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New Classification of *Allium* L. subg. *Melanocrommyum* (Webb & Berthel.) Rouy (*Alliaceae*) Based on Molecular and Morphological Characters

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With 7 Figures

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Summary

Fritsch R. M., Blattner F. R. & Gurushidze M. 2010. New classification of *Allium* L. subg. *Melanocrommyum* (Webb & Berthel.) Rouy (*Alliaceae*) based on molecular and morphological characters. – Phyton (Horn, Austria) 49(2): 145–220, with 7 figures.

Allium subgenus *Melanocrommyum* from Eurasia is taxonomically complicated with different and contradictory taxonomic treatments proposed in the past. A comprehensive study, covering nearly all existing taxonomic groups and their entire geographic distribution, by sequencing the nuclear rDNA internal transcribed spacer

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region (ITS) confirmed the monophyly of the subgenus, while most traditionally used sections were either para- or polyphyletic. Addition of ten more species and 150 new accessions to that dataset confirmed the earlier results and underlined that multiple rapid radiations occurred within different monophyletic groups of the subgenus. About 40 well separated molecular clades were recognized, and taxonomically discussed and affiliated, but their phylogenetic relations remained often unresolved. The splits of some large "classical" sections was unavoidable. Therefore the sections *Asteroprason* R. M. FRITSCH and *Procerallium* R. M. FRITSCH as well as the subsections *Humilicognata* R. M. Fritsch, *Diffusoumbellata* R. M. FRITSCH, *Keratoprason* R. M. FRITSCH and *Pharmakoprason* R. M. FRITSCH were newly described, the subsections *Decipientia* (OMELCZUK) R. M. FRITSCH and *Stellata* (F. O. KHASS. & R. M. FRITSCH) R. M. FRITSCH were raised to sectional level, four subspecies were raised to species level, and the name *Allium jaubertii* R. M. FRITSCH was created for an illegitimate species name.

Altogether 160 species and subspecies were accepted (plus 53 unclear or synonymous names) in the updated conspectus of *A.* subg. *Melanocrommyum*. They were affiliated to 20 sections and 22 subsections (sect. *Acanthoprason* WENDELBO and sect. *Melanocrommyum* WEBB & BERTHEL. were only subdivided in alliances). Lectotypes of 17 species were designated or validated, and neotypes for *A. isfairamicum* O. FEDTSCH., A. *suworowii* REGEL, *A. viridiflorum* POBED., and epitypes for *A. bakhtiaricum* REGEL and *A. derderianum* REGEL were designated.

Zusammenfassung

FRITSCH R. M., BLATTNER F. R. & GURUSHIDZE M. 2010. New classification of *Allium* L. subg. *Melanocrommyum* (WEBB & BERTHEL.) ROUY (*Alliaceae*) based on molecular and morphological characters. [Neue Klassifikation von *Allium* L. subg. *Melanocrommyum* (WEBB & BERTHEL.) ROUY (*Alliaceae*) basierend auf molekularen und morphologischen Merkmalen]. – Phyton (Horn, Austria) 49(2): 145–220, mit 7 Abbildungen.

Diese eurasisch verbreitete Untergattung ist taxonomisch schwierig. Bisherige Gliederungen sind sehr unterschiedlich und widersprechen einander. Eine bereits publizierte, umfassende Untersuchung fast aller beschriebenen taxonomischen Gruppen aus dem gesamten Verbreitungsgebiet analysierte die Sequenzen der ITS-Region (internal transcribed spacer Region der nuklearen rDNA). Hierbei wurde die Monophylie des Subgenus bestätigt, aber die meisten traditionell benutzten Sektionen waren entweder para- oder polyphyletisch. Eine neue Analyse mit erweitertem Material (10 Arten und 150 Akzessionen zusätzlich) bestätigte die genannten Resultate, insbesondere dass in verschiedenen monophyletischen Gruppen mehrfache schnelle Radiationen auftraten. Schließlich wurden ungefähr 40 gut getrennte, molekulare Gruppen erkannt, diskutiert und taxonomisch eingeordnet. Ihr phylogenetischer Anschluss wurde aber oft nicht aufgelöst. Die Auftrennung von einigen umfangreichen, „klassischen" Sektionen war unumgänglich, weshalb die Sektionen *Asteroprason* R. M. FRITSCH und *Procerallium* R. M. FRITSCH sowie die Subsektionen *Humilicognata* R. M. FRITSCH, *Diffusoumbellata* R. M. FRITSCH, *Keratoprason* R. M. FRITSCH und *Pharmakoprason* R. M. FRITSCH neu beschrieben, und die Subsektionen *Decipientia* (Omelczuk) R. M. FRITSCH und *Stellata* (F. O. KHASS. & R. M. FRITSCH) R. M. FRITSCH als Sektionen neu kombiniert wurden. In diesem Zusammenhang

wurden vier Unterarten zu Arten erhoben, und *Allium jaubertii* R. M. FRITSCH anstelle eines illegitimen Namens geschaffen.

Im neu gefassten Konspekt von *A.* subg. *Melanocrommyum* werden 160 Arten und Unterarten akzeptiert, weitere 53 als unklare Namen oder Synonyme. Sie werden 20 Sektionen und 22 Untersektionen zugeordnet, wobei die Sektionen *Acanthoprason* WENDELBO und *Melanocrommyum* WEBB & BERTHEL. nur in informelle Gruppen gegliedert sind. In diesem Zusammenhang wurden Lektotypen von 32 Arten bestimmt bzw. validiert, Neotypen für *A. isfairamicum* O. FEDTSCH., A. *suworowii* REGEL und *A. viridiflorum* POBED., sowie Epitypen für *A. bakhtiaricum* REGEL und *A. derderianum* REGEL bestimmt.

Content

1. Introduction

Allium is a very variable and taxonomically difficult genus naturally distributed over the northern hemisphere. The most recent classification proposal for this genus, based on morphological characters and considering also molecular data, accepted about 780 species belonging to fifteen subgenera and 56 sections (FRIESEN & al. 2006). Taxonomic inventorying of this genus focused recently mainly on the Mediterranean area, Southwest and parts of Central Asia and resulted in the descriptions of more than 30 new species and subspecies raising this number to more than 800 species in 2009.

Melanocrommyum is the second largest *Allium* subgenus comprising about 140 accepted species and subspecies in 2005 (FRIESEN & al. 2006). Very recently about 15 taxa were newly described (DENIZ & SUMBUL 2004; SEREGIN 2007; FRITSCH & al. 2007; FRITSCH & ABBASI 2009) and several hitherto undescribed ones are currently under investigation. Thus, at least 160 taxa belong to *A.* subg. *Melanocrommyum*. Characteristics for members of this subgenus are true tunicated bulbs, annual roots, mostly broad and flat leaves with subterranean (scarcely visible above earth) sheath parts, strong and most often strictly upright scapes of varying length, and large, fasciculate to globular inflorescences composed of many moderately small to large, and often star-like, flowers. The flowers of several species emit a sweet or in another way noticeable odor.

Despite many members of subg. *Melanocrommyum* do not own the specific taste and smell of garlic and common onion, several species are intensely used by the native population of Central Asia and Iran as vegetables and medicinal plants (KEUSGEN & al. 2006, ABBASI & al. 2008). In general they contain less cysteine sulphoxides, the main pharmacologically active substances, than garlic and common onion (KEUSGEN & al. 2008). Surprisingly, species possessing remarkable antibiotic activity and partly a much higher radical scavanger activity than garlic contain newly discovered dithiodipyrroles (JEDELSKÁ & al. 2008) and sulphur-pyridins (KUSTERER & KEUSGEN 2009). This substances are also present in many well known ornamental species (FRITSCH & al. 2008).

Former *Allium* classifications, used up to the 1950th, commonly included the members of subg. *Melanocrommyum* in the bulbous sect. *Molium* G. DON EX KOCH because of certain morphological similarities. Specific features and structures of bulb and inflorescence development present solely in Mediterranean members of sect. *Molium* bothered WENDELBO 1969 to accept this section in the strict sense at subgeneric level, and to separate the remaining species as subgenus *Melanocrommyum* which he even nominated as the "the most advanced of the subgenera" without presenting any argument. Additional studies detected more principal differences between these subgenera which concern chromosome base numbers, the principles of leaf, scape, and flower anatomy, the course of annual life cycle as perhaps the most important ones. Currently sect. *Molium* in the strict sense is affiliated to subg. *Amerallium* TRAUB which has nomenclatural priority.

Earlier the long-rhizomatous growth and presence of slender, many-scaled bulbs were postulated as ancient evolutionary level in the genus *Allium*. Then the absence of rhizomes and presence of few-scaled, true bulbs characterizing subg. *Melanocrommyum* as well as subg. *Allium* should be the advanced level (HANELT & al. 1992). However, different molecular studies presented evidence that *Allium* species belong to three evolutionary lineages, and rhizomatous as well as bulbous groups are pre-

sent in all of them (FRITSCH & FRIESEN 2002, FRIESEN & al. 2006). The basal split in the phylogenetic dendrograms separates the bulbous subgenera *Microscordum* (MAXIM.) N. FRIESEN, *Nectaroscordum* (LINDL.) ASCHERS. & GRAEBN., and *Amerallium* (the latter comprising also rhizomatous sections) from all other taxa of the genus. Subg. *Melanocrommyum* is the largest group of a second evolutionary lineage jointly with the mono- or oligotypic, bulbous subgenera *Caloscordum* (HERB.) R. M. FRITSCH, *Porphyroprason* (EKBERG) R. M. FRITSCH, *Vvedenskya* (KAMELIN) R. M. FRITSCH, and the small rhizomatous subg. *Anguinum* (G. DON ex KOCH) N. FRIESEN. The rhizomatous subgenera *Butomissa* (SALISB.) N. FRIESEN, *Rhizirideum* (G. DON ex KOCH) WENDELBO, *Polyprason* RADIĆ, *Reticulatobulbosa* (KAMELIN) N. FRIESEN, and *Cepa* RADIĆ as well as the bulbous subgenus *Allium* belong together to the third evolutionary lineage (FRIESEN & al. 2006). Thus subg. *Melanocrommyum* is neither a "most advanced" group nor is it closer related to the bulbous sections of subg. *Amerallium* and to subg. *Allium*.

A first subdivision of subgenus *Melanocrommyum* was already proposed by Wendelbo 1966 when he described sect. *Regeloprason* WENDELBO. Later (WENDELBO 1969) he accepted also the sections *Melanocrommyum* WEBB & BERTHEL., *Kaloprason* K. KOCH, *Acanthoprason* WENDELBO, *Megaloprason* WENDELBO, and *Thaumasioprason* WENDELBO in a paper focusing on Mediterranean and Southwest Asian species only. The many related species occurring in Central Asia were later transferred to subg. *Melanocrommyum* when KAMELIN 1973 proposed another classification. This author did not accept sect. *Megaloprason* and treated *Kaloprason, Acanthoprason,* and *Regeloprason* at subsectional level only, described sect. *Verticillata* KAMELIN and sect. *Vvedenskya* KAMELIN as new sections, and transferred also the sections *Porphyroprason*, *Microscordum*, and *Briseis* (SALISB.) STEARN to subg. *Melanocrommyum*. Later the Gatersleben *Allium* working group (HANELT & al. 1992) presented a broad array of morphological, anatomical, karyological, and chemical arguments to exclude again the sections *Microscordum*, *Vvedenskya*, and *Briseis*, to add the new sections *Acmopetala* R. M. FRITSCH, *Compactoprason* R. M. FRITSCH (both segregates of sect. *Megaloprason* sensu lato), and *Miniprason* R. M. FRITSCH, and to transfer sect. *Pseudoprason* WENDELBO to subg. *Melanocrommyum* (FRITSCH 1992). Finally the sections *Acaule* R. M. FRITSCH, *Aroidea* F. O. KHASS. & R. M. FRITSCH, *Brevicaule* R. M. FRITSCH, and *Popovia* F. O. KHASS. & R. M. FRITSCH were newly created by KHASSANOV & FRITSCH 1994 separating some morphologically rather isolated species of subg. *Melanocrommyum*. A classification proposal of SEISUMS 1994 introduced also a new section *Triptera* and four new subsections in subg. *Melanocrommyum*, but these groups were never validly described.

Beginning in the 1990ies, the application of different molecular marker systems confirmed subg. *Melanocrommyum* as clade well separated from other *Allium* subgenera and to consist of several subgroups. However,

different analyses displayed incongruent and often contradictory relations of the rather few taxa studied. Some results could best be explained by reticulate evolution (MES & al. 1997, 1999). Therefore detailed investigations analyzing sequences of the nuclear rDNA internal transcribed spacer region (ITS) and the plastid DNA *trn*L-*trn*F region of about 430 accessions representing more than 100 species were undertaken (GURUSHIDZE & al. 2008, GURUSHIDZE & al. in press). These results confirmed the monophyly of *A.* subg. *Melanocrommyum* and indicated multiple radiations within the group, but could not detect evidence for frequent introgressions. The investigated species form a basal grade and a core clade in the phylogenetic tree. 7 different clusters within the core clade occur as monophyletic units with all applied (phenetic, cladistic, and model-based) algorithms. The relationships among these clusters were not resolved, but the clusters were mostly well-supported in all analyses. Also some groups within these cluster got statistical support enabling characterization of their phylogenetic positions. Altogether two groups were recognized in the grade, and 10 more groups in the clade. Five of these groups were additionally characterized by different specific anatomical features of the septal nectaries while the remaining groups shared another (unspecific) type of nectary. Other (often small) groups were well separated with high support values but their positions remained unresolved in this phylogenetic tree. The phylogenetic analyses showed, as a main result, that most of the traditional taxonomic sections in subg. *Melanocrommyum* are either para- or polyphyletic, and favor the circumscription of smaller sections. The occurrence of cryptic species in subg. *Melanocrommyum* was documented for the first time in *Allium*.

The principal structure of this phylogenetic tree was confirmed by sequence analyses of the *trn*L-*trn*F region of chloroplast DNA (GURUSHIDZE & al. in press). A statistical parsimony network of 80 chloroplast haplotypes resulted in six main lineages which showed much congruence with subunits of the ITS-based phylogenetic tree, and rather few species positions were more or less incongruent with the ITS data. Also the number of inferred (missing in the data set) haplotypes was rather low.

Newly collected material enabled incorporation of more accessions and more species to the material analyzed by GURUSHIDZE & al. 2008 in order to prove splitting of traditional sections and especially the position of small segregate groups and their statistical support. Below we will present the final results of our investigation of subg. *Melanocrommyum*, including detailed discussion of taxonomic changes only shortly mentioned by GURUSHIDZE & al. 2008, and their nomenclatorial validations.

Most important is the conclusion, that taxa traditionally affiliated to one section are not necessarily closely related but may belong to genetically only distantly related subgroups.

2. Materials and Methods

2.1. Molecular Investigations

For the present investigation we included ITS sequences of 578 accessions (acc.) representing about 112 *Melanocrommyum* species and subspecies, 5 hybrid ornamental cultivars, and 8 outgroup species, from which 395 sequences were taken from our previous publication, while the remaining 183 acc. were sequenced for this study. All sequences were submitted to the EMBL nucleotide database. For detailed description of DNA extraction, PCR, and sequencing methods see GURUSHIDZE & al. 2008.

The data were analyzed using distance (Neighbor-Joining) and Bayesian algorithms. For the present study we have not performed Maximum Parsimony (MP) analyses due to following reasons. First, we showed that the Bayesian and MP results were highly compatible for analyzing relationships among ITS sequences within subgenus *Melanocrommyum* (GURUSHIDZE & al. 2008), and second, for such a large data-matrix MP would be computationally extremely demanding. The model of sequence evolution was tested in MODELTEST 3.7 (POSADA & CRANDALL 1998), GTR+G model was chosen as the best fitted model by the Akaike information criterion. This model was used for distance calculations in Neighbor-Joining (NJ) analyses with PAUP* (SWOFFORD 2002). Bayesian analyses (BI) was performed using MrBAYES 3.1 (RONQUIST & HUELSENBECK 2003). Eight chains were run for 10 million generations under the chosen model of sequence evolution, sampling a tree every 1000 generations. The posterior probabilities were calculated after discarding the initial 25% (non-stationary) of the resulting trees. The Bayesian tree with branch lengths and posterior probabilities is shown schematically on Figure 1 and in detail on the Figures 2 A - 2 F.

2.2. Accessions (in Numerical Sequence)

The scheme of the list is as follows: accession number: *species* AUTHOR(s); taxonomic affiliation (*subgenus* or *section*); origin (source, coordinates or collection site; herbarium and voucher no. or photo)

0348: *Allium oreophilum* C. A. MEY.; subg. *Porphyroprason*; Graz Botanic Garden Univ., Austria; (GAT). – 0465: *Allium macleanii* BAKER; *Compactoprason*; Botanical Garden Vrije Univ. Amsterdam, Netherlands; (GAT). – 0515: *Allium multibulbosum* JACQ.; *Melanocrommyum*; Leipzig Botanical Garden, Germany; (GAT). – 0531: *Allium stipitatum* REGEL; *Megaloprason*; Dushanbe Botanical Garden, Tajikistan; (GAT). – 0612: *Allium stipitatum* REGEL; *Megaloprason*; Budapest Botanical Garden, Hungary; (GAT). – 0616: *Allium backhousianum* REGEL; *Acmopetala*; Botanical Garden Univ. Budapest, Hungary; (GAT). – 0779: *Allium karataviense* REGEL; *Miniprason*; Jena Botanical Garden, Germany; (GAT). – 0799: *Allium atropurpureum* WALDST. & KIT.; *Melanocrommyum*; Jena Botanical Garden, Germany; (GAT). – 0975: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; Hissar mountain range, Varzob valley; (GAT). – 1017: *Allium atropurpureum* WALDST. & KIT.; *Melanocrommyum*; private collection Dr. WANDELT, Quedlinburg; (GAT). – 1033: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Afghanistan, received from Göteborg Botanical Garden; (GAT). – 1044: *Allium stipitatum* REGEL; *Megaloprason*; Afghanistan, received from Göteborg Botanicalal Garden; (GAT). – 1082: *Allium jesdianum* BOISS. & BUHSE

subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Afghanistan, received from Göteborg Botanical Garden; (GAT). – 1083: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Afghanistan, received from Göteborg Botanical Garden; (GAT). – 1090I: *Allium stipitatum* REGEL; *Megaloprason*; Iran; 344343N, 0483637E; (IRAN 43978). – 1119I: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 360337N, 0465148E; (IRAN 43974). – 1122I: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 350050N, 0465421E; (IRAN). – 1123I: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; near Sanandaj; (IRAN). – 112G: *Allium pseudowinklerianum* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Kyrgyzstan; Fergan mountain range (isotype); (GAT). – 1138I: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; prov. Zanjan; (IRAN). – 113G: *Allium sochense* R. M. FRITSCH & U. TURAKULOV; *Regeloprason*; Kyrgyzstan; Alai mountain range (isotype); (GAT). – 114G: *Allium derderianum* REGEL; *Acanthoprason*; Iran; prov. Tehran, Karaj valley; (GAT). – 1150: *Allium cyrilli* TEN.; *Melanocrommyum*; Leipzig Botanical Garden; (GAT). – 1164I: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 335900N, 0500700E; (IRAN). – 116G: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; steppe W Zelinograd; (GAT). – 1178: *Allium stipitatum* REGEL; *Megaloprason*; Botanical Garden Univ. Strasbourg, France; (GAT). – 117G: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 3222N, 05028E; (GAT). – 11929: *Allium* sp. 2; *Acanthoprason*; Iran; prov. Kurdestan, Zanjan to Bijar, pass S Khur-Khureh; (TARI 11929). – 119G: *Allium hexaceras* VVED.; *Acaule*; Uzbekistan; Hissar mountain range; (GAT). – 1222: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Moscow Main Botanical Garden; (GAT). – 1224I: *Allium stipitatum* REGEL s. lat.; *Megaloprason*; Iran; 325523N, 0503330E; (IRAN). – 1241I: *Allium* sp.; *Acanthoprason*; Iran; 302349N, 0515431E; (IRAN). – 1300: *Allium victorialis* L.; subg. *Anguinum*; Russia; Altai; (GAT). – 1311: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 3849N, 06848E (near type location); (GAT). – 1315: *Allium stipitatum* REGEL; *Megaloprason*; Dushanbe Botanical Garden, Tajikistan; (GAT). – 1323: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 3849N, 06848E; (GAT). – 1326: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 3847N, 06850E; (GAT). – 1327: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3858N, 06844E; (GAT). – 1343: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 3841N, 06852E; (GAT). – 1345: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; N Dushanbe; (GAT). – 1384: *Allium lipskyanum* VVED.; *Regeloprason*; Dushanbe Botanical Garden, Tajikistan; (GAT). – 1388: *Allium cristophii* TRAUTV.; *Kaloprason*; Botanic Garden Univ. Budapest, Hungary; (GAT). – 13H: *Allium* aff. *isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *isakulii*; *Regeloprason*; Uzbekistan; Fergan depression; (GAT). – 14164: *Allium derderianum* REGEL; *Acanthoprason*; Iran; Taleqan; (TARI 14164). – 14176: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Tehran, 68 km from Tehran to Qom; (TARI 14176). – 1502: *Allium backhousianum* REGEL; *Acmopetala*; Khorog, Pamir Botanical Garden, Tajikistan; (GAT). – 1623: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; Nurek; (GAT). – 1625: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; Hissar mountain range; (GAT). – 1626: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; Javros, near Dushanbe; (GAT). – 1631: *Allium hollandicum* R. M. FRITSCH; *Megaloprason*; private collection Dr.

Fritsch, Gatersleben (type population); (GAT). – 1650: *Allium multibulbosum* Jacq.; *Melanocrommyum*; Leipzig Botanical Garden; (GAT). – 16611: *Allium nigrum* L.; *Melanocrommyum*; Greece, Crete Island; 351403N, 0240555E; (OSBU 16611). – 16666: *Allium nigrum* L.; *Melanocrommyum*; Greece, Crete Island; 351741N, 0242524E; (OSBU 16666). – 16744: *Allium bisotunense* R. M. Fritsch; *Melanocrommyum*; Iran; prov. Kermanshah, Kuh-e Parrou; (TARI 16744). – 16799: *Allium* aff. *austroiranicum* R. M. Fritsch; *Acanthoprason*; Iran; prov. Kermanshah, Kuh-e Bozab, macrowave station; (TARI 16799). – 16833: *Allium breviscapum* Stapf; *Acanthoprason*; Iran; prov. Hamedan, Alvan Kuh, near Gandjnameh; (TARI 16833). – 16867: *Allium ubipetrense* R. M. Fritsch; *Acanthoprason*; Iran; prov. Kurdestan, Ghorveh towards Sanandaj; (TUH 16867). – 16905: *Allium saralicum* R. M. Fritsch; *Melanocrommyum*; Iran; prov. Kurdestan, Dasht-e Zaghe on road from Hamadan to Sanandaj c. 40 km E Sanandaj; (TARI 16905). – 17362: *Allium* aff. *ubipetrense* R. M. Fritsch; *Acanthoprason*; Iran; prov. Azarbeijan, Tabriz to Ghar-e Chaman, before this place; (TARI 17362). – 1801: *Allium hollandicum* R. M. Fritsch 'Purple Sensation'; *Megaloprason*; Gesellschaft der Staudenfreunde, Germany; (GAT). – 1869: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3845N, 06919E (type location); (GAT). – 1880: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3847N, 06849E; (GAT). – 1886: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3847N, 06848E; (GAT). – 1894: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3850N, 06849E; (GAT). – 1897: *Allium stipitatum* Regel; *Megaloprason*; Tajikistan; 3849N, 06846E; (GAT). – 1900: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3849N, 06846E; (GAT). – 1909: *Allium sarawschanicum* Regel; *Megaloprason*; Tajikistan; 3842N, 06853E; (GAT). – 1911: *Allium macleanii* Baker; *Compactoprason*; Tajikistan, vegetable market in Dushanbe; (GAT). – 1920: *Allium cristophii* Trautv.; *Kaloprason*; Manchester Botanic Garden; (GAT). – 19593: *Allium* aff. *akaka* S. G. Gmelin ex Schult. & Schult. f.; *Acanthoprason*; Iran; prov. Azarbeijan, W Rezaiyeh, hills W Silvana village; (TARI 19593). – 19746: *Allium* sp. 10; *Acanthoprason*; Iran; (location not available); (TARI 19746). – 19854: *Allium* aff. *hollandicum* R. M. Fritsch; *Megaloprason*; Iran; prov. Azarbeijan, SW of Rezaiyeh, Silvana valley; (TARI 19854). – 19932: *Allium* sp. 2; *Acanthoprason*; Iran; prov. Azarbeijan, 10 km on the road from Mianeh to Zanjan; (TARI 19932). – 1I: *Allium robustum* Kar. & Kir.; *Melanocrommyum*; Kazakhstan; 4719N, 08133E; (GAT). – 1o: *Allium orientale* Boiss. s. lat.; *Melanocrommyum*; Israel; Lehavim; (HUJ). – 2: *Allium orientale* Boiss. s. lat.; *Melanocrommyum*; Israel; Tel Krayot; (HUJ). – 20228: *Allium* aff. *egorovae* M. V. Agab. & Ogan.; *Acanthoprason*; Iran; prov. Azarbeijan, Arasbaran protected region; (TARI 20228). – 2121: *Allium stipitatum* Regel; *Megaloprason*; Marburg Botanical Garden, Germany; (GAT). – 2155H: *Allium* aff. *hollandicum* R. M. Fritsch; *Megaloprason*; Iran; prov. Azarbeijan, inter Rezaiyeh & Oshnaviyeh; (TARI 2155). – 2162: *Allium protensum* Wendelbo; *Kaloprason*; Rostock Botanical Garden, Germany; (GAT). – 2162S: *Allium noëanum* Reut. ex Regel; *Acanthoprason*; Iran; prov. Azarbeijan, in jugo Khan inter Baneh & Saqqez; (TARI 2162). – 2164H: *Allium* aff. *hollandicum* R. M. Fritsch; *Megaloprason*; Iran; prov. Azarbeijan, Dasht-e Bel; (TARI 2164). – 2182: *Allium verticillatum* Regel; *Verticillata*; Tajikistan; 3759N, 06834E; (GAT, photos). – 2194: *Allium atropurpureum* Waldst. & Kit.; *Melanocrommyum*; Bulgaria; Cape Emine; (GAT). – 2239: *Allium stipitatum* Regel; *Megaloprason*; Vácrátót Botanical Garden, Hungary; (GAT). – 2256: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Tajikistan; 3845N, 06918E (type location); (GAT). – 2257:

Allium stipitatum REGEL; *Megaloprason*; Tajikistan; 3845N, 06918E; (GAT). – 2262: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Tajikistan; 3849N, 06850E; (GAT). – 2264: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 3903N, 06845E; (GAT). – 2266: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3902N, 06847E; (GAT). – 2269: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Tajikistan; 3842N, 06853E; (GAT). – 2270: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 384201N, 0685311E; (GAT). – 2271: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; Kharangon valley N Dushanbe; (GAT). – 2276: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 3759N, 06834E; (GAT). – 2379: *Allium neriniflorum* (HERB.) BAKER; subg. *Caloscordum*; Mongolia; SE Sumber, Somon Chalchgol; (GAT). – 2399: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Tajikistan, received from Botanical Garden Tallin; (GAT). – 2413: *Allium macleanii* BAKER; *Compactoprason*; Chorog Botanical Garden, Tajikistan; (GAT). – 2415: *Allium macleanii* BAKER; *Compactoprason*; Chorog Botanical Garden, Tajikistan; (GAT). – 2432: *Allium* sp. 10; *Acanthoprason*; Iran; prov. Kurdestan, 15 km NE Banah; (TARI 2432). – 2445: *Allium stipitatum* REGEL; *Megaloprason*; Cluj-Napoca Botanical Garden, Romania; (GAT). – 24865: *Allium* aff. *egorovae* M. V. AGAB. & OGAN.; *Acanthoprason*; Iran; prov. Azarbeijan, Arasbaran protected area, between Kharil and Makiki; (TARI 24865). – 2497H: *Allium scotostemon* WENDELBO; *Thaumasioprason*; Iran; (data are missing); (TUH 2497). – 2517: *Allium aroides* POPOV & VVED.; *Aroidea*; Uzbekistan, Tashkent Botanical Garden; (GAT). – 2517A: *Allium ellisii* HOOK. f.; *Kaloprason*; Iran; (data missing); (TUH 2517). – 2521: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; 4139N, 06947E; (GAT). – 25222: *Allium* sp. 3; *Acanthoprason*; Iran; prov. Azarbeijan, Rezaiyeh, near Turkish border; (TARI 25222). – 2530: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3905N, 06923E; (GAT). – 2537: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 3821N, 07003E; (GAT). – 2541: *Allium rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3827N, 07011E; (GAT). – 2549: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 3830N, 07003E; (GAT). – 2552: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3903N, 06854E; (GAT). – 2557: *Allium alexeianum* REGEL; *Kaloprason*; Tajikistan; 3932N, 06838E; (GAT). – 2566: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3912N, 06733E; (GAT). – 2582: *Allium tricoccum* SOL.; subg. *Anguinum*; USA; Whistler's Woods, Southern Cook county, Illinois; (GAT, photos). – 2615: *Allium hollandicum* R. M. FRITSCH; 'Purple Sensation'; *Megaloprason*; Botanic Garden Vrije Univ. Amsterdam; (GAT). – 2616: *Allium multibulbosum* JACQ.; *Melanocrommyum*; Botanical Garden Vrije Univ. Amsterdam; (GAT). – 2618: *Allium stipitatum* REGEL; *Megaloprason*; Botanical Garden Vrije Univ. Amsterdam, Netherlands; (GAT). – 2657: *Allium stipitatum* REGEL; *Megaloprason*; Dresden Botanical Garden, Germany; (GAT). – 2673: *Allium victorialis* L.; subg. *Anguinum*; Georgia; Caukasus, Teberda, Dombai; (GAT, photos). – 2680: *Allium backhousianum* REGEL; *Acmopetala*; Kyrgyzstan; Alai mountain range; (GAT). – 2681: *Allium backhousianum* REGEL; *Acmopetala*; Kyrgyzstan; Alai mountain range; (GAT). – 2709: *Allium decipiens* FISCH. ex SCHULT. & SCHULT. f. subsp. *quercetorum* SEREGIN; *Melanocrommyum*; Ukraina; Crimea, Mt. Ayu-Dag; (GAT, photos). – 2735: *Allium ramosum* L.; subg. *Butomissa*; Alma-Ata Botanical Garden, Kazakhstan; (GAT). – 27559: *Allium derderianum* REGEL; *Acanthoprason*; Iran; prov. Tehran, between Tehran and Karadj, above Kalak village; (TARI 27559). – 27810: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; prov.

Azarbeijan, Assalem to Khalkhal after pass near Khalkhal; (TARI 27810). – 2793: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan, received from Dr. LEVICHEV, Leningrad, Russia; (GAT). – 2794: *Allium stipitatum* REGEL; *Megaloprason*; Uzbekistan; village Samsarak near Tashkent; (GAT). – 27959: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; prov. Azarbeijan, pass c. 20 km S Ahar on road to Tabriz; (TARI 27959). – 2797: *Allium neriniflorum* (HERB.) BAKER; subg. *Caloscordum*; Novosibirsk Centr. Siber. Botanic Garden, Russia; (GAT). – 2800: *Allium hollandicum* R. M. FRITSCH; *Megaloprason*; from Bundesgartenschau (German Federal Garden Show) Frankfurt/Main; (GAT). – 2846: *Allium macleanii* BAKER; *Compactoprason*; Afghanistan, received from Göteborg Botanical Garden; (GAT, photos). – 2935: *Allium hissaricum* VVED.; *Regeloprason*; Tajikistan; 3801N, 06828E; (GAT). – 2938: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 3804N, 06830E; (GAT). – 2946: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 3841N, 06900E; (GAT). – 2947: *Allium hissaricum* VVED.; *Regeloprason*; Tajikistan; 3841N, 06900E (type location); (GAT). – 2952: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 4038N, 06935E; (GAT). – 29524: *Allium pseudobodeanum* R. M. FRITSCH & MATIN; *Acanthoprason*; Iran; prov. Tehran, Firuzkuh, Gaduk; (TUH 29524). – 2966: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; 4356N, 07708E; (GAT). – 2975: *Allium fetisowii* REGEL; *Acmopetala*; Kazakhstan; 4321N, 07651E (type location); (GAT). – 2976: *Allium altissimum* REGEL; *Megaloprason*; Kazakhstan; 4321N, 07500E; (GAT). – 2977: *Allium aflatunense* B. FEDTSCH.; *Megaloprason*; Collection of Dr. KAMENETZKAJA, Kazakhstan; (GAT). – 2989: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 4110N, 07008E; (GAT). – 2992: *Allium zergericum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 4055N, 07330E (type location); (GAT). – 2E: *Allium chrysantherum* BOISS. & REUT.; *Melanocrommyum*; Iran; prov. Zanjan, Bijar; (IRAN 326/2). – 3024: *Allium schubertii* ZUCC.; *Kaloprason*; private collection Dr. WIERING, Bergen, Netherland; (GAT). – 3028: *Allium stipitatum* REGEL; *Megaloprason*; private collection Dr. WIERING, Bergen Netherland; (GAT). – 30358: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; prov. Azarbeijan, Maku to Khoy, mountains SW Kelisa-Kandi; (TARI 30358). – 3087: *Allium stipitatum* REGEL; *Megaloprason*; Botanical Garden Univ. Strasbourg, France; (GAT). – 3115: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 3844N, 06825E; (GAT). – 3118: *Allium lipskyanum* VVED.; *Regeloprason*; Tajikistan; 3844N, 06828E; (GAT). – 3121: *Allium suworowii* REGEL; *Acmopetala*; Tajikistan; 3822N, 06942E; (GAT). – 3123: *Allium trautvetterianum* REGEL; *Compactoprason*; Tajikistan; 3822N, 06942E (near type location); (GAT, photos). – 3129: *Allium hissaricum* VVED.; *Regeloprason*; Tajikistan; 3823N, 06943E; (GAT). – 3133: *Allium komarowii* LIPSKY; *Compactoprason*; Tajikistan; 3905N, 06821E; (GAT). – 3144: *Allium komarowii* LIPSKY; *Compactoprason*; Uzbekistan; 3850N, 06707E; (GAT). – 3219: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; private collection R. DADD, Wokingham, Berkshire, Great Britan; (GAT). – 323H: *Allium chelotum* WENDELBO; *Melanocrommyum*; Iran; prov. Gorgan, Golestan forest; (IRAN 323). – 3246: *Allium stipitatum* REGEL 'Mount Everest'; *Megaloprason*; Firm of Peter Nijsen, Heemstede, Netherlands; (GAT). – 324H: *Allium chelotum* WENDELBO; *Melanocrommyum*; Iran; prov. Gorgan, Golestan forest; (IRAN 324). – 32H: *Allium* aff. *hollandicum* R. M. FRITSCH; *Megaloprason*; Iran; prov. Azarbeijan, inter Rezaiyeh & Oshnaviyeh; (TARI). – 3335: *Allium protensum* WENDELBO; *Kaloprason*; Uzbekistan; Kashkadarya area, near Uradarya; (GAT). – 3347: *Allium stipitatum* REGEL;

Megaloprason; Kyrgyzstan; 4020N, 07238E; (GAT). – 3355: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; 4117N, 06951E (near type location); (GAT). – 3356: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; 411711N, 0695101E; (GAT). – 3357: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; 4117N, 06951E; (GAT). – 3362: *Allium majus* VVED.; *Compactoprason*; Uzbekistan; 3920N, 06710E; (GAT). – 34075: *Allium* sp. aff. *akaka* S. G. GMELIN; *Acanthoprason*; Iran; (location missing); (TUH 34075). – 34120: *Allium scotostemon* WENDELBO; *Thaumasioprason*; Iran; 3543N, 5212E; (TUH 34120). – 34268: *Allium shelkovnikovii* GROSSH.; *Acanthoprason*; Iran; prov. Azarbeijan, near Tabriz; (TUH 34268). – 34269: *Allium shelkovnikovii* GROSSH.; *Acanthoprason*; Iran; prov. Azarbeijan, campus of Tabriz University; (TUH 34269). – 34349: *Allium* sp. 9; *Acanthoprason*; Iran; prov. Qazvin, Alamut Mts.; (TARI 34349). – 343H: *Allium* sp. 1 *"chlorotepalum"*; *Acanthoprason*; Iran; prov. Esfahan, Esfahan to Daran; (TARI). – 34902: *Allium haemanthoides* BOISS. & REUT. ex REGEL s. str.; *Acanthoprason*; Iran; prov. Kurdestan, Novsoud 65 km to Marivan; (GAT). – 34903: *Allium elburzense* WENDELBO; *Acanthoprason*; Iran; prov. Tehran, Abali to Tehran; (GAT). – 34908: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Qazvin, Razan 24 km to Avaj; (GAT). – 34911: *Allium elburzense* WENDELBO; *Acanthoprason*; Iran; prov. Mazandaran, Dizin; (GAT). – 35079: *Allium elburzense* WENDELBO; *Acanthoprason*; Iran; prov. Tehran, Damavand towards Tar Lake; (TUH 35079). – 3625: *Allium kujukense* VVED.; subg. *Vvedenskya*; Kazakhstan; 4245N, 07056E; (GAT). – 3652: *Allium suworowii* REGEL; *Acmopetala*; Kazakhstan; 4308N, 07438E; (GAT). – 3655: *Allium saposhnikovii* NIKITINA; *Acmopetala*; Kazakhstan; 4253N, 07106E; (GAT). – 3657: *Allium suworowii* REGEL; *Acmopetala*; Kazakhstan; 4149N, 06924E; (GAT). – 3659: *Allium stipitatum* REGEL; *Megaloprason*; Uzbekistan; 3917N, 06654E; (GAT). – 3661: *Allium gypsaceum* POPOV & VVED.; *Popovia*; Uzbekistan; 3815N, 06651E; (GAT, photos). – 3666: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Uzbekistan; 3755N, 06647E; (GAT). – 3670: *Allium stipitatum* REGEL; *Megaloprason*; Uzbekistan; 3756N, 06645E; (GAT). – 3671: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Uzbekistan; 3756N, 06645E; (GAT). – 3672: *Allium protensum* WENDELBO; *Kaloprason*; Uzbekistan; 3756N, 06645E; (GAT). – 3673: *Allium sarawschanicum* REGEL; *Megaloprason*; Uzbekistan; 3919N, 06656E (type location); (GAT). – 3676: *Allium karataviense* REGEL; *Miniprason*; Kazakhstan; 4339N, 06838E (near type location); (GAT). – 3686: *Allium sewerzowii* REGEL; *Acmopetala*; Kazakhstan; 4250N, 06952E; (GAT). – 3693: *Allium fetisowii* REGEL; *Acmopetala*; Kazakhstan; 4321N, 07500E; (GAT). – 3699: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; 4445N, 07623E; (GAT). – 3703: *Allium aroides* POPOV & VVED.; *Aroidea*; Uzbekistan; 3917N, 06654E; (GAT). – 3714: *Allium sergii* VVED.; *Brevicaule*; Kazakhstan; 4339N, 06838E; (GAT, photos). – 3723: *Allium vvedenskyanum* PAVLOV; *Acmopetala*; Kazakhstan; 4321N, 07500E (near type location); (GAT, photos). – 3724: *Allium iliense* REGEL; *Regeloprason*; Kazakhstan; 4365N, 07705E (type location); (GAT, photos). – 3738: *Allium stipitatum* REGEL; *Megaloprason*; Kazakhstan; Kurdai pass area, Kurdai gorge; (GAT). – 3783: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 3787: *Allium chodsha-bakirganicum* GAFFAROV & TURAKULOV; *Regeloprason*; Kyrgyzstan; Northern slopes of Turkestan mountain range (type location); (GAT, photos). – 3884: *Allium macleanii* BAKER; *Compactoprason*; Mark MCDONOUGH, Pepperell, USA;

(GAT). – 3924: *Allium bakhtiaricum* Regel; *Megaloprason*; Iran; 3212N, 05032E; (GAT). – 3927: *Allium assadii* Seisums; *Acmopetala*; Iran; 3332N, 05104E; (GAT). – 3932: *Allium elburzense* Wendelbo; *Kaloprason*; Iran; prov. Tehran, Karaj valley; (GAT). – 3936: *Allium elburzense* Wendelbo; *Kaloprason*; Iran; 3601N, 05109E; (GAT). – 3940: *Allium* aff. *zagricum* R. M. Fritsch; *Acanthoprason*; Iran; 3713N, 04746E; (GAT). – 3947: *Allium cardiostemon* Fisch. & C. A. Mey.; *Pseudoprason*; Iran; 3804N, 04459E; (GAT). – 3948: *Allium materculae* Bordz.; *Acanthoprason*; Iran; 3814N, 04450E; (GAT). – 3951: *Allium jesdianum* Boiss. & Buhse subsp. *jesdianum*; *Megaloprason*; Iran; 3132N, 05413E (type location); (GAT). – 3953: *Allium jesdianum* Boiss. & Buhse subsp. *jesdianum*; *Megaloprason*; Iran; 3132N, 05413E (type location); (GAT). – 3958: *Allium stipitatum* Regel; *Megaloprason*; Iran; 3219N, 05030E; (GAT). – 3962: *Allium stipitatum* Regel; *Megaloprason*; Iran; 3222N, 05028E; (GAT). – 3964: *Allium stipitatum* Regel; *Megaloprason*; Iran; 3226N, 05006E; (GAT). – 3967: *Allium stipitatum* Regel; *Megaloprason*; Iran; 3221N, 05021E; (GAT). – 3I: *Allium tulipifolium* Ledeb.; *Melanocrommyum*; Kazakhstan; 4423N, 07649E; (GAT). – 3o: *Allium orientale* Boiss. s. lat.; *Melanocrommyum*; Israel; near Sartaba; (HUJ). – 3s: *Allium saralicum* R. M. Fritsch; *Melanocrommyum*; Iran; prov. Kurdestan, Saral area; (HCAT). – 4: *Allium jesdianum* Boiss. & Buhse; *Megaloprason*; Iran; prov. Kurdestan, Saral area; (HCAT). – 40711: *Allium ellisii* Hook. f.; *Acanthoprason*; Iran; prov. Semnan, c. 50 km N Semnan; (TARI 40711). – 40909: *Allium* aff. *scotostemon* Wendelbo; *Acanthoprason*; Iran; prov. Semnan, c. 20 km NW Shahrud; (TARI 40909). – 4522H: *Allium* sp. 5; *Acanthoprason*; Iran; prov. Kurdestan, cultivated in Sanandaj; (Sanandaj 4522). – 4I: *Allium viridulum* Ledeb.; *Melanocrommyum*; Kazakhstan; 4543N, 08016E; (GAT). – 5: *Allium saralicum* R. M. Fritsch; *Melanocrommyum*; Iran; prov. Kurdestan, Chatan; (HCAT). – 5013H: *Allium austroiranicum* R. M. Fritsch; *Acanthoprason*; Iran; prov. Kurdestan, Sanandaj to Maryvan, Mt. Shaneshin; (Sanandaj 5013). – 5027: *Allium dasyphyllum* Vved.; *Acmopetala*; Kyrgyzstan; 4253N, 07135E (type location); (GAT). – 5040: *Allium karataviense* Regel; *Miniprason*; Uzbekistan; 4136N, 06955E; (GAT). – 5043: *Allium severtzovioides* R. M. Fritsch; *Acmopetala*; Kazakhstan; 4245N, 07056E; (GAT). – 5047: *Allium saposhnikovii* Nikitina; *Acmopetala*; Kazakhstan; 4254N, 07108E; (GAT). – 5052: *Allium fetisowii* Regel; *Acmopetala*; Kyrgyzstan; 4253N, 07135E; (GAT). – 5057: *Allium chychkanense* R. M. Fritsch; *Acmopetala*; Kyrgyzstan; 4215N, 07300E; (GAT). – 5060: *Allium chychkanense* R. M. Fritsch; *Acmopetala*; Kyrgyzstan; 4210N, 07252E; (GAT). – 5066: *Allium schachimardanicum* Vved.; *Acmopetala*; Uzbekistan; 3958N, 07143E (type location); (GAT). – 5068: *Allium taeniopetalum* Popov & Vved. subsp. *turakulovii* R. M. Fritsch & F. O. Khass.; *Acmopetala*; Kyrgyzstan; 3959N, 06957E (type location); (GAT). – 5076: *Allium lipskyanum* Vved.; *Regeloprason*; Uzbekistan; 3844N, 06757E; (GAT). – 5078: *Allium nevskianum* Vved. ex Wendelbo; *Kaloprason*; Uzbekistan; 3845N, 06758E; (GAT). – 5079: *Allium nevskianum* Vved. ex Wendelbo; *Kaloprason*; Uzbekistan; 3840N, 06757E; (GAT). – 5080: *Allium stipitatum* Regel; *Megaloprason*; Uzbekistan; 3838N, 06757E; (GAT). – 5081: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Uzbekistan; 3838N, 06757E; (GAT). – 5092: *Allium ovalifolium* Hand.-Mazz.; subg. *Anguinum*; China; Provinz Quinghai, 120 km NÖ Xining; (GAT, photos). – 5132: *Allium rosenorum* R. M. Fritsch 'Purple King'; *Megaloprason*; Hoog & Dix Export, Heemstede, Netherlands; (GAT). – 5133: *Allium rosenorum* R. M. Fritsch; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5135: *Allium*-hybrid, subg. *Melanocrommyum* 'Mars'; Hoog & Dix Export, Heemstede

Netherland; (GAT). – 5136: *Allium*-hybrid, subg. *Melanocrommyum* 'Lucy Ball'; Hoog & Dix Export, Heemstede Netherland; (GAT). – 5137: *Allium rosenorum* R. M. FRITSCH 'Michael H. Hoog'; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5244: *Allium taeniopetalum* POPOV & VVED. subsp. *taeniopetalum*; *Acmopetala*; Uzbekistan; 4021N, 06602E; (GAT). – 5249: *Allium taeniopetalum* POPOV & VVED. subsp. *taeniopetalum*; *Acmopetala*; Uzbekistan; 4023N, 06603E; (GAT). – 5262: *Allium cristophii* TRAUTV.; *Kaloprason*; Turkmenistan; 3757N, 05759E; (GAT, photos). – 5263: *Allium stipitatum* Regel; *Megaloprason*; Turkmenistan; 3757N, 05759E; (GAT). – 5264: *Allium isakulii* R. M. Fritsch & F. O. Khass. subsp. *balkhanicum* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Turkmenistan; 3942N, 05428E (type location); (GAT). – 5272: *Allium helicophyllum* VVED.; *Kaloprason*; Turkmenistan; 3843N, 05616E; (GAT). – 5278: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *subkopetdagense* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Turkmenistan; 3829N, 05622E (type location); (GAT). – 5296: *Allium cyrilli* TEN.; *Melanocrommyum*; Turkey; 4157N, 02711E; (GAT). – 5321: *Allium multibulbosum* JACQ.; *Melanocrommyum*; Turkey; 3834N, 02727E; (GAT). – 5352: *Allium orientale* BOISS.; *Melanocrommyum*; Turkey; 3659N, 03030E; (GAT). – 5365: *Allium orientale* BOISS.; *Melanocrommyum*; Turkey; 3634N, 03022E; (GAT). – 5371: *Allium orientale* BOISS.; *Melanocrommyum*; Turkey; 3653N, 03020E; (GAT). – 5447: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; Chatkal mountain range; (GAT). – 5449: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; Chatkal mountain range, near Chimgan; (GAT). – 5451: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Uzbekistan; SW Hissar mountain range, pass Artusgar; (GAT). – 5455: *Allium macleanii* BAKER; *Compactoprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5475: *Allium stipitatum* REGEL; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5476: *Allium*-hybrid, subg. *Melanocrommyum* 'Globemaster'; Hoog & Dix-Export, Heemstede Netherland; (GAT). – 5477: *Allium*-hybrid, subg. *Melanocrommyum* 'Gladiator'; Hoog & Dix-Export, Heemstede Netherland; (GAT). – 5478: *Allium rosenorum* R. M. FRITSCH 'Purple King'; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5479: *Allium*-hybrid, subg. *Melanocrommyum* 'His Excellency'; Hoog & Dix-Export, Heemstede Netherland; (GAT). – 5480: *Allium stipitatum* REGEL 'White Giant'; *Megaloprason*; Hoog & Dix-Export, Heemstede, Netherlands; (GAT). – 5531: *Allium aschersonianum* W. BARBEY; *Melanocrommyum*; Israel; Jordan valley, near the border to Jordan; (GAT, photos). – 5562: *Allium aflatunense* B. FEDTSCH.; *Megaloprason*; Kyrgyzstan, received from Olomouc collection; (GAT). – 5614: *Allium rosenbachianum* REGEL s. l.; *Megaloprason*; Dushanbe Botanical Garden, Tajikistan; (GAT). – 5632: *Allium aflatunense* B. FEDTSCH.; *Megaloprason*; Kyrgyzstan; Central Tien-Shan mountain range, valley Kokomeren; (GAT). – 5669: *Allium gypsaceum* POPOV & VVED.; *Popovia*; Uzbekistan; 3812N, 06639E; (GAT, photos). – 5676: *Allium alaicum* VVED.; *Acmopetala*; Kyrgyzstan; 4031N, 07234E; (GAT). – 5679: *Allium pseudowinklerianum* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Kyrgyzstan; 4058N, 07333E; (GAT). – 5680: *Allium backhousianum* REGEL; *Acmopetala*; Kyrgyzstan; 4058N, 07333E; (GAT, photos). – 5685: *Allium fetisowii* REGEL; *Acmopetala*; Kyrgyzstan; 4245N, 07433E; (GAT). – 5686: *Allium saposhnikovii* NIKITINA; *Acmopetala*; Kyrgyzstan; 4245N, 07433E (type location); (GAT). – 5688: *Allium fetisowii* REGEL; *Acmopetala*; Kyrgyzstan; 4235N, 07454E; (GAT). – 5690: *Allium karataviense* REGEL; *Miniprason*; Kyrgyzstan; 4230N, 07321E; (GAT). – 5692: *Allium arkitense* R. M. FRITSCH; *Acmopetala*; Kyrgyzstan; 4150N, 07158E (type location); (GAT). – 5694:

Allium aflatunense B. FEDTSCH.; *Megaloprason*; Kyrgyzstan; 4150N, 07158E (near type location); (GAT). – 5695: *Allium dodecadontum* VVED.; *Acmopetala*; Kyrgyzstan; 4150N, 07158E (type location); (GAT). – 5699: *Allium viridiflorum* POBED.; *Verticillata*; Kyrgyzstan; 4150N, 07158E (type location); (GAT). – 5702: *Allium karataviense* REGEL; *Miniprason*; Kyrgyzstan; 4150N, 07158E; (GAT). – 5707: *Allium dodecadontum* VVED.; *Acmopetala*; Kyrgyzstan; 4139N, 07202E; (GAT). – 5713: *Allium karataviense* REGEL; *Miniprason*; Tajikistan; 4017N, 06926E; (GAT). – 5778: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 4108N, 07022E; (GAT, photos). – 5780: *Allium costatovaginatum* KAMELIN & LEVICHEV; *Acmopetala*; Uzbekistan; 4108N, 07022E; (GAT, photos). – 5783: *Allium costatovaginatum* KAMELIN & LEVICHEV; *Acmopetala*; Uzbekistan; 4108N, 07022E; (GAT, photos). – 5786: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *isakulii*; *Regeloprason*; Tajikistan; Mogoltau mountain range 4017N, 06927E (type location); (GAT). – 5788: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 6957N, 04138E; (GAT). – 5789: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; 6957N, 04138E; (GAT). – 5791: *Allium suworowii* REGEL; *Acmopetala*; Uzbekistan; 4845N, 04000E (near type location); (GAT). – 5793: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 4104N, 07034E; (GAT). – 5803: *Allium karataviense* REGEL; *Miniprason*; Tajikistan; 3951N, 07040E; (GAT, photos). – 5808: *Allium cupuliferum* REGEL subsp. *cupuliferum*; *Regeloprason*; Uzbekistan; Nuratau mountain range; (GAT). – 5837: *Allium decipiens* FISCH. ex SCHULT. & SCHULT. f. subsp. *quercetorum* SEREGIN; *Melanocrommyum*; Ukraina; Crimea, N Mt. Ayu-Dag; (GAT). – 5844: *Allium sewerzowii* REGEL; *Acmopetala*; Kazakhstan; Aksu-Zhabagly natural reserve; (GAT, photos). – 5873: *Allium caspium* (PALL.) M. BIEB. subsp. *baissunense* (LIPSKY) F. O. KHASS. & R. M. FRITSCH; *Kaloprason*; Uzbekistan; 3812N, 06715E (type location); (GAT, photos). – 5878: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Uzbekistan; 3835N, 06728E; (GAT). – 5879: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; 4140N, 06946E (type location); (GAT). – 5885: *Allium tashkenticum* F. O. Khass. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 4132N, 07002E; (GAT, photos). – 5888: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 4112N, 07015E; (GAT). – 5907: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Uzbekistan; 3850N, 06707E; (GAT). – 5908: *Allium komarowii* LIPSKY; *Compactoprason*; Uzbekistan; Hissar mountain range, near Kaltakul; (GAT). – 5910: *Allium taeniopetalum* POPOV & VVED. subsp. *mogoltavicum* (VVED.) R. M. FRITSCH & F. O. KHASS.; *Acmopetala*; Uzbekistan; 4121N, 06956E; (GAT). – 5916: *Allium stipitatum* REGEL; *Megaloprason*; Turkmenistan; 3758N, 05801E; (GAT). – 5917: *Allium regelii* TRAUTV.; *Regeloprason*; Turkmenistan; 3748N, 05822E (near type location); (GAT, photos). – 5919: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *subkopetdagense* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Turkmenistan; 3830N, 05705E; (GAT, photos). – 5920: *Allium cristophii* TRAUTV.; *Kaloprason*; Turkmenistan; 3821N, 05658E; (GAT). – 5922: *Allium brachyscapum* VVED.; *Acanthoprason*; Turkmenistan; 382030N, 0565630E; (GAT, photos). – 5927: *Allium caspium* (PALL.) M. BIEB. subsp. *caspium*; *Kaloprason*; Turkmenistan; 3915N, 05518E; (GAT). – 5931: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *balkhanicum* R. M. FRITSCH & F. O. KHASS.; *Regeloprason*; Turkmenistan; 3938N, 05421E; (GAT, photos). – 5936: *Allium caspium* (PALL.) M. BIEB. subsp. *caspium*; *Kaloprason*; Turkmenistan; 400142N, 0525242E; (GAT, photos). – 5937: *Allium regelii* TRAUTV.; *Regeloprason*; Turkmenistan; 384136N, 0564442E; (GAT, photos). – 5942: *Allium giganteum* REGEL; *Compactoprason*; Turkmenistan; 3757N, 05801E;

(GAT). – 5967: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Turkey; 3823N, 04323E; (GAT, photos). – 5977: *Allium cardiostemon* FISCH. & C. A. MEY.; *Pseudoprason*; Turkey; 3903N, 04345E; (GAT). – 5978: *Allium cardiostemon* FISCH. & C. A. MEY.; *Pseudoprason*; Turkey; 3916N, 04402E; (GAT). – 5980: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Turkey; 3930N, 04408E; (GAT). – 5I: *Allium robustum* KAR. & KIR.; *Melanocrommyum*; Kazakhstan; 4709N, 08206E; (GAT). – 6: *Allium* aff. *minutiflorum* REGEL; *Acanthoprason*; Iran; prov. Kurdestan, Chatan; (HCAT). – 6081: *Allium cardiostemon* FISCH. & C. A. MEY.; *Pseudoprason*; Armenia; 4023N, 04416E; (GAT). – 6086: *Allium cardiostemon* FISCH. & C. A. MEY.; *Pseudoprason*; Armenia; 4006N, 04448E; (GAT, photos). – 6086H: *Allium kingdonii* STEARN; subg. *Cyathophora*; China; 2702N, 10014E; (MB 14122). – 6090H: *Allium prattii* C. H. WRIGHT; subg. *Anguinum*; China; 3038N, 09312E; (OSBU). – 6102: *Allium cristophii* TRAUTV. s. lat.; *Kaloprason*; Iran; Alborz mountain range; (GAT, photos). – 6114: *Allium bucharicum* REGEL; *Kaloprason*; Tajikistan; 371745N, 0691528E (type location); (GAT, photos). – 6119: *Allium insufficiens* VVED.; *Acmopetala*; Tajikistan; 372249N, 0691243E; (GAT). – 6120: *Allium rosenbachianum* REGEL subsp. *rosenbachianum*; *Megaloprason*; Tajikistan; 372159N, 0691242E; (GAT). – 6122: *Allium giganteum* REGEL; *Compactoprason*; Tajikistan; 374358N, 0693945E; (GAT). – 6123: *Allium rosenbachianum* REGEL subsp. *rosenbachianum*; *Megaloprason*; Tajikistan; 374342N, 0693844E; (GAT, photos). – 6126: *Allium bucharicum* REGEL; *Kaloprason*; Tajikistan; 374531N, 0694000E; (GAT, photos). – 6129: *Allium trautvetterianum* REGEL; *Compactoprason*; Tajikistan; 374748N, 0701429E; (GAT, photos). – 6130: *Allium trautvetterianum* REGEL; *Compactoprason*; Tajikistan; 394752N, 0701334E; (GAT). – 6131: *Allium trautvetterianum* REGEL; *Compactoprason*; Tajikistan; 374733N, 0701459E; (GAT, photos). – 6132: *Allium rosenbachianum* REGEL subsp. *rosenbachianum*; *Megaloprason*; Tajikistan; 374730N, 0701415E; (GAT). – 6133: *Allium karataviense* REGEL; *Miniprason*; Tajikistan; 374755N, 0701411E; (GAT). – 6134: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 374755N, 0701411E; (GAT). – 6137: *Allium rosenbachianum* REGEL subsp. *rosenbachianum*; *Megaloprason*; Tajikistan; 3759N, 07011E; (GAT). – 6138: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 375905N, 0701051E (near type location); (GAT, photos). – 6140: *Allium rosenbachianum* REGEL subsp. *rosenbachianum*; *Megaloprason*; Tajikistan; 375858N, 0701028E; (GAT). – 6141: *Allium suworowii* REGEL; *Acmopetala*; Tajikistan; 375857N, 0701025E; (GAT). – 6143: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 380431N, 0701332E (type location); (GAT, photos). – 6144: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 380426N, 0701346E (type location); (GAT). – 6145: *Allium suworowii* REGEL; *Acmopetala*; Tajikistan; 375548N, 0701538E; (GAT). – 6147: *Allium karataviense* REGEL; *Miniprason*; Tajikistan; 380320N, 0702229E; (GAT). – 6148: *Allium giganteum* REGEL; *Compactoprason*; Tajikistan; Panj valley; (GAT). – 6150: *Allium macleanii* BAKER; *Compactoprason*; Tajikistan; 382629N, 0705556E; (GAT). – 6151: *Allium schugnanicum* VVED.; *Megaloprason*; Tajikistan; 372410N, 0712949E (type location); (GAT, photos). – 6153: *Allium chitralicum* F. T. WANG & TANG; *Brevicaule*; Tajikistan; 371200N, 0713208E; (GAT, photos). – 6157: *Allium hissaricum* VVED.; *Regeloprason*; Tajikistan; 381729N, 0691504E; (GAT). – 6158: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 381730N, 0691432E; (GAT). – 6159: *Allium rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH; *Megaloprason*; Tajikistan; 381728N, 0691502E; (GAT). – 6161: *Allium suworowii* REGEL; *Acmopetala*; Tajikistan; 384841N, 0684827E; (GAT, photos). –

6162: *Allium verticillatum* REGEL; *Verticillata*; Tajikistan; 384840N, 0684845E; (GAT). – 6169: *Allium taeniopetalum* POPOV & VVED. subsp. *mogoltavicum* (VVED.) R. M. FRITSCH & F. O. KHASS.; *Acmopetala*; Uzbekistan; 410730N, 0702135E; (GAT, photos). – 6171: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 413206N, 0695329E; (GAT, photos). – 6172: *Allium motor* Kamelin; *Acmopetala*; Uzbekistan; 413100N, 0700200E; (GAT, photos). – 6174: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; Chimgan massif, Aksai; (GAT). – 6175: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 414429N, 0700438E; (GAT). – 6176: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; 414542N, 0700504E; (GAT). – 6185: *Allium gypsaceum* POPOV & VVED.; *Popovia*; Uzbekistan; 380519N, 0672654E; (GAT, photos). – 6187: *Allium caspium* (PALL.) M. BIEB. subsp. *baissunense* (LIPSKY) F. O. KHASS. & R. M. FRITSCH; *Kaloprason*; Uzbekistan; 380533N, 0672651E (type location); (GAT, photos). – 6188: *Allium giganteum* REGEL; *Compactoprason*; Uzbekistan; 380533N, 0672651E; (GAT, photos). – 6189: *Allium aroides* POPOV & VVED.; *Aroidea*; Uzbekistan; 384946N, 0670715E; (GAT). – 6191: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Uzbekistan; 384906N, 0670740E; (GAT). – 6192: *Allium sarawschanicum* REGEL; *Megaloprason*; Uzbekistan; 384900N, 0670753E; (GAT, photos). – 6196: *Allium cupuliferum* REGEL subsp. *cupuliferum*; *Regeloprason*; Uzbekistan; 402154N, 0660057E (near type location); (GAT, photos). – 6201: *Allium verticillatum* REGEL; *Verticillata*; Uzbekistan; 400438N, 0674336E; (GAT, photos). – 6205: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 414202N, 0695555E (near type location); (GAT, photos). – 6208: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; 410702N, 0701418E; (GAT). – 6236: *Allium chelotum* WENDELBO; *Melanocrommyum*; Iran; 372136N, 0560043E; (GAT). – 6240: *Allium helicophyllum* VVED.; *Kaloprason*; Iran; 371851N, 0560011E; (GAT). – 6246: *Allium cristophii* TRAUTV.; *Kaloprason*; Iran; 372411N, 0561200E; (GAT). – 6248: *Allium sarawschanicum* REGEL; *Megaloprason*; Iran; 372636N, 0560439E; (GAT). – 6249: *Allium ellisii* HOOK. f.; *Kaloprason*; Iran; 363558N, 0585559E; (GAT). – 6254: *Allium ellisii* HOOK. f.; *Kaloprason*; Iran; 372604N, 0583526E; (GAT). – 6255: *Allium ellisii* HOOK. f.; *Kaloprason*; Iran; 372955N, 0583525E; (GAT). – 6258: *Allium giganteum* REGEL; *Compactoprason*; Iran; 373134N, 0583703E; (GAT). – 6259: *Allium sarawschanicum* REGEL; *Megaloprason*; Iran; 373134N, 0583703E; (GAT). – 6261: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 361201N, 0590514E; (GAT). – 6262: *Allium kuhsorkhense* R. M. FRITSCH & JOHARCHI; *Acanthoprason*; Iran; 361201N, 0590514E; (GAT, photos). – 6263: *Allium giganteum* REGEL; *Compactoprason*; Iran; 361207N, 0590530E; (GAT, photos). – 6278: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 390625N, 0685112E (type location); (GAT). – 6279: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 390733N, 0685150E (near type location); (GAT). – 6282: *Allium komarowii* LIPSKY; *Compactoprason*; Tajikistan; 391056N, 0685449E; (GAT, photos). – 6284: *Allium alexeianum* REGEL; *Kaloprason*; Tajikistan; 390336N, 0682045E; (GAT). – 6289: *Allium komarowii* LIPSKY; *Compactoprason*; Tajikistan; 390400N, 0682024E; (GAT). – 6290: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 390303N, 0681715E; (GAT). – 6291: *Allium alexeianum* REGEL; *Kaloprason*; Tajikistan; 390320N, 0681648E; (GAT). – 6292: *Allium winklerianum* REGEL; *Regeloprason*; Tajikistan; 390322N, 0681604E; (GAT). – 6296: *Allium komarowii* LIPSKY; *Compactoprason*; Tajikistan; 390850N, 0681718E (near type location); (GAT). – 6298: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 391220N, 0674829E; (GAT). – 6299: *Allium komarowii* LIPSKY; *Compactopra-*

son; Tajikistan; 391220N, 0674829E; (GAT, photos). – 6300: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 390641N, 0675050E; (GAT). – 6303: *Allium alexeianum* REGEL; *Kaloprason*; Tajikistan; 390612N, 0675035E; (GAT). – 6304: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 390642N, 0675038E; (GAT). – 6311: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Tajikistan; 391234N, 0674320E; (GAT). – 6313: *Allium komarowii* LIPSKY; *Compactoprason*; Tajikistan; Penjakent region, near Obiborik; (GAT, photos). – 6314: *Allium sarawschanicum* REGEL; *Megaloprason*; Tajikistan; 391238N, 0674312E; (GAT). – 6315: *Allium winklerianum* REGEL; *Regeloprason*; Tajikistan; 390428N, 0685206E; (GAT, photos). – 6340: *Allium rothii* ZUCC.; *Melanocrommyum*; Jordan; 321901N, 0373528E; (LI). – 6342: *Allium rothii* ZUCC.; *Melanocrommyum*; Jordan; 320115N, 0362500E; (LI). – 6345: *Allium rothii* ZUCC.; *Melanocrommyum*; Jordan; 300142N, 0352739E; (LI). – 6350: *Allium cupuliferum* REGEL subsp. *cupuliferum*; *Regeloprason*; Uzbekistan; 403131N, 0664604E; (GAT). – 6354: *Allium cupuliferum* REGEL subsp. *cupuliferum*; *Regeloprason*; Uzbekistan; Nuratau, north of village Uhum; (GAT). – 6356: *Allium cupuliferum* REGEL subsp. *cupuliferum*; *Regeloprason*; Uzbekistan; 403123N, 0664351E; (GAT). – 6357: *Allium altissimum* REGEL; *Megaloprason*; Uzbekistan; 403120N, 0664508E; (GAT). – 6362: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 411456N, 0694914E; (GAT). – 6364: *Allium costatovaginatum* KAMELIN & LEVICHEV; *Acmopetala*; Uzbekistan; 411449N, 0694926E; (GAT). – 6366: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 411448N, 0694933E; (GAT, photos). – 6369: *Allium motor* KAMELIN; *Acmopetala*; Uzbekistan; 411443N, 0695016E; (GAT). – 6370: *Allium stipitatum* REGEL; *Megaloprason*; Uzbekistan; 411433N, 0694916E; (GAT, photos). – 6372: *Allium taeniopetalum* POPOV & VVED. subsp. *mogoltavicum* (VVED.) R. M. FRITSCH & F. O. KHASS.; *Acmopetala*; Uzbekistan; 412138N, 0695532E; (GAT, photos). – 6373: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 412127N, 0695529E; (GAT). – 6377: *Allium severtzovioides* R. M. FRITSCH; *Acmopetala*; Uzbekistan; 414206N, 0700841E; (GAT). – 6388: *Allium elburzense* WENDELBO; *Kaloprason*; Iran; 360648N, 0511938E; (GAT). – 6390: *Allium derderianum* REGEL; *Acanthoprason*; Iran; 360904N, 0511840E; (GAT). – 6392: *Allium elburzense* WENDELBO; *Kaloprason*; Iran; 354522N, 0515723E (type location); (GAT). – 6397: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; 373512N, 0483717E (epitype accession); (GAT). – 6398: *Allium akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; 373422N, 0483440E; (GAT). – 6402: *Allium materculae* BORDZ.; *Acanthoprason*; Iran; 381958N, 0454828E; (GAT). – 6404: *Allium shelkovnikovii* GROSSH.; *Acanthoprason*; Iran; 381940N, 0454745E; (GAT). – 6405: *Allium shelkovnikovii* GROSSH.; *Acanthoprason*; Iran; 380817N, 0455437E; (GAT). – 6406: *Allium materculae* BORDZ.; *Acanthoprason*; Iran; 380817N, 0455437E; (GAT). – 6425: *Allium giganteum* REGEL; *Compactoprason*; Tajikistan; 384925N, 0695414E; (GAT). – 6427: *Allium macleanii* BAKER; *Compactoprason*; Tajikistan; 384357N, 0703557E; (GAT). – 6431: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 383734N, 0704007E; (GAT). – 6434: *Allium winklerianum* REGEL; *Regeloprason*; Tajikistan; 383813N, 0704246E (type location); (TAD). – 6438: *Allium giganteum* REGEL; *Compactoprason*; Tajikistan; 382556N, 0705524E; (GAT). – 6445: *Allium macleanii* BAKER; *Compactoprason*; Tajikistan; 383938N, 0720004E; (GAT). – 6446: *Allium giganteum* REGEL; *Compactoprason*; Tajikistan; 382914N, 0714742E; (GAT). – 6449: *Allium stipitatum* REGEL; *Megaloprason*; Tajikistan; 383425N, 0705103E; (GAT). – 6450: *Allium intradarvazicum* R. M. FRITSCH; *Regeloprason*; Tajikistan; 383724N,

0705149E; (GAT). – 6452: *Allium intradarvazicum* R. M. FRITSCH; *Regeloprason*; Tajikistan; 383802N, 0705206E (type location); (GAT). – 6454: *Allium intradarvazicum* R. M. FRITSCH; *Regeloprason*; Tajikistan; 382924N, 0705120E; (GAT). – 6461: *Allium rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH; *Megaloprason*; Tajikistan; 384224N, 0703311E; (GAT). – 6475: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 354749N, 0492124E; (GAT). – 6478: *Allium breviscapum* STAPF; *Acanthoprason*; Iran; 344537N, 0482604E (type location); (GAT). – 6479: *Allium stipitatum* REGEL; *Megaloprason*; Iran; prov. Hamadan, Assad Abad district; (GAT). – 6480: *Allium breviscapum* STAPF; *Acanthoprason*; Iran; 344022N, 0482512E; (GAT). – 6484: *Allium stipitatum* REGEL; *Megaloprason*; Iran, vegetable market in Assad Abad; (GAT). – 6485: *Allium stipitatum* REGEL; *Megaloprason*; Iran, vegetable market in Hamadan; (GAT). – 64855: *Allium* aff. *akaka* S. G. GMELIN ex SCHULT. & SCHULT. f.; *Acanthoprason*; Iran; prov. Zanjan, Mahneshan, Anguran, Belgheis Mts.; (TARI 64855). – 6487: *Allium hamedanense* R. M. FRITSCH; *Melanocrommyum*; Iran; 344511N, 0483615E (type location); (GAT). – 6489: *Allium bisotunense* R. M. FRITSCH; *Melanocrommyum*; Iran; 342725N, 0473442E (type location); (GAT). – 6490: *Allium noëanum* REUT. ex REGEL; *Melanocrommyum*; Iran; 341640N, 0464933E; (IRAN). – 6491: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 341407N, 0464012E; (GAT). – 6496: *Allium jesdianum* BOISS. & BUHSE subsp. *remediorum* R. M. FRITSCH; *Megaloprason*; Iran, vegetable market in Kerend; (GAT). – 6498: *Allium jesdianum* BOISS. & BUHSE subsp. *remediorum* R. M. FRITSCH; *Megaloprason*; Iran; 345807N, 0462744E (type location); (GAT). – 6499: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 345814N, 0462755E; (GAT). – 6500: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 345814N, 0462755E; (IRAN). – 6501: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 342543N, 0472301E; (GAT). – 6502: *Allium stipitatum* REGEL; *Megaloprason*; Iran; 352152N, 0465210E; (GAT). – 6503: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 352214N, 0465129E (type location); (IRAN 43975). – 6506: *Allium saralicum* R. M. FRITSCH; *Melanocrommyum*; Iran; 354023N, 0470722E (type location); (GAT). – 6507: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 360057N, 0465552E; (GAT). – 6508: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 360101N, 0485548E; (GAT). – 6509: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 360336N, 0465147E; (IRAN). – 6516: *Allium derderianum* REGEL; *Acanthoprason*; Iran; 360212N, 0511200E; (GAT). – 6519: *Allium elburzense* WENDELBO; *Kaloprason*; Iran; 360646N, 0511936E; (GAT). – 6523: *Allium jesdianum* BOISS. & BUHSE subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH; *Megaloprason*; Uzbekistan; 380122N, 0665014E; (GAT). – 6525: *Allium verticillatum* REGEL; *Verticillata*; Uzbekistan; 380220N, 0665121E; (GAT). – 6526: *Allium protensum* WENDELBO; *Kaloprason*; Uzbekistan; 380240N, 0665128E; (GAT, photos). – 6528: *Allium alexeianum* REGEL; *Kaloprason*; Uzbekistan; 3938N, 06829E; (GAT). – 6530: *Allium komarowii* LIPSKY; *Compactoprason*; Uzbekistan; 393827N, 0683011E; (GAT). – 6531: *Allium taeniopetalum* POPOV & VVED.; *Acmopetala*; Uzbekistan; 394040N, 0682903E; (GAT). – 6532: *Allium suworowii* REGEL; *Acmopetala*; Uzbekistan; 394536N, 0682441E; (GAT). – 6533: *Allium karataviense* REGEL; *Miniprason*; Uzbekistan; 414207N, 0700801E; (GAT). – 6535: *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH; *Acmopetala*; Uzbekistan; 414204N, 0700816E; (GAT). – 6553: *Allium darwasicum* REGEL; *Regeloprason*; Tajikistan; 385325N, 0705542E; (GAT). – 6557: *Allium darwasicum*

REGEL; *Regeloprason*; Tajikistan; 385233N, 0710538E; (GAT). – 6565: *Allium robustum* KAR. & KIR.; *Melanocrommyum*; Kazkhstan; 4747N, 08220E; (GAT). – 6570: *Allium rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH; *Megaloprason*; Tajikistan; 385422N, 0710135E; (GAT). – 6597: *Allium rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH; *Megaloprason*; Tajikistan; 384228N, 0703303E; (GAT). – 6612: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 341721N, 0501144E; (GAT). – 6613: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 341544N, 0494532E; (GAT). – 6616: *Allium moderense* R. M. FRITSCH; *Melanocrommyum*; Iran; 340613N, 0493834E (type location); (GAT). – 6617: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 335215N, 0492649E; (GAT). – 6620: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 335205N, 0492613E; (GAT). – 6621: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Markazi, N Razvand massif; (IRAN). – 6622: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 335210N, 0492628E; (GAT). – 6625: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 335204N, 0492627E; (GAT). – 6627: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 335837N, 0500704E; (GAT). – 6628: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 335841N, 0500647E; (GAT). – 6629: *Allium moderense* R. M. FRITSCH; *Melanocrommyum*; Iran; 355825N, 0500642E; (IRAN). – 6630: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 335305N, 0485812E; (GAT). – 6632: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 333325N, 0484950E; (GAT). – 6633: *Allium zagricum* R. M. FRITSCH; *Acanthoprason*; Iran; 333324N, 0484948E; (GAT). – 6635: *Allium jesdianum* BOISS. & BUHSE subsp. *remediorum* R. M. FRITSCH; *Megaloprason*; Iran; prov. Lurestan, market in Khorram Abad; (GAT). – 6637: *Allium jesdianum* BOISS. & BUHSE subsp. *remediorum* R. M. FRITSCH; *Megaloprason*; Iran; 335836N, 0482021E; (GAT). – 6638: *Allium jesdianum* BOISS. & BUHSE subsp. *remediorum* R. M. FRITSCH; *Megaloprason*; Iran; 335834N, 0482041E; (GAT). – 6639: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 335828N, 0482052E; (GAT). – 6640: *Allium zagricum* R. M. FRITSCH; *Acanthoprason*; Iran; 335813N, 0482140E; (GAT). – 6641: *Allium zagricum* R. M. FRITSCH; *Acanthoprason*; Iran; 335813N, 0482140E; (GAT). – 6643: *Allium zagricum* R. M. FRITSCH; *Acanthoprason*; Iran; 333836N, 0482731E (type location); (GAT). – 6644: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 333836N, 0482731E; (GAT). – 6648: *Allium haemanthoides* BOISS. & REUT. ex REGEL s. str.; *Acanthoprason*; Iran; 350053N, 0462133E (type location); (GAT). – 6651: *Allium keusgenii* R. M. FRITSCH; *Melanocrommyum*; Iran; 343858N, 0473650E (type location); (GAT). – 6652: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; 343910N, 0473656E; (GAT). – 6657: *Allium derderianum* REGEL; *Acanthoprason*; Iran; 355200N, 0512330E; (GAT). – 6658: *Allium elburzense* WENDELBO; *Kaloprason*; Iran; 355144N, 0512307E; (IRAN). – 6682: *Allium nigrum* L.; *Melanocrommyum*; Greece; 351046N, 0243359E; (GAT, photos). – 6692: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 332906N, 0515758E; (IRAN). – 6694: *Allium* sp. 1 *"chlorotepalum"*; *Acanthoprason*; Iran; 325512N, 0503350E; (GAT). – 6697: *Allium* sp. 1 *"chlorotepalum"*; *Acanthoprason*; Iran; 325523N, 0503330E (type location); (GAT). – 6699: *Allium* sp.; *Acanthoprason*; Iran; 325523N, 0503330E; (IRAN). – 6703: *Allium cathodicarpum* WENDELBO; *Regeloprason*; Iran; 302339N, 0531258E; (IRAN). – 6704: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 294113N, 0520326E; (GAT). – 6706: *Allium jesdianum* BOISS. & BUHSE; *Mega-*

loprason; Iran; 293730N, 0520038E; (IRAN). – 6708: *Allium austroiranicum* R. M. FRITSCH; *Pseudoprason*; Iran; 293712N, 0520031E; (GAT). – 6709: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 301806N, 0515755E; (GAT). – 6710: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 301806N, 0515755E; (GAT). – 6711: *Allium stipitatum* REGEL s. lat.; *Megaloprason*; Iran; 302349N, 0515431E; (IRAN). – 6712: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 302349N, 0515431E; (GAT). – 6716: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 313637N, 0540558E (type location); (GAT). – 6722: *Allium scotostemon* WENDELBO; *Thaumasioprason*; Iran; 354707N, 0522233E; (IRAN). – 6734: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 325523N, 0503330E; (GAT). – 6736: *Allium verticillatum* REGEL; *Verticillata*; Uzbekistan; 300953N, 0665846E; (GAT, photos). – 6737: *Allium caspium* (PALL.) M. BIEB. subsp. *baissunense* (LIPSKY) F. O. KHASS. & R. M. FRITSCH; *Kaloprason*; Uzbekistan; 373207N, 0664119E; (GAT, photos). – 6738: *Allium gypsaceum* POPOV & VVED.; *Popovia*; Uzbekistan; 373517N, 0663258E; (GAT, photos). – 6739: *Allium verticillatum* REGEL; *Verticillata*; Uzbekistan; 380427N, 0681332E; (GAT, photos). – 6740: *Allium caspium* (PALL.) M. BIEB. subsp. *baissunense* (LIPSKY) F. O. KHASS. & R. M. FRITSCH; *Kaloprason*; Uzbekistan; 380716N, 0661323E; (GAT, photos). – 6741: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Uzbekistan; 383028N, 0673930E; (GAT, photos). – 6742: *Allium suworowii* REGEL; *Acmopetala*; Uzbekistan; 383208N, 0673353E; (GAT, photos). – 6743: *Allium nevskianum* VVED. ex WENDELBO; *Kaloprason*; Uzbekistan; 383157N, 0673444E; (GAT, photos). – 6744: *Allium giganteum* Regel; *Compactoprason*; Uzbekistan; 380446N, 0672536E; (GAT, photos). – 6745: *Allium protensum* WENDELBO; *Kaloprason*; Uzbekistan; 381510N, 0670140E; (GAT, photos). – 6746: *Allium giganteum* REGEL; *Compactoprason*; Uzbekistan; 380828N, 0680659E; (GAT, photos). – 6747: *Allium rosenorum* R. M. FRITSCH; *Megaloprason*; Uzbekistan; 385045N, 0670706E; (GAT, photos). – 6748: *Allium komarowii* LIPSKY; *Compactoprason*; Uzbekistan; 305028N, 0670736E; (GAT, photos). – 6749: *Allium majus* VVED.; *Compactoprason*; Uzbekistan; 391156N, 0671715E; (GAT, photos). – 6750: *Allium* sp.; *Acmopetala?*; Uzbekistan; 410539N, 0704231E; (GAT, photos). – 6913H: *Allium* sp. 3; *Acanthoprason*; Iran; prov. Azarbeijan, Piranshahr, Mt. Dalanpar; (Sanandaj 6913). – 6I: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; 4556N, 08003E; (GAT). – 70664: *Allium* aff. *egorovae* M. V. AGAB. & OGAN.; *Acanthoprason*; Iran; prov. Azarbeijan, Arasbaran to Ahar 7 km to Barzid village; (TARI 70664). – 7600H: *Allium* sp. 4 *"mozaffarianii"*; *Melanocrommyum*; Iran; prov. Kurdestan, Sanandaj to Divandarreh, near Abbas-Abad; (Sanandaj 7600). – 7709H: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Kurdestan, Saghez to Baneh, Piromaran village; (Sanandaj 7709). – 7880H: *Allium* sp. 8; *Acanthoprason*; Iran; prov. Kurdestan, cultivated in Sanandaj; (Sanandaj 7880). – 7I: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; 443400N, 0763800E; (GAT). – 8196H: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Kurdestan, Mt. Koremyryam SW Sanadaj; (Sanandaj 8196). – 8464H: *Allium* sp. 3; *Acanthoprason*; Iran; prov. Kurdestan, Maryvan; (Sanandaj 8464). – 8465H: *Allium* sp. 3; *Acanthoprason*; Iran; prov. Kurdestan, Maryvan; (Sanandaj 8465). – 8480H: *Allium* aff. *egorovae* M. V. AGAB. & OGAN.; *Acanthoprason*; Iran; prov. E Azarbeijan, Arasbaran, Mt. Doghoron; (Sanandaj 8480). – 8684H: *Allium* sp. 4 *"mozaffarianii"*; *Melanocrommyum*; Iran; prov. Kurdestan, Maryvan, Darband Dezli; (Sanandaj 8684). – 8858H: *Allium* sp. 5; *Acanthoprason*; Iran; prov. Kurdestan, Maryvan, Mt. Dalani; (Sanandaj 8858). – 8860H:

Allium bisotunense R. M. FRITSCH; *Melanocrommyum*; Iran; prov. Kurdestan, cultivated in Sanandaj; (Sanandaj 8860). – 8861H: *Allium bisotunense* R. M. FRITSCH; *Melanocrommyum*; Iran; prov. Kurdestan, Kamiaran; (Sanandaj 8861). – 8863H: *Allium* sp. 5; *Acanthoprason*; Iran; prov. Kurdestan, Maryvan, Mt. Dalani; (Sanandaj 8863). – 8I: *Allium tulipifolium* LEDEB.; *Melanocrommyum*; Kazakhstan; 444500N, 0762100E; (GAT). – 9: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; prov. Kurdestan, Saral area; (HCAT). – 9001I: *Allium hooshidaryae* MASHAYEKHI, ZARRE & R. M. FRITSCH; *Compactoprason*; Iran; prov. Kurdestan (near type location); (Sanandaj). – 9002I: *Allium* aff. *koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; prov. Kurdestan; (Sanandaj). – 9003I: *Allium haemanthoides* BOISS. & REUT. ex REGEL s. str.; *Acanthoprason*; Iran; prov. Kurdestan; (Herbarium Sanandaj). – 9I: *Allium protensum* WENDELBO; *Kaloprason*; Kazakhstan; 444500N, 0762100E; (GAT). – ISR09: *Allium* aff. *nigrum* L.; *Melanocrommyum*; Israel; Mt. Meriron; (HUJ). – JA009: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Esfahan, 5 km E Daran; (GAT, photos). – JA014: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Chaharmahal-Bakhtiari, Kuh-e Kallar; (GAT, photos). – JA015: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Chaharmahal-Bakhtiari, Kuh-e Kallar; (GAT, photos). – JA022: *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO; *Pseudoprason*; Iran; prov. Kermanshah, Noah Kuh near Kerend; (GAT, photos). – JA026: *Allium breviscapum* STAPF; *Acanthoprason*; Iran; prov. Hamedan, Kuh-e Alvand; (GAT, photos). – JA029: *Allium* aff. *derderianum* REGEL; *Acanthoprason*; Iran; prov. Qazvin, pass N Qazvin; (GAT, photos). – JA031: *Allium* aff. *derderianum* REGEL; *Acanthoprason*; Iran; prov. Qazvin, second pass N Qazvin; (GAT, photos). – JA039: *Allium materculae* BORDZ. subsp. *graveolens* R. M. FRITSCH; *Acanthoprason*; Iran; 342721N, 0502574E; (GAT, photos). – JA047: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 321432N, 0501312E; (GAT, photos). – JA050: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; 321675N, 0501339E; (GAT, photos). – JA057: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Kurdestan, 10 km W Sanandaj; (GAT, photos). – JA060: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 352322N, 0464340E; (GAT, photos). – JA066: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 364447N, 0453213E; (GAT, photos). – JA076: *Allium* aff. *ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 364110N, 0484420E; (GAT, photos). – JA079: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Esfahan, near Melmand; (GAT, photos). – JA082: *Allium austroiranicum* R. M. FRITSCH; *Acanthoprason*; Iran; prov. Chaharmahal-Bakhtiari, pass Cheri; (GAT, photos). – JA090: *Allium jesdianum* BOISS. & BUHSE subsp. *jesdianum*; *Megaloprason*; Iran; 302747N, 0514103E; (GAT, photos). – JA097: *Allium* sp. 1 *"chlorotepalum"*; *Acanthoprason*; Iran; 325507N, 0503357E; (GAT, photos). – JA105: *Allium ubipetrense* R. M. FRITSCH; *Acanthoprason*; Iran; 335246N, 0492719E; (GAT, photos). – JA115: *Allium stipitatum* REGEL; *Megaloprason*; Iran; 331948N, 0495115E; (GAT, photos). – OS: *Allium schubertii* ZUCC.; *Kaloprason*; Botanical Garden Osnabrück, Germany; (OSBU). – Un10: *Allium* sp. 6 (aff. *A. minutiflorum*); *Melanocrommyum* ?; Iran; prov. Kurdestan, Saral area; (HCAT). – Un8: *Allium* sp. 7 (aff. *A. hooshidaryae*); *Compactoprason* ?; Iran; prov. Kurdestan, Saral area; (HCAT).

3. Results and Discussion of Molecular and Morphological Data

Addition of more species and accessions did not change the principal genetic substructure of *A.* subg. *Melanocrommyum* shown by GURUSHIDZE & al. 2008. The investigated species formed a basal grade characterized by statistically well supported divisions, and a core clade (Fig. 1). The 7 different clusters in the core clade retained as monophyletic units in the applied (phenetic, cladistic, and model-based) algorithms. The phylogenetic relationships among these clusters were not resolved, but the clusters were more or less well-supported in all analyses. Also some groups within and beside of these clusters got good statistical support despite their phylogenetic positions remained unclear. Altogether two groups (A, B) were recognized in the grade, and 10 more groups (C – L) in the clade. Thus, clusters and main groups of the ITS-tree, as discussed by GURUSHIDZE & al. 2008, form a well applicable measure for the following presentation of genetic relations.

3.1. Outgroups

Several species of the subgenera *Anguinum, Butomissa, Caloscordum, Porphyroprason, Reticulatobulbosa,* and *Vvedenskya* were included in this study as outgroup (Fig. 2 A). All accessions clustered only basally thus confirming the monophyly of subg. *Melanocrommyum*. The position of several species differs from the generic classification shown by FRIESEN & al. 2006, which may well be caused by long branch attraction as already discussed by GURUSHIDZE & al. 2008.

3.2. Basal Grade

3.2.1. sect. *Longibidentata*

Allium fetisowii and *A. chychkanense* from western Tianshan mountain range were recently split off from sect. *Acmopetala* at sectional level (FRITSCH 2009). They are morphologically rather similar (FRITSCH 2009), but their molecular characters differ remarkably and show much diversity. Analysis of additional material can perhaps clarify these relations.

These species are sister to all other clusters and groups (Fig. 1, Fig. 2 A) of subg. *Melanocrommyum*. Morphologically they are similar to some members of sect. *Acmopetala* and were formerly included there (KHASSANOV & FRITSCH 1994). According to our molecular data, sect. *Acmopetala* is to be split in several parts positioned in different clusters of the core clade (see chapters 3.5.4., 3.7.3 - 3.7.5, 3.8.1).

3.2.2. sect. *Decipientia*

Another species group, hitherto affiliated to sect. *Melanocrommyum,* contains the basal *A. decipiens* from Crimea and Caucasus, *A. viridulum*

(which is exceptional in having granulous periclinal walls of seed coat without verrucae, FRITSCH & al. 2006), *A. chelotum* from northern Iran, and *A. tulipifolium* from South Siberia (Fig. 2 A). Here we should point to an error in naming voucher specimens published in GURUSHIDZE & al. 2008 where *A. viridulum* and *A. robustum* were merged. It is perhaps a sign for a phylogenetically old bifurcation that *A. chelotum* from northern Iran is close to the geographically very distant *A. tulipifolium* alliance. Our molecular data do not support separation of the South Kazakh steppe plants of *A. tulipifolium* as *A. vakhtinae* (nom. nud.) by SEISUMS 1994, "holotype" in LE. Material of some possibly related species from Mongolia and western China was not available for study.

The above discussed species are characterized by rather narrow (at least 8 times longer than wide) and not undulate leaf blades, rose, lilac, or carmine (not white) tepals, tuberculate (not glossy or nearly smooth) surface of ovaries, and dominating S-like undulation of anticlinal walls of the seed coat (FRITSCH & al. 2006). They occupy a taxonomic position far from sect. *Melanocrommyum* (which constitutes the molecularly well characterized "group C", GURUSHIDZE & al. 2008, distantly positioned in the core clade, see Fig. 1 and chapters 3.3.2. and 3.3.3.) and represent a well separable section:

Allium sect. *Decipientia* (OMELCZUK) R. M. FRITSCH, **comb. & stat. nov.**

Basionym: *Allium* [sect. *Melanocrommyum* s. lat.] series *Decipientia* OMELCZUK in Ukr. Bot. Zh. 19, 3: 71, 1962. Type: *Allium decipiens* FISCH. ex SCHULT. & SCHULT. f.

The well-supported sistergroup relationship of *A. robustum*, another Siberian taxon, to *A. zergericum* and the whole core clade would support recognition as monotypic section, but we were not able yet to find out reliable morphological characters separating *A. robustum* from sect. *Decipientia*.

Surprisingly, *A. zergericum*, which is sister to the large core clade, belongs morphologically to the Alai-Fergan group of sect. *Acmopetala* (see chapter 3.8.1). On the other hand, several characters of the seed coat (FRITSCH & al. 2006) are much more similar to the species of sect. *Longibidentata* than to the Alai-Fergan group. More material would be essential to verify this topology of *A. robustum* and *A. zergericum*.

3.3. Core Clade, Cluster 1

All other investigated species were positioned in the core clade. The first cluster (Figs. 2 A, 2 B) consisted mainly of members of the sections *Melanocrommyum* and *Acanthoprason*, both in the narrow sense, sect. *Porphyroprason*, as well as a few species of sect. *Regeloprason*. Three main groups and some taxa with unresolved relations were also included here.

3.3.1. sect. *Pseudoprason* in the strict sense

This well supported and rather homogeneous group occupies the most basal position in cluster 1 (Fig. 2 A). It is divided in a small basal subgroup (*A. hooshidaryae* as well as two undetermined taxa only known from single herbarium specimens), plus *A. koelzii*. The first species shows some morphological similarity to sect. *Compactoprason* (where it was affiliated hitherto) as well as to *A. koelzii*. All taxa positioned in this group stem from the Northwest Iranian parts of Zagros mountain range. The peculiar flower characters (FRITSCH & al. 2007) as well as the permanently green ovaries are a good reason to hold *A. koelzii* separate at sectional level, but additional material would be necessary to clarify the correct relations to the other taxa. The singular separate position of acc. 9 may point to a hybrid state of this herbarium specimen.

3.3.2. sect. *Melanocrommyum* in the narrow sense

Although we added 20 more accessions in comparison to GURUSHIDZE & al. 2008, the species we investigated represent only a small part of up to 50 species affiliated to this section by different authors. Most basal and sister to the other three groups and sect. *Acanthoprason* (Fig. 1, Fig. 2 A) remained group "C" of GURUSHIDZE & al. 2008 comprising at basal position some East Mediterranean species, *A. aschersonianum*, *A. schubertii* (exceptional here as member of sect. *Kaloprason* which was also reported from the Libyan Cyrenaica), and *A. nigrum* as neo-typified by SEISUMS 1998. These species own green coarse ovaries. Advanced are two subgroups of closely related "species-pairs" from Central to Southeast Europe and the West Mediterranean characterized by smooth and at begin of anthesis black ovaries. These are the pair *A. multibulbosum* (*A. nigrum* in the traditional sense) and *A. atropurpureum*, and as second pair *A. orientale* (plants from Turkey) and *A. cyrilli*. All these species share one haplotype of the *trn*L-*trn*F region of chloroplast DNA, and most taxa possess also additional species-specific haplotypes (GURUSHIDZE & al. in press).

3.3.3. sect. *Melanocrommyum* in the wide sense

Other species traditionally affiliated to sect. *Melanocrommyum* group together (Fig. 2 A) but their phylogenetic relations to sect. *Acanthoprason* remained unresolved. They all share black ovaries. One small but well separated subgroup comprises only *A. bisotunense* and *A. keusgenii* from NW Iran, another subgroup *A. noëanum, A. saralicum*, and a hitherto undescribed species occuring also in NW Iran. A third subgroup comprises *A. "orientale"* and *A. "nigrum"* (from Israel, which do not belong to these species in a strict sense), *A. rothii* (an East Mediterranean desert species), and, more distantly related, *A. chrysantherum* sensu lato (to which another

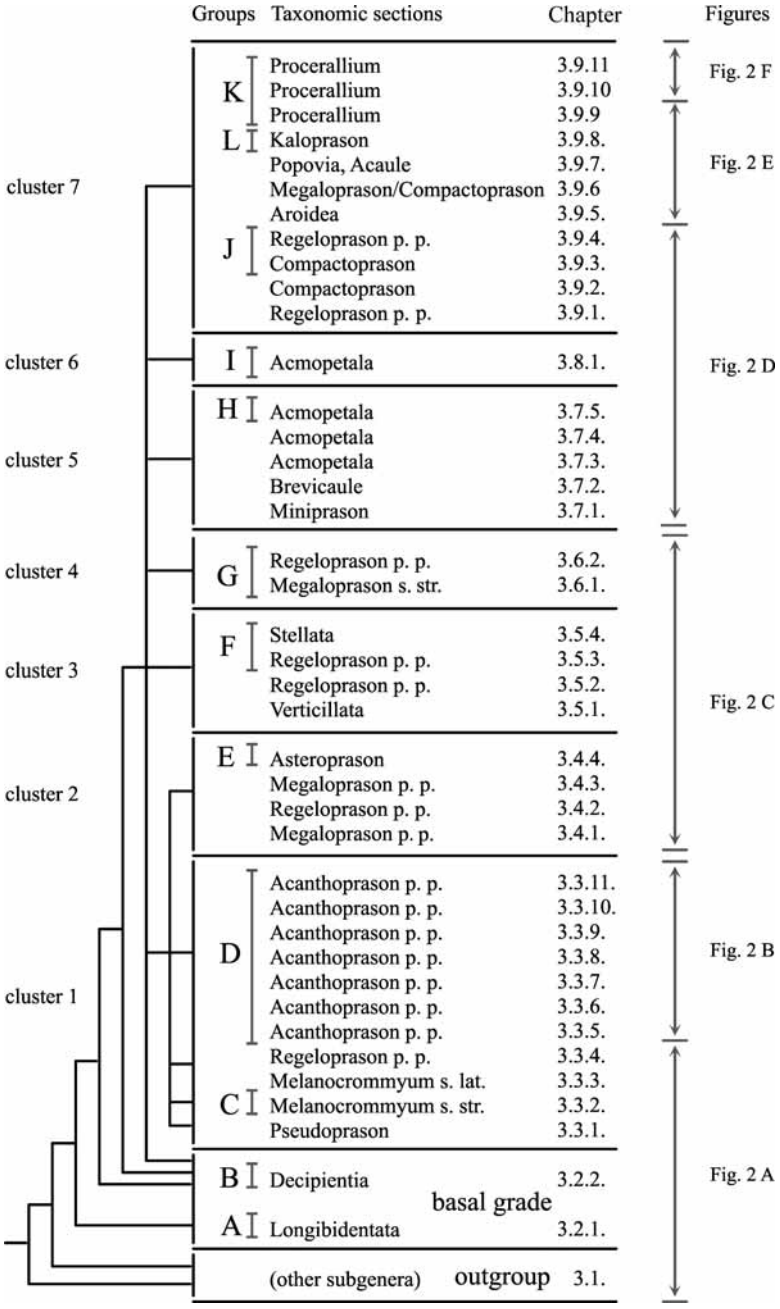

Fig. 1. Schematic overview of the presentation of results in the chapter "3. Results and Discussion"

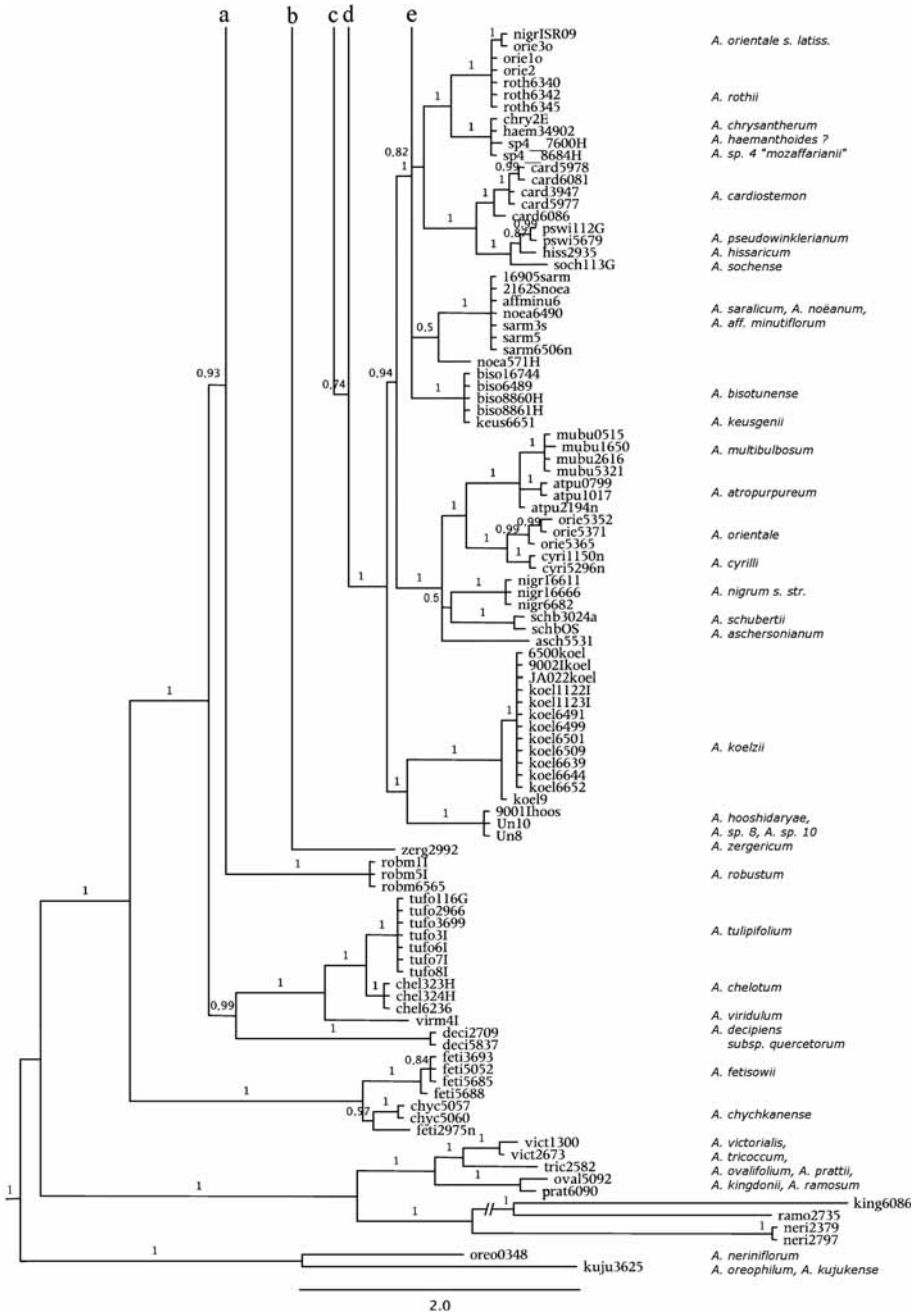

Fig. 2 A. Bayesian dendrogram, basal part: outgroups, basal grade, lower part of cluster1 of core clade

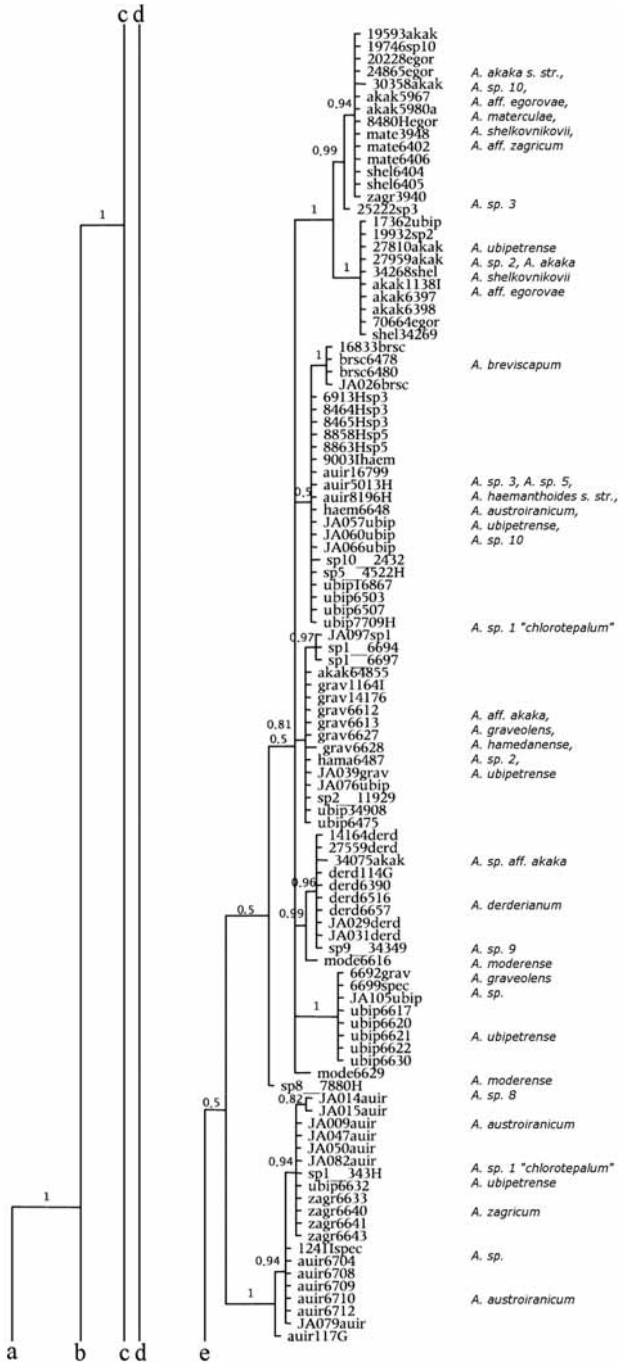

Fig. 2 B. Bayesian dendrogram, second part: core clade, upper part of cluster 1 (sect. *Acanthoprason*).

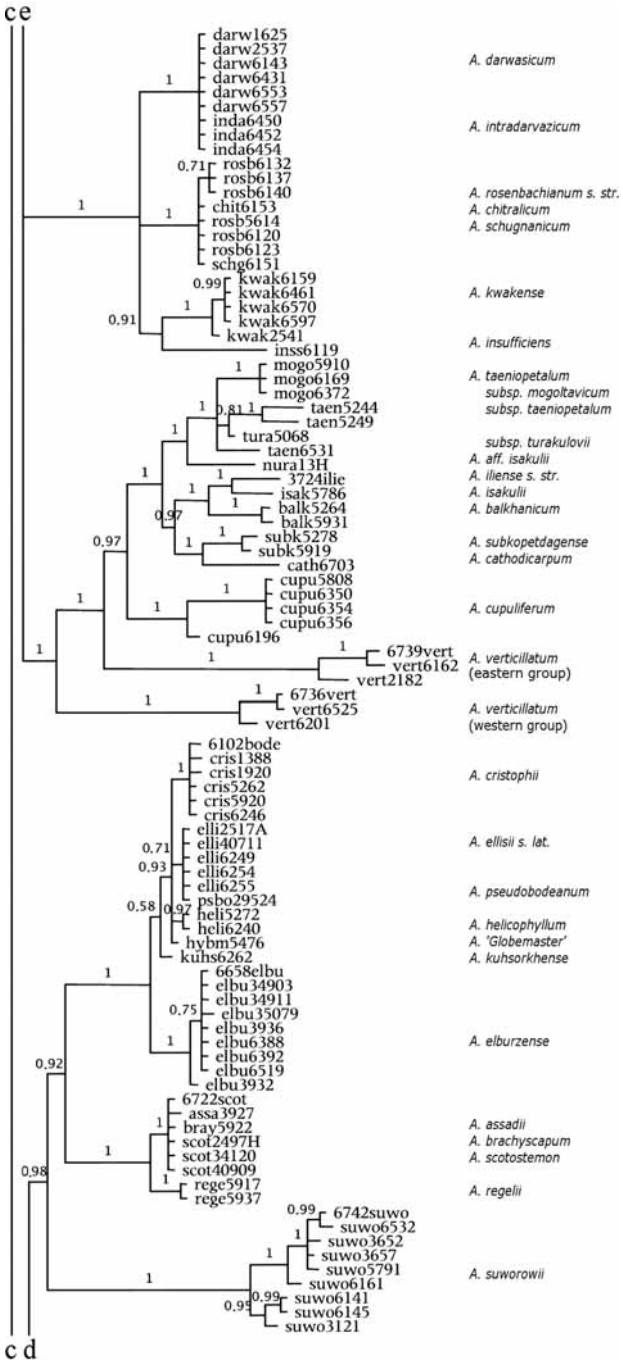

Fig. 2 C. Bayesian dendrogram, third (submedian) part: core clade, clusters 2, 3, and 4.

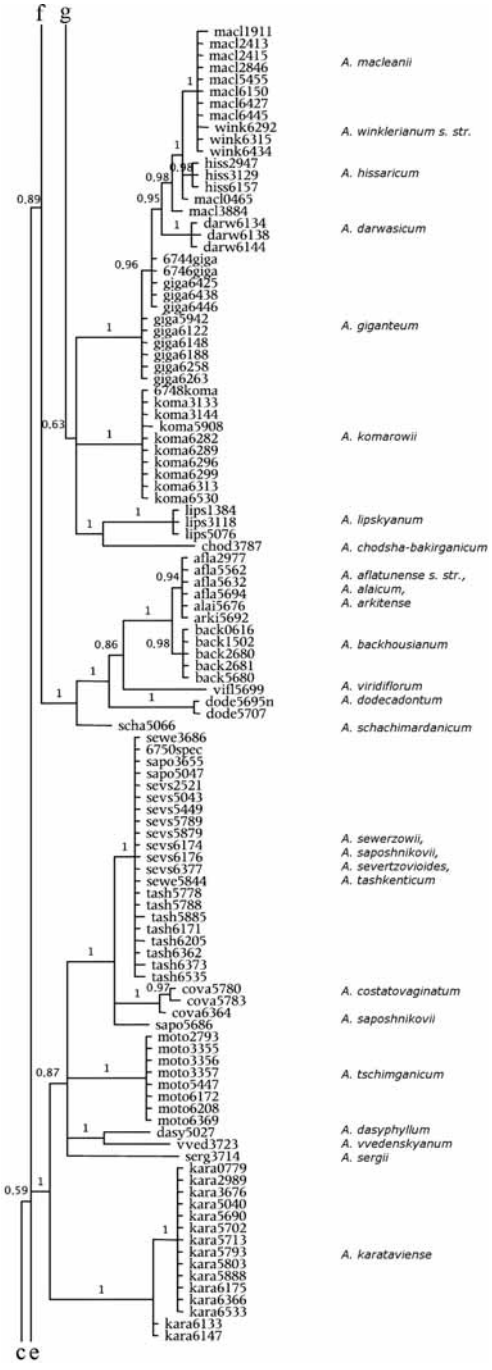

Fig. 2 D. Bayesian dendrogram, fourth (upper median) part: core clade, clusters 5, 6, and lower part of cluster 7.

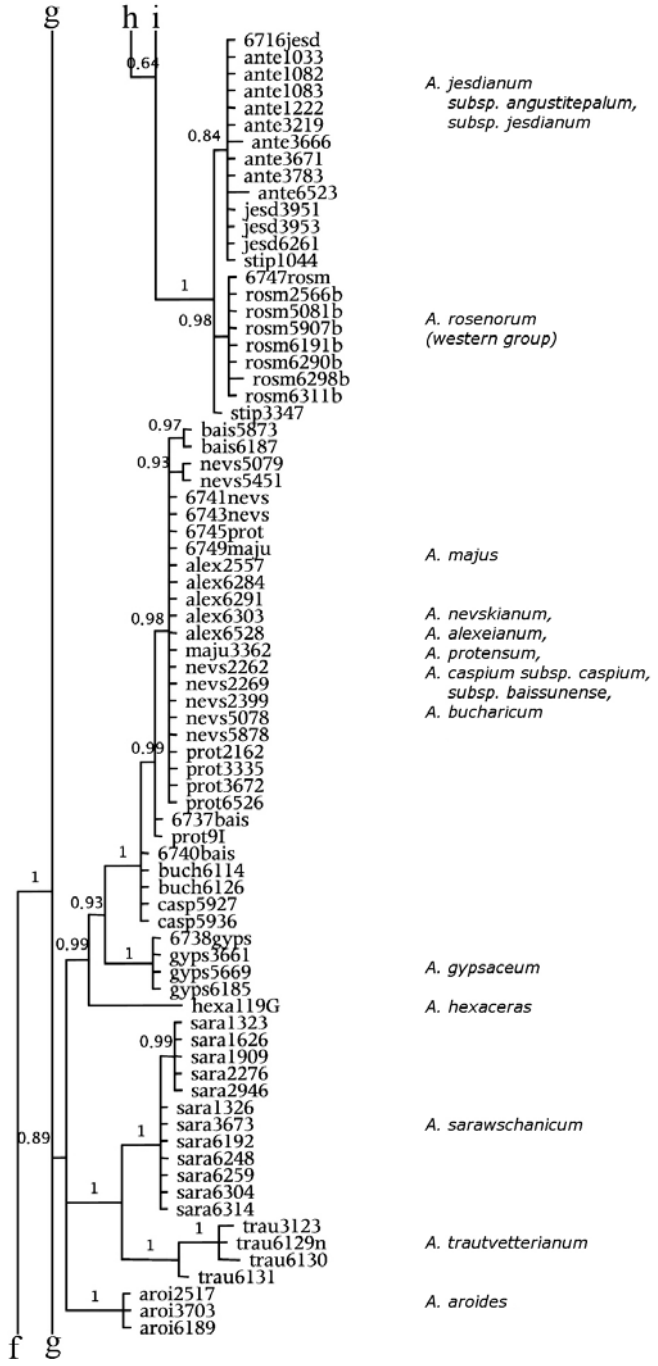

Fig. 2 E. Bayesian dendrogram, fifth (below upper) part: core clade, median part of cluster 7.

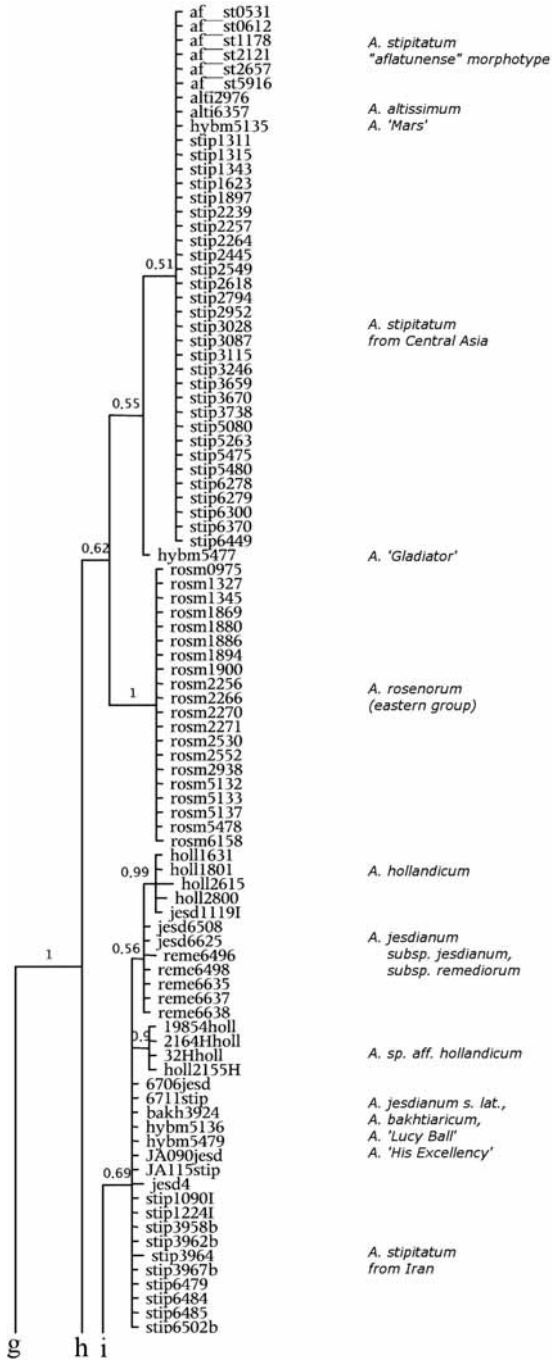

Fig. 2 F. Bayesian dendrogram, uppermost part: core clade, upper part of cluster 7.

not yet described species belongs) from Iran and Iraq, and the fourth subgroup the rather inhomogeneous (but without geographic correlation) *A. cardiostemon* from Armenia, Turkey, and Iran. Also the *A. pseudowinklerianum* alliance of sect. *Regeloprason* (see next chapter) belongs to the fourth subgroup.

Our results strongly underline that several well separated taxa exist in this area, and completely disagree with the taxonomic concept presented by DE WILDE-DUYFJES 1976 for the *A. orientale* group. A careful morphological and taxonomic analysis of this group based on more accessions from the eastern and south-eastern Mediterranean region seems urgently necessary.

As long as the phylogenetic relationships of these different subgroups are unresolved, all these species should remain members of sect. *Melanocrommyum*. This holds also true for *A. cardiostemon* because our data exclude the alternatively proposed affiliation to sect. *Pseudoprason* (GREGORY & al. 1998). As far as investigated, the different *trn*L-*trn*F haplotypes (GURUSHIDZE & al. in press) of all the species discussed in this chapter belong to one lineage confirming thus the affiliation to the same taxonomic group.

3.3.4. *Allium pseudowinklerianum* Alliance of sect. *Regeloprason*

Only few species of sect. *Regeloprason* belong to the first cluster (Fig. 2 A). In the dendrogram of GURUSHIDZE & al. 2008 they formed jointly with *A. cardiostemon* a well supported subgroup, and the separation became even better in our dendrogram. Despite all species share pinkish-purple flowers, their leaf characters differ strongly. *A. pseudowinklerianum* (Fergan mountain range) has straight, broad, and smooth leaves, but *A. sochense* (Central Turkestan mountain range) has very narrow, curled leaves. Both taxa are narrow endemics from Kyrgyzstan. The leaves of *A. hissaricum* (Central Tajikistan) are rough, linear, and moderately narrow. One accession of this species was also included in this subgroup, but all other accessions belong to cluster 7 (chapter 3.9.4., Fig. 2 D). Analyses of more material would be essential to prove this position in cluster 1 as sister of *A. cardiostemon*.

Rather small and stout plants developing more or less stinging tepals after anthesis were traditionally affiliated to sect. *Acanthoprason* which is typified by *A. akaka*. However, WENDELBO 1973 used this name in a very broad sense subsuming also *A. shelkovnikovii* and *A. haemanthoides* (WENDELBO 1971 accepted this name for a very variable taxon) as subspecies under *A. akaka*. Because herbarium specimens named *A. akaka* looked rather divers, detailed studies of living plants were undertaken which showed that besides *A. akaka, A. shelkovnikovii,* and *A. haemanthoides* s. str., at least three more phenotypes of *A. haemanthoides* s.

lat. can be separated among Iranian accessions (FRITSCH 2008). They were later described as new species *A. zagricum*, *A. ubipetrense*, and *A. austroiranicum* (FRITSCH & ABBASI 2009). Occurrence of three different chloroplast haplotypes of the *trn*L-*trn*F region (GURUSHIDZE & al. in press) in this alliance underline the inhomogeneous structure of this group. Many additional accessions collected in 2007 and 2008 could be added to the analyses resulting in a better resolution and more detailed subdivision than presented by GURUSHIDZE & al. 2008 as group D of cluster 1 (Fig. 1). Our new molecular data (Fig. 2 B) strongly support recognition of several taxa belonging to some statistically well supported groups. These groups will be presented and discussed in the next chapters. Two accessions from herbaria (7880H, 25222) were singled out between these groups. More material of them would be essential to verify whether these accessions are hybrids or represent new species. Because all the accessions forming this cluster were collected in Iran and adjacent Turkey, we accept sect. *Acanthoprason* as solely Southwest Asian group. Our molecular data strongly support the conclusion that this section has not only a centre of diversity in this region but also undergoes an intense phase of differentiation and radiation. Our data allow to predict that collection and molecular study of much additional material of many morphotypes will probably improve the circumscription and taxonomic position of many below discussed species, but will also add more accessions occupying unclear positions. It remains doubtful whether a stable infra-sectional classification of sect. *Acanthoprason* can be constructed currently.

3.3.5. *Allium austroiranicum* Subgroup (sect. *Acanthoprason*)

The accessions clustering in this well separated but heterogeneous group of sect. *Acanthoprason* refer to the second group of *A. haemanthoides* (according to FRITSCH 2008) distinguished by a very stout stature and very broad, shining, yellow-green leaves. Two Iranian species are placed here, which differ by some flower characters and were therefore affiliated to different taxonomic alliances in the conspectus (chapter 5). *Allium zagricum* was collected in the province Lorestan, and *A. austroiranicum* from the provinces Fars and Chaharmahal-Bakhtiari is divided in two geographical clusters. Three herbarium accessions (16799, 5013H, 8196H) of *A. austroiranicum* from Kurdestan were positioned in the *A. haemanthoides* alliance (chapter 3.3.9.). These vouchers represent variable populations typical for *A. austroiranicum*, but morphologically these plants could alternatively represent segregating populations of a hybrid of *A. haemanthoides* with one of the species having dark-colored filament tips. Somewhat surprising was the insertion of one accession of *A.* sp. 1 "*chlorotepalum*" (343H). Other accessions of this still undescribed species from Central Iran form a well supported subgroup close to the *A. grave-*

olens subgroup (see chapter 3.3.8.). One accession (6632) of *A. upipetrense* (see chapter 3.3.6.) also included here may represent a hybrid plant having homogenized ITS sequences.

3.3.6. *Allium ubipetrense* Alliance (sect. *Acanthoprason*)

This well supported group of sect. *Acanthoprason* includes mainly *A. ubipetrense* from eastern parts of province Markazi accompanied by one accession of *A. graveolens* and a still undescribed species. More surprising was the insertion of *A. ubipetrense* accessions in other groups of sect. *Acanthoprason* discussed in the chapters 3.3.5., 3.3.8., 3.3.9., and 3.3.11. This widespread molecular affiliation is difficult to explain, because we did not find yet any correlation of morphological character states with these topologies, which could support recognition of several species. The assumption that *A. ubipetrense* represents a morphotype which developed parallel in several evolutionary lines seems us more probable than to accept many cases of recent hybridization events of *A. ubipetrense*, which might have led to different homogenized sequences responsible for positions close to the respective parents. All these different accessions were collected in Northwest Iran in the mountain ranges South of Lake Orumiyeh.

3.3.7. *Allium derderianum* Alliance (sect. *Acanthoprason*)

Only plants collected in Alborz mountain range constitute the *A. derderianum* subgroup (acc. 34075 could not be traced and re-determined yet). This subgroup is homogeneous, despite morphologically divers accessions (Fritsch 2008: 60 f.) were included. Also a morphologically still more deviating, recently recognized taxon (*A.* sp. 9) only known yet from the area of Mt. Alamut, does not show molecular differences. Wendelbo 1971 included in *A. derderianum* also *A. austroiranicum*. These plants are similar only at a first glance and occur in mountain ranges in Central Iran. They are only distantly related to *A. derderianum* and belong to a subgroup discussed in chapter 3.3.5.

Basal to this clade and rather well supported, the type accession of *A. moderense* (6616) is positioned. A second accession of this species (6629) occupies an unresolved position. These positions are unexpected because this species belongs morphologically to the *A. colchicifolium* alliance of sect. *Melanocrommyum* (Fritsch & Abbasi 2009). The molecular position may indicate that *A. derderianum* or another species of sect. *Acanthoprason* was involved in the evolution of *A. moderense*.

3.3.8. *Allium graveolens* Subgroup (sect. *Acanthoprason*)

This weakly supported Iranian subgroup is composed of rather different taxa showing a weak geographic correlation. Most accessions belong to

the newly described *A. materculae* subsp. *graveolens* occurring in the provinces Markazi and Esfahan (Fritsch & Abbasi 2009). This subspecies is morphologically very similar to the typical subspecies (see chapter 3.3.11) which has a more northern distribution. Despite this similarity, our molecular data strongly favour to accept this taxon at species level.

Allium graveolens (R. M. Fritsch) R. M. Fritsch, **comb. & stat. nov.**

Basionym: *Allium materculae* subsp. *graveolens* R.M. Fritsch in Rostaniha 9 Suppl. 2: 31, 2009.

Also three accessions of *A. ubipetrense* (discussed in chapter 3.3.6.) from the pre-mountains along the borderlines of the provinces Zanjan and Hamedan were located in this subgroup. Also the only accession (6487) of *A. hamedanense*, a peculiar species only known from the mountains south of Hamedan (Fritsch & Abbasi 2009), another accession (11929) of *A.* sp. 2 from the Northwest of province Kurdestan (discussed in chapter 3.3.11.), and an aberrant, purple-flowering accession (64855) very similar to *A. akaka* from the western edge of province Zanjan are included. Finally we have to mention the well supported subclade of *A.* sp. 1 "*chlorotepalum*" occurring in the northwestern corner of province Esfahan. (One herbarium voucher of this taxon included in the *A. austroiranicum* subgroup, chapter 3.3.5., is morphologically different and may represent a hybrid.) *Allium* sp. 1 "*chlorotepalum*" is morphologically characterized by initially black and shining ovaries like the taxa discussed in chapter 3.3.3. On the other hand, also *A. hamedanense* owns shining (but not black) ovaries, and the ovaries of *A. graveolens* are faintly glossy. Therefore we can state that more or less glossy ovaries characterize this subgroup.

3.3.9. *Allium haemanthoides* Alliance (sect. *Acanthoprason*)

Also this subgroup of group "D" (Fig. 1) of Gurushidze & al. 2008 was strongly enlarged by addition of many acessions and herbarium vouchers. It became a well supported, mainly geographically characterized, and morphologically and taxonomically heterogeneous subgroup. It comprises all investigated accessions of *A. haemanthoides* in the strict sense, several accessions of *A. ubipetrense* (discussed in chapter 3.3.6.), and three hitherto undescribed new taxa. Tiny plants with very short, nearly suborbicular leaves and purplish tepals from the provinces Azarbeijan and Kurdestan south of Lake Orumiyeh were preliminary named *A.* sp. 3, but plants of *A.* sp. 5 from central parts of province Kurdestan are mostly larger and possess large, broadly lanceolate leaves and multiflorous, dense inflorescences. They are candidates for being described as new taxa. On the other hand, *A.* sp. 10 (acc. 2432) is perhaps only a variant of *A. haemanthoide*s having narrow leaves and dark-purple flowers. Investigation of additional living material would be essential. Also three accessions of *A.*

austroiranicum from province Kurdestan were affiliated here. They were already discussed in chapter 3.3.5.

3.3.10. *Allium breviscapum* Alliance (sect. *Acanthoprason*)

Four accessions of this local endemic from Alvand massif near Hamedan in northwestern Iran could be analyzed. They are the well supported sister group to the *A. haemanthoides* alliance (discussed in the chapter before) although *A. breviscapum* is morphologically more similar to *A. derderianum*. This molecular position reflects perhaps an ancient hybrid offspring of *A. breviscapum* with a taxon of the *A. haemanthoides* alliance and possibly *A. derderianum* as parents.

3.3.11. sect. *Acanthoprason* in the strictest sense

The *A. akaka* alliance was contradictory treated by different authors. Because only the geographical region (the Iranian province Ghilan) but not the exact collection site of the type specimen is known, Iranian material from that area fitting well the original description was studied (Fritsch 2008) and designated as epitype (Fritsch & Abbasi 2009). These epitypic plants (acc. 6398) and more accessions from the Iranian provinces Ardabil, West and East Azarbeijan form one well supported subgroup. Our material allows to conclude that the distribution of *A. akaka* reaches the Tabriz area in the West. Additional material of acc. 17362 would be necessary to verify whether determination as *A.* aff. *ubipetrense* is correct. Two accession of *A.* aff. *shelkovnikovii* (34268, 34269) from Tabriz town area clustered also in this subgroup, but two more accessions of this species (6404, 6405), collected about 20 km apart from Tabriz, clustered in the second subgroup discussed below. This taxon differs morphologically well from *A. akaka* s. str. (Fritsch 2008), but not much from *A. egorovae* (see below), and therefore affiliation of all accessions (also of acc. 70664 named *A.* aff. *egorovae*) to the second subgroup was expected. We cannot explain why they were included in the first subgroup.

Rather closely related is the well supported second subgroup comprising *A. materculae* s. str. (from North Iran and adjacent republics, see chapter 3.3.8.), a species preliminary named *A. shelkovnikovii* (see discussion in Fritsch 2008) collected North of Tabriz, and plants from eastern Turkey and West of Lake Orumiyeh hitherto also named *A. akaka* and discussed below. Several herbarium specimens from the mountains near the Araks valley (border to republic Azerbaijan) preliminarily named *A. egorovae* and another still undescribed species (*A.* sp. 2) known yet only from fruiting herbarium specimens from the province Azarbeijan belong also here. Beside *A. materculae*, these taxa differ from *A. akaka* s. str. by narrow filaments with dark tips and the different forms of tepals. Inclusion of acc. 3940, named with some doubt *A. zagricum* despite it was col-

lected in the province Zanjan and not in Lorestan, may indicate that this accession also belongs to *A.* sp. 2. However, another accession preliminary named in this way was included in the *A. graveolens* subgroup (chapter 3.3.8.).

The East Turkish – Northwest Iranian "*A. akaka*" plants are divers. Turkish plants differ remarkably by narrow, bluish-pinkish tepals. Like some Iranian plants they fit better the description and the geographic region of *A. latifolium* JAUB. & SPACH. Unfortunately, his name is a later homonym and thus illegitimate. Therefore a new name is necessary:

Allium jaubertii R. M. FRITSCH, **nom. novum** = *A. latifolium* JAUB. & SPACH, Ill. pl. orient. 2: t. 103, 1846, non *A. latifolium* W. YOUNG, Cat. arbr. Amer. 28, 1783, necque *A. latifolium* GILIB., Excerc. phyt. 2: 470, 1792.

Analysis of living plants in addition to the herbarium specimens would be urgently necessary to characterize all these taxa more in detail and to apply the names correctly.

3.4. Core Clade, Cluster 2

Three well separated groups recognized by GURUSHIDZE & al. 2008 were also present in our data, but as single units without further resolution of phylogenetic connections (Fig. 2 C).

3.4.1. *Allium suworowii* Alliance

This most basal and well supported subgroup of cluster 2 in the dendrogram of GURUSHIDZE & al. 2008 contains only one species morphologically completely different from the other species of cluster 2. *A. suworowii* is widely distributed (from western and central Tian Shan mountain ranges up to the western pre-mountains of western Hissar mountain range, northern Afghanistan, and the western Pamir area of Tajikistan). Therefore it is not surprising that our accessions are also genetically divers. Perhaps addition of much more accessions would allow to find out whether morphologically and geographically well circumscribed, infraspecific groups exist.

A. suworowii was most often affiliated to sect. *Megaloprason* in the widest sense. Only KHASSANOV & FRITSCH 1994 selected it as type species of subsect. *Spiralitunicata* (sect. *Acmopetala*) including also *A. fibriferum, A. insufficiens,* and *A. vvedenskyanum*. Our current molecular data support closer relations of *A. suworowii* to sect. *Megaloprason* in the strictest sense which were also confirmed by possessing identical chloroplast haplotypes (GURUSHIDZE & al. in press). *A. insufficiens* and *A. vvedenskyanum* belong to other groups (see chapters 3.6.1. and 3.7.3.), and *A. fibriferum* could not be analyzed. Thus, subsect. *Spiralitunicata* contains probably only one or two species and should be affiliated under sect. *Megaloprason*.

3.4.2. *Allium regelii* of sect. *Regeloprason*

Two accessions of this morphologically striking species from Turkmenistan, Southwest Afghanistan, and adjacent areas of Iran were available. They clustered jointly with the above discussed *A. brachyscapum* (chapter 3.3.10) alliance but formed a well supported sub-clade (Fig. 2 C). This points to a rather isolated position of *A. regelii* in sect. *Regeloprason*.

3.4.3. subsect. *Humilicognata*

This small but well supported clade occupies a middle position in the second clade of GURUSHIDZE & al. 2008 (Fig. 2 C). It consists of two well supported alliances: *A. regelii* (discussed below), and a group of three species possessing tepals reflexed after anthesis and rather long, patent filaments. Therefore WENDELBO 1971 affiliated the two species he knew to sect. *Megaloprason*. The first species *A. brachyscapum* is a small endemic from the alpine belt of Koppeh Dagh mountain range in Turkmenistan and Iran. Much taller but otherwise similar plants known from semi-desert plains and hills in North and Central Iran were separated some time ago at species level as *A. assadii* (SEISUMS 2000). The third species *A. scotostemon* differs remarkably by much narrower leaves, broader tepals, and purple filaments. It is a narrow endemic of Central Alborz mountain range in North Iran.

These taxa do not belong to sect. *Acmopetala* subsect. *Stellata* (proposed by FRITSCH & al. 2002 for *A. assadii*) but to sect. *Megaloprason* in the strictest sense (see chapter 3.6.1.) because *A. brachyscapum* and *A. rosenbachianum* share identical chloroplast haplotypes (GURUSHIDZE & al. in press). They are affiliated to a new subsection:

Allium [sect. *Megaloprason* s. str.] subsect. *Humilicognata* R. M. FRITSCH, **subsect. nova**

Type species: *A. brachyscapum* VVED.

Diagnosis: Scapus brevis flexuosus folia plerumque excedens vel subelongatus strictus. Inflorescentia plus minusque hemisphaerica, densiuscula. Perigonium stellatum; tepala basi libera, mox reflexa et plus minusque spiraliter contorta, filamenta carnosa subulata. Ovarium stipitatum, verruculosum.

Scapes either short and flexuous much shorter than leaves or somewhat longer and straight. Inflorescence ± hemispherical, rather dense. Flowers star-like, tepals free near base, later reflexed and spirally contorted. Filaments fleshy, subulate. Ovary stalked, with a rough surface.

3.4.4. sect. *Asteroprason*

The largest and most advanced group of the second cluster (in the dendrogram of GURUSHIDZE & al. 2008, Fig. 1) comprised the well sepa-

rated alliances of the important ornamental *A. cristophii*, of *A. elburzense*, and the few investigated accessions of *A. helicophyllum*. The separation of *A. ellisii* and *A. kuhsorkhense* was not resolved (Fig. 2 C).

All the species included here are morphologically well separated one from another but share loose globular inflorescences and star-like patent tepals. *A. cristophii* is naturally growing in the Turkmen and Iranian Koppeh Dagh mountain range and in the easternmost parts of Alborz mountain range. It shows remarkable infraspecific diversity (FRITSCH 2008) which may explain the certain degree of inhomogeneity of its subgroup. The taxonomic still unclear *A. ellisii* is a narrow endemic of Binalud and eastern Koppeh Dagh mountain ranges, *A. elburzense* and the perhaps conspecific *A. pseudobodeamum* occur in the central Elburz mountain range, *A. helicophyllum* also in the Turkmen and Iranian Koppeh Dagh mountain range, and *A. kuhsorkhense* in the lower mountain massifs south of Mashhad in the province Khorassan.

All available molecular data (GURUSHIDZE & al. 2008, GURUSHIDZE & al. in press) gave clear evidence that traditional affiliation of these species neither to sect. *Acanthoprason* (WENDELBO 1971) nor to sect. *Kaloprason* (GREGORY & al. 1998) is correct. They represent a new section:

Allium sect. *Asteroprason* R. M. FRITSCH, **sect. nova**

Type species: *A. elburzense* WENDELBO

Diagnosis: Scapus subelongatus conicus flexuosus brevior quam folia. Inflorescentia semiglobosa usque subglobosa, laxa usque subcompacta. Flores plus minusque plana stellata, tepala patentia vel demum recurvata post anthesin longitudinaliter convoluta.

Scape conical and flexuous, somewhat elongated but shorter than leaf blades. Inflorescence semiglobose to subglobose, loose to somewhat contracted. Flowers more or less flat star-like, tepals patent or later somewhat recurved, after anthesis longitudinally enrolled.

Allium subsect. *Asteroprason* R. M. FRITSCH, **subsect. nova**

Type species: *A. elburzense* WENDELBO

Diagnosis: Statura plantae compacta, folia glabra, tepala post anthesin longitudinaliter convoluta non autem aculeata.

Plants of compact stature, leaves glabrous, tepals after anthesis longitudinally enrolled but not prickly.

Species of the typical subsection *Asteroprason* are small plants having smooth leaves and longitudinally enrolled, crumpled, not prickly tepals in the fruiting stage. Only gradually different are the larger stature and hairy leaves of *A. cristophii*, but the tepals remain straight and surround later the capsules as stiff prickles (subsect. *Christophiana*). Our material named *A. ellisii* belongs also to the latter subsection, but other morphotypes fitting also the description of *A. ellisii* could not be studied yet as living plants. The smallest species is *A. monophyllum*, a rare taxon distributed in the alpine parts of Koppe Dagh mountain range. It is morphologically most

similar to the species of sect. *Asteroprason*, but no material was available to prove this affiliation by molecular data.

3.5. Core Clade, Cluster 3

Addition of more species and accessions led to a clear substructure of this cluster (Fig. 2 C) compared with the weak relations reported by GURUSHIDZE & al. 2008. Additionally, the haplotypes of *trn*L-*trn*F sequences of the investigated species of all included groups belong to the same lineage (GURUSHIDZE & al. in press) which confirmed the close relationship of all members of cluster 3.

3.5.1. sect. *Verticillata*

Only two species belong to this section, *A. verticillatum* from western parts of Tajikistan and Uzbekistan, and *A. viridiflorum*, a narrow endemic from the northwestern edge of Fergan depression in Kyrgyzstan. Both are rather small and inconspicuous in the general appearance but share an unique character: the leaf blades are longitudinally divided into several narrow, thread-like tips appearing like single leaves. It was unexpected that *A. verticillatum* belongs to two well separated and distant molecular subgroups positioned basally in cluster 3: most basal the accessions from West of 68° longitude, and slightly more advanced the investigated accessions from East of this longitude (Fig. 2 C). Both subgroups of *A. verticillatum* show high genetic diversity. Their insertion in cluster 3 may represent long branch attraction, as discussed already by GURUSHIDZE & al. 2008. The unique structure of the seed testa cells (flat granular periclinal and finely undulated anticlinal cell walls, FRITSCH & al. 2006) disagrees completely to all other species of cluster 3.

The only investigated accession of *A. viridiflorum* occupies a well supported position in cluster 6 (see chapter 3.8.1., Fig. 2 D) among morphologically dissimilar species from the same geographic region. This position may perhaps point to an ancient hybridization event. Also the different ornamentation of seed testa cells (FRITSCH & al. 2006) could be caused by hybridization. More accessions of both species would be essential to verify these positions in the ITS dendrogram.

3.5.2. *Allium cupuliferum* Alliance, sect. *Regeloprason*

Sister to *A. taeniopetalum* and the *A. balkhanicum* alliance is the ornamental species *A. cupuliferum* (endemic in the Aktau and Nuratau massifs up to the northern slopes of Turkestan mountain range in Uzbekistan). Although it shares several morphological characters with the species of the *A. balkhanicum* alliance, it is only distantly related (Fig. 2 C) and constitutes a well separated subgroup. A rather large genetic distance between acc. 6196 from Aktau massif and the other accessions from Nuratau massif (West Uzbekistan) may reflect long-standing geographic separation.

3.5.3. *Allium balkhanicum* Alliance, sect. *Regeloprason*

A. isakulii was described to comprise three geographically separated subspecies (FRITSCH 2000). However, the molecular analyses of GURUSHIDZE & al. 2008 did not confirm these relations: the only accession of the typical subspecies was positioned jointly with the *A. pseudowinklerianum* alliance in cluster 1, and the other subspecies were included in cluster 3 where they formed one subgroup of group F. Our new data (Fig. 2 C) do not confirm these different positions. After re-sequencing, the only accession of *A. isakulii* s. str., a narrow endemic of Nuratau and Mogoltau massifs in Uzbekistan and Tajikistan, occupied a sister position to the only accession of *A. iliense* s. str., distributed in the hilly semi-deserts nearby the Ili river in South Kazakhstan. Both species are sister to subsp. *balkhanicum*. Another accession most similar to subsp. *isakulii* from a newly detected site in Kurama mountain range in Uzbekistan became sister to sect. *Stellata*. Large molecular distances and separate positions of subsp. *isakulii,* subsp. *balkhanicum* (a narrow endemic of Great Balkhan massif in Turkmenistan), subsp. *subkopetdagense* (from lower mountains of Turkmen Central Kopetdag mountain range), and the Central Iranian *A. cathodicarpum* underlined, that all these taxa should be accepted at species level:

Allium subkopetdagense (R. M. FRITSCH & F. O. KHASS.) R. M. FRITSCH, **comb. & stat. nov.**

Basionym: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *subkopetdagense* R. M. FRITSCH & F. O. KHASS. in O. A. ASHURMETOV & al. (eds.), Plant Life S-W. Central Asia, Tashkent: 65, plate 1H, 2000.

Allium balkhanicum (R. M. FRITSCH & F. O. KHASS.) R. M. FRITSCH, **comb. & stat. nov.,**

Basionym: *Allium isakulii* R. M. FRITSCH & F. O. KHASS. subsp. *balkhanicum* R. M. FRITSCH & F. O. KHASS. in O. A. ASHURMETOV & al. (eds.), Plant Life S-W. Central Asia, Tashkent: 65, plate 1I, 2000.

3.5.4. sect. *Stellata*

The most advanced position in cluster 3 (Fig. 2 C) is occupied by three subspecies of *A. taeniopetalum*. They share a specific anatomy of nectaries (GURUSHIDZE & al. 2008) with the *A. balkhanicum* alliance (chapter 3.5.3.). The phylogenetic relations of the subspecies were not resolved. The rather large distances between them may reflect geographic diversity, but already inside of subsp. *taeniopetalum* from Uzbekistan the diversity is remarkable (acc. 5244 and 5249 were collected in the Aktau massif not far from one another, and acc. 6531 in the western Turkestan mountain range). Subspecies *turakulovii* occurs in the Eastern Turkestan (adjacent Kyrgyzstan) mountain range. It remains open whether the analysis of topo-typical plants of subsp. *mogoltavicum* from Mogoltau massif (North Tajikistan, all

investigated accessions stem from Chatkal mountain range in Uzbekistan 200 km apart) could enhance the molecular differentiation.

Although the lax globular inflorescence of *A. taeniopetalum* is more similar to sect. *Megaloprason* s. str., this species shares stellate tepals with some species of sect *Acmopetala* s. lat. Unfortunately, the phylogenetic relations to these sections remained as unresolved as shown by GURUSHIDZE & al. 2008. However, *A. taeniopetalum* shares identical haplotypes of *trn*L-*trn*F sequences (GURUSHIDZE & al. in press) with sect. *Kaloprason*, subsect. *Keratoprason* (chapter 3.9.6.), and *A. jesdianum* (see chapter 3.9.9.) but not with the sections *Megaloprason* and *Acmopetala* in the strict sense. Therefore recognition at sectional level seems appropriate:

Allium sect. *Stellata* (F. O. KHASS. & R. M. FRITSCH) R. M. FRITSCH, **comb. & stat. nov.**

Basionym: *Allium* [sect. *Acmopetala*] subsect. *Stellata* F. O. KHASS. & R. M. FRITSCH, Linzer Biol. Beiträge 26: 976, 1994. Type species: *A. taeniopetalum* VVED.

3.6. Core Clade, Cluster 4

This cluster was divided in three well-supported groups with unresolved phylogenetic relations (Fig. 2 C). Two groups contain taxa of the *A. rosenbachianum* alliance (in the strict sense, not *A. rosenbachianum* of gardens = *A. rosenorum* which belongs to cluster 7). Species of sect. *Regeloprason* constitute the third group.

3.6.1. sect. *Megaloprason* in the strictest sense

One group comprises several accessions of *A. rosenbachianum* s. str., as well as one accession each of *A. chitralicum* (which will be discussed in chapter 3.9.7.) and *A. schugnanicum*. The latter species, a narrow endemic from shady montane slopes of western Pamir mountain massifs, is morphologically very close to *A. rosenbachianum* which occurs on shady slopes and in submontane broad-leafed shrub and forest associations in southern and southeastern Tajikistan. Analyses of more accessions would be necessary in order to decide whether *A. schugnanicum* is not more than a montane variant of *A. rosenbachianum*. WENDELBO 1971 used the name *A. rosenbachianum* for *A. jesdianum* subsp. *angustitepalum* (see chapter 3.9.9.).

It is surprising that all analyzed accessions of *A. rosenbachianum* subsp. *kwakense* (which shares the area of distribution with subsp. *rosenbachianum*) belong to another group which is further subdivided (Fig. 2 C). The clear molecular distance to *A. rosenbachianum* favor to recognize this taxon at species level:

Allium kwakense (R. M. FRITSCH) R. M. FRITSCH, **comb. & stat. nov.**

Basionym: *A. rosenbachianum* REGEL subsp. *kwakense* R. M. FRITSCH in Candollea 48: 419, 1993.

The only analyzed accession of *A. insufficiens,* distributed in southeastern Tajikistan and adjacent parts of Afghanistan, is sister to *A. kwakense*. The long distance of *A. insufficiens* to all other species of cluster 4 implies recognition perhaps as monotypic subsection. Analysis of more accessions would be essential to confirm this position in sect. *Megaloprason* s. str.

3.6.2. *Allium intradarvazicum* Alliance

A. intradarvazicum is a recently described species (FRITSCH 2009) only known from the Khumbov valley in central Darvaz mountain range, Tajikistan. Surprisingly, it forms the third group of cluster 4 (Fig. 2 C) together with several accessions of the morphologically rather dissimilar *A. darwasicum* from southern Darvaz, Vakhsh, and Hissar mountain ranges. Other accessions of the latter species were located in cluster 7, and possible reason for the splitting will be discussed in more detail in chapter 3.9.4. The position of *A. intradarvazicum* and *A. darwasicum* in cluster 4 was unexpected because the morphologically most similar species of sect. *Regeloprason*, *A. winklerianum* and *A. hissaricum*, were also included in cluster 7 group J (Fig. 2 D) of the ITS-based dendrogram of GURUSHIDZE & al. 2008.

3.7. Core Clade, Cluster 5

Addition of many accessions did not much improve the resolution of the phylogenetic tree presented by GURUSHIDZE & al. 2008. The phylogenetic relationships of the well supported five larger groups remained still unresolved (Fig. 2 D). As far as analyzed by GURUSHIDZE & al. in press, the *trn*L-*trn*F sequences of all members of the clusters 5 and 6 belong to one lineage which underlines a rather high degree of general relationship.

3.7.1. sect. *Miniprason*

A. karataviense, the only species of this section, occupies a wide natural area of distribution from Kazakh Syrdarya Karatau mountain range and Chu-Ili-mountains in the North up to the Panj valley along the border between Tajikistan and Afghanistan (and perhaps up to Hindu Kush range in eastern Afghanistan and the Kugitang massif near the northeastern edge of Turkmenistan) in the South. It was somewhat surprising that both accessions from Panj valley (6133, 6147) are well supported segregates (Fig. 2 D) despite they do not differ morphologically. On the other hand, red flowering plants from Chatkal mountain range (accs. 2989, 5040, 5888, 6366) are part of the homogeneous main group (completely homogeneous also in the NJ-dendrogram, not shown), but material of the newly described subsp. *henrikii* RUKSANS were not available for study. As far as known hitherto, *A. karataviense* is the only species of subg. *Melano-*

crommyum having 2n = 18 chromosomes. All other species have 2n = 16 or multiples of it (FRITSCH & ASTANOVA 1998).

3.7.2. sect. *Brevicaule*

Only single accessions of two (out of three) species could be analyzed. *A. sergii* (a rare endemic species from central Syrdarya Karatau in Kazakhstan) occupies a phylogenetically unresolved and very distant position in cluster 5 (Fig. 2 D). It might be another case of long branch attraction already discussed by GURUSHIDZE & al. 2008 for *A. verticillatum*.

The second species *A. chitralicum* occurs in the higher mountains of East Afghanistan, Pakistan, and Tajikistan. The only accession investigated (from Tajikistan) was positioned in cluster 4 among *A. rosenbachianum* (sect. *Megaloprason* s. str., see chapter 3.6.1., Fig. 2 C). Thus both species were placed beside morphologically dissimilar species from the same geographical regions. More material, also of the third species *A. eugenii*, a narrow endemic of Great Balkhan massif in Turkmenistan, seems essential to resolve this discrepancy. The current data would also be compatible with the assumption that sect. *Brevicaule* is perhaps only an artificial aggregate of morphologically relatively similar but only very distantly related species.

3.7.3. *Allium dasyphyllum* Alliance

Another well supported group with unresolved relations (Fig. 2 D) consists of the only analyzed accessions of two narrow endemics from the northern limit of western Tianshan mountain range, *A. dasyphyllum* (from the Kyrgyz Talassian Alatau) and *A. vvedenskyanum* (from the Kazakh Chu-Ili-mountains). Formerly they were affiliated to different subsections of sect. *Acmopetala* discussed in chapters 3.5.4. and 3.8.1. These species are morphologically well separated from another as well as from *A. tschimganicum* and the other species included in cluster 5. Analysis of more accessions seems essential prior to recognition as separate taxonomic subgroup.

3.7.4 subsect. *Pharmakoprason*

A. tschimganicum (= *A. motor*, see chapter 3.13. below), a narrow Uzbek endemic from the Chatkal mountain range south and east of Tashkent, forms a homogeneous and well separated alliance in the ITS dendrogram (Fig. 2 D). It differs from the morphologically most similar species *A. severtzovioides* and other species discussed in the next chapter also by another nectary anatomy (GURUSHIDZE & al. 2008). Additionally, only this species is used as wild collected vegetable having remarkable medicinal properties (KEUSGEN & al. 2006) and contains sulphurpyrrols (GURUSHIDZE

2008). Therefore it should be accepted as monotypic new healthy onion subsection:

Allium [sect. *Acmopetala*] subsect. *Pharmakoprason* R. M. FRITSCH, **subsect. nova**

Type species: *A. tschimganicum* O. FEDTSCH., quoad lectotypum (= *A. motor* KAMELIN & LEVICHEV)

Diagnosis: Scapus valde elongatus proportione tenuis, strictus, folia plerumque excedens. Folium vaginatum extimum tenue sine colore. Inflorescentia sphaerica, densa. Perigonium stellatum; tepala basi libera, mox reflexa et plus minusque contorta. Filamenta interiora dilata basi utrinque triangulato-dentata. Ovarium verruculosum.

Scape very long and rather slender, straight, much longer than the leaves. Outer sheath leaf thin, colorless. Inflorescence spherical, dense. Flowers star-like, tepals basally free, later reflexed and ± contorted. Bases of inner filaments widened, with a triangular tooth at both sides. Ovary rough.

3.7.5. Western Tianshan Geographical Clade of sect. *Acmopetala*

This group is characterized by a specific type of nectary anatomy and was named "group H" by GURUSHIDZE & al. 2008. It consists of two well supported subgroups but with unresolved phylogenetic relations. All species included here are endemics of different parts of the western Tianshan mountain range in Uzbekistan, Kyrgyzstan, and Kazakhstan. The smaller subgroup (Fig. 2 D) contains only one molecularly inhomogeneous species, *A. costatovaginatum*. It possesses a hard, ribbed, and long-lasting basal sheath leaf and was hitherto affiliated to subsect. *Durovaginata* like *A. severtzovioides*. The latter species forms the second subgroup together with *A. tashkenticum* and *A. sewerzowii*, belonging to subsect. *Inornatae*, plus *A. saposhnikovii*, the only species of subsect. *Albidiflora*. It remained unclear whether the accession 6364 of *A. saposhnikovii* from northern slopes is a hybrid or deserves taxonomic recognition, whereas plants from southern slopes (5780, 5783) share all molecular character with the other species. Also *A. tashkenticum* is morphologically and molecularly somewhat divers. This union of several morphologically differing species in one molecularly rather homogeneous subgroup was not expected. It is difficult to predict whether the addition of more accessions of *A. sewerzowii* and other missing taxa (*A. rudolfii*, *A. tokaliense*) could result in a better resolution in separate taxa. Alternatively, subsections *Inornatae* and *Albidiflora* could be abandoned and all species inserted in subsect. *Durovaginata*.

3.8. Core Clade, Cluster 6

This small group is the sister to the species-rich cluster 7 of GURUSHIDZE & al. 2008 and consists mainly of monotypic, well supported groups

having mostly badly resolved phylogenetic relations (Fig. 2 D). Most species included share a general morphological similarity and belong to sect. *Acmopetala*. Their *trn*L-*trn*F haplotypes belong to the same lineage as those of cluster 5 (GURUSHIDZE & al. in press). However, all studied members of cluster 6 share a specific type of nectary anatomy (GURUSHIDZE & al. 2008) which underlines a close relationship.

3.8.1. Alai-Fergan Geographical Clade of sect. *Acmopetala*

This small cluster comprises five species occurring in a rather restricted geographic area in Central Asia which belongs partly to Kyrgyzstan, partly to Uzbekistan. Most basal are *A. schachimardanicum* (a narrow endemic of Alai mountain range South of Fergana town) and *A. dodecadontum* (endemic of the central Chatkal mountain range and the Sarychilek area). Hitherto both species were included in subsect. *Longibidentata*, but our molecular data deny that affiliation (see chapter 3.2.1.). Addition of more accessions would be essential to verify their current phylogenetic position and to decide whether their preliminary taxonomic affiliation to subsect. *Acmopetala* discussed below is a good solution.

Also the only investigated accession of *A. viridiflorum*, sect. *Verticillata* (see chapter 3.5.1.) was positioned in cluster 6 but shows unresolved relations.

The advanced position in cluster 6 is occupied by two subgroups. One of them comprises *A. aflatunense* in the strictest sense and *A. arkitense*, two morphologically strongly differing endemics of Sarychilek area, plus *A. alaicum*, a rare endemic from the northern slopes of Alai mountain range. Most surprising was the inclusion of *A. aflatunense* which shows only small differences of quantitative leaf, scape, and flower characters to *A. stipitatum* variants without haired leaves positioned in cluster 7 (see chapter 3.9.11.). Further detailed morphological analyses can perhaps trace additional reliable differences to the *A. stipitatum* alliance. No less surprising was the position of *A. zergericum* (endemic of the Fergan mountain range) as sister to the core clade (discussed in chapter 3.2.2.) because this taxon is morphologically close to *A. arkitense* and *A. alaicum* (FRITSCH & al. 2002).

The second subgroup comprises only *A. backhousianum*, an endemic of the northern slopes of Alai mountain range. It differs morphologically remarkably from all other species belonging to cluster 6. This taxonomic distance is also expressed by the molecular position as subgroup of its own (Fig. 2 D). On the other hand, molecular and anatomical data underline a far-reaching phylogenetic homogeneity of cluster 6. Therefore the *A. aflatunense* morphotype is probably another instance for the assumption discussed by GURUSHIDZE & al. 2008 in the cases of *A. stipitatum* and *A. rosenorum* (see chapter 3.9.11.), that independent evolutionary lineages seem

to have converged on similar phenotypes. Then, *A. aflatunense* s. str. should be affiliated to subsect. *Acmopetala*, but other similar phenotypes remain under *A. stipitatum*, sect. *Procerallium*.

The above discussed four groups (chapters 3.7.3 – 3.7.5., 3.8.1) represent the majority of species hitherto affiliated to sect. *Acmopetala* after splitting off several species as new sections *Longibidentata* (chapter 3.2.1.) and *Stellata* (chapter 3.5.4.), and transferring two species to sect. *Megaloprason* (subsect. *Spiralitunicata*, chapter 3.4.1.). The species remaining in sect. *Acmopetala* share *trn*L-*trn*F haplotypes belonging exclusively to lineage II (GURUSHIDZE & al. in press), and most of them share nectary types of either group H or group I (GURUSHIDZE & al. 2008). Also the seed coat structure studied by FRITSCH & al. 2006 does not contradict this narrower circumscription of sect. *Acmopetala*, though the rather great variation did not allow to separate similar subgroups as above presented. Only the sections *Longibidentata* and *Stellata* were separable by specific seed coat character states. Thus, we can accept section *Acmopetala* in the strict sense as a natural group, with the subsections *Acmopetala* (in a wide sense), *Durovaginata* (without *A. tschimganicum*), *Pharmakoprason*, and possibly *Inornatae* and *Albidiflora*. The phylogenetically closest relative is sect. *Miniprason*, member of cluster 5, but the relations to other sections were not resolved.

3.9. Core Clade, Cluster 7

This cluster is large and most complicated containing several groups having badly or not resolved phylogenetic relations. GURUSHIDZE & al. 2008 accepted three well supported main groups termed "J", "K" and "L" (Figs. 1, 2 D, 2 E, 2 F), and did not discuss the smaller ones. Addition of much more living accession and herbarium vouchers did not much change the general structure but remarkably enlarged several groups. Our data allow to recognize altogether at least 11 groups.

3.9.1. *Allium lipskyanum* Alliance, sect. *Regeloprason*

Also in cluster 7, a few species of sect. *Regeloprason* were included in two different subgroups. One well supported, small subgroup contains *A. lipskyanum*, an endemic of Southwest and Central Hissar mountain range in Tajikistan and Uzbekistan, and *A. chodsha-bakirganicum*, known only from the type location in central Turkestan mountain range, western Kyrgyzstan. Both show a moderate morphological similarity, which was expressed by the long distances after the basal bifurcation. Addition of more material would be essential to verify whether they actually belong to one clade. The other subgroup was located inside of sect. *Compactoprason* and will be discussed in chapter 3.9.4.

3.9.2. *Allium komarowii* Subgroup (sect. *Compactoprason*)

Only *A. komarowii*, naturally distributed in the northwestern Turkestan up to Southwest Hissar mountain ranges in Tajikistan and Uzbekistan, is included in this homogeneous subgroup (Fig. 2 D) which is identical with the morphologically well separated, monotypic subsect. *Komarowiana* of sect. *Compactoprason*. The infra-sectional subdivision is discussed in the chapter below.

3.9.3. sect. *Compactoprason*

Beside of three species of sect. *Regeloprason* (see next chapter), this group comprises only species of subsect. *Erectopetala* (Fig. 2 D). In a basal position is *A. giganteum*, distributed in an area stretching from Central Koppeh Dagh in Turkmenistan and Iran via northern Afghanistan to South Tajikistan and even the Panj valley in western Pamir region. It is divided into a basal subgroup comprising accessions from all parts (beside Afghanistan) of the above mentioned area of distribution. Somewhat advanced is another, rather well supported subgroup composed of Tajik (acc. 6746 stems from Uzbekistan near the Tajik border) accessions only. The members of these subgroups do not differ morphologically, and the small geographic and molecular differences do not justify their recognition at infraspecific level.

Rather homogeneous and phylogenetically more derived than *A. giganteum* is our material of *A. macleanii* (known from Central Hissar, Pamir, and Alai mountain ranges via Northwest Afghanistan to East Afghan Hindu Kush mountain range), if we assume that the accessions 0465 and 3884 (received from botanical collections) may represent hybrids and occupy therefore isolated positions. However, material from Afghanistan would be essential to verify these positions in this cluster.

It was unexpected that the members of the morphologically only moderately divers sect. *Compactoprason* were positioned in different molecular subclusters. The only species of subsect. *Spiralopetala*, *A. majus* (a rare species from southwestern Hissar mountain range), is morphologically rather similar to *A. giganteum* but was placed among the derived sub-clade of sect. *Kaloprason* (chapter 3.9.8.) close to taxa occurring in the same geographic region. Also *A. trautvetterianum*, morphologically still more similar to *A. giganteum*, is sister to *A. sarawschanicum* and will be discussed below in chapter 3.9.6. In terms of molecular characters, sect. *Compactoprason* is heterogeneous. On the other hand, inclusion of all members of this section in only three subgroups of cluster 7 underline a not too low degree of relatedness. Thus sect. *Compactoprason* is also no artificial group. However, at the moment we do not know enough character differences in order to propose a more natural subdivision. Also the seed coat characters of these species are rather similar (Fritsch & al. 2006) and do not present clues for another subdivision of this section.

3.9.4. sect. *Regeloprason* subsect. *Odoratae*

Three montane to subalpine species of this subsection were placed between *A. giganteum* and *A. macleanii*, sect. *Compactoprason* discussed above. The type species of subsect. *Odoratae*, *A. darwasicum*, is widely distributed from central and southern parts of Darvaz mountain range up to Central and south-western Hissar range in Tajikistan. This species forms one moderately homogeneous sub-clade being the sister to both the other species. *A. hissaricum* from Central Tajikistan forms another homogeneous, well separated sub-clade, and *A. winklerianum* (occurring in the Central Darvaz up to Central Hissar mountain ranges) is part of the most derived but well supported sub-clade jointly with *A. macleanii*. Recently *A. winklerianum* was reported by Xu & Kamelin 2000 to occur also in the upper Ili valley of Chinese Tian Shan mountain range, but material was not available to us.

These are problematical results, not only concerning the nearly identical ITS-sequences of members of two really dissimilar sections. Here only three accessions from the type location (most southern end of Darvaz mountain range) of *A. darwasicum* were included. Other analyzed accessions from this and other locations are clustering with *A. intradarvazicum* among species of sect. *Megaloprason* (see chapter 3.6.2.). Genome-wide screening by RAPD analysis of Gurushidze & al. 2008 provided evidence that the investigated accessions of *A. darwasicum* belong to two morphologically indistinguishable different evolutionary lineages affiliated to the clusters 4 and 7. Clear reasons for this case of cryptic species were not found. It seems extremely unlikely that several introgressions from *A. intradarvazicum* and subsequent homogenization of the rDNA loci towards the introgressed type could be responsible for the occurrence of *A. darwasicum* accessions in cluster 4.

3.9.5. sect. *Aroidea*

This monotypic section is morphologically well characterized and molecularly well separated, but the phylogenetic relationships are not resolved (Fig. 2 E). The only species *A. aroides* is a rare endemic in the western part of Uzbek Saravshan mountain range with an outpost in the northeastern corner of Turkmenistan. The seed coat has flat periclinal walls with evenly granulose ornamentation, and nearly straight anticlinal walls (Fritsch & al. 2006) which could be explained either as ancient or as advanced (extremely reduced) sculptures.

3.9.6. *Allium sarawschanicum* – *A. trautvetterianum* Clade

The union of these morphologically deviating species having also different areas of distribution in a molecularly well supported clade (Fig. 2 E) is really surprising.

A. sarawschanicum shares many morphological characters and ecological preferences with *A. rosenbachianum* s. str., the type species of sect. *Megaloprason* (see chapter 3.6.1.). The natural area of distribution of *A. sarawschanicum* stretches from the central and western parts of Saravshan and Hissar mountain ranges in Uzbekistan and Tajikistan via Northwest Afghanistan to the central and eastern parts of Koppeh Dagh mountain range in Turkmenistan and Iran. But the well supported separation in two sub-clades does not reflect geographic diversity, because accessions from Hissar mountain range, composing the somewhat separated sub-clade, are also present in the basal clade. Our molecular data do also not support to split plants from Turkmenistan as *A. pseudozeravschanicum* as proposed by SEISUMS 1992, 2000.

A singular character of *A. sarawschanicum* is the presence of six radial horn-like to rib-like outgrowths on the top of the ovary. This character is rare in subg. *Melanocrommyum* and not known from any other member of sect. *Megaloprason* s. lat. The molecular data underline a separate position, but we hesitate to describe a new section as long as the phylogenetic difference to the sections *Procerallium, Acmopetala*, and *Compactoprason* remains unresolved. Currently recognition of a new monotypic subsection of sect. *Megaloprason* s. str. seems us the best solution:

Allium [sect. *Megaloprason* s. str.] subsect. *Keratoprason* R. M. FRITSCH, **subsect. nova**

Type species: *A. sarawschanicum* REGEL

Scapus valde elongatus, strictus, levis, folia excedens. Folia in numero 2–3 (vel unum), sublate lanceolata, stricta apice nutantia. Inflorescentia sphaerica, densa. Perigonium stellatum patelliforme, tepala lanceolata acuta. Filamenta basi dilatata connata interiora utrinque indistincte unidentata supra subulata. Ovarium breve hexasulcatum pyriforme apice toris acutis radialibus vel cornibus brevibus 6 provisum.

Scape very long, straight, smooth. Leaves shorter than scape, up to 3 in number, ± widely lanceolate, straight with down hanging tips. Inflorescence globose and dense. Flowers star-like bowl-shaped, tepals lanceolate and acute, filaments basally widened and united, inner filaments basally with one tooth at every side, above subulate. Ovary shortly and 6-furrowed pear-shaped, with 6 sharp horn-like or radial outgrowths.

A. trautvetterianum is only distributed in a small area in southeast Tajikistan roughly along longitude 70° E and latitude from 37.5° to 38.5° N. It shares only character states very common in subg. *Melanocrommyum* with *A. sarawschanicum*. All other characters and character states differ remarkably and show a high degree of similarity to *A. giganteum*. Morphologically, *A. trautvetterianum* belongs certainly to sect. *Compactoprason* in the strict sense, and we do not hesitate to leave it there. Difficult to explain is the molecular diversity (Fig. 2 E) because most of the investigated accessions were collected in the narrow vicinity of one village.

3.9.7. sections *Popovia* and *Acaule*

Section *Popovia* comprises only *A. gypsaceum* and is also morphologically well characterized, well separated by molecular characters, and occupies sister position to sect. *Kaloprason* s. str. (Fig. 2 E). This position may explain that the seed coat of *A. gypsaceum* shows a variable undulation of anticlinal cell walls like most members of sect. *Kaloprason* (FRITSCH & al. 2006).

The only analyzed accession of *A. hexaceras*, the only species of sect. *Acaule*, is well separated as sister of the sections *Popovia* and *Kaloprason*, but the relationship to the other taxonomic groups of cluster 7 remained unresolved. This rare species is only known from two separate places in the subalpine belt of the Hissar mountain range in Tajikistan and Uzbekistan. Analysis of more material seems essential in order to confirm this position.

3.9.8. sect. *Kaloprason* in the strict sense

Our molecular data support recognition of this well separated but heterogeneous section in a rather narrow sense without the *A. cristophii* and *A. elburzense* alliances forming a well separated clade of cluster 2 (see chapter 3.4.4., Fig. 2 C). The type species *A. caspium* (widely distributed in sandy deserts from Pakistan and Iran to South Russia and Kazakhstan) occupies a basal position (Fig. 2 E) jointly with *A. bucharicum*, a narrow endemic of southern Tajikistan. More advanced is the position of *A. alexeianum*, whereas *A. nevskianum* (vicarious species with *A. alexeianum* from central and southwestern Hissar, western Saravshan, and western Turkestan mountain ranges), *A. protensum* (clay and stony deserts from Afghanistan to the eastern Karakum desert and Lake Balkhash area in Kazakhstan), and *A. baissunense*, an ecologically specialized, narrow endemic of South Tajikistan and South Uzbekistan, occupies basal, intermediate, and derived positions. The latter species is morphologically very similar to *A. caspium* and was accepted as subspecies by KHASSANOV & FRITSCH 1994, but our molecular data would equally support recognition at species level. The next relative of this section is *A. gypsaceum*, the only member of sect. *Popovia*. We already mentioned in chapter 3.9.3. that we did not find yet obvious reasons for the inclusion of *A. majus*, belonging to sect. *Compactoprason*, among members of sect. *Kaloprason*.

One main sub-cluster of cluster 7 comprises the important ornamentals *A. stipitatum*, *A. altissimum*, *A. jesdianum*, *A. rosenorum*, and *A. hollandicum* (= *A. aflatunense* of Dutch bulb trade). A close genetic relationship of these morphologically similar species traditionally affiliated to sect. *Megaloprason* s. lat. was expected.

The well supported group "K" (GURUSHIDZE & al. 2008) contained four well separated and closely related subgroups. Many additional accessions blurred this picture: Now the Central Asian subclade is divided in the

badly resolved *A. stipitatum* alliance and the well separated *A. rosenorum* alliance (Figs. 2 E, 2 F); sister is the complicated Iranian *A. stipitatum* – *A. remediorum* alliance, and the well resolved Afghan-Iranian *A. jesdianum* alliance jointly with a second group of *A. rosenorum* from Central Asia.

3.9.9. *Allium jesdianum* Alliance (sect. *Procerallium*)

This group is composed of two somewhat heterogeneous clades. One contains plants from the type location of *A. jesdianum* from Central Iran, one accession (6261) from Binalud mountain range in NE Iran probably belonging to the recently described *A. oriento-iranicum* (Neshati & al. 2009), and all available accessions of *A. jesdianum* subsp. *angustitepalum* of Afghan origin from botanic gardens, from bulb trade, and own collections in South Uzbekistan which are somewhat heterogeneous. These data strongly support the close relationship of *A. angustitepalum* Wendelbo and *A. jesdianum* ascertained by Khassanov & Fritsch 1994. One accession of *A. stipitatum* (1044) positioned here was initially collected in Afghanistan and may represent a hybrid with subsp. *angustitepalum*.

The second, well supported sub-clade contains only accessions of *A. rosenorum* from western Zaravshan and Hissar mountain ranges. All this material was collected West of 68° longitude in Tajikistan and Uzbekistan. Other morphologically indistinguishable accessions collected East of this longitude belong to another subgroup presented in chapter 3.9.11. The taxonomic problems of this separation is discussed below.

Difficult to explain is the unresolved inclusion of *A. stipitatum* accession 3347 (from the northern premountains of Alai mountain range in Kyrgyzstan) in the *A. jesdianum* alliance because there is neither a geographic nor a taxonomic relation. The determination was correct, but re-collection and re-sequencing of material was impossible hitherto.

3.9.10 NW Iranian Geographic Clade

As already discussed by Gurushidze & al. 2008, this phylogenetically not resolved and heterogeneous group is formed by all investigated accessions of *A. stipitatum* from Iran (= *A. hirtifolium*, Zagros mountain range in NW Iran north of 30° N latitude), the only available accession of A. *bakhtiaricum* (from Bakhtiar Mountains), and the ornamental *A. hollandicum* ("*A. aflatunense*" of bulb traders) as derived sub-clade. Beside additional accessions of the above mentioned taxa, also other taxa from Northwest Iran were included in this clade: the recently described *A. jesdianum* subsp. *remediorum* (Fritsch & Abbasi 2009), some more accessions named *A. jesdianum*, and also a taxon most similar to *A. hollandicum* but separated as rather well supported extra subgroup. These data enable us now to set the discussion of some taxonomic problems on a stronger fundament of facts.

First we can only repeat that the Northwest Iranian accessions of *A. stipitatum* are morphologically not separable from the most common morphotype of *A. stipitatum* in Central Asia. We accept them as geographically separated variants of the generally rather divers *A. stipitatum* alliance (see next chapter). The borderline separating these variants is apparently situated south of the North Iranian mountain ranges Alborz and Koppeh Dagh. However, a closer relation to *A. hollandicum* must be denied now because that species constitutes a well separated subgroup which includes also one accession of *A. jesdianum* from Kurdestan. This ornamental stems certainly from Iran, but is apparently closer related and was probably selected from a taxon preliminarily affiliated to *A. jesdianum* as discussed below. It was really surprising that morphologically very similar plants from the mountains West of Lake Orumiyeh did not cluster jointly with *A. hollandicum* but as rather well supported extra subgroup. This position supports to describe them as a new taxon.

Problematic remains the taxonomic treatment of the accessions named *A. jesdianum* subsp. *jesdianum* and subsp. *remediorum*. Several accessions from the provinces Markazi, Lurestan, Kermanshah, and Kurdestan belong to a slightly separated subgroup related to *A. hollandicum*, but the only two investigated accessions from province Shiraz (6706, JA090) were inserted beside *A. stipitatum*. Morphologically, the accessions 1119, 6508, and 6625 do not differ from typical *A. jesdianum* and might represent a parallel case as described for *A. rosenorum* in the chapters 3.9.9. and 3.9.11. The above mentioned plants from province Shiraz are slender in the general appearance. Careful morphological comparison will be essential to decide whether the name *A. kazerouni* PARSA can be applied to them. The third group of accessions fit well the characters of subsp. *remediorum*.

3.9.11. *Allium stipitatum* and *A. rosenorum* Alliances

All wild *A. rosenorum* accessions from the area east of the 68° longitude in Tajikistan (southern slopes of central Hissar mountain range, there is also the type location) belong to one well supported clade. They are closely allied to conspecific plants from botanic gardens and bulb trade, without any subdivision. These molecular data strongly underline a clear separation of *A. rosenorum* from *A. jesdianum* as proposed by KHASSANOV & FRITSCH 1994.

The second alliance got low support but otherwise is very homogeneous, comprising accessions collected in South Kazakhstan, Uzbekistan, Tajikistan, and in the Turkmen Ashgabat area, as well as accessions from botanic gardens and bulbs sold in shops. Most accessions belong to *A. stipitatum* (moderately tall plants with more or less hairy leaves, sometimes only with teeth along the leaf margins, verified by plants from the type location), two accessions to *A. altissimum* (less tall plants with nar-

rower hairless leaves and a lower number of darker flowers, but wider tepals), and some more accessions to a third morphotype traditionally named *A. aflatunense* and characterized by taller and later flowering plants with hairless and rather wide leaves. These facts strongly support the already earlier discussed assumption (FRITSCH 1993) that *A. stipitatum* is a highly variable species and possess morphotypes more similar to *A. aflatunense* (but plants from the type location of *A. aflatunense* were affiliated to sect. *Acmopetala*, see chapter 3.8.1.) and other ones fitting the description of *A. altissimum*. Unfortunately, we were not able to analyze plants from the type location of *A. altissimum* in southeastern Tajikistan anywhere near Baljuan. It must remain undecided whether that taxon is a good species or just a variant of *A. stipitatum*.

One prominent taxonomic problem became visible among the species of the above discussed group "K": several morphologically inseparable taxa were affiliated to different molecular subgroups which are also geographically characterized. If we regard these molecular differences as important argument for separation of taxa at species or at least at subspecies level, we should separate the "western" accessions of *A. rosenorum* as taxon close to *A. jesdianum* and the accessions of *A. jesdianum* from Northwest Iran as taxon close to *A. stipitatum*, must rise *A. jesdianum* subsp. *remediorum* to species level, and must accept *A. hirtifolium* and *A. stipitatum* as separate species. However, these taxa can only be determined knowing their geographic origin. In the parallel case discussed in chapter 3.3.6., new names should be given to the accessions of *A. ubipetrense* inserted among the groups dicussed in the chapters 3.3.5., 3.3.8., 3.3.9., and 3.3.11. It remains very doubtful whether an extremely detailed morphological comparison of the above discussed taxa may resolve this problem. GURUSHIDZE & al. 2008 assumed in *A. rosenorum* and *A. stipitatum*, that independent evolutionary lineages seem to have converged on similar phenotypes. An alternative offspring by hybridization seems not probable, because only a single accession of *A. rosenorum* (and no accession of *A. stipitatum*) possessed a deviating chloroplast haplotype (GURUSHIDZE & al. in press). Thus only singular cases of introgression with chloroplast capture occur.

Irrespective of the above discussed problems, the taxa of the chapters 3.9.9.–3.9.11. are closely related and should represent a formal section. Because the traditionally applied sectional name *Megaloprason* is nomenclaturally typified by *A. rosenbachianum* which represents a well separated clade (chapter 3.6.1.), a new section is created here to which the subsections *Costatae* (type species: *A. jesdianum*) and *Elatae* (type species: *A. stipitatum*) should be transferred.

Allium [subg. *Melanocrommyum*] sect. *Procerallium* R. M. FRITSCH, **sect. nova**

Type species: *A. stipitatum* REGEL

Scapus valde elongatus proportione tenuis, strictus, levis vel costatus (in sicco semper costatus), folia minimum aequantia plerumque excedens. Folia recurvata. Inflorescentia plerumque sphaerica, densa. Perigonium stellatum; tepala etiam basi libera, saepe mox reflexa et plus minusque contorta. Ovarium plerumque manifeste stipitatum, verruculosum.

Scape very long and slender, straight, smooth or ribbed (in dry state always ribbed), mostly much longer than (rarely equal to) the recurved leaves. Inflorescence commonly globose and dense. Flowers star-like, tepals free near base, soon reflexed and ± contorted. Ovary commonly distincly stalked, with rough surface.

3.10. sect. *Regeloprason*

This is one of the moderately small sections comprising about 18 species and subspecies which were affiliated to the subsections *Regeloprason* (c. 10 species and subspecies) and *Odoratae* (c. 8 species). All species possess narrowly campanulate to funnel-shaped flowers with connate basal parts of tepals and filaments. The dimensions of nearly all plant parts are moderate, the filaments are always remarkably shorter than the tepals, only white, yellow, and different kinds of pinkish-purple flowers occur. Only length, width, number, and structure of leaves and density of inflorescences are rather variable. Therefore sect. *Regeloprason* is generally regarded as one of the best circumscribed infra-subgeneric groups of subg. *Melanocrommyum*.

It was very surprising to see that molecular data draw a contradictory picture. Members of sect. *Regeloprason* were scattered over the ITS-based phylogenetic tree reported by GURUSHIDZE & al. 2008, and also the haplotypes of the *trn*L-*trn*F region of chloroplast DNA belong to well-separated lineages (GURUSHIDZE & al. in press). 17 species and subspecies were investigated and split in eight separate groups belonging to clusters 1, 2, 3, 4, and 7 (Fig. 1). It must be concluded that only members of one group are closely related, because the genetic distances to all other taxa of this section are large. This fact can perhaps best be explained by accepting the flower form of sect. *Regeloprason* as ancient structure, which did not much change, contrary to other morphological and genetic characters, during the fast diversification (rapid radiation) which happened during evolution of the current subg. *Melanocrommyum*. The detection of cryptic species only in a member of this section, *A. darwasicum,* (discussed in chapter 3.9.4.) may also be seen as confirmation of a conservative morphology. Probably this section is phylogenetically old. We may imagine that basal group(s) did not survive, and several descendants developed independently during later phases of evolution but retained the specific flower characters. Also the very variable characters of seed coats in this section (FRITSCH & al.

2006: missing verrucae in *A. regelii*, variable amplitudes and wave lengths of anticlinal wall undulation among the other species) may point to different directions of evolution.

Our results show a strong infra-subsectional diversity of subsect. *Regeloprason* and a quite separate position of its type species *A. regelii*. Therefore another subsection will be split off here:

Allium [sect. *Regeloprason*] subsect. *Diffusoumbellata* R. M. FRITSCH, **subsect. nov.**

Type species: *A. cupuliferum* REGEL

Folia oblonga usque anguste ovata, crassa, patentia usque solum versus adpressa. Inflorescentia iam ante anthesin rara fasciculata, post anthesin laxissima plus minusque sphaerica pedicellis inaequilongis.

Leaves oblong to narrowly ovate, thick, patent or adpressed to the soil. Inflorescence initially loosely fasciculate, after anthesis very loose and more or less globose with pedicels of unequal length.

This subsection comprises the alliances of *A. cupuliferum* and *A. isakulii* located in cluster 3.

The separate position in the clusters 1 and 4 favors *A. pseudowinklerianum, A. intradarvazicum,* and *A. sochense* as candidates for one more subsection, but they share a slender general stature, narrow and strict leaves, and compact inflorescences with sweet-smelling flowers with typical members of subsect. *Odoratae*.

3.11. sect. *Thaumasioprason*, not Included in this Study

This oligotypic section contains three Afghan endemics *A. mirum* (type species), *A. caroli-henrici,* and *A. cucullatum*. Another recently described species *A. khozratense* (FRITSCH 2009), a narrow endemic from Khozratishoh mountain range in Tajikistan, was also preliminarily affiliated to this section. These species are morphologically rather well separated from members of all other sections and should be respected also furthermore. Material of them was not available for molecular analyses yet.

3.12. Ornamental Cultivars and Hybrids

About 15 ornamental cultivars were initially included in this study, and 12 probes showed single or homogenized ITS copies and occupied clear positions in the dendrograms. 'Purple Sensation' (accs. 1801, 2615) is heterogeneous but does not really differ from other accessions of *A. hollandicum*. Our molecular data do not support the thesis that his cultivar is a hybrid. Similarly, 'Michael H. Hoog' and 'Purple King' (accs. 5132, 5137, 5478) belong clearly to *A. rosenorum*, and 'Mount Everest' and 'White Giant' (accs. 3246, 5480) to Central Asian *A. stipitatum*. These positions completely confirm the results of FRIESEN & al. 1997. Also 'Mars' and

'Gladiator' (accs. 5135, 5477) were positioned inside of Central Asian *A. stipitatum*, despite they are morphologically deviating. 'Gladiator' is probably a hybrid of *A. hollandicum*, the only parent found by FRIESEN & al. 1997, with *A. stipitatum* as second parent because it shows double peaks clearly uniting the *stipitatum* and *hollandicum* copies (15 wobble positions). 'Mars' is most probably a mutant of *A. stipitatum* only (also FRIESEN & al. 1997 found no other genome). 'Lucy Ball' and 'His Excellency' (accs. 5136, 5479) occupy an unresolved position in the clade containing Iranian accessions of *A. stipitatum, A. jesdianum* s. lat., and *A. hollandicum*. 'Lucy Ball' also may be a hybrid with a homogenized ITS sequence between any of these species (FRIESEN & al. 1997 accepted *A. hollandicum* as one parent) and any taxon from another clade, while the accession no. 5479 showed additionally the ITS copy of *A. macleanii*, pointing that *A. macleanii* is another parent of 'His Excellency'. Also 'Globemaster' (acc. 5476) in sect. *Asteroprason* is placed next to *A. cristophii*, which fits well as one parent, but the position is indifferent concerning *A. macleanii* (both recognized by FRIESEN & al. 1997) as a second parent. However, in the sequence of this accession several nucleotide positions showed double peaks, which correspond well to the sequence of *A. macleanii*. Thus our data confirmed both parents of this cultivar found by FRIESEN & al. 1997. Our data also showed that the *A. macleanii* like sequence was partially homogenized towards the *A. cristophii* type.

4. Typifications

Several species affiliated in the conspectus (next chapter) were treated in differing sense by several authors. In some cases the type material was interpreted in different way, or consists of morphologically differing plants. As far as possible and practical, lectotypes or neotypes are designated below. Also the holotype sheets of rather many Central Asian species bear several plants often differing one from another. Then also single plant should be designated as lectotypes. This selection requires careful comparison of all available material, including living specimens, which could not be done in the frame of the current work. Such nomenclatural decisions must remain one of the assignments for further regional revisions or a general taxonomic revision of subg. *Melanocrommyum*.

Lectotype of *A. albopilosum* WRIGHT (designated here): [no label, lettering on the sheet] "*Allium albopilosum* C. H. WRIGHT in Gard. Chron. XXXIV p. 34, with fig. 138–02. ELLIS. Hort. Kew. 9 June 1903. Figured for Bot. Mag. 7982" (K, barcoded K000464557)

Material sent by VAN TUBERGEN to Kew was mentioned in the original description. Three sheets containing parts of such plants are present in K. The inflorescence depicted in Botanical Magazine (also mentioned in the

original description) is designated herewith as lectotype. It is visible that the inflorescence was divided in two (somewhat unequal) halves. The accompanying leaf may belong to the type plant, but evidence is missing.

Lectotype of *A. atriphoenicum* BORNM. (designated here): "*Allium atrophoeniceum* (sic!) BORNM. m. (ex aff. *A. cardiostemon*), Erzurum, am Khash-Khash-Dagh, 1934 VII. leg. KOTZSCH" (JE)

According to the text of description, type specimens of *A. atriphoenicum* were given to "Herb. Haussknecht, Weimar, und Herb. d. Technischen Hochschule, Dresden". The specimen in JE is extant containing one plant and the draft of a description in BORNMÜLLER's handwriting. It is designated here as lectotype.

Epitype of *A. bakhtiaricum* REGEL (designated here): [Iran, prov.] "Chaharmahal-Bakhtiari, 5 km S of Farsan, Deh Cheshmeh Pirghar, 17.5.1994 leg. R. FRITSCH" (IRAN 286)

The holotype specimen of *A. bakhtiaricum* (Iran: Montys Bakhtinis, leg. BODE init. Maji 1840, LE) is in a bad state and shows only one (formerly two) inflorescences and parts of scapes. The problematic interpretation of this name was discussed in detail by FRITSCH 1996 who also gave an emendated description based on plants newly collected in the Bakhtiar mountains. Objections raised by SEISUMS 2000 against this interpretation where answered by FRITSCH & al. 2002. In order to warrant a stabile application of the name, a voucher of the plants discussed by FRITSCH 1996 is designated here as epitype.

Lectotype of *A. breviscapum* STAPF (designated here): [Iran:] "Auf steinigen Abhängen bei Gentschnahme, 19 (?) Mai", second label: "*Allium breviscapum* STAPF, In declivibus saxosis ad Ganjname, 19./5. 82, leg. Th. PICHLER" (WU)

The type sheet at WU contains two plants. The left plant was marked by an asterisk and designated as lectotype by WENDELBO (label dated 1967), but this selection was apparently never published. It shall be validated herewith.

Lectotype of *A. dasyphyllum* VVED. (designated here): [Kazakhstan:] "Prov. Syr-Darja, distr. Aulie-ata, Montes Alexandri in tesquis subalpinis saxosis prope Utsch-bulak; 8. VII. 1924, leg. MOKEEVA et POPOV", [Herbarium Florae Asiae Mediae 57. *Allium dasyphyllum* VVED. sp. n.] (the very right plant, TASH)

Apparently a rather high number of syntypes were distributed as the above mentioned exsiccata in 1925. One plant of the specimen stored at TASH is herewith designated as lectotype. This sheet belongs probably to

the material used by VVEDENSKY himself and transferred to TASH in the early 1990ies.

Epitype of *A. derderianum* REGEL (designated here): "Iran, prov. Tehran, Karaj, Chalus road, Asara, slopes N of the road. 23. 5. 2006 leg. ABBASI, M., FRITSCH, R., KEUSGEN, M." (IRAN 44046)

REGEL 1875 mentioned material of three collectors in the protologue, out of which "Persia borealis, leg. DERDERIAN" (LE) was designated as lectotype by AGABABIAN & OGANESIAN 2000. However, this was not really helpful, because the collection site of DERDERIANS plants is not known, and *A. derderianum* is a rather variable taxon (FRITSCH 2008). Therefore a specimen with known collection site is designated as epitype which shows narrowly linear-triangulate tepals about 10 mm long and 1 mm wide (FRITSCH 2008: 61, fig. 8A) as originally described.

Lectotype of *A. dilutum* STAPF (designated here): "Iter persicum Dr. J. E. POLAK 1882. *Allium dilutum* STAPF. Persia borealis. Inter Kaswin et Zerschk, 5. 5. leg. Th. PICHLER" (WU)

The type sheet at WU contains two plants. The right plant and the bulb in the centre were marked by a cross and designated as lectotype by WENDELBO (label dated 1981), but this selection was apparently never published. It shall be validated here. WENDELBO intended perhaps to correct the earlier statement (WENDELBO 1966: 49) "*A. dilutum* STAPF of which I have had the type on loan from Kew . . .".

Lectotype of *A. eginense* FREYN (designated here): "P. SINTENIS: Iter orientale 1890. No. 2436 *Allium chrysantherum* B. & REUT. Armenia turcica. Szanduk, in campis. 17. V. det. J. FREYN" (the left-hand, narrow-leafed plant, WU)

Two different numbers of exsiccata collected by SINTENIS were mentioned in the protologue. Several of these syntypic sheets are extant in several herbaria, but no voucher annotated by FREYN could be traced. One plant of the voucher in WU is designated here as lectotype which fits perhaps best the original description.

Lectotype of *A. ellisii* HOOK. f. (designated here): "*Allium* ex affinitate *A. karataviensis* REGEL Bot. Mag. 6451 from Hon. Ch. ELLIS, Haslemere, June, 1900. Collected in Persia by Ney ELIAS", second label "*Allium* sp. n. *A. karataviense Allium Ellisii,* HOOK. f. June 6. 1900 Type of Bot. Mag. t. 7875" (K, barcoded K000464378)

This specimen delivers all the data mentioned in the protologue and bears also the determination by HOOKER. WENDELBO added the remark "To me this seems to be a coarse specimen of *A. bodeanum* RGL." in 1966. A

second sheet at K (K000464377) containing flowers, capsules and an inflorescence may also represent original material: ". . . April, 1897. Sent for name by Honbl. C. ELLIS.".

Lectotype of *A. giganteum* REGEL (designated here): "Ex horto bot. Petropolitano 82.6 *Allium giganteum* RGL.", second label "lectotypus A. SEISUMS 1992" (two inflorescences on the left side, LE)

In the protologue, beside a wrong offspring ("Stammt aus dem Himalaya ") only cultivated material was mentioned (" es wurden uns von Hrn. Frank MILES in Bingham, Nottinghamshire, Zwiebeln mitgetheilt."). Later (REGEL 1887: 362) he cited as material "In Turcomaniae angustiis (RADDE), prope Merw (A. DONOWAN)". Because herbarium vouchers labelled in this way could not be traced at LE, we must conclude that these were also living plants. Also the "Typus" cited by WENDELBO 1971: 88: "Planta quaedam culta, probabiliter e bulbis in Persia inter Mashhad et Chacha, O'DONOVAN, LE" was not among the authentic specimens in LE (alternatively it might be the rephrased second reference of 1887). But a sheet containing two inflorescences of cultivated plants collected in 1882 may well represent that material sent by MILES and used by REGEL when describing *A. giganteum* in 1883. Also the label was written by REGEL. Herewith the hitherto unpublished designation of SEISUMS shall be confirmed and validated.

Lectotype of *A. hirtifolium* BOISS. (designated here): "In Persia prope Ispahan, leg. AUCHER No. 5389" (G, iso-lectotype K)

BOISSIER cited two herbarium vouchers in the protologue, and those cited above was named as type by WENDELBO 1971: 85. WENDELBO's selection was a good choice and shall also formally be validated here as lectotypification.

Neotype of *A. isfairamicum* O. FEDTSCH. (designated here): [Kirgizstan:]"Alaijskij khrebet: Langar (Ucz-Kurganskij), 28. VI. 1904, leg. B. A. FEDTSCH.", second label "neotypus A. SEISUMS 1992". (LE)

The first, very short description by O. FEDTSCHENKO did not mention offspring of the plants, and the second description by B. FEDTSCHENKO in 1907 ("*A. isphairamicum*") described the source of the material as "Montes Alaici: In decliviis inter Ucz-Kurgan et Karaul, VI. 1904, (B. FEDTSCHENKO !!)". However, herbarium vouchers from this site could not be traced neither in LE nor in FEDTSCHENKO's herbarium at TASH. Therefore it seems the best solution to validate the hitherto unpublished designation of SEISUMS. Because a clear indication is missing that this sheet was used when *A. isfairamicum* was described, only a neotype can be designated.

Lectotypus of *A. jenischianum* REGEL (designated here): "Persia Jenisch" (LE)

WENDELBO 1966: 49 analyzed both syntypes mentioned in the protologue and decided "One sheet is labelled 'Persia Jenisch' and this must be considered the type sheet". Though I was not able to see the type when I visited LE, the decision of Wendelbo was correct and shall be validated herewith.

Lectotype of *A. kazerouni* PARSA (designated here): "*Allium Saporis* STAPF cult. hort Vindob. 1886 Bulb. in jugo Kotael Henan prope Kasrun legit STAPF", second label "*Allium Kazerouni* PARSA in Kew Bull. 1949, 34. Determinavit 22.IV.47 G. PARSA" (the very right plant, K, barcoded K000464369)

The type sheet contains beside some more labels and notes a plant with 3 leaves laid in the press when still in buds, 3 inflorescences, and one inflorescence with 2 fragmented leaves designated as lectotype. Bulbs are missing.

Lectotype of *A. kharputense* FREYN & SINT. (designated here): "P. SINTENIS: Iter orientale 1889. No. 711 *Allium kharputense* FREYN & SINT. n. sp. Armenia turcica, Kharput, in campis ad Miadun, 8. V." (the right plant, WU)

As in the case of *A. eginense*, two different numbers of exsiccata collected by SINTENIS and distributed to several herbaria were mentioned in the protologue, but no annotated sheet could be traced. The designation follows WENDELBO 1971: 79, who mentioned the LD specimen of no. 711 as "Typus (isotypus)".

Lectotype of *A. olivieri* BOISS. (designated here): [Iraq:] "Mesopotamia inter Mossul et Baghdad, leg. OLIVIER" (G, not seen)

BOISSIER mentioned two voucher specimens in the protologue. WENDELBO 1971: 78 named only one of them as "Typus". The second syntype was apparently not traced because it was also not mentioned under the material seen. Therefore WENDELBO's selection is followed here to designate the lectotype.

Lectotype of *A. saposhnikovii* NIKITINA (designated here): [Kirgizstan:] "Kirgizskij khrebet, predgor'ya nad Chon-Arykam lesoposadki Akademii (Premountains of Kirgiz mountain range above Chonaryk, forest plantings of academy) 1 iyunya [June] 1956 leg. E. V. NIKITINA", second label "Lecto-Typus 26.5.1997 Reinhard M. FRITSCH" (FRU)

In the protologue, "Predgorýa khrebta Kirgizskij Ala-Too. Gora Paspel'dyk. Stepnye fitotsenozy. 1. VI. 1956, E. V. NIKITINA (in Herb. Ac. Sci.

Kirghiz. Frunze)" was described as type. However, a voucher bearing exactly this label could not be found, but several vouchers with a rephrased description of the collection site with identical date and collector are present in LE and FRU. It is very probable that they represent syntypes. The lectotype chosen in 1997 shall be validated here.

Neotype of *A. suworowii* REGEL (designated here): "Ex horto bot. Petropolitano 82.5 *Allium Suworowi* RGL. Fl. turkest.", second label "Lectotypus 1992 A. SEISUMS" (LE)

No herbarium specimen from the type location "In deserto kirghisico prope pagum Uralsk (A. REGEL)" could be traced in LE. Probably also this taxon was described from cultivated living plants collected by A. REGEL in Turkestan. Also in TASH no voucher from this place (a former post station about 90 km S Tashkent) was found. SEISUMS proposed a voucher of a plant cultivated in St. Petersburg and labelled in E. REGEL's handwriting as lectotype specimen. Though it contains a leaf part and an inflorescence with a part of the scape only, a better voucher is not known. Because this material was collected after the publication of *A. suworowii*, it can only be designated as neotype.

Lectotype of *A. trilophostemon* BORNM. (designated here): "*Allium* – Cilicia: in m. Tauro et Antitauro leg. DIECK 1906 cult. in Zöschen 1907 VI. 10 com. pl. viv. (small plant in the left corner above, B, barcoded B 10 0268786)

Four plants annotated by BORNMÜLLER are still extant in B. A large plant labelled "*Allium trilophostemon* BORNM. sp. n. Fedde Repert. 1912 ? cult. in horto meo (Weimar) pl. viv. a 1906 leg. DIECK 1911. VI. leg. J. BORNMÜLLER" (probably collected after submission of the description), and the lectotype specimen were mounted at one sheet. A second sheet bears one non-flowering and one flowering plant collected 19. 06. 1912 (after publication of the description at 31.12.1911) together with an analytic figure of the flower parts.

Lectotype of *A. tschimganicum* O. FEDTSCH. (designated here): *"Allium tschimganicum* B. F. Ol'gino, cult. 1902 g. Semena iz Chimgana poseyali IX. 1897, tsvety v 1j raz v 1901 g. (Seeds from Chimgan, sown Sept. 1897, flowered for the first time in 1901)" with a second label "lectotypus A. SEISUMS 1992" (LE)

= *A. motor* KAMELIN & LEVICHEV

Olga FEDTSCHENKO described this taxon in Progress. Sadov. Ogorodn. No. 36: 332, 1906 (in Russian) as a tall plant with narrower leaves and violet flowers. A longer description (as far as known written by VVEDENSKY) in the Russian book of M. G. POPOV (ed.), Key Pl. Envir. Tashkent:

65, 1923, mentioned linear, subobtuse, c. 4 mm long tepals and 5–21 mm wide leaves having cartilagineously dentate margins. These characters fit rather well the later described taxon *A. costatovaginatum* also occurring in the Chimgan area. Obviously VVEDENSKY interpreted *A. tschimganicum* without having seen the authentic specimens (which were labelled by him "Potius *A. Severtzovii* RGL." only at 23.I.1924). Later VVEDENSKY treated *A. tschimganicum* as synonym of *A. fetisowii* and *A. sewerzowii*, but revived *A. tschimganicum* in VVEDENSKY & KOVALEVSKAYA 1971: 53, 84 as taxon separated by pink tepals from the pinkish-violet flowering *A. "severtzovii"* sensu VVED.

Only several years ago herbarium specimens of *A. tschimganicum* collected in FEDTSCHENKO's garden prior to the description of this species were traced in LE. These plants are 70 – 100 cm high, have ± lanceolate, acute tepals 5–7 mm long, inner filaments with small side teeth, rough ovaries, and leaves 30 – 50 cm long and up to 30 mm wide. These characters fit neither to *A. fetisowii* nor to *A. sewerzowii* s. str. nor to *A. costatovaginatum*, but could well belong to *A. motor* or to *A. severtzovioides*. Violet flowers as mentioned in the original description fit better to the purplish-pink tepals of *A. motor* which bears regularely side-teeth at the base of inner filaments, whereas *A. severtzovioides* owns clear pink flowers and only sometimes side-teeth. Leaf blades and scape characters of these two species are similar, but *A. severtzovioides* bears a long, coarse, and rather hard sheath leaf covering above soil the basal part of the plants mostly till anthesis. *A. motor* bears only a small, soft, and quickly decomposing sheath leaf. Unfortunately, no authentic plant bears bulbs, and no remains of sheath leaves are visible at all. Certainly the outstanding and carefully working botanists Olga and Boris FEDTSCHENKO would have recognized the conspicuous sheath leaf if it was present, and would have taken care that it remains at the specimens laid into the press. Thus, there are three arguments to regard *A. tschimganicum* as conspecific with *A. motor*.

The authentic plants were mounted at 3 sheets. The sheet containing one large plant without bulb in anthesis shall be validated here as lectotype.

Neotype of *Allium viridiflorum* POBED. (designated here): "Semennoe vosproisvedenie tipa, dostavlenno v oranzhereyu N 24, s Ferganskogo khr., ur. Arkit, Dzhalalabadskoj obl. O. I. NEUSTRUEVOJ v 1945 g. (Reproduction from seed of the type, delivered to the glasshouse no. 24 from Fergan Mts., place Arkit, district Dshalalabad, by O. I. NEUSTRUEVA in 1945), 15. VIII. 1952 leg. E. G. POBEDIMOVA" (the left upper plant, LE)

It was clearly said in the Russian text of the original description and was also indicated in the protologue "Typus: Distr. Dshelalabad. In decliviis montium prope Arkit, culta in horto Instituta botanici Academiae Scientarum URSS, leg. O. NEUSTRUEVA 1945" that this species was de-

scribed from a living plant (valid according to art. 37.1 ICBN). However, a voucher specimen of this cultivated plant could not be traced in LE, and only the above mentioned specimen referred to NEUSTRUEVA or POBEDIMOVA. Because that voucher of *A. viridiflorum* was not available when this species was described, only a neotype could be designated.

Lectotype of *A. vvedenskyanum* PAVLOV (designated here): [Kazakhstan:] *Allium Vvedenskyanum* N. PAVL. sp. n. Kaz. SSR Almaatinsk. obl., sukhaya step bliz st. Otar [region Alma-Ata, dry steppe near station Otar] 2. VI. 1940, No. 583 Leg. + Det. N. V. PAVLOV (MW)

Probably syntypes of this species were distributed to several herbaria, but a specimen in AA could not be seen. The specimen housed in MW is in a good state, and the label bears the determination in PAVLOV's handwriting. It is designated here as lectotype.

5. Conspectus speciorum generis *Allium* L. subgeneris *Melanocrommyum* (WEBB & BERTHEL.) ROUY

5.1. Conspectus

1. sect. *Longibidentata* (R. M. FRITSCH) R. M. FRITSCH
   Allium fetisowii REGEL, type species (= *A. simile* Regel), *Allium chychkanense* R. M. Fritsch
2. sect. *Decipientia* (OMELCZUK) R. M. FRITSCH
   Allium decipiens FISCH. ex SCHULT. & SCHULT. f., type species, subsp. *decipiens*, *Allium decipiens* subsp. *quercetorum* SEREGIN, *Allium chelotum* WENDELBO, *Allium grande* LIPSKY, *Allium roborowskianum* REGEL, *Allium robustum* KAR. & KIR., *Allium sinkiangense* F. T. WANG & Y. C. TANG, *Allium tulipifolium* LEDEB., *Allium viridulum* LEDEB.
3. sect. *Regeloprason* WENDELBO
   3.1 subsect. *Regeloprason* (WENDELBO) KAMELIN s. str. *Allium regelii* TRAUTV., type species of section and subsection *Regeloprason* (= *A. yatei* AITCH. & BAKER), *Allium victoris* VVED.
   3.2 subsect. *Diffusoumbellata* R. M. FRITSCH *Allium cupuliferum* REGEL, type species, subsp. *cupuliferum*, *Allium cupuliferum* subsp. *nuratavicum* R. M. FRITSCH & BESHKO, *Allium balkhanicum* (R. M. FRITSCH & F. O. KHASS.) R. M. FRITSCH, *Allium cathodicarpum* WENDELBO, *Allium iliense* REGEL s. str., *Allium isakulii* R. M. FRITSCH & F. O. KHASS. (= *A. cupuliferum* sensu KAMELIN subsp. *nuratense* KAMELIN), *Allium subkopetdagense* (R. M. FRITSCH & F. O. KHASS.) R. M. FRITSCH
   3.3 subsect. *Odoratae* R. M. FRITSCH *Allium darwasicum* REGEL, type species, *Allium chodsha-bakirganicum* GAFFAROV & TURAKULOV, *Allium hissaricum* VVED., *Allium intradarvazicum* R. M. FRITSCH, *Allium lipskyanum* VVED., *Allium pseudowinklerianum*

R. M. Fritsch & F. O. Khass., *Allium sochense* R. M. Fritsch & U. Turakulov, *Allium winklerianum* Regel s. str.

4. sect. *Melanocrommyum* Webb & Berthel. s. str.
   - 4.1 *Allium nigrum* alliance *Allium nigrum* L., nom. cons., type species of subgenus, section, and subsection *Melanocrommyum* [= *A. afrum* (Zuccagni) Kunth, *A. magicum* L., nom. rej., *A. bauerianum* Baker], *Allium struzlianum* Ogan.
   - 4.2 *Allium asclepiadeum* alliance *Allium asclepiadeum* Bornm., *Allium chrysantherum* Boiss. & Reut. (= *A. reflexum* Boiss. & Reut. non F. Dietr.), *Allium eginense* Freyn, *Allium kharputense* Freyn & Sint., *Allium nemrutdaghense* Kit Tan & Sorger, *Allium olivieri* Boiss., *Allium saralicum* R. M. Fritsch, *Allium shatakiense* Rech. f., *Allium stenopetalum* Boiss. & Kotschy ex Regel, *Allium urmiense* Kamelin & Seisums
   - 4.3 *Allium bisotunense* alliance *Allium bisotunense* R. M. Fritsch, *Allium keusgenii* R. M. Fritsch
   - 4.4 *Allium cardiostemon* alliance *Allium cardiostemon* Fisch. & C. A. Mey. (= *A. atriphoeniceum* Bornm., *A. nabelekii* Kamelin & Seisums, *A. trilophostemon* Bornm.), *Allium mariae* Bordz., *Allium woronowii* Miscz. ex Grossh. (= *A. leonidis* Grossh.)
   - 4.5 *Allium colchicifolium* alliance *Allium colchicifolium* Boiss., *Allium haussknechtii* Náběl ek, *Allium libani* Boiss., *Allium moderense* R. M. Fritsch, *Allium straussii* Bornm.
   - 4.6 *Allium multibulbosum* alliance *Allium atropurpureum* Waldst. & Kit., *Allium cyrilli* Ten., (= *A. auctum* Omelczuk, *A. fragrans* Cirillo ex Ten.), *Allium elmaliense* Deniz & Sümbül, *Allium multibulbosum* Jacq. (= *A. nigrum* auct. non L., *A. monspessulanum* Gouan, *A. speciosum* Cirillo), ? *Allium rhetoreanum* Náběl ek
   - 4.7 *Allium noëanum* alliance *Allium karamanoglui* Koyuncu & Kollmann, *Allium noëanum* Reut. ex Regel (= *A. dilutum* Stapf, *A. jenischianum* Regel)
   - 4.8 *Allium orientale* alliance *Allium aschersonianum* Barbey (incl. subsp. *ambiguum* Bèg. & Vacc.), *Allium crameri* Aschers. & Boiss., *Allium dumetorum* Feinbr. & Szelub., *Allium fedtschenkoi* Náběl ek, *Allium lachnophyllum* Paine, *Allium lycaonicum* Siehe, *Allium orientale* Boiss., *Allium tel-avivense* Eig, ? *Allium tubergenii* Freyn
   - 4.9 *Allium rothii* alliance *Allium rothii* Zucc., *Allium vinicolor* Wendelbo
5. sect. *Acanthoprason* Wendelbo
   - 5.1 *Allium akaka* alliance *Allium akaka* S. G. Gmelin ex Schult. & Schult. f., type species of sect. *Acanthoprason*

5.2 *Allium austroiranicum* ALLIANCE *Allium austroiranicum* R. M. FRITSCH, *Allium jaubertii* R. M. FRITSCH (= *A. latifolium* JAUB. & SPACH non W. YOUNG necque GILIB.)
5.3 *Allium derderianum* alliance *Allium breviscapum* STAPF, *Allium derderianum* REGEL, *Allium egorovae* M. V. AGAB. & OGAN., ? *Allium ramazanicum* PARSA, *Allium shelkovnikovii* GROSSH., *Allium vasilevskajae* OGAN.
5.4 *Allium haemanthoides* alliance *Allium haemanthoides* BOISS. & REUT. ex REGEL s. str., *Allium zagricum* R. M. FRITSCH
5.5 *Allium materculae* alliance *Allium materculae* BORDZ., *Allium graveolens* (R. M. FRITSCH) R. M. FRITSCH
5.6 *Allium minutiflorum* alliance *Allium hamedanense* R. M. FRITSCH, *Allium minutiflorum* REGEL
5.7 *Allium ubipetrense* alliance *Allium ubipetrense* R. M. FRITSCH (= *A. haemanthoides* var. *lanceolatum* BOISS.)

6. sect. *Pseudoprason* (WENDELBO) K. PERSS. & WENDELBO *Allium koelzii* (WENDELBO) K. PERSS. & WENDELBO, type species, *Allium hooshidaryae* MASHAYEKHI, ZARRE & R. M. FRITSCH
7. sect. *Asteroprason* R. M. FRITSCH
   7.1 subsect. *Asteroprason* R. M. FRITSCH *Allium elburzense* WENDELBO, type species of section and subsect. *Asteroprason*, *Allium helicophyllum* VVED., *Allium monophyllum* VVED., *Allium kuhsorkhense* R. M. FRITSCH & JOHARCHI, *Allium pseudobodeanum* R. M. FRITSCH & MATIN
   7.2 subsect. *Christophiana* TSCHOLOK. *Allium cristophii* TRAUTV., nom. & orth. cons., type species (= *A. albopilosum* WRIGHT, *A. bodeanum* REGEL, nom. rej., *A. walteri* REGEL), *Allium ellisii* HOOK. f.
8. sect. *Stellata* (F. O. KHASS. & R. M. FRITSCH) R. M. FRITSCH *Allium taeniopetalum* POPOV & VVED., type species, subsp. *taeniopetalum, Allium taeniopetalum* subsp. *mogoltavicum* (VVED.) R. M. FRITSCH & F. O. KHASS. (= *A. baschkyzylsaicum* KRASSOVSK.), *Allium taeniopetalum* subsp. *turakulovii* R. M. FRITSCH & F. O. KHASS.
9. sect. *Megaloprason* WENDELBO s. str.
   9.1 subsect. *Megaloprason* R. M. FRITSCH *Allium rosenbachianum* REGEL s. str., type species of section and subsection *Megaloprason, Allium insufficiens* VVED., *Allium kwakense* (R. M. FRITSCH) R. M. FRITSCH, *Allium schugnanicum* VVED.
   9.2 subsect. *Humilicognata* R. M. FRITSCH *Allium brachyscapum* VVED., type species, *Allium assadii* SEISUMS (= *A. brachyscapum* sensu WENDELBO), *Allium scotostemon* WENDELBO
   9.3 subsect. *Keratoprason* R. M. FRITSCH *Allium sarawschanicum* Regel, type species, (= *A. pseudozeravschanicum* POPOV & VVED. ex B. FEDTSCH. & POPOV)

9.4 subsect. *Spiralitunicata* R. M. FRITSCH *Allium suworowii* REGEL, type species, *Allium fibriferum* WENDELBO

10. sect. *Miniprason* R. M. FRITSCH
Allium karataviense REGEL (= *A. cabulicum* BAKER, *A. singulifolium* RECH. f.; ? incl. subsp. *henrikii* RUKSANS)

11. sect. *Acmopetala* R. M. FRITSCH

11.1 subsect. *Acmopetala* R. M. FRITSCH *Allium backhousianum* REGEL, type species of section and subsection *Acmopetala* (= *A. gulczense* O. FEDTSCH.), *Allium aflatunense* B. FEDTSCH. non hort., *Allium alaicum* VVED., *Allium arkitense* R. M. FRITSCH, *Allium bekeczalicum* LAZKOV, *Allium calocephalum* WENDELBO, *Allium dasyphyllum* VVED., ? *Allium kurdaicum* BAJTENOV, *Allium pangasicum* TURAKULOV, *Allium schachimardanicum* VVED., *Allium vvedenskyanum* PAVLOV, *Allium zergericum* F. O. KHASS. & R. M. FRITSCH

11.2 subsect. *Albidiflora* R. M. FRITSCH *Allium saposhnikovii* NIKITINA (= *A. collis-magni* KAMELIN s. str.)

11.3 subsect. *Durovaginata* R. M. FRITSCH *Allium costatovaginatum* KAMELIN & LEVICHEV, type species, (= *A. rudolfii* TURAKULOV), *Allium dodecadontum* Vved., *Allium severtzovioides* R. M. FRITSCH (= *A. sewerzowii* auct. non REGEL), *Allium tokaliense* KAMELIN & LEVICHEV

11.4 subsect. *Inornatae* R. M. FRITSCH *Allium sewerzowii* REGEL s. str., type species, *Allium tashkenticum* F. O. KHASS. & R. M. FRITSCH, (= *A. collis-magni* auct. non KAMELIN)

11.5 subsect. *Pharmakoprason* R. M. FRITSCH *Allium tschimganicum* O. FEDTSCH. s. str. (= *A. motor* KAMELIN & LEVICHEV)

12. sect. *Verticillata* KAMELIN
Allium verticillatum REGEL, type species, *Allium viridiflorum* POBED.

13. sect. *Compactoprason* R. M. FRITSCH

13.1 subsect. *Erectopetala* F. O. KHASS. *Allium giganteum* REGEL, type species of sect. *Compactoprason* and subsect. *Erectopetala* (= *A. procerum* TRAUTV. ex REGEL), ? *Allium isfairamicum* O. FEDTSCH., *Allium macleanii* BAKER (= *A. elatum* REGEL, *A. lucens* NIKITINA, nom. invalid.), *Allium trautvetterianum* REGEL

13.2 subsect. *Komaroviana* F. O. KHASS. & R. M. FRITSCH *Allium komarowii* LIPSKY

13.3 subsect. *Spiralopetala* F. O. KHASS. & R. M. FRITSCH *Allium majus* VVED.

14. sect. *Procerallium* R. M. FRITSCH

14.1 subsect. *Elatae* R. M. FRITSCH *Allium stipitatum* REGEL, type species of sect. *Procerallium* and subsect. *Elatae* (= *A. hirtifolium* BOISS.), *Allium altissimum* REGEL, *Allium botschantzevii* KAMELIN

14.2 subsect. *Costatae* R. M. FRITSCH *Allium jesdianum* BOISS. & BUHSE, type species, subsp. *jesdianum*, *Allium jesdianum* subsp. *angustitepalum* (WENDELBO) F. O. KHASS. & R. M. FRITSCH (= *A. ecornutum* F. O. KHASS. & MALTZEV), *Allium jesdianum* subsp. *remediorum* R. M. FRITSCH, *Allium bakhtiaricum* REGEL, *Allium hollandicum* R. M. FRITSCH, (= *A. aflatunense* hort. non B. FEDTSCH.), ? *Allium kazerouni* PARSA, *Allium rosenorum* R. M. FRITSCH (= *A. rosenbachianum* auct. non REGEL)

15. sect. *Aroidea* F. O. KHASS. & R. M. FRITSCH
Allium aroides POPOV & VVED.

16. sect. *Acaule* R. M. FRITSCH
Allium hexaceras VVED.

17. sect. *Popovia* F. O. KHASS. & R. M. FRITSCH
Allium gypsaceum POPOV & VVED.

18. sect. *Thaumasioprason* WENDELBO
Allium mirum WENDELBO, type species, *Allium caroli-henrici* WENDELBO, *Allium cucullatum* WENDELBO, *Allium khozratense* R. M. FRITSCH

19. sect. *Kaloprason* K. KOCH

19.1 subsect. *Kaloprason* (K. KOCH) KAMELIN s. str. *Allium caspium* (PALL.) M. BIEB., type species of section and subsection *Kaloprason*, subsp. *caspium* (= *A. brahuicum* BOISS.), *Allium caspium* subsp. *baissunense* (LIPSKY) F. O. KHASS. & R. M. FRITSCH (= *A. rhodanthum* VVED.), *Allium bucharicum* REGEL

19.2 subsect. *Ligulifolia* R. M. FRITSCH *Allium alexeianum* REGEL s. str., type species, *Allium hindukuschense* KAMELIN & SEISUMS, *Allium nevskianum* VVED. ex WENDELBO, *Allium protensum* WENDELBO (= *A. schubertii* auct. non ZUCC.)

19.3 subsect. *Schubertia* KAMELIN *Allium schubertii* ZUCC. s. str.

20. sect. *Brevicaule* R. M. FRITSCH
Allium sergii VVED., type species, *Allium chitralicum* F. T. WANG & TANG s. str. (= *A. pauli* VVED., *A. badakhshanicum* WENDELBO), *Allium eugenii* VVED.

21. Species incertae sedis
Allium triste KUNTH & BOUCHÉ (type not known, perhaps a member of sect. *Kaloprason* or sect. *Asteroprason*), *Allium chitralicum* sensu WENDELBO 1971 (no authentic material seen, probably a member of sect. *Procerallium*), *Allium lallemantii* REGEL & RACH. (type not known, perhaps a member of sect. *Decipientia*), *Allium loratum* BAKER (type plants are in buds only, perhaps a member of sect. *Compactoprasum* or sect. *Decipientia*)

5.2. Index of Specific and Infraspecific Names Applied in the "Conspectus"

Scientific name	Position
Allium graveolens (R. M. Fritsch) R. M. Fritsch	5.5
Allium gulczense O. Fedtsch.	11.1
Allium gypsaceum Popov & Vved.	17
Allium haemanthoides Boiss. & Reut. ex Regel s. str.	5.4
Allium haemanthoides var. *lanceolatum* Boiss.	5.7
Allium hamedanense R. M. Fritsch	5.6
Allium haussknechtii Nábělek	4.5
Allium helicophyllum Vved.	7.1
Allium hexaceras Vved.	16
Allium hindukuschense Kamelin & Seisums	19.2
Allium hirtifolium Boiss.	14.1
Allium hissaricum Vved.	3.3
Allium hollandicum R. M. Fritsch	14.2
Allium hooshidaryae Mashayekhi, Zarre & R. M. Fritsch	6
Allium iliense Regel s. str.	3.2
Allium insufficiens Vved.	9.1
Allium intradarvazicum R. M. Fritsch	3.3
Allium isakulii R. M. Fritsch & F. O. Khass.	3.2
Allium isfairamicum O. Fedtsch.	13.1
Allium jaubertii R. M. Fritsch	5.2
Allium jenischianum Regel	4.7
Allium jesdianum Boiss. & Buhse subsp. *jesdianum*	14.2
Allium jesdianum subsp. *angustitepalum* (Wendelbo) F. O. Khass. & R. M. Fritsch	14.2
Allium jesdianum subsp. *remediorum* R. M. Fritsch	14.2
Allium karamanoglui Koyuncu & Kollmann	4.7
Allium karataviense Regel	10
Allium karataviense Regel subsp. *henrikii* Ruksans	10
Allium kazerouni Parsa	14.2
Allium keusgenii R. M. Fritsch	4.3
Allium kharputense Freyn & Sint.	4.2
Allium khozratense R. M. Fritsch	18
Allium koelzii (Wendelbo) K. Perss. & Wendelbo	6
Allium komarowii Lipsky	13.2
Allium kuhsorkhense R. M. Fritsch & Joharchi	7.1
Allium kurdaicum Bajtenov	11.1
Allium kwakense (R. M. Fritsch) R. M. Fritsch	9.1

Scientific name	Position
Allium lachnophyllum Paine	4.8
Allium lallemantii Regel & Rach.	21
Allium latifolium Jaub. & Spach non W. Young necque Gilib.)	5.2
Allium leonidis Grossh.	4.4
Allium libani Boiss.	4.5
Allium lipskyanum Vved.	3.3
Allium loratum Baker	21
Allium lucens Nikitina	13.1
Allium lycaonicum Siehe	4.8
Allium macleanii Baker	13.1
Allium magicum L., nom. rej.	4.1
Allium majus Vved.	13.3
Allium mariae Bordz.	4.4
Allium materculae Bordz.	5.5
Allium minutiflorum Regel	5.6
Allium mirum Wendelbo	18
Allium moderense R. M. Fritsch	4.5
Allium monophyllum Vved.	7.1
Allium monspessulanum Gouan	4.6
Allium motor Kamelin & Levichev	11.5
Allium multibulbosum Jacq.	4.6
Allium nabelekii Kamelin & Seisums	4.4
Allium nemrutdaghense Kit Tan & Sorger	4.2
Allium nevskianum Vved. ex Wendelbo	19.2
Allium nigrum auct. non L.	4.6
Allium nigrum L.	4.1
Allium noëanum Reut. ex Regel	4.7
Allium olivieri Boiss.	4.2
Allium orientale Boiss.	4.8
Allium pangasicum Turakulov	11.1
Allium pauli Vved.	20
Allium procerum Trautv. ex Regel	13.1
Allium protensum Wendelbo	19.2
Allium pseudobodeanum R. M. Fritsch & Matin	7.1
Allium pseudowinklerianum R. M. Fritsch & F. O. Khass.	3.3
Allium pseudozeravschanicum Popov & Vved. ex B. Fedtsch. & Popov	9.3
Allium ramazanicum Parsa	5.3
Allium reflexum Boiss. & Reut. non F. Dietr.	4.2
Allium regelii Trautv.	3.1
Allium rhetoreanum Nábělek	4.6
Allium rhodanthum Vved.	19.1
Allium roborowskianum Regel	2

Scientific name	Position
Allium robustum KAR. & KIR.	2
Allium rosenbachianum auct. non REGEL	14.2
Allium rosenbachianum REGEL s. str.	9.1
Allium rosenorum R. M. FRITSCH	14.2
Allium rothii ZUCC.	4.9
Allium rudolfii TURAKULOV	11.3
Allium saposhnikovii NIKITINA	11.2
Allium saralicum R. M. FRITSCH	4.2
Allium sarawschanicum REGEL	9.3
Allium schachimardanicum VVED.	11.1
Allium schubertii auct. non ZUCC.	19.2
Allium schubertii ZUCC. s. str.	19.3
Allium schugnanicum VVED.	9.1
Allium scotostemon WENDELBO	9.2
Allium sergii VVED.	20
Allium severtzovioides R. M. FRITSCH	11.3
Allium sewerzowii auct. non REGEL	11.3
Allium sewerzowii REGEL s. str.	11.4
Allium shatakiense RECH. f.	4.2
Allium shelkovnikovii GROSSH.	5.3
Allium simile REGEL	1
Allium singulifolium RECH. f.	10
Allium sinkiangense F. T. WANG & Y. C. TANG	2
Allium sochense R. M. FRITSCH & U. TURAKULOV	3.3
Allium speciosum CIRILLO	4.6
Allium stenopetalum BOISS. & KOTSCHY ex REGEL	4.2
Allium stipitatum REGEL	14.1
Allium straussii BORNM.	4.5
Allium struzlianum OGAN.	4.1
Allium subkopetdagense (R. M. FRITSCH & F. O. KHASS.) R. M. FRITSCH	3.2
Allium suworowii REGEL	9.4
Allium taeniopetalum POPOV & VVED. subsp. *taeniopetalum*	8
Allium taeniopetalum subsp. *mogoltavicum* (VVED.) R. M. FRITSCH & F. O. KHASS.	8
Allium taeniopetalum subsp. *turakulovii* R. M. FRITSCH & F. O. KHASS.	8
Allium tashkenticum F. O. KHASS. & R. M. FRITSCH	11.4
Allium tel-avivense EIG	4.8
Allium tokaliense KAMELIN & LEVICHEV	11.3
Allium trautvetterianum REGEL	13.1
Allium trilophostemon BORNM.	4.4
Allium triste KUNTH & BOUCHÉ	21
Allium tschimganicum O. FEDTSCH. s. str.	11.5
Allium tubergenii FREYN	4.8
Allium tulipifolium LEDEB.	2
Allium ubipetrense R. M. FRITSCH	5.7
Allium urmiense KAMELIN & SEISUMS	4.2
Allium vasilevskajae OGAN.	5.3
Allium verticillatum REGEL	12
Allium victoris VVED.	3.1
Allium vinicolor WENDELBO	4.9
Allium viridiflorum POBED.	12
Allium viridulum LEDEB.	2
Allium vvedenskyanum PAVLOV	11.1
Allium walteri REGEL	7.2
Allium winklerianum REGEL s. str.	3.3
Allium woronowii MISCZ. ex GROSSH.	4.4
Allium yatei AITCH. & BAKER	3.1
Allium zagricum R. M. FRITSCH	5.4
Allium zergericum F. O. KHASS. & R. M. FRITSCH	11.1

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