Virtual symposium

Phylogenetics and taxonomy of Caryophyllaceae

Current understanding of relationships and work towards an online species-level checklist

08 – 10 February 2022

Programme and abstracts

Virtual symposium

Phylogenetics and taxonomy of Caryophyllaceae

Current understanding of relationships and work towards an online species-level checklist

This symposium is intended to bring together researchers working on systematics, phylogenetics and taxonomy of Caryophyllaceae and has three major aims: 1) To present ongoing research, 2) to encourage collaboration and to promote community-building, and 3) to start working towards a comprehensive species-level taxonomic backbone of the Caryophyllaceae.
Topics of presentations focus on: Genus-level or species-level phylogenetic studies, biogeography, morphology and character evolution, floristics and species inventories, regional flora treatments or regional checklists, revisions, and monographs of specific taxa. Student presentations are very welcome.
The symposium consists of sessions of presentations and one discussion session focusing on the approach towards assembling an online species-level taxonomic backbone for the Caryophyllaceae in the context of the Global Caryophyllales Initiative.

Local organizing committee - Botanic Garden Berlin

Nadja Korotkova

Walter Berendsohn

Markus Dillenberger

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Richard K. Rabeler – *University of Michigan, Ann Arbor, USA*

Iraj Mehregan – *Islamic Azad University, Tehran, Iran*

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Gianniantonio Domina – *University of Palermo, Italy*

Bengt Oxelman – *University of Gothenburg, Göteborg, Sweden*

Organization: Botanic Garden Berlin, web-hosting: Universita degli Studi di Palermo

Programme

The time slots are specified according to Central European Time.

Day 1. Tuesday, February 8. 2022

Session 1.

Chair: Gianniantonio Domina

15:00 – 15:20 Mostafa Assadi and Iraj Mehregan
An overview of the family Caryophyllaceae in Iran

15:20 – 15:40 Abbas Gholipour
A review on the genus *Silene* in Iran

15:40 – 16:00 Martin Timaná and Maria Alejandra Cuentas
Caryophyllaceae in the Third Pole: examining the biogeographic impact of climate change in the Himalayan region

16:00 – 16:20 Emanuele Del Guacchio, Daniele De Luca, Duilio Iamonico, Fabio Conti and Paolo Caputo
Molecular analyses reveal a new species of *Minuartiella* (Caryophyllaceae, Alsinoideae)

16:20 – 16:40 Break

Session 2.

Chair: Richard Rabeler

16:40 – 17:00 Markus Dillenberger, Dorian M. Alban, Elisabeth M. Biersma and Joachim W. Kadereit
Colonization of the Southern Hemisphere by *Sagina* and *Colobanthus*

17:00 – 17:20 Daniel Montesinos
Diversity, evolution, and biogeography of *Drymaria* and relatives (Caryophyllaceae) in the Andes

17:20 – 17:40 Andrea E. Berardi
Insights into floral evolution and revision of North American *Silene* section *Physolychnis*

17:40 – 18:00 Hilda Flores-Olvera
Contributions to the taxonomic knowledge of Caryophyllaceae in Mexico

18:00 – 18:10 Break

18:10 – 19:00 Discussion and socializing

Day 2. Wednesday, February 9. 2022

Session 3.

Chair: Iraj Mehregan

15:00 – 15:20 Arya Sindhu and Venugopalan Nair Saradhamma Anil Kumar
Taxonomic revision and floral variations in the genus *Polycarpaea* Lam. (Caryophyllaceae) from India

15:20 – 15:40 Anush Nersesyan
An updated overview of the *Gypsophila* L. s.l. (Caryophyllaceae) genus in the flora of Armenia

15:40 – 16:00 Masoumeh Safaeishakib, Mostafa Assadi, Iraj Mehregan and Shahina A. Ghazanfar
Phylogenetic study of *Silene* sections *Auriculatae*, *Spergulifoliae*, *Ampullatae*, and *Lasiocalycinae* in Iran

16:00 – 16:20 Melilia Mesbah, Llorenç Sáez, Javier López-Alvarado, Gianluigi Bacchetta, Ridha El Mokni, Lorenzo Peruzzi and Bengt Oxelman
Re-establishment of *Silene neglecta* Ten. (Caryophyllaceae) with taxonomic notes on some related taxa

16:20 – 16:40 Break

Session 4.

Chair: Duilio Iamonico

16:40 – 17:00 Bengt Oxelman, Patrik Cangren, Melilia Mesbah, Ntwae Moiloa and Anne-Sophie Quatela
Species delimitation - philosophy and practical considerations

17:00 – 17:20 Lorenzo Peruzzi
From nomenclature to population genomics: an ongoing integrated taxonomic study of the *Dianthus virgineus* group in the central Mediterranean area

17:20 – 17:40 Giulio Barone, Ridha El Mokni, Gianniantonio Domina
Towards a revision of *Dianthus* (Caryophyllaceae) in Tunisia

17:40 – 18:00 Ana Terlević, Sandro Bogdanović, Martina Temunović, Simone Fior, Hirzi Luqman Bin Jalaluddin, Alex Widmer, Božo Frajman and Ivana Rešetnik
Disentangling the diversification of the *Dianthus sylvestris* complex on the Balkan Peninsula using an integrative approach: taxonomic implications within a dynamic system

18:00 – 18:10 Break

18:10 – 19:00 Discussion and socializing

Day 3. Thursday, February 10. 2022

Session 5.

Chair: Markus Dillenberger

15:00 – 15:20 Gonzalo Nieto Feliner, Inés Álvarez, Mario Rincón and Mario Mairal
Phylogenomic study of *Arenaria* Sect. *Plinthine* (Caryophyllaceae)

15:20 – 15:40 Masoumeh Mahmoudi-Shamsabad
Biogeographic history and diversification patterns in the Irano-Turanian genus *Acanthophyllum* s.l. (Caryophyllaceae)

15:40 – 16:00 Georgia Fassou, Nadja Korotkova, Anush Nersesyan, Marcus A. Koch, Panayotis Dimopoulos and Thomas Borsch
Taxonomy of *Dianthus*: a phylogenetic approach combined with an up-to-date checklist

16:00 – 16:20 Richard K. Rabeler and Sabine von Mering
Caryophyllaceae since Hernández-Ledesma et al. (2015) – changes and challenges

16:20 – 16:40 Break

16:40 – 17:00 Walter Berendsohn, Nadja Korotkova and Andreas Müller
Assembling the global Synthesis of Caryophyllales using the EDIT Platform for Cybertaxonomy

17:00 – 19:00 Discussion: next steps towards compiling the Caryophyllaceae species-level checklist led by Nadja Korotkova & Walter Beredshon

Abstracts

Mostafa Assadi[1] and Iraj Mehregan[2]

An overview of the family Caryophyllaceae in Iran

[1] Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran, [2] Department of Biology, Science and Research Branch, Islamic Azad University, Tehran, Iran

Lack of a comprehensive and updated "Flora" with main focus on mere Iran, encouraged the senior author (MA) to propose and coordinate the publication of mega project "Flora of Iran" in Farsi, started late 1990s. After more than 30 years of continuous publication, the project is nearing its final stages with only few volumes remained unpublished. The account for Caryophyllaceae, also one of the larger families of flowering plants in Iran, is currently in preparation. Modern taxonomic tools besides the new intensive collections from different and usually hard-to-reach parts of the country have shed light on the current understanding of the family. The Iranian Caryophyllaceae in their current treatments contain ca. 350 spp. (370 including subspecies and varieties) classified in 27 genera, including the monotypic genus *Gypsophiloides* Mahdavi and Assadi. The seven larger genera of the Iranian Caryophyllaceae are *Silene* (115 spp.), *Gypsophila* (38 spp.), *Dianthus* (34 spp.), *Cerastium* (27 spp.), *Acanthophylum* (24 spp.), *Minuartia* (23 spp.), and *Arenaria* (22 spp.), respectively. With about 130 endemic species, 40 of them from the genus *Silene*, Iran is a center of species diversity for Caryophyllaceae.

Giulio Barone[1], Ridha El Mokni[2], Gianniantonio Domina[1]

Towards a revision of *Dianthus* (Caryophyllaceae) in Tunisia

[1]University of Palermo, Palermo, Italy. [2]University of Monastir, Monastir, Tunisia.

Currently for Tunisia seven specific and subspecific taxa of *Dianthus* (Caryophyllales, Caryophyllaceae) are accepted. These taxa are included within the groups of *Dianthus* crinitus Sm., *D. rupicola* Biv. and *D. virgineus* L. Much of the knowledge for the Tunisian territory dates back to the 19th century and the dissimilar treatments are due to different taxonomic interpretations. In fact, 21 specific and infraspecific taxa have been reported for Tunisia; most of the names proposed are considered as synonyms even if in many cases where the nomenclatural types are not known or well defined. More recently, we have started a taxonomic study on *Dianthus* in Tunisia based on the analysis of protologues, of historical exsiccata preserved in the main European herbaria (P, MPU, K, W, etc.) together with a new fieldwork performed in various phytogeographic areas of the Tunisian territory. This study also makes use of the parallel research conducted in Europe. In the next years this research will be completed and integrated, considering also the taxa described from the rest of North Africa, to present an updated account for this group.

Keywords: Nomenclature, Taxonomy, plant morphology, herbaria.

Acknowledgements

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Andrea E. Berardi

Harvard University, Boston, MA, USA

Insights into floral evolution and revision of North American *Silene* section *Physolychnis*

Determining how and why reproductive traits evolve between and within species is key to understanding patterns of speciation. In plants, floral traits such as color are major drivers of diversification. Flower color is a key reproductive trait in the North American species of *Silene* (Caryophyllaceae). Only eight species of *Silene* produce truly red flowers, comprising ~1% of the entire genus. In this genus there appears to be an intriguing interaction between ploidy and flower color evolution, all red-flowering species are polyploids. First, I revise the phylogeny of the North American *Silene* species of section *Physolychnis* using a target sequence capture approach. I then combine phylogenomics, gene sequencing, biochemistry, and trait mapping to answer the following main questions: What is the most likely driver of floral color evolution in *Silene* - pollinator shifts, sympatric competition, abiotic factors, or polyploidy? Are red flowers transgressive phenotypes? Do all red species use the same pigments to create red? And last, do the existing red species represent independent origins?

Walter Berendsohn, Nadja Korotkova and Andreas Müller

Botanic Garden and botanical Museum Berlin, Germany

Assembling the global Synthesis of Caryophyllales using the EDIT Platform for Cybertaxonomy

The Caryophyllales Network plays an important role as one of several Taxonomic Expert Networks (TENs) in the World Flora Online initiative. The TENs have the role of providing a taxonomic backbone classification, including the treatment of all effectively published names (explicitly excluding those that have to be excluded for nomenclatural or taxonomic reasons). A brief overview of the current state of the Caryophyllales database will be given.
Different approaches towards assembling the taxonomic backbone for families in the Caryophyllales have been taken, including direct use of monographic treatments, importing and revising the names in the initial WFO-Backbone (largely based on The Plant List 1.1), or (partially) importing names and the classification from existing databases such as the World Checklist of Vascular Plant Families. Beyond the names and taxonomic backbone, Nepenthaceae were used to illustrate the possibility to aggregate descriptive and other data based on a revised taxonomic backbone.
The presentation will focus on editorial, curatorial and technical lessons learned in the process. It will also address the potential of an expert-driven taxonomic synthesis in regional and applied contexts of taxonomic information.

Emanuele Del Guacchio[1], Daniele De Luca, Duilio Iamonico, Fabio Conti and Paolo Caputo

[1]*University of Naples "Federico II", Naples, Italy*

Molecular analyses reveal a new species of *Minuartiella* (Caryophyllaceae, Alsinoideae)

The montane-Mediterranean small genus *Mcneillia* Dillenb. & Kadereit (Caryophyllaceae) has been recently segregated from *Minuartia* Loefl. basing on molecular data. It would include five species, among which the most widespread and variable is *M. graminifolia* (Ard.) Dillenb. & Kadereit (Conti 2003), with 5 subspecies: subsp. *graminifolia* (eastern Alps), subsp. *clandestina* (Port.) Dillenb. & Kadereit (Balkans and Apennines), subsp. *rosanoi* (Ten.) F.Conti, Bartolucci, Iamonico & Del Guacchio (Apennines and Sicily), subsp. *hungarica* (Jáv.) F.Conti & Bartolucci (Romania), and subsp. *brachypetala* (Kamari) Dillenb. & Kadereit (Mt. Boutsi in northern Greece). During a study on the whole genus, we found that this latter subspecies, based on both nuclear and chloroplast DNA evidence, is better placed into the genus *Minuartiella* Dillenb. & Kadereit. It is to be noted that this latter genus is currently known only for 6 taxa (5 species and a hybrid) occurring in Iran, Transcaucasus, and Asian Turkey.

Mcneillia graminifolia subsp. *brachypetala* resulted as sister group to all the species of *Minuartiella* investigated until now. This finding somehow concurs with morphology, because *Minuartiella* is mainly distinct from *Mcneillia* on account of its petals shorter than sepals, which is indeed a diagnostic feature of *Mcneillia graminifolia* subsp. *brachypetala*.

[1] Markus Dillenberger[1,2], Dorian M. Alban[2], Elisabeth M. Biersma[3] and Joachim W. Kadereit[2]

[1] Freie Universität Berlin, Germany, [2] Johannes Gutenberg-Universität Mainz, Germany, [3] University of Copenhagen, Denmark

Colonization of the Southern Hemisphere by *Sagina* and *Colobanthus*

Sagina L. and *Colobanthus* Bartl. are sister genera in tribe Sagineae (Caryophyllaceae). The two genera share a similar morphology and ecology but show very distinct distribution ranges. The centre of diversity of *Sagina* is clearly in the Northern Hemisphere (i.e. Europe), and *Colobanthus* is a southern temperate genus found in South America, New Zealand and Australia as well as on several smaller islands. Apart from the northern temperate taxa, *Sagina* can also be found in high mountains in South America, Africa, SE Asia and Australia. In our study we provide the first comprehensive molecular phylogeny of the two genera, and use these phylogenies for biogeographic reconstructions of colonization routes of the Southern Hemisphere.
Our analyses confirm both genera to be monophyletic. Molecular dating revealed a much younger crown age for *Colobanthus* than for *Sagina*, explaining the better resolved phylogenetic backbone of *Sagina*. While biogeographic reconstructions based on cpDNA and ITS contradict each other regarding the entry of *Colobanthus* in the Southern Hemisphere (cpDNA: South America; ITS: New Zealand), they show similar results for *Sagina*. In *Sagina*, most Southern Hemisphere species form a single clade (including species from several continents) and colonization happened from Eurasia to Africa or Australasia. Furthermore, North America was colonized more than once including one colonization event from South America.

Georgia Fassou[1], Nadja Korotkova[2], Anush Nersesyan[3], Marcus A. Koch[4], Panayotis Dimopoulos[1] and Thomas Borsch[2]

University of Patras, Greece, [2]Botanischer Garten und botanisches Museum Berlin,[3]A. Takhtayian Institute of Botany, Yerevan, Armenia, [4]Univeristy of Heidelberg, Germany

Taxonomy of *Dianthus*: a phylogenetic approach combined with an up-to-date checklist

Caryophyllaceae is a large family consists of 70 to 86 genera. Amongst them, the genus *Dianthus* is the second largest with approximately 300 species. Using a combination of four plastid regions (*matK-trnK-psbA*, *rpl32-trnL*, *trnQ-rps16*, *psbA-trnH*) and nuclear ITS, we investigated the phylogenetic relationship within the genus, and we present an overall phylogenetic frame. We confirmed that *Velezia* could not be treated as a separate genus along with few taxa of *Petrorhagia*, that were found nested within *Dianthus*. Moreover, a species-level checklist for the genus was compiled from literature. The checklist covers 1653 names, with 367 accepted species, 147 accepted heterotypic subspecies, 12 heterotypic varieties and two forms (not counting autonyms) and 979 synonyms. There are 49 hybrid names and 172 unresolved names.

Gonzalo Nieto Feliner, Inés Álvarez, Mario Rincón and Mario Mairal

Real Jardin Botánico, CSIC, Madrid, Spain

Phylogenomic study of *Arenaria* Sect. *Plinthine* (Caryophyllaceae)

Arenaria sect. *Plinthine* (Caryophyllaceae) is an easily distinguishable monophyletic group in which 14 species, in addition to 5 additional subspecies, are currently recognized. It is distributed in SW Europe, but its diversity is mostly concentrated in the Iberian Peninsula since only three of the 19 taxa occur outside this region, two of which also occur in Iberia. Morphologically, representatives of this section share sessile flowers, densely surrounded by bracts, and small decussate subcoriaceaous leaves with thickened margins. Detailed taxonomic studies of the section are available. Yet, circumscription and relationships of some species are not fully settled. Numerous chromosome number records available support the occurrence of a polyploidy series in *A. tetraquetra* and possibly other polyploidization events elsewhere. But chromosome number variation, even within a single population, suggests the existence of aneuploidy as well. Several phylogenetic analyses have included representatives of this section, particularly our own study based on Sanger sequencing of plastid and nuclear ribosomal DNA from c. 70 samples. However, both resolution and monophyly of samples from the same species obtained in this analysis were rather unsatisfactory. Thus, we have started a phylogenomic study using a target enrichment approach (HybSeq) with the Angiosperm353 bait kit. The aims are to reconstruct the evolutionary history of the group, including the most determinant processes responsible for its diversity, and to refine its taxonomy.

Hilda Flores-Olvera

Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico City, Mexico

Contributions to the taxonomic knowledge of Caryophyllaceae in Mexico

Despite Mexico being the country with the third flowering plant diversity in the world, a floristic treatment for the territory is still lacking. Caryophyllaceae is not the exception and so, our current knowledge can only be taken as provisional. A revision based on regional floristic treatments and checklists showed that the family has in Mexico 25 genera with at least 137 species. Most genera are monotypic, including *Achyronychia*, *Calycotropis*, *Cerdia*, *Polycarpon*, *Triplateia* and *Pseudostellaria*, but there are also diverse genera with only one species occurring in Mexico, such as *Gypsophila*, *Lychnis*, and *Minuartia*. The richest genera are *Arenaria*, *Cerastium*, *Drymaria*, *Paronychia*, *Sagina*, *Silene*, *Spergularia* and *Stellaria*, with more than three species, being the first three the most specious in Mexico. Since Oaxaca is the State with the highest diversity in general for Mexico, we conducted a floristic treatment for Caryophyllaceae in that area. We found 12 genera and 30 species; this diversity is comparable to that in the Chihuahuan Dessert, where 11 genera and 42 species are recorded in a much larger area. In most given areas of Mexico, *Drymaria* is the richest genus having in total 40 species out of the 50 recognized for the genus, 23 of them are endemic to the country and 17 are distributed along the Mexican portion of the Chihuahuan Desert. *Drymaria* is therefore a priority in our research. To begin understanding the diversity of the genus, we are conducting a systematic study of the lyropetala series, comprising four species: *D. elata*, *D. lyropetala*, *D. subumbellata* and *D. suffruticosa*, all endemic to the Chihuahuan Desert mainly on gypsum soils. The species boundaries within this series are debatable mainly within the *D. lyropetala* complex that includes up to three varieties. Molecular sequences using ITS, *matK*, *trnL-trnF*, *ndhF-rpl32* are in progress in contrast to detail morphological assessment of the populations. Preliminary results show conflict between molecular and morphological data and reveal molecular groups related to geography.

Abbas Gholipour

Payame Noor University, Sari, Iran

A review on the genus *Silene* in Iran

Out of about 850 species of the genus *Silene* (Caryophyllaceae) in the world, 121 (14.5 %) species including 42 endemic plants grow in Iran. This important genus is a problematic taxon in Iran. In this paper, the studies of the last three decades in this genus were reviewed in Iran. During these studies, 8 new species; *S. ferdowsii*, *S. mishudaghensis*, *S. ghahremaninejadii*, *S. oxelmanii*, *S. orientoalbursensis*, *S. circumcarmanica*, *S. lulakabadensis* and *S. aminiradii* were described, 3 sections (*Scorpioideae*, *Caespitosae* and *Cucubalus*), 13 *Silene* species and *S. odontopetala* subsp. *congesta* were recorded for the first time from Iran. Examination of the type specimens of these species showed that some taxa were misnamed. About 4 species has been determined as synonymous of other species. Anatomical, chromosomal, Seed and pollen micromorphology and molecular systematics studies were reviewed. Chromosome number of about 73 species were reported. Anatomical features of about 56 species were studied and leaf and stem epidermis characteristics of 80 Iranian *Silene* species were described. Seed and pollen micromorphology of 75 and 80 species respectively were studied and described by using scanning electron microscope. According to the studies, about 40% of the species of this genus have not been studied in Iran, ecological and phytogeographical studies of the Iranian *Silene* species are needed.

Masoumeh Mahmoudi-Shamsabad

Tarbiat modares university, Kerman, Iran

Biogeographic history and diversification patterns in the Irano-Turanian genus *Acanthophyllum* s.l. (Caryophyllaceae)

Acanthophyllum C.A.Mey., with ca. 70 subshrubby species, is a mainly Irano-Turanian genus that inhabits areas between Syria and Western China. *Acanthophyllum* species are important components of the steppe and mountain vegetation in Central and South West Asia. *Acanthophyllum squarrosum* and two closely related species, *A. heratense* and *A. laxiusculum* (Caryophyllaceae), form a complex that is endemic in Irano-Turanian (IT) region. In this study, we investigated phylogeny, phylogeography and genetic structure of this complex based on partial sequences of two chloroplast [*psbA–trnH* and *rpl32–trnL* (UAG)] and two nuclear (EST24 and ITS) DNA regions. We analysed 80 individuals in eight populations and detected twelve chloroplast haplotypes, sixteen nuclear alleles in EST24 and eight alleles in ITS sequences. Phylogeny trees and haplotype networks did not show distinct genetic groups in the complex and this could be explained by recent and incomplete lineage sorting or introgression between species. Divergence time analysis revealed a Quaternary origin for *A. squarrosum* complex at approximately 1.8 MYA and the neutrality test results indicated that this complex experienced a recent population expansion. AMOVA analysis on the chloroplast regions showed a significant genetic differentiation among and low genetic differentiation within populations, but opposite results were found with nuclear markers, implying introgression between *A. squarrosum* complex populations. In addition, we used Maximum entropy modeling to predict the climate change effects on the distribution range of *A. squarrosum* complex. We used data from four different models: CCSM, CCCMA, MIROC-ESM and CSIRO, with RCP2.6 and RCP8.5 scenarios in modern time, 2030, 2070 and 2080. Our results showed that *A. squarrosum* has a suitable habitat in ca. 1 million km² of the IT region (33% of our study area) and will likely experience a northward shift, gaining new habitat in Azerbaijan, Armenia and North of Afghanistan in the near decades. Under both RCP2.6 and RCP8.5 scenarios, Maxent model predicts *A. squarrosum* complex populations from southern Iran (Sistan and Baluchistan, south of Khorasan, Kerman and Yazd province) to be under treat of extinction, especially at lower altitudes regions and this prediction may concern other subalpine species occurring in the same region. This information can be useful for conservation practice and biodiversity management programs in the Irano-Turanian region. Among the climatic variables investigated, annual mean temperature,

precipitation of the warmest and coldest quarters were those that mostly affected *A. squarrosum* complex distribution.
In this study, we investigated the tempo and mode of the diversification and biogeographic patterns of *Acanthophyllum*. The ancestral area analysis suggests that *Acanthophyllum* originated in East of Zagrous Mountain area in ca. 11 MYA in the Miocene and migrated to West of Zagrous mountain area in 6- 8 MYA. We discovered a shift in the rate of speciation in the Oligosperma section clade in ca. 3 MYA in the late Pliocene. The uplift of the mountains and Qinghai-Tibetan Plateau caused a dramatic climatic and ecological shift facilitating *Acanthophyllum* speciation in this era.

Melilia Mesbah[1], Llorenç Sáez, Javier López-Alvarado, Gianluigi Bacchetta, Ridha El Mokni, Lorenzo Peruzzi and Bengt Oxelman

[1] *University of Bejaia, Algeria*

Re-establishment of *Silene neglecta* Ten. (Caryophyllaceae) with taxonomic notes on some related taxa

Silene section *Silene* (Caryophyllaceae) is one of the largest sections mainly distributed in the Mediterranean. The phylogenetic study related to this section has shown some taxonomic ambiguities namely the application of the names *Silene nocturna* L., *S. neglecta* Ten., and *S. mutabilis* L. Several morphological characters (petal shape, calyx indumentum, hairiness of stamen filaments, seed size, seed-coat surface and shape) are used to confirm the misunderstood and confusion of *Silene neglecta* with *S. nocturna*. Moreover, *S. mutabilis* (which has been considered a priority name over *S. neglecta*) and *S. martinolii* (an alleged endemic species to south-western Sardinia) are considered here as taxonomic synonyms of *S. nocturna* and *S. neglecta*, respectively.
Keywords: *Silene neglecta*, Mediterranean Basin; morphometrics; nomenclature; taxonomy

Daniel Montesinos

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Diversity, evolution and biogeography of *Drymaria* and relatives (Caryophyllaceae) in the Andes

The Andean region in South America stands out by high species diversity and constitutes one of the global biodiversity hotspots. Yet there are still huge gaps in the knowledge of biodiversity, in particular in Peru. The proposed project will employ modern methods to analyse an Andean flowering plant group (genus *Drymaria* and relatives in tribe Polycarpeae, Caryophyllaceae) in an exemplar study. Overall goals are to illuminate evolutionary relationships and to understand how these plants evolved through time and space, giving particular attention to the upheaval of the Andes and to generate a reliable taxonomic treatment that recognizes evolutionarily well-circumscribed entities. Knowledge about which species exist and how they are distributed is central to conservation and sustainable use of biodiversity. The study includes methods of phylogeny and evolutionary biology as well as electronic tools to analyse and manage structured character data linked to plant specimens is therefore important for species discovery and description.

Anush Nersesyan

A. Takhtajyan Institute of Botany of the Armenian National Academy of Sciences, Yerevan, Armenia

An updated overview of the *Gypsophila* L. s.l. (Caryophyllaceae) genus in the flora of Armenia

Gypsophila L. *s.l.* is one of the most taxonomically difficult genera in the family of *Caryophyllaceae*. A series of studies have revealed that this group is polyphyletic (Hernández-Ledesma & al. 2015, Willdenowia 45: 281, etc.).

Twelve of the 26 species of *Gypsophila* recorded for the flora of the Caucasus grow in Armenia. Our investigations based on the field data and herbarium research (ERE, G, G-BOIS, K, LE, TBI, TGM, W, WU) revealed that *G. virgata* should be excluded from the list of the flora of Armenia. Actually, all herbarium specimens from Armenia earlier determined as *G. virgata* Boiss. turned out to be *G. szovitsiana* Lazkov. In the meantime, it is expected that *G. virgata,* as well as G. *hispida* Boiss., could be found in the country due to the records from areas close to the boundaries of Armenia.
Eight representatives of *Gypsophila* s.l. of the Armenian flora and the three species that are highly likely to be close to the species of the Armenian flora were included in the recent phylogenetic study on the *Caryophylleae* tribe (Madhani & al. 2018, Taxon 67 (1): 83-112). The list of the *Gypsophila* group in Armenia is updated in the following order: *Gypsophila anatolica* Boiss. et Heldr., *G. bicolor* (Freyn & Sint.) Grossh., *G. elegans* M. Bieb., *G. heteropoda* Freyn & Sint., *G. lipskyi* Schischk., *G. pilosa* Huds., *G. pulvinaris* Rech. f., *G. stevenii* Fisch. ex Schrank, *G. szovitsiana* Lazkov, *G. takhtadzhanii* Schischk., *G. tenuifolia* M. Bieb., *G. vaccaria* (L.) Sm. (=*Vaccaria pyramidata* Medik.); *Psammophiliella muralis* (L.) Ikonn. (≡ *Gypsophila muralis* L.).
The 8 species are perennials, incl. 1 cushion-forming; 1 species is annual or biennial, and 3 species are annuals. General distribution of 10 species is limited by W Asia. Five species are endemic to the Caucasus Ecoregion, incl. 1 endemic of Armenia and 3 endemics of the S Caucasus.
The recent state of the single population of the Armenian endemic species *G. takhtadzhanii* was investigated. *Ex situ* conservation of the species is being carried out through long-term storage of seeds in the Seed Bank of Armenian Flora of the A. Takhtajyan Institute of Botany as well as trough living collections and clonal micropropagation.
It is planned to carry out molecular studies of certain endemic species of the Caucasus in order to clarify their place in the modern classification of *Gypsophila* and its closely related genera.

Bengt Oxelman[1], Patrik Cangren, Melilia Mesbah, Ntwae Moiloa and Anne-Sophie Quatela

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Species delimitation - philosophy and practical considerations

Despite often being considered as one of the fundamental levels of biological organisation, the concept of species remains controversial. For obvious reasons, taxonomic delimitations of species have mainly been based on phenotypical traits. However, at least implicitly, species are often considered to exist due to their genetic integrity and/or historical uniqueness. Retrieving genomic information is becoming more and more feasible, so direct use of genetic information has enormous potential to inform species delimitation. In phylogenetics, the concept of monophyly refers to clades which exist regardless of our ability to recognize them. Similarly, species have been argued to have no defining properties, which is typical for individuals. In phylogenetic systematics, species may be viewed as an arbitrary rank in the taxonomic hierarchy, but ontologically indifferent from other ranks such as genera, families, etc. However, the concept of monophyly may be difficult to apply to taxa recognized as species. It has been argued that most species concepts refer to species being separately evolving metapopulation lineages, or in other words, the branches of the phylogenetic tree (the species tree). The multi-species coalescent (MSC) model provides scientists with operational means to view genomic data and assess species assignment and phylogenetic relationships simultaneously. MSC-based approaches to species delimitation have gained significant popularity, but have also been criticized because they tend to identify what biologists usually view as populations rather than species. This should not be a surprise given that assumptions of the MSC. Here, we discuss the implications of viewing species-as-clades versus species-as-branches, and how these relate to concepts including phenotypical aspects, and conclude that a quantitative model for saving the notion of species as a unique level of organisation is at best very difficult to achieve.

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From nomenclature to population genomics: an ongoing integrated taxonomic study of the *Dianthus virgineus* group in the central Mediterranean area

The *Dianthus virgineus* L. species complex includes more than 25 species/subspecies in central Mediterranean area. Taxa are scientific hypotheses about the distribution of variation in nature, but all of these *Dianthus* taxa are still in the so called Turril's alpha-taxonomy, i.e. they were originally described solely on qualitative morphological observations. To better test/circumscribe species hypotheses, a rigorous, quantitative, integrative taxonomic approach is ongoing, including nomenclatural studies, morphometric, karyological, and population genomics analyses. The application of 17 names have been fixed including the Linnean name *D. virgineus*, which is the oldest available for this group, and *Dianthus sylvestris* Wulfen, widely used previously to denote the whole group. All the studied populations so far across the Alps and central Mediterranean area (29 concerning chromosome number, 44 concerning genome size) highlight a diploid status with 2n = 30 chromosomes, albeit populations from Sardinia show a slightly higher relative genome size (RGS). Preliminary genomic and morphometric results show a geographical gradient of variation across the Italian peninsula and slightly distinct subgroups in Sicily and Sardinia. In the next years these results will be completed and integrated, to produce a sound and reliable taxonomic setting for this group.

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Caryophyllaceae since Hernández-Ledesma et al. (2015) – changes and challenges

The synopsis of the Caryophyllales published in 2015 created a new summation of information about genera in the families within the order. Since that publication appeared, the activity in the Caryophyllaceae noted during the 20 years after the Bittrich treatment appeared in 1993 has continued, resulting in many updates to both the list of genera and what we know about them. We present here an overview of the family classification, a summary of the major updates as well as thoughts on where future work is still needed.

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Phylogenetic study of *Silene* sections *Auriculatae*, *Spergulifoliae*, *Ampullatae*, and *Lasiocalycinae* in Iran

Phylogenetic analyses of some sections of *Silene* (Caryophyllaceae) were presented by using nrDNA ITS and cpDNA rps16 intron sequences. Forty taxa, belonging to the sections *Auriculatae*, *Spergulifoliae*, *Lasiocalycinae*, and *Ampullatae*, were investigated. The molecular results showed that the species belonging to *S.* sect. *Auriculatae*, *Spergulifoliae*, and *Ampullatae* were strongly supported as one separated clade. Furthermore, species in *S.* sect. *Lasiocalycinae* remain closely related to those in the *S.* sect. *Auriculatae*. In this study, a comparative evaluation was performed among these four sections to determine which classification (local flora or recent molecular studies) can be proven. Furthermore, the phylogenetic position of some new species, which have been described and reported from Iran after Melzheimer investigation, were discussed. Some species were nested within *S.* sect. *Auriculatae*

displayed great affinity. On the other hand, the position of three new species, *S. muradica*, *S. bornmuelleri* and *S. montbretiana* were confirmed and supported by these analyses
Keywords: cpDNA rps16 intron, nrDNA ITS, phylogeny

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Taxonomic revision and floral variations in the genus *Polycarpaea* Lam. (Caryophyllaceae) from India

The genus *Polycarpaea* Lam. (Caryophyllaceae) comprises of approximately 50 species, mostly distributed in the tropics and subtropics of Old World, while few taxa occur in the New World tropics. The genus is represented in India by seven species. The geographical distribution of this genus is confined in abundance to 2the Western Ghats, Eastern Ghats, and Deccan region of India. A few like *Polycarpaea spicata* and *P. corymbosa* are reported from the arid zones of Gujarat and Rajasthan. The genus is characterized by stipules that are often bifurcated, sepals which are colored or hyaline, 3-4 valved capsules, inflorescence in dense or lax cyme. On critical evaluation of *Polycarpaea* from India, we found that the major traits that delineate various species are shape and size of bract and bracteole, sepals, nature of stipules, color of petals, shape of gynoecium and shape of seed. Considering such delineating traits, recently a new species of *Polycarpaea* (*Polycarpaea palakkadensis*) has been reported from Kerala India. However there occur a few variable traits which include shape of leaf, pubescence of stem, inflorescence branching pattern, number of stamens, number of seed and shape of capsule that has led to different phenotypes. A taxonomic key to delineate different taxa in India, along with its detailed micromorphology as well as variable and consistent morphological traits are presented here.

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Disentangling the diversification of the *Dianthus sylvestris* complex on the Balkan Peninsula using an integrative approach: taxonomic implications within a dynamic system

The *Dianthus sylvestris* complex is a group comprising morphologically highly variable taxa distributed in central Mediterranean, with the highest taxonomic diversity described in Italy. Another diversity centre is the Balkan Peninsula, from where six taxa mostly treated as subspecies of *D. sylvestris* have been described: subsp. *alboroseus*, subsp. *bertisceus*, subsp. *kozjakensis*, subsp. *nodosus*, subsp. *sylvestris* and subsp. *tergestinus*. Their identification is challenging due to great morphological variability and complex patterns of variation with respect to ecological preferences. In an ongoing study, we are combining an array of methods ranging from nomenclatural revision and morphometrics, over karyological and genome size estimation, to environmental niche modelling and population genetic analyses to disentangle relationships within *D. sylvestris* s.l. on the Balkan Peninsula. The morphometric analyses revealed a continuous variability of quantitative morphological characters and an absence of clear-cut qualitative morphological differences among the subspecies. In addition, the niche overlap assessment indicated that niche similarity is more common among the six subspecies, than niche divergence. Preliminary SNPs analyses suggest that *D. sylvestris* subsp. *tergestinus* presents a separate evolutionary lineage, while other populations on the Balkan Peninsula form a cline of genetic differentiation in the SE-NW direction. Finally, the relative genome size estimation using flow cytometry, with confirmatory chromosome counts, revealed polyploidisation in the NW Balkan Peninsula, as the tetraploid populations (2n=4x=60) are restricted to the Istrian Peninsula and Kvarner in Croatia and Italy. All the remaining Balkan populations were diploid (2n=2x=30).

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Caryophyllaceae in the Third Pole: examining the biogeographic impact of climate change in the Himalayan region

Species of the Caryophyllaceae are among some of the most important floristic components of Arctic, Antarctic and, in particular, alpine ecosystems across the World. They can be found in all major mountain region from the high Andes to the Himalayas. This biogeographic distribution makes Caryophyllaceae an ideal study subject to examine the potential impacts of anthropogenic climate change in plant species distribution in mountain environments. Previous studies have shown that the increase in global temperature has induced a spatial upward shift in the distribution of species associated with ecological responses in local biodiversity and spatial displacement to adjacent ecosystems. Here we apply a species distribution model approach based on the MaxEnt algorithm to examine the potential impact of climate change in the spatial distribution of nine Caryophyllaceae species which are present in the Himalayan region (Hindu Kush Himalayas, HKH) and surrounding areas: *Arenaria polytrichoides* Edgew., *A. serpyllifolia* L., *Dianthus anatolicus* Boiss., *Eremogone bryophylla* (Fernald) Pusalkar & D.K.Singh, *E. kansuensis* (Maxim.) Dillenb. & Kadereit, *Lepyrodiclis holosteoides* (C.A.Mey.) Fenzl ex Fisch. & C.A.Mey., *Silene gonosperma* (Rupr.) Bocquet, *S. moorcroftiana* Benth. and *Thylacospermum caespitosum* (Cambess.) Schischk. Therefore, eight bioclimatic variables provided by the high-resolution (~1km) global downscaled climate dataset CHELSA (Climatologies at high resolution for the earth's land surface areas) were projected until 2050 using IPCC's high greenhouse gas concentration scenario 8.5. Preliminary results show either a clear reduction in the range size of the analyzed species, and/or changes in their geographic distribution; different degrees of range reduction are detected, including at a local extinction level. The study may serve as a guide for the implementation of climate change adaptation programs, the establishment of protected areas, and the conservation of biodiversity in this fragile mountain ecosystem.