F. Ritter
- Monotypic; sampled by Korotkova & al. (2010) and resolved as sister to *Lymanbensonia*.
- Carnegiea** Britton & Rose in *J. New York Bot. Gard.* 9: 187. 1908 sec. Hunt (2006). – Type: *Carnegiea gigantea* (Engelm.) Britton & Rose – Fig. 3B.
- Castellanosia** Cárdenas in *Cact. Succ. J.* (Los Angeles) 23: 90. 1951 sec. Hunt (2006). – Type: *Castellanosia caineana* Cárdenas
- Cephalocereus** Pfeiff. in *Allg. Gartenzeitung* (Otto & Dietrich) 6: 142. 1838 sec. Arias & al. (2012) ≡ *Pilocereus* Lem., *Cact. Gen. Sp. Nov.*: 6-7. 1839, nom. illeg. – Type: *Cephalocereus senilis* (Haw.) K. Schum.
- = *Haseltonia* Backeb. in *Blätt. Sukkulenteenk.* 1: 3. 1949.
- = *Neodawsonia* Backeb. in *Blätt. Sukkulenteenk.* 1: 4. 1949.
- See under *Neobuxbaumia*.
- Cereus** Mill. in *Gard. Dict. Abr.*, ed. 4: [308]. 1754 sec. Hunt (2006). – Type: *Cereus hexagonus* (L.) Mill.
- = *Piptanthocereus* (A. Berger) Riccob. in *Boll. Reale Orto Bot. Palermo* 8: 225. 1909.
- = *Subpilocereus* Backeb. in *Blätt. Kakteenf.* 1938(6): 1938.
- = *Mirabella* F. Ritter, *Kakteen Südamerika* 1: 108. 1979.
- Cipocereus** F. Ritter in *Kakteen Südamerika* 1: 54. 1979 sec. Hunt (2006). – Type: *Cipocereus pleurocarpus* F. Ritter
- = *Floribunda* F. Ritter, *Kakteen Südamerika* 1: 58. 1979.
- Recent floristic monograph by Taylor & Zappi (2004).
- Cleistocactus** Lem., *Ill. Hort.* 8. 1861 sec. Hunt (2006). – Type: *Cleistocactus baumannii* (Lem.) Lem.

- = *Maritimocereus* Akers & Buining in Succulenta (Netherlands) 1950: 49. 1950.
- = *Bolivocereus* Cárdenas in Cact. Succ. J. (Los Angeles) 23: 91. 1951.
- = *Cephalocleistocactus* F. Ritter in Succulenta (Netherlands): 108. 1959.
- = *Seticleistocactus* Backeb. in Descr. Cact. Nov. 3. 1963.
- = *Hildewintera* F. Ritter in Kakteen And. Sukk. 17: 11. 1966, nom. inval.
- = *Winterocereus* Backeb., Kakteenlexikon 455. 1966.

The broad circumscription of *Cleistocactus* as employed by Anderson (2001, 2005), and Hunt (2006) goes back to the *Cactaceae* consensus classification reported by Hunt & Taylor (1986), where the predominantly ornithophilous floral syndrome was used as a diagnostic character. Schlumpberger & Renner (2012) found that *Cleistocactus* s.l. is polyphyletic – the monotypic *Cephalocleistocactus* was placed as sister to *Yungasocereus*, with *Cleistocactus* s.str. as sister to *Vatricania* next to *Weberbauerocereus*, and two terminals representing the former *Borzicactus* and *Loxanthocereus* were placed in the *Oreocereus* clade, the former next to *Matucana* and the latter next to *Haageocereus*. Deciding whether *Cleistocactus* s.l. should be retained or split up is difficult, since sampling of the group and its possible sister taxa is still inadequate. The affiliation of *Loxanthocereus* with *Haageocereus* was seen earlier, and Nyffeler & Egli (2010b) listed it as synonym of *Haageocereus*.

***Coleocephalocereus*** Backeb. in Blätt. Kakteenf. 1938(6): [22]. 1938 sec. Hunt (2006). – Type: *Coleocephalocereus fluminensis* (Miq.) Backeb.

- = *Buiningia* Buxb. in Krainz, Kakteen: 46–47, C IV. 1971.

Recent floristic monograph by Taylor & Zappi (2004).

***Consolea*** Lem. in Rev. Hort. (Paris) 1862: 174. 1862 sec. Majure & al. (2012). – Type: *Consolea spinosissima* (Mill.) Lem.

Plastid and nuclear ITS data so far provided inconclusive results for the placement of *Consolea* and its separation from *Opuntia*. *Consolea* was found to be imbedded in *Opuntia* by Griffith & Porter (2009) based on combined nuclear and plastid data. The plastid and nuclear data of Majure & al. (2012) supported the monophyly but were incongruent regarding the placement of *Consolea*: while plastid data resolved *Consolea* outside of *Opuntia* (BS=53%), nuclear ITS data resolve *Consolea* within *Opuntia* (BS=75%), yet both these placements receive only weak support. Support for a placement outside of *Opuntia* increased to 81% BS when only diploids were included in a combined nuclear and plastid analysis. Majure & al. (2012) pointed out that evolution in *Opuntia* and allies involves hybridization and allopolyploidization and that *Consolea* might be of allopolyploid origin, as indicated by the incongruent

plastid and nuclear trees. Nevertheless, Majure & al. (2012) argued for recognizing *Consolea* as a genus distinct from *Opuntia* because of good support for its monophyly, the placement by combined plastid and nuclear data outside of *Opuntia* and unique morphological characteristics.

***Copiapoa*** Britton & Rose, Cactaceae 3: 85. 1922 sec. Hunt (2006). – Type: *Copiapoa marginata* (Salm-Dyck) Britton & Rose

- = *Pilocopiapoa* F. Ritter in Kakteen And. Sukk. 12: 20. 1961.

Recent floristic treatment by Hoffmann & Walter (2005).

***Corryocactus*** Britton & Rose, Cactaceae 2: 66. 1920 sec. Hunt (2006). – Type: *Corryocactus brevistylus* (K. Schum. ex Vaupel) Britton & Rose

- = *Erdisia* Britton & Rose, Cactaceae 2: 104. 1920.

***Coryphantha*** (Engelm.) Lem. in Cactées: 32. 1868, nom. cons. prop. sec. Hunt (2006) = *Mammillaria* subg. *Coryphantha* Engelm. in Proc. Amer. Acad. Arts 3: 264. 1856. – Type: *Coryphantha sulcata* (Engelm.) Britton & Rose

- = *Lepidocoryphantha* Backeb. in Blätt. Kakteenf. 1938(6): 22. 1938.

- = *Escobrittonia* Doweld in Sukkulenty 3: 17. 2000.

Found as highly polyphyletic by Bárcenas & al. (2011), and as nested in *Mammillaria*. One core *Coryphantha* clade was resolved but only weakly supported as monophyletic (0.65 PP from Bayesian Inference). Vázquez-Sánchez & al. (2013) likewise found *Coryphantha* as polyphyletic, but not nested in *Mammillaria*; however, far fewer species were sampled therein. One maximally supported group was found that also contains *Neolloydia matehualensis* Backeb., while other *Coryphantha* species were found close to *Echinomastus* and *Escobaria*. As in the whole mammilloid clade, support for the relevant nodes is still weak and generic limits of *Coryphantha* need further evaluation. See also notes under *Mammillaria* and *Neolloydia*. Recent traditional monograph by Dicht & Lüthy (2003).

***Cumarinia*** (F. M. Knuth) Buxb. in Oesterr. Bot. Z. 98: 61. 1951 sec. Vázquez-Sánchez & al. (2013). – Type: *Cumarinia odorata* (Boed.) Buxb.

Monotypic; segregated from *Coryphantha* based on the results of Vázquez-Sánchez & al. (2013).

***Cumulopuntia*** F. Ritter in Kakteen Südamerika 2: 399. 1980 sec. Ritz & al. (2012). – Type: *Cumulopuntia ignescens* (Vaupel) F. Ritter

- = *Sphaeropuntia* Guiggi in Cactology 3 (Suppl. II): 1. 2012.

Griffith & Porter (2009) found no support for a monophyletic *Cumulopuntia*, but it was also not contradicted. *Cumulopuntia* was then confirmed as monophyletic by Ritz & al. (2012). *Cumulopuntia* falls in two clades in the molecular phylogeny, one consisting of *C. sphaerica* (C. F. Först.) E. F. An-



- derson and related taxa from the W Andean slopes of Chile and Peru, characterized by forming dwarf shrubs with easily detachable stem segments, and another consisting of *Cumulopuntia* s.str., characterized by growth in often dense cushions, with firmly attached stem segments (Griffith & Porter 2009; Ritz & al. 2012). For the *C. sphaerica* clade, the generic name *Sphaeropuntia* was recently published, but its circumscription is not yet fully resolved, and it is thus better treated as synonym for the time being.
- Cylindropuntia*** (Engelm.) F. M. Knuth, Nye Kaktusbog 102. 1930 sec. Hunt (2006) ≡ *Opuntia* subg. *Cylindropuntia* Engelm. in Proc. Amer. Acad. Arts 3: 302. 1856. – Type: *Cylindropuntia arborescens* (Engelm.) F. M. Knuth  
Griffith & Porter (2009) found no support for a monophyletic *Cylindropuntia* based on combined nuclear and plastid markers, while Bárcenas & al. (2011) found a monophyletic *Cylindropuntia* with high to maximal support based on plastid data only.
- Dendrocereus*** Britton & Rose, Cactaceae 2: 113. 1920 sec. Hunt (2006). – Type: *Dendrocereus nudiflorus* (Engelm.) Britton & Rose
- Denmoza*** Britton & Rose, Cactaceae 3: 78. 1922 sec. Hunt (2006). – Type: *Denmoza rhodacantha* (Salm-Dyck) Britton & Rose  
Monotypic; distributed in Argentina. Formal monograph by Leuenberger (1993).
- Discocactus*** Pfeiff. in Allg. Gartenzeitung (Otto & Dietrich) 5: 241. 1837 sec. Hunt (2006). – Type: *Discocactus insignis* Pfeiff.  
Recent floristic treatment by Taylor & Zappi (2004).
- Disocactus*** Lindl., Edwards's Bot. Reg. 31: t. 9. 1845 sec. Hunt (2006). – Type: *Disocactus biformis* (Lindl.) Lindl.  
= *Aporocactus* Lem. in Ill. Hort. 7: misc. 67. 1860.  
= *Cereus* subsect. *Heliocereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 78. 1905 ≡ *Heliocereus* (A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 433. 1909.  
= *Chiapasia* Britton & Rose, Cactaceae 4: 203. 1923.  
= *Nopalxochia* Britton & Rose, Cactaceae 4: 204. 1923.  
= *Bonifazia* Standl. & Steyerl. in Publ. Field Mus. Nat. Hist., Bot. Ser. 23: 66. 1944.  
= *Pseudonopalxochia* Backeb., Cactaceae Handb. Kakteen. Pereskioideae Opuntioideae 1: 69. 1958.
- Echinocactus*** Link & Otto, Verh. Vereins. Beförd. Gartenbaues Königl. Preuss. Staaten 3: 420. 1827 sec. Vázquez-Sánchez & al. (2013). – Type: *Echinocactus platyacanthus* Link & Otto  
= *Echinofossulocactus* Lawr. in Gard. Mag. & Reg. Rural Domest. Improv. 17: 317. 1841.  
= *Homalocephala* Britton & Rose, Cactaceae 3: 181. 1922.  
= *Emorycactus* Doweld in Succulenta (Netherlands) 75: 270. 1996.  
= *Meyerocactus* Doweld in Succulenta (Netherlands) 75: 271. 1996.  
= *Kroenleinia* Lodé in Cact. Avent. Int. 102: 25. 2014.  
*Echinocactus* turns out to be paraphyletic in recent molecular studies (Bárcenas & al. 2011; Hernández-Hernández & al. 2011; Vázquez-Sánchez & al. 2013), with *E. grusonii* Hildm. resolved in a separate clade from the remaining four species, yet with only low support (Vázquez-Sánchez & al. 2013) or in a polytomy (Bárcenas & al. 2011). Vázquez-Sánchez & al. (2013) re-circumscribed *Echinocactus* to include only four species, excluding *E. grusonii* and also *E. polycephalus* Engelm. & J. M. Bigelow but did not suggest new generic assignment for these species. The generic name *Kroenleinia* was recently erected for *E. grusonii*, but it may be premature to accept this monotypic genus in view of the numerous unresolved or poorly supported topologies in the group.
- Echinocereus*** Engelm. in Wislizenus, Mem. Tour N. Mexico: 91. 1848 sec. Sánchez & al. (2014). – Type: *Echinocereus viridiflorus* Engelm.  
= *Wilcoxia* Britton & Rose in Contr. U. S. Natl. Herb. 12: 434. 1909.  
*Echinocereus* was studied in detail and found as monophyletic by Sánchez & al. (2014) but excluding *E. pensilis* J. A. Purpus, which was resolved distant from *Echinocereus* and as sister to the *Stenocereus* group. Because *E. pensilis* had been regregated as a monotypic genus *Morangaya*, its reinstatement was suggested by Sánchez & al. (2014).
- Echinopsis*** Zucc. in Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 2: 675. 1837 sec. Hunt (2006). – Type: *Echinopsis eyriesii* (Turpin) Zucc. ex Pfeiffer & Otto  
= *Trichocereus* (A. Berger) Riccob. in Boll. Reale Orto Bot. Palermo 8: 236. 1909.  
= *Chamaecereus* Britton & Rose, Cactaceae 3: 48. 1922.  
= *Lobivia* Britton & Rose, Cactaceae 3: 49. 1922.  
= *Acanthocalycium* Backeb., Kaktus ABC: 224, 412. 1935.  
= *Soehrensia* Backeb. in Blätt. Kakteenf. 1938(6): [21]. 1938.  
= *Setiechinopsis* (Backeb.) de Haas in Succulenta (Netherlands) 22: 9. 1940.  
= *Acantholobivia* Backeb. in Cactaceae (Berlin) 1941(2): 76. 1942.  
= *Pseudolobivia* (Backeb.) Backeb. in Cactaceae (Berlin) 1941: 76. 1942.  
= *Reicheocactus* Backeb. in Cactaceae (Berlin) 1941(2): 76. 1942.  
= *Helianthocereus* Backeb. in Cact. Succ. J. Gr. Brit. 11: 53. 1949.  
= *Leucosteles* Backeb. in Kakt. And. Sukk. 4: 1. 1953.  
The present wide circumscription of *Echinopsis* goes back to the mid-1970s. First indications that this broad *Echinopsis* is polyphyletic were found by Lendel & al. (2006) and Ritz & al. (2007), and Schlump-

berger & Renner (2012) in their deeply sampled study indeed found vast polyphyly and paraphyly throughout most of the subtribe *Trichocereinae*. Species of *Echinopsis* were scattered over eight different clades and interspersed with species of *Acanthocalycium*, *Arthrocerus*, *Borzicactus*, *Cephalocleistocactus*, *Cleistocactus*, *Denmoza*, *Espostoa*, *Haageocereus*, *Harrisia*, *Matucana*, *Mila*, *Oreocereus*, *Oroya*, *Pygmaeocereus*, *Rauhocereus*, *Samaipaticereus*, *Weberbauerocereus* and *Yungasocereus*, all of which are part of a highly supported clade (100% BS). To transform their results into a formal classification of monophyletic genera is no easy task. It would entail either to further broaden an already very heterogeneous genus by including the genera mentioned above or to accept about a dozen segregates (valid generic names are at hand). Nevertheless, maintaining *Echinopsis* (sensu Hunt 2006) is rather not an option, as it is clearly polyphyletic and should be split up. The necessary new combinations are already available (Schlumberger 2012); a fully revised generic circumscription is still to be published.

**Epiphyllum** Haw. in Syn. Pl. Succ.: 197. 1812 sec. Hunt (2006) = *Phyllocactus* Link, Handbuch 2: 10. 1829, nom. illeg. – Type: *Epiphyllum phyllanthus* (L.) Haw. = *Marniera* Backeb. in Cact. Succ. J. (Los Angeles) 22. 1950.

**Epithelantha** F. A. C. Weber ex Britton & Rose, Cactaceae 3: 92. 1922 sec. Vázquez-Sánchez & al. (2013). – Type: *Epithelantha micromeris* (Engelm.) F. A. C. Weber ex Britton & Rose

The number of species is in dispute, and the recent work of Donati & Zanollo (2011) recognizes about half a dozen species. So far only *E. micromeris* sampled in a phylogenetic study (Vázquez-Sánchez & al. 2013), and found in an isolated position within the tribe *Cacteeae*.

**Eriogyne** Phil. in Anales Univ. Chile 41: 721. 1872 sec. Hunt (2006). – Type: *Eriogyne sandillon* (Gay) Phil.

= *Islaya* Backeb. in Blätt. Kakteenf. 1834: [3]. 1834.  
= *Neopteris* Britton & Rose, Cactaceae 3: 94. 1922.  
= *Pyrrhocactus* A. Berger, Kakteen: 215, 345. 1929.  
= *Horridocactus* Backeb. in Blätt. Kakteenf. 1938(6): [21]. 1938.

= *Neochilenia* Backeb. in Repert. Spec. Nov. Regni Veg. 51: 60. 1942.

= *Thelocephala* Y. Itô, Explan. Diagr. Austroechinocactinae: 292. 1957.

= *Rimacactus* Mottram in Bradleya 19: 75. 2001.

The diminutive *Eriogyne laui* Lüthy from northern Chile has been found to differ morphologically from the remaining taxa of *Eriogyne* s.l. by Nyffeler & Egli (1997), and was subsequently segregated as the monotypic genus *Rimacactus*. As long as this segregation is not backed up by molecular data, it appears premature to accept the genus. Recent treatments by

Kattermann (1994) and Hoffmann & Walter (2005; Chile).

**Escobaria** Britton & Rose, Cactaceae 4: 53. 1923 sec. Hunt (2006). – Type: *Escobaria tuberculosa* (Engelm.) Britton & Rose

= *Neobesseya* Britton & Rose, Cactaceae 4: 51. 1923.

= *Cochiseia* W. H. Earle in Saguaro Land Bull. 30: 65. 1976.

= *Escocoryphantha* Doweld in Sukkulenty 1999(1): 10. 1999.

See notes under *Mammillaria*.

**Escontria** Rose in Contr. U. S. Natl. Herb. 10: 125. 1906 sec. Hunt (2006). – Type: *Escontria chiotilla* (F. A. C. Weber ex K. Schum.) Rose

Recent monograph by Gibson (1988a).

**Espostoa** Britton & Rose, Cactaceae 2: 60. 1920 sec. Hunt (2006). – Type: *Espostoa lanata* (Kunth) Britton & Rose

= *Pseudoespostoa* Backeb. in Blätt. Kakteenf. 1834: gen. 104. 1834 = *Binghamia* Britton & Rose, Cactaceae 2: 167. 1920.

= *Thrixanthocereus* Backeb. in Blätt. Kakteenf. 1937(8): Nachtr. 15. 1937.

**Espostoopsis** Buxb. in Krainz, Kakteen: 38–39, C Va. 1968 sec. Hunt (2006). – Type: *Espostoopsis dybowskii* (Rol.-Goss.) Buxb.

**Eulychnia** Phil. in Fl. Atacam.: 23. 1860 sec. Hunt (2006). – Type: *Eulychnia breviflora* Phil.

= *Philippicereus* Backeb. in Cactaceae (Berlin) 1941(2): 75. 1942.

Recent monograph by Hoffmann & Walter (2005).

**Facheiroa** Britton & Rose, Cactaceae 2: 173. 1920 sec. Hunt (2006). – Type: *Facheiroa pubiflora* Britton & Rose

= *Zehntnerella* Britton & Rose, Cactaceae 2: 176. 1920. Recent floristic treatment by Taylor & Zappi (2004).

**Ferocactus** Britton & Rose, Cactaceae 3: 123. 1922 sec. Vázquez-Sánchez & al. (2013). – Type: *Ferocactus wislizeni* (Engelm.) Britton & Rose

= *Bisnaga* Orcutt in Cactography 1. 1926 = *Ferocactus* sect. *Bisnaga* (Orcutt) N. P. Taylor & J. Y. Clark in Bradleya 1: 6. 1983.

Vázquez-Sánchez & al. (2013) found *Ferocactus* in its current circumscription to be vastly polyphyletic, and the same is true for *F.* sect. *Bisnaga*. The *Ferocactus* clade found by Vázquez-Sánchez & al. (2013) also includes the genera *Glandulicactus*, *Leuchtenbergia*, *Stenocactus* and *Thelocactus*, corroborating the results of a much less dense sampling by Hernández-Hernández & al. (2011). The *Ferocactus* clade is morphologically characterized by pericarpels with scales and ribbed stems, and Vázquez-Sánchez & al. (2013) suggested expanding *Ferocactus* to embrace the genera just mentioned as the best taxonomic solution to make *Ferocactus* monophyletic, yet *Leuchtenbergia* is the oldest name of this assemblage and would have priority, unless the name *Ferocactus* is conserved.

- Frailea*** Britton & Rose, *Cactaceae* 3: 208. 1922 sec. Hunt (2006). – Type: *Frailea cataphracta* (Dams) Britton & Rose
- Geohintonia*** Glass & W. A. Fitz. Maur. in *Cact. Suc. Mex.* 37: 16. 1992 sec. Vázquez-Sánchez & al. (2013). – Type: *Geohintonia mexicana* Glass & W. A. Fitz. Maur.  
Monotypic; sampled by Vázquez-Sánchez & al. (2013) and resolved as sister to *Aztekium*.
- Glandulicactus*** Backeb. in *Blätt. Kakteenf.* 1938(6): [22]. 1938 sec. Hunt (2006). – Type: *Glandulicactus uncinatus* (Galeotti ex Pfeiff.) Backeb.  
See notes under *Ferocactus*.
- Grusonia*** Rchb. f. ex Britton & Rose, *Cactaceae* 1: 215. 1919 sec. Hunt (2006). – Type: *Grusonia bradtiana* (J. M. Coult.) Britton & Rose  
= *Corynopuntia* F. M. Knuth, *Kaktus ABC*: 114, 410. 1936.  
= *Micropuntia* Daston in *Amer. Midl. Naturalist* 36: 661. 1946.  
= *Marenopuntia* Backeb. in *Desert Pl. Life* 22: 27. 1950. *Corynopuntia* was included in *Grusonia* s.l. (Wallace & Dickie 2002; Anderson 2001, 2005; Nyffeler & Eggli 2010b), then accepted as separate genus by Hunt (2006). Griffith & Porter (2009) argued for recognizing *Corynopuntia* as a distinct genus, and *Grusonia* as monotypic, although support for the monophyly of *Corynopuntia* was only 67% BS in their study. Their data also suggest that *Micropuntia* could be recognized as a separate genus. Bárcenas & al. (2011) did not find support for treating *Corynopuntia* separately from *Grusonia*, and in addition found no support for a monophyletic *Corynopuntia*; therefore, the circumscription of *Corynopuntia* still needs to be clarified.
- Gymnocalycium*** Pfeiff. ex Mittler, *Taschenb. Cactuslieb.* 2: 124. 1844 “Gymnocalycium” sec. Demaio & al. (2011). – Type: *Gymnocalycium gibbosum* (Haw.) Pfeiff. ex Mittler  
Found as monophyletic at first by Ritz & al. (2007), then studied in more detail and confirmed as monophyletic by Meregalli & al. (2010). Demaio & al. (2011) conducted the most detailed phylogenetic study by sampling almost the whole genus and again confirmed the monophyly of *Gymnocalycium* with maximal support. Recent illustrated synopsis by Charles (2009).
- Haageocereus*** Backeb. in *Blätt. Kakteenf.* 1934(6): [1]. 1934 sec. Hunt (2006). – Type: *Haageocereus pseudomelanostele* (Werderm. & Backeb.) Backeb.  
= *Loxanthocereus* Backeb. in *Cactaceae* (Berlin) 1937(1): 24. 1937.  
= *Peruvocereus* Akers in *Cact. Succ. J. (Los Angeles)* 19: 67. 1947.  
= *Maritinocereus* Akers & Buining in *Succulenta* (Netherlands) 1950: 49. 1950.  
Recent monograph by Calderón & al. (2007).
- Harrisia*** Britton in *Bull. Torrey Bot. Club* 35: 561. 1909 sec. Franck & al. (2013a). – Type: *Harrisia gracilis* (Mill.) Britton  
= *Eriocereus* Riccob. in *Boll. Reale Orto Bot. Palermo* 8: 238. 1909.  
= *Roseocereus* Backeb. in *Blätt. Kakteenf.* 1938(6): 21. 1938.  
= *Estevesia* P. J. Braun in *Kakteen And. Sukk.* 60(3): 64. 2009.  
*Harrisia* was confirmed as monophyletic by Franck (2012), with a revised infrageneric classification published shortly after (Franck & al. 2013a). The recently described genus *Estevesia* P. J. Braun was not included in any molecular study so far. It was provisionally placed in the synonymy of *Harrisia* by Nyffeler & Eggli (2010b). For synopsis see Franck (2012); further phylogenetic studies see Franck & al. (2013b).
- Hattiora*** Britton & Rose in L. H. Bailey, *Standard Cycl. Hort.*: 1432. 1915 sec. Korotkova & al. (2011). – Type: *Hattiora salicornioides* (Haw.) Britton & Rose  
= *Pseudozygocactus* Backeb. in *Blätt. Kakteenf.* 1938(6): [5, 21]. 1938.  
The circumscription of *Hattiora* has been clarified recently. *Hattiora* including *Rhipsalidopsis* as adopted by Barthlott (1987), Barthlott & Hunt (1993), Barthlott & Taylor (1995), Hunt (2006) and Nyffeler & Eggli (2010b) was found to be polyphyletic (Calvente & al. 2011; Korotkova & al. 2011). *Hattiora* should therefore be restricted to species with cylindrical stems, terete pericarpels, and small yellow-orange or magenta flowers, corresponding to *Hattiora* in the traditional sense. Accordingly, *Rhipsalidopsis* in its traditional circumscription should again be accepted at generic rank.
- Hylocereus*** (A. Berger) Britton & Rose in *Contr. U. S. Natl. Herb.* 12: 428. 1909 sec. Hunt (2006) ≡ *Cereus* subg. *Hylocereus* A. Berger in *Rep. (Annual) Missouri Bot. Gard.* 16: 72. 1905. – Type: *Hylocereus triangularis* (L.) Britton & Rose  
= *Wilmattea* Britton & Rose, *Cactaceae* 2: 195. 1920.  
*Hylocereus* is morphologically very similar to *Selenicereus*, and available phylogenetic studies as well as morphological and anatomical data so far suggest that the two genera could be merged (Hernández-Hernández & al. 2011; Bárcenas & al. 2011, Gómez-Hinostrosa & al. 2014), but they still need to be studied more extensively before firm conclusions on their circumscription are possible.
- Jasminocereus*** Britton & Rose, *Cactaceae* 2: 146. 1920 sec. Hunt (2006). – Type: *Jasminocereus thoarsii* (F. A. C. Weber) Backeb.
- Lasiocereus*** F. Ritter in *Kakteen Südamerika* 4: 1477. 1981 sec. Hunt (2006). – Type: *Lasiocereus rupicola* F. Ritter
- Lemaireocereus*** Britton & Rose in *Contr. U. S. Natl. Herb.* 12: 424. 1909 sec. Arias & al. (2012) ≡ *Pachycereus* subg. *Lemaireocereus* (Britton & Rose) Bravo

in Cact. Suc. Mex. 17: 119. 1972  $\equiv$  *Pachycereus* sect. *Lemaireocereus* (Britton & Rose) P. V. Heath in Calyx 2: 106. 1992. – Type: *Lemaireocereus hollianus* (F. A. C. Weber) Britton & Rose

= *Anisocereus* Backeb. in Blätt. Kakteenf. 1938(6): 21. 1938.

In the second half of the 20<sup>th</sup> century, *Lemaireocereus* was referred to as a synonym of *Pachycereus* (see there) by Buxbaum (1961), Bravo-Hollis (1978), and Gibson & Horak (1978), based on similar floral morphology. Phylogenies based on molecular (Arias & al. 2003) and structural data (Arias & Terrazas 2006) consistently have revealed that *Lemaireocereus* is an early-diversified lineage within *Pachycereinae*. *Lemaireocereus* should be restricted to species with rounded ribs, terminal flowers with long hairs and bristles, fruit with irregular dehiscence, and red pulp (Arias & Terrazas 2009; Arias & al. 2012).

**Leocereus** Britton & Rose, Cactaceae 2: 108. 1920 sec. Hunt (2006). – Type: *Leocereus bahiensis* Britton & Rose

Recent floristic treatment by Taylor & Zappi (2004).

**Lepismium** Pfeiff. in Allg. Gartenzeitung 3: 315. 1835 sec. Korotkova & al. (2011). – Type: *Lepismium commune* Pfeiff.

= *Nothorhypsalis* Doweld in Sukkulenty 4(1–2): 29. 2002.

= *Ophiorhypsalis* (K. Schumann) Doweld in Sukkulenty 4(1–2): 39. 2002.

Several considerably different generic concepts have been suggested for *Lepismium* in the past 80 years. It was either recognized as monotypic for *L. cruciforme* (Vell.) Miq., e.g. by Britton & Rose (1923) or included into *Rhypsalis* (Schumann 1899; Vaupel 1925, 1926). Barthlott (1987) and Barthlott & Taylor (1995) redefined *Lepismium* based on the mesotonic branching as the main diagnostic character, but this circumscription was found to be polyphyletic by Nyffeler (2002) and Korotkova & al. (2010). Consequently, some of its species were transferred to *Lymanbensonia* and *Pfeiffera* by Korotkova & al. (2010). Recent monograph by Barthlott & Taylor (1995).

**Leptocereus** (A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 433. 1909 sec. Hunt (2006)  $\equiv$  *Cereus* subg. *Leptocereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 79. 1905. – Type: *Leptocereus assurgens* (C. Wright ex Griseb.) Britton & Rose

= *Neoabbottia* Britton & Rose in Smithsonian Misc. Collect. 72: 2. 1921.

**Leuchtenbergia** Hook. in Bot. Mag.: 4393. 1848 sec. Hunt (2006). – Type: *Leuchtenbergia principis* Hook.

See notes under *Ferocactus*.

**Leuenbergeria** Lodé in Cact. Avent. Int. 97: 26. 2012 sec. Lodé (2012)  $\equiv$  *Pereskia* subg. *Leuenbergera* G. D. Rowley in Cactaceae Syst. Init. 32: 7. 2014. – Type: *Leuenbergeria quisqueyana* (Alain) Lodé

Segregated from *Pereskia* to include the northern clade; see note under *Pereskia*.

**Lophocereus** (A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 426. 1909 sec. Arias & al. (2012)  $\equiv$  *Cereus* subg. *Lophocereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 62. 1905  $\equiv$  *Pachycereus* sect. *Lophocereus* (A. Berger) P. V. Heath in Calyx 2: 106. 1992. – Type: *Lophocereus schottii* (Engelm.) Britton & Rose

= *Marginatocereus* (Backeb.) Backeb., Cact. Jahrb. Deutsch. Kakt.-Ges. 77. 1941 (1942).

*Lophocereus* (including *L. gates* and *L. schottii*) was strongly recognized as a separate genus, restricted to the Sonoran Desert, by e.g. Lindsay (1963) and Bravo-Hollis (1978). Comparative studies carried out by Gibson & Horak (1978) showed that those species share morphological and anatomical characteristics with *Pachycereus marginatus* (DC.) Britton & Rose. However, other taxonomists preferred to include this genus and others (e.g. *Backebergia*, *Lemaireocereus*, *Marginatocereus*, *Mitrocereus*, *Pterocereus*) in a broader genus *Pachycereus* (Barthlott & Hunt 1993; Hunt 2006). Phylogenetic studies based on structural (anatomy + morphology) and molecular data confirm that *Lophocereus* is monophyletic including three species (*L. marginatus* (DC.) S. Arias & Terrazas as sister to the remaining species). The genus represents a lineage within the subtribe *Pachycereinae*, but is not directly related to *Pachycereus* s.str. or *Backebergia* (see there; Hartmann S. & al. 2001, 2002; Arias & al. 2003; Arias & Terrazas 2006). A proposal to recognize this genus newly circumscribed (now going also beyond the Sonoran Desert) was conducted by Arias & al. (2012). *Lophocereus* now includes taxa characterized by cylindrical stems with basal branching, an apical fertile zone with areoles, and spines larger than those of the sterile zone, and two or more flowers per areole. The flowering zone is conspicuously modified in all three species, although in *L. gatesii* M. E. Jones and *L. schottii* internodes are shorter and spines are longer (Arias & Terrazas 2009; Arias & al. 2012). Structural changes in the fertile zone exist between several genera of *Pachycereinae*, including cephalium (e.g. *Backebergia* and *Cephalocereus* species), pseudocephalium (e.g. *Lophocereus* and *Neobuxbaumia* species) and intermediate forms. However, those structures are highly homoplastic and occur within several genera.

**Lophophora** J. M. Coult. in Contr. U. S. Natl. Herb. 3: 131. 1894 sec. Vázquez-Sánchez & al. (2013). – Type: *Lophophora williamsii* (Lem. ex Salm-Dyck) J. M. Coult.

Butterworth & al. (2002) found *L. williamsii* as sister to *Obregonia* and *L. diffusa* (Croizat) Bravo as sister to *Acharagma*, yet both with only moderate support. In contrast, *Lophophora williamsii* and *L. dif-*

- fusa* were resolved as sisters with moderate support in the study of Vázquez-Sánchez & al. (2013), who also found high support for the sister relationship of *Lophophora* and *Obregonia*, justifying generic rank for both.
- Lymanbensonia** Kimnach in Cact. Succ. J. (Los Angeles) 56: 101. 1984 sec. Korotkova & al. (2010). – Type: *Lymanbensonia micrantha* (Vaupel) Kimnach
- = *Acanthorhopsalis* Kimnach in Cact. Succ. J. (Los Angeles) 55: 177. 1983, nom. illeg.
- Segregated from *Acanthorhopsalis* (Kinnach 1984), but otherwise either assigned to *Lepismium* (Barthlott 1987; Barthlott & Taylor 1995; Anderson 2001, 2005) or to *Pfeiffera* (Hunt 2006). The molecular phylogenetic study of Korotkova & al. (2010) unexpectedly found the three species now assigned to *Lymanbensonia* to represent a highly supported isolated clade distant from either *Lepismium* or *Pfeiffera*. As this new clade contained the nomenclatural type of *Lymanbensonia*, this generic name was reinstated.
- Maihuenia** (Phil. ex F. A. C. Weber) K. Schum. in Gesamtbeschr. Kakt. 651: 754. 1898 sec. Hunt (2006) = *Pereskia* subg. *Maihuenia* Phil. ex F. A. C. Weber in Bois, Dict. Hort. 2: 938. 1898. – Type: *Maihuenia poeppigii* (Otto ex Pfeiff.) F. A. C. Weber ex K. Schum. Recent monograph by Leuenberger (1997).
- Maihueniopsis** Speg. in Anales Soc. Ci. Argent. 99: 86. 1925 sec. Ritz & al. (2012). – Type: *Maihueniopsis molfinoi* Speg.
- = *Puna* R. Kiesling in Hickenia 1: 289. 1982 = *Maihueniopsis* subg. *Puna* (R. Kiesling) Stuppy in Succ. Pl. Res. 6: 50. 2002.
- Griffith & Porter (2009) found *Maihueniopsis* polyphyletic based on a combined analysis of nuclear ITS and plastid *trnL-F*, but Ritz & al. (2012) found a monophyletic *Maihueniopsis* to be strongly supported by nuclear *phyC* and plastid *trnK/matK*. The reasons for these deviating results are discussed in detail by Ritz & al. (2012) and appear to result from peculiarities in the evolution of the ITS sequences used by Griffith & Porter (2009) that seem unsuitable to adequately represent phylogenetic relationships.
- Mammillaria** Haw. in Syn. Pl. Succ.: 177. 1812, nom. cons. sec. Hunt (2006) = *Cactus* L., Sp. Pl. 1: 466. 1753 = *Neomammillaria* Britton & Rose, Cactaceae 4: 65. 1923. – Type: *Mammillaria simplex* Haw.
- = *Mammillaria* subg. *Cochemiea* K. Brandegee, Erythea 5: 113. 1897.
- = *Cochemiea* (K. Brandegee) Walton in Cact. J. (London) 2: 50. 1899.
- = *Bartschella* Britton & Rose, Cactaceae 4: 57. 1923.
- = *Dolichothele* (K. Schum.) Britton & Rose, Cactaceae 4: 61. 1923.
- = *Mamillopsis* Britton & Rose, Cactaceae 4: 19. 1923.
- = *Phellosperma* Britton & Rose, Cactaceae 4: 60. 1923.
- = *Solisia* Britton & Rose, Cactaceae 4: 64. 1923.
- = *Chilita* Orcutt in Cactography 2. 1926.
- = *Porfiria* Boed. in Z. Sukkulantenk. 2. 1926.
- = *Krainzia* Backeb. in Blätt. Kakteenf. 1938(6): [22]. 1938.
- = *Mammilloidia* Buxb. in Oesterr. Bot. Z. 98: 64. 1951.
- = *Oehmea* Buxb. in Sukkulantenk. 7: 17. 1951.
- = *Pseudomammillaria* Buxb. in Oesterr. Bot. Z. 98: 84. 1951.
- = *Leptocladodia* Buxb. in Oesterr. Bot. Z. 101. 1954.
- = *Escobariopsis* Doweld in Sukkulenty 3: 23. 2000.
- Mammillaria* is the largest genus within *Cactaceae*, and numerous suggestions for infrageneric entities have been proposed, often then segregated as different genera; the different taxonomic concepts were summarized by Butterworth & Wallace (2004). Although several phylogenetic studies dealing with the genus and allies have been published, there are still many uncertainties that result from insufficient phylogenetic resolution and support. *Mammillaria* was studied in detail using data from the plastid *rpl16* intron and *psbA-trnH* intergenic spacer by Butterworth & Wallace (2004), who sampled c. 4/5 of the accepted species, and Bárcenas & al. (2011) for *trnK/matK* compiled an even more extensive sampling. *Mammillaria* was also included in the phylogenetic studies of the tribe *Cacteeae* by Butterworth & al. (2002) and Vázquez-Sánchez & al. (2013), though with much fewer species sampled. The first sequence data already hinted at a non-monophyly of *Mammillaria* (Butterworth & al. 2002), yet without support. The results of Butterworth & Wallace (2004), based on a detailed sampling, again suggested polyphyly of *Mammillaria*. The genera *Coryphantha*, *Escobaria*, *Mammilloidia*, *Neolloydia*, *Ortegocactus* and *Pelecyphora* were found nested in a maximally supported *Mammillaria* s.l. clade. Bárcenas & al. (2011) did not find sufficient support for a monophyletic *Mammillaria*, and *Coryphantha* (likewise polyphyletic), *Escobaria* and *Ortegocactus* were nested in different *Mammillaria* clades. Vázquez-Sánchez & al. (2013) found that *Coryphantha* and *Mammillaria* could be separate clades, yet *Mammillaria* was supported as monophyletic only in the parsimony tree (61% BS/78% JK), but not found as monophyletic by Bayesian Inference. A clade of *Coryphantha* incl. *Neolloydia* was maximally supported in the parsimony and Bayesian trees, but *C. macromeris* (Engelm.) Lem. fell outside that clade, suggesting that *Coryphantha* is likewise polyphyletic. *Escobaria* was found polyphyletic as well (Vázquez-Sánchez & al. 2013), but only few species have been sampled. The results of Vázquez-Sánchez & al. (2013) also provided some insights into generic limits in the whole assemblage, as well as taxonomic changes by segregating *Cochemiea* from *Mammillaria*, and *Cumarinia* from *Coryphantha*. *Mammilloidia* was found nested in *Mammillaria* (Butterworth & al. 2002; Butterworth & Wallace 2004; Bárcenas & al. 2011; Vázquez-Sánchez & al. 2013), and

all authors argue *Mammilloidya* should therefore no longer be recognized at generic rank. The *Mammillaria* assemblage therefore remains one of the *Cactaceae* groups that need further detailed study. Some nodes were so far only weakly supported, and final conclusions regarding the monophyly and generic limits of *Mammillaria* must await a more extensive sampling, especially for *Coryphantha* and *Escobaria*; only then will firm taxonomic and nomenclatural conclusions be possible.

**Matucana** Britton & Rose, *Cactaceae* 3: 102. 1922 sec. Hunt (2006). – Type: *Matucana haynei* (Otto ex Salm-Dyck) Britton & Rose

= *Submatucana* Backeb., *Cactaceae* Handb. Kakteen. Pereskioideae Opuntioideae 2: 1059. 1959.

= *Eomatucana* F. Ritter in *Kakteen* And. Sukk. 16: 230. 1965.

Recent monograph by Bregmann (1996).

**Melocactus** Link & Otto in *Verh. Preuss. Ver. Gartenb.* 3: 417. 1827, nom. cons. sec. Hunt (2006). – Type: *Cactus melocactus* L.

Recent monograph by Taylor (1991); recent floristic treatment by Taylor & Zappi (2004; Brazil).

**Micranthocereus** Backeb. in *Blätt. Kakteenf.* 1938(6): [22]. 1938 sec. Hunt (2006). – Type: *Micranthocereus polyanthus* (Werderm.) Backeb.

= *Austrocephalocereus* Backeb. in *Blätt. Kakteenf.* 1938(6): [22]. 1938.

= *Siccobaccatus* P. J. Braun & Esteves in *Succulenta* (Netherlands) 69: 6. 1990.

Recent floristic treatment by Taylor & Zappi (2004).

**Mila** Britton & Rose, *Cactaceae* 3: 211. 1922 sec. Hunt (2006). – Type: *Mila caespitosa* Britton & Rose

**Miqueliopuntia** Frič ex F. Ritter in *Kakteen Südamerika* 3: 869. 1980 sec. Hunt (2006). – Type: *Miqueliopuntia miquelii* (Monv.) F. Ritter

Monotypic; sampled by Griffith & Porter (2009) and not found nested in any other genus, justifying generic rank.

**Morangaya** G. D. Rowley in *Ashingtonia* 1: 44. 1944 sec. Sánchez & al. (2014). – Type: *Morangaya pensilis* (K. Brandege) G. D. Rowley

See note for *Echinocereus*.

**Myrtillocactus** Console in *Boll. Reale Orto Bot. Palermo* 1: 10. 1897 sec. Hunt (2006). – Type: *Myrtillocactus geometrizans* (Mart. ex Pfeiff.) Console

**Neobuxbaumia** Backeb. in *Blätt. Kakteenf.* 6: 17; 8, 12, 24. 1938 sec. Arias & al. (2012). – Type: *Neobuxbaumia tetetzo* (J. M. Coult.) Backeb.

= *Rooksbya* (Backeb.) Backeb., *Cactaceae* Handb. Kakteen. Pereskioideae Opuntioideae 4: 2165. 1960.

Phylogenetic studies so far resolved *Neobuxbaumia* as closely related to *Cephalocereus* and *Pseudomitrocereus* (Arias & al. 2003; Arias & Terrazas 2006; Hernández-Hernández & al. 2011). However, these studies did not specifically focus on *Neobuxbaumia*, and its generic limits are therefore not yet firmly estab-

lished. Arias & al. (2003) found *Neobuxbaumia* in a weakly supported polytomy with *Cephalocereus* and *Pachycereus fulviceps* (F. A. C. Weber ex Schumann) D. R. Hunt (= *Pseudomitrocereus*) as sister to both. The two *Cephalocereus* species were well supported as sister to each other, but could not be separated from *Neobuxbaumia* in any tree (Arias & al. 2003). Bárcenas & al. (2011) and Hernández-Hernández & al. (2011) found *Neobuxbaumia* to be polyphyletic but the relevant nodes were weakly supported, therefore a monophyletic *Neobuxbaumia* is neither confirmed nor contradicted by the currently available data.

**Neolloydia** Britton & Rose in *Bull. Torrey Bot. Club* 49: 251. 1922 sec. Hunt (2006). – Type: *Neolloydia conoidea* (DC.) Britton & Rose

Found to be polyphyletic by Vázquez-Sánchez & al. (2013), with the type species sister to the rest of the mammilloid clade, but support <50%, while *N. matehualensis* Backeb. was nested in *Coryphantha* with maximal support.

**Neoraimondia** Britton & Rose, *Cactaceae* 2: 181. 1920 sec. Hunt (2006). – Type: *Neoraimondia macrostibas* (K. Schum.) Britton & Rose

= *Neocardenasia* Backeb. in *Blätt. Sukkulantenk.* 1: 2. 1949.

**Neowerdermannia** Frič in *Kaktusár* 1: 85. 1930 sec. Hunt (2006). – Type: *Neowerdermannia vorwerkii* Frič

**Nyctocereus** (A. Berger) Britton & Rose in *Contr. U. S. Natl. Herb.* 12: 423. 1909 sec. Arias & al. (2005). – Type: *Nyctocereus serpentinus* (Lag. & Rodr.) Britton & Rose

Monotypic; segregated from *Peniocereus* by Arias & al. (2005) because *N. serpentinus* was resolved distant from the *Peniocereus* clade.

**Obregonia** Frič in *Zivot v Prirod* 29(2): 3. 1925 sec. Vázquez-Sánchez & al. (2013). – Type: *Obregonia denegrii* Frič

See notes under *Lophophora*.

**Opuntia** Mill. in *Gard. Dict. Abr.*, ed. 4: [974]. 1754 sec. Majure & al. (2012). – Type: *Opuntia vulgaris* Mill. – Fig. 3C.

= *Nopalea* Salm-Dyck, *Cact. Hort. Dyck.* (1849): 63-64, 233. 1850.

*Opuntia* is the second-largest genus of the family *Cactaceae*. As in all species-rich *Cactaceae* groups, numerous different generic concepts with a varying number of segregate genera have been suggested for *Opuntia*. Both extensive splitting (e.g. Backeberg 1966) or lumping into a broadly defined *Opuntia* were put forward (Rowley 1958; Benson 1982). The first phylogenetic study by Wallace & Dickie (2002) based on the *rpl16* intron found *Opuntia* in the broad sense to be polyphyletic. For the revised generic classification they presented based on their data, they argued for splitting *Opuntia*, because otherwise further genera (e.g. *Peresklopsis*, *Pterocactus*) were also nested within *Opuntia* and merging those would make *Opuntia* a

- highly heterogenous assemblage. Therefore, Wallace & Dickie suggested reinstating the earlier-proposed *Opuntia* segregates *Austrocyliodropuntia*, *Brasiliodropuntia*, *Consolea*, *Corynopuntia*, *Cumulopuntia*, *Cylindropuntia*, *Grusonia*, *Maihueiopsis*, *Miqueliopuntia*, *Nopalea*, *Tephrocactus*, and *Tunilla*. *Opuntia* s.str. was thus restricted to the taxa with flattened stems and reticulate pollen. This concept was entirely adapted by Hunt (2006), and largely by Nyffeler & Egli (2010b). Griffith & Porter (2009), using data from plastid *trnL-F* and nuclear ITS, found *Opuntia* in this restricted sense to additionally include *Consolea* and *Nopalea*, the clade including all these genera received 100% support, and both *Consolea* and *Nopalea* were also as monophyletic with 100%. The tree resolution, however, did not allow an immediate conclusion on the delimitation of these genera. *Nopalea* used to be separated from *Opuntia* s.str. because it differs primarily in its hummingbird-syndrome flowers. Nevertheless, it was repeatedly found to be nested in *Opuntia* (Wallace & Gibson 2002; Griffith & Porter 2009; Bárcenas & al. 2011; Hernández-Hernández & al. 2011; Majure & al. 2012) and is therefore no longer maintained as separate genus. The relationship of *Consolea* to *Opuntia* has remained more difficult to resolve, but available data suggest it is not part of *Opuntia* (see also notes under *Consolea*).
- Oreocereus** (A. Berger) Riccob. in Boll. Reale Orto Bot. Palermo 8: 258. 1909 sec. Hunt (2006) ≡ *Cereus* subg. *Oreocereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 64. 1905. – Type: *Oreocereus celsianus* (Lem. ex Salm-Dyck) Riccob.  
 = *Arequipa* Britton & Rose, Cactaceae 3: 100. 1922.  
 = *Morawetzia* Backeb. in Jahrb. Deutsch. Kakteen-Ges. 1: 73. 1936.  
 = *Arequipiopsis* Kreuz. & Buining in Repert. Spec. Nov. Regni Veg. 50: 198. 1941.
- Oroya** Britton & Rose, Cactaceae 3: 102. 1922 sec. Hunt (2006). – Type: *Oroya peruviana* (K. Schum.) Britton & Rose
- Ortegocactus** Alexander in Cact. Succ. J. (Los Angeles) 33: 39. 1961 sec. Vázquez-Sánchez & al. (2013). – Type: *Ortegocactus macdougallii* Alexander  
 Merging *Ortegocactus* into *Mammillaria* was proposed by Hunt & Taylor (1990) and Barthlott & Hunt (1993). The sole species, *O. macdougallii*, was first sampled by Butterworth & Wallace (2004) and found nested in *Mammillaria*, so the authors argued future transfer to *Mammillaria* may be justified, but must await further clarification of generic limits in this group. Vázquez-Sánchez & al. (2013) found *O. macdougallii* not nested in *Mammillaria*, but in a weakly supported polytomy in the mammilloid clade, suggesting maintaining it as a separate genus for the time being.
- Pachycereus** (A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 420. 1909 sec. Arias & Terrazas (2009) ≡ *Cereus* subg. *Pachycereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 63. 1905. – Type: *Pachycereus pringlei* (S. Watson) Britton & Rose  
 = *Backebergia* Bravo in Anales Inst. Biol. Univ. Nac. México 24: 230. 1954.  
 = *Pterocereus* T. MacDoug. & Miranda in Ceiba 4: 135. 1954.  
 Phylogenetic studies based on morphological and molecular data show consistently that *Pachycereus* s.str. is a monophyletic group with five species (Arias & al. 2003; Arias & Terrazas 2006, 2009; Arias & al. 2012). Other species previously considered in *Pachycereus* (Buxbaum 1961; Gibson & Horak 1978; Anderson 2001; Hunt 2006; Nyffeler & Egli 2010b) have been transferred to *Lemaireocereus*, *Lophocereus*, and *Pseudomitrocereus*. More inclusive and robust new evidence may corroborate or refute the current delimitation of these last genera. *Pachycereus* s.str. includes tree-like species, interareolar grooves on the stems, abundant trichomes on the flower, and flexible spines on the fruit. The genera *Backebergia* and *Pterocereus* (both monotypic) remain inconclusive on molecular data available (Arias & al. 2003; Hernández-Hernández 2011); therefore their recognition as separate genera remains premature. Recent monograph by Arias & Terrazas (2009).
- Parodia** Speg. in Anales Soc. Ci. Argent. 96: 70. 1923 sec. Hunt (2006). – Type: *Parodia microsperma* (F. A. C. Weber) Speg.  
 = *Malacocarpus* Salm-Dyck, Cact. Hort. Dyck. (1849): 24-25, 141. 1850 ≡ *Wigginsia* D. M. Porter in Taxon 13: 210. 1964.  
 = *Notocactus* (K. Schum.) Frič in Cacti Price-List 1928: [3]. 1928.  
 = *Acanthocephala* Backeb. in Blätt. Kakteenf. 1938(6): [7]. 1938.  
 = *Erioccephala* Backeb. in Blätt. Kakteenf. 1938(6): [7, 21]. 1938 ≡ *Eriocactus* Backeb. in Cactaceae (Berlin) 1941: 76. 1942.  
 = *Brasilicactus* Backeb. in Cactaceae (Berlin) 1941: 76. 1942.  
 = *Brasiliparodia* F. Ritter, Kakteen Südamerika 1: 144. 1979.
- Pediocactus** Britton & Rose in Ill. Fl. N. U. S. (Britton & Brown) 2: 569. 1913 sec. Hunt (2006). – Type: *Pediocactus simpsonii* (Engelm.) Britton & Rose  
 = *Utahia* Britton & Rose, Cactaceae 3: 215. 1922.  
 = *Navajoa* Croizat in Cact. Succ. J. (Los Angeles) 15: 89. 1943.  
 = *Pilocanthus* B. W. Benson & Backeb. in Kakteen And. Sukk. 8: 188. 1957.  
 = *Neonavajoa* Doweld in Sukkulenty 1999(2): 24. 1999.  
 = *Puebloa* Doweld in Sukkulenty 1999(1): 20. 1999.  
 Recent monographs by Heil & al. (1981) and Hochstätter (2007).

**Pelecyphora** Ehrenb. in Bot. Zeitung (Berlin) 1: 737. 1843 sec. Vázquez-Sánchez & al. (2013). – Type: *Pelecyphora aselliformis* Ehrenb.

= *Encephalocarpus* A. Berger, Kakteen: 331. 1929.

The generic limits are not yet clarified, *Pelecyphora* was found monophyletic by Vázquez-Sánchez & al. (2013) and Bárcenas & al. (2011), who additionally found *Escobaria* paraphyletic to *Pelecyphora*.

**Peniocereus** (A. Berger) Britton & Rose in Contr. U. S. Natl. Herb. 12: 428. 1909 sec. Arias & al. (2005) ≡ *Cereus* subsect. *Peniocereus* A. Berger in Rep. (Annual) Missouri Bot. Gard. 16: 77. 1905. – Type: *Peniocereus greggii* (Engelm.) Britton & Rose

= *Neoevansia* W. T. Marshall, Cactaceae (Marshall & Bock): 84. 1941.

= *Cullmannia* Distefano in Kakteen And. Sukk. 7: 8. 1956.

The generic circumscription of *Peniocereus* was revised based on the molecular phylogenetic study of Arias & al. (2005). Their study based on plastid *trnL-F* and *rpl16* found *Peniocereus* polyphyletic, its species resolved in three lineages. *Peniocereus* subg. *Pseudoacanthocereus* Sánchez-Mej. was found to be nested in *Acanthocereus*, yet both were also paraphyletic. For a classification reflecting these relationships, *Peniocereus* subg. *Pseudoacanthocereus* would need to be transferred to *Acanthocereus*. The other major *Peniocereus* clade found by Arias & al. (2005) corresponds to *Peniocereus* subg. *Peniocereus*. *Peniocereus serpentinus* (Lag. & Rodr.) N. P. Taylor was resolved as a separate lineage. Since it is the type species of the earlier-proposed genus *Nyctocereus*, Arias & al. (2005) suggested reinstating it as monotypic.

**Pereskia** Mill. in Gard. Dict. Abr., ed. 4: [1026]. 1754 sec. Hunt (2006). – Type: *Pereskia aculeata* Mill. – Fig. 3D.

= *Pereskia* sect. *Rhodocactus* A. Berger, Kakteen: 43. 1929 ≡ *Rhodocactus* (A. Berger) F. M. Knuth, Nye Kaktusbog: 102. 1930.

*Pereskia* has been repeatedly found to be paraphyletic by Nyffeler (2002), Edwards & al. (2005), and Butterworth & Edwards (2008). The genus forms a grade at the base of the *Cactaceae*, with a northern clade including Mesoamerican and Caribbean pereskias as the first branching group followed by a southern clade, with mainly the Andean pereskias, which also include the nomenclatural type of *Pereskia* (Butterworth & Wallace 2005; Edwards & al. 2005). No nomenclatural changes to reflect the paraphyly of *Pereskia* were proposed by Edwards & al. (2005), who preferred their results to be tested with additional genes before suggesting a new classification for *Pereskia*. Also, no generic name was readily available for the northern *Pereskia* clade – the type of the earlier-proposed segregate *Rhodocactus* was in the southern clade together with the type of *Pere-*

*skia* itself. *Pereskia* was accepted as polyphyletic to reflect its morphological differences to the rest of the *Cactaceae*. Both *Pereskia* clades have characters that are interpreted as ancestral within *Cactaceae*, such as a woody stem, the presence of true leaves, a flower morphology that differs from the rest of the *Cactaceae* and  $C_3$  photosynthesis. Only recently, the northern pereskias were segregated as *Leuenbergeria*, yet this segregation also received criticism because the two clades are hard to distinguish morphologically (<http://www.mobot.org/MOBOT/research/Edge/apr13/apr13lit.shtml>; Hunt 2013). Seeking a compromise between molecular phylogenetic hypotheses and nomenclatural stability, Rowley (2013) suggested a subgenus *Leuenbergera* (note the different spelling!) for the northern *Pereskia* clade. Monograph by Leuenberger (1986).

**Peresklopsis** Britton & Rose in Smithsonian Misc. Collect. 50: 331. 1907 sec. Hunt (2006). – Type: *Peresklopsis brandegeei* (K. Schum.) Britton & Rose

**Pfeiffera** Salm-Dyck in Cact. Hort. Dyck. 1844: 40. 1845 sec. Korotkova & al. (2010). – Type: *Pfeiffera cereiformis* Salm-Dyck

= *Rhipsalis* subg. *Acanthorhipsalis* K. Schum., Gesamtbeschr. Kakt.: 615. 1898 ≡ *Acanthorhipsalis* (K. Schum.) Britton & Rose, Cactaceae 4: 211. 1923.

The circumscription of *Pfeiffera* has undergone several radical changes in the past, and until the early 1980s, it was treated as a monotypic genus with *P. ianthothele* (Monv.) F. A. C. Weber. Kimmach (1983) subsumed *Pfeiffera* under *Rhipsalis*, while Barthlott (1987), Barthlott & Taylor (1995) and Anderson (2001, 2005) synonymized it with *Lepismium*. In the molecular phylogeny of Nyffeler (2002), *P. ianthothele* unexpectedly grouped together with two traditional *Lepismium* species, and widely distant from either *Rhipsalis* or *Lepismium*. Hunt (2006) broadened the concept of *Pfeiffera* to include nine species. This circumscription of *Pfeiffera* was evaluated and clarified by Korotkova & al. (2010), who rejected the circumscription of Hunt (2006), which also included the species now segregated as *Lymanbensonia* (see there). Recent annotated checklist by Barthlott & Taylor (1995, as *Lepismium* subg. *Pfeiffera* (Salm-Dyck) Barthlott).

**Pilosocereus** Byles & G. D. Rowley in Cact. Succ. J. Gr. Brit. 19: 66. 1957 sec. Hunt (2006). – Type: *Pilosocereus leucocephalus* (Poselg.) Byles & G. D. Rowley

= *Pseudopilocereus* Buxb. in Beitr. Biol. Pflanzen 44: 249. 1968.

Recent monograph by Zappi (1994); recent floristic treatment by Taylor & Zappi (2004).

**Polaskia** Backeb. in Blätt. Sukkulantenk. 1: 4. 1949 sec. Hunt (2006) ≡ *Chichipia* Backeb. in Liste Cact. Jard. Bot. Les Cèdres 12. 1950, nom. illeg. – Type: *Polaskia chichipe* (Rol.-Goss.) Backeb.



- = *Heliabravoa* Backeb. in *Cact. Succ. J. Gr. Brit.* 18: 23. 1956.  
Recent monograph by Gibson (1988b).
- Praecereus*** Buxb. in *Beitr. Biol. Pflanzen* 44: 273. 1968 sec. Hunt (2006). – Type: *Praecereus smithianus* (Britton & Rose) Buxb.
- Pseudoacanthocereus*** F. Ritter in *Kakteen Südamerika* 1: 47. 1979 sec. Hunt (2006). – Type: *Pseudoacanthocereus brasiliensis* (Britton & Rose) F. Ritter
- Pseudomitrocereus*** Bravo & Buxb. in *Bot. Stud.* 12: 53. 1961 sec. Arias & al. (2012). – Type: *Pseudomitrocereus fulviceps* (F. A. C. Weber ex K. Schum.) Bravo & Buxb.
- = *Cephalocereus* subg. *Mitrocereus* Backeb. in *Blätt. Kakteenf.* 1938(6). 1938 ≡ *Mitrocereus* (Backeb.) Backeb. in *Cactaceae* (Berlin) 2: 77. 1942.  
Monotypic; *Pseudomitrocereus fulviceps* was previously included in *Pachycereus* or *Cephalocereus*, later elevated to generic rank as *Mitrocereus* (Backeberg 1942) and later *Pseudomitrocereus* (Bravo & Buxbaum, in Buxbaum 1961). Arias & al. (2003) found *P. fulviceps* to be unrelated to *Pachycereus* and instead as sister sister to a clade of *Cephalocereus* and *Neobuxbaumia*. Therefore, *Pseudomitrocereus* was reinstated by Arias & al. (2012). *Pseudomitrocereus* is characterized by having distinct fertile stem parts, flowers completely covered with trichomes, and thick axial tissue (pericarpel and receptacle; Buxbaum 1961). Its inclusion in *Pachycereus* was supported by non-informative attributes (e.g. growth form), shared by other members of *Pachycereinae* (or *Echinocereinae* sensu Nyffeler & Egli 2010b). However, it is part of the clade “*Cephalocereus*” according to Arias & al. (2003), composed by *Cephalocereus*, *Neobuxbaumia*, and *Pseudomitrocereus*. The species of this clade share the presence of prismatic crystals in the epidermis, inner stamens and nectarial chamber, while the fruit is dehiscent and the pulp is white (Arias & Terrazas 2006). *Mitrocereus* was based on the name *Pilocereus chrysomallus* Lem. as the type species, but this name represents another species included in the synonymy of *Pachycereus militaris* (Audot) D. R. Hunt. Consequently, Buxbaum and Bravo (Buxbaum 1961) proposed the name *Pseudomitrocereus*, with *P. fulviceps* as the nomenclatural type.
- Pseudorhypsalis*** Britton & Rose, *Cactaceae* 4: 213. 1923 sec. Hunt (2006). – Type: *Pseudorhypsalis alata* (Sw.) Britton & Rose
- = *Wittia* K. Schum. in *Monatsschr. Kakteenk.* 13: 117. 1903, nom. illeg.
- = *Wittiocactus* Rauschert in *Taxon* 31: 558. 1982.
- = *Disisorhypsalis* Doweld in *Sukkulenty* 4(1–2): 40. 2002.  
Recent monographs by Kimmach (1993) and Bauer (2003).
- Pterocactus*** K. Schum. in *Monatsschr. Kakteenk.* 7: 6. 1897 sec. Griffith & Porter (2009). – Type: *Pterocactus kuntzei* K. Schum.  
Confirmed as monophyletic with maximal support by Griffith & Porter (2009) and Ritz & al. (2012). Recent monograph by Kiesling (1982).
- Punotia*** D. R. Hunt in *Cactaceae Syst. Init.* 25: 26. 2011 sec. Ritz & al. (2012). – Type: *Punotia lagopus* (K. Schum.) D. R. Hunt  
The sole species of this recently segregated genus, *Punotia lagopus*, was formerly placed in *Austrocylindropuntia*, but was recovered as sister to the remaining species of *Austrocylindropuntia* and *Cumulopuntia* by Ritz & al. (2012). It differs from *Austrocylindropuntia* in several characters, especially its growth form as flat, extensive cushions.
- Pygmaeocereus*** H. Johnson & Backeb. in *Natl. Cact. & Succ. Journ.* 12: 86. 1957 sec. Hunt (2006). – Type: *Pygmaeocereus bylesianus* Andreae & Backeberg  
Suggested as synonym of *Haageocereus* by Nyffeler & Egli (2010b).
- Quiabentia*** Britton & Rose, *Cactaceae* 4: 252. 1923 sec. Hunt (2006). – Type: *Quiabentia zehntneri* (Britton & Rose) Britton & Rose
- Rapicactus*** Buxb. & Oehme in *Cactaceae* (Berlin) 1942: 24. 1942 sec. Hunt (2006). – Type: *Rapicactus subterraneus* (Backeb.) Buxb. & Oehme
- = *Lodia* Mosco & Zanovello in *Bradleya* 18: 44. 2000.  
Traditionally included in *Turbinicarpus* (see there); separated from it by Vázquez-Sánchez & al. (2013) after *Turbinicarpus* was found to be polyphyletic by them and previously also by Bárcenas & al. (2011). Recent monograph by Lüthy (2003).
- Rauhocereus*** Backeb. in *Descr. Cact. Nov.* 5: 1957 sec. Hunt (2006). – Type: *Rauhocereus riosaniensis* Backeb.
- Rebutia*** K. Schum. in *Monatsschr. Kakteenk.* 5: 102. 1895 sec. Ritz & al. (2007). – Type: *Rebutia minuscula* K. Schum.  
The circumscription of *Rebutia* s.l. vs a suite of proposed segregates (including *Aylosteria*, *Digitorebutia*, *Medioblobivia*, *Sulcorebutia* and *Weingartia*) has been the subject of continued debate in the past 30 years. The wide circumscription (including these taxa) was adopted by Anderson & al. (2001) and Hunt (2006), but not by Anderson (2005), who recognized *Sulcorebutia* and *Weingartia*. The broad concept goes back to the consensus *Cactaceae* classification as summarized by Hunt & Taylor (1986), and some participants of the discussions at that time even argued that *Rebutia* sensu latissimo should be placed in the synonymy of an even more expanded *Echinopsis*. Recent molecular phylogenetic studies showed, however, that *Rebutia* does not belong in the *Echinopsis* clade (Ritz & al. 2007; Mosti & al. 2011; Schlumpberger & Renner 2012), and that the genus in this broad concept is an untenable polyphyletic assemblage, as first noted by Lendel & al. (2006). In

the molecular phylogeny of Ritz & al. (2007), three independent clades with taxa of *Rebutia* s.l. are found, namely “*Rebutia* I” (including the segregates *Aylostera*, *Digitorebutia* and *Mediolobivia*), “*Rebutia* II” (conforming to *Rebutia* s.str.) and *Weingartia* (incl. *Cintia* and *Sulcorebutia*). While *Rebutia* s.str. is placed as sister to *Browningia*, *Aylostera* is placed in a clade with *Cereus* and *Stetsonia* (Ritz & al. 2007; Mosti & al. 2011). Therefore it appears reasonable to abandon the concept of *Rebutia* s.l., to restrict *Rebutia* to the “true” rebutias, and to accept both *Aylostera* as well as *Weingartia* as separate genera. Most of the necessary new combinations have been published for *Aylostera* (Monti & al. 2011) and *Weingartia* (Hentzschel & Augustin 2008).

***Rhipsalidopsis*** Britton & Rose, *Cactaceae* 4: 209. 1923 sec. Korotkova & al. (2011). – Type: *Rhipsalidopsis rosea* (Lagerh.) Britton & Rose

As explained under *Hatiora*, the inclusion of *Rhipsalidopsis* in *Hatiora* is not supported by recent molecular phylogenies. Calvente & al. (2011) found the two traditional *Rhipsalidopsis* species (*R. gaertneri* (Regel) Moran, *R. rosea*) are sister to *Schlumbergera*, but with moderate support. Korotkova & al. (2011), however, found *Hatiora* s.str., *Rhipsalidopsis* and *Schlumbergera* to form a grade, and even though support for this topology is also moderate, support for the monophyly of the three genera is maximal: therefore, *Rhipsalidopsis* (Easter cacti) is best kept separate from *Schlumbergera* (Christmas cacti). Recent annotated checklist by Barthlott & Taylor (1995, as *Hatiora* subg. *Rhipsalidopsis* (Britton & Rose) Barthlott).

***Rhipsalis*** Gaertn. in *Fruct. Sem. Pl.* 1: 137. 1788, nom. cons. sec. Korotkova & al. (2011). – Type: *Rhipsalis cassutha* Gaertn.

= *Erythrorhipsalis* A. Berger in *Monatsschr. Kakteenk.* 30: 4. 1920.

The circumscription of *Rhipsalis* – one of the oldest genera of the family – has changed repeatedly over time, and often *Hatiora*, *Lepismium* and *Pseudorhipsalis*, all now accepted at generic rank, were variously subsumed under *Rhipsalis*. The morphology-based circumscription of *Rhipsalis* by Barthlott & Taylor (1995) has been entirely confirmed as monophyletic with maximal support in the molecular phylogenetic study of Korotkova & al. (2011); the same result was shown by Calvente & al. (2011b), though with a less comprehensive sampling. *Rhipsalis* is notable since *R. baccifera* (Sol.) Stearn is the only species of the family that naturally occurs outside the New World. Recent annotated checklist by Barthlott & Taylor (1995).

***Salmiopuntia*** Frič ex Guiggi, *Cactology* 2 (Suppl.): 2. 2011 sec. Majure & al. (2012). – Type: *Salmiopuntia salmiana* (J. Parm. ex Pfeiff.) Guiggi

This monotypic genus has been found in a polytomy

with *Brasiliopuntia* + *Tacinga* and *Opuntia* s.str. (i.e. the platyopuntioids) by Griffith & Porter (2009). The study of Majure & al. (2012) confirmed that *Salmiopuntia* is not part of *Opuntia* s.str.

***Samaipaticereus*** Cárdenas in *Cact. Succ. J.* (Los Angeles) 24: 141. 1952 sec. Hunt (2006). – Type: *Samaipaticereus corroanus* Cárdenas

***Schlumbergera*** Lem. in *Ill. Hort.* 5: 24. 1858 sec. Korotkova & al. (2011). – Type: *Schlumbergera epiphylloloides* Lem.

= *Zygocactus* K. Schum., *Fl. Bras.* 4: 223. 1890.

= *Epiphyllanthus* A. Berger in *Rep. (Annual) Missouri Bot. Gard.* 16: 84. 1905.

*Schlumbergera* (Christmas cacti) is one of the best-known and one of the morphologically best-defined *Cactaceae* genera, recognizable by its flattened stems and bright pink zygomorphic flowers. Its monophyly was confirmed by the molecular phylogenetic analysis of Calvente & al. (2010) and Korotkova & al. (2011). Recent annotated checklist by Barthlott & Taylor (1995).

***Sclerocactus*** Britton & Rose, *Cactaceae* 3: 212. 1922 sec. Vázquez-Sánchez & al. (2013). – Type: *Sclerocactus polyancistrus* (Engelm. & J. M. Bigelow) Britton & Rose

= *Echinomastus* Britton & Rose, *Cactaceae* 3: 147. 1922.

= *Toumeyia* Britton & Rose, *Cactaceae* 3: 91. 1922, nom. illeg.

= *Ancistrocactus* Britton & Rose, *Cactaceae* 4: 3. 1923.

= *Coloradoa* Boissév. & C. Davidson in *Colorado Cact.* 54. 1941.

Confirmed as monophyletic by Butterworth & al. (2002) and Vázquez-Sánchez & al. (2013). The generic status and limits of *Echinomastus* need further evaluation because it was found to be polyphyletic by Vázquez-Sánchez & al. (2013). Revisions/monographs by Heil & Porter (1994) and Hochstätter (2005).

***Selenicereus*** (A. Berger) Britton & Rose in *Contr. U. S. Natl. Herb.* 12: 429. 1909 sec. Hunt (2006) = *Cereus* subsect. *Selenicereus* A. Berger in *Rep. (Annual) Missouri Bot. Gard.* 16: 76. 1905. – Type: *Selenicereus grandiflorus* (L.) Britton & Rose

= *Cryptocereus* Alexander in *Cact. Succ. J.* (Los Angeles) 22: 164. 1950.

= *Chiapasophyllum* Doweld in *Sukkulenty* 4(1–2): 32. 2002.

***Stenocactus*** (K. Schum.) A. W. Hill in *Index Kew. Suppl.* 8: 228. 1933 sec. Hunt (2006) = *Echinocactus* subg. *Stenocactus* K. Schum., *Gesamtbeschr. Kakt.*: 292. 1898. – Type: *Stenocactus coptonogonus* (Lem.) A. W. Hill ex A. Berger

See notes under *Ferocactus*.

***Stenocereus*** (A. Berger) Riccob. in *Boll. Reale Orto Bot. Palermo* 8: 253. 1909, nom. cons. sec. Hunt (2006) = *Cereus* subg. *Stenocereus* A. Berger in *Rep. (Annual)*

- Missouri Bot. Gard. 16: 66. 1905. – Type: *Stenocereus stellatus* (Pfeiff.) Riccob.  
 = *Rathbunia* Britton & Rose in Contr. U. S. Natl. Herb. 12: 414. 1909.  
 = *Machaerocereus* Britton & Rose, Cactaceae 2: 114. 1920.  
 = *Lemaireocereus* subg. *Isolatocereus* Backeb. in Blätt. Kakteenf. 1938(6): 17. 1938 = *Isolatocereus* Backeb. in Cactaceae (Berlin) 1941(2): 47, 76. 1942.  
 = *Ritterocereus* Backeb. in Jahrb. Deutsch. Kakteen-Ges. 1941: 76. 1942.  
 = *Hertrichocereus* Backeb. in Cact. Succ. J. (Los Angeles) 22: 153. 1950.  
 = *Marshallocereus* Backeb. in Cact. Succ. J. (Los Angeles) 22: 154. 1950.  
 = *Griseocactus* Guiggi in Cactology 3(Suppl.): 1. 2012.  
 = *Griseocereus* Guiggi in Cactology 3: 7. 2012, nom. inval.  
 Recent treatments by Gibson (1991) and Arreola-Nava & Terrazas (2003).
- Stephanocereus** A. Berger in Entwicklungslin. Kakt.: 97. 1926 sec. Hunt (2006). – Type: *Stephanocereus leucostele* (Gürke) A. Berger  
 = *Coleocephalocereus* subg. *Lagenopsis* Buxb. in Krainz, Kakteen: 48–49, CIVb. 1972 = *Pilosocereus* subg. *Lagenopsis* (Buxb.) Braun in Bradleya 6: 89. 1988 = *Stephanocereus* subg. *Lagenopsis* N. P. Taylor & Egli in Bradleya 9: 91. 1991 = *Lagenocereus* Doweld in Turczaninowia 5: 8. 2002.  
 Recent floristic treatment by Taylor & Zappi (2004).
- Stetsonia** Britton & Rose, Cactaceae 2: 64. 1920 sec. Hunt (2006). – Type: *Stetsonia coryne* (Salm-Dyck) Britton & Rose
- Strombocactus** Britton & Rose, Cactaceae 3: 106. 1922 sec. Vázquez-Sánchez & al. (2013). – Type: *Strombocactus disciformis* (DC.) Britton & Rose  
 Confirmed as monophyletic by Vázquez-Sánchez & al. (2013).
- Strophocactus** Britton & Rose in Contr. U. S. Natl. Herb. 16: 262. 1913 sec. Hunt (2006). – Type: *Strophocactus wittii* (K. Schum.) Britton & Rose  
 = *Deamia* Britton & Rose, Cactaceae 2: 212. 1920.
- Tacinga** Britton & Rose, Cactaceae 1: 39. 1919 sec. Hunt (2006). – Type: *Tacinga funalis* Britton & Rose  
 Recent floristic monograph by Taylor & Zappi (2004).
- Tephrocactus** Lem. in Cactées: 88. 1868 sec. Ritz & al. (2012). – Type: *Tephrocactus diademata* (Lem.) Lem.  
 = *Ursopuntia* P. V. Heath, Calyx 6(2): 41. 1999.  
 = *Quasitephrocactus* G. Popov, Kakt. Klub 15(1–2): 13, 2012, nom. illeg.  
*Tephrocactus* was confirmed as monophyletic by Ritz & al. (2012). Recent monographs by Kiesling (1984) and Gilmer & Thomas (1998).
- Thelocactus** (K. Schum.) Britton & Rose in Bull. Torrey Bot. Club 49: 251. 1922 sec. Hunt (2006) = *Echinocactus* subg. *Thelocactus* K. Schum., Gesamtschr. Kakt.: 429. 1898. – Type: *Thelocactus hexaedrophorus* (Lem.) Britton & Rose  
 = *Hamatocactus* Britton & Rose, Cactaceae 3: 104. 1922.  
 = *Torreyocactus* Doweld in Sukkulenty 1998(1): 19. 1998.  
 See notes under *Ferocactus*.
- Tunilla** D. R. Hunt & Iliff in Cactaceae Syst. Init. 9: 10. 2000 sec. Hunt (2006). – Type: *Tunilla soehrensii* (Britton & Rose) D. R. Hunt & Iliff
- Turbincarpus** Buxb. & Backeb. in Cactaceae (Berlin) 1937(1): 27. 1937 sec. Vázquez-Sánchez & al. (2013). – Type: *Turbincarpus schmiedickeanus* (Boed.) Buxb. & Backeb.  
 = *Gymnocactus* Backeb. in Blätt. Kakteenf. 1938(6): [22]. 1938.  
 = *Normanbokea* Kladiwa & Buxb. in Krainz, Kakteen 40: 40, C VIIIb. 1969.  
 = *Bravocactus* Doweld in Sukkulenty 1998(1): 22. 1998.  
 = *Kadenicarpus* Doweld in Sukkulenty 1998(1): 22. 1998.  
*Turbincarpus* has been found to be polyphyletic in the molecular studies of Bárcenas & al. (2011) and Hernández-Hernández & al. (2011). The most comprehensively sampled dataset of Vázquez-Sánchez & al. (2013) showed *Turbincarpus* to fall into three separate clades. *Turbincarpus* was re-circumscribed restricted to 11 species, while species with a tuberous root connected to the body with a long, thin neck are now segregated as *Rapicactus* based on these results. Two further species (*T. horripilus* (Lem.) V. John & Ríha and *T. pseudomacroechele* (Backeb.) Buxb. & Backeb.) are outside the main *Turbincarpus* clade (incl. *Gymnocactus*) and a new generic name would be needed for them. Recent treatments by Lüthy (2002) and Lüthy & Moser (2002).
- Uebelmannia** Buining in Succulenta (Netherlands) 46: 159. 1967 sec. Hunt (2006). – Type: *Uebelmannia gummifera* (Backeb. & Voll) Buining  
 Recent works by Nyffeler (1998), Lüthy & Moser (2002), and Taylor & Zappi (2004).
- Vatricania** Backeb. in Cact. Succ. J. (Los Angeles) 22: 154. 1950 sec. Schlumpberger & Renner (2012). – Type: *Vatricania guentheri* (Kupper) Backeb.  
 Included in *Espostoa* s.l. by modern lexicographic treatments such as Anderson (2001, 2005) and Hunt (2006), the genus was found to be distant from the *Espostoa* in the *Cleistocactus* s.str. clade by Schlumpberger & Renner (2012). Consequently, the monotypic *Vatricania* was suggested to be reinstated.
- Weberbauerocereus** Backeb. in Cactaceae (Berlin) 1941(2): 31, 75. 1942 sec. Hunt (2006). – Type: *Weberbauerocereus fascicularis* (Meyen) Backeb.  
 Recent monograph by Arakaki (2003).
- Weberocereus** Britton & Rose in Contr. U. S. Natl. Herb. 12: 431. 1909 sec. Hunt (2006). – Type: *Weberocereus tunilla* (F. A. C. Weber) Britton & Rose

= *Werckleocereus* Britton & Rose in Contr. U. S. Natl. Herb. 12: 432. 1909.

= *Eccremocactus* Britton & Rose in Contr. U. S. Natl. Herb. 16: 261. 1913.

**Weingartia** Werderm. in Kakteenkunde 1937: 20, 21. 1937 sec. Ritz & al. (2007). – Type: *Weingartia fidai-ana* (Backeb.) Werderm.

= *Sulcorebutia* Backeb. in Cact. Succ. J. Gr. Brit. 13: 96. 1951.

= *Cintia* Kníže & Říha in Kaktusy (Brno) 31: 37. 1995.

= *Gymnorebutia* Doweld in Sukkulenty 4(1–2): 24. 2002.

*Weingartia* and *Sulcorebutia* used to be merged in *Rebutia*, e.g. by Barthlott & Hunt (1993), Anderson (2001), and Hunt (2006), but were recognized by Anderson (2005). The *Rebutia* s.l. assemblage was found highly polyphyletic by Ritz & al. (2007), and was shown to be separated into three well-supported clades. One of these clades comprises species of *Cintia*, *Sulcorebutia* and *Weingartia* and includes the nomenclatural type of *Weingartia*. Ritz & al. (2007) suggested that all three could be merged into a single genus, for which *Weingartia* is the oldest name.

**Yavia** R. Kiesling & Piltz in Kakteen And. Sukk. 52(3): 57. 2001 sec. Hunt (2006). – Type: *Yavia cryptocarpa* R. Kiesling & Piltz

**Yungasocereus** F. Ritter in Kakteen Südamerika 2: 668. 1980 sec. Hunt (2006). – Type: *Yungasocereus inquisivensis* (Cárdenas) F. Ritter

### **Caryophyllaceae** Juss. sec. APG (2009).

A family of chiefly opposite-leaved herbs comprising about 100 genera and 3000 species. The family is widely distributed in north-temperate, montane and alpine areas with a centre of diversity in the eastern Mediterranean and Irano-Turanian regions, while presence in the tropics and the southern hemisphere is limited and mostly at higher elevations (Bittrich 1993c; Rabeler & Hartman 2005a). Several taxa (especially species of *Dianthus*, *Gypsophila* and *Silene*) are important in the horticultural trade, while others (e.g. *Stellaria media* (L.) Vill.) have become widely known weedy taxa. The number of genera included here is over 10% higher than most recent estimates (Bittrich 1993c; Rabeler & Hartman 2005a; Harbaugh & al. 2010), reflecting the results of recent molecular studies on large genera (especially *Minuartia*; Dillenberger & Kadereit 2014) as well as retention of several genera (e.g. *Myosoton*, *Velezia* and *Xerotia*) that may eventually disappear. The family is monophyletic as circumscribed by Bittrich (1993c), although the “traditional” division into three subfamilies (Bittrich 1993c; Pax & Hoffmann 1934) based on stipule, petal, sepal and fruit features does not provide monophyletic groups and should be replaced with the tribe-based scheme presented by Harbaugh & al. (2010) and confirmed by subsequent studies (e.g. Greenberg & Donoghue 2011).

**Acanthophyllum** C. A. Mey. in Verz. Pfl. Casp. Meer.: 210. 1831 sec. Pirani & al. (2014). – Type: *Acanthophyllum mucronatum* C. A. Mey.

= *Ochotonophila* Gilli in Repert. Spec. Nov. Regni Veg. 59: 169. 1956.

= *Kuhitangia* Ovcz. in Dokl. Akad. Nauk Tadzh. SSR 10: 50. 1967.

= *Scleranthopsis* Rech. f. in Ann. Naturhist. Mus. Wien 70: 37. 1967.

Consists of about 60 cushion-forming subshrubby species of the subalpine steppe region in central to southwestern Asia (Bittrich 1993b; Ghaffari 2004). Pirani & al. (2014) showed that the genus is paraphyletic in this circumscription with *Allochrusa*, *Diaphanoptera* p.p., *Ochotonophila* and *Scleranthopsis* nested within it.

**Achyronychia** Torr. & A. Gray in Proc. Amer. Acad. Arts 7: 330. 1868 sec. Bittrich (1993c). – Type: *Achyronychia cooperi* Torr. & A. Gray

Monotypic genus; southwestern United States and Mexico. Hartman (2005a) noted that seed and flower characters suggest a close relationship to *Scopulophila*. Greenberg & Donoghue (2011) showed a similar result from molecular data.

**Agrostemma** L., Sp. Pl. 1: 435. 1753 sec. Oxelman & al. (2001) ≡ *Githago* Adans., Fam. Pl. 2: 255. 1763. – Type: *Agrostemma githago* L.

Two to three species, probably native in the Mediterranean region, but widely spread as agricultural weeds and/or ornamentals. Several phylogenetic studies (Oxelman & Lidén 1995; Oxelman & al. 1997; Fior & al. 2006; Greenberg & Donoghue 2011) strongly support *Agrostemma* as a sister group to the rest of the tribe *Sileneae*.

**Allochrusa** Bunge ex Boiss., Fl. Orient. 1: 559. 1867 sec. Bittrich (1993c). – Type: *Allochrusa versicolor* (Fisch. & C. A. Mey.) Boiss.

Comprises seven species from southwestern Asia that are probably nested in *Acanthophyllum* (Pirani & al. 2014).

**Ankyropetalum** Fenzl in Bot. Zeitung (Berlin) 1: 393. 1843 sec. Bittrich (1993c). – Type: *Ankyropetalum gypsophiloides* Fenzl

Four species in the eastern Mediterranean region east to Armenia. Closely related to *Gypsophila*, but not yet sampled for DNA.

**Arenaria** L., Sp. Pl. 1: 423. 1753 sec. Sadeghian & al. (2015). – Type: *Arenaria serpyllifolia* L. – Fig. 3E.

= *Spergulastrum* Michx., Fl. Bor.-Amer. 1: 275. 1803.

= *Cernohorskya* Á. Löve & D. Löve in Preslia 46: 127. 1974.

= *Willwebera* Á. Löve & D. Löve in Lagasalia 4: 9. 1974.

About 160 species, in north-temperate areas, the Mediterranean, and Andean South America. Harbaugh & al. (2010), Greenberg & Donoghue (2011) and most recently Sadeghian & al. (2015) have sampled *Are-*

- naria* and, between their results, have removed about one-half of the species into four segregate genera not aligning in the same tribe as *Arenaria*. Sadeghian & al. (2015) found that four of the five remaining subgenera that McNeill (1962) recognized form *Arenaria* s.str., with the placement of *A.* subg. *Dicranilla* (Fenzl) F. N. Williams still unknown. While a few of the infrageneric groups recognized by McNeill (1962) are confirmed by molecular results (e.g. *A.* subg. *Leiosperma* McNeill, *A.* sect. *Plinthine* (Rchb.) McNeill), most are not.
- Atocion** Adans. in Fam. Pl. (Adanson) 2: 254. 1763 sec. Oxelman & al. (2001). – Type: *Atocion armeria* (L.) Raf.  
= *Minjaevia* Tzvelev in Novosti Sist. Vyssh. Rast. 33: 102. 2001.  
Recently revised by Frajman & al. (2013), who recognized six, mostly European species. Well supported as monophyletic by several unlinked DNA sequence regions, and also as sister to *Viscaria* (Frajman & al. 2009b; see under *Viscaria*).
- Bolanthus** (Ser.) Rchb., Deut. Bot. Herb.-Buch: 205. 1841 sec. Bittrich (1993c) ≡ *Saponaria* sect. *Bolanthus* Ser. in Candolle, Prodr. 1: 366. 1824. – Type: *Bolanthus hirsutus* (Labill.) Barkoudah – Fig. 3F.  
About 15 species in the eastern Mediterranean region, especially Greece and Turkey (Koç & Hamzaoğlu 2015). Closely related to *Acanthophyllum* and *Gypsophila*, but not yet sampled for DNA.
- Brachystemma** D. Don, Prodr. Fl. Nepal.: 216. 1825 sec. Bittrich (1993c). – Type: *Brachystemma calycinum* D. Don  
Monotypic; Himalayas, SE Asia. Likely near *Arenaria* and *Moehringia*; one *rbcL* sequence exists (Saslis-Lagoudakis & al. 2012), but has not been included in a phylogeny including these genera.
- Bufonia** L., Sp. Pl. 1: 123. 1753 sec. Bittrich (1993c). – Type: *Bufonia tenuifolia* L.  
About 20 species in the Mediterranean region. Greenberg & Donoghue (2011) showed *Bufonia* as sister to the remainder of *Sagineae* (except for *Drypis*), while Dillenberger & Kadereit (2014) found it was an unsupported sister to a clade containing *Minuartia* s.str. and *Mcneillia*.
- Calycotropis** Turcz. in Bull. Soc. Imp. Naturalistes Moscou 35: 327. 1862 sec. Bittrich (1993c). – Type: *Calycotropis minuartioides* Turcz.  
Monotypic; Mexico. Listed as a “doubtful genus” in the *Caryophyllaceae* by Bittrich (1993c).
- Cardionema** DC., Prodr. 3: 372. 1828 sec. Bittrich (1993c). – Type: *Cardionema multicaule* DC.  
Six species found from western North America south to Chile. Sosa & al. (2006) found *Cardionema* and *Scopulophila* clustered with *Cerdia*. Greenberg & Donoghue (2011) showed *Cardionema* belonging to a poorly resolved group of genera in the tribe *Polycarpaeae*.
- Cerastium** L., Sp. Pl. 1: 437. 1753 sec. Greenberg & Donoghue (2011). – Type: *Cerastium arvense* L.  
Includes 100 or, more likely, close to 200 north-temperate species, especially diverse in the eastern Mediterranean. The genus is in need of monographic study. The most recent infrageneric classification is presented by Schischkin (1936); even with corrected nomenclature and inclusion of extra-Russian taxa, it is not likely to be representative of relationships in the genus. Greenberg & Donoghue (2011) included 39 species of *Cerastium* in their study and found several interesting points. *Cerastium* subg. *Dichodon* (Bartl. ex Rchb.) Boiss. should be treated as a genus, *Dichodon* (see there), being a sister to *Holosteum*. As in *Dianthus*, resolution of the species was very poor, most species falling into either a polytomy of 11 species or one of 23. They also found *Cerastium* formed a clade within *Stellaria*. These genera are considered quite distinct by nearly all workers, so this must be investigated further.
- Cerdia** Moc. & Sessé ex DC., Prodr. 3: 377. 1828 sec. Sosa & al. (2006). – Type: not designated.  
Monotypic; endemic to Mexico. Placement within the *Polycarpaeae* is probable (near *Cardionema* and *Scopulophila*?), but Sosa & al. (2006) suggested that further study is needed. In a broader survey using a different voucher, Greenberg & Donoghue (2011) found *Cerdia* clustering near *Drymaria*.
- Chaetonychia** (DC.) Sweet in Hort. Brit., ed. 3: 263. 1839 sec. Bittrich (1993c) ≡ *Paronychia* sect. *Chaetonychia* DC., Prodr. 3: 370. 1828. – Type: *Chaetonychia cymosa* (L.) Sweet  
Monotypic; western Mediterranean. Probably a close relative of *Paronychia*, but as yet not sampled for molecular phylogenetic analysis.
- Cherleria** L., Sp. Pl. 1: 425. 1753 sec. Dillenberger & Kadereit (2014). – Type: *Cherleria sedoides* L.  
= *Wierzbickia* Rchb., Deut. Bot. Herb.-Buch: 205; Syn. Red.: 106. 1841.  
= *Lidia* Á. Löve & D. Löve in Bot. Not. 128: 510. 1976.  
Originally including only *C. sedoides* found in mountains of Europe, but Dillenberger & Kadereit (2014) proposed expanding it to 19 species of Eurasia and western North America; Mosyakin suggests 23 to account for some additional eastern European taxa not yet transferred to *Cherleria* (S. Mosyakin, unpubl. data). Formerly included (with *Pseudocherleria*) in *Minuartia* sect. *Spectabiles* (Fenzl) Hayek, Dillenberger & Kadereit (2014) found the two groups segregated into different clades far from *Minuartia* s.str., proposing the recognition of both *Cherleria* and *Pseudocherleria*.
- Colobanthus** Bartl., Ord. Nat. Pl.: 305. 1830 sec. Bittrich (1993c). – Type: *Colobanthus quitensis* (Kunth) Barthlott  
Comprises 20 species of cushion plants most diverse

in the southern hemisphere. The genus is monophyletic and a sister to *Sagina*.

**Cometes** L., Syst. Nat., ed. 12 (2): [109, 127]. 1767 sec. Bittrich (1993c). – Type: *Cometes surattensis* L.

Two species; deserts from NW India to NE Africa. Likely a member of *Polycarpaeae*, but the one available ITS sequence has not been included in a broader survey.

**Corrigiola** L., Sp. Pl. 1: 271. 1753 sec. Bittrich (1993c). – Type: *Corrigiola litoralis* L.

About 11 species. Harbaugh & al. (2010) and Greenberg & Donoghue (2011) both confirmed placement (with *Telephium*) in tribe *Corrigioleae*, near the base of *Caryophyllaceae*.

**Cyathophylla** Bocquet & Strid, Mount. Fl. Greece 1: 175. 1986 sec. Bittrich (1993c). – Type: *Cyathophylla chlorifolia* (Poir.) Bocquet & Strid

Monotypic; mountains of Greece and Turkey. Closely related to *Saponaria*, but not yet sampled for DNA.

**Dadjoua** Parsa, Fl. Iran 8: 248. 1960 sec. Bittrich (1993c). – Type: *Dadjoua pteranthoidea* Parsa

Monotypic; Iran. Listed as a “doubtful genus” in the *Caryophyllaceae* by Bittrich (1993c).

**Dianthus** L., Sp. Pl. 1: 409. 1753 sec. Bittrich (1993c). – Type: *Dianthus caryophyllus* L. – Fig. 4A.

With about 300 species, *Dianthus* is the second largest genus in the *Caryophyllaceae*. *Dianthus* is most diverse in southeastern Europe and southwestern Asia. No recent monographic work has been undertaken; the most comprehensive infrageneric classification is presented in Pax & Hoffmann (1934). Although Greenberg & Donoghue (2011) included 37 species in their analysis, virtually no resolution was found; 26 species formed a polytomy. May include *Velezia* (see there).

**Diaphanoptera** Rech. f. in Repert. Spec. Nov. Regni Veg. 48: 41. 1940 sec. Bittrich (1993c). – Type: *Diaphanoptera khorasanica* Rech. f.

A genus of six species according to Schiman-Czeika (1988), but recent molecular phylogenetic analyses indicate polyphyly, with some species nested in *Acanthophyllum* (Pirani & al. 2014).

**Dicheranthus** Webb in Ann. Sci. Nat., Bot., ser. 3, 5: 28. 1846 sec. Bittrich (1993c). – Type: *Dicheranthus plocamoides* Webb

Monotypic; Canary Islands. A member of the *Polycarpaeae*, clustering with *Pteranthus* (Greenberg & Donoghue 2011).

**Dichodon** (Bartl. ex Rchb.) Rchb., Deut. Bot. Herb.-Buch: 205. 1841 sec. Ikonnikov (1973) ≡ *Stellaria* [unranked] *Dichodon* Bartl. ex Rchb., Fl. Germ. Excurs. 24: 785. 1832. – Type: *Dichodon dubium* (Bastard) Ikonn.

= *Provancheria* B. Boivin in Naturaliste Canad. 93: 644. 1967.

Five species of the Arctic, central Europe, and Iran. Treated as *Cerastium* subg. *Dichodon* (Bartl. ex

Rchb.) Boiss. in most recent works. Greenberg & Donoghue (2011) found that the two sampled species of *Dichodon* formed a clade sister to *Holosteum*, and together formed a clade sister to *Cerastium* + *Moenchia*.

**Dolophragma** Fenzl, Ann. Wiener Mus. Naturgesch. 1: 63. 1836 sec. Sadeghian & al. (2015). – Type: *Dolophragma globiflorum* Fenzl

A genus of four or five Himalayan species. Most recently treated as a subgenus of *Arenaria* (McNeill 1962). Sadeghian & al. (2015) suggested the genus be again recognized after finding that the one sampled species clustered near *Eremogone*, either as a sister to *Silene* or between *Eremogone* and *Silene*. They also noted that the result reported by Greenberg & Donoghue (2011), showing *Arenaria przewalskii* Maxim. clustering with members of *Lepyrodiclis* and *Pseudostellaria*, suggests that *Dolophragma* may be polyphyletic.

**Drymaria** Willd. ex Schult., Syst. Veg. ed. 15bis 5: 31, 406. 1819 sec. Bittrich (1993c). – Type: *Drymaria arenarioides* Humb. & Bonpl. ex Schult.

= *Pinosia* Urb. in Ark. Bot. 23A(5): 70. 1930.

About 50 species, all but two found only in the New World. Little is known about relationships within *Drymaria*. Duke's (1962) preliminary revision, in which he described but did not validly publish 17 series, is the only recent comprehensive study. Greenberg & Donoghue (2011) included all four sampled taxa and show a poorly resolved, possibly polyphyletic genus.

**Drypis** L., Sp. Pl. 1: 413. 1753 sec. Bittrich (1993c). – Type: *Drypis spinosa* L.

Monotypic; eastern Mediterranean. Formerly placed in an isolated position within the *Caryophylloideae*. Molecular studies, including Harbaugh & al. (2010), Greenberg & Donoghue (2011) and Dillenberger & Kadereit (2014), place *Drypis* as sister to all other sampled taxa in tribe *Sagineae*.

**Eremogone** Fenzl in Vers. Darstell. Alsin.: 13. 1833 sec. Rabeler & Wagner (2015). – Type: *Eremogone graminifolia* Fenzl

= *Brewerina* A. Gray in Proc. Amer. Acad. Arts 8: 620. 1873.

About 90 species, most diverse in eastern Asia and western North America. Harbaugh & al. (2010) confirmed the wide separation from *Arenaria* that Fior & al. (2006) reported. Broad sampling is still needed to resolve infrageneric relationships; existing information (Sadeghian & al. 2015) is not consistent with the extant classification (McNeill 1962) erected for these taxa in two subgenera under *Arenaria*.

**Eudianthe** (Rchb.) Rchb., Deut. Bot. Herb.-Buch: 206. 1841 sec. Oxelman & al. (2001) ≡ *Lychnis* [unranked] *Eudianthe* Rchb., Fl. Germ. Excurs. 24: 824. 1832 ≡ *Pontinia* Fries in Bot. Not. (1843): 141. 1843. – Type: *Eudianthe coeli-rosa* (L.) Fenzl ex Endl.

- Two western Mediterranean annual species, well supported as not belonging to the core *Silene/Lychnis* group (Oxelman & Lidén 1995; Oxelman & al. 1997; Oxelman & al. 2001).
- Facchinia** Rchb., Deut. Bot. Herb.-Buch: 204; Syn. Red.: 63. 1841 sec. Dillenberger & Kadereit (2014). – Type: *Facchinia lanceolata* (All.) Rchb.  
Five species found in high mountains of Europe. Dillenberger & Kadereit (2014) found *Facchinia* to be both distant from *Minuartia* s.str. and a sister to the clade containing *Colobanthus* and *Sagina*.
- Gymnocarpus** Forssk., Fl. Aegypt.-Arab.: 65. 1775 sec. Oxelman & al. (2002). – Type: *Gymnocarpus decandrus* Forssk.  
= *Sclerocephalus* Boiss., Diagn. Pl. Orient., ser. 1, 3: 12. 1843.  
= *Lochia* Balf. f. in Proc. Roy. Soc. Edinb. 12: 409. 1884.  
Ten species, occurring from the Canary Islands east to Mongolia. Oxelman & al. (2002) found an expanded *Gymnocarpus* was monophyletic and sister to part of *Paronychia*.
- Gypsophila** L., Sp. Pl. 1: 406. 1753 sec. Bittrich (1993c). – Type: *Gypsophila repens* L.  
= *Bolbosaponaria* Bondarenko in Opred. Rast. Sred. Azii 2: 327. 1971.  
= *Pseudosaponaria* (F. N. Williams) Ikonn. in Novosti Sist. Vyssh. Rast. 15: 144. 1979.  
*Gypsophila* includes about 150 species and is especially diverse in the eastern Mediterranean and southwestern Asia. Most of the infrageneric classification is derived from Barkoudah's (1962) monograph of *Gypsophila* and three related genera. Greenberg & Donoghue (2011) included 24 species in their analysis and found *Gypsophila* to be polyphyletic, with most species forming a clade sister to *Saponaria* and four species resolving close to *Dianthus/Petrorragia*; one of these species, *G. muralis* L., is here treated as *Psammophiliella*. Pirani & al. (2014) found *G. cerastioides* D. Don nested within *Acanthophyllum*. Recognition of *Bolbosaponaria* seems likely; while Greenberg & Donoghue (2011) found *B. bucharica* (B. Fedtsch.) Bondarenko clustered with two other species of *Gypsophila*, Pirani & al. (2014) found it to be a sister taxon to *Diaphanoptera afghanica* Podl.
- Habrosia** Fenzl in Bot. Zeitung (Berlin) 1: 322. 1843 sec. Bittrich (1993c). – Type: *Habrosia spinuliflora* (Ser.) Fenzl  
Monotypic; southwestern Asia. Smissen & al. (2003) placed *Habrosia* as sister to *Drypis*. Greenberg & Donoghue (2011), citing the ITS voucher from the Smissen & al. (2003) study, reported *H. spinuliflora* nested in *Minuartia* (*Sabulina* sec. Dillenberger & Kadereit 2014), sister to a clade of five North American species.
- Haya** Balf. f. in Proc. Roy. Soc. Edinb. 12: 408. 1884 sec. Bittrich (1993c). – Type: *Haya obovata* Balf. f.  
Monotypic; Socotra Island. Kool & al. (2007, 2012) found *H. obovata* nested in a clade of *Polycarphaea*; the genus is retained pending additional resolution of the polyphyletic *Polycarphaea*.
- Heliosperma** (Rchb.) Rchb., Deut. Bot. Herb.-Buch: 206. 1841, nom. cons. sec. Frajman & Rabeler (2006) = *Silene* [unranked] *Heliosperma* Rchb., Fl. Germ. Excurs. 24: 817. 1832 = *Ixoca* Raf., Autik. Bot.: 25. 1840. – Type: *Silene quadrifida* (L.) L.  
A chiefly central and southeastern European group with four to 16 species depending on species delimitations (Frajman & Oxelman 2007). *Heliosperma* has been conserved over its senior synonym *Ixoca* (Barrie 2011), as proposed by Frajman & Rabeler (2006). Frajman & al. (2009a) analysed several independent nuclear and plastid loci showing strong support for monophyly of the genus, although it appears to have a complex history, possibly involving ancient hybridization events.
- Herniaria** L., Sp. Pl. 1: 218. 1753 sec. Bittrich (1993c). – Type: *Herniaria glabra* L.  
= *Heterochiton* Graebn. & Mattf. in Syn. Mitteleur. Fl. 5: 870. 1919.  
About 50 species, most of them narrowly distributed endemics. *Herniaria* remains largely unsampled for DNA (four species in Greenberg & Donoghue 2011) and is likely to be closely related to *Paronychia* subg. *Anoplonychia* (Fenzl) Rchb.; see Oxelman & al. (2002) and Greenberg & Donoghue (2011).
- Holosteum** L., Sp. Pl. 1: 88. 1753 sec. Bittrich (1993c). – Type: *Holosteum umbellatum* L.  
Three to four species of temperate Eurasia. While Harbaugh & al. (2010) found that *Holosteum* and *Moenchia* were sister taxa, Greenberg & Donoghue (2011) found *Holosteum* and *Dichodon* to be sisters, with that clade a sister to the clade that include *Cerastium* and *Moenchia*.
- Honckenya** Ehrh. in Neues Mag. Aerzte 5: 206. 1783 sec. Bittrich (1993c). – Type: *Honckenya peploides* (L.) Ehrh.  
Monotypic; circumpolar in sandy coastal areas. Harbaugh & al. (2010) found *Honckenya* and *Wilhelmsia* are sister to each other and both are the closest relatives to the Hawaiian *Schiedea*.
- Illecebrum** L., Sp. Pl. 1: 206. 1753 sec. Bittrich (1993c). – Type: *Illecebrum verticillatum* L.  
Monotypic; native to the Canary Islands and the Mediterranean. Greenberg & Donoghue (2011) showed *Illecebrum* belonging to a poorly resolved group of genera in the *Polycarphaea*, closest to *Cardionema* as shown by Kool & al. (2007).
- Kabulia** Bor & C. E. C. Fisch. in Indian Forester 65: 611. 1939 sec. Bittrich (1993c). – Type: *Kabulia akhtarii* Bor & C. E. C. Fisch.  
Monotypic; Afghanistan. There is no new information to contradict Bittrich's (1993) placement as incertae sedis in the *Paronychioideae* (?*Paronychieae*).

- Krauseola** Pax & K. Hoffm., Nat. Pflanzenfam. (ed. 2) 16c: 308. 1934 sec. Bittrich (1993c). – Type: *Krauseola mosambicina* (Moss) Pax & Hoffm.  
Two species from tropical east Africa. Likely included in the *Polycarpaeae*, but not yet sampled for DNA.
- Lepyrodiclis** Fenzl in Endlicher, Gen. Pl.: 966. 1840 sec. Bittrich (1993c). – Type: *Lepyrodiclis holosteoides* (C. A. Mey.) Fisch. & C. A. Mey.  
Three species of central Asia. Sadeghian & al. (2015) found two species formed a clade sister to one including *Odontostemma* and *Pseudostellaria*. Greenberg & Donoghue (2011) noted that *L. holosteoides* clustered with *Stellaria monosperma* Buch.-Ham. ex D. Don.
- Loeflingia** L., Sp. Pl. 1: 35. 1753 sec. Bittrich (1993c). – Type: *Loeflingia hispanica* L.  
Seven species of the Mediterranean, southwestern Asia, and western North America. Fior & al. (2006) and Harbaugh & al. (2010) both showed *Loeflingia* and *Polycarpon* clustering together; a result not shown in the Kool & al. (2007) study of *Polycarpon*. Greenberg & Donoghue (2011) found it clustered in a poorly resolved clade including eleven other genera of *Polycarpaeae*.
- Lychnis** L., Sp. Pl. 1: 436. 1753 sec. Oxelman & al. (2001). – Type: *Lychnis chalcedonica* L.  
= *Coronaria* Guett. in Hist. Acad. Roy. Sci. Mém. Math. Phys. (Paris 4to) 1750: 229. 1754.  
= *Hedona* Lour., Fl. Cochinch. 1: 286. 1790.  
= *Exemix* Raf., Autik. Bot.: 27. 1840.  
= *Coccyganthe* (Rchb.) Rchb., Deut. Bot. Herb.-Buch: 206. 1841 ≡ *Lychnis* [unranked] *Coccyganthe* Rchb., Fl. Germ. Excurs. 24: 825. 1832.  
= *Uebelinia* Hochst. in Flora 24: 664. 1841.  
This circumscription, including around twenty species, is strongly supported as monophyletic (e.g. Popp & al. 2008; Greenberg & Donoghue 2011), with the African *Uebelinia* nested within. However, its relationships to *Silene* are not fully resolved (see under *Silene*).
- Mcneillia** Dillenb. & Kadereit, Taxon 63: 78. 2014 sec. Dillenberger & Kadereit (2014). – Type: *Mcneillia graminifolia* (Ard.) Dillenb. & Kadereit  
Five species of southeastern Europe and Turkey. Treated as *Minuartia* [sect. *Lanceolatae* (Fenzl) Graebn.] ser. *Graminifoliae* Mattf. by McNeill (1962), Dillenberger & Kadereit (2014) found these taxa forming a clade sister to *Minuartia* s.str.
- Micropyles** Phil., Fl. Atacam.: 20, t. 1. 1860 sec. Bittrich (1993c). – Type: *Micropyles litoralis* Phil.  
= *Wangerinia* C. Franz in Bot. Jahrb. Syst. 42(2–3, Beibl. 97): 11. 1908.  
Three species in Chile. Traditionally placed in *Polycarpaeae*, but not yet sampled for DNA.
- Minuartia** L., Sp. Pl. 1: 89. 1753 sec. Dillenberger & Kadereit (2014). – Type: *Minuartia dichotoma* L.  
= *Queria* L., Sp. Pl. 1: 90. 1753.  
= *Alsinanthe* (Fenzl) Rchb., Deut. Bot. Herb.-Buch: 205. 1841.  
= *Tryphane* (Fenzl) Rchb., Deut. Bot. Herb.-Buch: 205. 1841 ≡ *Alsine* [unranked] *Tryphane* Fenzl in Endlicher, Gen. Pl.: 965. 1840.  
= *Alsinopsis* Small, Fl. S. E. U. S.: 419. 1903.  
= *Lidia* Á. Löve & D. Löve in Bot. Not. 128: 510. 1976.  
= *Minuopsis* W. A. Weber in Phytologia 58(6): 383. 1985.  
About 54 species, chiefly in Mediterranean Europe and eastward into south-central Asia. While several molecular studies had shown *Minuartia* to be polyphyletic, Dillenberger & Kadereit's (2014) study is the most comprehensive to date, including the first sequences for *Minuartia* sect. *Minuartia*. They found that the 96 species of *Minuartia* sampled belonged to ten different clades representing four different tribes. This circumscription restricts *Minuartia* to two of the twelve sections of *Minuartia* subg. *Minuartia* recognized by McNeill (1962).
- Minuartiella** Dillenb. & Kadereit, Taxon 63: 78. 2014 sec. Dillenberger & Kadereit (2014). – Type: *Minuartiella acuminata* (Turill) Dillenb. & Kadereit  
Four species of the mountains of Turkey and Iran. Treated as *Minuartia* [sect. *Lanceolatae* (Fenzl) Graebn.] ser. *Dianthifoliae* Mattf. by McNeill (1962), Dillenberger & Kadereit (2014) found the sampled taxa forming an isolated clade that could be interpreted as sister to a clade that included *Colbanthus*, *Facchinia*, *Sabulina* and *Sagina*.
- Moehringia** L., Sp. Pl. 1: 359. 1753 sec. Fior & Karis (2007). – Type: *Moehringia muscosa* L.  
A group of 25 north-temperate species. Fior & Karis (2007) found *Moehringia* could be made monophyletic by transferring four Iberian species to *Arenaria*.
- Moenchia** Ehrh. in Neues Mag. Aerzte 5: 203. 1783, nom. cons. sec. Bittrich (1993c). – Type: *Moenchia quaternella* Ehrh.  
Three species found in western and central Europe. While Harbaugh & al. (2010) noted that *Moenchia* and *Holosteum* were sister taxa, Greenberg & Donoghue (2011) found that *Moenchia* was a sister to *Cerastium*.
- Mononeuria** Rchb., Deut. Bot. Herb.-Buch: 205; Syn. Red.: 118. 1841 sec. Dillenberger & Kadereit (2014). – Type: *Mononeuria patula* (Michx.) Dillenb. & Kadereit  
= *Geocarpon* Mack. in Torreya 14: 67. 1914.  
= *?Selleola* Urb. in Ark. Bot. 23A(5): 69. 1930.  
= *Porsildia* Á. Löve & D. Löve in Bot. Not. 128: 509. 1976.  
Nine species of eastern North America. Dillenberger & Kadereit (2014) found *Geocarpon* was nested within a clade consisting of *Minuartia* sect. *Uninerviae* (Fenzl) Mattf.; that clade was sister to a clade containing *Triplateia* and three species of *Stellaria* on the basis of *matK* sequences.



- Myosoton** Moench, *Methodus*: 225. 1794 sec. Bittrich (1993c). – Type: *Myosoton aquaticum* (L.) Moench = *Malachium* Fr. ex Rchb., *Fl. Germ. Excurs.* 24: 795. 1832, nom. illeg.  
Monotypic; temperate Eurasia. Treatment of the species as *Stellaria aquatica* L. may be warranted pending a serious review of *Stellaria*. It was found clustering near species of *Stellaria* sect. *Stellaria* by both Harbaugh & al. (2010) and by Greenberg & Donoghue (2011) in a study that more densely sampled *Stellaria*.
- Odontostemma** Benth. ex G. Don in *Gen. Syst.* 1: 449. 1831 sec. Sadeghian & al. (2015). – Type: *Odontostemma glandulosum* Benth. ex G. Don = *Gooringia* F. N. Williams in *Bull. Herb. Boissier* 5: 530. 1897.  
About 65 species of the Himalayas and adjacent southern China. Considered as a subgenus of *Arenaria* by many (e.g. McNeill 1962), Harbaugh & al. (2010) proposed, and Sadeghian & al. (2015) confirmed, that *Odontostemma* should be treated as a genus, clustering with *Cerastium* and *Stellaria* rather than *Arenaria*. Work on new combinations necessary for recognizing most species in *Odontostemma* is underway (R. Rabeler & W. Wagner, unpubl. data).
- Ortegia** L., *Sp. Pl.* 1: 560. 1753 sec. Bittrich (1993c). – Type: *Ortegia hispanica* L.  
Monotypic; Italy and Iberian Peninsula. A member of tribe *Polycarpeae*, but relationships vary in different studies. Fior & al. (2006) showed *Ortegia* in a cluster with *Loeflingia* and *Polycarpon*; Kool & al. (2007) reported *Ortegia* clustering with *Cardionema* and *Illecebrum*. Curiously, using the *matK* sequence from the Fior & al. (2006) study, both Harbaugh & al. (2010) and Greenberg & Donoghue (2011) found that *Ortegia* clustered with a Hawaiian collection of *Drymaria cordata* (L.) Willd. ex Schult. var. *pacifica* Mizush.
- Paronychia** Mill. in *Gard. Dict. Abr.*, ed. 4: [1019]. 1754 sec. Bittrich (1993c). – Type: *Paronychia argentea* Lam.  
= *Anychia* Michx., *Fl. Bor.-Amer.* 1: 112–113. 1803.  
= *Siphonychia* Torr. & A. Gray, *Fl. N. Amer.* 1: 173. 1838.  
= *Gibbesia* Small in *Bull. Torrey Bot. Club* 25: 621. 1898.  
= *Anychiastrum* Small, *Fl. S. E. U. S.*: 400. 1903.  
= *Odontonychia* Small, *Fl. S. E. U. S.*: 401. 1903.  
= *Gastronychia* Small, *Man. S. E. Fl.*: 480, f. 1933.  
In a study mainly addressing *Gymnocarpus*, Oxelman & al. (2002) found *Paronychia* to be polyphyletic, with the subgenera *Paronychia* and *Siphonychia* forming a strongly supported sister group to *Gymnocarpus*, whereas species in *P.* subg. *Anoplonychia* (Fenzl) Rchb. were found to be more closely related to *Herniaria* and *Philippiella*. This was confirmed by Greenberg & Donoghue (2011). The genus consists of 110 (Hartman & al. 2005) or more than 150 species (Bittrich 1993b). It is one of the large genera in the family that has not yet been extensively studied with DNA sequence data, especially in *P.* subg. *Anoplonychia* (Fenzl) Rchb. (only two of 48 species sampled).
- Pentastemonodiscus** Rech. f. in *Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl.* 102: 11. 1965 sec. Bittrich (1993c). – Type: *Pentastemonodiscus monochlamydeus* Rech. f.  
Monotypic; Afghanistan. Presumed to be close to *Scleranthus*, but has not yet been sampled for DNA.
- Petrocoptis** A. Braun ex Endl. in *Endl. Gen. Suppl.* 2: 78. 1842 sec. Oxelman & al. (2001). – Type: *Petrocoptis pyrenaica* (Bergeret) A. Braun ex Walp.  
= *Silenopsis* Willk. in *Bot. Zeitung* (Berlin) 5: 237. 1847.  
Endemic to the Iberian Peninsula, in particular the Pyrenees. Species-level taxonomy is controversial, with anything between one and 12 species (Cires & Prieto 2015) recognized. Phylogenetically, it occupies a position distinctly outside of the core *Silene/Lychnis* clade according to several putatively unlinked genes (e.g. Oxelman & Lidén 1995; Oxelman & al. 1997; Popp & Oxelman 2004), but the exact position varies, suggesting a possible ancient hybrid origin (Frajman & al. 2009a). Cires & Prieto (2015) confirmed the genus was monophyletic but noted that additional study was needed to resolve infragenetic relationships.
- Petrorrhagia** (Ser.) Link in *Handbuch* 2: 235. 1829 sec. Rabeler & Hartman (2005b) ≡ *Gypsophila* sect. *Petrorrhagia* Ser. in *Candolle, Prodr.* 1: 354. 1824. – Type: *Petrorrhagia saxifraga* (L.) Link  
= *Tunica* Ludw., *Inst. Regn. Veg.* (ed. 2): 129. 1757.  
= *Kohlrauschia* Kunth, *Fl. Berol.* ed. 2. 1: 108. 1838.  
= *Fiedleria* Rchb., *Icon. Fl. Germ. Helv.* 6: 42. 1844.  
Comprising 33 species, ranging from the Canary Islands east to Kashmir. Shown to cluster as sister to a clade including *Dianthus* and *Velezia* by Harbaugh & al. (2010), Greenberg & Donoghue (2011) and Pirani & al. (2014). The genus has not been widely sampled. Although kept separate by Bittrich (1993c), most recent treatments of the genus include *Kohlrauschia* as a section in *Petrorrhagia* following the monograph of Ball & Heywood (1964). This may deserve further investigation since Greenberg & Donoghue (2011) cited three samples in their study; a voucher of “*P. velutina* Guss.” (a later name for *P. dubia* (Raf.) G. López & Romo) was shown as a sister to a clade including *P. saxifraga* (L.) Link and a second voucher of *P. dubia*; the identification of the vouchers should be verified.
- Philippiella** Speg. in *Revista Fac. Agron. Univ. Nac. La Plata* 1897: 566. 1897 sec. Bittrich (1993c). – Type: *Philippiella patagonica* Speg.  
Monotypic; Patagonia. Oxelman & al. (2002) and Greenberg & Donoghue (2011) found *P. patagonica*

was nested within *Herniaria*; the genus is retained pending additional sampling in *Herniaria*.

**Phrynella** Pax & K. Hoffm., Nat. Pflanzenfam. (ed. 2) 16c: 364. 1934 sec. Bittrich (1993c). – Type: *Phrynella ortegioides* (Fisch. & C. A. Mey.) Pax & K. Hoffm. Monotypic; Turkey. Possibly related to *Gypsophila*, but not yet sampled for DNA.

**Pirinia** M. Král in Preslia 56: 161. 1984 sec. Bittrich (1993c). – Type: *Pirinia koenigii* M. Král Monotypic; Bulgaria. Placed in the *Polycarpaeae*, but not yet sampled for DNA.

**Pleioneura** Rech. f. in Bot. Jahrb. Syst. 75: 357. 1951 sec. Bittrich (1993c). – Type: *Pleioneura griffithiana* (Boiss.) Rech. f.

Monotypic; central Asia to Himalayas. Possibly related to either *Psammosilene* or *Saponaria* (Bittrich 1993c), but not yet sampled for DNA.

**Plettkea** Mattf. in Schriften Vereins Naturk. Unterweser 7: 11, 13, 17. 1934 sec. Bittrich (1993c). – Type: not designated.

Four species of the Peruvian Andes. The single species that has been sequenced clustered among species of *Stellaria* in both Harbaugh & al. (2010) and Greenberg & Donoghue (2011).

**Pollichia** Aiton in Hort. Kew. 1: 5. 1789–1789, nom. cons. sec. Bittrich (1993c). – Type: *Pollichia campestris* Aiton

Monotypic; eastern and southern Africa. Kool & al. (2012) placed *P. campestris* as sister to the monotypic *Sphaerocoma*; both genera form a clade that is sister to a clade containing *Polycarpaea* and *Polycarpon*.

**Polycarpaea** Lam. in J. Hist. Nat. 2: 3, 5. 1792, nom. cons. sec. Bittrich (1993c). – Type: *Polycarpaea teneriffae* Lam.

= *Robbairia* Boiss., Fl. Orient. 1: 735. 1867.

= *Reesia* Ewart in Proc. Roy. Soc. Victoria, n.s., 26: 9. 1913.

A paleotropical group of 50+ species. Kool & al. (2007, 2012) found it to be polyphyletic; additional sampling is required to treat the genus, resolve infrageneric relationships and decide how some small genera (e.g. *Haya*, *Xerotia*) should be treated.

**Polycarpon** L., Syst. Nat., ed. 10: 859, 881, 1360. 1759 sec. Kool & al. (2007). – Type: *Polycarpon tetraphyllum* (L.) L.

Monotypic; Mediterranean and western North America. Kool & al. (2007) found *Polycarpon* was polyphyletic with species distributed in three clades. Two of these included species of *Polycarpaea* and were removed from *Polycarpon*. The third included members of the *P. tetraphyllum* group; tight relations in the remaining clade suggested reduction to one polymorphic species.

**Polytepalum** Suess. & Beyerle in Bot. Jahrb. Syst. 69: 143. 1938 sec. Bittrich (1993c). – Type: *Polytepalum angolense* Suess. & Beyerle

Monotypic; Angola. Placed in the *Polycarpaeae*, but not yet sampled for DNA.

**Psammophiliella** Ikonn. in Novosti Sist. Vyssh. Rast. 11: 116. 1976 sec. Ikonnikov (1976). – Type: *Psammophiliella muralis* (L.) Ikonn.

= *Psammophila* Fourr. ex Ikonn. in Novosti Sist. Vyssh. Rast. 8: 273. 1971, nom. illeg. = *Psammophila* Fourr. in Ann. Soc. Linn. Lyon sér. 2. 16: 345. 1868, nom. inval.

Four species of central Asia. Most often treated as *Gypsophila* subg. *Macrorrhizaea*, but both Greenberg & Donoghue (2011) and Pirani & al. (2014) showed *P. muralis* as sister to a clade of *Dianthus/Petrorragia*, clearly separate from the remainder of *Gypsophila*.

**Psammosilene** W. C. Wu & C. Y. Wu in L. P. King, Icon. Pl. Medic. 1: [s.n.], t. 1. 1945 sec. Bittrich (1993c). – Type: *Psammosilene tunicoides* W. C. Wu & C. Y. Wu

Monotypic; in montane forests of Yunnan, China. Oxelman & Lidén (1995) found *Psammosilene* to be sister to subfamily *Caryophylloideae*, while Greenberg & Donoghue (2011) found it to be a sister to tribe *Caryophylleae* (*Dianthus/Gypsophila/Saponaria*, etc.).

**Pseudocerastium** C. Y. Wu & al. in Acta Bot. Yunnan. 20: 395. 1998 sec. Lu & Rabeler (2001). – Type: *Pseudocerastium stellarioides* X. H. Guo & X. P. Zhang

Monotypic; China. Presumed close to *Cerastium*, but not yet sampled for DNA.

**Pseudocherleria** Dillenb. & Kadereit in Taxon 63: 79. 2014 sec. Dillenberger & Kadereit (2014). – Type: *Pseudocherleria laricina* (L.) Dillenb. & Kadereit

Comprises 12 species found in the Caucasus region, arctic Asia and northwestern North America. Formerly included (with *Cherleria*) in *Minuartia* sect. *Spectabiles* (Fenzl) Hayek, Dillenberger & Kadereit (2014) found the two groups segregated into different clades far from *Minuartia* s.str., proposing the recognition of both genera.

**Pseudostellaria** Pax, Nat. Pflanzenfam. (ed. 2) 16c: 318. 1934 sec. Bittrich (1993c). – Type: *Pseudostellaria rupestris* (Turcz.) Pax

A group of about 20 species, mostly in central Asia east to Japan, with one species in Europe and three in western North America. The few species thus far sampled cluster near *Lepyrodiclis* and *Odontostemma*. Greenberg & Donoghue (2011) included four species and found the American *P. jamesiana* (Torr.) W. A. Weber & R. L. Hartm. did not cluster with the three Asian species; their report showing *Stellaria jamesiana* Torr. (= *P. jamesiana* (Torr.) W. A. Weber & R. L. Hartm.) clustering among *Cerastium* is based on a misidentified specimen of *C. arvense* L.

**Pteranthus** Forssk. in Fl. Aegypt.-Arab.: 36. 1775 sec. Bittrich (1993c). – Type: *Pteranthus dichotomus* Forssk.

- Monotypic; northern Africa east to Iran. A member of the *Polycarpaeae*, clustering with *Dicheranthus* (Greenberg & Donoghue 2011).
- Pycnophyllopsis*** Skotts. in Kongl. Svenska Vetenskapsakad. Handl. 56(5): 216. 1916 sec. Bittrich (1993c). – Type: *Pycnophyllopsis muscosa* Skotts. Segregation of *Pycnophyllopsis* from *Pycnophyllum* has been confirmed (M. Timaná, unpubl. data). *Plettkea* may belong here.
- Pycnophyllum*** Remy in Ann. Sci. Nat., Bot., ser. 3, 6: 355. 1846 sec. Bittrich (1993c). – Type: not designated. A genus of 17 Andean species that clusters close to *Drymaria*, a result first reported by Smissen & al. (2003) and confirmed in four further studies. This contradicts the earlier placement (e.g. Bittrich 1993c) as a member of subfamily *Alsinoideae*.
- Reicheella*** Pax, Nat. Pflanzenfam., Nachtr. 2: 21. 1900 sec. Bittrich (1993c). – Type: *Reicheella andicola* (Phil.) Pax Monotypic; Chile. Not yet sampled in a molecular study.
- Rhodalsine*** J. Gay in Ann. Sci. Nat., Bot., ser. 3, 4: 25. 1845 sec. Favarger & Monserrat (1991). – Type: *Rhodalsine procumbens* J. Gay = *Psammanthe* Rchb., Deut. Bot. Herb.-Buch: 205; Syn. Red.: 94. 1841, nom. rej. prop. (Kool & Thulin 2013). Five mostly Mediterranean species. Formerly treated as *Minuartia* subg. *Rhodalsine* (J. Gay) Graebn. (McNeill 1962), Harbaugh & al. (2010), Greenberg & Donoghue (2011) and Kool (2012) each found *Rhodalsine* to be sister to *Spergula* and *Spergularia*.
- Sabulina*** Rchb., Fl. Germ. Excurs. 24: 785. 1832 sec. Dillenberger & Kadereit (2014). – Type: *Sabulina tenuifolia* (L.) Hiern. Comprising c. 65 species (possibly 70, including some eastern European and western Asian taxa not yet transferred to *Sabulina*: S. Mosyakin, unpubl. data), all but two found in the northern hemisphere (Europe, Asia and North America). Including members of six sections of McNeill's (1962) *Minuartia* subg. *Minuartia* as well as *Stellaria fontinalis* (Short & Peter) B. L. Rob., these species form a clade that is sister to a clade including *Colobanthus*, *Facchinia* and *Sagina*. Rabeler & al. (2014) suggested this clade may be further subdivided, possibly recognizing four other genera.
- Sagina*** L., Sp. Pl. 1: 128. 1753 sec. Bittrich (1993c). – Type: *Sagina procumbens* L. = *Spergella* Rchb., Handb. Gewächsk., ed. 2, 1: 65. 1827. A genus of about 30 species, most diverse in north-temperate and arctic areas with a few taxa found on some tropical mountains. Sampling shows *Sagina* to be monophyletic, although infrageneric relationships have not been studied.
- Sanctambrosia*** Skotts. ex Kuschel in Ark. Bot., ser. 2, 4: 418. 1962 sec. Bittrich (1993c). – Type: *Sanctambrosia manicata* (Skotts.) Skotts. ex Kuschel Monotypic; San Ambrosio Island (Desventurados archipelago), Chile. Kool (2012) reported it nested within a *Spergularia* clade.
- Saponaria*** L., Sp. Pl. 1: 408. 1753 sec. Bittrich (1993c). – Type: *Saponaria officinalis* L. = *Melandryum* [unranked] *Gastrolychnis* Fenzl in Endlicher, Gen. Pl.: 974. 1840. = *Spanizium* Griseb., Spic. Fl. Rumel. 1: 180. 1843. About 40 species, most diverse in the Mediterranean and southwestern Asia. The most comprehensive monograph dates from 1910 (Simmler 1910), with Shults (1989) providing an updated account for Russian taxa. Up to now, sampling has been minimal and offers no information on how related genera (*Bolbosaponaria*, *Cyathophylla*, *Pleioneura*, etc.) may best be treated.
- Schiedea*** Cham. & Schltdl. in Linnaea 1: 46. 1826 sec. Wagner & al. (2005). – Type: *Schiedea ligustrina* Cham. & Schltdl. = *Alsinidendron* H. Mann in Proc. Boston Soc. Nat. Hist. 10: 311. 1866. A monophyletic group of 34 species endemic to the Hawaiian Islands. See Wagner & al. (2005) for a monographic/phylogenetic revision and Harbaugh & al. (2010) for comments on the origin of *Schiedea*.
- Scleranthus*** L., Sp. Pl. 1: 406. 1753 sec. Bittrich (1993c). – Type: *Scleranthus annuus* L. = *Mniarum* J. R. Forst. & G. Forst, Char. Gen. Pl., ed. 2: [1]. 1776. About 12 species native to Eurasia and Australasia. Smissen & al. (2003) found *Scleranthus* to be monophyletic and to be treated as two subgenera: *S.* subg. *Scleranthus* (three species, Eurasia) and *S.* subg. *Mniarum* (J. R. Forst. & G. Forst.) Pax (nine species, southeastern Australasia). Dillenberger & Kadereit (2014) found *Scleranthus* was sister to one of ten clades of *Minuartia* s.l., treated by them as *Cherleria*.
- Scopulophila*** M. E. Jones in Contr. W. Bot. 12: 5. 1908 sec. Bittrich (1993c). – Type: *Scopulophila nitrophiloides* Jones Two species; southwestern United States and Mexico. Hartman (2005b) noted seed and flower characters suggesting a close relationship to *Achyronychia*; Greenberg & Donoghue (2011) showed this for *S. rixfordii* (Brandege) Munz & I. M. Johnst., but *S. parryi* (Hemsl.) I. M. Johnst. clustered with *Sphaerocoma aucheri* Boiss. (= *S. hookeri* T. Anderson subsp. *aucheri* (Boiss.) Kool & Thulin).
- Silene*** L., Sp. Pl. 1: 416. 1753, nom. cons. prop. sec. Oxelman & al. (2001) = *Viscago* Zinn, Cat. Pl. Gott.: 188. 1757 = *Kaleria* Adans., Fam. Pl. 2: 506. 1763 = *Corone* Hoffmanns ex Steud., Nomencl. Bot., ed. 2, 1: 422. 1840 = *Oncerum* Dulac, Fl. Hautes-Pyrénées: 255. 1867. – Type: *Silene anglica* L. – Fig. 3G.

- = *Cucubalus* L., Sp. Pl. 1: 414. 1753 ≡ *Scribaea* Borkh. in Rhein. Mag. 1: 591. 1793.
  - = *Oberna* Adans., Fam. Pl. 2: 255. 1763 ≡ *Silene* sect. *Behenantha* Otth in Candolle, Prodr. 1: 367. 1824 ≡ *Behenantha* (Otth) Schur in Verh. Naturf. Vereins Brünn 15(2): 130. 1877.
  - = *Otites* Adans., Fam. Pl. 2: 255. 1763.
  - = *Lychnanthos* S. G. Gmel. in Novi Comment. Acad. Sci. Imp. Petrop. 14(1): 525. 1770.
  - = *Melandrium* Röhl., Deutschl. Fl. (ed. 2) Phanerog. Gew. 2: 37, 274. 1812.
  - = *Lychnis* sect. *Physolychnis* Benth., Ill. Bot. Himal. Mts.: 80. 1834 ≡ *Lychnis* [unranked] *Gastrolychnis* Fenzl in Endlicher, Gen. Pl.: 974. 1840 ≡ *Gastrolychnis* (Fenzl) Rchb., Deut. Bot. Herb.-Buch: 206. 1841 ≡ *Wahlbergella* Fries in Bot. Not. (1843): 143. 1843 ≡ *Physolychnis* Rupr. in Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 7, 14: 41. 1869.
  - = *Alifiola* Raf., Autik. Bot.: 24. 1840.
  - = *Ebraxis* Raf., Autik. Bot.: 29. 1840.
  - = *Evactoma* Raf., Autik. Bot.: 23. 1840.
  - = *Pleconax* Raf., Autik. Bot.: 24. 1840 ≡ *Conosilene* (Rohrb.) Fourr. in Ann. Soc. Linn. Lyon sér. 2. 16: 344. 1868.
  - = *Xamilenis* Raf., Autik. Bot.: 24. 1840.
  - = *Elisanthe* (Fenzl) Rchb., Deut. Bot. Herb.-Buch: 206. 1841.
  - = *Silenanthe* Griseb. & Schenk in Archiv für Naturgeschichte 18: 300. 1852.
  - = *Polyschemone* Schott, Nymann & Kotschy in Schott, Analecta Bot.: 55. 1854.
  - = *Carpophora* Klotzsch in Bot. Ergebn. Reise Walde-mar: 139. 1862.
  - = *Leptosilene* Fourr. in Ann. Soc. Linn. Lyon sér. 2. 16: 344. 1868.
  - = *Muscipula* Fourr. in Ann. Soc. Linn. Lyon sér. 2. 16: 344. 1868.
  - = *Petrosilene* Fourr. in Ann. Soc. Linn. Lyon sér. 2. 16: 344. 1868.
  - = *Petrocoma* Rupr. in Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 7, 15(2): 200. 1869.
  - = *Anotites* Greene in Leaf. Bot. Observ. Crit. 1: 97. 1904.
  - = *Gastrocalyx* Schischk. in Izv. Kavkazsk. Muz. 12: 200. 1919 ≡ *Schischkiniella* Steenis in Blumea 15: 145. 1967.
  - = *Charesia* E. A. Busch in Trudy Bot. Muz. 19: 182. 1926.
  - = *Sofianthe* Tzvelev in Novosti Sist. Vyssh. Rast. 33: 97. 2001.
  - = *Neoussuria* Tzvelev in Novosti Sist. Vyssh. Rast. 34: 299. 2002.
- Generic delimitation has been notoriously controversial (see Oxelman & Lidén 1995 for a review). Some authors have lumped all c. 850 species of the tribe *Sileneae* (except *Agrostemma*) in *Silene* (e.g. Greuter 1995), whereas Tzvelev (2001) recognized 23 gen-

era in Europe alone. Molecular evidence clearly supports separation of *Agrostemma*, *Atocion*, *Eudianthe*, *Heliosperma*, *Petrocoptis* and *Viscaria* (e.g. Oxelman & Lidén 1995; Oxelman & al. 1997, 2001; Popp & Oxelman 2004; Frajman & al. 2009a, b; Greenberg & Donoghue 2011). However, monophyly of *Silene*, in the sense adopted here, is only rarely supported by individual gene trees. Several studies have identified two major clades (*S.* subg. *Behenantha* (Otth) Endl. and *S.* subg. *Silene*; e.g. Oxelman & Lidén 1995; Oxelman & al. 1997, 2001; Eggens & al. 2007; Erixon & Oxelman 2008; Rautenberg & al. 2012; Aydin & al. 2014), but their relationship to *Lychnis* is ambiguous. *Silene* sect. *Atocion* Otth, a small group of annuals from the eastern Mediterranean, appears to be blurring the picture, possibly due to highly elevated substitution rates across the genome (Z. Aydin & al., unpubl. data).

***Solitaria*** (McNeill) Sadeghian & Zarre, Bot. J. Linn. Soc. 178: 667. 2015 sec. Sadeghian & al. (2015) ≡ *Arenaria* subg. *Solitaria* McNeill, Notes Roy. Bot. Gard. Edinburgh. 24: 128, 1962. – Type: *Solitaria ciliolata* (Edgew.) Sadeghian & Zarre

A genus of about seven Himalayan species. Sadeghian & al. (2015) found *Solitaria* clustering as a sister to either *Odontostemma* or *Pseudostellaria*.

***Spergula*** L., Sp. Pl. 1: 440. 1753 sec. Bittrich (1993c). – Type: *Spergula arvensis* L.

Five north-temperate species. While López González (2010) suggested *Spergularia* should be included in *Spergula* based on morphology, Kool (2012) demonstrated that both genera are monophyletic.

***Spergularia*** (Pers.) J. Presl & C. Presl, Fl. Cech.: 94. 1819, nom. cons. sec. Bittrich (1993c) ≡ *Arenaria* subg. *Spergularia* Pers., Syn. Pl. 1: 504. 1805 ≡ *Tissa* Adans., Fam. Pl. 2: 507, 611. 1763. – Type: *Spergularia rubra* (L.) J. Presl & C. Presl

= *Delia* Dumort. in Fl. Belg. 1: 110. 1827.

About 60 species (Hartman & Rabeler 2005), especially diverse in the Mediterranean and temperate South America. The genus is monophyletic (Kool 2012), but infrageneric relationships are not defined.

***Sphaerocoma*** T. Anderson in J. Proc. Linn. Soc., Bot. 5: 16. 1861 sec. Kool & al. (2012). – Type: *Sphaerocoma hookeri* T. Anderson

Monotypic; in deserts from Somalia east to Pakistan. Kool & al. (2012) noted that *Sphaerocoma* is sister to the monotypic *Pollichia* and together they form a sister clade to one including *Polycarpaea* and *Polycarpon*.

***Stellaria*** L., Sp. Pl. 1: 421. 1753 sec. Bittrich (1993c). – Type: *Stellaria holostea* L.

= *Alsine* L., Sp. Pl. 1: 272. 1753.

= *Tytthostemma* Nevski in Trudy Bot. Inst. Akad. Nauk S. S. S. R., Ser. 1, Fl. Sist. Vyssh. Rast 4: 305. 1937.

= *Mesostemma* Vved. in Bot. Mater. Gerb. Bot. Inst. Uzbekistansk. Fil. Akad. Nauk S. S. S. R. 3: 4. 1941.

= *Fimbrietalum* (Turcz.) Ikonn. in Novosti Sist. Vyssh. Rast. 14: 78. 1977.

- A genus of about 150 to more likely 200 species of Eurasia and North America, most diverse in the mountains of central Asia. *Stellaria* is in need of a monographic revision; the most recent infrageneric classification is that of Pax & Hoffman (1934). Greenberg & Donoghue (2011) conducted the most extensive sampling of *Stellaria* to date, including 44 species. *Stellaria* is clearly polyphyletic and in need of further study: *S. obtusa* Engelm. appeared as a sister to a clade including *Honckenya*, *Schiedea* and *Wilhelmsia*; three Mexican/Caribbean species were sister to *Minuartia* sect. *Uninerviae* (Fenzl) Mattf. (= *Mononeuria* of Dillenberger & Kadereit 2014); *S. americana* (Porter ex B. L. Rob.) Standl. clustered with *Pseudostellaria jamesiana* (Torr.) W. A. Weber & R. L. Hartm.; and *S. holostea*, the type of *Stellaria*, appeared as sister to the clade that includes *Cerastium*, *Dichodon*, *Holosteum*, *Moenchia* and the majority of *Stellaria* species sampled.
- Stipulicida*** Michx., Fl. Bor.-Amer. 1: 26, pl. 6. 1803 sec. Bittrich (1993c). – Type: *Stipulicida setacea* Michx. *Stipulicida* is found only in the southeastern United States and Cuba. Long thought to be monotypic, a recent morphological study (Poindexter & al. 2014) proposed recognition of two species. Work is underway to confirm placement in the *Polycarpaeae* (K. Neubig & R. Rabeler, unpubl. data).
- Telephium*** L., Sp. Pl. 1: 271. 1753 sec. Bittrich (1993c). – Type: *Telephium imperati* L. Five species of the Mediterranean and southwestern Asia. Harbaugh & al. (2010) and Greenberg & Donoghue (2011) both placed *Telephium* in tribe *Corrigioleae*, near the base of *Caryophyllaceae*.
- Thurya*** Boiss. & Balansa in Boissier, Diagn. Pl. Orient., ser. 2, 5: 63. 1856 sec. Bittrich (1993c). – Type: *Thurya capitata* Boiss. & Balansa Monotypic; SW Asia. Not yet sampled in a molecular study.
- Thylacospermum*** Fenzl in Endlicher, Gen. Pl.: 967. 1840 sec. Bittrich (1993c). – Type: *Periandra caespitosa* Cambess. Two species, central Asia and Himalayas. The phylogenetic placement is still uncertain. Harbaugh & al. (2010) placed it “tentatively” into *Eremogoneae*, whereas Greenberg & Donoghue (2011) and Dillenberger & Kadereit (2014) both found *Thylacospermum* closely aligned with *Spergula*; Greenberg & Donoghue (2011) considered their placement “uncertain”.
- Triplateia*** Bartl. in Ord. Nat. Pl.: 305. 1830 sec. Dillenberger & Kadereit (2014). – Type: *Triplateia diffusa* Bartl. = *Hymenella* Ser. in Candolle, Prodr. 1: 389. 1824, nom. illeg. Monotypic; endemic to central Mexico. Treated by McNeill (1962) as *Minuartia* subg. *Hymenella* (Ser.) McNeill. Harbaugh & al. (2010) and Greenberg & Donoghue (2011) both reported it as sister to *Geocarpon minimum* Mack., a species endemic to the Ozark region of the United States. Dillenberger & Kadereit (2014) found that it was a sister taxon to three species of *Stellaria* from Mexico and the Caribbean. This clade was, depending on the gene chosen, either sister to *Mononeuria* (*Minuartia* sect. *Uninerviae* + *Geocarpon*) (*matK*) or sister to a clade including *Honckenya*, *Schiedea* and *Wilhelmsia* (ITS).
- Vaccaria*** Wolf, Gen. Pl.: 3. 1776 sec. Bittrich (1993c). – Type: *Vaccaria pyramidata* Medik. One or four species, native to Eurasia. While usually thought to be closely related to *Saponaria*, both Harbaugh & al. (2010) and Greenberg & Donoghue (2011) found a potential relation with *Gypsophila* based on different vouchers: sister to *Gypsophila* in the former study, clustering near the base of a *Gypsophila* clade in the latter.
- Velezia*** L., Sp. Pl. 1: 332. 1753 sec. Bittrich (1993c). – Type: *Velezia rigida* L. Six species occurring from the Mediterranean east to Afghanistan. May be included in *Dianthus*; Harbaugh & al. (2010) and Greenberg & Donoghue (2011) both found *V. rigida* nested in *Dianthus*, while Pirani & al. (2014) showed *Velezia* as a sister to *Dianthus*.
- Viscaria*** Bernh. in Syst. Verz.: 261. 1800, nom. cons. sec. Oxelman & al. (2001) = *Steris* Adans., Fam. Pl. 2: 255. 1763. – Type: *Viscaria vulgaris* Bernh. = *Liponeurum* Schott, Nymann & Kotschy in Schott, Analecta Bot.: 55. 1854. Recently revised by Frajman & al. (2013) with three chiefly European and North American species.
- Wilhelmsia*** Rchb., Consp. Regn. Veg.: 206. 1828 sec. Bittrich (1993c). – Type: *Arenaria physodes* Fisch. ex Ser. Monotypic; arctic northwestern North America and eastern Asia. Harbaugh & al. (2010) found *Wilhelmsia* and *Honckenya* are sister to each other and both are the closest relatives to the Hawaiian *Schiedea*.
- Xerotia*** Oliv. in Hooker’s Icon. Pl.: t. 2359. 1895 sec. Bittrich (1993c). – Type: *Xerotia arabica* Oliv. Monotypic; Arabia. Found to be nested in one of the clades of *Polycarpaea* by Kool & al. (2012); placement awaits further resolution of polyphyly in *Polycarpaea*.
- Chenopodiaceae*** Vent. sec. Müller & Borsch (2005). The family *Chenopodiaceae* is cosmopolitan predominantly occurring in temperate and subtropical regions, and especially in semi-arid or arid environments (Kühn 1993; Kadereit & al. 2003). Our delimitation of the *Chenopodiaceae* follows the concept of Ulbrich (1934), and Kühn (1993) with the exception of the *Polycnemoidae* (see *Amaranthaceae*). Considering that the core of *Chenopodiaceae* (composed of *Betoideae*, *Camphorosmoideae*, *Chenopodioideae*, *Salicornioideae*, *Salsoloidae* and *Suaedoideae*) is likely to be monophyletic, we

maintain the *Chenopodiaceae* as a family distinct from the *Amaranthaceae* in line with a series of current taxonomic treatments and morphological, physiological and phylogenetic studies (Tzvelev & al. 1996; Welsh & al. 2003; Zhu & al. 2003; Kadereit & al. 2005; Kapralov & al. 2006; Voznesenskaya & al. 2007; Akhani & al. 2007; Zacharias & Baldwin 2010; Kadereit & al. 2010; Sukhorukov 2010; Flores-Olvera & al. 2011; Sukhorukov & Kushunina 2014). We believe that name stability is important as it facilitates the assignment of genera to the respective major *Amaranthaceae* and *Chenopodiaceae* clades in line with the vast literature on *Chenopodiaceae*. The monophyletic core *Chenopodiaceae* had already been found with maximum support based on *matK-trnK* sequence data (Müller & Borsch 2005a), although relationships of the six major subfamilies were not clear. Much progress has been made in the last decade on the internal relationships of *Chenopodiaceae*. Schütze & al. (2003) found two major clades of *Suaedoideae* Ulbr., to which *Bienertia* is sister. The *Salicornioideae* were clearly identified as monophyletic and are a lineage of about 90 species growing worldwide in coastal and inland saline habitats (Kadereit & al. 2006) with often succulent-articulated stems. Phylogenetic analysis yielded good support for the *Camphorosmoideae* that include several major lineages of mostly steppe, semi-desert and desert plants (Kadereit & Freitag 2011), but genera of the *Salsoloideae* such as *Salsola* L. were depicted as largely polyphyletic (Akhani & al. 2007; Kadereit & Freitag 2011). The *Chenopodioideae* were confirmed as monophyletic, although the members of the genus *Chenopodium* in its pre-phylogenetic circumscription appeared scattered across the subfamily, leading to a re-circumscription at genus and tribal level (Fuentes-Bazán & al. 2012a, b).

**Acroglochis** Schrad., Mant. 1: 69, 227. 1822 sec. Kühn (1993). – Type: *Acroglochis chenopodioides* Schrad. The central Asian genus *Acroglochis* represents an ancient lineage in *Chenopodiaceae* and stands phylogenetically isolated from other subfamilies (Hohmann & al. 2006; Kadereit & al. 2012, online supplement). The genus was formerly included in *Betoideae* and should probably be classified as a subfamily of its own.

**Agriophyllum** M. Bieb. in Fl. Taur.-Caucas. 3: 6. 1819–1820 sec. Kühn (1993). – Type: *Agriophyllum arenarium* M. Bieb.

*Agriophyllum* comprises six western and central Asian species of annual herbs and belongs to the *Corispermoidae* (Kadereit & al. 2003).

**Allenrolfea** Kuntze in Revis. Gen. Pl. 2: 545. 1891 sec. Kühn (1993). – Type: *Allenrolfea occidentalis* (S. Watson) Kuntze – Fig. 4B.

*Allenrolfea* comprises two or three species of stem-succulent halophytes distributed in the Americas (Kadereit & al. 2006a).

**Anabasis** L., Sp. Pl. 1: 223. 1753 sec. Kühn (1993). – Type: *Anabasis aphylla* L.

= *Brachylepis* C. A. Mey. ex Ledeb., Icon. Pl. 1: 12. 1829.

= *Fredolia* (Coss. & Durieu ex Bunge) Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 451, 578. 1934.

= *Esfandiaria* Charif & Aellen in Verh. Naturf. Ges. Basel 63: 262. 1952.

A diverse genus within the *Salsoleae* s.str. (Akhani & al. 2007) distributed throughout northern African and Eurasian steppes, semi-deserts and deserts. The genus evolved some extremely drought-tolerant species, e.g. *A. calcarea* (Charif & Aellen) Bokhari & Wendelbo, showing anatomical and morphological adaptations to drought such as stunted growth forms, reduced leaves, central water storage tissues and a multi-layered epidermis (Bokhari & Wendelbo 1978). The fruit anatomy of the genus was studied by Sukhorukov (2008).

**Anthochlamys** Fenzl in Endlicher, Gen. Pl.: 300. 1837 sec. Kühn (1993). – Type: *Anthochlamys polygaloides* (Fisch. & C. A. Mey.) Moq.

*Anthochlamys* comprises three southwestern Asian species of annual herbs and belongs to the *Corispermoidae* (Kühn 1993a; Kadereit & al. 2003). Carpologically it is closely related to *Corispermum* (Sukhorukov 2014).

**Aphanisma** Nutt. ex Moq. in Candolle, Prodr. 13(2): 43, 54. 1849 sec. Kühn (1993). – Type: *Aphanisma blitoides* Nutt. ex Moq.

This monotypic genus is distributed in coastal habitats of California and according to Hohmann & al. (2006) it belongs to *Betoideae–Hablitzieae*. Together with its sister genus *Oreobliton*, which is distributed in northern Africa, *Aphanisma* represents an interesting example of a western Eurasian–western North American disjunction (Kadereit & Baldwin 2012).

**Archiatriplex** G. L. Chu in J. Arnold Arbor. 68: 461. 1987 sec. Kühn (1993). – Type: *Archiatriplex nanpinensis* G. L. Chu

This monotypic genus is only known from northern Sichuan province, China, near Nanping (Chu 1987). *Archiatriplex* is interpreted as an ancient lineage of the *Chenopodieae* (formerly *Atripliceae*), based on molecular phylogenetic and morphological evidence (Kadereit & al. 2010).

**Arthrocnemum** Moq. in Chenop. Monogr. Enum.: 111. 1840 sec. Kühn (1993). – Type: *Arthrocnemum glaucum* Ung.-Sternb.

*Arthrocnemum* belongs to *Salicornioideae*. In its current circumscription, the genus consists of two disjunctly distributed species, the Eurasian and northern African *A. macrostachyum* (Moric.) K. Koch and the North American and Mesoamerican *A. subterminale* (Parish) Standl. Both are stem-succulent hygrophalophytes (Kadereit & al. 2006a).

**Arthropytum** Schrenk in Bull. Cl. Phys.-Math. Acad. Pétersb. 3: 211. 1845 sec. Kühn (1993). – Type: *Arthropytum subulifolium* Schrenk

The genus belongs to *Salsoleae* s.str. and comprises c. nine species (Akhani & al. 2007).

- Atriplex** L., Sp. Pl. 1: 1052. 1753 sec. Kadereit & al. (2010). – Type: *Atriplex hortensis* L.  
 = *Obione* Gaertn., Fruct. Sem. Pl. 2: 198. 1791.  
 = *Atriplex* [unranked] *Theleophyton* Hook. f. in London J. Bot. 6: 279. 1847 = *Theleophyton* (Hook. f.) Moq. in Candolle, Prodr. 13(2): 44, 115. 1849.  
 = *Blackiella* Aellen in Bot. Jahrb. Syst. 68: 423. 1938.  
 = *Morrisiella* Allen in Bot. Jahrb. Syst. 68: 422. 1938.  
 = *Pachypharynx* Allen in Bot. Jahrb. Syst. 68: 429. 1938.  
 = *Senniella* Aellen in Bot. Jahrb. Syst. 68: 416. 1938.  
 = *Cremnophyton* Brullo & Pavone in Candollea 42: 622. 1987.

*Atriplex* is the most species-rich genus within *Chenopodiaceae* with c. 300 species. This cosmopolitan genus comprises annual or perennial herbs, subshrubs and shrubs that are often prominent floristic elements of steppes, semi-deserts and coastal habitats (Kadereit & al. 2010). Most species of *Atriplex* are C<sub>4</sub> plants that all belong to one large C<sub>4</sub> lineage. Many species of the genus are halophytes and possess salt glands. Ontogenetic studies showed that the two more or less concrescent “bracteoles” that envelop the fruit and that are characteristic of *Atriplex* are better interpreted as two tepals (Flores-Olvera & al. 2011). The circumscription of *Atriplex* has changed over time, and several infrageneric classifications have been proposed (Flores & Davis 2001; Kadereit & al. 2010). Recent phylogenetic studies based on molecular data (Kadereit & al. 2010; Zacharias & Baldwin 2010) show that *Atriplex* in its traditional circumscription is not monophyletic and includes several satellite genera that have been separated in the past. A new infrageneric classification is needed. Previously *Atriplex* was placed in the tribe *Atripliceae*. However, because the previous *Chenopodieae* are paraphyletic to *Atripliceae* the tribes were merged together by Fuentes-Bazán & al. (2012b). The accepted name of the tribe in the new, monophyletic definition is *Atripliceae*.

- Axyris** L., Sp. Pl. 1: 979. 1753 sec. Kühn (1993). – Type: *Axyris amaranthoides* L.  
*Axyris*, together with *Ceratocarpus* and *Krascheninikovia*, constitutes the *Axyrideae* (Kadereit & al. 2010). The genus consists of six species mainly concentrated in the mountains of central Asia and eastern Siberia (Sukhorukov 2011); some species (especially *A. amaranthoides* L.) occur as alien weeds in Eurasia and North America beyond their native range. Investigated species of the genus show heterocarpy (Sukhorukov 2005, 2011).
- Baolia** H. W. Kung & G. L. Chu in Acta Phytotax. Sin. 16(1): 119. 1978 sec. Kühn (1993). – Type: *Baolia bracteata* H. W. Kung & G. L. Chu  
 The phylogenetic position of this rare monotypic

genus from China is unknown. According to Kühn (1993a) it belongs to the *Chenopodioideae*.

- Bassia** All. in Mélanges Philos. Math. Soc. Roy. Turin 3: 177. 1766 sec. Kadereit & Freitag (2011). – Type: *Bassia muricata* (L.) Asch.  
 = *Kochia* Roth in J. Bot. (Schrader) 1800(1): 307. 1801.  
 = *Echinopsilon* Moq., Ann. Sci. Nat. Bot., ser. 2, 2: 127. 1834, nom. illeg.  
 = *Londesia* Fisch. & C. A. Mey. in Index Seminum [St. Petersburg (Petropolitanus)] 2: 40. 1836.  
 = *Panderia* Fisch. & C. A. Mey. in Index Seminum [St. Petersburg (Petropolitanus)] 2: 21. 1836.  
 = *Kirilowia* Bunge in Del. Sem. Hort. Dorpat. 1843: 7. 1843.  
 = *Chenoleoides* (Ulbr.) Botsch. in Bot. Zhurn. (Moscow & Leningrad) 61: 1408. 1976 = *Chenolea* sect. *Chenoleoides* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 530. 1934.  
*Bassia* belongs to *Camphorosmoideae–Camphorosmeae* and in the circumscription adopted here consists of c. 20 C<sub>4</sub> annuals or perennials. The genus is distributed from the western Mediterranean to eastern Asia (Kadereit & Freitag 2011), with the main centre of diversity in central Asia. It represents an interesting example of C<sub>4</sub> leaf-type diversity (Freitag & Kadereit 2014) and multiple reduction of water-storage tissue (Akhani & Khoshravesh 2013; Kadereit & al. 2014).

- Beta** L., Sp. Pl. 1: 222. 1753 sec. Kadereit & al. (2006b). – Type: *Beta vulgaris* L.  
*Beta* comprises seven species of annuals or biennial and perennial herbs with a storage root. *Beta* is subdivided into two sections and is the only genus of tribe *Beteae*. *Beta* sect. *Procumbentes* Ulbr. (= *B.* [unranked] *Patellares* Tranzschel) was excluded from *Beta* on the basis of molecular phylogenetic and morphological results (see under *Patellifolia*; Hohmann & al. 2006; Kadereit & al. 2006b). *Beta vulgaris* and its various cultivated varieties (sugar beet, beetroot, fodder beet and chard) are the economically most important crops within *Caryophyllales* (McGrath & al. 2011). For *B. vulgaris* the chloroplast genome (Li & al. 2014) and the nuclear genome (Dohm & al. 2013) have been sequenced recently.

- Bienertia** Bunge ex Boiss. in Fl. Orient. [Boissier]: 945. 1879–1879 sec. Kühn (1993). – Type: *Bienertia cycloptera* Bunge ex Boiss.

The genus comprises three species that grow in temporarily wet saline habitats in Iran and surrounding countries (Akhani & al. 2005, 2012). The discovery of Akhani & al. (1997) and Freitag & Stichler (2002) that *B. cycloptera* Bunge is a C<sub>4</sub> plant without Kranz tissues triggered a large number of physiological, biochemical and genetic studies investigating C<sub>4</sub> photosynthesis in this genus (Akhani & al. 2009).

- Blitum** L., Sp. Pl. 1753 1: 4. 1753 sec. Fuentes-Bazán & al. (2012b) = *Morocarpus* Boehm., Def. Gen. Pl., ed. 3: 385. 1760, nom. illeg. = *Chenopodium* sect. *Bli-*

*tum* (L.) Benth. & Hook f., Gen. Pl. 3(1): 52. 1880 = *Chenopodium* sect. *Eublittum* Aellen in Verh. Naturf. Ges. Basel 41: 103. 1930 = *Chenopodium* subg. *Blitum* (L.) Hiitonon, Suom. Kasvio: 307. 1933. – Type: *Blitum capitatum* L.

= *Anserina* Dumort., Fl. Belg. 1: 21. 1827 = *Agathophytum* Moq. in Ann. Sci. Nat., Bot., ser. 2, 1: 291. 1834, nom. illeg. = *Orthosporum* subg. *Agathophytum* T. Nees, Gen. Fl. Germ. [1]: ad. t. [57]. 1835 = *Chenopodium* sect. *Agathophytum* (T. Nees) Benth. & Hook. f., Gen. Pl. 3(1): 52. 1880.

= *Monolepis* Schrad. in Index Seminum Hort. Acad. Gotting. 1830: 4. 1830.

= *Chenopodium* [unranked] *Californica* Standl., N. Amer. Fl. 21(1): 30. 1916.

= *Chenopodium* sect. *Atriplicina* Allen in Verh. Naturf. Ges. Basel 41: 99. 1930 = *Scleroblittum* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 495. 1934.

In the last century, the Linnaean *Blitum*, with its two species, *B. capitatum* and *B. virgatum* L., was usually merged with *Chenopodium* s.l. (e.g. Aellen 1929; Iljin & Aellen 1936; Aellen & Just 1943; Aellen 1960–1961; Grubov 1966; Brenan & Akeroyd 1993; Mosyakin 1996; Uotila 1997, 2001a, b; Clemants & Mosyakin 2003), or rarely recognized in the original Linnaean circumscription (Scott 1978a). However, the resurrection of this genus based on phylogenetic reconstruction supports a monophyletic lineage and a wide concept of *Blitum* including c. ten species (Fuentes-Bazán & al. 2012b), most of them in the northern hemisphere and one (*B. atriplicinum* F. Muell.) in Australia. *Blitum* belongs to the tribe *Anserineae*.

***Camphorosma*** L., Sp. Pl. 1: 122. 1753 sec. Kadereit & Freitag (2011). – Type: *Camphorosma monspeliaca* L. *Camphorosma* belongs to *Camphorosmoideae*–*Camphorosmeae* and consists of four  $C_4$  annuals or perennials. The genus is distributed from the western Mediterranean to central Asia (Kadereit & Freitag 2011).

***Caroxylon*** Thunb., Nov. Gen. 2: 37. 1782 sec. Akhani & al. (2007) = *Salsola* sect. *Caroxylon* (Thunb.) Fenzl, Nov. Gen. 2: 37. 1782. – Type: *Caroxylon aphyllum* (L. f.) Tzvelev

= *Salsola* sect. *Cardiandra* Aellen in Notes Roy. Bot. Gard. Edinburgh 28: 32. 1967.

= *Salsola* sect. *Malpighipila* Botsch. in Bot. Zhurn. (Moscow & Leningrad) 54: 990. 1969.

= *Salsola* sect. *Irania* Botsch. in Bot. Zhurn. (Moscow & Leningrad) 71: 1400. 1986.

= *Nitrosalsola* Tzvelev in Ukrayins'k. Bot. Zhurn. 50: 80. 1993.

The genus *Caroxylon* was resurrected by Tzvelev (1993) and then confirmed and re-circumscribed based on molecular and morphological evidence (Akhani & al. 2007). In that circumscription, it is the most diverse genus in *Salsoloideae* with c. 100 species distributed in central and southwestern Asia,

the Mediterranean region and northern and southern Africa (Feodorova 2011). Feodorova & Samigullin (2014) revealed four clades within *Caroxylon* s.l. and provisionally advocated further splitting of the genus, with recognition of *Caroxylon* s.str., a re-circumscribed *Nitrosalsola*, and possibly two other segregate genera, based on molecular and morphological evidence.

***Ceratocarpus*** L., Sp. Pl. 1: 969. 1753 sec. Kühn (1993). – Type: *Ceratocarpus arenarius* L.

= *Ceratoides* Gagnebin in Acta Helv. Phys.-Math. 2: 59. 1755.

This monotypic genus comprises one annual widespread Eurasian species and belongs to the *Axyrideae* G. Kadereit & Sukhor. (Kadereit & al. 2010).

***Chenolea*** Thunb. in Nov. Gen. Pl.: 9. 1781 sec. Kadereit & Freitag (2011). – Type: *Chenolea diffusa* Thunb.

This genus is distributed in southern Africa and comprises two perennial species (Snijman & Manning 2013; Kadereit & al. 2014). Other taxa previously placed in *Chenolea* are now mainly included in *Bassia* s.l. or *Chenoleoides* (see discussion under *Bassia*).

***Chenopodiastrum*** S. Fuentes & al. in Willdenowia 42: 14. 2012 sec. Fuentes-Bazán & al. (2012b) = *Chenopodium* subsect. *Undata* Aellen & Iljin ex Mosyakin & Clemants in Novon 6: 400. 1996. – Type: *Chenopodiastrum murale* (L.) S. Fuentes & al.

= *Chenopodium* [unranked] *Hybrida* Standl., N. Amer. Fl. 21(1): 13. 1916 = *Chenopodium* sect. *Grossefoveata* Aellen & Iljin ex Mosyakin in Ukrayins'k. Bot. Zhurn. 50: 75. 1993 = *Chenopodiastrum* sect. *Grossefoveata* (Mosyakin) Mosyakin in Phytoneuron 2013-56: 6. 2013.

*Chenopodiastrum* is a widespread new genus with six or seven species and segregated from *Chenopodium* s.l. Its recognition is based mainly on molecular phylogenetic studies (Fuentes-Bazán & al. 2012a, b). The genus is subdivided into two groups, for which sectional rank was proposed (Mosyakin 2013).

***Chenopodium*** L., Sp. Pl. 1: 218. 1753 sec. Fuentes-Bazán & al. (2012b) = *Chenopodium* sect. *Leprophyllum* Dumort., Fl. Belg. 1: 21. 1827 = *Chenopodium* sect. *Chenopodiastrum* Moq. in Candolle, Prodr. 13(2): 61. 1849 = *Vulvaria* Bubani, Fl. Pyren. 1: 174. 1897, nom. illeg. – Type: *Chenopodium album* L. – Fig. 4C & D.

= *Rhagodia* R. Br., Prodr. Fl. Nov. Holland.: 408. 1810.

= *Einadia* Raf., Fl. Tellur. 4: 121. 1838.

= *Chenopodium* ser. *Cicatricosa* Aellen in Feddes Repert. Spec. Nov. Regni Veg. 69: 69. 1964 = *Chenopodium* subsect. *Cicatricosa* (Aellen) Mosyakin & Clemants in Novon 6: 402. 1996.

= *Chenopodium* ser. *Favosa* Aellen in Feddes Repert. Spec. Nov. Regni Veg. 69: 69. 1964 = *Chenopodium* subsect. *Favosa* (Aellen) Mosyakin & Clemants in Novon 6: 401. 1996.



- = *Chenopodium* subsect. *Fremontiana* (Standl.) Mosyakin & Clemants in Novon 6: 401. 1996 = *Chenopodium* [unranked] *Fremontiana* Standl. in Fl. Bor.-Amer. (Michaux) 21: 18. 1916.
- = *Chenopodium* subsect. *Leptophylla* (Standl.) Mosyakin & Clemants in Novon 6: 400. 1996 = *Chenopodium* [unranked] *Leptophylla* Standl. in Fl. Bor.-Amer. (Michaux) 21: 14. 1916.
- = *Chenopodium* subsect. *Standleyana* Mosyakin & Clemants in Novon 6: 402. 1996.
- Chenopodium* has been considered one of the most diverse genera within *Chenopodiaceae* with c. 150 species (Kühn 1993), or even up to 250 species (under a narrow species concept). The circumscription has considerably changed over time, and several infrageneric classifications have been proposed. In a wide sense, Kühn (1993) and Mosyakin & Clemants (1996) recognized three subgenera: *C.* subg. *Ambrosia* A. J. Scott, *C.* subg. *Blitum* (L.) Hiitonen and *C.* subg. *Chenopodium*, and this classification was followed by several authors in recent treatments for the genera. However, it was proposed, based initially on morphological data, to include *C.* subg. *Ambrosia* into the re-circumscribed genus *Dysphania* R. Br. (Mosyakin & Clemants 2003, 2008; Clemants & Mosyakin 2003; Zhu & al. 2003). Recent phylogenetic studies based on molecular data (Fuentes-Bazán & al. 2012a, b) have shown that *Chenopodium* in its traditional circumscription is not monophyletic and consists of six independent lineages. Fuentes-Bazán & al. (2012b) also gave the morphological descriptions of the segregates, including *Chenopodium* s.str., which still remains the most species-rich and most widespread genus of the group. *Chenopodium* belongs to *Atripliceae* (earlier *Chenopodieae*), which is monophyletic in the circumscription by Fuentes-Bazán & al. (2012b). The typification of the genus *Chenopodium* is debated. If the same solution is adopted for *Chenopodium* as that proposed for *Salsola* by Akhani & al. (2014), i.e. the recognition of the lectotype proposed under the “American Code” (Arthur & al. 1907) (*C. rubrum* L. in our case), then the genus recognized here as *Oxybasis* should be called *Chenopodium* s.str., and the genus containing *C. album* L. (the lectotype of *Chenopodium* as recognized here) should probably be called *Rhagodia*, which will have disastrous consequences for taxonomy and nomenclature of the group (see discussion in Mosyakin & Clemants 1996; Fuentes-Bazán & al. 2012b).
- Choriptera** Botsch. in Bot. Zhurn. (Moscow & Leningrad) 52: 804. 1967 sec. Kühn (1993). – Type: *Choriptera semhahensis* (Vierh.) Botsch.
- = **Gyroptera** Botsch. in Bot. Zhurn. (Moscow & Leningrad) 52: 807. 1967.
- This genus has not yet been included in any molecular phylogenetic study. It belongs to the African-Arabian subtribe *Sevadinae*, presumably included in *Salsoleae* (Botschantzev 1975).
- Climacoptera** Botsch. in Sborn. Geobot. Akad. Su-kachev: 111. 1956 sec. Akhani & al. (2007). – Type: *Climacoptera lanata* (Pall.) Botsch.
- Climacoptera* s.str. represents a monophyletic  $C_4$  genus within *Caroxyleae*. The genus is distributed in central and southwestern Asia and comprises only annual species. Highly contradictory species numbers, ranging from six to c. 42, are given (Akhani & al. 2007; Prato 1986).
- Corispermum** L., Sp. Pl. 1: 4. 1753 sec. Kühn (1993). – Type: *Corispermum hyssopifolium* L.
- Corispermum* comprises 60–65 annual psammophytic (rarely glareophytic) species naturally distributed mainly in Eurasia, with fewer than ten species native in North America (Mosyakin 1995). Species delimitations and distribution are poorly understood because of high morphological variability and possible recent explosive radiation of local races. There is one molecular phylogenetic study of *Corispermum* by Xue & Zhang (2011) that is limited to Chinese species and shows a rather poor infrageneric resolution. The genus is in need of a taxonomic revision based on comprehensive molecular phylogenetic and morphological studies.
- Cornulaca** Delile in Fl. Egypte: 206. 1813-1814 sec. Kühn (1993). – Type: *Cornulaca monacantha* Delile
- Cornulaca* comprises c. six species occurring in central and southwestern Asia and northern Africa. The genus is presumably monophyletic (Akhani & al. 2007).
- Cyathobasis** Aellen in Candollea 12: 160. 1949 sec. Kühn (1993). – Type: *Cyathobasis fruticulosa* (Bunge) Aellen
- A monotypic genus from Anatolia, closely related to *Girgensohnia* and *Hammada* of *Salsoleae* s.str. (Akhani & al. 2007).
- Cycloloma** Moq. in Chenop. Monogr. Enum.: 17. 1840 sec. Kühn (1993). – Type: *Cycloloma platyphyllum* (Michx.) Moq.
- = *Cyclolepis* Moq. in Ann. Sci. Nat., Bot., sér. 2, 1: 203. 1834, nom. illeg.
- A monotypic genus from North America that is probably phylogenetically nested within *Dysphania* (*Dysphanieae*; G. Kadereit, unpubl. data).
- Didymanthus** Endl. in Nov. Stirp. Dec.: 7. 1839 sec. Kühn (1993). – Type: *Didymanthus roei* Endl.
- This monotypic genus belongs to the Australian *Camphorosmeae* and is closely related to *Dissocarpus* and *Eriochiton* (Cabrera & al. 2009). The genus is endemic to Australia (Wilson 1984).
- Dissocarpus** F. Muell. in Trans. Phil. Inst. Vict. 2: 75. 1858 sec. Kühn (1993). – Type: *Dissocarpus biflorus* F. Muell.
- Four species are currently recognized in *Dissocarpus* (Australian *Camphorosmeae*). The genus is endemic

to Australia (Wilson 1984). It is closely related to *Didymanthus* and *Eriochiton* (Cabrera & al. 2009).

- Dysphania** R. Br., Prodr. Fl. Nov. Holland.: 411. 1810 sec. Fuentes-Bazán & al. (2012b). – Type: *Dysphania littoralis* R. Br.
- = *Chenopodium* [unranked] *Orthosporum* R. Br., Prodr. Fl. Nov. Holland.: 407. 1810 = *Blitum* [unranked] *Orthosporum* (R. Br.) C. A. Mey. in Ledebour, Fl. Altaic. 1: 11. 1829 = *Orthosporum* (R. Br.) T. Nees, Gen. Fl. Germ. [1]: ad t. [57] [!]. 1834 = *Dysphania* sect. *Orthospora* (R. Br.) Mosyakin & Clemants in Ukrayins'k. Bot. Zhurn. 59: 382. 2002.
  - = *Chenopodium* [unranked] *Botryoides* C. A. Mey. in Ledebour, Fl. Altaic. 1: 410. 1829 = *Chenopodium* [unranked] *Botrys* Rchb., Fl. Germ. Excurs. 24: 580. 1832 = *Chenopodium* sect. *Botrys* (Rchb.) W. D. J. Koch, Syn. Fl. Germ. Helv: 607. 1837 = *Ambrina* sect. *Botryois* Moq., Chenop. Monogr. Enum.: 36. 1840, nom. illeg. = *Vulvaria* sect. *Botrys* (Rchb.) Bubani, Fl. Pyren. 1: 177. 1897 = *Botrys* (Rchb.) Nieuwl. in Amer. Midl. Naturalist 3: 274. 1914 = *Chenopodium* subsect. *Botrys* Aellen & Iljin, Fl. URSS 6: 46. 1936 = *Neobotrydium* Moldenke in Amer. Midl. Naturalist 35: 330. 1946 = *Chenopodium* sect. *Botryoides* A. J. Scott in Bot. Jahrb. Syst. 100: 212. 1978 = *Dysphania* sect. *Botryoides* (C. A. Mey.) Mosyakin & Clemants in Ukrayins'k. Bot. Zhurn. 59: 383. 2002.
  - = *Roubieva* Moq. in Ann. Sci. Nat., Bot., ser. 2, 1: 292. 1834 = *Ambrina* Spach, Hist. Nat. Vég. 5: 295. 1836, nom. illeg. = *Chenopodium* sect. *Roubieva* (Moq.) Volkens, Nat. Pflanzenfam. 3(1a): 61. 1893 = *Dysphania* sect. *Roubieva* (Moq.) Mosyakin & Clemants in Ukrayins'k. Bot. Zhurn. 59: 382. 2002.
  - = *Botrydium* Spach, Hist. Nat. Vég. 5: 298. 1836.
  - = *Ambrina* Moq., Chenop. Monogr. Enum.: 36. 1840 = *Ambrina* sect. *Adenois* Moq., Chenop. Monogr. Enum.: 39. 1840 = *Chenopodium* sect. *Ambrina* Benth. & Hook. f., Gen. Pl. 3(1): 51. 1880 = *Chenopodium* [unranked] *Ambrosioidia* Standl., N. Amer. Fl. 21(1): 26. 1916 = *Chenopodium* subg. *Ambrosia* A. J. Scott in Bot. Jahrb. Syst. 100: 211. 1978 = *Dysphania* sect. *Adenois* (Moq.) Mosyakin & Clemants in Ukrayins'k. Bot. Zhurn. 59: 382. 2002.
  - = *Chenopodium* [unranked] *Carinata* Standl., N. Amer. Fl. 21(1): 27. 1916.
  - = *Chenopodium* [unranked] *Incisa* Standl., N. Amer. Fl. 21(1): 25. 1916.
  - = *Meiomeria* Standl., N. Amer. Fl. 21(1): 7. 1916.
  - = *Chenopodium* sect. *Tetrasepala* Allen in Bot. Jahrb. Syst. 63: 490. 1930 = *Dysphania* sect. *Tetrasepala* (Allen) A. J. Scott in Bot. Jahrb. Syst. 100: 218. 1978.
  - = *Chenopodium* sect. *Margaritaria* Brenan in Kew Bull. 11: 166. 1956.
  - = *Chenopodium* sect. *Nigrescentia* Allen in Acta Bot. Acad. Sci. Hung. 19: 3. 1973.
  - = *Dysphania* sect. *Caudatae* A. J. Scott in Bot. Jahrb. Syst. 100: 218. 1978.

The widespread genus *Dysphania* comprises c. 50 species native mostly to South America (*D.* sect. *Adenois*), Eurasia and Africa (*D.* sect. *Botryoides*) and Australia (*D.* sect. *Dysphania*, *D.* sect. *Orthospora* and *D.* sect. *Tetrasepala*). Traditionally, only native Australian taxa were included in *Dysphania* (Scott 1978; Wilson 1983, 1984); later an expanded circumscription of the genus was proposed (Mosyakin & Clemants 2002, 2008) based on morphological evidence. Further molecular phylogenetic studies (Kadereit & al. 2003, 2010; Fuentes-Bazán & al. 2012a, b) demonstrated that *Dysphania* is phylogenetically distant from *Chenopodium* and forms the tribe *Dysphanieae* together with the closely related *Suckleya* and *Teloxys*. The latter was included in *Dysphania* based on morphology (Mosyakin & Clemants 2002, 2008; Clemants & Mosyakin 2003; Zhu & al. 2003), but should be recognized as a separate genus based on molecular results (Kadereit & al. 2010; Fuentes-Bazán & al. 2012a, b).

**Enchylaena** R. Br., Prodr. Fl. Nov. Holland.: 407. 1810 sec. Kühn (1993). – Type: *Enchylaena tomentosa* R. Br.

*Enchylaena* seems to be polyphyletic (Cabrera & al. 2009). However, more molecular data for this genus of Australian *Camphorosmeae* are needed before taxonomic rearrangements can be done.

**Eokochia** Freitag & G. Kadereit in Taxon 80: 72. 2011 sec. Kadereit & Freitag (2011). – Type: *Eokochia saxicola* (Guss.) Freitag & G. Kadereit

A rare endangered monotypic genus of *Camphorosmeae* growing on coastal cliffs in the central Mediterranean (Iamónico & Kadereit 2013). *Eokochia* is sister to the North American genus *Neokochia* (Kadereit & Freitag 2011), thus belonging to a clade showing an ancient Mediterranean–North American disjunction.

**Eremophea** Paul G. Wilson in Fl. Australiana 4: 326. 1984 sec. Kühn (1993). – Type: *Eremophea aggregata* Paul G. Wilson

The genus is endemic to Australia and belongs to the *Camphorosmeae*. It is closely related to *Neobassia* (Cabrera & al. 2009).

**Exomis** Fenzl ex Moq. in Chenop. Monogr. Enum.: 49. 1840 sec. Kühn (1993). – Type: *Exomis axyrioides* Fenzl ex Moq.

A monotypic genus distributed in South Africa. It belongs to the *Archiatrilex* clade within *Chenopodieae*, formerly *Atripliceae* (Kadereit & al. 2010).

**Extriplex** E. H. Zacharias in Syst. Bot. 35: 850. 2010 sec. Zacharias & Baldwin (2010). – Type: *Extriplex joaquinana* (A. Nelson) E. H. Zacharias

The two species of *Extriplex* are endemic to the California Floristic Province. *Extriplex* belongs to the *Archiatrilex* clade within *Chenopodieae*, formerly *Atripliceae* (Kadereit & al. 2010; see Zacharias & Baldwin 2010 for detailed information on the genus).

- Girgensohnia*** Bunge ex Fenzl, Fl. Ross.: 835. 1851 sec. Sukhorukov (2007). – Type: *Girgensohnia pallasii* Bunge  
*Girgensohnia* comprises five annual species in central Asia and Iran (Sukhorukov 2007). The genus belongs to the *Salsoleae* s.str. and is closely related to *Cyathobasis* and *Hammada* (Akhani & al. 2007).
- Grayia*** Hook. & Arn. in Bot. Beechey Voy.: 387. 1840–1840 sec. Zacharias & Baldwin (2010). – Type: *Grayia polygaloides* Hook. & Arn.  
 = *Zuckia* Standl. in J. Wash. Acad. Sci. 5: 58. 1915.  
 A small North American genus that belongs to the *Archiatriplex* clade within *Chenopodieae*, formerly *Atripliceae* (Kadereit & al. 2010; see Zacharias & Baldwin 2010 for detailed information on the genus).
- Grubovia*** Freitag & G. Kadereit in Taxon 80: 72. 2011 sec. Kadereit & Freitag (2011). – Type: *Grubovia dasyphylla* (Fisch. & C. A. Mey.) Freitag & G. Kadereit  
 A central Asian genus comprising three annual  $C_3$  species previously included in *Bassia* and/or *Kochia*. *Grubovia* is sister to the speciose clade of Australian *Camphorosmeae* (Kadereit & Freitag 2011).
- Hablitzia*** M. Bieb. in Mém. Soc. Imp. Naturalistes Moscou 5: 24. 1817 sec. Kühn (1993). – Type: *Hablitzia tamnoides* M. Bieb.  
 The monotypic genus belongs to the *Hablitzieae–Betoideae* (Hohmann & al. 2006; Kadereit & al. 2006). *Hablitzia tamnoides* is one of the very few climbing species in *Chenopodiaceae*. Annual shoots grow from a fleshy root in this species, which is endemic to Caucasus and NW Iran.
- Halarchon*** Bunge in Mém. Acad. Imp. Sci. St.-Petersbourg, Sér. 7, 4(11): 19, 75. 1862 sec. Kühn (1993). – Type: *Halarchon vesiculosus* (Moq.) Bunge  
 Phenotypically this monotypic genus from Afghanistan fits into *Halimocnemis* s.l. However, several attempts to generate sequences for this species have failed (H. Akhani, pers. comm.).
- Halimione*** Aellen in Verh. Naturf. Ges. Basel 49: 121. 1938 sec. Kadereit & al. (2010). – Type: *Halimione pedunculata* (L.) Aellen  
*Halimione* consists of three species (one annual, two perennial), which are distributed in Europe, the Mediterranean and western Asia. The genus is often included in *Atriplex*. Molecular and morphological data, however, support the generic status of *Halimione* (Kadereit & al. 2010), which is sister to the species-rich *Atriplex* in the tribe *Chenopodieae*, formerly *Atripliceae*.
- Halimocnemis*** C. A. Mey. in Ledebour, Fl. Altaic. 1: 381. 1829 sec. Akhani & al. (2007). – Type: *Halimocnemis sclerosperma* (Pall.) C. A. Mey.  
 = *Halanthium* K. Koch in Linnaea 17: 313. 1844.  
 = *Gamanthus* Bunge in Mém. Acad. Imp. Sci. Saint-Petersbourg, Sér. 7, 4(11): 19, 76. 1862.  
 = *Halotis* Bunge in Mém. Acad. Imp. Sci. Saint-Petersbourg, Sér. 7, 4(11): 19, 73. 1862.  
*Halimocnemis* is an aggregate of Irano-Turanian annual species that is phylogenetically not well resolved. Based on phylogenetic studies (Akhani & al. 2007), a broad concept was adopted in which *Gamanthus*, *Halanthium* and *Halotis* are included. Further phylogenetic studies are required for possible inclusion of genera such as *Halarchon*, *Physandra* and *Piptoptera*.
- Halocharis*** Moq. in Candolle, Prodr. 13(2): 48, 201. 1849 sec. Kühn (1993). – Type: *Halocharis sulphurea* (Moq.) Moq.  
*Halocharis* comprises seven annual species and belongs to the *Caroxyleae* (Akhani & al. 2007).
- Halocnemum*** M. Bieb. in Fl. Taur.-Caucas. 3: 3. 1819–1820 sec. Kühn (1993). – Type: *Halocnemum strobilaceum* (Pall.) M. Bieb.  
*Halocnemum* belongs to *Salicornioideae* and comprises two hygrophalophytic species of shrubs. The genus is distributed in the southern Mediterranean and southern, western and west-central Asia and is closely related to *Haloepelis* and *Halostachys* (Kadereit & al. 2006).
- Halogeton*** C. A. Mey. in Icon. Pl. [Ledebour] 1: 10. 1829 sec. Kühn (1993). – Type: *Halogeton glomeratus* (M. Bieb.) C. A. Mey.  
 = *Agathophora* (Fenzl) Bunge in Mém. Acad. Imp. Sci. Saint-Petersbourg, Sér. 7, 4(11): 19, 92. 1862.  
*Halogeton* belongs to *Salsoleae* s.str. and is likely monophyletic (Akhani & al. 2007). This Eurasian genus, one species of which is also found in the southwestern and partly central United States as a widespread invasive alien, comprises c. five annual and perennial species and is often found in saline habitats.
- Haloepelis*** Bunge ex Ung.-Sternb. in Vers. Syst. Salicorn.: 102. 1866 sec. Kühn (1993). – Type: *Haloepelis nodulosa* (Delile) Bunge ex Ung.-Sternb.  
*Haloepelis* comprises three species of annual and perennial hygrophalophytes distributed in the southern Mediterranean, South Africa and southern, western and central Asia. The genus belongs to *Salicornieae* and is closely related to *Halocnemum* and *Halostachys* (Kadereit & al. 2006).
- Halostachys*** C. A. Mey. ex Schrenk in Bull. Cl. Phys.-Math. Acad. Pétersb. 1: 361. 1843 sec. Kühn (1993). – Type: *Halostachys caspica* (M. Bieb.) C. A. Mey. ex Schrenk  
 This monotypic genus of *Salicornieae* is distributed in central, southern and western Asia and southern and eastern Europe. It is closely related to *Halocnemum* and *Haloepelis* (Kadereit & al. 2006). Nomenclatural note: Pfeiffer (1874) had chosen *Halostachys songarica* Schrenk as the type of *Halostachys*, but this species was by that time already placed in the new genus *Haloepelis* (see Piirainen 2015 for details). A proposal has been published to

conserve the name *Halostachys* with *H. caspica* as its conserved type (Piiirainen 2015).

***Halothamnus*** Jaub. & Spach, Ill. Pl. Orient. 2: 50. 1845 sec. Kothe-Heinrich (1993). – Type: *Halothamnus bottae* Jaub. & Spach

= *Aellenia* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 567. 1934.

*Halothamnus* belongs to *Salsoleae* s.str. and is likely monophyletic (Akhani & al. 2007). The genus comprises 21 species, most of which are small shrubs or subshrubs, only two species are annuals. It is found from Somalia in the west to Kazakhstan in the east in desert and semi-desert habitats (Kothe-Heinrich 1993).

***Haloxylon*** Bunge, Fl. Ross.: 292. 1852 sec. Kühn (1993). – Type: *Haloxylon ammodendron* (C. A. Mey.) Bunge  
The molecular phylogenetic studies by Akhani & al. (2007) reject a wide interpretation of *Haloxylon* as suggested by Hedge (1977).

***Hammada*** Iljin in Bot. Zhurn. (Moscow & Leningrad) 33: 582. 1948 sec. Akhani & al. (2007). – Type: *Hammada leptoclada* (Popov) Iljin

Generic circumscription of *Hammada* requires more studies. The molecular phylogeny of three studied species showed paraphyly of the studied samples (Akhani & al. 2007).

***Heterostachys*** Ung.-Sternb., Atti Congr. Bot. Firenze 1874: 267, 268, 331. 1876 sec. Kühn (1993). – Type: *Heterostachys ritteriana* (Moq.) Ung.-Sternb.

This halophytic genus belongs to the *Salicornioideae* and comprises two species in Central and South America. It is closely related to *Allenrolfea* (Kadereit & al. 2006).

***Holmbergia*** Hicken in Apuntes Hist. Nat. 1: 65. 1909 sec. Zacharias & Baldwin (2010). – Type: *Holmbergia exocarpa* (Griseb.) Hicken

A monotypic South American genus of *Chenopodiaceae* (incl. *Atripliceae*) (Kadereit & al. 2010; Zacharias & Baldwin 2010). It is one of the rare *Chenopodiaceae* with berry-like fruits.

***Horaninovia*** Fisch. & C. A. Mey. in Enum. Pl. Nov. 1: 10. 1841 sec. Kühn (1993). – Type: *Horaninovia ulicina* Fisch. & C. A. Mey.

= *Eremochion* Gilli in Repert. Spec. Nov. Regni Veg. 62: 22. 1959.

A likely monophyletic genus within *Salsoleae* s.str. comprising six annual species distributed in desert habitats in central and western Asia (Akhani & al. 2007).

***Iljinia*** Korovin ex Kom., Fl. URSS 6: 309, 877. 1936 sec. Kühn (1993). – Type: *Iljinia regelii* (Bunge) Korovin ex Kom.

This presumably monotypic genus likely belongs to *Salsoloideae*, but has not yet been included in molecular studies.

***Kali*** Mill., Gard. Dict. Abr., ed. 4: [unpaged]. 1754 sec. Akhani & al. (2007) = *Salsola* sect. *Kali* (Mill.) Du-

mort., Fl. Belg. (Dumortier): 23. 1827. – Type: *Kali turgidum* (Dumort.) Guterm.

The genus comprises c. 20  $C_4$  annual species with spiny leaf tip, except for the shrubby species *Kali griffithii* (Bunge) Akhani & Roalson, an endemic of southeastern Iran, southern Afghanistan and adjacent Pakistan. The genus is native to Asia, Europe and the Mediterranean basin and is also widely introduced in Australia, South Africa and North America (Brullo & al. 2015a, b). However, it is likely that some species are native to Australia and North America (see Hrusa & Gaskin 2008; Chinnock 2010). The typification and nomenclature of *Kali* are discussed in Akhani & al. (2014). See also under *Salsola*.

***Kalidium*** Moq. in Candolle, Prodr. 13(2): 46, 146. 1849 sec. Kühn (1993). – Type: *Kalidium foliatum* (Pall.) Moq.

= *Kalidiopsis* Aellen in Notes Roy. Bot. Gard. Edinburgh 28: 31. 1967.

This genus belongs to the *Salicornioideae* and comprises five perennial halophytic species that are distributed in central and southwestern Asia as well as southern and southeasternmost Europe. The monophyly of *Kalidium* is only weakly supported by molecular data (Kadereit & al. 2006).

***Kaviria*** Akhani & Roalson in Int. J. Pl. Sci. 168: 948. 2007 sec. Akhani & al. (2007). – Type: *Kaviria tomentosa* (Moq.) Akhani

= *Salsola* sect. *Belanthera* Iljin in Trudy Bot. Inst. Nauk SSSR 1,3: 158. 1937.

This genus belongs to *Caroxyleae* and includes c. ten xerohalophytic species mainly distributed in deserts of central and southwestern Asia (Akhani & al. 2007).

***Krascheninnikovia*** Gueldenst. in Novi Comment. Acad. Sci. Imp. Petrop. 16: 551. 1772 sec. Kühn (1993). – Type: *Krascheninnikovia ceratoides* (L.) Gueldenst.

= *Eurotia* Adans., Fam. Pl. 2: 260. 1763, nom. illeg.

*Krascheninnikovia*, according to a molecular study (ITS phylogeny only) by Heklau & Röser (2008), comprises only one widespread and highly polymorphic species with two subspecies (Eurasian and North American ones). However, considerable morphological diversity and wide geographical distribution (from southern Europe through central Asia to southwestern and west-central North America) of representatives of the genus suggest recognition of several species and/or subspecies (Grubov 1966; Zhu & al. 2003). The genus belongs to the *Axyrideae* (Kadereit & al. 2010).

***Lagenantha*** Chiov. in Fl. Somalia 1: 292. 1929 sec. Kühn (1993). – Type: *Lagenantha nogalensis* Chiov.

The genus likely belongs to *Salsoloideae*, but has not yet been included in molecular studies.

***Lipandra*** (Less.) Moq. in Chenop. Monogr. Enum.: 19. 1840 sec. Fuentes-Bazán & al. (2012b) = *Oligandra* Less. in Linnaea 9: 199. 1834, nom. illeg. = *Gandriloa* Steud., Nomencl. Bot., ed. 2, 1: 662. 1840,

- nom. illeg.  $\equiv$  *Oliganthera* Endl., Gen. Pl., Suppl. 1: 1377. 1841, nom. illeg. – Type: *Lipandra atriplicoides* (Less.) Moq.
- = *Chenopodium* [unranked] *Polysperma* Standl., N. Amer. Fl. 21(1): 13. 1916  $\equiv$  *Chenopodium* subsect. *Polysperma* (Standl.) Kowal ex Mosyakin & Clemants in Novon 6: 400. 1996.
- The isolated lineage of *Chenopodium polyspermum* L., revealed in the phylogenetic study of Fuentes-Bazán & al. (2012b), is well supported by the unique morphological characters of that widespread Eurasian species, which led to the creation of a monotypic subsection within *Chenopodium* s.l. (Mosyakin & Clemants 1996).
- Maireana** Moq. in Chenop. Monogr. Enum.: 95. 1840 sec. Kühn (1993). – Type: *Maireana tomentosa* Moq.
- = *Austrobassia* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 532. 1934.
- = *Duriala* (R. H. Anderson) Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 537. 1934.
- = *Eriochiton* (R. H. Anderson) A. J. Scott in Repert. Spec. Nov. Regni Veg. 89: 119. 1978.
- A species-rich genus of *Camphorosmoideae*, mostly endemic to Australia (Wilson 1975). Monophyly of the genus is unclear (Cabrera & al. 2009).
- Malacocera** R. H. Anderson in Proc. Linn. Soc. New South Wales, ser. 2, 51: 382. 1926 sec. Kühn (1993). – Type: *Malacocera tricornis* (Benth.) R. H. Anderson
- A small genus endemic to Australia and belonging to *Camphorosmoideae* (Wilson 1984; Cabrera & al. 2009).
- Manochlamys** Aellen in Bot. Jahrb. Syst. 70: 379. 1939 sec. Kadereit & al. (2010). – Type: *Manochlamys albicans* (Aiton) Aellen
- A monotypic genus distributed in South Africa. It belongs to the *Archiatripliceae* clade within *Chenopodieae*, formerly *Atripliceae* (Kadereit & al. 2010).
- Microcnemum** Ung.-Sternb., Atti Congr. Bot. Firenze 1874: 268, 269, 280. 1876 sec. Kühn (1993). – Type: *Microcnemum fastigiatum* (Loscos & J. Pardo) Ung.-Sternb.
- A monotypic genus in *Salicornioideae* of rare hydrohalophytic herbs with two subspecies that show a disjunct distribution in the western and eastern Mediterranean region to central Iran (Kadereit & Yaprak 2008).
- Microgynoecium** Hook. f., Gen. Pl. 3(1): 56. 1880 sec. Kühn (1993). – Type: *Microgynoecium tibeticum* Hook. f.
- The phylogenetic position of the monotypic Himalayan genus *Microgynoecium* is in *Atripliceae* (earlier *Chenopodieae*) based on morphological and strong molecular evidence (Kadereit & al. 2010; Fuentes-Bazán & al. 2012a, b).
- Micromonolepis** Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 499. 1934 sec. Ulbrich (1934). – Type: *Micromonolepis pusilla* (Torr. ex S. Watson) Ulbr.
- A monotypic genus distributed in western North America and likely closely related to *Chenopodium* (Kadereit & al. 2010).
- Nanophyton** Less. in Linnaea 9: 197. 1834 sec. Kühn (1993). – Type: *Nanophyton erinaceum* (Pall.) Bunge
- A genus of c. ten closely related xerophytic species that are distributed in central Asia (Pratov 1985). *Nanophyton* is related to *Halocharis* and *Kaviria* based on phylogenetic studies (Akhani & al. 2007).
- Neobassia** A. J. Scott in Feddes Repert. 89: 117. 1978 sec. Kühn (1993). – Type: *Neobassia astrocarpa* (F. Muell.) A. J. Scott
- A small genus endemic to Australia and belonging to *Camphorosmoideae* (Wilson 1984, Cabrera & al. 2009).
- Neokochia** (Ulbr.) G. L. Chu & S. C. Sand. in Madroño 55: 255. 2009 sec. Kadereit & Freitag (2011)  $\equiv$  *Kochia* sect. *Neokochia* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 535. 1934. – Type: *Neokochia americana* (S. Watson) G. L. Chu & S. C. Sand.
- A North American genus of *Camphorosmoideae* comprising two closely related species of subshrubs or dwarf shrubs.
- Noaea** Moq. in Candolle, Prodr. 13(2): 207. 1849 sec. Kühn (1993). – Type: *Noaea mucronata* (Forssk.) Asch. & Schweinf.
- A small genus of three xerophytic  $C_4$  species distributed in northern Africa eastwards to southwestern and central Asia (Akhani & al. 2007).
- Nucularia** Batt. in Bull. Soc. Bot. France 50: 469. 1903 sec. Kühn (1993). – Type: *Nucularia perrinii* Batt.
- Ofaiston** Raf., Fl. Tellur. 3: 46. “1836” [1837] sec. Kühn (1993). – Type: *Ofaiston monandrum* (Pall.) Moq.
- A monotypic genus endemic to southeastern Europe, southwestern Siberia, and central Asia. It is closely related to *Petrosimonia* (Akhani & al. 2007).
- Oreobliton** Durieu in Duch. Rev. Bot. 2: 428. 1847 sec. Kühn (1993). – Type: *Oreobliton thesioides* Durieu & Moq. ex Durieu
- Hohmann & al. (2006) showed that this monotypic genus belongs to *Betoideae–Hablitzieae*. *Oreobliton thesioides* is a subshrub distributed on calcareous rocks in Algeria and Tunisia. Together with its sister genus *Aphanisma* it represents an interesting example of a western Eurasian–western North American disjunction (Kadereit & Baldwin 2012).
- Osteocarpum** F. Muell. in Trans. Phil. Inst. Vict. 2: 77. 1858 sec. Mueller (1858). – Type: *Osteocarpum saluginosum* F. Muell.
- = *Babbagia* F. Muell., Rep. Pl. Babbage’s Exped.: 21. 1859.
- A small genus endemic to Australia and belonging to *Camphorosmoideae* (Cabrera & al. 2009).
- Oxybasis** Kar. & Kir. in Bull. Soc. Imp. Naturalistes Moscou: 738. 1841 sec. Fuentes-Bazán & al. (2012b). – Type: *Oxybasis minutiflora* Kar. & Kir.

- = *Blitum* subg. *Pseudoblitum* (Gren. & Godr.) Schur, Enum. Pl. Transsilv.: 571. 1866 ≡ *Chenopodium* sect. *Pseudoblitum* (Gren. & Godr.) Syme, Engl. Bot., ed. 3, 8: 20. 1868 ≡ *Chenopodium* [unranked] *Rubra* Standl., N. Amer. Fl. 21(1): 29. 1916.
- = *Chenopodium* sect. *Pseudoblitum* Hook. f. in Benth. & Hook. f., Gen. Pl. 3: 52. 1880 ≡ *Blitum* sect. *Pseudoblitum* (Hook. f.) Mosyakin in Ukrayins'k. Bot. Zhurn. 69(3): 394. 2012 ≡ *Oxybasis* sect. *Pseudoblitum* (Hook. f.) Mosyakin in Phytoneuron 2013-56: 3. 2013.
- = *Chenopodium* [unranked] *Glauca* Standl., N. Amer. Fl. 21(1): 28. 1916 ≡ *Chenopodium* subsect. *Glauca* (Standl.) A. J. Scott in Bot. Jahrb. Syst. 100: 216. 1978 ≡ *Chenopodium* sect. *Glauca* Ignatov in Sosud. Rast. Sovet. Dal'nego Vostoka 3: 22. 1988 ≡ *Oxybasis* sect. *Glaucæ* (Standl.) Mosyakin in Phytoneuron 2013-56: 4. 2013 ≡ *Blitum* sect. *Glauca* (Standl.) Mosyakin in Ukrayins'k. Bot. Zhurn. 69(3): 395. 2012.
- = *Chenopodium* [unranked] *Urbica* Standl., N. Amer. Fl. 21(1): 11. 1916 ≡ *Chenopodium* sect. *Urbica* (Standl.) Mosyakin in Ukrayins'k. Bot. Zhurn. 59: 700. 2002 ≡ *Oxybasis* sect. *Urbicae* (Standl.) Mosyakin in Phytoneuron 2013-56: 5. 2013.
- = *Chenopodium* sect. *Degenia* Aellen in Magyar Bot. Lapok 25: 56. 1927.

*Oxybasis* was described by Karelin & Kirilov (1841) and included at that time only one species, *O. minutiflora* Kar. & Kir. (= *Oxybasis chenopodioides* (L.) S. Fuentes & al.). The phylogenetic studies by Fuentes-Bazán & al. (2012b) and Sukhorukov & al. (2013) supported the monophyly of this widespread genus as a member of *Chenopodieae* and enlarged its circumscription with species segregated from *Chenopodium* s.l. At least ten species are currently known (some recently transferred from *Chenopodium*: see Mosyakin 2013; Sukhorukov 2014), and some occur in saline habitats. Since *Oxybasis* contains *O. rubra* (L.) S. Fuentes & al., and its basionym, *C. rubrum* L., is considered by some authors to be lectotype of *Chenopodium*, the adoption of that lectotype would result in *Oxybasis* becoming a synonym of *Chenopodium* (see there).

***Patellifolia*** A. J. Scott & al. in Taxon 26: 284. 1977 sec. Kadereit & al. (2006b) ≡ *Beta* [unranked] *Patellares* Tranzschel in Trudy Prikl. Bot. Selektiv. 17: 205. 1927 ≡ *Patellaria* J. T. Williams & al. in Feddes Repert. 87: 289. 1976, nom. illeg. – Type: *Patellifolia webbiana* (Moq.) A. J. Scott & al.

According to Kadereit & al. (2006) *Patellifolia* is a separate genus, more closely related to *Hablitia* than to *Beta*. According to Thulin & al. (2010) *Patellifolia* includes only one polymorphic species within a wide Macaronesian–Mediterranean distribution and a small disjunct eastern African population.

***Petrosimonia*** Bunge in Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 7, 4(11): 19, 52. 1862 sec. Kühn (1993). – Type: *Petrosimonia monandra* (Pall.) Bunge

A genus of c. 12 species distributed in saline soils of central and southwestern Asia, westwards to the eastern Mediterranean. *Petrosimonia* is a typical genus with bifurcate hairs. It forms a monophyletic group with *Ofaiston* within *Caroxyleae* (Akhani & al. 2007).

***Physandra*** Botsch. in Sborn. Geobot. Akad. Sukachev: 114. 1956 sec. Botschantzev (1956). – Type: *Physandra halimocnemis* (Botsch.) Botsch.

*Physandra* has not yet been included in any phylogenetical study. It is presumably a member of *Halimocnemis* s.l. (Akhani & al. 2007).

***Piptoptera*** Bunge in Trudy Imp. S.-Peterburgsk. Bot. Sada 5: 644. 1877 sec. Kühn (1993). – Type: *Piptoptera turkestanica* Bunge

See notes under *Halimocnemis* on the possible synonymy of *Piptoptera*.

***Proatriplex*** (W. A. Weber) Stutz & G. L. Chu in Amer. J. Bot. 77: 366. 1990 sec. Zacharias & Baldwin (2010) ≡ *Atriplex* subg. *Proatriplex* W. A. Weber in Madroño 10: 189. 1950. – Type: *Proatriplex pleiantha* (W. A. Weber) Stutz & G. L. Chu

***Pyankovia*** Akhani & Roalson in Int. J. Pl. Sci. 168(6): 949. 2007 sec. Akhani & al. (2007). – Type: *Pyankovia brachiata* (Pall.) Akhani & Roalson

*Pyankovia* is a recent segregate of *Climacoptera* and *Salsola* s.l.; it was initially described as a monotypic genus (Akhani & al. 2007). Further studies showed that the genus contains more than one species (Wen & al. 2010). There are probably at least three species distributed from southeasternmost Europe through the Caspian area, the Caucasus, and Iran to central Asia (S. Mosyakin, unpubl. data).

***Rhaphidophyton*** Iljin in Acta Inst. Bot. Acad. Sc. URSS, Ser. I, 3: 157. 1936 sec. Kühn (1993). – Type: *Rhaphidophyton regelii* (Bunge) Iljin

A monotypic genus from central Asia belonging to the tribe *Salsoleae* of *Salsoloideae* (Akhani & al. 2007).

***Roycea*** C. A. Gardner in J. Roy. Soc. Western Australia 32: 77. 1948 sec. Kühn (1993). – Type: *Roycea pycnophylloides* C. A. Gardner

A small genus comprising three species, endemic to Australia (Wilson 1984).

***Salicornia*** L., Sp. Pl. 1: 3. 1753 sec. Kadereit & al. (2006a). – Type: *Salicornia europaea* L.

The genus is distributed worldwide (except for Australia and South America) in salt marshes and saline inland habitats and consists of annual species. It is nested within the perennial *Sarcocornia*. For recent molecular and morphological studies see Kadereit & al. (2007, 2012), Akhani (2008), Teege & al. (2011), Slenzka & al. (2013) and Steffen & al. (2015).

***Salsola*** L., Sp. Pl. 1: 222. 1753. – Type: *Salsola soda* L.  
= *Salsola* sect. *Coccosalsola* Fenzl. in Ledeb. Fl. Ross. 3,2: 802. 1851 ≡ *Salsola* sect. *Coccosalsola* Fenzl subsect. *Coccosalsola* (Fenzl.) Botsch. p.p. in Nov. Sist. Vys. Rast. 13: 94. 1976;

- = *Soda* Fourr. in Ann. Soc. Linn. Lyon sér. 2, 17: 145. 1869;
- = *Seidlitzia* Bunge ex Boiss., Fl. Orient. 4: 950. 1879;
- = *Hypocylix* Wol. in Denkschr. Kaiserl. Akad. Wiss., Wien. Math.-Naturwiss. Kl. 51: 275. 1886;
- = *Darniella* Maire & Weiller in Bull. Soc. Hist. Nat. Afrique N. 30: 301. 1939;
- = *Fadenia* Aellen & C. C. Towns. in Kew Bull. 27: 501. 1972;
- = *Salsola* sect. *Obpyrifolia* Botsch. & Akhani in Bot. Zhurn. 74(11): 1664. 1989;
- = *Neocaspiya* Tzvelev in Ukrayins'k. Bot. Zhurn. 50(1): 81. 1993.
- Salsola* s.l. was a heterogenous and polyphyletic complex, which has been split into at least ten lineages based on nuclear and chloroplast markers (Akhani & al. 2007; Pyankov & al. 2001; Kadereit & Freitag 2013). *Caroxylon* as the largest group, and *Climacoptera*, *Kaviria* and *Pyankovia* were transferred to the tribe *Caroxyleae* (*Caroxyloneae*). Several other segregates have either been described as new genera or were resurrected from existing names, including *Kali*, *Turania* and *Xylosalsola*. Three names were informally mentioned: “*Canarosalsola*”, “*Collinosalsola*” and “*Oreosalsola*”, the last soon to be formally published (Akhani & Khoshravesh, in press). The two species, *S. webbii* Moq. and *S. genistoides* Juss. ex Poir., are sister of *Salsoleae* and therefore should be described as separate genera (Voznesenskaya & al. 2013).
- The typification of the genus *Salsola* is debated (Akhani & al. 2014; Mosyakin & al. 2014), and a conserved type, *S. kali* L., is proposed instead of the current type, *S. soda* (Mosyakin & al. 2014). If accepted, the name *Salsola* L. will replace *Kali* Mill. and *Salsola* sensu Akhani & al. will be *Soda* Fourr. In its present circumscription accepted here, *Salsola* is still a morphologically very diverse group that probably deserves further splitting into several more natural genera, following more comprehensive molecular and morphological studies.
- Sarcocornia*** A. J. Scott in J. Linn. Soc., Bot. 75: 366. 1978 sec. Kadereit & al. (2006a) = *Salicornia* sect. *Perennes* Duval-Jouve ex Moss in J. Bot. 49: 178. 1911. – Type: *Sarcocornia perennis* (Mill.) A. J. Scott
- = *Salicornia* subg. *Arthrocnemoides* Ung.-Sternb. in Versuch einer Systematik der Salicornieen: 54. 1866. *Sarcocornia* belongs to *Salicornieae* and comprises c. 28 species of perennial, stem-succulent halophytes distributed worldwide (Alonso & Crespo 2008; Steffen & al. 2010; de la Fuente & al. 2013). The genus is paraphyletic with respect to *Salicornia*. A worldwide molecular phylogenetic study shows the multiple parallel evolution of prostrate, mat-forming habits (Steffen & al. 2015).
- Sclerochlamys*** F. Muell. in Trans. Phil. Inst. Vict. 2: 76. 1858 sec. Mueller (1858). – Type: *Sclerochlamys brachyptera* F. Muell.
- A small genus belonging to the *Camphorosmoideae* and endemic to Australia (Wilson 1984; Cabrera & al. 2009).
- Sclerolaena*** R. Br., Prodr. Fl. Nov. Holland.: 410. 1810 sec. Kühn (1993). – Type: *Sclerolaena uniflora* R. Br.
- = *Cyrlwhitea* Ising in Trans. Roy. Soc. South Australia 88: 1964. 1964.
- = *Stelligera* A. J. Scott in Repert. Spec. Nov. Regni Veg. 89: 114. 1978.
- A species-rich genus of *Camphorosmoideae*, endemic to Australia. Monophyly of the genus remains unclear (Wilson 1980; Cabrera & al. 2009); further studies are needed.
- Sedobassia*** Freitag & G. Kadereit in Taxon 60: 72. 2011 sec. Kadereit & Freitag (2011). – Type: *Sedobassia sedoides* (Pall.) Freitag & G. Kadereit
- This monotypic genus belongs to *Camphorosmoideae*, with an annual species distributed from Hungary to southern Siberia and showing a C<sub>3</sub>/C<sub>4</sub> intermediate photosynthetic pathway (Kadereit & al. 2014). The illegitimate name *Salsola sedoides* Pall. (the basionym of *Sedobassia sedoides*) was proposed for conservation against *Salsola sedoides* L. (Freitag & Sennikov 2014). If this proposal is accepted, the name *Sedobassia sedoides* (Pall.) Freitag & G. Kadereit will remain in use.
- Sevada*** Moq. in Candolle, Prodr. 13(2): 47, 154. 1849 sec. Kühn (1993). – Type: *Sevada schimperii* Moq.
- A monotypic African genus.
- Spinacia*** L., Sp. Pl. 1: 1027. 1753 sec. Kühn (1993). – Type: *Spinacia oleracea* L.
- The small Eurasian genus *Spinacia* is supported as monophyletic and sister to *Blitum*, both genera belonging to the tribe *Anserineae* Dumort. (Fuentes-Bazán & al. 2012a).
- Spirobassia*** Freitag & G. Kadereit in Taxon 60: 71. 2011 sec. Kadereit & Freitag (2011). – Type: *Spirobassia hirsuta* (L.) Freitag & G. Kadereit
- A monotypic genus in *Camphorosmoideae* comprising an annual species distributed from the northern Mediterranean to southern Siberia.
- Stutzia*** E. H. Zacharias in Syst. Bot. 35: 851. 2010 sec. Zacharias & Baldwin (2010). – Type: *Stutzia dioica* (Nutt.) E. H. Zacharias
- = *Endolepis* Torr. in Pacif. Rail. Rep. 12: 47. 1860, nom. illeg.
- Suaeda*** Forssk. ex J. F. Gmel. in Onomat. Bot. Compl. 8: 797. 1776, nom. cons. sec. Kapralov & al. (2006). – Type: *Suaeda vera* Forssk. ex J. F. Gmel.
- = *Alexandra* Bunge in Linnaea 17: 120. 1843.
- = *Brezia* Moq. in Candolle, Prodr. 13(2): 47. 1849.
- = *Calvelia* Moq. in Candolle, Prodr. 13(2): 47. 1849.
- = *Helicilla* Moq. in Candolle, Prodr. 13(2): 47, 169. 1849.
- = *Borsczowia* Bunge in Trudy Imp. S.-Peterburgsk. Bot. Sada 5: 643. 1877.
- Molecular phylogenetic studies clearly show that

*Alexandra* and *Borsczowia* should be included in a monophyletic *Suaeda* (Kapralov & al. 2006), despite the arguments by Lomonosova & Freitag (2011), who preferred a paraphyletic *Suaeda* by keeping *Alexandra* as a separate genus. The study by Schütze & al. (2003) is currently the most comprehensive molecular and morphological study of the genus. The pollen morphology of *Suaeda* was studied by Dehghani & Akhani (2009).

**Suckleya** A. Gray in Proc. Amer. Acad. Arts 11: 103. 1876 sec. Kühn (1993). – Type: *Suckleya petiolaris* A. Gray  
The monotypic North American genus *Suckleya* belongs to the *Dysphanieae*, in which it is sister to *Cycloloma* and *Dysphania* (Kadereit & al. 2010).

**Sympegma** Bunge in Bull. Acad. Imp. Sci. Saint-Pétersbourg 25: 351, 371. 1879 sec. Kühn (1993). – Type: *Sympegma regelii* Bunge

**Tecticornia** Hook. f., Gen. Pl. 3(1): 65. 1880 sec. Shepherd & Wilson (2007). – Type: *Tecticornia cinerea* (F. Muell.) Baill.

= *Pachycornia* Hook. f., Gen. Pl. 3(1): 65. 1880.

= *Halosarcia* Paul G. Wilson in Nuytsia 3: 28. 1980.

= *Sclerostegia* Wilson in Nuytsia 3: 17. 1980.

= *Tegicornia* Paul G. Wilson in Nuytsia 3: 25. 1980.

A genus of *Salicornioideae* with c. 25 hygrophilic species, largely endemic to Australia.

**Teloxys** Moq. in Ann. Sci. Nat., Bot., ser. 2, 1: 289. 1834 sec. Fuentes-Bazán & al. (2012b) ≡ *Chenopodium* sect. *Teloxys* (Moq.) Beck, Icon. Fl. Germ. Helv. (Reichenbach) 24: 116. 1908 ≡ *Chenopodium* [unranked] *Aristata* Standl., N. Amer. Fl. 21(1): 25. 1916 ≡ *Chenopodium* subsect. *Teloxys* (Moq.) Aellen & Iljin, Fl. URSS 6: 47. 1936 ≡ *Dysphania* subsect. *Teloxys* (Moq.) Mosyakin & Clemants in Ukrayins'k. Bot. Zhurn. 59: 383. 2002. – Type: *Teloxys aristata* (L.) Moq.

Since the treatment of Beck (1907–1909), *Teloxys* was included and mostly accepted in *Chenopodium* subsect. *Teloxys*. For the Flora of North America, Mosyakin & Clemants (2002) transferred this species to *Dysphania*. However, the phylogenetic studies of Kadereit & al. (2010) and Fuentes-Bazán & al. (2012a) recovered an isolated position of the monotypic *Teloxys*, supporting its first circumscription (Moquin 1834) and also revealing its close relationship to *Cycloloma*, *Dysphania* and *Suckleya*.

**Threlkeldia** R. Br., Prodr. Fl. Nov. Holland.: 409. 1810 sec. Kühn (1993). – Type: *Threlkeldia diffusa* R. Br.

A small genus belonging to the *Camphorosmoideae* and endemic to Australia (Wilson 1984; Cabrera & al. 2009).

**Traganopsis** Maire & Wilczek in Bull. Soc. Hist. Nat. Afrique N. 27: 67. 1936 sec. Kühn (1993). – Type: *Traganopsis glomerata* Maire & Wilczek

**Traganum** Delile, Descr. Égypte, Hist. Nat. 2: 204. 1813–1814 sec. Kühn (1993). – Type: *Traganum nudatum* Delile

**Turania** Akhani & Roalson, Int. J. Pl. Sci. 168: 946. 2007 sec. Akhani & al. (2007). – Type: *Turania sogdiana* (Bunge) Akhani

= *Salsola* sect. *Androssowia* Rilke in Biblioth. Bot. 149: 77. 1999.

= *Salsola* sect. *Sogdiana* (Iljin) Rilke in Biblioth. Bot. 149: 69. 1999.

A small segregate genus of the *Salsola* s.l. complex, with three species endemic to Aralo-Caspian sandy deserts.

**Xylosalsola** Tzvelev in Ukrayins'k. Bot. Zhurn. 50: 81. 1993 sec. Akhani & al. (2007). – Type: *Xylosalsola arbuscula* (Pall.) Tzvelev

A segregate genus of *Salsola* s.l. consisting of small or large shrubs occurring in sandy or gravelly habitats of the central Asian and Iranian deserts (Tzvelev 1993; Akhani & al. 2007).

**Didiereaceae** Radlk. sec. APG (2009).

A family with six genera and 20 species (Bruyns & al. 2014). Traditionally, *Didiereaceae* included xerophytic shrubs and trees endemic to Madagascar with short lateral shoots bearing spines or alternate leaves (Kubitzki 1993a; Cuénoud 2003). However, molecular phylogenetic studies (Applequist & Wallace 2001, 2003; Nyffeler & Egli 2010a; Bruyns & al. 2014) showed a well-supported clade including the traditional *Didiereaceae* plus the African genera *Calyptrotheca*, *Ceraria* and *Portulacaria*, previously placed in *Portulacaceae*. This expanded circumscription of the family is accepted here, which includes also much-branched plants with opposite leaves and without spines. Applequist & Wallace (2003) divided the family into three subfamilies: *Calyptrothecoideae*, *Didiereoideae* (= traditional *Didiereaceae*) and *Portulacarioideae*. The recent molecular phylogeny of Bruyns & al. (2014) supports the monophyly of these subfamilies and the inclusion of *Ceraria* within *Portulacaria*.

**Alluaudia** (Drake) Drake in Bull. Mus. Hist. Nat. (Paris) 9: 37. 1903 sec. Kubitzki (1993a) ≡ *Didierea* sect. *Alluaudia* Drake in Compt. Rend. Hebd. Séances Acad. Sci. 133: 240. 1901. – Type: *Alluaudia procera* (Drake) Drake – Fig. 4E.

**Alluaudiopsis** Humbert & Choux in Compt. Rend. Hebd. Séances Acad. Sci. 199: 1651. 1934 sec. Kubitzki (1993a). – Type: *Alluaudiopsis fiherenensis* Humbert & Choux

**Calyptrotheca** Gilg in Bot. Jahrb. Syst. 24: 307. 1897 sec. Carolin (1993). – Type: *Calyptrotheca somalensis* Gilg

**Decarya** Choux in Compt. Rend. Hebd. Séances Acad. Sci. 188: 1620. 1929 sec. Kubitzki (1993a). – Type: *Decarya madagascariensis* Choux

**Didierea** Baill. in Bull. Mens. Soc. Linn. Paris 1-2: 258. 1880 sec. Kubitzki (1993a). – Type: *Didierea madagascariensis* Baill.

**Portulacaria** Jacq. in Coll. 1: 160. 1787 sec. Carolin (1993). – Type: *Portulacaria afra* Jacq. – Fig. 4F.



= *Ceraria* Pearson & Stephens in Ann. S. African Mus. 9: 32. 1912.

**Dioncophyllaceae** Airy Shaw sec. APG (2009).

A small family of woody lianas comprising three monotypic genera endemic to the Guineo-Congolian rainforest (Poremski & Barthlott 2003). The family is characterized by leaves with grapnels on branches or paired at the leaf apex, elongated funicles and large discoid and winged seeds (Heubl & al. 2006). The family is considered as partially carnivorous because it includes both carnivorous (*Triphyophyllum*) and non-carnivorous taxa (*Dioncophyllum* and *Habropetalum*). The studies by Heubl & al. (2006) and Renner & Specht (2011) concluded that within *Dioncophyllaceae* occurred a partial secondary loss of carnivory. See also notes under *Ancistrocladaceae*.

**Dioncophyllum** Baill. in Bull. Mens. Soc. Linn. Paris 1–2: 870. 1890 sec. Poremski & Barthlott (2003). – Type: *Dioncophyllum thollonii* Baill.

**Habropetalum** Airy Shaw in Kew Bull. 1951: 334. 1952 sec. Poremski & Barthlott (2003). – Type: *Habropetalum dawei* (Hutch. & Dalziel) Airy Shaw

**Triphyophyllum** Airy Shaw in Kew Bull. 1951: 341. 1952 sec. Poremski & Barthlott (2003). – Type: *Triphyophyllum peltatum* (Hutch. & Dalziel) Airy Shaw – Fig. 4G.

**Droseraceae** Salisb. sec. APG (2009).

The family includes perennial or annual carnivorous herbs and sometimes submerged aquatics (Kubitzki 2003b) characterized by having perception of tactile and chemical stimuli, leaf blade and tentacle movement and genetically by a loss of the *rpl2* intron (Heubl & al. 2006). The family comprises three genera, two of them monotypic: *Aldrovanda* distributed in Eurasia, southeastern Africa and northeastern Australia, and *Dionaea* endemic to the southeastern United States. *Drosera* is cosmopolitan and comprises probably more than 100 species (Kubitzki 2003b; Rivadavia & al. 2003). The family is well known to attract, capture, retain and digest small prey animals (mainly small arthropods) with active snap-traps (*Aldrovanda* [waterwheel plant] and *Dionaea* [Venus flytrap]) or with active sticky flypaper traps (*Drosera* [= sundews]) and to absorb the resulting nutrients (Poppinga 2013). The relationships of *Droseraceae* to the other carnivorous families of the *Caryophyllales* remain unclear; the results of several molecular phylogenetic studies resulted in three main hypotheses: *Droseraceae* as sister of *Nepenthaceae* (e.g. Nandi & al. 1998: *rbcL*; Cuénoud & al. 2000; Brockington & al. 2009: combined nuclear and plastid data; Schäferhoff & al. 2009: *petD*); *Droseraceae* as sister of a clade including *Drosophyllaceae* + [*Ancistrocladaceae* + *Dioncophyllaceae*] (e.g. Schäferhoff & al. 2009: *petD*) and *Droseraceae* as sister of the rest of the carnivorous families (e.g. Meimberg & al. 2000: partial *matK*; Schäferhoff & al. 2009: complete *matK*; Renner & Specht 2011: combined nuclear, ribosomal and plastid data).

**Aldrovanda** L., Sp. Pl. 1: 281. 1753 sec. Kubitzki (2003b). – Type: *Aldrovanda vesiculosa* L.

**Dionaea** J. Ellis in Nova Acta Regiae Soc. Sci. Upsal., ser. 2, 1: 98. 1773 sec. Kubitzki (2003b). – Type: *Dionaea muscipula* J. Ellis

**Drosera** L., Sp. Pl. 1: 281. 1753 sec. Kubitzki (2003b). – Type: *Drosera rotundifolia* L. – Fig. 5A & B.

= *Sondera* Lehm., Nov. Stirp. Pug. 8: 44. 1844.

= *Freatulina* Chrtek & Slavíková in Čas. Nár. Mus., Odd. Přír. 165: 140. 1996.

*Drosera* has a worldwide distribution, but the majority of species are found in the southern hemisphere, especially in southwestern Australia and New Zealand (Kubitzki 2003b; Rivadavia & al. 2003). Several classifications have been proposed for the genus; the last one was that by Seine & Barthlott (1994), who recognized three subgenera and 11 sections based on morphological, anatomical, palynological and cyt-taxonomical characters; the molecular phylogenetic study that included the most representative subgenera and sectional sampling so far (i.e. Rivadavia & al. 2003) supported the monophyly of only some of these groups.

**Drosophyllaceae** Chrtek & al. sec. APG (2009).

A monotypic family that includes carnivorous subshrubs distributed in Spain, Portugal and Morocco (Kubitzki 2003c). These are characterized by reverse circinate leaves, basal placentation, polyporate pollen and a chromosome base number  $x = 6$  (Heubl & al. 2006). Historically, the single genus *Drosophyllum* was placed within *Droseraceae*, but its position as an independent lineage has been well supported by several molecular phylogenetic studies (e.g. Meimberg & al. 2000; Cuénoud & al. 2002; Hilu & al. 2003; Brockington & al. 2009; Schäferhoff & al. 2009). These studies also revealed the closer relationship of *Drosophyllaceae* with the clade *Ancistrocladaceae* + *Dioncophyllaceae* rather than *Droseraceae*.

**Drosophyllum** Link in Neues J. Bot. 1(2): 53. 1805 sec. Kubitzki (2003c). – Type: *Drosophyllum lusitanicum* (L.) Link

**Frankeniaceae** Desv. sec. APG (2009).

A monogeneric family with 70–80 species of halophytic and xerophytic shrubs, subshrubs and herbs (Whalen 1987; Kubitzki 2003d) distributed throughout the warmer dry regions of the world (Kubitzki 2003d). Kubitzki (2003d) recognized two genera: *Frankenia* and the monotypic *Hypericopsis*; however in the same year Olson & al. (2003) supported the inclusion of *Hypericopsis* within *Frankenia* based on wood-anatomical characters. The position of *Hypericopsis* within the Eurasian and Australian clade of *Frankenia* has also been well supported by the molecular phylogenetic study of Gaskin & al. (2004).

**Frankenia** L., Sp. Pl. 1: 331. 1753 sec. Gaskin & al. (2004). – Type: *Frankenia laevis* L.

- = *Beatsonia* Roxb. in Beatson, Tracts St. Helena: 300. 1816.
- = *Hypericopsis* Boiss., Diagn. Pl. Orient. 6: 25. 1846.
- = *Niederleinia* Hieron. in Bol. Acad. Nac. Ci. 3: 218. 1879.
- = *Anthobryum* Phil. in Anales Mus. Nat. Santiago de Chile 1891: 51. 1891.

### **Gisekiaceae** Nakai sec. APG (2009).

*Gisekia* was excluded from *Aizoaceae* and raised to family level by Nakai (1942). Recent molecular studies support the family status and show an isolated position of *Gisekiaceae* within core-*Caryophyllales* (Brockington & al. 2009; Schäferhoff & al. 2009; Crawley & Hilu 2012; Bissinger & al. 2014).

***Gisekia*** L., Mant. Pl.: 554, 562. 1771 sec. Gilbert (1993).

– Type: *Gisekia pharnacioides* L.

Gilbert (1993) revised the genus and accepted seven species; however, Bissinger & al. (2014) found all species to be polyphyletic and suggested to treat them as one polymorphic species or species complex, *Gisekia pharnaceoides* agg. *Gisekia pharnaceoides* is a  $C_4$  species with atriplicoid Kranz anatomy and NAD-ME biochemical type. The lineage originated in South Africa and presumably migrated along arid areas of eastern Africa during the late Miocene/Pliocene (Bissinger & al. 2014).

### **Halophytaceae** A. Soriano sec. APG (2009).

A monotypic family of succulent monoecious herbs, endemic to semi-deserts of western and southwestern Argentina (Hunziker 1998; Bittrich 1993c; Pozner & Cocucci 2006). For many years the position of the only species, *Halophytum ameghinoi* (Speg.) Speg. within *Caryophyllales* was uncertain. When the species was described, it was placed in *Aizoaceae* and later transferred to *Chenopodiaceae* (e.g. Cronquist 1981). Several molecular phylogenetic studies have shown that it represents a well-supported independent lineage within the *Portulacineae* (Brockington & al. 2009, 2011; Nyffeler & Eggli 2010a; Ocampo & al. 2010; Arakaki & al. 2011), but its relationships with the other families in this group remain uncertain. The most recent phylogenetic study, based on data from several nuclear and chloroplast markers, supports a close relationship between *Halophytum* and *Basellaceae* and a close relationship of both with *Didiereaceae* (Anton & al. 2014).

***Halophytum*** Speg. in Anales Mus. Nac. Buenos Aires 7: 152. 1902 sec. Bittrich (1993d). – Type: *Halophytum ameghinoi* (Speg.) Speg. – Fig. 5C.

### **Kewaceae** Christenh. sec. Christenhusz & al. (2014).

Monogeneric family segregated from *Molluginaceae* (Christenhusz & al. 2014) based on results from Christin & al. (2011).

***Kewa*** Christenh. in Phytotaxa 181: 240. 2014 sec. Chris-

tenhusz & al. (2014). – Type: *Kewa salsoloides* (Burch.) Christenh.

Eight species, distributed in Africa and Saint Helena; checklist of species in Christenhusz & al. (2014). These species were formerly included in *Hypertelis* (*Molluginaceae*), but have been shown to occupy an isolated position in *Caryophyllales* (Christin & al. 2011).

### **Limeaceae** Shipunov ex Reveal sec. APG (2009).

A monogeneric family with c. 20 species, distributed mainly in southern Africa with a few species in Sudan, Ethiopia and southern Asia (Endress & Bittrich 1993). Traditionally, the single genus *Limeum* was placed in *Molluginaceae*. However, the position of the genus as an independent lineage and its distant placement from *Molluginaceae* has been well supported by several molecular studies (Brockington & al. 2009; Schäferhoff & al. 2009; Christin & al. 2011). The family includes herbs and subshrubs characterized by pseudomonocarpous two-chambered ovaries (Endress & Bittrich 1993).

***Limeum*** L., Syst. Nat., ed. 10: 995. 1759 sec. Endress & Bittrich (1993). – Type: *Limeum africanum* L.

### **Lophiocarpaceae** Doweld & Reveal sec. APG (2009).

Small family of about six species distributed in Africa, mainly in the southwest, and southwestern Asia (Endress & Bittrich 1993; Rohwer 1993). The family includes the genus *Lophiocarpus*, previously placed in *Phytolaccaceae* subfamily *Microteoideae* and the genus *Corbichonia*, previously placed in *Molluginaceae*. The clade *Lophiocarpus* + *Corbichonia* was first recovered and well supported in the molecular phylogeny based on *matK* sequences by Cuénoud & al. (2002). The family was described by Doweld and Reveal (2008) and the clade was later confirmed by Schäferhoff & al. (2009) and Brockington & al. (2011). The two genera included in *Lophiocarpaceae* are morphologically very different. While members of *Lophiocarpus* are herbs and sometimes suffrutescent, characterized by flowers in spikes (with five tepals and four stamens) and achenes (Rohwer 1993), members of *Corbichonia* are herbs or subshrubs, characterized by flowers in cymes (with five sepals and several petaloid staminodes and stamens) and capsules (Endress & Bittrich 1993; Boulos 1999; Sukhorukov & Kushunina 2015).

***Corbichonia*** Scop. in Intr. Hist. Nat.: 264. 1777 sec. Endress & Bittrich (1993). – Type: *Corbichonia decumbens* (Forssk.) Exell

***Lophiocarpus*** Turcz. in Bull. Soc. Imp. Naturalistes Moscou 16: 55. 1843 sec. Rohwer (1993a). – Type: *Lophiocarpus polystachyus* Turcz.

### **Macarthuriaceae** Christenh. sec. Christenhusz & al. (2014).

A monogeneric family restricted to Australia. The poorly known genus *Macarthuria* has been shown to be sister to

all core *Caryophyllales* (Brockington & al. 2011; Christin & al. 2011) and a separate family *Macarthuriaceae* was proposed (Christenhusz & al. 2014).

**Macarthuria** Hügel ex Endl., Enum. Pl.: 11. 1837 sec. Endress & Bittrich (1993). – Type: *Macarthuria australis* Hügel ex Endl.

About ten species of rush-like shrubs from Australia, especially southwestern Australia.

**Microteaceae** Schäferh. & Borsch sec. APG (2009).

A monogeneric family restricted to the Neotropics and distributed from Central America and the Antilles to South America (Rohwer 1993; Schäferhoff & al. 2009). Based mainly on the presence of single-ovuled ovaries, Nowicke (1969) placed *Microtea*, together with *Lophiocarpus*, in *Phytolaccaceae* subfamily *Microteoideae*. However, Schäferhoff & al. (2009) showed that these two genera are not closely related and the position of *Microtea* as an independent lineage was well supported, resulting in the description of the new family. These results were later confirmed by Brockington & al. (2011).

**Microtea** Sw., Prodr. [O. P. Swartz]: 4, 53. 1788 sec. Rohwer (1993a). – Type: *Microtea debilis* Sw.

A poorly studied genus of annual herbs from Central and South America and the Antilles. The number of species is estimated to c. 12 (Schäferhoff & al. 2011); a modern monograph is lacking. *Microtea* was found in an isolated phylogenetic position (Schäferhoff & al. 2011; two species have been sampled).

**Molluginaceae** Bartl. sec. APG (2009).

A family with nine genera and c. 90 species mainly distributed in southern Africa, but also found in the tropics around the world. The circumscription has been problematic and some of the taxa formerly assigned to *Molluginaceae* are now considered as members of other families (especially *Aizoaceae* and *Phytolaccaceae*) or as independent families within the *Caryophyllales* (e.g. *Kewaceae*, *Limeaceae*, *Lophiocarpaceae*) (Endress & Bittrich 1993; Schäferhoff & al. 2009; Christin & al. 2011; Christenhusz & al. 2014). The family as currently circumscribed is characterized by an undifferentiated perianth with alternitepalous stamens, except for *Glinus*, which occasionally has small petals (Brockington & al. 2013).

**Adenogramma** Rchb. in Iconogr. Bot. Exot. 2: 3. 1828 sec. Endress & Bittrich (1993). – Type: *Adenogramma mollugo* Rchb.

**Coelanthum** E. Mey. ex Fenzl in Ann. Wiener Mus. Naturgesch. 1: 353. 1836 sec. Endress & Bittrich (1993). – Type: *Coelanthum grandiflorum* E. Mey. ex Fenzl

**Glinus** L., Sp. Pl. 1: 463. 1753 sec. Endress & Bittrich (1993). – Type: *Glinus lotoides* L.

**Glischrothamnus** Pilg. in Bot. Jahrb. Syst. 40: 396. 1908 sec. Endress & Bittrich (1993). – Type: *Glischrothamnus ulei* Pilg.

**Hypertelis** E. Mey. ex Fenzl in Ann. Wiener Mus. Naturgesch. 1: 352. 1836 sec. Endress & Bittrich (1993). – Type: *Hypertelis spergulacea* E. Mey. ex Fenzl  
Monotypic genus (after segregation of *Kewa*, see there), distributed in Namibia. Might belong to an expanded *Mollugo* (Christin & al. 2011), but further study is needed to clarify this.

**Mollugo** L., Sp. Pl. 1: 89. 1753 sec. Endress & Bittrich (1993). – Type: *Mollugo verticillata* L.

Recent phylogenetic analysis has shown that the genus is not monophyletic and that its species are scattered across the *Molluginaceae* phylogeny (Christin & al. 2011). A thorough re-evaluation of the circumscription of *Mollugo* is clearly needed.

**Pharnaceum** L., Sp. Pl. 1: 272. 1753 sec. Endress & Bittrich (1993). – Type: *Pharnaceum incanum* L.

**Polpoda** C. Presl in Polpoda: 1–2. 1829 sec. Endress & Bittrich (1993). – Type: *Polpoda capensis* C. Presl

**Psammotropha** Eckl. & Zeyh. in Enum. Pl. Afric. Austral. [Ecklon & Zeyher]: 286. 1836 sec. Endress & Bittrich (1993). – Type: *Psammotropha parvifolia* Eckl. & Zeyh.

**Suessenguthiella** Friedrich in Mitt. Bot. Staatssamml. München 2: 60. 1955 sec. Endress & Bittrich (1993). – Type: *Suessenguthiella scleranthoides* (Sond.) Friedrich

**Montiaceae** Raf. sec. APG (2009).

A family with 13 genera and around 200 species distributed around the world (Nyffeler & Egli 2010a). The species of this family are traditionally considered as members of *Portulacaceae*; however, molecular phylogenetic studies have shown that the traditional *Portulacaceae* are not monophyletic (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001; Nyffeler 2007; Nyffeler & Egli 2010a; Ocampo & Columbus 2010). Nyffeler & Egli (2010a) proposed the segregation of the traditional *Portulacaceae* into four families (*Anacampserotaceae*, *Montiaceae*, *Portulacaceae* and *Talinaceae*) based on morphological and molecular data. The circumscription of *Montiaceae* follows the proposal of Hershkovitz (1993, 2006) and Hershkovitz & Zimmer (2000). *Montiaceae* also includes *Hectorellaceae* (Applequist & al. 2006; Wagstaff & Hennion 2007; Nyffeler & Egli 2010a).

**Calandrinia** Kunth, Nov. Gen. Pl. (folio ed.) 6: 77. 1823, nom. cons. sec. Hershkovitz (1993). – Type: *Calandrinia caulescens* Kunth

= *Baitaria* Ruiz & Pav., Fl. Peruv. Prodr.: 63. 1823.

= *Monocosmia* Fenzl, Nov. Stirp. Dec.: 84. 1839.

**Calyptridium** Nutt. in Fl. N. Amer. 1: 198. 1838 sec. Nyffeler & Egli (2010a). – Type: *Calyptridium monandrum* Nutt.

*Calyptridium* is a North American genus with eight species (Guilliams 2009). Although Hershkovitz (1990) treated *Calyptridium* as a section of *Cistanthe*, phylogenetic analyses have shown that this consideration makes *Cistanthe* a non-monophyletic group

(Hershkovitz & Zimmer 2000; Applequist & Wallace 2001; Hershkovitz 2006).

**Cistanthe** Spach in Hist. Nat. Vég. 5: 229. 1836 sec. Nyffeler & Eggli (2010a). – Type: not designated.

= *Spraguea* Torr. in Smithsonian Contr. Knowl. 6(2): 4. 1853.

= *Diazia* Phil., Fl. Atacam.: 22. 1860.

= *Silvaea* Phil., Fl. Atacam.: 21. 1860.

= *Philippiamra* Kuntze, Revis. Gen. Pl. 2: 58. 1891, nom. illeg.

= *Lewisioopsis* Govaerts, World Checkl. Seed Pl. 3: 21. 1999.

See under *Calyptridium* (*Montiaceae*).

**Claytonia** L., Sp. Pl. 1753 1: 204. 1753 sec. Miller & Chambers (2006) ≡ *Claytonia* [unranked] *Euclaytonia* Walp., Repert. Bot. Syst. 2: 237. 1843, nom. inval. ≡ *Claytonia* [unranked] *Cormosae* A. Gray in Proc. Amer. Acad. Arts 22: 278. 1887 ≡ *Claytonia* sect. *Cormosae* A. Gray ex Poelln. in Repert. Spec. Nov. Regni Veg. 30: 281. 1932, nom. superfl. – Type: *Claytonia virginica* L. – Fig. 5D.

= *Limnia* Haw., Syn. Pl. Succ.: 11. 1812 ≡ *Claytonia* sect. *Limnia* (Haw.) Torr. & A. Gray, Fl. N. Amer. 1: 199. 1838 ≡ *Montia* sect. *Limnia* (Haw.) B. L. Rob., Syn. Fl. N. Amer. 1: 273. 1897 ≡ *Claytonia* subg. *Limnia* (Haw.) Holub in Preslia 47: 328. 1975.

= *Claytonia* [unranked] *Caudicosae* A. Gray in Proc. Amer. Acad. Arts 22: 279. 1887.

= *Claytonia* [unranked] *Rhizomatosae* A. Gray in Proc. Amer. Acad. Arts 22: 280. 1887 ≡ *Montia* [unranked] *Rhizomatosae* (A. Gray) B. L. Rob., Syn. Fl. N. Amer. 1: 272. 1897 ≡ *Claytonia* sect. *Rhizomatosae* (A. Gray) Poelln. in Repert. Spec. Nov. Regni Veg. 30: 281, 296. 1932.

= *Claytonia* sect. *Chenopodinae* Poelln. in Repert. Spec. Nov. Regni Veg. 30: 280. 1932.

**Hectorella** Hook. f. in Handb. N. Zeal. Fl.: 27. 1864 sec. Philipson (1993). – Type: *Hectorella caespitosa* Hook. f.

Monotypic; endemic to New Zealand (South Island). The taxonomic position of *Hectorella* remained controversial for a long time and was even treated in a separate family along with *Lyallia* (*Hectorellaceae*; Philipson & Skipworth 1961). However, phylogenetic analyses have confirmed that this monotypic genus is nested in *Montiaceae* (Applequist & al. 2006; Wagstaff & Hennion 2007; Nyffeler & Eggli 2010a).

**Lenzia** Phil. in Anales Univ. Chile 23: 381. 1863 sec. Carolin (1993). – Type: *Lenzia chamaepitys* Phil.

**Lewisia** Pursh, Fl. Amer. Sept. 2: 368. 1814 sec. Hershkovitz & Hogan (2003). – Type: *Lewisia rediviva* Pursh

= *Oreobroma* Howell in Erythea 1: 31. 1893.

= *Erocallis* Rydb. in Bull. Torrey Bot. Club 33: 140. 1906.

**Lyallia** Hook. f., Fl. Antarct. 2: 548, t. 122. 1847 sec. Philipson (1993). – Type: *Lyallia kerguelensis* Hook. f.

Monotypic; endemic to the subantarctic Kerguelen Islands. *Lyallia kerguelensis* was found to be sister to *Hectorella* and both are nested in *Montiaceae* (Wagstaff & Hennion 2007; see also under *Hectorella*).

**Montia** L., Sp. Pl. 1: 87. 1753 sec. Miller (2004). – Type: *Montia fontana* L.

= *Crunocallis* Rydb. in Bull. Torrey Bot. Club 33: 139. 1906.

= *Naiocrene* (Torr. & A. Gray) Rydb. in Bull. Torrey Bot. Club 33: 139. 1906.

= *Montiastrum* Rydb., Fl. Rocky Mts.: 1061. 1917.

= *Limnalsine* Rydb., N. Amer. Fl. 21(4): 295. 1932.

= *Mona* Ö. Nilsson in Bot. Not. 119: 266. 1966.

= *Neopaxia* Ö. Nilsson in Bot. Not. 119: 469. 1966.

= *Maxia* Ö. Nilsson in Palynol. 7: 359. 1967.

= *Claytoniella* Jurtzev in Bot. Zhurn. (Moscow & Leningrad) 57: 644. 1972.

**Montiopsis** Kuntze, Revis. Gen. Pl. 3(3): 14. 1898 sec. Hershkovitz (1993). – Type: *Montiopsis boliviana* Kuntze

**Parakeelya** Hershk. in Phytologia 84: 101. 1998 sec. Hershkovitz (1998). – Type: *Parakeelya ptychosperma* (F. Muell.) Hershk.

= ?*Rumicastrum* Ulbr., Nat. Pflanzenfam. (ed. 2) 16c: 519. 1934.

Based on phylogenetic analyses (Hershkovitz 1996), Hershkovitz (1998) transferred 35 Australian *Calandrinia* species to the new genus *Parakeelya*. However, the relationships of the species of this genus within *Montiaceae* are not well supported (Hershkovitz 1996; Hershkovitz & Zimmer 2000), so further studies are needed to evaluate its affinities. Australian botanists still continue to use the name *Calandrinia* for species assignable to *Parakeelya*. The relationships of the Australian genus *Rumicastrum* are not clear. It was considered as a genus closely related to *Atriplex* (*Chenopodiaceae*). Carolin (1987) and Hershkovitz (1993) used the name to represent the Australian calandrinias (*Montiaceae*); however, Hershkovitz & Zimmer (2000) opted to use the name *Parakeelya* for those taxa. Further studies are required to clarify the correct use of *Rumicastrum*.

**Phemeranthus** Raf. in Specchio Sci. 1: 86. 1814 sec. Kiger (2004) ≡ *Talinum* sect. *Phemeranthus* (Raf.) DC., Prodr. 3: 356. 1828. – Type: *Phemeranthus teretifolius* (Pursh) Raf.

Species of *Phemeranthus* were considered as members of *Talinum*. However, morphological and molecular analyses have shown that c. 30 New World species that have terete to semi-terete leaves represent a lineage different from *Talinum* (*Talinaceae*; Carolin 1987; Hershkovitz & Zimmer 2000; Applequist & Wallace 2000; Nyffeler & Eggli 2010a; Ocampo & Columbus 2010).

**Schreiteria** Carolin in Palynol. 3: 330. 1985 sec. Carolin (1993). – Type: *Schreiteria macrocarpa* (Speg.) Carolin

An enigmatic monotypic genus, placed here with doubts, and not included in any recent analysis.

***Nepenthaceae*** Dumort. sec. APG (2009).

A monogeneric family comprising 120–138 species (McPherson 2009, 2011) native to tropical Asia, distributed from Madagascar through Indo-Malesia to New Guinea and New Caledonia (Kubitzki 2003e; Meimberg & Heubl 2006). The family includes woody climbers or scrambling shrubs and some epiphytes (Kubitzki 2003e) widely known as the carnivorous “pitcher plants”. They are characterized by unisexual flowers, axilar placentation, filaments united into a column, three- or four-locular ovaries and the loss of vascularization in glands (Heubl & al. 2006). The affinities of *Nepenthaceae* have long been discussed (Meimberg & al. 2001). Traditionally, the family was placed in the order *Nepenthales*, either as a monofamilial order (e.g. Takhtajan 1980) or together with *Droseraceae* and *Sarraceniaceae* (e.g. Cronquist 1988). The placement of the family within *Caryophyllales* was shown by the early molecular phylogenetic study of Nandi & al. (1998). Several molecular phylogenetic studies have shown (although with moderate support) the close relationship of *Nepenthaceae* and *Droseraceae* (Nandi & al. 1998; Cuénoud & al. 2000; Brockington & al. 2009; Schäferhoff & al. 2009; further information under *Droseraceae*). Another study, based on parsimony analysis of combined *rbcL* and *matK* shows with high support *Nepenthes* as sister to the rest of the carnivorous families, whereas the study of Renner & Specht (2011), based on the ML and Bayesian analysis of the combined data of nuclear, ribosomal and plastid DNA, shows also with high support the relationship of *Nepenthaceae* with the *Drosophyllaceae* + [*Dioncophyllaceae* + *Ancistrocladaceae*] clade.

***Nepenthes*** L., Sp. Pl. 1: 955. 1753 sec. Kubitzki (2003e).  
– Type: *Nepenthes distillatoria* L.  
= *Anurosperma* Hallier f. in Beih. Bot. Centralbl. 39(2): 162. 1921.

***Nyctaginaceae*** Juss. sec. APG (2009).

This family comprises c. 30 genera and 300–400 species (Bittrich & Kühn 1993; Spellenberg 2003) of trees, shrub and herbs. These are found in all warmer areas of the world (Douglas & Spellenberg 2010), but mostly in the Americas, with two centres of distribution: arid western North America (southwestern U.S.A. and northern Mexico) and the Neotropics (tropical and subtropical South America and the Antilles). Some genera, such as *Boerhavia*, *Mirabilis* and *Pisonia*, have some species occurring in the Old World, but some of them are introduced (*Mirabilis*), whereas *Commicarpus*, with few American species, is most diverse in Africa; *Phaeoptilum* is endemic to southwestern Africa and Botswana (Bittrich & Kühn 1993; Douglas & Spellenberg 2010). Recently, Douglas & Spellenberg (2010), based on the molecular phylogeny of the family by Douglas & Manos

(2007), made some adjustments to Bittrich and Kühn’s classification of 1993, so that seven tribes were recognized: *Boldoeae*, *Bougainvilleeae*, *Caribeeae*, *Colignoniaceae*, *Leucastereae*, *Nyctagineae* and *Pisonieae*; the relationship of *Caribeeae* with the others is unknown since it is known only from the type. Several genera, especially those of North America that include the suffrutescent and herbaceous taxa, have been the focus of interest of various studies. However, most of the taxa distributed in the Neotropics, including the trees and shrubs in the diverse genera *Guapira*, *Neea* and *Pisonia*, are poorly known.

***Abronia*** Juss., Gen. Pl.: 448. 1789 sec. Galloway (2003).  
– Type: *Abronia californica* J. F. Gmel.

***Acleisanthes*** A. Gray in Amer. J. Sci. Arts ser. 2, 15: 259. 1853 sec. Levin (2002). – Type: *Acleisanthes crassifolia* A. Gray

= *Selinocarpus* A. Gray in Amer. J. Sci. Arts ser. 2, 15: 262. 1853.

= *Ammocodon* Standl. in J. Wash. Acad. Sci. 6: 631. 1916.

***Allionia*** L., Syst. Nat., ed. 10, 2: 883, 890, 1361. 1759, nom. cons. sec. Turner (1994) ≡ *Wedelia* Loeffl., Iter. Hispan.: 180. 1758 ≡ *Wedeliella* Cockerell in Torreya 9: 166. 1909, nom. illeg. – Type: *Allionia incarnata* L.

***Andradea*** Allemão, Pl. Novas Brasil Andradea. 1845 sec. Bittrich & Kühn (1993). – Type: *Andradea floribunda* Allemão

***Anulocaulis*** Standl. in Contr. U. S. Natl. Herb. 12: 374. 1909 sec. Hernández-Ledesma & al. (2010). – Type: *Anulocaulis eriosolenus* (A. Gray) Standl.

***Belemia*** Pires in Bol. Mus. Paraense “Emilio Goeldi”, N. S., Bot. 52: 1. 1981 sec. Bittrich & Kühn (1993). – Type: *Belemia fucsioides* Pires

***Boerhavia*** L., Sp. Pl. 1: 3. 1753 sec. Bittrich & Kühn (1993). – Type: *Boerhavia erecta* L.

*Boerhavia*, with c. 40 species, is distributed in warm-temperate and tropical regions worldwide (Spellenberg 2003) and has been recognized as a natural group by Douglas & Manos (2007). Several authors (Fay 1980; Spellenberg 2001, 2003) have highlighted that at the species level this is a taxonomically difficult group due to morphological variation. Especially among annuals of the Sonoran desert and the pan-tropical *B. diffusa* Vahl and *B. coccinea* Mill. complex (Spellenberg 2001, 2003), apparently factors such as wide dispersal, hybridization and autogamy have contributed to that variation (Fay 1980; Spellenberg 2001, 2003). The genus is in need of a critical revision.

***Boldoa*** Cav. ex Lag. in Gen. Sp. Pl.: 9. 1816 sec. Bittrich & Kühn (1993). – Type: not designated.

The genus is monotypic, with *B. purpurascens* Cav. ex Lag. distributed from Mexico and the Antilles to northern South America. Along with *Cryptocarpus* and *Salpianthus*, *Boldoa* is placed within the tribe *Boldoeae* (Douglas & Spellenberg 2010), and in

several treatments (Standley 1911, 1918, 1931; Fay 1980; Pérez & al. 2000; Spellenberg 2001; Hernández-Ledesma & Flores 2003; González 2007) the genus has been included in the wide concept of the genus *Salpianthus*. Here we follow Bittrich & Kühn (1993) and Harling (2010), who consider them as separate genera because of differences of the perianth: *Boldoa* has a campanulate perianth (2–3.5 mm long) with glandular and uncinata hairs, *Salpianthus* has a tubular perianth (6–7 mm long) with straight hairs, while *Cryptocarpus* has a pyriform perianth (1.5–2 mm long). A revision and phylogenetic analysis including all the species of the tribe is necessary to evaluate the circumscription of the genera.

**Bougainvillea** Comm. ex Juss., Gen. Pl.: 91. 1789, nom. cons. sec. Bittrich & Kühn (1993). – Type: *Bougainvillea spectabilis* Willd. – Fig. 5E.

Standley and Steyermark (1946) state that *Bougainvillea* contains c. 14 species native to South America, three of which were cultivated in tropical and subtropical regions of the world. According to Fay (1980), the genus includes ten species, but that author argued that artificial selection processes, hybridization and the spread of clonal variants have produced a complex pattern of variation only loosely related to any natural group. Gillis (1976) treated the bougainvilleas of cultivation, considering three species and one hybrid. The biology, artificial selection as well as the lack of a monographic treatment make it difficult to determine the current number of species.

**Caribea** Alain in Candollea 17: 113. 1960 sec. Bittrich & Kühn (1993). – Type: *Caribea litoralis* Alain

An endemic genus from Cuba that has a unique morphology among the *Nyctaginaceae* (Douglas & Spellenberg 2010). *Caribea* includes compact bush-forming taprooted perennials characterized by opposite leaves forming a stipulariform sheath at the base (Bittrich & Kühn 1993; Douglas & Spellenberg 2010). Because the genus is known only from the type collection, the most recent classification system for the family (Douglas & Spellenberg 2010) included it in its own tribe, *Caribeeae*. It is awaiting its rediscovery in the field.

**Cephalotomandra** H. Karst. & Triana in Nuev. Jen. Esp.: 23. 1855 sec. Bittrich & Kühn (1993). – Type: *Cephalotomandra fragrans* H. Karst. & Triana

**Colignonia** Endl., Gen. Pl.: 311. 1837 sec. Bittrich & Kühn (1993). – Type: *Colignonia parviflora* (Kunth) Choisy

**Commicarpus** Standl. in Contr. U. S. Natl. Herb. 12: 373. 1909 sec. Bittrich & Kühn (1993). – Type: *Commicarpus scandens* (L.) Standl.

**Cryptocarpus** Kunth, Nov. Gen. Sp. (folio ed.) 2: 150. “1817” [1818] sec. Bittrich & Kühn (1993). – Type: *Cryptocarpus pyriformis* Kunth

The genus is monotypic with *C. pyriformis* restricted

to Ecuador, Peru, and the Galapagos Islands. For further information see notes under *Boldoa*.

**Cuscatlania** Standl. in J. Wash. Acad. Sci. 13: 437. 1923 sec. Bittrich & Kühn (1993). – Type: *Cuscatlania vulcanicola* Standl.

A monotypic genus, *C. vulcanicola* is a perennial herb reported from El Salvador.

**Cyphomeris** Standl. in Contr. U. S. Natl. Herb. 13: 428. 1911 sec. Mahrt & Spellenberg (1995). – Type: *Cyphomeris gypsophiloides* (M. Martens & Galeotti) Standl.

**Grajalesia** Miranda in Anales Inst. Biol. Univ. Nac. México 21: 299. 1951 sec. Bittrich & Kühn (1993). – Type: *Grajalesia ferruginea* Miranda

**Guapira** Aubl. in Hist. Pl. Guiane: 308. 1775 sec. Bittrich & Kühn (1993). – Type: *Guapira guianensis* Aubl. – Fig. 5F.

= *Torrubia* Vell., Fl. Flumin.: 139. “1825” [1829].

A neotropical genus with c. 70 species, distributed from southern Florida to South America and the Antilles. It is closely related to *Neea*, also being dioecious and having fleshy fruits. Both genera form a complex and their distinctness has been questioned by several authors (e.g. Standley 1931; Burger 1983; Pool 2001; Douglas & Manos 2007) because they are distinguished only by the presentation of the stamens, which are included in *Neea* and exserted in *Guapira*. In the phylogenetic analysis by Douglas & Manos (2007), the two genera form a clade in which both are paraphyletic; however those authors questioned if this result was the effect of their sampling (*Guapira*, two species; *Neea*, three species) or whether the paraphyly is due to the lack of resolution between both genera. *Guapira* needs a taxonomic revision and also needs to be evaluated in a phylogenetic analysis that includes an extensive sampling along with *Neea*.

**Leucaster** Choisy in Candolle, Prodr. 13(2): 457. 1849 sec. Bittrich & Kühn (1993). – Type: *Leucaster caniflorus* (Mart.) Choisy

**Mirabilis** L., Sp. Pl. 1: 177. 1753 sec. Le Duc (1995). – Type: *Mirabilis jalapa* L.

= *Oxybaphus* L’Hér. ex Willd., Sp. Pl. (ed. 4): 170, 185. 1797.

= *Quamoclidion* Choisy in Candolle, Prodr. 13(2): 429. 1849.

= *Allioniella* Rydb. in Bull. Torrey Bot. Club 29: 687. 1902.

= *Hesperonia* Standl. in Contr. U. S. Natl. Herb. 12: 306, 360. 1909.

A genus with 50–60 American and one Asiatic species. It includes herbs, suffrutescent herbs and shrubs characterized by the presence of involucre of accrescent bracts, often connate, which surround one or more flowers. Traditionally the genus was classified into six sections, some of them corresponding to previously separated genera. Molecular phylogenetic studies, which have mainly been focused on the

- North American species, support the monophyly of the genus (Levin 2000; Douglas & Manos 2007; P. Hernández-Ledesma & al., unpubl. data) but not the monophyly of the sections (P. Hernández-Ledesma & al., unpubl. data). In order to achieve a natural sub-generic classification, the South American species should be included in the sampling.
- Neea** Ruiz & Pav., Fl. Peruv. Prodr.: 52. 1794 sec. Bittrich & Kühn (1993). – Type: *Neea verticillata* Ruiz & Pav.  
*Neea* shows extensive morphological variation in habit, leaves, pubescence, inflorescences, flowers and fruits (Burger 1983). Some authors (e.g. González 2007) have considered it the taxonomically least understood group in the Neotropics. *Neea* seems to be the most species-rich genus within *Nyctaginaceae*; Douglas & Spellenberg (2010) mentioned that the genus has c. 80 species. However, the lack of a revision, along with the morphological variation and dioecy, has generated many species names (c. 150), whereas the actual number of species remains uncertain. For further information see notes under *Guaipira*.
- Neeopsis** Lundell in *Wrightia* 5: 241. 1976 sec. Bittrich & Kühn (1993). – Type: *Neeopsis flavifolia* (Lundell) Lundell
- Nyctaginia** Choisy in Candolle, Prodr. 13(2): 429. 1849 sec. Bittrich & Kühn (1993). – Type: *Nyctaginia capitata* Choisy
- Okenia** Schltld. & Cham. in *Linnaea* 5: 92. 1830 sec. Bittrich & Kühn (1993). – Type: *Okenia hypogaea* Schltld. & Cham.
- Phaeoptilum** Radlk. in *Abh. Naturwiss. Vereins Bremen* 8: 435. 1883 sec. Bittrich & Kühn (1993). – Type: *Phaeoptilum spinosum* Radlk.
- Pisonia** L., Sp. Pl. 1753 1: 1026. 1753 sec. Bittrich & Kühn (1993). – Type: *Pisonia aculeata* L. – Fig. 5G.  
 = *Ceodes* J. R. Forst. & G. Forst., *Char. Gen. Pl.*, ed. 2: 141. 1776.  
 = *Calpidia* Thouars, *Hist. Vég. Isles Austral. Afriq.*: 37. 1805.  
 = *Rockia* Heimerl in *Oesterr. Bot. Z.* 63: 289. 1913.  
 = *Heimerlia* Skotts. in *Svensk Bot. Tidskr.* 30: 738. 1936 ≡ *Heimerliodendron* Skotts. in *Svensk Bot. Tidskr.* 35: 364. 1941.  
 This genus includes shrubs, trees and woody climbers characterized by stout spines on the stems and coriaceous fruits with stipitate glands. Its distribution is pantropical with a centre of diversity in the Neotropics. Molecular phylogenetic studies (e.g. Douglas & Manos 2007; León de la Luz & Levin 2012) supported the monophyly of *Pisonia*, although the genus was poorly sampled in both studies. *Pisonia* has not been monographed, and the number of species is uncertain; some treatments considered 40 species (e.g. Spellenberg 2001; DeFilippis & Maina 2003; González 2007) whereas others (e.g. Spellenberg 2003) considered a range between 10–50 species; in the literature there are numerous accepted and unresolved names.
- Pisoniella** (Heimerl) Standl. in *Contr. U. S. Natl. Herb.* 13: 385. 1911 sec. Bittrich & Kühn (1993) ≡ *Pisonia* sect. *Pisoniella* Heimerl, *Nat. Pflanzenfam.* 3(1b): 29. 1889. – Type: *Pisoniella arborescens* (Lag. & Rodr.) Standl.
- Ramisia** Glaz. ex Baill. in *Bull. Mens. Soc. Linn. Paris* 1(88): 697. 1887 sec. Bittrich & Kühn (1993). – Type: *Ramisia reclinata* Glaz.
- Reichenbachia** Spreng. in *Bull. Soc. Philom.* 1823: 54. 1823 sec. Bittrich & Kühn (1993). – Type: *Reichenbachia hirsuta* Spreng.
- Salpianthus** Bonpl., *Pl. Aequinoct.* 1(6): 154. 1807 sec. Bittrich & Kühn (1993). – Type: *Salpianthus arenarius* Bonpl.  
 The genus includes shrubs with alternate leaves, a four- or five-lobed tubular petaloid perianth with straight glandular hairs, three to four long-exserted stamens and a linear style (Bittrich & Kühn 1993). Three species are recognized following this concept: *S. aequalis* Standl., *S. arenarius* and *S. macrodonatus* Standl., all of them with restricted distributions in Mexico. *Salpianthus* was assumed to be monophyletic by Douglas & Manos (2007); however, only *S. arenarius* was included in their study. For further information see notes under *Boldoa*.
- Tripterocalyx** (Torr.) Hook. in *Hooker's J. Bot. Kew Gard. Misc.* 5: 261. 1853 sec. Galloway (2003) ≡ *Abronia* [unranked] *Tripterocalyx* Torr., *Rep. Exped. Rocky Mts.*: 96. 1843. – Type: *Tripterocalyx micranthus* (Torr.) Hook.
- Physenaceae** Takht. sec. APG (2009).  
 A monogeneric family with two species endemic to Madagascar (Dickson 2003). Traditionally, the only genus *Physena* was placed in *Capparales/Capparaceae* (e.g. Pax & Hoffmann 1936) or *Flacourtiaceae* (e.g. Perrier de la Bâthie 1946). Later, it was considered as a family of its own and placed in the order *Sapindales* (e.g. Takhtajan 1980, 1987) and was then even transferred to the separate order *Physenales* (e.g. Takhtajan 1997). However, already the early molecular phylogenetic studies of Morton & al. (1997) showed the affinities of *Physenaceae* with *Caryophyllales* and its close relationship to *Asteropeiaceae*. These results were confirmed by subsequent molecular phylogenetic studies (e.g. Cuénoud & al. 2002; Brockington 2009, 2011; Soltis & al. 2011). The relationship between *Asteropeiaceae* and *Physenaceae* is also supported by wood-anatomical characters. For further information see notes under *Asteropeiaceae*.
- Physena** Noronha ex Thouars in *Gen. Nov. Madagasc.*: 6. 1806 sec. Dickson (2003). – Type: *Physena madagascariensis* Thouars ex Tul.
- Phytolaccaceae** R. Br. sec. APG (2009).  
 This family comprises herbs, trees or lianas dis-

tributed mainly in the Americas, including the Antilles, but with some members distributed in Australia and New Caledonia. They are characterized by styloids, elongate crystals, racemes or spikes and four or five tepals (Rohwer 1993a; Stevens 2001 onwards). The circumscription of the family has long been controversial. Following the treatment by Rohwer (1993a), *Phytolaccaceae* have been disintegrated step by step according to the results of molecular phylogenetic studies (e.g. Cuénoud & al. 2002; Hilu & al. 2003; Schäferhoff & al. 2009; Brockington & al. 2011), which have shown that the subfamilies *Agdestioideae*, *Barbeuioideae* and *Microteoideae* (sec. Rohwer 1993a) are well-supported independent lineages. Therefore, these taxa are now treated at family level (see further notes under those families). These studies have also shown that *Phytolaccaceae* s.l. comprising the subfamilies *Phytolaccoideae* and *Rivinoideae* (sec. Rohwer 1993a) are not monophyletic. The most recent study by Brockington & al. (2011) included most of the genera recognized in these subfamilies and showed that the *Phytolaccoideae* (= *Phytolaccaceae* s.str.) represents a well-supported independent lineage, while the support for *Rivinoideae* is present but weak. Recent studies (J. Petersen, T. Borsch & P. Hernández-Ledesma, unpubl. data) show that the latter is probably more closely related to *Nyctaginaceae* than to *Phytolaccaceae* s.str. *Rivinaceae* have been recognized as an independent family within *Caryophyllales* by Stevens (2001 onwards). However, the correct family name for a clade that includes the genera *Petiveria* and *Rivina* would have to be *Petiveriaceae* C. Agardh (1824) and not *Rivinaceae* C. Agardh (1824). Both family names were published in the same work (Agardh 1824) but Meissner (1836) included *Rivina* under *Petiveriaceae* separate from *Phytolaccaceae*. This gives priority to *Petiveriaceae*. The taxon has a complicated taxonomic history. In some early treatments members were classified either within *Phytolaccaceae* and distinct from *Petiveriaceae* C. Agardh (Lindley 1853), or vice versa (e.g. Hutchinson 1959; Brown & Varadarajan 1985), or at an infrafamilial or infrageneric level within *Phytolaccaceae* (e.g. *Petiveriae*, *Rivineae*, *Rivinoideae*) (including *Petiveria* and related genera) (e.g. Heimerl 1889, 1934; Rohwer 1993a).

**Anisomeria** D. Don in Edinb. N. Phil. Journ. 13: 238. 1832 sec. Rohwer (1993a). – Type: *Anisomeria coriacea* D. Don

**Ercilla** A. Juss. in Ann. Sci. Nat. (Paris) 25: 11. 1832 sec. Rohwer (1993a). – Type: *Ercilla volubilis* A. Juss.

**Gallesia** Casar. in Nov. Stirp. Bras. Dec. 5: 43. 1843 sec. Rohwer (1993a). – Type: *Gallesia scorodendrum* Casar.

**Hillieria** Vell. in Fl. Flumin.: 47. 1829 sec. Rohwer (1993a). – Type: *Hillieria elastica* Vell.  
= *Mohlana* Mart., Nov. Gen. Sp. Pl. 3: 170. 1829.

**Ledenbergia** Klotzsch ex Moq. in Candolle, Prodr. 13(2): 4, 14. 1849 sec. Rohwer (1993a). – Type: *Ledenbergia seguierioides* Klotzsch ex Moq.

= *Flueckigera* Kuntze, Revis. Gen. Pl. 2: 550. 1891.

**Monococcus** F. Muell., Fragm. 1: 46. 1858 sec. Rohwer (1993a). – Type: *Monococcus echinophorus* F. Muell.

**Petiveria** L., Sp. Pl. 1: 342. 1753 sec. Rohwer (1993a). – Type: *Petiveria alliacea* L.

**Phytolacca** L., Sp. Pl. 1: 441. 1753 sec. Rohwer (1993a). – Type: *Phytolacca americana* L.

= *Nowickeia* J. Martínez & J. A. McDonald in Brittonia 41: 399. 1989.

*Phytolacca* comprises 25–35 species of perennial herbs, shrubs and trees distributed in North and South America, eastern Asia and New Zealand. The genus *Nowickeia* is here included; it was characterized by a well-developed gynophore, green herbaceous and often elongated tepals and obovoid or obpyriform fruits with narrowly ellipsoid seeds (Martínez & McDonald 1989). Since its publication, the genus was known only from the type and considered as distinct from *Phytolacca*. However, Cruz & Alcántara (2000) described several anomalous characteristics in *P. icosandra* L. and showed similarities with *Nowickeia*. Recently, Ramírez-Amezcuca & Steinmann (2013) showed that the *Nowickeia* species correspond to anomalous plants of *P. icosandra*: the evidence was based on specimens showing the characteristic flowers of *P. icosandra* along with anomalous flowers (in one plant) showing the distinctive characteristics of *Nowickeia*.

**Rivina** L., Sp. Pl. 1: 121. 1753 sec. Rohwer (1993a). – Type: *Rivina humilis* L. – Fig. 6A.

**Schindleria** H. Walter in Bot. Jahrb. Syst. 37, Beibl. 85: 24. 1906 sec. Rohwer (1993a). – Type: not designated.

**Seguieria** Loeffl., Iter. Hispan.: 191. 1758 sec. Rohwer (1993a). – Type: *Seguieria americana* L.

**Trichostigma** A. Rich. in Hist. Fis. Cuba 10: 306. 1845 sec. Rohwer (1993a). – Type: *Trichostigma rivinoides* A. Rich. – Fig. 6B.

= *Villamilla* Ruiz & Pav. ex Moq. in Candolle, Prodr. 13(2): 10. 1849.

### **Plumbaginaceae** Juss. sec. APG (2009).

A cosmopolitan family of perennial herbs or shrubs, rarely climbers, mainly distributed in the temperate zones of the northern hemisphere, especially in the Mediterranean and Irano-Turanian regions but also in southern Africa, southern South America and Western Australia. The family comprises 25–30 genera and 650–1000 species, which predominantly occur in arid and saline environments and often in coastal habitats. The family is characterized by flowers that have stamens opposite the petals and a single basal anatropous ovule with a curled funicle. Molecular studies based on different markers have shown that *Plumbaginaceae* are well supported as monophyletic family within *Caryophyllales* and sister to *Polygonaceae* (e.g. Cuénoud & al. 2002; Hilu & al. 2003). Lledó & al. (1998, 2001) confirmed the classification of *Plumbagi-*



naceae into two subfamilies, *Limonioideae* and *Plumbaginoideae*, well differentiated by morphological, chemical and molecular characters. *Plumbaginoideae* are mostly distributed in the pantropical region and comprise four genera; *Plumbago* with c. 20 species is the largest. *Limonioideae* have diversified in regions with a Mediterranean climate and are morphologically more diverse. This subfamily is divided into two tribes: *Aegialitideae* (one genus with two species) and *Limonieae*. Most species of *Limonieae* (> 85%) are grouped into three genera: *Acantholimon*, *Armeria* and *Limonium*, while the remaining species belong to monotypic or small genera (Kubitzki 1993b) mostly segregated from *Acantholimon* and *Limonium*. The status of most of these genera is unclear; generic concepts and relationships are in need of revision.

**Acantholimon** Boiss. in *Diagn. Pl. Orient.*, ser. 1, 7: 69. 1846, nom. cons. sec. Kubitzki (1993b). – Type: *Acantholimon glumaceum* (Jaub. & Spach) Boiss. – Fig. 6C.

A large genus of cushion-forming subshrubs; 150–200 species (including many narrow endemics) distributed from southeastern Europe to central Asia, centred in the mountainous regions of Turkey, Iran and Afghanistan (Kubitzki 1993b). The study by Lledó & al. (2005) included only one representative of *Acantholimon*, which was recovered in a clade together with *Cephalorhizum* and *Dictyolimon*. Moharrek & al. (2014) studied 50 species *Acantholimon* from Iran. Due to the unresolved position of *Cephalorhizum turcomanicum* Popov (found either as sister to *Acantholimon* or nested within it), monophyly of *Acantholimon* is uncertain. Old sections of *Acantholimon* were not found as monophyletic (Moharrek & al. 2014).

**Aegialitis** R. Br., *Prodr. Fl. Nov. Holland.*: 426. 1810 sec. Kubitzki (1993b). – Type: *Aegialitis annulata* R. Br. A genus of two woody mangrove species (shrubs or small trees); one native to southeastern Asia, the other native to Australia and Papua New Guinea. Sister to the rest of *Limonioideae* (Lledó & al. 2001, 2005) and placed in the monogeneric tribe *Aegialitideae* (Lledó & al. 2001).

**Afrolimon** Lincz. in *Novosti Sist. Vyssh. Rast.* 16: 168. 1979 sec. Kubitzki (1993b). – Type: *Afrolimon peregrinum* (P. J. Bergius) Lincz.

A group of about ten species from the Cape region of South Africa. Two representatives sampled by Lledó & al. (2005; *A. peregrinum*, *A. purpuratum* Lincz.) were found nested within *Limonium*. According to these results, the status as a distinct genus can not be maintained.

**Armeria** Willd., *Enum. Pl.*: 333. 1809, nom. cons. sec. Kubitzki (1993b) = *Statice* L., *Sp. Pl.* 1: 274. 1753. – Type: *Armeria vulgaris* Willd. – Fig. 6D.

A genus of c. 90 species, found in temperate regions of the northern hemisphere and in South America (Chile, Tierra del Fuego); a centre of distribution is

the Iberian Peninsula (Nieto Feliner 1990). Monophyly of *Armeria* is supported by several studies (Lledó & al. 2005; Moharrek & al. 2014). Fuertes Aguilar & Nieto Feliner (2003) discussed the reticulate evolution in *Armeria*.

**Bakerolimon** Lincz. in *Novosti Sist. Vyssh. Rast.* 1968: 175. 1968 sec. Kubitzki (1993b). – Type: *Bakerolimon plumosum* (Phil.) Lincz.

Two species, distributed in the deserts of Chile and Peru. One sampled species was found in a clade together with *Armeria-Psylliostachys*, *Myriolimon* and *Saharanthus* (Lledó & al. 2005).

**Bamiania** Lincz. in *Bot. Zhurn. (Moscow & Leningrad)* 56: 1634. 1971 sec. Kubitzki (1993b). – Type: *Bamiania pachycorma* (Rech. f.) Lincz.

Monotypic; from Afghanistan. No sequence data are available for this species yet.

**Bukiniczia** Lincz. in *Bot. Zhurn. (Moscow & Leningrad)* 56: 1634. 1971 sec. Kubitzki (1993b) = *Aeoniopsis* Rech. f., *Fl. Iran.* 108: 24. 1974. – Type: *Bukiniczia cabulica* (Boiss.) Lincz.

Monotypic; *B. cabulica* is distributed in Afghanistan and Pakistan. Not yet included in molecular studies.

**Cephalorhizum** Popov & Korovin in *Trudy Turkestansk. Nauch. Obsc.* 1: 39. 1923 sec. Kubitzki (1993b). – Type: not designated.

Two(?) species from Afghanistan and central Asia. One species was sampled (*C. coelicolor* (Rech. f.) Rech. f.) and found in a clade together with *Acantholimon acerosum* (Willd.) Boiss. and *Dictyolimon macrorrhabdos* (Boiss.) Rech. f. (Lledó & al. 2005). Sequence data for *C. turcomanicum* Popov were generated by Akhiani & al. (2013).

**Ceratolimon** M. B. Crespo & Lledó in *Bot. J. Linn. Soc.* 132: 169. 2000 sec. Crespo & Lledó (2000). – Type: *Ceratolimon feei* (Girard) M. B. Crespo & Lledó = *Bubania* Girard in *Mém. Sect. Sci. Acad. Sci. Montpellier* 1: 182. 1848, nom. illeg.

= *Limoniastrum* sect. *Bubania* Batt., *Fl. Algkr. (Dicot.)*: 726. 1890 = *Limoniastrum* subg. *Bubania* (Batt.) Maire in *Bull. Soc. Hist. Nat. Afrique N.* 27: 247. 1936.

*Ceratolimon*, a segregate from *Limoniastrum*, includes four species of dwarf shrubs with disjunct distributions on the Atlantic and Indian Ocean edges of the Sahara Desert (Crespo & Lledó 2000). Three species sampled by Lledó & al. (2000) formed a well-supported clade, that is sister to *Limoniastrum*.

**Ceratostigma** Bunge, *Enum. Pl. China Bor.*: 55. 1833 sec. Kubitzki (1993b). – Type: *Ceratostigma plumbaginoides* Bunge

= *Valoradia* Hochst. in *Flora* 25(1): 239. 1842.

A genus of about eight species; distributed in Asia, especially in China and the Himalayas; one species in eastern Africa.

**Chaetolimon** (Bunge) Lincz. in *Trudy Tadzisk. Bazy* 8: 586. 1940 sec. Kubitzki (1993b) = *Acantholimon*

- sect. *Chaetolimon* Bunge in Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 7, 18(2): 68. 1872. – Type: *Chaetolimon sogdianum* Lincz.
- Dictyolimon** Rech. f. in Fl. Iran. 108: 21. 1974 sec. Kubitzki (1993b). – Type: *Dictyolimon macrorrhabdos* (Boiss.) Rech. f.  
Four species distributed in Afghanistan, Pakistan, and India. One representative was sampled (*D. macrorrhabdos*) and found in a clade together with *Acantholimon acerosum* (Willd.) Boiss. and *Cephalorhizum coelicolor* (Rech. f.) Rech. f. (Lledó & al. 2005).
- Dyerophytum** Kuntze in Revis. Gen. Pl. 2: 394. 1891 sec. Kubitzki (1993b) = *Vogelia* Lam., Tabl. Encycl. 2: 147. 1792, nom. illeg. – Type: *Dyerophytum africanum* (Lam.) Kuntze  
Three species of shrubs or subshrubs; from India, Arabia, Socotra and southern Africa.
- Ghaznianthus** Lincz. in Novosti Sist. Vyssh. Rast. 16: 167. 1979 sec. Kubitzki (1993b). – Type: *Ghaznianthus rechingeri* (Freitag) Lincz.  
Monotypic; from Afghanistan. No sequence data are available yet.
- Gladiolimon** Mobayen in Revis. Taxon. Acanthol.: 296. 1964 sec. Kubitzki (1993b). – Type: *Gladiolimon speciosissimum* (Aitch. & Hemsl.) Mobayen  
Monotypic; distributed in Afghanistan. No sequence data are available yet.
- Goniolimon** Boiss. in Candolle, Prodr. 12: 632. 1848 sec. Kubitzki (1993b). – Type: not designated.
- Ikonnikovia** Lincz. in Fl. URSS 18: 745. 1952 sec. Kubitzki (1993b). – Type: *Ikonnikovia kaufmanniana* (Regel) Lincz.  
Monotypic; distributed in central Asia. No sequence data are available yet.
- Limoniastrum** Fabr. in Enum. Meth. Pl. Hort. Helmstad: 25. 1759 sec. Crespo & Lledó (2000). – Type: *Limoniastrum articulatum* Moench  
Only two species, *Limoniastrum guyonianum* Boiss. and *L. monopetalum* (L.) Boiss., distributed in the Mediterranean region. Narrow circumscription (see Crespo & Lledó 2000) based on results from Lledó & al. (2000).
- Limoniopsis** Lincz. in Fl. URSS 18: 744. 1952 sec. Kubitzki (1993b). – Type: *Limoniopsis owerinii* (Boiss.) Lincz.  
Two species, *Limoniopsis davisii* Bokhari and *L. owerinii*, distributed in eastern Turkey and Caucasia, respectively. Not yet sampled in any molecular studies.
- Limonium** Mill., Gard. Dict. Abr., ed. 4: [1328]. 1754, nom. cons. sec. Kubitzki (1993b). – Type: *Limonium vulgare* Mill.  
= *Eremolimon* Lincz. in Novosti Sist. Vyssh. Rast. 22: 200. 1985.  
The largest genus of the family with an estimated c. 350 species with a preference for coastal habitats; distributed worldwide but mainly in the Mediterranean region. *Afrolimon* was shown to be nested in *Limonium* and related to *L. vulgare*, the type of *Limonium* (Lledó & al. 2005). *Limonium* is divided into two major clades corresponding to subgenera, but otherwise the current infrageneric classification proved to be artificial (Lledó & al. 2005). Akhani & al. (2013) studied the Irano-Turanian taxa of *Limonium*. They stated that segregation of *Eremolimon* is not supported by morphology or molecular data (Akhani & al. 2013). Evolutionary studies of this group are complicated by hybridization, many microspecies and apomictic taxa.
- Muellerolimon** Lincz. in Bot. Zhurn. (Moscow & Leningrad) 67: 675. 1982 sec. Kubitzki (1993b). – Type: *Muellerolimon salicorniaceum* (F. Muell.) Lincz.  
Monotypic genus; halophytic *M. salicorniaceum* distributed in Western Australia. Related to *Goniolimon* (Lledó & al. 2005).
- Myriolimon** Lledó & al. in Taxon 54: 811. 2005 sec. APG (2009) = *Statice* sect. *Myriolepis* Boiss. in Candolle, Prodr. 12: 667. 1848 = *Limonium* sect. *Myriolepis* (Boiss.) Sauvage & Vindt, Fl. Maroc 1: 47, 74. 1952 = *Limonium* subg. *Myriolepis* (Boiss.) Pignatti in Bot. J. Linn. Soc. 64: 361. 1971 = *Myriolepis* (Boiss.) Lledó & al. in Taxon 52: 71. 2003, nom. illeg. – Type: *Myriolimon ferulaceum* (L.) Lledó & al.  
Two species distributed along the central and western coasts of the Mediterranean region.
- Neogontscharovia** Lincz. in Bot. Zhurn. (Moscow & Leningrad) 56: 1633. 1971 sec. Kubitzki (1993b). – Type: *Neogontscharovia miranda* (Lincz.) Lincz.
- Plumbagella** Spach in Hist. Nat. Vég. 10: 333. 1841 sec. Kubitzki (1993b). – Type: *Plumbagella micrantha* (Ledeb.) Boiss.  
Monotypic; distributed in central Asia.
- Plumbago** L., Sp. Pl. 1: 151. 1753 sec. Kubitzki (1993b). – Type: *Plumbago europaea* L.  
A genus of 10–20 species (“leadworts”) with pantropical distribution.
- Popoviolimon** Lincz. in Bot. Zhurn. (Moscow & Leningrad) 56: 1633. 1971 sec. Kubitzki (1993b). – Type: *Popoviolimon turcomanicum* (Popov ex Lincz.) Lincz.  
Monotypic; distributed in Turkmenistan. No sequence data are available yet.
- Psylliostachys** (Jaub. & Spach) Nevski in Trudy Bot. Inst. Akad. Nauk S. S. S. R., Ser. 1, Fl. Sist. Vyss. Rast 4: 314. 1937 sec. Kubitzki (1993b) = *Statice* subg. *Psylliostachys* Jaub. & Spach, III. Pl. Orient. 1: 158. 1844. – Type: *Psylliostachys spicata* (Willd.) Nevski  
Two or three species; distributed in Asia (former Soviet central Asia, Iran, Afghanistan). *Psylliostachys* species formed a well-supported clade (Moharrek & al. 2014) and were shown to be sister to representatives of *Armeria* (Lledó & al. 2001, 2005; Moharrek & al. 2014).
- Saharanthus** M. B. Crespo & Lledó in Bot. J. Linn. Soc. 132: 169. 2000 sec. Crespo & Lledó (2000) = *Caballeroa* Font Quer in Cavanillesia 7: 150. 1935, nom.

inval. = *Lerrouxia* Caball. in Trab. Mus. Nac. Ci. Nat., Ser. Bot., 28: 13. 1935, nom. illeg. – Type: *Saharantus ifniensis* (Caball.) M. B. Crespo & Lledó

Monotypic genus; distributed in the western Sahara Desert. Segregated from *Limoniastrum* based on results from Lledó & al. (2000); was found in a clade together with *Armeria-Psylliostachys*, *Bakerolimon* and *Myriolimon* (Lledó & al. 2005).

**Vassilczenkoa** Lincz. in Novosti Sist. Vyssh. Rast. 16: 166. 1979 sec. Kubitzki (1993b). – Type: *Vassilczenkoa sogdiana* (Lincz.) Lincz.

### **Polygonaceae** Juss. sec. APG (2009).

The *Polygonaceae* are a morphologically diverse clade containing more than 50 genera and 1200 species. The family is a monophyletic group with the morphological synapomorphies of an ocrea, orthotropous ovules, (usually) trigonous achenes and quincuncial aestivation (Judd & al. 2007). *Polygonaceae* are distributed worldwide and are present in almost all ecosystems ranging from tropical rainforests to alpine regions and tundra (Brandbyge 1993; Sanchez & al. 2009). Burke & Sanchez (2011), based on phylogenetic data, recognized three subfamilies: *Eriogonoideae*, *Polygonoideae* and *Symmerioideae*. *Polygonoideae* were considered non-monophyletic in previous studies (Lamb Frye & Kron 2003; Sanchez & Kron 2008), but a new circumscription by Sanchez & al. (2011) supported a monophyletic subfamily including the type genus *Polygonum* and other genera such as *Atraphaxis*, *Fagopyrum*, *Fallopia*, *Koenigia*, *Muehlenbeckia*, *Oxyria*, *Persicaria*, *Rheum* and *Rumex*; whereby *Eriogonoideae* was expanded to include currently recognized *Antigonon*, *Coccoloba*, *Ruprechtia*, *Triplaris* and other members of the woody genera previously included in *Polygonoideae* (Sanchez & Kron 2009; Burke & al. 2010). It is important to mention that much work is still needed within the tribe *Eriogoneae* (or *Eriogonoideae* s.str.), since most of the recognized genera have no support as being monophyletic (Kempton 2012). *Symmerioideae* is monotypic and the only species recognized is *Symmeria paniculata* Benth.; this subfamily shows a unique trans-Atlantic disjunction, in the Amazon Basin and western Africa, which needs further study (Burke & Sanchez 2011).

**Acanthoscyphus** Small in Bull. Torrey Bot. Club 25: 53. 1898 sec. Reveal (2005). – Type: *Acanthoscyphus parishii* (Parry) Small

**Aconogonon** (Meisn.) Rchb. in Handb. Nat. Pfl.-Syst.: 236. 1837 sec. Brandbyge (1993). – Type: *Aconogonon alpinum* (All.) Schur

**Afrobrunnichia** Hutch. & Dalziel in Fl. W. Trop. Afr. [Hutchinson & Dalziel] 1: 118. 1927 sec. Sanchez & Kron (2009). – Type: *Afrobrunnichia erecta* (Asch.) Hutch. & Dalziel

**Antigonon** Endl., Gen. Pl.: 310. 1837 sec. Brandbyge (1993) = *Corculum* (Endl.) Stuntz in Bull. Bur. Pl. Industr. U. S. D. A. 282: 86. 1913. – Type: *Antigonon leptopus* Hook. & Arn.

The genus *Antigonon*, with three to six species, consists of woody or herbaceous perennial lianas that grow in Mexico and Central America, with the exception of *A. leptopus* Hook. & Arn., which is widely cultivated as an ornamental (Brandbyge 1993). Sanchez & Kron (2009), Sanchez & al. (2009), Burke & al. (2010) and Burke & Sanchez (2011), based on consistent and highly supported molecular data, proposed that *Antigonon* and *Brunnichia*, two genera with suffrutescent habit and tendril-bearing lianas, are clearly distinguished from the rest of the subfamily *Eriogonoideae*. According to Brandbyge (1993), the described species are poorly defined and a taxonomic revision is needed.

**Aristocapsa** Reveal & Hardham in Phytologia 66: 84. 1989 sec. Brandbyge (1993). – Type: *Aristocapsa insignis* (Curran) Reveal & Hardham

**Atraphaxis** L., Sp. Pl. 1: 333. 1753 sec. Schuster & al. (2011a). – Type: *Atraphaxis spinosa* L.

**Bistorta** Adans., Fam. Pl. 2: 277, 525. 1763 sec. Brandbyge (1993). – Type: *Bistorta major* Gray

**Brunnichia** Banks ex Gaertn. in Fruct. Sem. Pl. 1: 213. 1788 sec. Sanchez & Kron (2009). – Type: *Brunnichia cirrhosa* Gaertn.

**Calligonum** L., Sp. Pl. 1: 530. 1753 sec. Brandbyge (1993). – Type: *Calligonum polygonoides* L.

**Centrostegia** A. Gray ex Benth. in Candolle, Prodr. 14: 27. 1856 sec. Brandbyge (1993). – Type: *Centrostegia thurberi* A. Gray ex Benth.

**Chorizanthe** R. Br. ex Benth. in Trans. Linn. Soc. London 17: 405, 416. 1836 sec. Reveal (2005). – Type: *Chorizanthe virgata* Benth.

= *Acanthogonum* Torr. in Pacif. Rail. Rep. 4: 132. 1856.

= *Eriogonella* Goodman in Ann. Missouri Bot. Gard. 21: 90. 1934.

**Coccoloba** P. Browne in Civ. Nat. Hist. Jamaica: 209. 1756, nom. cons. sec. Brandbyge (1993). – Type: *Coccoloba uvifera* (L.) L. – Fig. 6E & F.

= *Guaibara* Mill., Gard. Dict. Abr., ed. 4: [590]. 1754. *Coccoloba* includes c. 120 Neotropical species, which are grouped in four areas with distinguished endemism: the Antilles, Central America, northern South America and the Amazon region of Brazil (Stohr 1982; Brandbyge 1993). The presence of an ocrea (also ochrea), flowers with five tepals and eight stamens and the globose or trigonous achenes are the fundamental characteristics that support the relationships among *Coccoloba*, *Neomillspauhia* and *Podopterus* (Sanchez & Kron 2009; Burke & al. 2010; Burke & Sanchez 2011). The particular ecological conditions and ecological isolation of the Antilles allow inferring a radiation, mainly in Cuba and Hispaniola, with c. 40 endemic species; however, there is no biogeographic hypothesis for the genus. Currently, *Coccoloba* is classified in several sections, which have not been phylogenetically evaluated.

**Dedeckera** Reveal & J. T. Howell in Brittonia 28: 245.

- 1976 sec. Brandbyge (1993). – Type: *Dedeckera eurekaensis* Reveal & J. T. Howell
- Dodecahema** Reveal & Hardham in Phytologia 66: 86. 1989 sec. Brandbyge (1993). – Type: *Dodecahema leptoceras* (A. Gray) Reveal & Hardham
- Duma** T. M. Schust. in Int. J. Plant. Sci. 172: 1053. 2011 sec. Schuster & al. (2011b). – Type: *Duma florulenta* (Meisn.) T. M. Schust.  
A new genus segregated from *Muehlenbeckia*, based on the molecular study by Schuster & al. (2011). The genus comprises three species restricted to Australia, and is characterized by erect shrubs with thornlike branches. This habit it not found in any other *Muehlenbeckia* (as studied by Schuster & al. 2011). In addition, *Duma* does not possess extrafloral nectaries at the petiole base, which are present in most species of *Fallopia*, *Muehlenbeckia* and *Reynoutria*.
- Emex** Campd. in Monogr. Rumex: 56. 1819, nom. cons. sec. Brandbyge (1993). – Type: *Emex spinosa* (L.) Campd.
- Eriogonum** Michx., Fl. Bor.-Amer. 1: 246. 1803 sec. Brandbyge (1993). – Type: *Eriogonum tomentosum* Michx.  
= *Pterogonum* H. Gross in Bot. Jahrb. Syst. 49: 239. 1913.  
= *Sanmartinia* M. Buchinger in Com. Inst. Nac. Invest. Cienc. Nat., Buenos Aires, Cienc. Bot. 1: 5. 1950.
- Eskemukerjea** Malick & Sengupta in Bull. Bot. Surv. India 11: 433. 1972 sec. Brandbyge (1993). – Type: *Eskemukerjea nepalensis* Malick & Sengupta  
This genus has been considered as a synonym of *Fagopyrum*, based on pollen morphology (Hong 1988). However, recent molecular analyses did not place it in *Fagopyrum* (Ohsako & al. 2001; Galasso & al. 2009; Sanchez & al. 2011). Since there are morphological characters that suggest placement in *Fagopyrum*, but no molecular evidence for that relationship, *Eskemukerjea* was left as incertae sedis by Sanchez & al. (2011).
- Fagopyrum** Mill., Gard. Dict. Abr., ed. 4: [495]. 1754, nom. cons. sec. Brandbyge (1993). – Type: *Fagopyrum esculentum* Moench  
= *Harpagocarpus* Hutch. & Dandy in Bull. Misc. Inform. Kew 1926: 364. 1926.  
= *Parapteropyrum* A. J. Li in Acta Phytotax. Sin. 19: 330. 1981.
- Fallopia** Adans., Fam. Pl. 2: 277, 557. 1763 sec. Brandbyge (1993). – Type: *Polygonum scandens* L.  
= *Bilderdykia* Dumort., Fl. Belg. 1: 18. 1827.  
= *Pleuropterus* Turcz. in Bull. Soc. Imp. Naturalistes Moscou 21: 587. 1848.
- Gilmania** Coville in J. Wash. Acad. Sci. 26: 210. 1936 sec. Brandbyge (1993). – Type: *Gilmania luteola* (Coville) Coville
- Goodmania** Reveal & Ertter in Brittonia 28: 427. 1977 sec. Brandbyge (1993). – Type: *Goodmania luteola* (Parry) Reveal & Ertter
- Gymnopodium** Rolfe in Hooker's Icon. Pl.: t. 2699. 1901 sec. Brandbyge (1993). – Type: *Gymnopodium floribundum* Rolfe  
= *Millspaughia* B. L. Rob. in Bot. Jahrb. Syst. 36(3, Beibl. 80): 13. 1905.  
The genus *Gymnopodium* was originally described with three species, growing as shrubs or small trees on limestone soils in Belize, Guatemala, and the Yucatán Peninsula in Mexico (Blake 1921; Brandbyge 1993). Sanchez & al. (2009) and Burke & al. (2010) showed that *Gymnopodium* is strongly supported as monophyletic in the subfamily *Eriogonoideae* (sec. Burke & Sanchez 2011); based on leaf shape and pubescence characters, the genus should be recognized with only one polymorphic species (Burke & Sanchez 2011).
- Harfordia** Greene & Parry in Proc. Davenport Acad. Nat. Sci. 5: 27. 1886 sec. Brandbyge (1993). – Type: *Harfordia macroptera* (Benth.) Greene & Parry
- Hollisteria** S. Watson in Proc. Amer. Acad. Arts 14: 296. 1879 sec. Brandbyge (1993). – Type: *Hollisteria lanata* S. Watson
- Johanneshowellia** Reveal in Brittonia 56: 299. 2004 sec. APG (2009). – Type: not designated.
- Knorringia** (Czukav.) Tzvelev in Nov. Syst. Pl. Vas. 24: 76. 1987 sec. Sanchez & al. (2011) ≡ *Polygonum* sect. *Aconogonon* Meisn., Monogr. Polyg.: 43, 55. 1826 ≡ *Polygonum* sect. *Knorringia* Czukav. in Novosti Sist. Vyssh. Rast. 3: 92-93. 1966 ≡ *Aconogonon* sect. *Knorringia* (Czukav.) Soják in Preslia 46: 151. 1974. – Type: *Knorringia sibirica* (Laxm.) Tzvelev  
The genus was segregated from *Polygonum* s.l. (or from *Aconogonon*) and placed in the *Coccolobeae* by Hong (1989). Later on it was included within *Persicaria* (*Persicarieae*) by Brandbyge (1993) and after that considered as incertae sedis within *Polygoneae* by Galasso & al. (2009). Its isolated position from *Persicaria* was statistically well supported by molecular data in Sanchez & al. (2011). The taxon is sister to the remaining members of the *Polygoneae*, with which it shares characters such as tepal nervature, structure of the exocarp and pollen morphology (Galasso & al. 2009).
- Koenigia** L., Syst. Nat., ed. 12, 2: 3, 35. 1767 sec. Brandbyge (1993). – Type: *Koenigia islandica* L.
- Lastarriaea** J. Rémy, Fl. Chil. 5: 289. 1851-1852 sec. Brandbyge (1993). – Type: *Lastarriaea chilensis* J. Rémy
- Leptogonum** Benth., Gen. Pl. 3(1): 103. 1880 sec. Brandbyge (1993). – Type: *Leptogonum domingensis* Benth.  
*Leptogonum* is an interesting genus of small trees or shrubs, endemic to Hispaniola (Liogier 1983; Brandbyge 1989). In Burke & al. (2010), this genus was placed in the subfamily *Eriogonoideae* and recognized as its own subtribe *Leptogoneae* (Burke & Sanchez 2011), based on the lack of accrescent tepals

- in the fruit, the reduction to three stamens, and the leaves clustered at the stem apices.
- Magoniella** Adr. Sanchez in Syst. Bot. 36: 708. 2011 sec. Sanchez & al. (2011). – Type: *Magoniella obidensis* (Huber) Adr. Sanchez  
This recently published genus comprises two species distributed in Brazil, Bolivia and Venezuela, and it was segregated from *Ruprechtia* based on molecular and morphological characters (Sanchez & Kron 2011). *Magoniella* is characterized by a strict lianaceous habit, and it shares with *Salta* and *Triplaris* the presence of a scar at the base of the perianth in the fruit.
- Mucronea** Benth. in Trans. Linn. Soc. London 17: 405, 419. 1836 sec. Brandbyge (1993). – Type: *Mucronea californica* Benth.
- Muehlenbeckia** Meisn., Pl. Vasc. Gen. 1: 227. 1841, nom. cons. sec. Brandbyge (1993). – Type: *Muehlenbeckia australis* (G. Forst.) Meisn.  
= *Homalocladium* (F. Muell.) L. H. Bailey in Gentes Herb. 2: 56. 1929.
- Nemacaulis** Nutt. in Proc. Acad. Nat. Sci. Philadelphia 4: 18. 1848 sec. Brandbyge (1993). – Type: *Nemacaulis denudata* Nutt.
- Neomillspaughia** S. F. Blake in Bull. Torrey Bot. Club 48: 84. 1921 sec. Brandbyge (1993). – Type: *Neomillspaughia paniculata* (Donn. Sm.) S. F. Blake  
With only two recognized species, the genus is restricted to the dry forests of Mexico and Central America (Brandbyge 1993; Burke & al. 2010). Previous to their assignment to a new genus by Blake (1921), species of *Neomillspaughia* had been placed in either *Campderia* Benth. (Donnell Smith 1899) or *Podopterus* (Gross 1913). Roberty & Vautier (1964) included *Neomillspaughia* in the genus *Podopterus*; however, based on molecular data, *Neomillspaughia* receives strong support as sister to *Coccoloba* (Sanchez & al. 2009; Burke & al. 2010).
- Oxygonum** Burch. ex Campd. in Monogr. Rumex: 18. 1819 sec. Brandbyge (1993). – Type: *Oxygonum alatum* Burch.  
*Oxygonum* comprises c. 35 species and is confined to the African continent and Madagascar (Graham 1957; Ortiz & Paiva 1999). Several studies have placed the genus in *Polygoneae* (Haraldson 1978; Brandbyge 1993; Hong & al. 1998; Galasso & al. 2009); however, Haraldson (1978) suggested a close affinity to *Fagopyrum* and genera in *Rumiceae*. Ronse Decraene & Akeroyd (1988) suggested an affinity with *Polygonum*. *Oxygonum* has not been sampled in any molecular study; therefore it was left as *incertae sedis* by Sanchez & al. (2011).
- Oxyria** Hill in Veg. Syst. 10: 24. 1765 sec. Brandbyge (1993). – Type: *Oxyria digyna* (L.) Hill
- Oxytheca** Nutt. in Proc. Acad. Nat. Sci. Philadelphia 4: 16. 1848 sec. Brandbyge (1993). – Type: *Oxytheca dendroidea* Nutt.
- Persicaria** Mill., Gard. Dict. Abr., ed. 4: [1054]. 1754 sec. Brandbyge (1993). – Type: *Persicaria maculosa* Gray  
= *Tovara* Adans., Fam. Pl. 2: 276, 612. 1763.  
= *Antenoron* Raf., Fl. Ludov.: 28. 1817.  
= *Echinocaulon* (Meisn.) Spach, Hist. Nat. Vég. 10: 521. 1841.  
= *Cephalophilum* Meisn. ex Börner in Bot. Syst. Not. 276. 1912.  
= *Physopyrum* Popov in Ind. Sem. Hort. Bot. Almaat. Acad. Sci. URSS. 2: 23. 1935.
- Podopterus** Bonpl., Pl. Aequinoct. 2: 89. 1812 sec. Brandbyge (1993). – Type: *Podopterus mexicanus* Bonpl.  
*Podopterus* includes three species restricted to Mexico and Guatemala (Brandbyge 1993). The genus has strong morphological affinities to *Neomillspaughia* and *Coccoloba*, based on habit and the presence of five tepals (Burke & al. 2010). Although the placement of *Podopterus* is not well supported, Burke & Sanchez (2011) included the genus in the tribe *Coccolobaeae* alongside *Coccoloba* and *Neomillspaughia*. *Neomillspaughia* and *Podopterus* share the presence of accrescent and membranous inner tepals (Blake 1921; Roberty & Vautier 1984).
- Polygonum** L., Sp. Pl. 1: 359. 1753, nom. cons. sec. Schuster & al. (2011a). – Type: *Polygonum aviculare* L.  
= *Polygonella* Michx., Fl. Bor.-Amer. 2: 240. 1803.
- Pteropyrum** Jaub. & Spach, Ill. Pl. Orient. 2: 7. 1844 sec. Brandbyge (1993). – Type: *Pteropyrum aucheri* Jaub. & Spach
- Pterostegia** Fisch. & C. A. Mey. in Index Seminum [St. Petersburg] 2: 23. 1835 sec. Brandbyge (1993). – Type: *Pterostegia drymarioides* Fisch. & C. A. Mey.
- Pteroxygonum** Dammer & Diels in Bot. Jahrb. Syst. 36: 36. 1905 sec. Brandbyge (1993). – Type: *Pteroxygonum giraldui* Dammer & Diels  
A monotypic genus found in China. The genus was considered part of *Fagopyrum* (Haraldson 1978; Ronse Decraene & Akeroyd 1988) but molecular studies do not support this placement (Sun & al. 2008; Sanchez & al. 2009; Tavakkoli & al. 2010). Sun & al. (2008) suggested that this genus should be placed in *Persicarieae*, but in Sanchez & al. (2009) the position is unresolved. In Tavakkoli & al. (2010) there is conflicting placement of *Pteroxygonum* depending on the gene region. Therefore, Sanchez & al. (2011) decided to leave this genus as *incertae sedis*.
- Reynoutria** Houtt., Nat. Hist. 2(8): 639. 1777 sec. Brandbyge (1993). – Type: *Reynoutria japonica* Houtt.
- Rheum** L., Sp. Pl. 1: 371. 1753 sec. Brandbyge (1993). – Type: *Rheum rhaponticum* L.
- Rubrivena** M. Král in Preslia 57(1): 65. 1985 sec. Brandbyge (1993) ≡ *Persicaria* sect. *Rubrivena* (M. Král) S. P. Hong in Pl. Syst. Evol. 186: 112. 1993. – Type: *Rubrivena polystachya* (Wall. ex Meisn.) M. Král  
A monotypic genus distributed in Afghanistan, Pakistan, India and China (Qaiser 2001). The taxonomy of

*Rubrivena* is complex; its members have been included in *Polygonum* (*P. polystachyum*; Li & al. 2003) and *Persicaria* (*P. wallichii*; Freeman 2005), and both names are accepted by Tropicos (undated). However, based on molecular studies, the placement of *Rubrivena* is strongly supported as sister to *Aconogonon* and *Koenigia* (Sanchez & al. 2011).

**Rumex** L., Sp. Pl. 1: 333. 1753 sec. Brandbyge (1993). – Type: *Rumex patientia* L.

= *Acetosella* (Raf.) Fourr. in Ann. Soc. Linn. Lyon ser. 2, 17: 145. 1869.

= *Bucephalophora* Pau in Not. Bot. Fl. Españ. 1: 24. 1887.

= *Acetosa* Mill., Gard. Dict. Abr., ed. 4: [unpaged]. 1754.

**Ruprechtia** C. A. Mey. in Mém. Acad. Imp. Sci. St-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6: 148. 1840 sec. Brandbyge (1993). – Type: *Ruprechtia ramiflora* (Jacq.) C. A. Mey.

= *Enneatypus* Herzog in Meded. Rijks-Herb. 46: 3. 1922.

**Salta** Adr. Sanchez in Syst. Bot. 36: 708. 2011 sec. Sanchez & al. (2011). – Type: *Salta triflora* (Griseb.) Adr. Sanchez

A new monotypic genus described in Sanchez & Kron (2011), based on morphological and molecular data. This genus is commonly found in Argentina, Bolivia, Brazil and Paraguay, and is characterized by a pronounced development of brachyblasts and the short axis of the inflorescences borne on a short shoot (Pendry 2004; Sanchez & Kron 2011). Molecular studies have strongly supported the placement of this genus as sister of a clade that includes *Magoniella*, *Ruprechtia* and *Triplaris* (Burke & al. 2010; Sanchez & Kron 2011).

**Sidotheca** Reveal in Harvard Pap. Bot. 9: 211. 2004 sec. APG (2009) ≡ *Oxytheca* sect. *Neoxytheca* Ertter. in Brittonia 32: 92. 1980. – Type: not designated.

*Sidotheca* was established as a new name, replacing *Oxytheca* sect. *Neoxytheca*.

**Stenogonum** Nutt. in Proc. Acad. Nat. Sci. Philadelphia 4: 19. 1848 sec. Brandbyge (1993). – Type: *Stenogonum salsuginosum* Nutt.

**Symmeria** Benth. in London J. Bot. 4: 630. 1845 sec. Brandbyge (1993). – Type: *Symmeria paniculata* Benth.

**Systemotheca** Reveal & Hardham in Phytologia 66: 85. 1989 sec. Brandbyge (1993). – Type: *Systemotheca vortreidei* (Brandege) Reveal & Hardham

**Triplaris** Loefl., Iter. Hispan.: 256. 1758 sec. Brandbyge (1993). – Type: *Triplaris americana* L. – Fig. 6G.

**Portulacaceae** Juss. sec. Nyffeler & Eggli (2010a).

A monogeneric family with c. 100 species mainly distributed in tropical and subtropical areas of the world.

**Portulaca** L., Sp. Pl. 1: 445. 1753 sec. Nyffeler & Eggli (2010a). – Type: *Portulaca oleracea* L.

= *Lemia* Vand., Fl. Lusit. Brasil. Spec. 35. 1788.

= *Sedopsis* (Engl. ex Legrand) Exell & Mendonça, Consp. Fl. Angol. 1: 116. 1937.

= *Merida* Neck., Elem. Bot. 2: 382. 1790, nom. inval.

= *Lamia* Vand. ex Endl., Gen. Pl.: 949. 1840, nom. inval.

Although the circumscription of the genus has been relatively stable, the infrageneric classification remains controversial. Previous proposals (von Poellnitz 1934; Legrand 1958; Geesink 1969) are only in part consistent with the results of a recent phylogenetic analysis (Ocampo & Columbus 2012). The genus is monophyletic and has two main lineages: one whose members have opposite leaves (OL clade) and are distributed in Africa, Asia and Australia (except *P. quadrifida* L., which is a pantropical weed), and a second lineage whose species have alternate to subopposite leaves (AL clade), are more widespread and originated in the New World. These major clades and their subclades have anatomical and morphological features (Ocampo & Columbus 2012; Ocampo & al. 2013) that will be used to amend the classification of *Portulaca*.

**Rhabdodendraceae** Prance sec. APG (2009).

A monogeneric family comprising three species distributed in tropical South America, the Guyanas, the Amazonian region and northeastern Brazil (Prance 2003). The family has had a complicated taxonomic history. Traditionally, species that are now placed in *Rhabdodendron* were included in different families of *Rutales*, in the family *Chrysobalanaceae* (as the genus *Lecostemon* DC.) (Bentham 1853) or in *Rutaceae* (Gilg & Pilger 1905; Huber 1909; Takhtajan 1980). In other systems (e.g. Cronquist 1981), *Rhabdodendron* was placed within *Rosales* (for a detailed taxonomic history until the 1970s see Prance 1972). Based on morphological, palynological and anatomical characters, Prance (1972) considered *Rhabdodendron* in its own family, and suggested for the first time some affinities with *Caryophyllales*, specifically with *Phytolaccaceae*. Later on, the early molecular phylogenetic study of Fay & al. (1997) confirmed the affinities of *Rhabdodendraceae* with *Caryophyllales*. Since then, the position of the family within the order was also confirmed by subsequent studies (e.g. Cuénoud & al. 2002; Hilu & al. 2003; Schäferhoff & al. 2009; Brockington & al. 2009, 2011; Qiu & al. 2010; Soltis & al. 2011), although there are several hypothesis about its internal position.

**Rhabdodendron** Gilg & Pilg. in Verh. Bot. Vereins Prov. Brandenburg 47: 152. 1905 sec. Prance (2003). – Type: *Rhabdodendron columnare* Gilg & Pilg.

**Sarcobataceae** Behnke sec. APG (2009).

A monogeneric family with two species distributed in North America (Kühn 1993; Hils & al. 2003), from the western United States to northwestern Mexico. The

family includes shrubs characterized by having thorny branches, ebracteolate and unisexual flowers, staminate flowers arranged in spikes, whereas the pistillate ones are solitary (Wels & al. 2003). Traditionally, the only genus, *Sarcobatus*, was placed in *Chenopodiaceae* (for a detailed taxonomic history until the 1990s see Behnke 1997). The early molecular phylogenetic study by Downie & al. (1997) supported the position of *Sarcobatus* as an independent lineage. In this study, *Sarcobatus* showed a close relationship with members of *Nyctaginaceae* and *Phytolaccaceae* rather than *Chenopodiaceae*. Based on these results in addition to characters of the sieve-element plastids and some morphological characters, Behnke (1997) described the new family; nevertheless, some authors continued to treat the genus as part of *Chenopodiaceae* (e.g. Hils & al. 2003). The position of *Sarcobatus* as an independent lineage was confirmed by other molecular phylogenetic studies (e.g. Cuénoud & al. 2002; Hilu & al. 2003; Brockington 2009, 2011; Soltis & al. 2011; Schäferhoff & al. 2009), which showed a close but only moderately supported relationship of the family with *Agdestidaceae*.

***Sarcobatus*** Nees, *Reise Nord-America* 2: 446. 1841 sec.

Hils & al. (2003). – Type: *Sarcobatus maximilianii* Nees – Fig. 7A.

= *Fremontia* Torr., *Rep. Exped. Rocky Mts.*: 95. 1843.

***Simmondsiaceae*** Tiegh. ex Reveal & Hoogland sec. APG (2009).

A monotypic family native to the Sonoran Desert of northwestern Mexico and to neighbouring regions in Arizona and southern California (Vázquez Yanes & al. 1999); it is also introduced in some countries of South America, Europe, Asia and Africa. The family includes evergreen dioecious shrubs with opposite and thick leaves, clearly articulated near the stem; the staminate flowers are small and borne in terminal inflorescences, while the pistillate flowers are single and axillary; the calyx is much enlarged in fruit (Stevens 2001 onwards; Köhler 2003). Traditionally, the family was placed in *Hamamelidales* (sensu Takhtajan 1980), *Euphorbiales* (sensu Cronquist 1988) or in its own order *Simmondsiales* (sensu Takhtajan 1997), in some cases within *Buxaceae* or close to it. However, the early molecular phylogenetic study by Fay & al. (1997) showed the affinities of *Simmondsiaceae* with *Caryophyllales*: this agrees also with several morphological characters of the stylochia, calyces and secondary growth (Köhler 2003). The affinities of the family with *Caryophyllales* were confirmed by subsequent molecular phylogenetic studies (e.g. Cuénoud & al. 2002; Brockington 2009, 2011; Soltis & al. 2011), which showed that *Simmondsiaceae* are closer to *Rhabdodendraceae* and/or to the remainder of the caryophyllid clade. For further information see notes under *Rhabdodendraceae*.

***Simmondsia*** Nutt. in *London J. Bot.* 3: 400. 1844 sec.

Köhler (2003). – Type: *Simmondsia californica* Nutt.

The only species, *Simmondsia chinensis* C. K. Schneid., is known as a dominant shrub in its native distribution area. The species is well appreciated for the liquid wax, extracted from the seeds, which is used mainly in the cosmetic industry (jojoba; Vázquez Yanes & al. 1999).

***Stegnospermataceae*** Nakai sec. APG (2009).

A monogeneric family with three species occurring from northwestern Mexico to Nicaragua and the Antilles (Rohwer 1992). The family includes small trees and shrubs characterized by bisexual flowers with a two-whorled perianth, one whorl consisting of five free green sepals, and the other whorl of five white narrow-based petals adherent to the alternisepalous stamens at the base. The fruits are capsules and the seeds are arillate (Rohwer 1993). When the only genus, *Stegnosperma*, was described in 1844, it was placed in *Phytolaccaceae* and accepted by other authors (e.g. Heimerl 1934). Nakai (1942) elevated the genus to the family level. Recognition as a family was also supported by morphological, palynological and wood-anatomical characters (e.g. Nowicke 1969; Bell 1980; Carlquist 1999). For a detailed taxonomic history until the 1980s see Bell (1980). The early molecular phylogenetic studies of Downie & al. (1997) and Fay & al. (1997) showed the position of *Stegnosperma* as an independent lineage. However, both classifications, the recognition of *Stegnospermataceae* (e.g. Rohwer 1993; Takhtajan 1997) and *Stegnosperma* within *Phytolaccaceae* (e.g. Stevens 2001), continued to be used. Subsequent phylogenetic studies (e.g. Savolainen & al. 2000; Cuénoud & al. 2002; Schäferhoff & al. 2009; Qiu & al. 2010; Brockington 2009, 2011; Soltis & al. 2011) confirmed the findings of Downie & al. (1997) and Fay & al. (1997), resulting in the wide recognition of *Stegnospermataceae* as a separate family.

***Stegnosperma*** Benth., *Bot. Voy. Sulphur*: 17. 1844 sec.

Rohwer (1993b). – Type: *Stegnosperma halimifolium* Benth.

***Talinaceae*** Doweld sec. Nyffeler & Egli (2010a).

A family with three genera and around 28 species mainly distributed in Africa, but with a few taxa in the Americas and the tropics around the world (Nyffeler & Egli 2010a). The species of this family are traditionally considered as members of *Portulacaceae*; however, molecular phylogenetic studies have shown that the traditional *Portulacaceae* are not monophyletic (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001; Nyffeler 2007; Nyffeler & Egli 2010a; Ocampo & Columbus 2010). Nyffeler & Egli (2010a) proposed the segregation of the traditional *Portulacaceae* into four families (*Anacampserotaceae*, *Montiaceae*, *Portulacaceae* and *Talinaceae*) based on morphological and molecular data.

**Amphipetalum** Bacigalupo in *Candollea* 43: 409. 1988 sec. Nyffeler & Egli (2010a). – Type: *Amphipetalum paraguayense* Bacigalupo

**Talinella** Baill. in *Bull. Mens. Soc. Linn. Paris* 1(69): 569. 1886 sec. Applequist (2005). – Type: *Talinella boiviniana* Baill.

= *Sabouraea* Leandri in *Adansonia sér.* 2, 2: 224. 1962. Unique in the suborder *Portulacineae* in having berry-like fruits. Molecular phylogenies show *Talinella* embedded in *Talinum* (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001; Nyffeler 2007; Nyffeler & Egli 2010a), but Nyffeler & Egli (2010a) suggested to accept the genus pending further research towards a deeply sampled phylogeny of *Talinum*. Recent treatments by Egli (1997) and Applequist (2005).

**Talinum** Adans., *Fam. Pl.* 2: 245, 609. 1763, nom. cons. sec. Nyffeler & Egli (2010a). – Type: *Talinum triangulare* (Jacq.) Willd.

Molecular and phylogenetic analyses have shown that the New World species with terete to semi-terete leaves formerly treated as members of *Talinum* form a monophyletic genus within *Montiaceae* (*Phemeranthus*; Carolin 1987; Hershkovitz & Zimmer 2000; Applequist & Wallace 2000; Nyffeler & Egli 2010a; Ocampo & Columbus 2010).

### **Tamaricaceae** Link sec. APG (2009).

Five genera and c. 80 species occurring in Africa, Asia and Europe with major distribution in the Irano-Turanian and Mediterranean regions (Gaskin 2003). Phylogenetic studies support the monophyly of the genera. Three well-supported clades have been recovered: *Hololachna* and *Reaumuria*; *Myricaria* and *Myrtama*; and *Tamarix*. *Tamarix* is sister to the clade comprising *Myricaria* and *Myrtama*, and this group is sister to *Hololachna* and *Reaumuria* (Gaskin & al. 2004). The main feature in most genera of *Tamaricaceae* is the presence of salt glands, which enable successful growth in salty and riparian habitats.

**Hololachna** Ehrenb. in *Linnaea* 2: 273. 1827 sec. Gaskin (2003). – Type: *Hololachna songarica* (Pall.) Ehrenb.

This is a monotypic genus restricted to central Asia and Mongolia. *Hololachna* is sister to *Reaumuria* (Gaskin & al. 2004).

**Myricaria** Desv. in *Ann. Sci. Nat. (Paris)* 4: 349. 1825 sec. Gaskin (2003). – Type: *Myricaria germanica* (L.) Desv.

*Myricaria* is a hygrophytic genus with c. 13 species occurring in Europe and central Asia. Molecular phylogenetic studies support a sister group relationship between *Myrtama* and *Myricaria* (Wang & al. 2009).

**Myrtama** Ovcz. & Kinzik. in *Dokl. Akad. Nauk Tadzh. SSR* 20(7): 55. 1977 sec. Gaskin (2003) ≡ *Tamaricaria* Qaiser & Ali in *Blumea* 24: 153. 1978. – Type: *Myrtama elegans* (Royle) Ovcz. & Kinzik.

The monotypic genus *Myrtama* is variously interpreted in taxonomic references, both as an independent

genus or as a synonym of *Myricaria* (Yang & Gaskin 2007) or *Tamarix* (Baum 1978).

**Reaumuria** L., *Syst. Nat.* (ed. 10) 2: 1081. 1759 sec. Gaskin (2003). – Type: *Reaumuria vermiculata* L.

*Reaumuria* is a xerohalophytic genus with c. 13 shrubby and rarely annual species occurring in deserts and semi-deserts of southwestern and central Asia (Bobrov 1966; Zohary & Danin 1970). Except for one polymorphic species group (*R. alternifolia* (Labill.) Britten), *Reaumuria* species are characterized by cylindrical succulent leaves.

**Tamarix** L., *Sp. Pl.* 1: 270. 1753 sec. Gaskin (2003). – Type: *Tamarix gallica* L. – Fig. 7B.

*Tamarix* with c. 60 species is most diversified in saline and wet habitats of the Old World and is naturalized in Australia and the Americas, sometimes as aggressive invasive plants. It is one of the few lineages in *Caryophyllales* that contain large trees and shrubs with a significant role in carbon sequestration and vegetation under harsh and salty conditions. The taxonomy and phylogenetic reconstruction of *Tamarix* are challenging due to the absence of reliable constant characters and the occurrence of hybridization even among morphologically very different species (Gaskin & Kazmer 2009; Mayonde & al. 2015; Samadi & al. 2013; H. Akhiani & T. Borsch, unpubl. data).

### **Incertae sedis**

**Jorena** Adans. in *Fam. Pl.* (Adanson) 2: 249. 1763 sec. Bittrich (1993c). – Type: not designated.

Listed as a “doubtful genus” in the *Caryophyllaceae* by Bittrich (1993c).

## **Summary: current knowledge, trends, gaps**

### **Phylogenetic sampling as a basis for classification**

The synopsis of the genera currently accepted in *Caryophyllales* along with a discussion on the recent work dealing with these genera provides a comprehensive source of information on the current knowledge of this group of plants. In the context of global undertakings, such as the World Flora Online (WFO; CBD-SBSTTA 2012), this study forms the basis for a gap analysis on the availability of treatments for a major group of flowering plants. The results indicate that there is a substantial taxonomic turnover when comparing the current classification with generic concepts available in the complete treatment of the order in Kubitzki’s “Families and genera of vascular plants” (FGVP; Kubitzki & al. 1993; Kubitzki & Bayer 2003; Table 2). The number of families has increased substantially (27 vs 39 families), reflecting changes necessary because families were not monophyletic (e.g. *Portulacaceae*). In addition, several isolated lineages have been recovered that were consequently elevated to family rank (e.g. *Kewaceae*, *Macarthuraceae*). The most diverse families in terms of numbers of genera are



the *Cactaceae*, *Aizoaceae*, *Chenopodiaceae* and *Caryophyllaceae* (all with over 100 genera), while 28 families comprise only one to six genera (Table 2). At the generic level, the numbers have increased by more than ten percent in comparison to the last complete treatments in the FGVP volumes (Table 2). While the number of genera has remained equal (or nearly so) in 18 families, generic boundaries have changed dramatically in some families, especially in *Cactaceae* and *Caryophyllaceae*.

It is also clear that sampling at the species level is far from complete, so that many genera or entire tribes lack data needed to assert their monophyly and/or their exact position in the families, while others are already known to be polyphyletic but are insufficiently sampled to be reclassified. In addition, for many taxa no taxonomic revision is available or the existing one is clearly outdated.

For example, in the *Aizoaceae* of South Africa, 55 % of taxa are in need of revision, 52 % of the recognized taxa in the family have not been treated in any revision, with an additional 12 % of taxa revised prior to 1970 (von Staden & al. 2013). In the *Ruschioideae* the five largest genera, *Ruschia* (206 species), *Lampranthus* (194 species), *Delosperma* (142 species), *Drosanthemum* (107 species) and *Antimima* (96 species) have never been comprehensively revised at species level (i.e. there is no key to the species). The same is true for numerous smaller genera such as *Stomatium* (39 species), *Hereroa* (27 species) and *Malephora* (16 species). In addition, a recent extensive phylogenetic study of *Ruschieae*, the most speciose clade in *Aizoaceae*, showed that numerous genera are not monophyletic, including the large genus *Ruschia* (Klak & al. 2013). Despite the lack of resolution in parts of the tree due to the lack of variable gene regions, the many cases of polyphyly detected in the phylogeny were an indication of misplaced taxa and narrow generic concepts upheld by traditional taxonomists (Klak & al. 2013). In particular, mono- and bitypic genera in *Ruschieae*, which were found to be nested within larger genera, need critical re-evaluation (Klak & al. 2013). In contrast, for the *Mesembryanthemoideae* a phylogeny is available with an almost complete sampling of species (Klak & al. 2007) as well as detailed morphological studies and revisions published for most clades over the last 30 years (e.g. Bittrich 1986; Klak & Linder 1998; Klak & al. 2006; Gerbaulet 1995, 1996a–c, 1997, 2001). However, a conflict in genus delimitation has erupted between taxonomists with regard to the number of genera that should be recognized in *Mesembryanthemoideae*. Whereas Klak & Bruyns (2013) favoured a generic concept based on monophyly, Gerbaulet (2012) supported the traditional system of “many genera”, which upholds also genera shown to be paraphyletic (e.g. *Phyllobolus*). No detailed phylogeny is available for the *Aizooideae*, which include c. 108 species in seven genera. Finally, a further phylogeny including 18 species from *Tetragonioideae* indicated that several genera, such as *Aizoanthemum*, *Aizoon* and *Gunniop-*

*sis* may not be monophyletic (C. Klak, pers. comm.). In contrast, phylogenetic relationships of the smallest subfamily, *Sesuvioideae*, which is sister to the remaining *Aizoaceae* (Klak & al. 2003a, b), are resolved and generic concepts were clarified recently (Thulin & al. 2012; Bohley & al. 2015).

For *Basellaceae*, Eriksson (2007) recognized four genera and 19 species in comparison to four genera and 17–22 species accepted by Sperling & Bittrich (1993). In his phylogenetic analysis based on morphological data, three of the genera are supported as monophyletic, while the monophyly of the fourth genus (*Basella*) is more uncertain. This analysis is well sampled (all taxa), but the resolution is rather poor. No analysis based on molecular data has been done yet.

### Available treatments in modern floras are patchy on a global level

Monographic work provides the in-depth synthetic information, and the checklist and gap analysis presented here is aimed at defining part of the baseline for such analysis in the *Caryophyllales* where it is still missing. However, for the aim of creating a global synthesis of knowledge in the *Caryophyllales* it is indispensable to consider also the information published in floras.

It is difficult to know in how many floras or related works the *Caryophyllales* have been treated in the past, especially in regions with a long history of botanical activity such as C and W Europe. In fact, if we take the establishment of the Linnaean classification system and naming as a starting point, we can commence right away in the 18<sup>th</sup> century, for example with Linnaeus’s own *Flora suecica* (Linné 1745). Flora treatments are numerous; setting aside the numerous works of mostly historical interest, Frodin (2001) in the second edition of “Guide to standard floras of the world” gave information on nearly 1000 general floras distributed in ten major regions of the world. Only in a few cases is there specific information about the families or groups treated in each flora (e.g. *Flora of Nigeria: Caryophyllales* by Ghazanfar 1991); for the other floras it is necessary to review each flora individually in order to identify works of significance for a global synthesis.

Our approach for uniting the information available for the global synthesis is partly based on taking advantage of information technologies, and fortunately floras are increasingly published on the World Wide Web. An initial review of such publication has revealed that many historical floras that include treatments of *Caryophyllales* are already available online, for example the pre-1900 floras of the Alps, Australia, Barbados, Brazil, India, Jamaica, Niger, Sri Lanka and Syria, and pre-1990 treatments from Chile, Costa Rica, Fiji, Guatemala, Japan, Madagascar, Panama, South Africa and Taiwan. The bibliographic references of these floras are cited in Frodin (2001), but can also be accessed through

the Biodiversity Heritage Library (BHL 2005+), JSTOR (JSTOR 2000+), Gallica (1997+) and Google Books (2015). More recent floras including the *Caryophyllales* are those from China, Nicaragua, the Malesian region (Indonesia, Malaysia, Singapore, Brunei Darussalam, the Philippines, and Papua New Guinea) and the Zambesi river basin (Botswana, Malawi, Mozambique, Zambia, Zimbabwe and the Caprivi Strip), in which the last treatments for some families of *Caryophyllales* were printed in the 2000s. Incomplete floras (and incomplete for *Caryophyllales* so far) treat Argentina, the Hawaiian Islands, North America north of Mexico, the Marquesas Islands, Mesoamerica, Madagascar, the Neotropics, Pakistan, Palestine and Tasmania.

Most of these are simply digitized print treatments (representing images of the actual print work, which, depending on their quality, may or may not be searchable after optical character recognition – OCR). In contrast to this, very few “true” e-floras exist, i.e. floras produced with the online publication as their principal output and making full use of existing biodiversity informatics techniques. An example of the latter is the Flora of Western Australia (Western Australian Herbarium 1998+).

However, increasingly various intermediates between electronic representations of print media and true e-floras are becoming available, partly as a result of the computerized editing process of the print publication, and partly because printed floras are “marked up” in order to database their content, for example the treatments of Flora Malesiana (see Hamann & al. 2014).

Another important source of information on *Caryophyllales* are checklists, which are mostly available online, because most of them were developed over the past two decades. Some of them refer to taxa treated in previously printed floras, some of them are continuously updated and others are in progress. Such checklists are available for Africa, Argentina, Australia, Bolivia, Botswana, Brazil, central Africa, Cono Sur (Argentina, southern Brazil, Chile, Paraguay and Uruguay), Costa Rica, Croatia, Cyprus, Ecuador, Europe plus the Mediterranean region, Germany, the Guiana Shield (Guyana, Suriname, French Guiana and part of Venezuela), Iran, Ireland, Israel, Lesotho, Madagascar, Mexico, Micronesia, Mongolia, Myanmar, Namibia, Nepal, New Zealand, the pan-Arctic region, Paraguay, Peru, Portugal, the Philippines, Singapore, South Africa, southern Africa, Suriname, Swaziland, Switzerland, Taiwan and the United States.

All of these floristic projects have generated valuable information that has increased our knowledge about the *Caryophyllales*. An online bibliography of such sources of information focussing on *Caryophyllales* is in preparation, and we envision using this as the base of a comprehensive gap analysis for the order, and also as the basis for an analysis of regional differences in taxon concepts. It became clear from the preliminary survey that such gaps exist, and that there is a lack of synchronization of taxon concepts, partly due to the state of knowledge

at the time of the production of the treatment, but often also caused by a specific local perspective that needs to be placed into a wider geographic context. This was one of the reasons for the decision to use the EDIT Platform for Cybertaxonomy for data management, because this is currently the only taxonomic software system natively supporting different classifications, taxonomic concepts and taxon-concept relationships. It indicates also the need for increased efforts to share and integrate the information generated and to promote the filling of gaps in both geographic and taxonomic coverage. This will be facilitated by the application of information technology, making the information openly available in electronic form and thus furthering the process of future revision and dissemination. Additionally, it enables new kinds of links to current data, including those available only in virtual form, which has not readily been possible in the past (Frodin 2001).

## Conclusions and future work

While the published version of this treatment only includes citable publications as its basic reference, there will be a dynamic online version of this generic synopsis that will not only be continuously updated but also become more extensive. To facilitate both interaction in the scientific community and to inspire further research on the *Caryophyllales*, key data to relevant current projects and research underway will be presented. One of the key steps on the way to a synthesis of *Caryophyllales* will be identifying specialists who are working at the species level; some of them are those who contributed to this generic synopsis, but others have already been identified and agreed to collaborate. Within the network, we then have to organize the work on taxonomic groups with several specialists and to develop a format, as standardized as possible, for the species-level taxonomic treatments. In addition, directories of specialists, of electronic resources and an online bibliography for the *Caryophyllales* will be developed. Starting with the *Caryophyllales 2015* conference in Berlin (September 2015), regular meetings of the *Caryophyllales* community will drive this process.

## Role of authors

The draft of the generic checklist and the initial data entry was the work of PH, who also provided the treatments of *Achatocarpaceae*, *Agdestidaceae*, *Ancistrocladeaceae*, *Asteropeiaceae*, *Barbeuiaceae*, *Didiereaceae*, *Dioncophyllaceae*, *Droseraceae*, *Drosophyllaceae*, *Frankeniaceae*, *Halophytaceae*, *Limeaceae*, *Lophiocarpaceae*, *Microteaceae*, *Nepenthaceae*, *Nyctaginaceae*, *Physenaceae*, *Rhabdodendraceae*, *Sarcobataceae*, *Simmondsiaceae* and *StegnospERMataceae* and collaborated in some notes of *Chenopodiaceae*, *Phytolaccaceae* and

*Polygonaceae*. The following groups were revised by specific authors: *Aizoaceae*: CK, with contributions by GK (*Sesuvioideae*); *Amaranthaceae*: TB, with contributions by GK (*Polycnemoideae*); *Anacampserotaceae*, *Molluginaceae* and *Portulacaceae*: GO; *Montiaceae* and *Talinaceae*: GO, with contributions by UE; *Cactaceae*: SA, UE, NK, RN, BOS; *Caryophyllaceae*: RR, BO (*Sileneae*), with contributions by SvM; *Basellaceae*: RE; *Chenopodiaceae*: HA, HFO, SFB, GK, PU; *Gisekiaceae*: GK; *Plumbaginaceae*, *Kewaceae*, *Macarthuraceae* and contributions to other families (e.g. *Deeringia*, *Hyperteilis*, *Microtea*): SvM; *Polygonaceae*: ICN, AS; *Tamariaceae*: HA. WGB extensively rechecked the nomenclatural references and standardization of database entries. SvM edited entries and updated the database. Introduction and summary were prepared as a draft by PH, TB and WGB. Comments from co-authors were incorporated, and the final text edited by WGB, SvM, NK and TB.

## Acknowledgements

We would like to acknowledge the technical support by Katja Luther, Andreas Müller and Cherian Mathew at the BGBM during work with the EDIT Platform software and the production of the generic list directly from the database. There was a productive exchange with James Solomon (Missouri Botanical Garden) while checking our nomenclatural data against the Tropicos database. Werner Greuter, Nicholas Turland, and Wolf-Henning Kusber are acknowledged for advice on complicated cases of nomenclature. Demet Töre provided literature on *Plumbaginaceae*.

Wilhelm Barthlott, Peter Bruyns and Nicholas Turland are thanked for granting permission to use their photographs. David Hunt, John McNeill, Sergei Mosyakin, Kai Müller, Louis Ronse de Craene, Nigel Taylor and one anonymous reviewer are thanked for their valuable comments on an earlier version of the manuscript.

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