

## Morphology and taxonomy of *Polygonum cognatum* Meisn., *P. alpestre* C. A. Mey. and allied taxa from Central Asia and the Caucasus (Polygonaceae)

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**Summary:** A taxonomic review of *Polygonum* ser. *Cognata* Kom. distributed in Southwest Asia, Central Asia and South Siberia is presented. A phylogenetic reconstruction of the genus *Polygonum* based on ITS 1-5.8S-ITS 2 rDNA sequences demonstrates the division of *Polygonum* into several clades, corresponding to: 1) section *Duravia* combined with *Polygonella*, 2) section *Polygonum* comprising the species from temperate climate regions of the Northern Hemisphere, 3) a vast group of Middle and Central Asiatic species, including two members of section *Pseudomollia*, i.e. *P. molliiforme* and *P. bornmuelleri*, nested among other species. Therefore a taxonomic revision of this group is required. Heterogeneity of ser. *Cognata* was evident by placing *P. cognatum*, *P. myrtillofolium* and *P. serpyllaceum* in one subclade and *P. alpestre* and *P. fibrilliferum* in another subclade. The morphological analysis of ser. *Cognata* using analysis of growth forms, leaves, ochreas, flowers, achenes and pollen grains revealed clear diagnostic differences which are extensively illustrated. Ser. *Cognata* Kom. is artificial comprising three taxonomically distant species: 1) *P. alpestre* C. A. Mey. including *P. ammanioides* Jaub. et Spach, 2) *P. fibrilliferum* Kom., 3) *P. cognatum* Meisn. (= *P. rupestre* Kar. et Kir.) including two varieties in addition to the typical one: *P. cognatum* var. *serpyllaceum* (Jaub. et Spach) O. V. Yurtseva and *P. cognatum* var. *myrtillofolium* (Kom.) O. V. Yurtseva.

**Keywords:** *Polygonum*, Polygonaceae, ITS 1-2, morphology, taxonomy, molecular evolution, growth form, achene, ultrasculpture, tepals, leaf

Studies of floral and fruit morphology as well as pollen grains gave the reasons to subdivide the genus *Polygonum* L. (Polygonaceae) into four sections: *Polygonum*, *Pseudomollia* Boiss., *Duravia* S. Watson and *Tephis* (Adans.) Meisn. (BOISSIER 1879; HEDBERG 1946; RONSE DE CRAENE & AKEROYD 1988; RONSE DE CRAENE et al. 2000; HONG et al. 1998, 2005). Preliminary phylogenetic studies of *Polygonum* based on ITS 1-5.8S-ITS 2 (ITS 1-2) sequences of nuclear rDNA (YURTSEVA et al. 2009, 2010) were contradictory to the taxonomic division based on morphology. Three Asiatic *Polygonum* species (*P. arianum* Grig., *P. atraphaxiforme* Botsch. and *P. toktogulicum* Lazkov) were assigned to the clade of the genus *Atraphaxis* L., the nearest genus to *Polygonum*. The members of *Polygonum* section *Duravia* and of *Polygonella* Michx. formed a cluster distinct from the other *Polygonum* species, which were distributed among two clades. The first one comprises species of the section *Polygonum* from the temperate zone of the Northern Hemisphere. The second clade includes two members of the section *Pseudomollia*, i.e. *P. molliiforme* Boiss. and *P. bornmuelleri* Litv., nested among numerous *Polygonum* species from Middle and Central Asia which were treated as members of the section *Polygonum* before (CHUKAVINA 1967). It was concluded that most of the Asiatic species of the genus *Polygonum* might be attributed to the section *Pseudomollia*, which needs taxonomic revision (YURTSEVA et al. 2009, 2010).

The present paper is contributed to the taxonomy of the genus *Polygonum* by means of a taxonomic survey of Asiatic species of ser. *Cognata* Kom. (KOMAROV 1936), including *P. alpestre* C. A. Mey., *P. ammanioides* Jaub. et Spach, *P. fibrilliferum* Kom., *P. myrtillofolium* Kom., *P. pamiroalaicum* Kom., *P. serpyllaceum* Jaub. et Spach and *P. rupestre* Kar. et Kir. The ITS 1-2 data indicate heterogeneity of ser. *Cognata* Kom. (YURTSEVA et al. 2010), combining perennial herbs with a many-headed caudex and frondose thyrses, oval or ovate-lanceolate leaves, transparent ochreas with ovate-lanceolate, dentate or lacerate lacinulas, connate perianth divided to  $\frac{1}{2}$  or  $\frac{1}{3}$  into five lobes, the two outer are keeled and acute; stamens 8; achene ovoid, triangular, smooth, shiny or grainy. In the phylogenetic trees, *P. cognatum*, *P. myrtillofolium* and *P. serpyllaceum* were combined in one subclade while *P. alpestre* and *P. fibrilliferum* fell to another subclade with *P. thymifolium* Jaub. et Spach. These results brought us to study the morphology of the group in detail.

## Materials and methods

Plant specimens for morphological and molecular analyses were taken from herbarium collections [LE, MO, MW, MHA] or were collected by colleagues. For morphological investigations we used stereoscopic microscope MBS-1 and scanning electronic microscopes Camscan-S2 and JSM-6380LA at the Laboratory of Electron Microscopy of Lomonosov Moscow State University. ITS 1-2 sequences of 68 species (103 samples) were analyzed. Sequences of 26 samples obtained for this study were added to sequences of 49 accessions elaborated previously (YURTSEVA et al. 2009, 2010) and 28 sequences were downloaded from GENBANK (2012). All studied samples are listed in Appendix, including GenBank accession numbers and voucher details.

**DNA isolation, amplification and sequencing:** DNA was extracted from herbarium specimens by the modified hexadecyltrimethylammonium bromide (CTAB) method (DOYLE & DOYLE 1987) or using the plant NucleoSpin Plant Extraction Kit (Macherey-Nagel, Germany). The yield of DNA ranged from 5 to 100  $\mu$ g per 0.1 g of plant material. DNA was precipitated with ethanol, and after washing with 70% ethanol, it was dissolved in TE buffer (pH 8.0) and stored at  $-20^{\circ}\text{C}$ . For the amplification of ITS 1-2 region external primers L, 4 and B, and in some cases, internal primers 2 and 3 were used (WHITE et al. 1990). Polymerase chain reaction was performed in 20  $\mu$ l of a mixture of 10–20 ng DNA, 10 pmol of each primer and MaGMix (Dialat LTD, Russia) containing 200  $\mu$ M of each dNTP, 2.0 mM  $\text{MgCl}_2$ , 2.5 units of Smart Taq polymerase with the following program: initial denaturation  $-95^{\circ}\text{C}$ , 3 min; followed by 30 cycles of denaturation  $-94^{\circ}\text{C}$ , 30 s; annealing of primers  $-58^{\circ}\text{C}$ , 30 s; elongation  $-72^{\circ}\text{C}$ , 30 s and then 3 min of extension time at  $72^{\circ}\text{C}$ .

ITS 1-2 amplification products were purified by electrophoresis in 1% agarose gel in TAE buffer in the presence of ethidium bromide (SAMBROOK et al. 1989). Specific DNA fragments were extracted from the gel using GFX™ PCR DNA and Gel Band Purification Kit (GE HealthCare, U.S.A.) and then used as a template in sequencing reactions with the ABI Prism BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems, USA) following the standard protocol provided for 3100 Avant Genetic Analyzer (Applied Biosystems, USA).

**Molecular phylogenetic analyses:** Sequences were aligned manually with BioEdit (HALL 1999) using alignment for a larger Polygonaceae data set (YURTSEVA et al. 2010) as a scaffold. For constructing phylogenetic trees two sets of sequences were used, i.e. Set 1 for 68 species presented by 103 specimens including 66 representatives of the tribe *Polygoneae*, 12 members of the tribe

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

*Rumiceae* and 22 members of the tribe *Persicarieae*, *Calligonum* and *Fagopyrum*, with three *Eriogonum* species as an outgroup, and Set 2 for 23 species presented by 43 specimens of the genus *Polygonum* with *P. achoreum* as an outgroup. The number of variable positions in sequences was counted by MEGA5 (TAMURA et al. 2011). Phylogenetic trees were constructed by maximum parsimony (MP) and maximum likelihood (ML) methods. The MP analyses were performed with TNT 1.1 (GOLOBOFF et al. 2008) using New Technology Search option with ratchet, drift and tree fusing algorithms and three-time search for minimal trees. Gaps were treated as a fifth nucleotide. Other parameters were taken as given by default. Support for nodes was assessed by 500 replications of a symmetrical resampling (SR) implemented in the program. The construction of trees by the ML was performed with RAxML-7.2.6. (STAMATAKIS & ALACHIOTIS 2010) using the GTRGAMMA model of nucleotide substitution and 500 bootstrap replications. Bootstrap support (BS) and SR values in percents were indicated in the text below without a percent sign.

## Results and discussion

### Phylogenetic analyses

The Set 1 alignment for 103 specimens and the Set 2 alignment for 43 specimens consist of 903 and 605 sites, respectively; all of which were included in analyses. Differences in the length of sets were defined mainly by the presence of insertions in the alignment positions 59-133 of ITS 1 in the basal group of species belonging to the genera *Bistorta*, *Aconogonon*, *Koenigia*, *Persicaria*, and *Atraphaxis*. In Set 1 and Set 2, the numbers of variable positions were 533 and 129, and parsimony informative positions 395 and 97, respectively.

The general topology of trees constructed by ML and MP methods, namely the position of common and well supported groups, was similar. So we present only trees constructed by ML method (Figs 1, 2).

In the ML tree in Fig. 1 with *Eriogonum* as an outgroup, other representatives of the following genera consistently branched off: *Paroxygonum* (BS=100), *Fagopyrum* (BS=98), *Calligonum* (BS=100) and the tribe *Persicarieae* (BS=89) consisting of *Persicaria* (BS=99), *Bistorta* (BS=100), *Aconogonon* + *Koenigia* (BS=99).

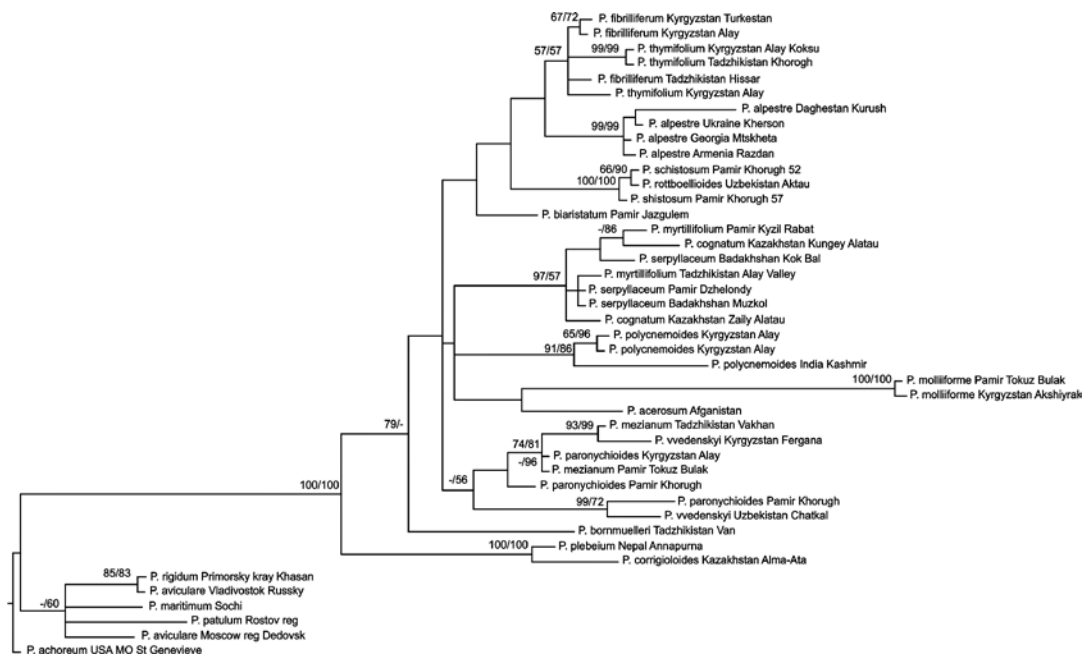
The clade corresponding to the tribe *Rumiceae* (BS=95) is sister to the tribe *Polygoneae* (BS=98) with a common BS equal to 90. The close relation of the tribe *Polygoneae* to the tribe *Rumiceae* has already been traced by other authors in the analyses of the combined data sets of three or five chloroplast fragments and nuclear ITS and LEAFY (SANCHEZ et al. 2009, 2011; SCHUSTER et al. 2011). As to morphological features, all representatives of the tribe *Polygoneae* possess filaments dilatated and flattened at base, invisible nectaries (presented by glandular zone on receptacle), angular or keeled perianth lobes of the outer whorl with a dendroid vein and sometimes a commissural middle vein, irregular or elongated epidermal cells of tepals (RONSE DE CRAËNE & AKEROYD 1988; HONG 1998). The grouping of *Rumex acetosa* and *R. thyrsiflorus* in the subclade (BS=100) separated from the other species of the genus *Rumex* confirms the taxonomic independence of the genus *Acetosa* described by MILLER (1754).

Among *Polygoneae*, there are several sister clades with rather high support: *Reynoutria* (including *Reynoutria japonica* and *R. sachalinensis*) with BS=98, *Muehlenbeckia*, *Fallopia* (BS=100), *Polygonum* sect. *Duravia* (*Polygonum douglasii* + *P. kelloggii*) with BS=87, *Atraphaxis* with



**Figure 1.** Maximum likelihood (ML) phylogenetic tree for 103 Polygonaceae specimens (Set 1) based on nucleotide sequences of ITS1-2 region of nuclear rDNA. Bootstrap support values > 50% are indicated. The branches with bootstrap support values < 50% are condensed. MCA clade consists of 37 specimens of 18 *Polygonum* species mainly from Middle and Central Asia.

*P. toktogulicum* + *P. atraphaxiforme* + *P. arianum* with BS=98, *Polygonum* sect. *Polygonum* with BS=89. Position of *Fallopia* and *Reynoutria* in different clades corresponds with the different structure of stigmas and habit and allows to attribute them to different genera (HARALDSON 1978) but not to different sections of the genus *Fallopia* Adans. (RONSE DE CRAENE & AKEROYD 1988; RONSE DE CRAENE et al. 2000). The heterogeneity of the genus *Fallopia* was also shown as well in molecular phylogenetic analyses based on *rbcL* (GALASSO et al. 2009), three or five chloroplast genes and nuclear genes LEAFY and ITS (LAMB FRYE & KRON 2003; SANCHEZ et al. 2009, 2011; SCHUSTER et al. 2011). Our results support the idea of HARALDSON (1978) that *Polygonella*, *Fallopia* and *Atraphaxis* are the closest taxa to the genus *Polygonum*, what coincides with the other results from molecular data (SANCHEZ et al. 2009, 2011; SCHUSTER et al. 2011).

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

**Figure 2.** Maximum likelihood (ML) phylogenetic tree based on nucleotide sequences of ITS1-2 region of nuclear rDNA for a clade MCA rooted at its sister group (see Fig. 1). At the nodes bootstrap support values > 50% are below slashes and symmetrical resampling supports from parsimony estimation are above slashes.

*Polygonella articulata* (L.) Meisn. and two species of section *Duravia* of the genus *Polygonum* formed a low-supported clade (BS=57) isolated from the rest of the *Polygonum* L. s. str. species. The similarity in morphology and pollen structure of *Polygonella* and *Polygonum* section *Duravia* motivated RONSE DE CRAENE et al. (2000) to include *Polygonella* as a subsection in section *Duravia*, what coincides with the results of molecular-phylogenetic reconstructions (SANCHEZ et al. 2009, 2011; SCHUSTER et al. 2011).

*Polygonum ovczinnikovii* Czukav. has an isolated position in the tree. It is a small shrub with frondose thyrses, flowers and pollen grains similar to some *Atraphaxis* species, so it is a transitional taxon between *Polygonum* and *Atraphaxis*. Subclade *Atraphaxis*, including *Polygonum arianum* + *P. toktogulicum* + *P. atraphaxiforme*, is separated by a branch with 25 substitutions in the ML/MP trees with 98/100 supports. This forces us to transpose *P. arianum*, *P. toktogulicum* and *P. atraphaxiforme* from *Polygonum* to the genus *Atraphaxis*. These three species are small semi-shrubs and shrubs close to some *Atraphaxis* species in morphology of shoot system, inflorescence and pollen grains, but they differ in flower structure typical of *Polygonum*. The representatives of this group are also combined by presence of synapomorphic insertion of 8-15 bp near the beginning of ITS 2 and are distinguished from all other *Polygonum* species by presence of 27-32 bp insertions at the end of the first half of ITS 1. Position of *Atraphaxis spinosa*, *A. frutescens* and *A. replicata* specimens in the clade let us suggest that they are in extremely close relation.

The other *Polygonum* species form two sister clades. One of them (BS=99) includes the members of section *Polygonum* from the temperate zone of the Northern Hemisphere. In this study, it is presented by five species (*P. aviculare* and others). Its internal structure based on the analysis of larger taxon sampling has already been presented (YURTSEVA et al. 2010). This clade is

characterized by a synapomorphic 4-7 bp insertion at the central part of ITS 1. The second clade with BS=77 designated in Fig. 2 as MCA (Middle and Central Asia) includes two species of the section *Pseudomollia* (*P. molliiforme* and *P. bornmuelleri*) nested among 16 Asiatic species (34 samples) of section *Polygonum*. This morphologically quite heterogeneous clade is not highly supported in ML tree (Fig. 1, BS=77). ML tree constructed for a smaller data Set 2 comprises 18 *Polygonum* species from Middle and Central Asia and 5 *Polygonum* species from the temperate zone of the Northern Hemisphere (Fig. 2). The exclusion of basal groups of the Set 1 resulted in the shortening of the alignment due to removal of many positions with gaps. The omitting of more distantly related species from the analyses lowers the chances of homoplasy occurrence. As a result, a support of MCA clade reaches the maximal value. However, its internal structure is still poorly resolved. According to the tree, the most important conclusions are that sect. *Pseudomollia* traditionally comprising only *P. molliiforme* and *P. bornmuelleri* is heterogeneous and that species from Middle and Central Asia need taxonomic revision. Several preliminary conclusions from the ML tree based on ITS 1-2 structure concern the similarity between *P. fibrilliferum* and *P. thymifolium*, *P. rottboellioides* and *P. schistosum*, *P. paronychioides* and *P. mesianum*, *P. plebeium* and *P. corrigioloides*, and a possible hybrid origin of *P. vvedenskyi* due to hybridization of *P. paronychioides* and *P. biaristatum*. We concentrate here on members of ser. *Cognata* Kom. (KOMAROV 1936) demonstrating heterogeneity. In ML/MP trees, the assessments of *P. cognatum*, *P. serpyllaceum* (= *P. pamiroalaicum*) and *P. myrtillofolium* form a clade with BS=57 and SR=97, while *P. alpestre* and *P. fibrilliferum* enter another distant clade (BS=72, SR=67) together with *P. thymifolium*, a rather different small shrub with bracteose thyrses, lanceolate leaf blades and a deeply dissected perianth covered with papillae. The intermingling of different specimens of *P. cognatum*, *P. myrtillofolium* and *P. serpyllaceum* (= *P. pamiroalaicum*) from different localities in a highly supported clade allows to attribute them to a single polymorphic species, namely *P. cognatum* Meisn. s.l.

### Taxonomic history of the group

*Polygonum cognatum* Meisn. is a type species of ser. *Cognata* Kom. described from Siberia as follows: “floribus axillaribus; ochreis laxis, membranaceis, laceris; foliis obovatis, mucronatis; caule erecto, ramoso, basi suffruticoso” (MEISNER 1826). *Polygonum alpestre* C. A. Mey., a similar species described from the Caucasus has “floribus vere axillaribus 3–8 subsessilibus (majusculis), caryopse calyce tecta faciebus ovato-triangularibus laevissimis, ochreis subintegerrimis internodio longioribus, foliis ellipticis oblongisve acutiusculis aveniis planis margine scabris, caulibus herbaceis procumbentibus ramosis, radice perenni” (MEYER 1831). The main difference of *P. cognatum* is a mucro at the leaf blade.

*Polygonum rupestre* Kar. et Kir. described from rocky and shadow places of East Tarbagatay (Kazakhstan) has pedicels twice longer than the perianth compared to *P. alpestre* (KARELIN & KIRILOV 1841). LEDEBOUR (1849–1851) pointed out that pedicels of *P. alpestre* are shorter than the perianth, while pedicels of *P. rupestre* are equal to the perianth or longer. Fischer and Meyer (1842; cited from LEDEBOUR 1849–1851) considered *P. rupestre* a variety of *P. alpestre*, while Ledebour considered both as varieties of *P. cognatum*.

KOCH (1849) discriminated *P. alpestre* from *P. cognatum*. The first possesses prostrate to ascending shoots with gradually acuminate leaves, three flowers in a cluster and achenes hidden in perianths,

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

while *P. cognatum* has erect stems with rounded and shortly mucronate leaves, four flowers in a cluster and exerted achenes. Recognizing the species rank of *P. alpestre*, JAUBERT & SPACH (1844–46) described *P. ammanioides* Jaub. et Spach, a related species from Persian Azerbaijan, with leaves twice as short and narrow and pedicels twice as long as in *P. alpestre*. This was supported by other scientists (KOMAROV 1936; GROSSHEIM 1930, 1945; RZAZADE 1952; GALUSHKO 1978). On the contrary, the opinion of BOISSIER (1879) that *P. ammanioides* is a variety, viz. *P. alpestre* var. *ammanioides* (Jaub. et Spach) Boiss., was also shared by others later (AVETISJAN 1956; RECHINGER & SCHIMAN-CZEIKA 1968; KUTATELADZE 1975; TZVELEV 1989). TZVELEV (1989) selected *P. alpestre* in subsection *Alpestrina* Tzvel. of section *Polygonum*.

Later Meisner treated *P. alpestre*, *P. rupestre* and *P. ammanioides* as three varieties of *P. cognatum* Meisn. (MEISNER 1857). This opinion was shared by authors who broadly treated *P. cognatum* (ROZHANETS 1916; ASENOV 1966; COODE & CULLEN 1967; TAKHTADJAN & FEDOROV 1972; AKEROYD et al. 1993; QAISER 2001). Some authors used *P. alpestre* as a prior name and *P. cognatum* as a synonym (KRECHETOVITCH 1937; GROSSHEIM 1930, 1945; KUTATELADZE 1975). On the contrary, *P. cognatum* was treated as a species different from *P. alpestre* in some floras, but under the name of *P. rupestre* (KRYLOV 1930; KOMAROV 1936; KASTSCHENKO 1953; BAJTENOV & PAVLOV 1960; CHUKAVINA 1968). In recent years, the earlier name *P. cognatum* has been preferred (GRUBOV 1982; BORODINA 1989; LI et al. 2003), but the diagnostic characters and distribution of the taxa are not quite clear so far.

*Polygonum serpyllaceum* Jaub. et Spach described from the alpine belt of Elburs in Persia borealis (JAUBERT & SPACH 1844–46) has characteristics placing it close to *P. alpestre* and *P. ammanioides*. *Polygonum pamiroalaicum* Kom. described from the alpine belt of the Pamir-Alay (KOMAROV 1936) is similar to *P. serpyllaceum*, differing in perianth dissected to  $\frac{1}{3}$  in *P. pamiroalaicum* and to  $\frac{1}{2}$  in *P. serpyllaceum*. Later *P. pamiroalaicum* was treated as a synonym of *P. serpyllaceum* Jaub. & Spach (CHUKAVINA 1967, 1968, 1971). *P. pamiroalaicum* differs from *P. rupestre* by shorter pedicels and from *P. alpestre* by smaller shoots, leaves and flowers (KOMAROV 1936). RECHINGER & SCHIMAN-CZEIKA (1968) discriminated *P. pamiroalaicum* and *P. serpyllaceum* as well as *P. alpestre*, *P. chitralicum* Rech. f. & Schiman-Czeika and *P. myrtillofolium* Kom. in Flora Iranica. The distribution area of *P. serpyllaceum* in Persia coincides with the area of *P. alpestre* also occurring in Anatolia, the Caucasus, in Kurdistan and Talush. In Afghanistan, the areas of *P. serpyllaceum* and *P. pamiroalaicum* overlap as well (RECHINGER & SCHIMAN-CZEIKA 1968). In Flora of Pakistan, QAISER (2001) attributes *P. pamiroalaicum* to a highly variable *P. cognatum* subsp. *cognatum*, the first differing in smaller mucronate leaves and densely foliate branches. So, the rank and relationship of *P. pamiroalaicum* and *P. serpyllaceum* are not quite clear. Another endemic species of Pamir-Alay, *P. myrtillofolium* Kom., is a small semi-shrub with lignified stems and a purple perianth divided to  $\frac{3}{4}$  (KOMAROV 1936), sharing other characteristics with *P. pamiroalaicum* and *P. rupestre*.

*Polygonum fibrilliferum* Kom. described from the Sanzar valley at the border of Tajikistan, Uzbekistan and Kyrgyzstan differs in smaller achenes and ochreas lacerate in numerous filaments (KOMAROV 1936; SUMNEVITCH 1953). CHUKAVINA (1967, 1968, 1971) included the perennial herbs *P. fibrilliferum*, *P. serpyllaceum* (= *P. pamiroalaicum*) and *P. rupestre* in the ser. *Cognata*, putting apart a small semi-shrub *P. myrtillofolium*. Obscure differences of the taxa enumerated above demand thorough morphological studies to resolve their taxonomic rank and relationship.

## Morphological analyses

**Growth forms and habitats:** JAUBERT & SPACH (1844–46) referred *P. alpestre*, *P. ammanioides* and *P. serpyllaceum* to small semi-shrubs, while KOMAROV (1936), BAJTENOV & PAVLOV (1960), CHUKAVINA (1971) and GRUBOV (1982) assigned *P. alpestre*, *P. ammanioides*, *P. serpyllaceum*, *P. pamiroalaicum*, *P. fibrilliferum*, *P. rupestre* to perennial herbs. *Polygonum alpestre* was referred to perennial herbs or small semi-shrubs (GROSSHEIM 1930). *Polygonum myrtillifolium* was described as small semi-shrub (KOMAROV 1936). Both small semi-shrubs and perennial herbs have the basal parts of annual shoots (residua *sensu* NUKHIMOVSKY 1969a, b) incorporated in a woody perennial shoot system, forming a many-headed caudex, while distal parts of the shoots die off for the most part of their length (SEREBRJAKOV 1962, 1964; BESPALOVA 1965; GOLUBEV 1973). In small semi-shrubs the proximal parts of the shoots with renewal buds usually rise over the surface, being sometimes buried by moving substrate. On the contrary, the basal lignified parts of the shoots with renewal buds are usually buried in perennial herbs. Many species growing in a wide range of habitats at mountain slopes and hills are small semi-shrubs or perennial herbs depending on the position of their residua and renewal buds in relation to the substrate surface (SHALYT 1955; BORISOVA 1960; NAKHUTSRISHVILY 1981).

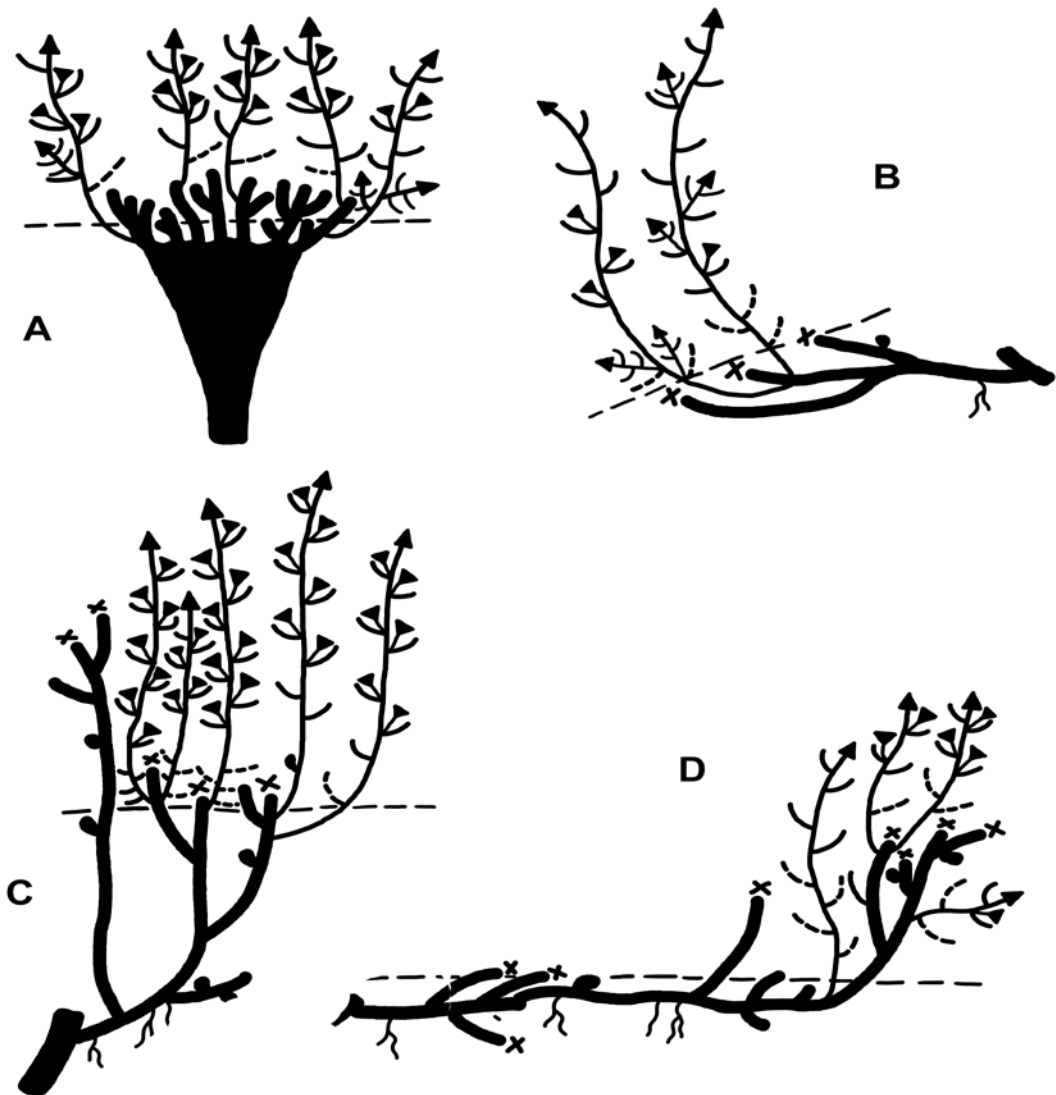
*Polygonum alpestre* inhabits the subalpine or alpine belt of the Balkans, the Caucasus and Asia Minor. It is a perennial herb with underground vertical or ascending ± woody many-headed caudex, 3–15 mm thick and with numerous elongated shoots 10–15(25) cm long, with 15–18 internodes 4–15 mm long. The shoots are erect, prostrate or ascending, basally lignified, light-brown, distally rounded or angulate, glabrous or unclear-striate, minutely papillate at ribs and below nodes, light-green or with antocyan colouring, densely covered with rusty rests of ochreas, drooping leaves equal to or exceeding internodes and axillary clusters with 5–6 flowers. The leaves of main shoots are much longer than internodes and twice longer than leaves of lateral branches. Distal parts of the shoots die off, 3–7 basal internodes form 1–2 renewal buds and adventitious roots. At alpine meadows the many-headed caudex branched to 2–3 order (Fig. 3A) is buried, but some residua rise over the surface. At scree slopes the shoots with renewal buds are buried for the great part of their length (Fig. 3B). The specimens designated as *P. ammanioides* bear diminished leaves at lateral branches of annual shoots and have both growth forms.

*Polygonum fibrilliferum* inhabits dry stony or gravelly slopes, clay and sandy fields in Central Asia. Usually it is a prostrate perennial herb with vertical or ascending rhizome (caudex) 3–20 mm thick and numerous elongated shoots 5–20(40) cm long with 10–20 internodes 3–20 mm long, developing for 1–2 seasons. The shoots are prostrate, ascending or rarely erect, simple or poorly branched, basally lignified, light-brown, covered with fulvous rests of ochreas and adventitious roots, at distal part ribbed, papillate along ribs, light-green or pale-yellow, evenly leafy, with clusters of 5–8 flowers in axils of drooping leaves. At main shoots the leaves are 3–8 times longer than internodes and twice longer than leaves of lateral branches. In autumn, the distal parts of monocarpic shoots die off, preserving 2–7 basal poorly lignified internodes with buds covered with scales and the rests of the ochreas. The elongated basal internodes buried by substrate often run down along the screes forming renewal buds and adventitious roots (Fig. 3B). Rarely, densely branched residua rise to 5–10 cm above the ground (Fig. 3C), what is typical of prostrate or ascending small semi-shrubs.



Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

The specimens identified as *P. cognatum* and *P. rupestre* grow on gravelly, stony or clay slopes from the middle to subnival mountain belt, on sandy alluvium, pebble river beds, lake coasts in Central Asia, West Siberia, Northern Mongolia, Tibet and West Himalaya. In their life history the first-year plants form vertical roots and annual shoots 6–8 cm long, branching to 1–2 order and dying off in winter except their basal parts. At the age of 2–20 years the plants elaborate a many-headed caudex with long underground shoots forming partial clumps, and at the age of



**Figure 3.** Growth forms of *Polygonum* ser. *Cognata*. A – perennial herb with compact caudex and shortened residua buried underground, *P. alpestre*, Azerbaijan, Lerik distr., Kosmoljan, thorn-cushion plant formation. 22.06.1977. Pimenov M. G. et al. [MW]. B – perennial herb with many-headed rhizome and long residua buried by crumble scree, *P. fibrilliferum*, Tajikistan, Leninabad distr., Turkestan ridge, Schakhristan distr., Kusavli Say, 2350 m a.s.l. 3.08.1968. Konnov A. A. [MW]. C – transition between perennial herb and small semi-shrub with residua and buds partly buried, *P. cognatum*, South Kazakhstan, Zaily Ala-Tau, northern slope of the Malaya Almaatinka rift, gravelly scree, 2600 m a.s.l. 2.09.1963. Skvortsov A. K. [MHA]. D – prostrate small semi-shrub with lignified residua and renewal buds, *P. myrtillofolium*, Kyrgyzstan, Issyk Kul distr., sandy terrace of the Karasay river. 29.07.1965. Chikun I. & Kozhevnikova N. [MHA].

20–30 the caudex particulates and desintegrates (SCHUBIN 1983). Numerous shoots, 10–30 cm long with 10–20 internodes 5–20 mm long, are simple or poorly branched, prostrate or ascending, basally lignified, light-brown and covered with the remainings of the ochreas, distally rounded or angulate, glabrous or minutely papillate at ribs, below nodes light-green with anthocyan, covered with leaves of equal size with 4–5 flowers in each axillary cluster. Later in season distal internodes die off, 3–7 basal internodes form renewal buds 2–4 mm long incorporated into the many-headed vertical or ascending  $\pm$  woody rhizome (caudex) 0.5–2 cm thick. On screes the system of residua branching to 2–5 order is usually buried by crumbled substrate (Fig. 3 B), on alpine meadows the plants form underground many-headed caudices 0.5–1 cm thick (Fig. 3 A), the shoots with shortened internodes 2–5 mm long and renewal buds are buried under the earth, what is common for perennial herbs. On pebble river beds the system of residua branching to 2–3 order partly elevates above the surface (Fig. 3 C, D), what is characteristic of small semi-shrubs.

*Polygonum serpyllaceum* grows in the alpine belt of Elburs, *P. pamiroalaicum* grows on alpine meadows near the snow patches, on rocky slopes, screes, disturbed places, sometimes descending to the forest or shrubby belt in Pamir-Alay and Tien Shan. Both are perennial herbs with a many-headed compact woody caudex 0.5–2 cm thick and a dense pillow-like bunch of numerous residua and ascending or prostrate shoots 3–5 cm long with internodes 5–7 mm long (Fig. 3 A), densely covered with leaves and flower clusters. In winter the shoots die off for the most part of their length, while 2–3 basal internodes 2–5 mm long incorporate into underground caudex, what is typical of perennial herbs.

*Polygonum myrtillofolium* inhabits the alpine belt of Pamir-Alay and grows on slate or gravely screes or in herb groupings. It is a small creeping semi-shrub or rarely a perennial herb, 10–40 cm high with woody branched rhizome (caudex) up to 0.5 cm thick, hidden deep in substrate with numerous residua and elongated shoots and renewal buds buried in soil or sometimes elevating 1–4 cm above the surface. Residua, 3–10 cm long with 4–10 internodes branching to 4–5 order (Fig. 3 C, D), are covered by the remainings of the ochreas, later they bear adventitious roots and renewal buds. The shoots are erect, prostrate or ascending, 15–25 cm long with internodes 10–15 mm long, purple, papillate below nodes, covered with leaves as long as internodes with axillary clusters of 1–2 flowers. Thus, *P. cognatum*, *P. rupestre*, *P. serpyllaceum*, *P. pamiroalaicum* and *P. myrtillofolium* vary their growth forms depending on the mobility of the substrate, i.e. whether they grow as rhizomatous perennial herbs on crumbled slopes and alpine meadows or as semi-shrubs on immovable rocks or pebble.

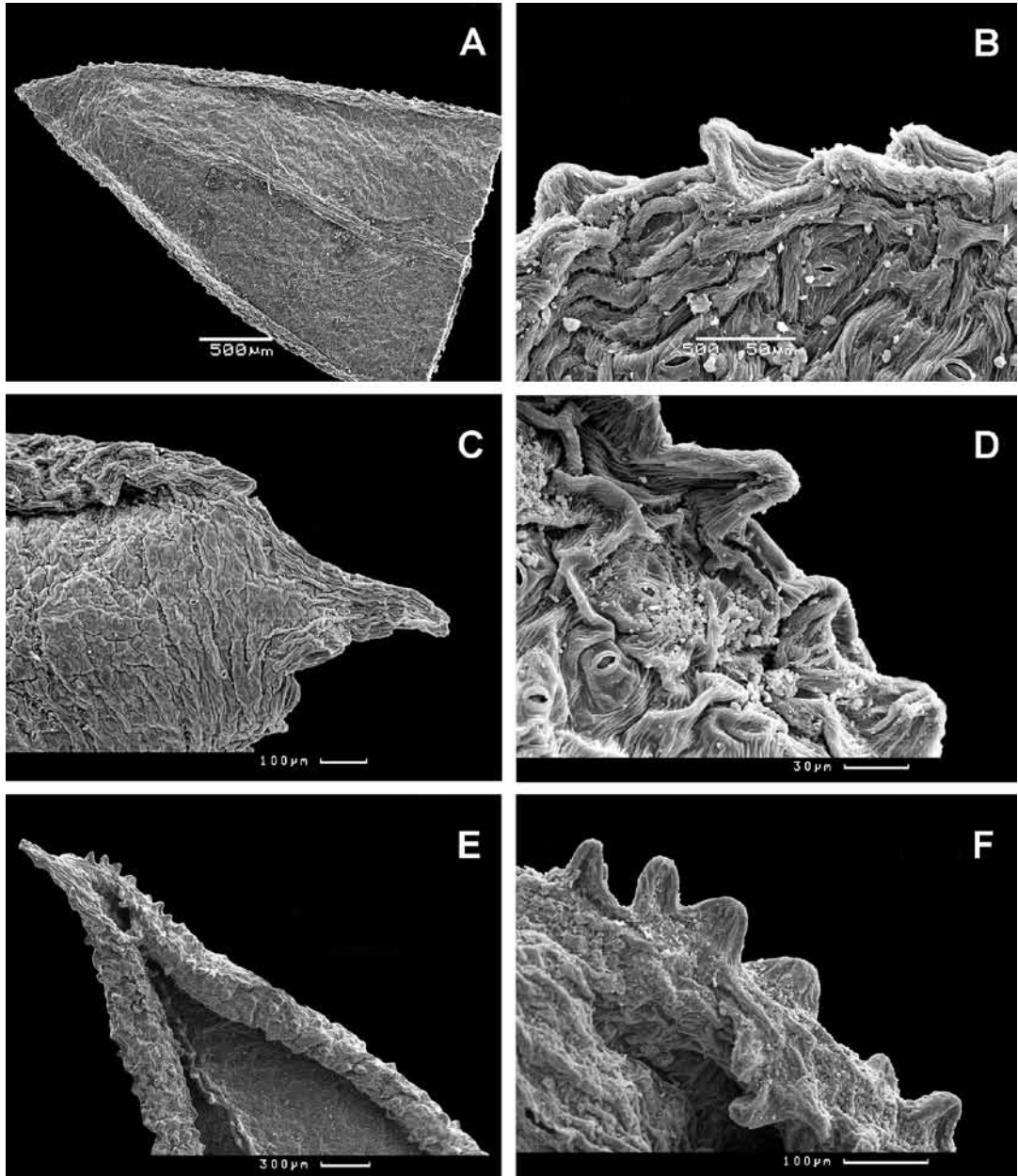
**Leaves:** All species have leaf blades narrowed into petioles (angustate) downward to the node. *P. fibrilliferum* and *P. alpestre* (including *P. ammanioides*) have leaves elliptic, oblong-elliptic or oblanceolate with maximum width at the upper part, gradually acuminate, with a small mucro or without it, grayish-green (Figs 4 A, B, 5 A, 6 A).

*Polygonum alpestre* has leaf blades 10–30 mm long, 3–12 mm wide with petioles 2–5 mm long at main shoot, twice as small and sessile at lateral branches (Fig. 5 A). Blades elliptic or oblong-elliptic, rarely oblanceolate, gradually narrowed to the base, gradually acuminate or obtusate at the top with small mucro, margin rough, flat or sometimes recurved, with conspicuous midvein and oblique second veins,  $\pm$  leathery, glabrous, minutely scabrous due to papillae along edge and main vein below, grey-green, a bit fleshy. The specimens designated as *P. ammanioides* usually possess small and narrow leaf blades typical of lateral branches of *P. alpestre* specimens. As the type

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

sheet of *P. alpestre* contains the shoots with leaves typical of both *P. alpestre* and *P. ammanioides*, there is no reason to distinguish these taxa by the size of leaves.

*Polygonum fibrilliferum* has leaf blades 8–40 mm long and 3–10 mm wide with petioles 2–3 mm long at main shoots and leaf blades 5–15 mm long and 1.5–3 mm wide at lateral shoots. They are oblong or oblanceolate, with cuneate base narrowed into the petiole, gradually or suddenly acuminate to the top, with small mucro, revolute scabrous margin, prominent middle vein and

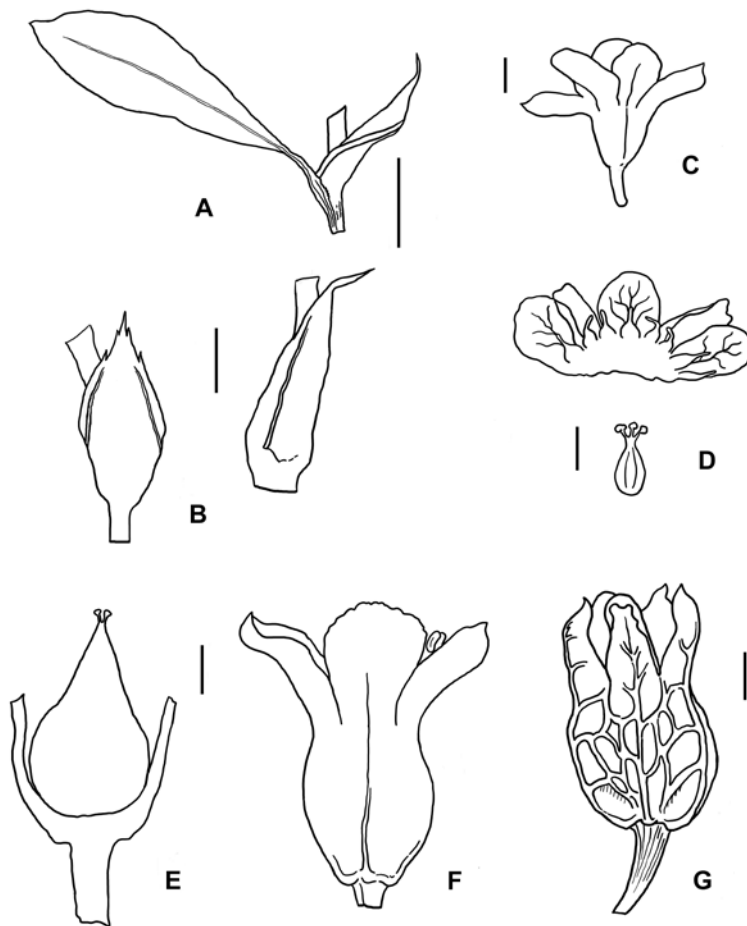


**Figure 4.** SEM images of leaf blades with papillae. A, B – *P. fibrilliferum*, South Kazakhstan, basin of the Keles river, between the Badam and the Keles rivers. C – *P. cognatum*, Kyrgyzstan, West Tien Shan, valley of the Santalash river, Pskemsky ridge. D – *P. cognatum*, West Mongolia, Mongol Altay. E, F – *P. myrtillifolium*, Pamir, Kyzyl-Rabat, valley of the Karicol river. Scale Bars: A = 500 µm; B = 50 µm; C, F = 100 µm; D = 30 µm; E = 300 µm.

oblique side veins, a bit leathery, grayish-green (Figs 4 A, B, 6 A). The edges and middle vein bear papilla with longitudinally-striate surface.

*Polygonum cognatum* (= *P. rupestre*), *P. serpyllaceum*, *P. pamiroalaicum* and *P. myrtillofolium* have obviously mucronate leaf blades (Figs 4 C–F, 7 A–C) with maximum width in the middle, abaxially with conspicuous or obscure midvein widening to the petiole. *P. cognatum* (Fig. 7 A, B) has leaf blades 5–25 mm long, 3–17 mm wide, rounded, obovate, rarely elliptic, suddenly narrowed into petioles 3–10 mm long, acuminate or obtuse, evidently mucronate, smooth-edged, flat or a bit recurved, glabrous, ± fleshy, green, with papillae along edge and midvein below, papillae with longitudinally striate surface (Fig. 4 C, D). *P. myrtillofolium* has leaves of similar size and shape, 10–15 mm long, 5–7(10) mm wide, mucronate, but flat and reddish (Fig. 4 E, F). *P. serpyllaceum* and *P. pamiroalaicum* differ by smaller obovate or oblanceolate leaves, 5–10(12) mm long and 2–5 mm wide, exceeding internodes, gradually narrowed into petioles 1–2 mm long, revolute (Figs 7 C, 9 B, C).

**Ochreas:** The ochreas of *P. alpestre* are 5–10(12) mm long, equal to or exceeding internodes at the top, shorter at the base, ovate-lanceolate or oval, smooth-edged, acuminate, shallow dentate



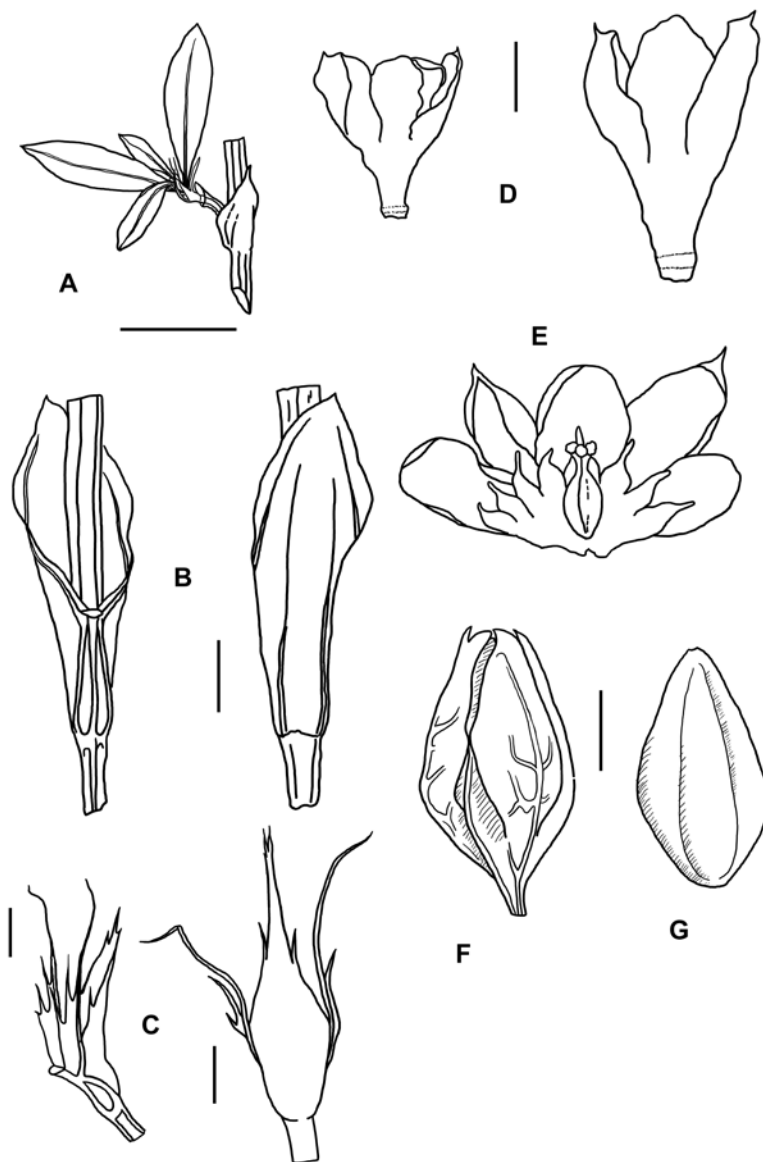
**Figure 5.** Morphological characteristics of *P. alpestre*. A – leaf with ochrea; B – ochreas with two veins included; C – young flower; D – flower, cut open; E – achene; F – perianth in flowering stage; G – perianth in fruiting stage. Scale bars: A, B = 10 mm, C–G = 1 mm.

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

at the top, hyaline, membranaceous, transparent, minutely scabrous, a little bit rusty at base, distally silvery-white, with 2–4(8) light fulvous or light-brown veins included (Fig. 5 A, B). Later they are lacerate, without aristae.

The ochreas of *P. fibrilliferum* are 5–10 mm long, at upper leaves exceeding internodes, ovate or ovate-lanceolate, acuminate, smooth-edged, rusty-brown at base, white-hyaline and transparent at the top, with 2(4) fulvous veins included, soon disintegrated in numerous filiform lacinulas and two brown aristae exceeding them (Fig. 6 A–C).

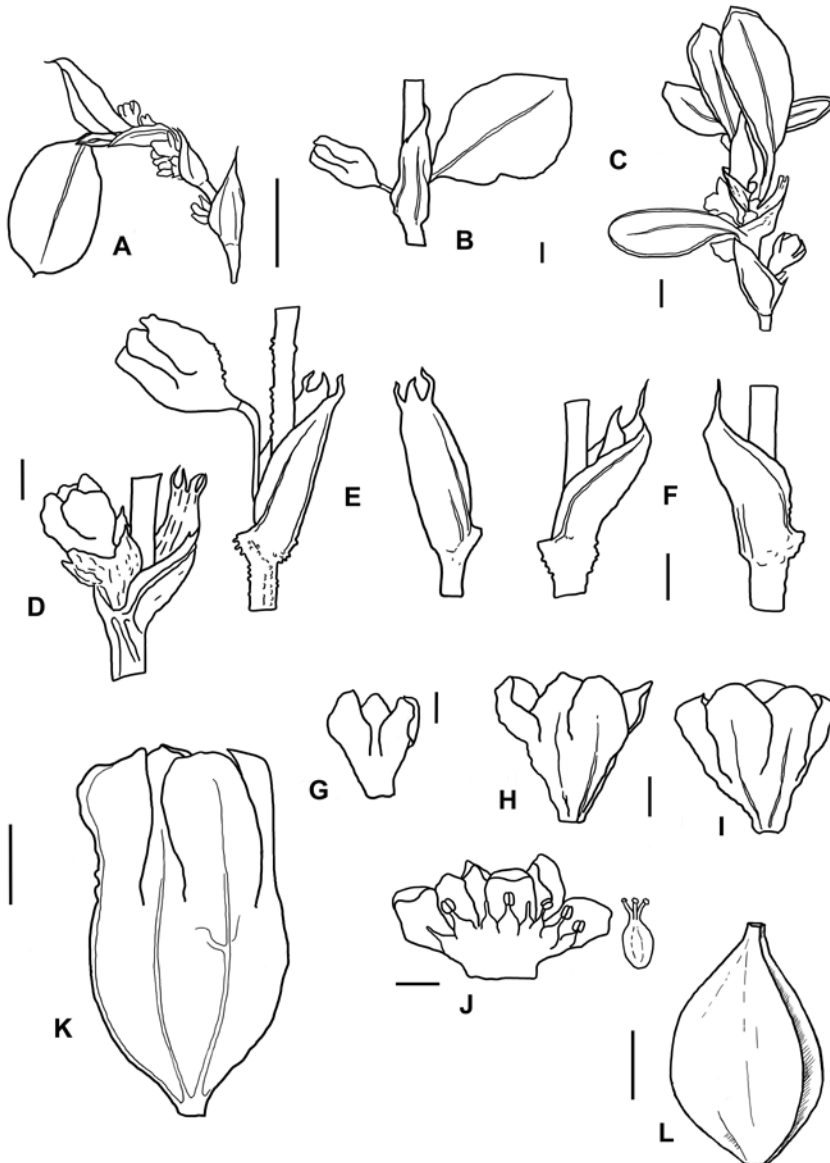
The ochreas of *P. cognatum* (= *P. rupestre*), *P. serpyllaceum*, *P. pamiroalaicum*, *P. myrtillifolium* are (3)5–8(10) mm, equal to or exceeding internodes, ovate-lanceolate, entire, acuminate or dentate



**Figure 6.** Morphological characteristics of *P. fibrilliferum*. A – ochrea with axillary shoot; B – young ochrea with four aristae included; C – senile ochrea with two aristae; D – young flowers; E – flower, cut open; F – perianth in fruiting stage; G – mature achene. Scale bars: A = 10 mm, B–G = 1 mm.

at the apex, hyaline, membranaceous, a little rusty at base, transparent, silvery, entire or dentate at the top, later lacerate to  $\frac{1}{2}$ – $\frac{2}{3}$ , with fulvous or light brown veins included: 3–4 in *P. cognatum* (= *P. rupestre*), *P. rupestre* and *P. myrtillifolium*, none or two hardly visible veins in *P. serpyllaceum* and *P. pamiroalaicum* (Fig. 7 A–F).

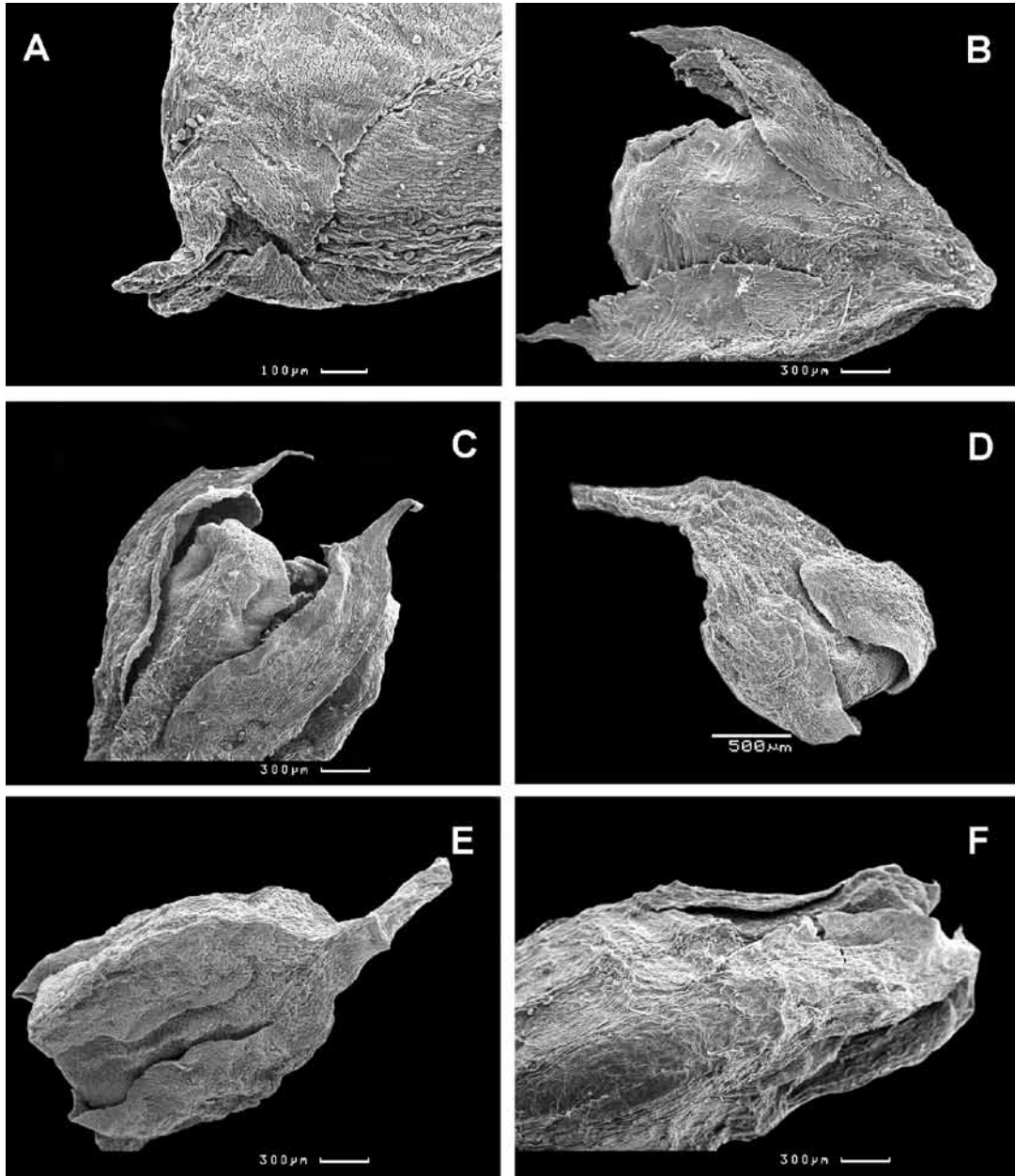
**Flowers:** Flowers demonstrate the most remarkable differences between the taxa. *P. alpestre* has 5–6 flowers in axillary monochasia, forming frondose thyrses. Pedicels strict, 2–4 mm long, angulate, thick, conspicuously broaden under the tube and join without articulation (Figs 5 A, C, F, G, 9 A), surrounded by campanulate, dentate- or fimbriate-lacerate ochreolas. Perianth in



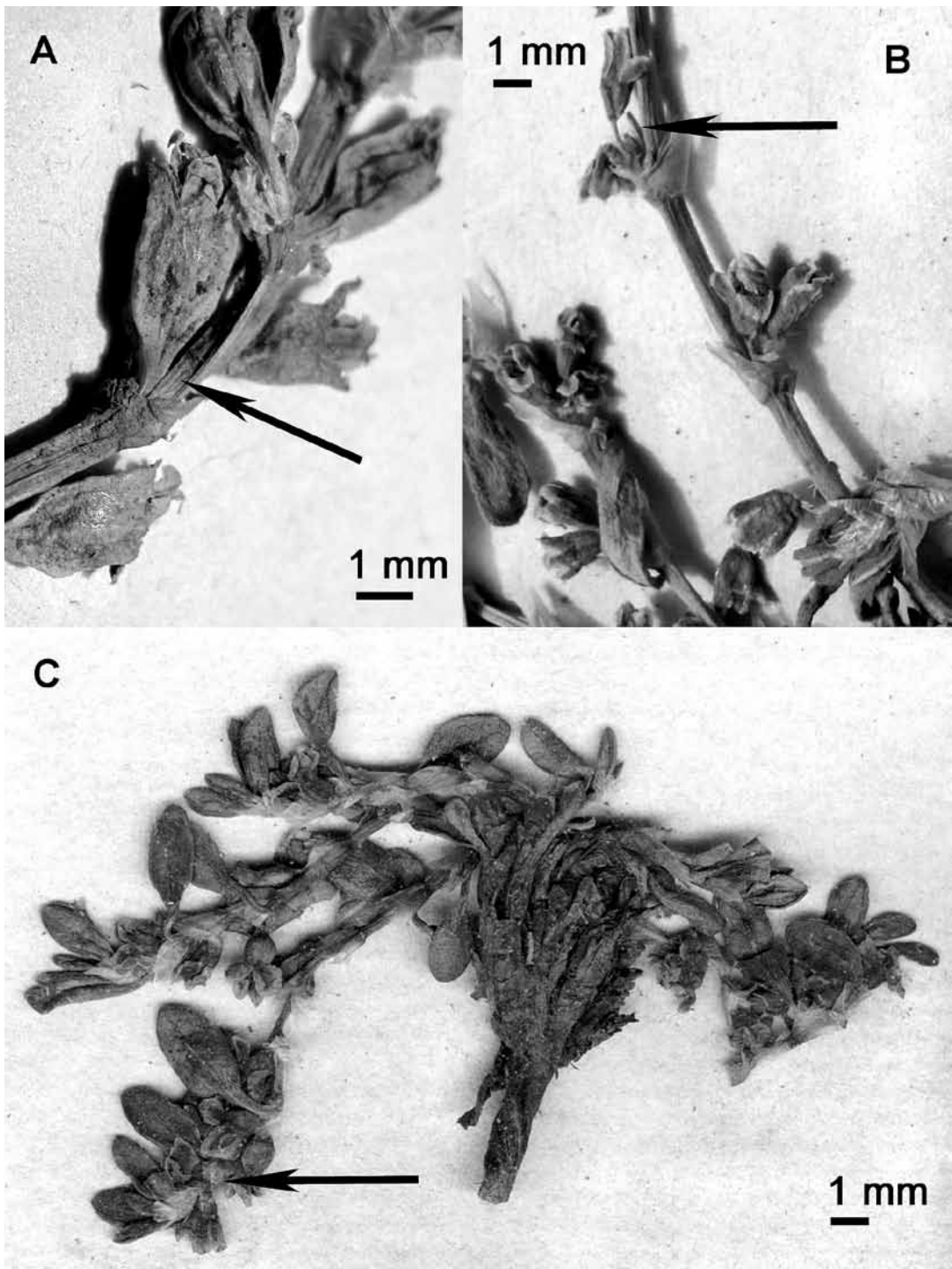
**Figure 7.** Morphological characteristics of *P. cognatum* (A, B, G, J, K), *P. serpyllaceum* (C, D, H, L) and *P. myrtillifolium* (E, F, I). A – fragment of the shoot; B – leaf with ochrea; C – fragment of the shoot; D – ochrea with axillary flower; E, F – ochrea with axillary flower; G – flower bud; H, I – flower; J – flower, cut open; K – perianth in fruiting stage; L – mature achene. Scale bars: A = 10 mm; B–L = 1 mm.

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

flowers is campanulate, 3–4 mm long, with narrow funnel-like tube divided to  $\frac{1}{2}$  in 5 horizontally reflected outer tepals, the perianth in fruits is 5–6 mm long (Fig. 5 C–D, F–G), divided to  $\frac{1}{3}$ – $\frac{1}{2}$ , urceolate with three bulged keeles. Two outer tepals ovate, acuminate, cucullate with concave apex, with hardly visible horn-like spurs a bit below their tops, keeled in the middle vein, decline in flowering; inner tepals a bit shorter, obtuse, flat, approximate in fruit. Perianth tube and lobes



**Figure 8.** SEM images of flower buds (A, B, D, E) and flowers (C, F). A – *P. fibrilliferum*, Southern Kazakhstan, basin of the Keles river, divide of the Badam and the Keles rivers; B – *P. fibrilliferum*, Tajikistan, Pamir and Pamir-Alay, Kugitang; C – *P. fibrilliferum*, Tajikistan, Kangurt distr.; D – *P. serpyllaceum*, Tajikistan, Badakhshan, Andarob, valley of the Garm-Chashma river and its side-stream Khoz-Guni; E – *P. myrtillofolium*, ibid; F – *P. cognatum*, Kyrgyzstan, West Tien Shan, Terskey Alatau, valley of the Karabatkak, basin of the Chon-Kzyl-Su. Scale bars: A = 100 µm; B, C, E, F = 300 µm; D = 500 µm.

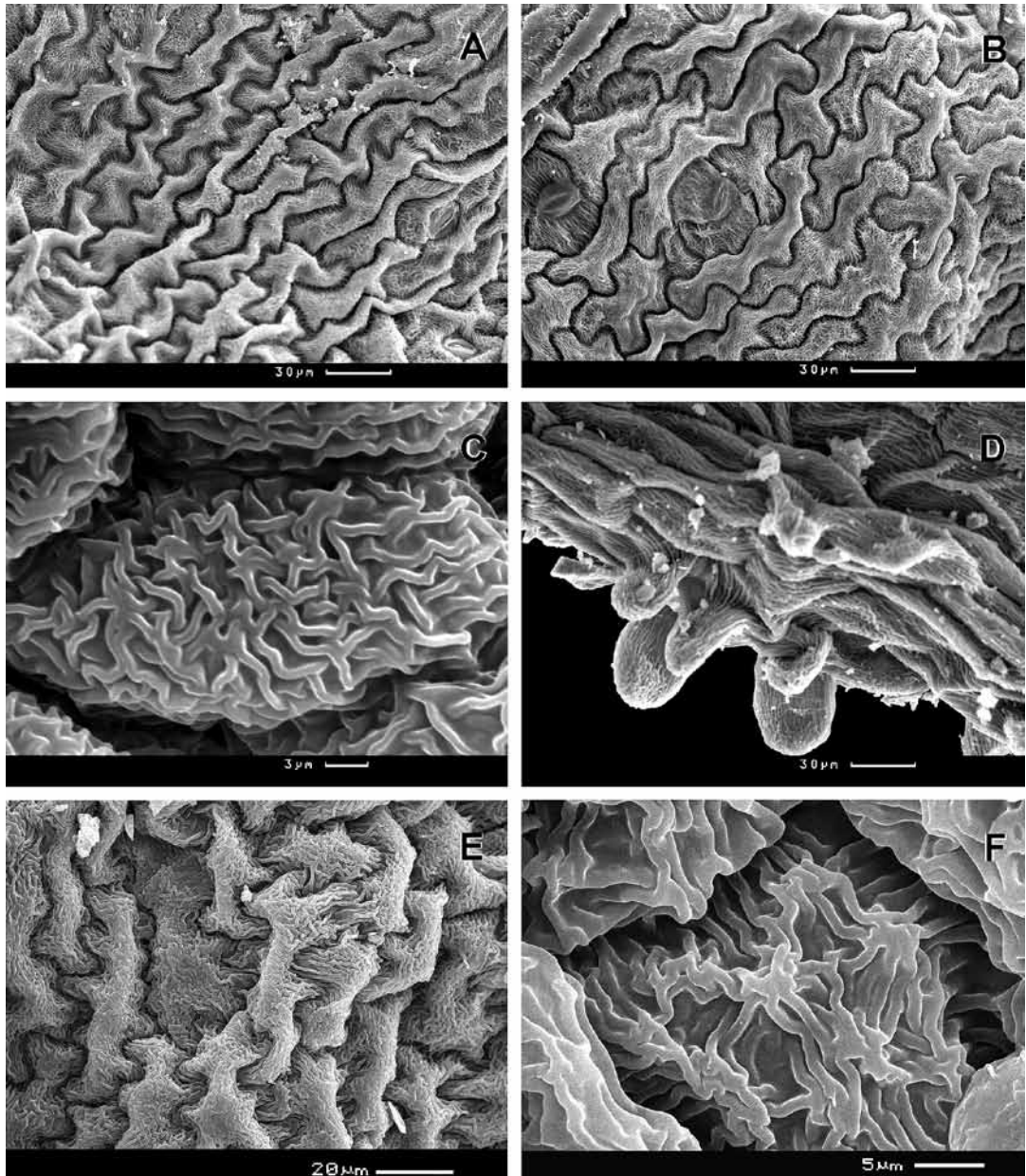


**Figure 9.** Authentic and type specimens. A – *P. alpestre* C. A. Mey., Enum. cauc. casp. n. 1398, Meyer, Herb. Ledebour, authentic specimen [LE]. B – *P. pamiroalaicum* Kom. (Pamir), Angustiis Kumar, Valley of Kumar river near Varzaminor (left bank of Zeravshan river) by the entry of Phon river, alt. 10000 pd, alpine belt, leg. V. L. Komarov, type specimen [LE]. C – *P. serpyllaceum* Jaub. et Spach, (Iran), Alp. Elamouth, Aucher-Eloy-Herbier-d’Orient, No. 5274, image K000568196 from the collection of the Royal Botanic Gardens, Kew, isolectotype [K]. © The Board of Trustees of the Royal Botanic Gardens, Kew. Reproduced with the consent of the Royal Botanic Gardens, Kew. Arrows point at pedicels joint without articulation (A) or with articulation (B, C). Scale bars: A–C = 1 mm.

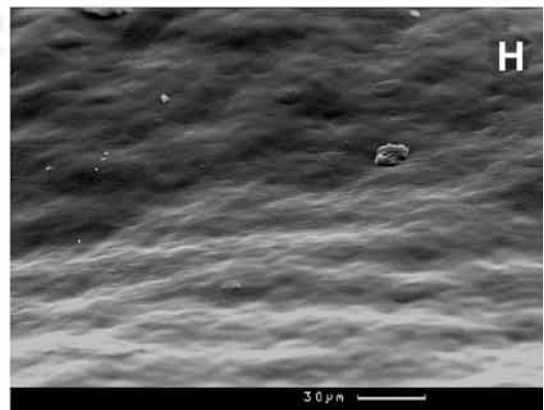
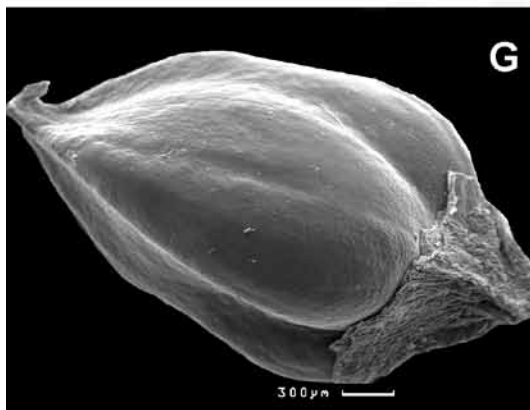
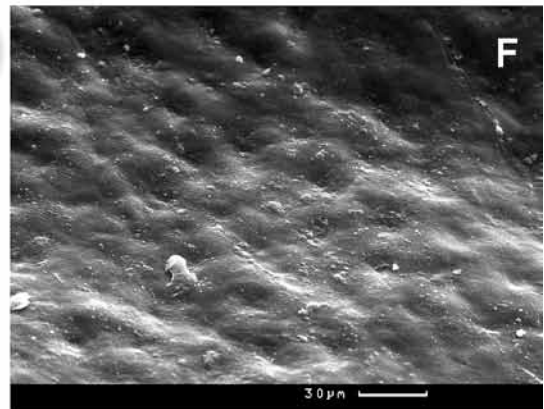
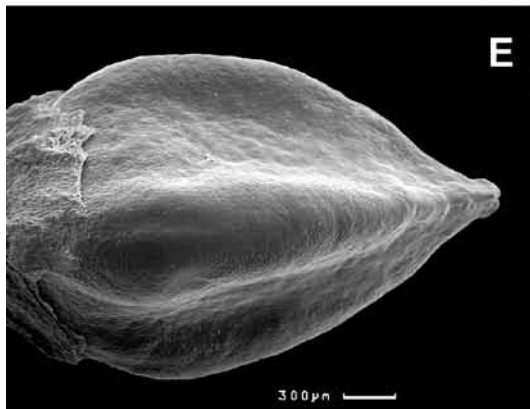
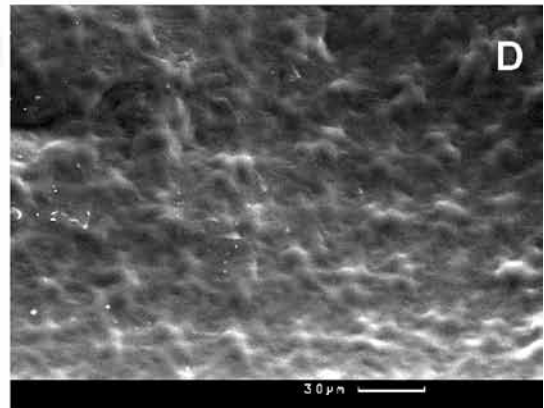
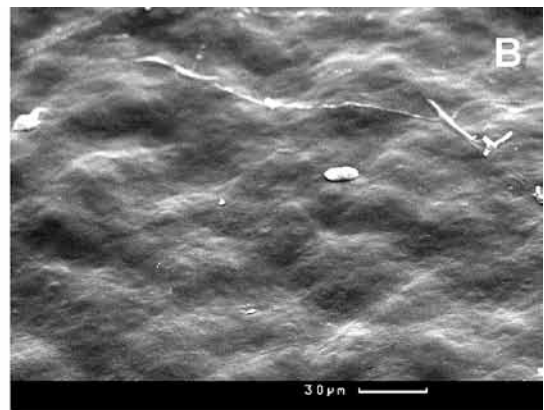
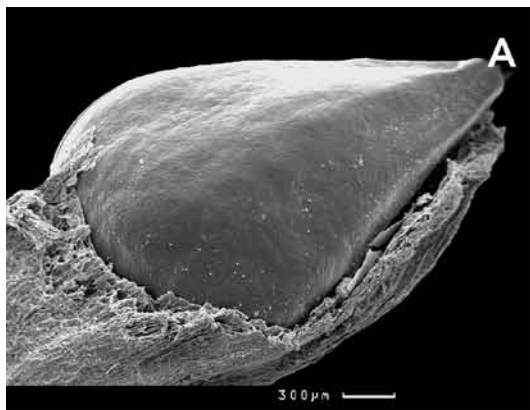


Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

are papery, light-green with yellow-whitish border at lobes, in fruits with prominent net of close-loop veins at tube. In fruits the pedicels are significantly expanded under the perianth tube, strict, sturdy, trigonous or flattened, so the achenes are tightly surrounded by perianth and drop with pedicel (Figs 5 G, 9 A). Tepal cells are oblong-elongate with sinuate outline and reticulate-striate ultrasculpture (Fig. 10 A). Perianth tube, tepal keels and edges bear papillae with longitudinally



**Figure 10.** SEM images of tepal epidermis (A–C, E–F) and papillae at perianth tube (D). A – *P. alpestre*, Armenia, near the lake Gokcha; B – *P. fibrilliferum*, Tajikistan, Pamir and Pamir-Alay, Kugitang; C – *P. fibrilliferum*, Southern Kazakhstan, basin of the Keles river, divide of the Badam and the Keles rivers; D – *P. cognatum*, Kyrgyzstan, West Tien Shan, Terskey Alatau Ridge, rift of the river Karabatkak, basin of the river Chon-Kzyl-Su; E, F – *P. serpyllaceum*, Tajikistan, Badakhshan, Andarob, the Garm-Chashma valley and side-stream Khoz-Guni. Scale bars: A, B, D = 30 μm; C = 3 μm; E = 20 μm; F = 5 μm.



Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

striate ultrasculpture. Stamens 8, with filaments dark-pink, 0.5–1 mm long, dilatated at base and subulate at top, with small yellow anthers, hidden in perianth and adhered to the base of the tube. Styles 3, fused at base to  $\frac{1}{3}$ , 0.5 mm long, with small capitate stigmas. Ovary is oval-ovate.

*Polygonum fibrilliferum* has 3–6 flowers in axillary monochasia along main shoot or side branches. Pedicels unequal, erect, 1–3 mm long, filiform, joint to filiformly narrowed perianth tube with articulation, hidden in ochrea and ochreolas. Perianth 2.5–4(4.5) mm long, funnel-like, divided to  $\frac{1}{2}$ – $\frac{2}{3}$  in 5 tepals with dendrite veins. Two outer lobes a bit convex, keeled, cucullate, with horn-like spurs 0.2–0.4 mm long, locked in flower bud and often drop after flowering (Figs 6D–E, 8A–C). Inner tepals flat, ovate. Lobes green with light-green border, sometimes pinkish. Tepal cells are elongate with sinuate outline and evenly reticulate-striate ultrasculpture (Fig. 10B). Tube cells are round or elongate, with strict anticlinal walls and convex outer walls with evenly reticulate-striate ultrasculpture (Fig. 10C). Stamens 8, with smooth pink filaments 0.3–0.4(1) mm long, dilatated at base, with rounded or oval violet anthers. Styles 3, fused at base to  $\frac{1}{3}$ , 0.5 mm long, with small capitate stigmas. The achene is tightly surrounded by perianth and totally hidden in it, but not adhered to the perianth tube.

*Polygonum cognatum* (= *P. rupestre*) has (1)3–5 flowers in axillary clusters, forming frondose thyrses. Pedicels 3–5 mm long, filiform, rounded, strict in flowers and bent and hooked in fruits, joint to perianth tube with noticeable articulation. Perianth orbiculate- or elongate-campanulate in flowering stage, tubulate-urceolate in fruiting stage, 2.5–4.5 mm long, divided to  $\frac{1}{3}$ – $\frac{1}{2}$  in 5 lobes (Figs 7G, J, K, 8F). Tepals  $\pm$  oval or ovate, green with white or purple border, tightly surround the achene. Two outer tepals are acuminate, concave-cucullate at the top, with branching middle vein, keeled and papillate. Inner tepals are ovate-orbiculate, flat. Tube  $\pm$  trigonous, with longitudinally striate papillae along keels and veins. In *P. cognatum*, *P. myrtillofolium* and *P. serpyllaceum*, the tepal cells are oblong, sinuate in outline and longitudinally striate at the outer wall (Fig. 10E, F). Tube cells oblong-rectangular with more or less strict anticlinal walls and striate-reticulate ultrasculpture, forming ‘knots’. Some epidermal cells along veins and keels bear papillae with longitudinally striate ultrasculpture (Fig. 10D). Stamens 8, filaments dark-pink, 0.5–1 mm long, dilatated at base and subulate at top, anthers red-violet. Styles 2–3, fused at base to  $\frac{1}{3}$ , 0.5–1 mm long, with  $\pm$  capitate stigmas. Ovary is oval-ovate. The achene is equal to perianth and hidden in it.

*Polygonum serpyllaceum* and *P. pamiroalaicum* have 1–3 flowers in axillary clusters (Fig. 7B, C); pedicels 1–4 mm long, filiform, equal in diameter, joint under the urceolate perianth tube with articulation; perianth 2–3 mm long, tubulate-campanulate in flowers, 3–4.5 mm long oval-oblong urceolate in fruits (Fig. 7H), divided to  $\frac{1}{2}$ – $\frac{2}{3}$  in 5 green or reddish lobes with white or pink borders.

*Polygonum myrtillofolium* has 1–2 flowers in axillary clusters with pedicels 2–5(8) mm long, bent, joint under the rounded base of perianth tube; perianth 2–2.5(3) mm long orbiculate to

<< **Figure 11.** SEM images of achenes and ultrasculpture of their surface. A – *P. alpestre*, Azerbaijan, Kuzun; B – *P. alpestre*, Daghestan, Akhtyn distr., Kurush; C – *P. fibrilliferum*, Kyrgyzstan, Khodusen Ridge at the border of Uzbekistan and Kyrgyzstan; D – *P. fibrilliferum*, Kyrgyzstan, Turkestan Ridge, pass Chash-Mardak; E – *P. serpyllaceum*, Kazakhstan, Tulkubass distr., West Tien Shan, Talas Alatau ridge; F – *P. serpyllaceum*, Kyrgyzstan, West Tien Shan, Talas Alatau ridge; G, H – *P. myrtillofolium*, Tajikistan, Pamir, Kyzyl-Rabat, valley of the Karikol river. Scale bars: A, C, E, G = 300  $\mu$ m; B, D, F, H = 30  $\mu$ m.

**Table 1.** Pollen morphological data of five *Polygonum* species.

Taxon	Polar axis (P), $\mu\text{m}$	Equatorial diameter (E), $\mu\text{m}$	P/E	Exine thickness, $\mu\text{m}$
<i>P. alpestre</i>	28.0 (24.9–29.6)	22.5 (21.6–23.6)	1.25	1.9
<i>P. fibrilliferum</i>	30.8 (29.2–32.8)	22.6 (19.0–24.1)	1.36	1.5
<i>P. rupestre</i>	27.8 (26.6–29.5)	20.3 (19.6–21.2)	1.37	1.9
<i>P. myrtillifolium</i>	26.7 (23.8–30.1)	20.1 (17.7–21.6)	1.33	1.6
<i>P. serpyllaceum</i>	28.1 (26.0–29.6)	21.3 (19.1–24.8)	1.32	1.5

tubulate in flowering stage, tabulate-campanulate in fruiting stage, divided to  $\frac{2}{3}$ – $\frac{3}{4}$  in 5 lobes, dark-purple, a bit papillate at tube (Figs 7 I, 8 E).

**Fruits:** The achenes of these species are trigonous or rarely digonous (Fig. 11).

*Polygonum alpestre* (and *P. ammanioides*) has achenes 2.5–3.5(4) mm long, 1–1.5 mm wide, ovate or oblong-ovate, gradually acuminate, equally trigonous or biconvex with flat or concave ovate faces and obtuse or rounded ribs, leathery, smooth, glossy, dark-brown to black, twice as short as perianth, tightly surrounded by tube and adhered to the bottom of the perianth tube. Ultrasculpture is smooth-wavy (Figs 5 E, 11 A, B).

*Polygonum fibrilliferum* has achenes 2–3.5 mm long, 0.8–1.4 mm wide, oblong-ovate, gradually acuminate, almost equally-trigonous, with flat or slightly concave lanceolate-ovate faces and rounded ribs, black, glossy, freely surrounded by perianth and hidden in it. Ultrasculpture is smooth, wavy-smooth or smooth-foveolate (Figs 6 G, 11 C, D).

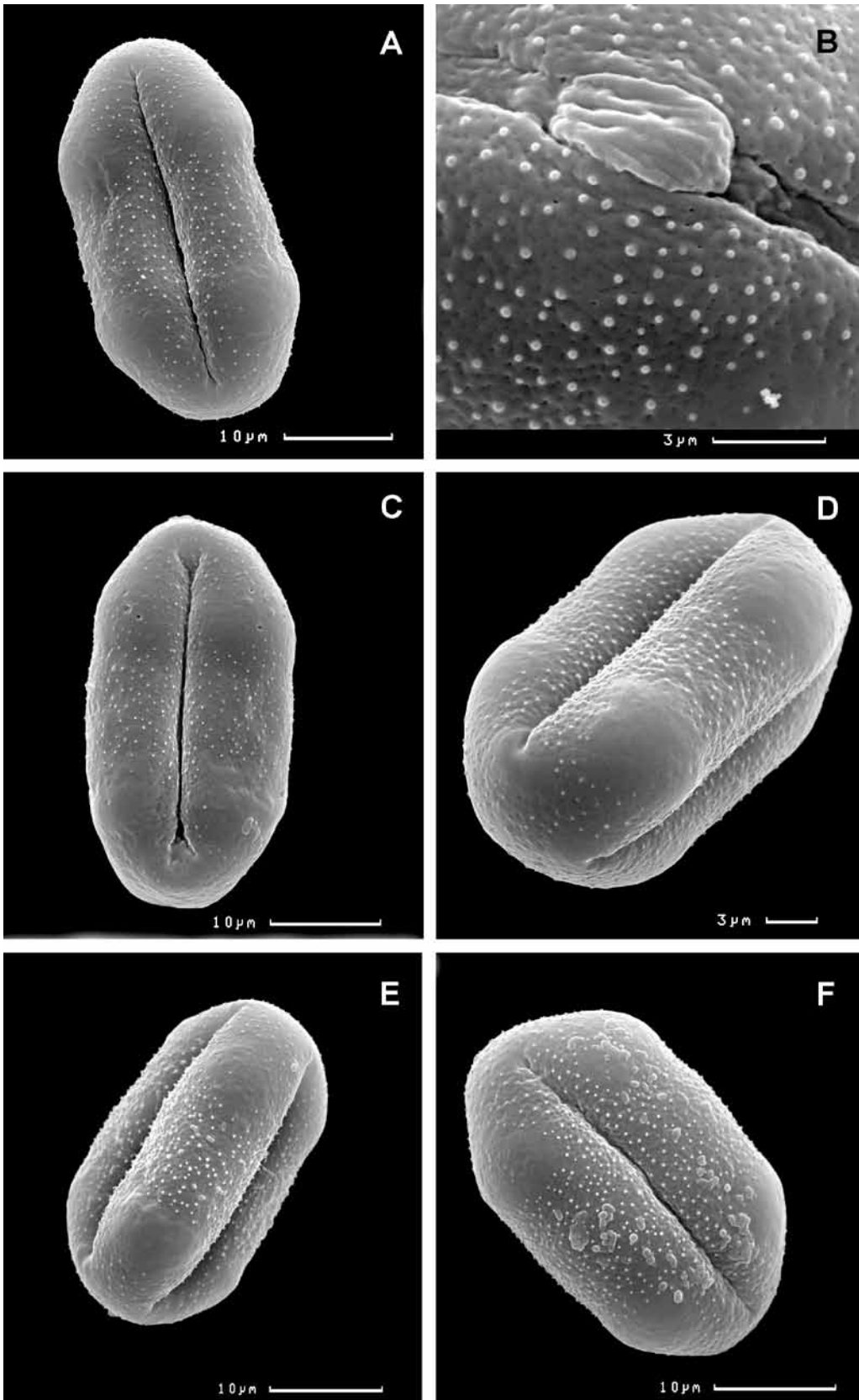
The achenes of *P. cognatum* (= *P. rupestre*), *P. serpyllaceum*, *P. pamiroalaicum* and *P. myrtillifolium* vary from broadly-ovate to lanceolate, trigonous with slightly concave faces and rounded ribs, acuminate, black or dark brown, shining, enclosed in perianth, tightly surrounded by tepals, but not adhered to the tube base (Figs 7 L, 11 E–H). In *P. cognatum* the achenes are 2.5–3.5 mm long, 1–1.5(2) mm wide; in *P. serpyllaceum* and *P. pamiroalaicum* 2.5–3 mm long, 0.8–1.4 mm wide; in *P. myrtillifolium* 2–2.5 mm long, 0.8–1.4 mm wide.

**Pollen:** Pollen grains of some species of ser. *Cognata* were previously described by HEDBERG (1946), BORZOVA & SLADKOV (1969) and HONG et al. (2005). BORZOVA & SLADKOV (1969) revealed some differences in shape and exine thickness of pollen grains of *P. fibrilliferum*, *P. rupestre*, *P. myrtillifolium* and *P. pamiroalaicum*. The pollen grains of the latter species are more angular in equatorial view, spheroidal (P/E = 1) and have a nexine equal to the sexine.

According to our exploration (Fig. 12), pollen grains of all investigated taxa are very similar and belong to one palynological type (Avicularia type sensu HONG et al. 2005). They are tricolporate, mostly prolate (P/E 1.25–1.37), rounded or rounded-rectangular in equatorial view, slightly thickened at the edges, triangular in polar view. The colpi are narrow and long, about  $\frac{3}{4}$ – $\frac{4}{5}$  of the polar axis. The endoapertures are lalongate, forming an equatorial belt. Exine is 1.5–1.9  $\mu\text{m}$

**Figure 12.** Pollen grains of *Polygonum* ser. *Cognata* (SEM). A – *P. alpestre*, Armenia, near the lake Gokcha, Schordzha; B – *P. alpestre*, Armenia, near the lake Gokcha, Eleanovka; C – *P. fibrilliferum*, Tajikistan, Gissar Ridge, pass Anzob, 2500 m a.s.l.; D – *P. myrtillifolium*, Kyrgyzstan, lake Issyk Kul, the river Karasay; E – *P. cognatum*, N and Central Tien Shan, Terskey Alatau, the river Chon-Kzyl-Su; F – *P. serpyllaceum*, Tajikistan, Badakhshan, between Lyanchar and Alychur. Scale bars: A, C, E, F = 10  $\mu\text{m}$ ; B, D = 3  $\mu\text{m}$ . >>

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.



thick in the centre of mesocolpium and slightly thicker at the edges (Table 1). Sexine is 1.5–2 times thicker than nexine. Surface under light microscope is smooth, negatively reticulate. In SEM images the surface is microverrucate or microechinate and psilate at the edges. Tectum has small perforations. Palynological data do not allow to distinguish the species in ser. *Cognata*.

### Taxonomic conclusions

Ser. *Cognata* Kom. is artificial and subsumes three well distinguishable species: *P. alpestre* (= *P. ammanioides*), *P. fibrilliferum* and *P. cognatum* (= *P. rupestre*), the latter comprising ecotypes differing in growth form, shoot and leaf size, stem and perianth colouring.

*Polygonum fibrilliferum* and *P. alpestre* have clear diagnostic features confirming their species rank and isolated position in phylogenetic trees. Both share oblanceolate acuminate leaves, flat in *P. alpestre* and slightly recurved in *P. fibrilliferum*; keeled outer tepals with horn-like spurs at their tops, conspicuous in *P. fibrilliferum* and hardly visible in *P. alpestre*. *P. fibrilliferum* differs by ochreas disintegrating in filiform filaments and two long aristae and a funnel-like perianth. *P. alpestre* possesses entire or lacerate ochreas, large skittle-like perianths with broad tubes bearing a prominent net of veins and sturdy pedicels joint without articulation (Fig. 9A), the achenes are twice as short as the perianth. We didn't find any differences between *P. ammanioides* and *P. alpestre* for exception of narrower leaf blades of the first. As the type sheet of *P. alpestre* contains the shoots with leaves typical of both taxa, there is no reason to distinguish them.

*Polygonum cognatum* (= *P. rupestre*), *P. pamiroalaicum*, *P. serpyllaceum* and *P. myrtillofolium* share ovate or oblanceolate mucronate leaf blades, entire or partly lacerate ochreas with scarcely visible veins, tubulate-campanulate perianth with cucullate outer tepals, smooth achenes. Variability in size and shape of leaf blades, in perianth colour, growth forms varying from perennial herbs to small semi-shrubs, provides a basis for referring them to a single polymorphic species. This agrees with the position of their assessments in a high supported subclade. The earliest name *P. cognatum* Meisn. is preferable. Comparing *P. cognatum* Meisn. with *P. rupestre* Kar. et Kir., Meisner did not designate the type of *P. cognatum* (MEISNER 1926), it is not designated among “Type specimens of *Polygonum* (*Polygonaceae*) in the Meisner Herbarium at the New York Botanical Garden” (PARK 1987). Among three varieties of *P. cognatum* recognized by MEISNER (1857: 96), *P. cognatum* var. *alpestre* and *P. cognatum* var. *ammanioides* both correspond to *P. alpestre*. Among the specimens attributed to the variety *P. cognatum* var. *rupestre* by Meisner, the specimens from “Iberia (Ficher! Wilhelms!), prope Damascus (h.DC.!)” can be assigned to *P. alpestre*, so they should be excluded as well. The other specimens attributed to *P. cognatum* var. *rupestre* came from Tarbagatai (Enum. Pl. Alt. 1840, No. 789 [LE!], Soongoria (Soongor. No. 722) and Sibiria Altaica (Ledeb.) and share the characters of the type specimen of *P. rupestre* Kar. et Kir., designated in KARELIN & KIRILOV (1841) as follows: “*P. rupestre* Karelin et Kiriloff. In rupestribus umbrosis montium Tarbagatai ad torrentem Tscheharak-Assu, nec non in rupestribus Saja-Assu jugi Tarbagataici orientalis, ad fontes flur. Taldy. Leg. Karelin et Kiriloff a. 1840. 427. Soc. Imp. Nat. Cur. Mosqu.” [LE!]. The number 427 in “Soc. Imp. Nat. Cur. Mosqu.” distributed in many herbaria of the world corresponds to collection number 789. So the first specimen of *P. cognatum* var. *rupestre* from Tarbagatai (Enum. Pl. Alt. 1840, No. 789) mentioned by MEISNER (1857) corresponds to the type specimen of *P. rupestre* Kar. et Kir. (427. Soc. Imp. Nat. Cur. Mosqu.).

Here we designate the type specimen of *P. rupestre* Kar. et Kir. preserved in Komarov Botanical Institute, St. Petersburg [LE!] as lectotype of *P. cognatum* Meisn., all the more because, as it has

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

a pencil mark: "*P. cognatum* Meisn. Herb. Ledebour". Isolectotype of *P. rupestre* from the New York Botanical Garden [NY 00323897] has a pencil mark "*P. cognatum* var. *rupestre* Meisn. in DC. Prodr." Other isolectotypes are preserved in the National Museum of Natural History, Paris [P00734306, P0073407, P00734308, P00734309, P00734310: photos!], and St. Petersburg [LE, many specimens !].

The comparison of the type specimens of *P. serpyllaceum* Jaub. & Spach (JAUBERT & SPACH 1844) and of *P. pamiroalaicum* Kom. (KOMAROV 1936) showed their conformity. The type specimens of *P. serpyllaceum* [FI, G, K: photos!] and *P. pamiroalaicum* [LE!] have cushion-shaped growth form with many-headed caudex, numerous residua and prostrate shoots, small obovate or oblanceolate leaves, tubulate-campanulate perianth in flowering stage and urceolate in fruiting stage, pedicels joint with articulation (Fig. 9 B, C). JAUBERT & SPACH (1844) designated "Plant Exsicc. n. 5274, in Herb. Mus. Par., Webb, Delessert, et Jaubert", as the type of *P. serpyllaceum*. As this exsiccate is absent from the National Museum of Natural History [P], we here designate the specimen stored in Florence [FL-2632, Herbarium Webbianum] as a lectotype of *P. serpyllaceum*. We consider *P. serpyllaceum* a high-mountain ecotype of *P. cognatum*, differing in shorter shoots and internodes and smaller and narrower leaves. While *P. cognatum* inhabits the middle mountain belt in Dzhungarian Alatau, Altay, Dzhungaria, Kashgar, Mongolian Altay, Tibet, Himalaya, Inner Mongolia, *P. serpyllaceum* occurs on alpine meadows and heathlands of Kurdistan, Pamir-Alay and Central Tien Shan. ZAKIROV (1948) mentioned transitional forms between *P. cognatum* (*P. rupestre*) and *P. serpyllaceum* (*P. pamiroalaicum*) in Zeravshan.

*Polygonum myrtillifolium* is a small prostrate semi-shrub from Pamir-Alay and Central Tien Shan with lignified proximal parts of shoots, purple stems and perianth, long pedicels, but all these characteristics are also present in *P. cognatum*. In view of similarity in other features we consider *P. myrtillifolium* a high-mountain ecotype and a variety of *P. cognatum* Meisn s.l.

### Determination key of the taxa investigated

- 1 Ochrea ovate-lanceolate with 2(–4) veins included, later fimbriate-lacerate with two free aristae. Leaf blades oblong or oblong-ob lanceolate, at main shoots twice as large as at lateral branches, a bit leathery, papillate at edge. Perianth 2.5–4 mm long, funnel-like, dissected to  $\frac{2}{3}$ – $\frac{3}{4}$ , outer lobes cucullate with horn-like spurs, pedicel filiform joint to the tube with articulation ..... *P. fibrilliferum*
- Ochrea ovate-lanceolate with 2–4(8) veins included, later lacerate or dentate, without long free aristae. Perianth campanulate in flowering, tubulate-urceolate in fruiting ..... 2
- 2 Leaf blades oblong or oblong-ob lanceolate, at main shoots twice as large as at lateral branches, a bit leathery, papillate at edge, gradually acuminate; perianth 5–6 mm in fruiting, dissected to  $\frac{1}{2}$ – $\frac{1}{3}$ , with keeled outer lobes and tube with prominent net of veins, gradually narrowed into sturdy pedicel without articulation. Achene twice as small as perianth, adhered to the base ..... *P. alpestre*
- Leaf blades rounded, obovate or oblanceolate, all of equal size, fleshy, merely papillate at the edge, mucronate. Perianth orbiculate in flowering, tubulate-campanulate or urceolate in fruiting, 2.5–4 mm, with filiform pedicel joint to base with articulation ..... 3
- 3 Leaf blades obovate, oblanceolate or spatulate, 5–10(12) mm long and 2–5 mm wide, longer than internodes, ochrea lanceolate with 0–2 veins included, acuminate or dentate at

- the top. Perennial herb with compact caudex and creeping shoots up to 10 cm long .....  
 ..... *P. cognatum* var. *serpyllaceum*
- Leaf blades rounded or obovate, 10–25 mm long and 5–10(17) mm wide, equal to or shorter than internodes ..... 4
- 4 Perennial herb, perianth dissected to  $\frac{1}{2}$ – $\frac{1}{3}$ , green with white-pink border, pedicels 1–4 mm, shoots 12–30 cm long ..... *P. cognatum* var. *cognatum*
- Creeping small semi-shrub, perianth dissected to  $\frac{2}{3}$ – $\frac{3}{4}$ , deeply purple, pedicels 2–5(8) mm, shoots 5–10 cm long ..... *P. cognatum* var. *myrtillifolium*

1. *P. alpestre* C. A. Mey. Verz. Pfl. Casp. Meer. 157 (1831); Boiss. Fl. Or. 4: 1037 (1879); Grossh. Fl. Cauc. 2 : 48 (1930); id. Fl. Cauc. 3: 105 (1945); Post, Fl. Syria, Palest., Sinai, ed. 2, 2: 474 (1933); Kom. Fl. URSS, 5: 609 (1936); Rzazade, in Fl. Azerbaijan. 3: 170 (1952); Thiebaut, Fl. Libano-Syr.: 122 (1953); Avetisjan, in Fl. Armen. 2: 439 (1956); Rech. f. et Schiman-Czeika, in Rech. f., Fl. Iran. 56: 65 (1968); Kutateladze, in Fl. Gruz. 3: 150 (1975); Galushko, Fl. Severn. Kavkasa 1: 212 (1978).  $\equiv$  *P. cognatum* var. *alpestre* (C. A. Mey.) Ledeb. 3: 533 (1849–1851); Meisn. in DC. Prodr. 14: 96 (1857).

**Lectotype:** (The Caucasus, Kabardino-Balkaria) “In lapidosis ripae fluvii Terek supra Wladikawkas, nec non in rupestribus subalpinis. 400–1200 xpd. No. 215. 12–17 Aug. (1830?) year. C. A. Meyer” [LE! typified by N. N. Tzvelev].

**Syntype:** Caucasus, Talusch, C. A. Meyer, [P00734313: photo!].

Authentic specimen: Enum. Cauc. Casp. n. 1398, Meyer, Herb. Ledebour [LE!].

= *P. ammanioides* Jaub. et Spach, Ill. Pl. Or. 2: 28 (1844–46); Grossh., Fl. Cauc. 2: 49 (1930); id., Fl. Cauc., 3: 104 (1945); Rzazade, in Fl. Azerbaijan. 3: 170 (1952); Kutateladze, in Fl. Gruz. 3: 150 (1975); Galushko, Fl. Severn. Kavkasa 1: 211 (1978). = *P. cognatum* var. *ammanioides* (Jaub. et Spach) Meisn. in DC. Prodr. 14: 96 (1857); Boiss. Fl. Or. 4: 1038 (1879).

**Lectotype:** (the Caucasus) “Aderbidjan, *Aucher-Éloy*, 5273” [G00330055: photo!].

**Isolectotype:** [FI-2634, *Herb. Webbianum*: photo!].

= *P. cognatum* auct. Meisn. Webb & Chater, in Tutin et al., Fl. Europ. 1: 77 (1964); Cullen & Coode, in P. H. Davis, Fl. Turk. 2: 216 (1966); Asenov, in Fl. Bulgar. 3: 222 (1966); Takhtajan et Fedorov, Fl. Erevan.: 100 (1972). = *P. cognatum* var. *rupestre* (Kar. et Kir.) Meisn., in DC. Prodr. 14: 96 (1857) quoad pl. non Kar. et Kir.

= *P. pluriflorum* K. Koch, Linnaea 22: 337 (1849), nom. illeg.

**Icon.:** Ill. Pl. Or. 2: tab. 118 et 119 (1844–46) sub. *P. alpestre* et *P. ammanioides*; Fl. URSS, 5: tab. 39, Fig. 6 sub *P. rupestre* et Fig. 7 sub. *P. ammanioides*; Fl. Armen. 2: tab. 140.

Figs 3A, 5, 9A, 10A, 11A, B, 12A, B.

Fl. VI–VII, fr. VII–IX.

**Ecology:** Rocky and stony slopes, along tracks and paths, at wasty places from middle to alpine mountain belt.



Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

**Distribution:** The Balkans (Bulgaria), Asia Minor (Turkey, W Syria, Syrian Desert), the Caucasus, Iran (Kurdistan).

**Specimens examined:** **The Caucasus:** Hohenacker [LE]; 1826 Prescott [MW]; Ledebour 1875 [LE]; No. 818.28, Ledebour [LE]; 1877, Vdovjeva [MW]; (Kabardino-Balkaria) Bermamyt. 8200, Akinfiev [LE]; Kislovodsk, m. Bermashut. 23.07.1887. I. Akinfiev [LE]; an Wigan an dessan Rallan bei Lakum. No. 32, No. 2930, Hohenacker [LE]; Caucasus, St. Nikolaus. 17.07.1902. I. Akinfiev [LE]; **Transcaucasia:** Tabasgur lake, 6700 m; Beshtau, 3000 ft. 09.1888. I. Akinfiev [LE]; **West Caucasus:** Karachaevo-Cherkessia, Elbrus reg, in clif. Khurzuk-river. 6.08.1986. Khandzhyan [LE]; **Daghestan:** Akhtyn distr, Usur, subalpine meadow, 2600 m. 31.07.1940. ? [LE]; Akhtyn distr., 3 km to the S of Kurush. 23.07.1986. Yu. Menitsky [LE]; Kurush – 1873. No. 11, 1974. No. 24, 1880. No. 269, No. 32, No. 315, 28.06.1885. No. 8, A. Becker [LE, MW]; Kurush. 28.06.1885. No. 8, G. Radde [LE]; Tarki, Lagowsky [LE]; Djulti Tschai, confluivium Samuri. Jul. 1860. Ruprecht [LE]; Gunib, Verkhny Gunib. 4.06.1950. Kharkevich [LE]; Gunib, in cliff Bets, 1200 m. 5.07.1928. No. 562, A. Poretsky [LE]; Laky distr., Kozy-Kumuh Koisu, entry of the river Chirinek, 2000–2100 m. 6.09.1927. A. Poretsky, G. Schults [LE]; Tlyarata distr, Suetl', W of Khindakh, 3000–3500, the valley of Tcharakh-river, stone slope. 21.07.1961. No. 3951, N. Tzvelev et al. [LE]; Samur distr., pr. pag. Gedym, in ruderalis, 7000 ft. 17.08.1900. Alexeenko [LE]; Kumen distr., the road from Vash to Khosrog, 1900 m. 16.08.1981. No. 448, Yu. Menitsky et al. [LE]; the flumen Tscharyntschai. 2.07.1990. A. P. Khokriakov [MW]; **Georgia:** Iberia, Welhalms [LE]; North Caucasus: (Kazbek distr.) between Karaulki, Gviletskaya and Devdorakeva. 26.06.1884. O. et B. Fedtchenko [LE]; prope pagum Kazbek, alt. 900 hexap. 8.08.1944. No. 2092, Dr. Kolenati [LE]; Karabach; Imeretia. No. 407 [LE]; Gruzia, Kobi, 25.06.1888, the road from Zromah to Ardont. 17.07.1890. I. Akinfiev [LE]; Alagez, Kurmyzlu, 2250 m. 23.08.1932. E. et N. Bush [LE]; Alagez, pr. pag. Kaznaphor. 15.07.1932. E. et N. Bush [LE]; Alagez, forest near Nyzhny Kosh-Bulag, left slope of Pyr-Bulak, 1900. 22.08.1932. E. et N. Bush [LE]; Tiflis, in collibus aridis ultra Hort. Bot. 9.07.1890. No. 1167, St. Sommier [LE]; Tiflis, the isl. of Roses. 19.09.1914. T. Roon [LE]; Tiflis, Kodzhory. 7.10.1935. V. L. Komarov [LE]; Tbilisi, Kodzhor cliff. 18.04.1989. A. P. Khokriakov [MW]; Kodshoria. 1878. Smirnov [LE]; Tiflis reg., Akhalts. distr., Zarum. D. Litwinow [LE]; Tiflis, Akhalkalass distr., the lake Tabistskhur. 6.07.1916, P. Krylov, E. Schteinberg [LE]; Tiflis. 30.05.1871, Sitovsky [MW]; Tiflis, pr. pag. Tabachrucly. 31.07.1921. A. Grossheim [LE]; Tiflis distr, in cliff. Arenaz, Mtskheta, 21.05.1917. B. K. Schischkin [LE]; Prov. Tiflis, distr. Gori, in viciniis pag. Bakuriani in clivis siccis. 2.07.1920. B. Schischkin [LE]; Prope Tiflis. No. 412, Pomorzoff [LE]; Mtskheta, the monastery of church Dzhvary. 21.05.1985. No. 33 et No. 34, N. Tzvelev [LE]; Tiflis. 14.05.1972. Overin [LE]; Bakuriani, mt. Tsra-Tskharo, 8200. 15.07.1903. I. Akinfiev [LE]; Bakuriani, the Central Caucasus Ridge, pass Styr-hoh, 9000 ft. 29.07.1894. Aragva, Lagowsky [LE]; Borzhomi distr., Bakuriani, near road. 1.09.1976. L. Smol'aninova [LE]; Adzharia, SE part of Khuloy distr., Sary-Chair. 2.08.1951. A. Dmitrieva, I. Akinfiev [LE]; West Grusia, 7 km from Borzhom to Bakuriani. 12.07.1952. A. K. Skvortsov [MHA]; Gub. Kutais, Ratscha, Para, No. 254 [LE]; Kachetia, Kardanach. 10–23.05.1900. P. Averkin [MW]; **Armenia:** Swant, Armen., Schischkin [LE]; Prov. Erivan et Elisavetpol, Karavan-Saray, circa lake Goktscha. 28.05.1897. I. Chociatowski [LE]; Erivan gub., Surmalinsky u., near Zor. 6.08.1986. Khandzhyan [LE]; Pazdan distr., Ankavan (Mickhana). 8.07.1955. E. Avetisjan [LE]; Razdan distr, m. Ampasar, above Megradzor, 2500 m. 5.08.1986. Yu. Menitsky [LE]; Goktscha lake, E coast of Ardamysh gulf, at rocks. 22.07.1893. No. 71, Ivanovsky [LE]; Erivan, lake Goktscha, Egavert. 7.05.1896. I. Khotsjatovsky [LE]; Manychar, lake Goktscha. 27.06.1897. I. Khotsjatovsky [LE]; lake Goktscha, Ada-Mana. 30 maj 1897/96. [LE]; lake Goktscha (Sevan). 1927. V. A. Poddubnaja-Arnoldi [MW]; lake Goktscha, Shordzha. 23.06.1929. No. 321 [MW]; north bank of the lake Sevan. 30.06.1960. N. Savich [LE]; Nor-Bajazet. 7.07.1909. R. Karapetjan [LE]; Erivani, rocky slope. 15.04.1916. B. Schischkin [LE]; Erivan, Novo-Bajazet. 1.07.1925. I. Novopokrovsky [LE]; Novo-Bajazet, near Gedjan-Bulkh. 12.08.1926. A. Magakjan, T. Zhamekotchan [MW]; pr. Novo-Bajazet, 6700 hexap. 13.07.1928. A. Grossheim [LE];

Novo-Bajazet, pass Selim. 26.07.1925. No. 2471a, I. Novopokrovsky [LE]; Dzhelagez, mts. Teke-Dandurak. 30.07.1931. I. Karjagin [MW]; mt. Aragats, in cliffs, 3600 m. 30.08.1947. I. Vysokooostrovskaya [LE]; Megri, the river Megrigert, near Vardnizdor. 6.08. 1956. No. 2095. T. Egorova et al. [LE]; Akhuryan distr., Shirak Ridge, the summit at S branch of Ridge, to N from Ketı, 1900 m. 21.06.1960. No. 286, N. Tzvel., S. Cherepanov [LE]; Akhuryan distr., Shirak ridge, to E of pass Dzhodzhur, 1900 m. 23.05.1960. No. 286, N. Tzvel., S. Cherepanov [LE]; Dzermuk, 2300 m, the right bank of the river Arpy. 9.07.1984. G. Konechnaya [LE]; Artik distr., Paros. 1995 m. 17.07.1948. Asyat ... [LE]; Bittchenach. 6.06.1871. No. 385, G. Radde [LE]; Kirovakan. 30.07.1938. N. Yuztanjan [MW]; Leninakan. 19.06.1926. A. Tschukina [MW]; **Turkey:** Palantecken, 8000 f. 2.08.1874. G. Radde [LE]; Erzerum, No. 7, E. Radde [LE]; Kars reg. and distr., Sarykamysh. 9.06.1914. D. Litvinov [LE]; Kars, Ardanuch, 10000 hexap. 20.08.1896. B. Levadovsky [LE]; m. Ararat, ad pagum Akuni in Schenilibus. 15.07. No. 828, Schovits [LE]; **Azerbaijan:** Baku, Kuba distr., in pasquis Tshachut. 17.06.1928. A. Achverdov [LE]; Nakhitchevan ASSR, Ordubad, 11.06.1956, No. 617, T. Egorova et al. [LE]; Nakhitchevan, Paratcha, the river Partcha-Tchaj. 20.06.1931. I. Karelin [LE]; Nakhichevan, Shakhbuza distr., Kelyany, 30.05.1947. A. Grossheim [LE]; Murov-dagh, m. Kanyaz, 9.07.1970. Yu. Menitsky [LE]; Baku, Gandzha distr., mt. Katchkar-Dagh, 17.07.1929. M. Kasimov [LE]; Talush, Zuvart, 7.07.1909 [LE]; Talush, mt. Kyz-Yurt at the border with Iran, 26.07.1936. No. 2201, Al. Pheodoroff [LE]; (Zuvand) Diabar, maj 1870. No. 47 et No. 62, G. Radde [LE]; Lenkoran, mt. Sibirdu. 9.07.1931. No. 724, I. Schipchinsky [LE]; Lenkoran, mt. Sibirdu. 9.07.1931. No. 724, N. Schipchinsky [MW]; Lerik, rocky slopes. 8.07.1963. No. 682, A. Bobrov, N. Tzvelev [LE]; Lerik, 10.05.1946. A. Grossheim [LE]; Lerik, Kosmoljan. 22.06.1977. No. 848, M. Pimenov et al., [MW]; Lerik, SE slope, 17.07.1963. No. 545, A. Bobrov, N. Tzvelev [LE]; Shamkhor, 1925. No. 23, Ivanova [LE]; Nagorny Karabakh, the niche under Tschukinkaya fortress, 17.07.19???. V. et I. Petrov [MW]; Nagorny Karabakh, Saksagan, 1.08.1936. No. 407, V. et I. Petrov [MW]; Zangelan d., Pirchevan, 400 m. 7.05.1948. A. Grossheim [LE]; Kirovabad (Elizabethpol), 1839. Hohenaker [LE]; Elizabethpol, No. 1470. 14.05.1844. Kovalev [LE]; Elizabethpol, D. Lagovsky [LE]; (Kirovabad) Gandzha, mt. Koshkar-dagh, 2200 m. 6.07.1928. B. Sedjukov [LE]; Helenendorf (Geygel), No. 32, Hohenaker [LE]; Helenendorf (Geygel), C. A. Meyer [LE].

**2. *P. fibrilliferum* Kom.** Fl. URSS, 5: 607, Add. 4: 718 (1936); Zak. in Izv. Akad. Nauk Uzbeksk. S.S.R. 1: 12 (1948); Kastsch. in Fl. Kyrgyz. 4: 131 (1953); Sumn. in Fl. Uzb. 2: 182 (1953); Grig. Opred. rast. Stalinabad: 102 (1953); Bajten. et Pavl. in Fl. Kazakhst. 3: 153 (1960); Czuk. in Fl. Tadz. SSR. 3: 261 (1968); id. in Cons. Fl. Asiae Mediae, 2: 209 (1971); Seyfulin, Opred. rast. Turkmenist. 2: 39 (1980); Nikit. et Geldikh., Opred. rast. Turkm.: 163 (1988).

= *P. cognatum* auct. Fl. As. Med., p. p.

**Type:** (Turkmenistan) "In jugo Turkestanico ad riv. Terekli-saj, fl. Sanzar infl. 14.VI.1914. A. Michelson" [LE!].

**Icon.:** Fl. URSS, 5: tab. 39: Fig. 4 (1936); Fl. Tadz. SSR. 3., tab. 46, Fig. 1–3 (1968); Fl. Kazakhst. tab. 14, Fig. 4 (1960).

Figs 3 B, 4 A, B, 6, 8 A–C, 10 B, C, 11 C, D, 12 C.

Fl. V–VIII, fr. VII–XI.

**Ecology:** Foothills and high-mountains. Dry stony or gravelly slopes, subalpine zone, juniper and marple forest, bushes, clay or sandy fields at 1200–3200 m a.s.l.

**Distribution:** Iran, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, South Kazakhstan.

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

**Specimens examined:** **Iran:** Gylan (Schakhrisyab), 17.06.1896. V. Lypsky [LE]; **Turkmenistan:** Khodzhapil. 24.08.1935. No. 72, Prjanishnikov [MW]; Kugitang ridge, above Khodzhapil, 1900 m. 12.06.1975. N. Beljanina, G. Proskurjakova [MHA]; **Uzbekistan:** *Tashkent reg.:* inter the rivers Keles and Badam. 18.06.1914. No. 623, Z. v. Minkvitz [LE]; Chimgan, pass Pesochny. 17.07.1897. O. Fedchenko [LE]; Big Chimgan. 5.06.1914. No. 1227, Z. v. Minkvitz [LE]; basin of the river Chirchik, the valley of the river Nam, Kyzyl-Tal. 18–19.06.1914. No. 686, Z. v. Minkvitz [LE]; inter Parkend and Zarkend. 17.05.1914. No. 1070, Z. v. Minkvitz [LE]; mt. Khadret-Bova. 20.06.1909. No. 84, V. Borodin, V. Kallistov [LE]; the river Angren, near Turk. 20.06.1909. V. Borodin, V. Kallistov [LE]; the river Angren, Kichkina, Yangoklyk soy. 1952. G. Kultiasova [MHA]; Arasan, 8500–9000'. 20.07.1909. No. 189, V. Borodin, V. Kallistov [LE]; the reservation Parkent. 5.08.1960. A. P. Khokhrjakov [MHA]; Parkent d., Pavich. 10.09.1957. No. 8826, Voroshilov [MHA]; *Fergana reg.:* Kokand, Karabulak, Kyzyl-Tamyr. 10.05.1899. No. 524, Z. v. Minkvitz [LE]; Namangan, the river Choshkali, Bish-Aral. 4.07.1899. D. Litvinov [LE]; Kokand, Karakazuk. 10.07.1871. O. Fedchenko [LE]; *Samarkand reg.:* Khodzhent distr., S from Novobad, 27.06.1914. No. 450, O. v. Knorring [LE, MHA]; Khodzhent d., Novobad. 27.06.1914. No. 450, O. v. Knorring [LE]; Khodusen d., Andarak. 23.07.1914. No. 575, O. v. Knorring [LE]; Zeravshan Ridge, pass Akby-Zerkak. 9.06.1913. No. 2052, A. I. Michelson [LE]; Dzhizak d., Turkestan Ridge, the river Archa-Maydan-Say (Goldraut). 19.07.1914. A. I. Michelson [LE]; inter Zeravshan and Gyssar ridge, mt. Laylak-Tau, inter Sosh and Shink. 11.06.1913. No. 2365, A. I. Michelson [LE]; Zeravshan valley, in cliff Sangy-Dzhuman. 24.05.1869. No. 3561-7113, O. Fedchenko [LE]; Alpes Zeravshan, fl. Jagnob, 3500 m. 31.07.1913. No. 750, I. Bornmuller [LE]; Surkhan-Darja reg., Chulbair ridge, 2400 m, 20 km to N from Denau, near Syn. 24.05.1961. I. Gubanov [MW]; ibidem, Vlasov [MHA]; *Gyssar:* Rusgan. 3.08.1913. No. 850, I. Bornmuller [LE]; Kschtut, fl. Kschtut, 1550 m. 22.07.1913. No. 146, G. Kukenthal [LE]; *Zeravshan ridge:* Aman-Kutan. 27.07.1932. No. 12-202, Massagetov, Masalsky [LE]; *Bukhara reg.:* Guzar d., the Kichik-Uru river, Chachma-Mirok. 24.05.1913. A. I. Michelson [LE]; Guzar d., Dzhaylau Kyzyl-Say, Gyssar Ridge, pass Aucha, inter Bel-Auty and mt. Ulpas. 23–24.05.1913. Nos. 1841, 2827, A. I. Michelson [LE]; pass Tian inter mt. Puli-Sangin and Fairabad, 27.07.1914. No. 602a, M. G. Popov [LE]; Baysun, mountains. 18.06.1913. No. 724, M. G. Popov [LE]; Baldshuan, Talbarg. 5.07.1897. V. Lypsky [LE]. **Kyrgyzstan:** Turkestan ridge, S slope, the riverhead of Vishiet-Say, 2772 m a.s.l. 20.07.1948. No. 111, N. Chestnaya [LE]. **Tajikistan:** *Gyssar ridge:* river Karatag, Khakimi. 19.06.1915. No. 1197, M. G. Popov [LE]; Karatag, Darty. 20.07.1932. A. et N. Tschukiny [MW]; Shamahu, 2.07.1896. V. Lypsky [LE]; ibidem, Koruk. 4.07.1896. V. Lypsky [LE]; S slope, Silbursay. 6.08.1947. No. 13, Kryvotulyenko [LE]; S slope, basin of the river Varzob, canyon Kondary, plateau Rundasht, 18–19.06.1945. No. 332, V. Pysjaukova [LE]; ibidem. 15.08.1945. No. 1094a, V. Pysjaukova [LE]; ibidem. 18–19.07.1945. Nos. 682, 682a, 775a, V. Pysjaukova [LE]; inter Kaydar-Bulak and Tashkurgan. 2.08.1978. Nevsky [LE]; S slope, pass Anzob, 2500 m. 4.08.1992. T. Konovalova, N. Shevyreva [MHA]; Basin of the river Khanaka. mt. Khanak. 26.06.1948. No. 64, Nikitin, V. Borisova [LE]; *Zeravshan ridge:* E slopes to W from Pagna, 2180 m. 20.06.1932. No. 764, P. Ovczinnikov, A. Slobodov [LE]; Schachsara-Dichbalan, the river Jagnob, 8000 pd. 23.07.1892. V. L. Komarov [LE]; the riverhead of the river Zeravshan, Pakschif, 7–10000 pd. 30.07.1893. V. L. Komarov [LE]; *Rengen-Tau ridge:* Tashmechet', 1580 m. 20.07.1958. No. 158, Batriatdinova, Akhmetshina [LE]; pass from Khashili to plateau Bedek, 1670 m. 28.06.1937. No. 60, I. Goncharov, V. Mihailovsky [LE]; *Shuroabad distr.:* mt. Imam-Askar, 2700 m. 26.08.1935. No. 1226, I. Linchevsky, T. Maslennikova [LE]; Lulichan ridge near mt. Alakyzrak, 2555 m. 9.08.1935. No. 1054, I. Linchevsky, T. Maslennikova [LE]; Lulichyan ridge in front of Zulumabad, 2420 m. 8.08.1935. No. 1018, I. Linchevsky, T. Maslennikova [LE]; inter Sumbum-Khon and Khodzhabag, 1855 m. 30.07.1935. No. 884, I. Linchevsky, T. Maslennikova [LE]; *Tan-Maylizh ridge:* 1700 m. 30.05.1939. No. 154, N. Temioev [LE]; *Gazymaykik ridge:* W slope, 12.06.1960. No. 297, E. Filatov, A. Grebennikova [MHA]; *Turkestan ridge:* basin of the river Sanzar, to S from the river Aldashman, 12.07.1934. No. 89, P. Gomolitsky, G. Protopopov [LE, MW]; NE slope, the riverhead of Aksu, 2430 m,

15.08.1934. No. 477, K. Afanasiev [LE]; the river Adar, 1800 m, 16.06.1956. No. 363, ? [LE]; NW slope, the road to pass Tshash-Mardak. 17.07.1933. No. 128, Arsenjeva [MW]; N slopes, mt. East Uzungyr, 6.06.1941. M. Prjanishnikov [MHA]; *Stalinabad (Dushanbe) reg.*: Kok-Tepe, 16.09.1934. No. 766, V. Chernov, E. Silantjeva [LE]; Kangurt, Khadzhinaur, 10.07.1934. O. Kharitonova [MHA]; Baldzhuan, 2200 m. 25.06.1935. Vasilchenko [MHA]; Basin of the river Ob-Kabut, the riverhead of Vahsh (Surhob), Bepe-Sya, 1800 m. 08.1926. No. 580, ? [LE]; *Leninabad (Khudzhant) reg.*: Shahrstan d., Turkestan ridge, Kusavli-Say, 2350 m. 3.08.1968. No. 68404, Roslaya, A. Konnov [LE, MW]; st. Ura-Tube. 3.06.1895. No. 4398, S. Korshinsky [LE]; Mt. Kuh-Kok-Dush, 1000 m. 9.08.1959. No. 761, Yunusov [LE]; Gardani-Ushti ridge, pass Khodzha-Bekob, 2000 m. 12.06.1960. No. 270, I. Shibhov [LE]; **South Kazakhstan**: Bostandyk, Ugamsky ridge, the riverhead of Kaynar-say, 2000 m. 4.08.1954. No. 371, V.N. Pavlov [MW]; Alma-Ata reg., the riverhead of Komissarovka, 3000 m. 31.07.1936. No. 478 [MW].

**3. *P. cognatum* Meisn.** Monogr. Polyg.: 91 (1826); Ldb. Fl. Ross. 3: 533 (1849), quoad pl. K. et K.; Hook. f., Fl. Brit. Ind. 5(13): 25 (1886), quoad plants Soongoria; Steward, in Contr. Gray Herb. Harvard Univ. 88: 22 (1930), quoad pl. As. Media; Kitamura, Fl. Afghan.: 89 (1960); Bhopal et Chaudhri in Pak Syst. 1(2): 83 (1977); Stewart, Ann. Cat. Vasc. Pl. W. Pak. et Kashm.: 204 (1972); Grubov, Opređ. sosud. rast. Mongol.: 82 (1982); Munshi et Javeid, Syst. Stud. Polygon. Kashm. et Himal.: 53 (1986); Tupitsyna, Fl. Sibir. 5: 130 (1992); Qaiser in Fl. Pakist. 205: 83 (2001); Anjen Li et al. in Fl. China. 5: 283 (2003).

**Neotype: designated here** (Altay) sub. “*P. rupestre* Kar. et Kir. In rupestribus umbrosis montium Tarbagatai ad torrentem Tscheharak-Assu, nec non in rupestribus Saja-Assujugi Tarbagataici orientalis, ad fontes flur. Taldy. Flor. Majo. a. 1840. No. 427, Karelin et Kirilloff” [LE!].

= *P. rupestre* Kar. et Kir. Enum. pl. Alt. in Bull. Soc. Nat. Mosc. 14, 4: 740 (1841); Kryl. Fl. Sibir. Occid. 4: 852 (1930); Kom. Fl. URSS. 5: 609 (1936); Krech. in Fl. Turcom. 2, 1: 86 (1937) sub. *P. alpestre*; Zak. in Izv. Akad. Nauk Uzbeksk. S.S.R. 1: 12 (1948); Kastsch. in Fl. Kyrgyz. SSR. 4: 132 (1953); Sumn. in Fl. Uzb. 2: 182 (1953); Bajten. et Pavl. in Fl. Kazakhst. 3: 153 (1960); Ikon. in Acta Statio biol. Pamir. Bot. Inst. Acad. Sci. Tadz. SSR. 20: 94 (1963); Czuk. in Fl. Tadz. SSR. 3: 264 (1968); Czuk. in Consp. Fl. Asiae Mediae, 2: 210 (1971). = *P. alpestre* var. *β. rupestre* Fisch. et Mey. Ind. sem. Horti Petrop. 8: 69 (1842), quoad pl. Asia Media. = *P. cognatum* var. *rupestre* Meisn. 1857 in DC. Prodr. 14: 96, quoad pl. Kar. et Kir.; Rozhan., 1916, in O. et B. Fedtsch. Consp. Fl. Turkestan. 6: 287, quoad pl. Kar. et Kir.

**Lectotype:** (Altay) “In rupestribus umbrosis montium Tarbagatai ad torrentem Tscheharak-Assu, nec non in rupestribus Saja-Assujugi Tarbagataici orientalis, ad fontes flur. Taldy. Flor. Majo. a. 1840. No. 427, Karelin et Kirilloff” [LE!]

**Isolectotype:** [P 00734308: photo!].

**Icon.:** Grubov, Opređ. sosud. rast. Mongol.: tab. 36, Fig. 170 (1982); Fl. China, 5: Fig. 238, 4–6 (2003); Fl. URSS, 5: tab. 39, Fig. 2 (1936), sub *P. alpestre*; Fl. Kyrgyz. SSR. 4: tab. 26, Fig. 2 (1953), sub *P. rupestre*; Fl. Uzbek. 2: tab. 18, Fig. 3 (1953), sub *P. rupestre*; Fl. Kazakhst. 3: tab. 14, Fig. 5 (1960), sub *P. rupestre*; Fl. Tadz. SSR. 3: tab. 47, Figs 1–3 (1968), sub *P. rupestre*. Figs 3 C, 4 C, D, 7 A, B, G, J, K, 8 F, 10 D, 12 E.

Fl. VI–VIII, fr. VII–IX.

**Ecology:** Dry rocky, stony or clay slopes from middle to subnival (1400–4600 m a.s.l.) mountain belt; sandy alluvium and pebble beds of streams and lakes, salt meadows, along roads.

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

**Distribution:** Pakistan, Afghanistan (Badakhshan), West Iran (Kurdistan), Turkmenistan, Tajikistan, Kyrgyzstan, Kazakhstan (Chu-Ili, Dzhungaria, Soongoria), Russia (Altay), Mongolia, China (Kashgaria, Tibet, West Himalaya).

**Specimens examined:** **Turkmenistan:** Kopet-Dagh. 05.1895. G. Minkevich [LE]; **Kyrgyzstan:** **Talas-Alatau:** the riverhead of Topchak-Su. 2.08.1931. No. 907 [LE, MW] et 24.07.1931. No. 739, N. Pavlov [LE, MW]; Syr-Darya reg., Tashkent u., the river Maydantay-su. 5.06.1909. I. Polovoy [LE]; ibidem, inter Akbulak and Chuptandzhay. 5.06.1899. No. 1069, M. Soloviev [LE]; Syr-Darya reg., Aulie-Ata (Talas) u., pass Kok-Kiya, 1909. No. 993, O. Knorring [LE]; ibidem, pass Kotonuzbe. 10.07.1909. Dolenko [LE]. **Kyrgyz ridge:** Syr-Darya reg., Aulie-Ata (Talas) u., Alexandrovsky (Kyrgyz) ridge, N slope, Bok-Tiken. 10.07.1903. S. Ailchinov [LE]; ibidem, in cliff Dzhul-Uirandy. 10.07.1909. No. 1004, Z. v. Minkvits [LE]; Central Tien-Chan, Semirechensk reg., Pishpek (Bishkek) u., pass Oy-kayin. 26.07.1908. No. 1514, R. Rozhevits [LE]; ibidem, road from pass Oy-kayin to Dzumgal. 28.07.1908. No. 1575, R. Rozhevits [LE]; the valley of E Karakol. 20.07.1908. No. 1290, R. Rozhevits [LE]; ibidem, S slope of Alexandrovsky (Kyrgyz) ridge, the river Chichar. 31.05.1916. M. Sovetkina, S. Chausova [LE]; ibidem, river Kyzart, Kochkorsk. 17.08.1915. V. Sapozhnikov, T. Tripolitova [LE]; ibidem, the river Big Kebin, Kokuyrak. 26.06.1913. B. Schishkin, V. Geniba [LE]; ibidem, Uzungur vol., N slope of Alexandrovsky (Kyrgyz) ridge, inter Alamedin and Chungurchak rivers. 31.05.1916. No. 352, A. Savenkova [LE]; Turkestan (Semirechensk) Karaburapan (Alexsandergebirge). 08.1976. ? [LE]; **Terskey-Alatau:** basin of Chon-Kzyl-Su, Karabash kak 19.07.1950. L. Sobolev [LE]; Semirechensk. reg., Przhevalsk u., Kokdzhar river. 26.07.1912. V. Sapozhnikov, B. Schishkin [LE]; Semirechensk reg., Przhevalsk u., pass Kugart. 2.08.1915. No. 283, M. Spiridonov [LE]; Fergana, Andizhan u., pass Kugart. 20.07.1915. No. 282, M. Spiridonov [LE]; Tian-Chan, Semirechie, pass Santash. 1893. No. 167, P. et W. Roborowski [LE]; Kyrgyz Alatau, the riverhead of Tuyuk, the lake Kara-Kul. 9.07.1931. No. 34-67, Massagetov et Masalsky [LE]; **Central Tien-Chan,** the riverhead of Naryn, 50 km E of Naryn. 22.06.1958. I. Gubanov [LE]; West Tien-Shan, Syr-Darya reg., Susamyr vol., W slope of Utpék. 14.08.1905. V. Abramov [LE]; West Tien-Chan, the valley of Santalash, Belipainak. 14.08.1902. B. Fedchenko [LE]; West Tien-Chan, the valley of Santalash, east slope of Pskem ridge, in cliff Bugultar, 3000 m. 12.08.1962. No. 165, V. Pavlov [MW]; West Tian-Chan, pass Kumysh-mar. 11.08.1897. B. Fedchenko [LE]; Kyrgyzstan, Kokand khanstvo, Khodzha-Chiburgan, 21.05.1871. O. Fedchenko [LE]; **Alay:** Fergana, Osh u., Ak-bosach. 5.09.1911. No. 274, 5.09.1911. B. Fedchenko, R. Rozhevits [LE]; Pamir-Alay, Alay Valley, Sary-Tash, 14.08.1931. No. 865, S. Lipshits [LE, MW]; Fergana, Andizhan u., pass Taldy-Bel. 21.08.1911. No. 1794, Z. v. Minkvits [LE]; Fergana. 29.08.1913. No. 88, F. Sokolov [LE]; Alay range, the basin of river Sokh, slope to the river Saj. 12.08.1974. O. Politova, E. Alekseev [MW]; **Chatkal:** Fergana, Namangan u., valley of the river Aram. 4.07.1909. No. 221. V. Yuferev [LE]; Turkestan, Namangan, (Jalal-Abad province), the lake Sary-Chelek. 27.06.1899. D. Litvinov [LE]; **Tajikistan:** Pamir, in cliff Archat. 14.07.1878. A. Kuschakevich [LE]; Pamir, Kyzyl-dong ridge. 27.08.1961. No. 6087, G. Kuzmina [LE]; Badakhshan, Alichur, Karelin [LE]; Pamir-Alay, Tschaptschal pass, 28.06.1878. No. 2, A. Regel [MW]; Gyssar ridge, Myn-Chukur, 3550 m. 16.08.1935. No. 181, P. Gordienko [MW]; **Kazakhstan:** **Chu-Ili, Ketmen:** Alma-Ata reg., the riverhead of Malaya Almaaatinka, Minzhilke. 3800 m. 28.08.1936. N. Pavlov [MW]; Semirechie, Vernoe d. (Alma-Ata), Dalashik ridge. 27.07.1915. No. 2040, V. Titov [LE]; Semirechie, Vernoe d., inter Asy et Dzhanishke. 16.06.1912. V. Sapozhnikov, B. Schishkin [LE]; Semirechie, Vernoe, Kushakevich [LE]; Semirechensk, Chu-Ili mountains, pass Ugen-Tas. 28.07.1914. V. Titov [LE]; Zaily Alatau, Turaigyr ridge, to SE of Terekty, 1500 m. 28.05.1953. V. Goloskokov [LE]; Zaily Alatau, Semirechie, pass Kastek 573 m. 20.05.1912. B. Schishkin [LE]; Ili, prope pass Samba /Ketmen ? [LE]; Ketmen, Dschilgalau, 5–6000 ft. 18.07.?. A. Regel [LE]; Turkestan, Sairam Sudifer. 07.1877. A. Regel [LE]; Semirechie, Dzsharkent u., pass Ketmen, the riverhead of Ketmen. 6.07.1912. V. Sapozhnikov [LE]; pass Ketmen. 13.07.1845. Kushakevich [LE]; mt. Kok-Tas. 1842. Kushakevich [LE]; Kungey-Alatau, N slopes, basin of the river

Tau-Chilik, the riverhead of Sapty-river. 2900 m. 10.07.1952. V. Goloskokov [LE]; Semirechie, Dzharkent, valley of Karkaryn, 15.06.1910. No. 1128, A. Mihelson [LE]; South Kazakhstan, Bostandyk, the riverhead of Ispay-Say. 3100 m., Pskem ridge. 13.08.1953. No. 557, V. N. Pavlov [MW]; **Dzhungaria**: Semirechie. Dzhungar Alatau, Kopalk u. Suyuk-Tube. 17.06.1909. No. 1603, V. Lipsky [LE]; Dzhungar Alatau, riverhead of Karatak et Chin-Bulak. 24.08.1930. No. 541, N. Schipchinsky [LE]; Tian-Chan, Dzhungar Alatau, Khorog vol., Chok, Tas-Tau. 2.08.1928. N. Desyatkin [LE]; (Tian-Chan), Dzhungar Alatau, basin of Karatal, the watershed of Koksou and Chimbulak, Ak-Tube. 7.08.1948. V. Goloskokov [LE]; (Tian-Chan), Dzhungar Alatau, valley of Chin-Bulak (Oy-Saz), the riverhead of Karatal, 4.08.1902. V. Sapozhnikov [LE]; Dzhungar Alatau, S slopes, mts. Suattau, pass Ugent. 7.06.1956. V. Goloskokov [LE]; Semipalatinsk, Zaysan, Saur ridge, the river Chegan-obo. 18.07.1914. V. Sapozhnikov [LE]; Semipalatinsk, Zaysan, Saur ridge, Uy-Tas. 22.07.1914. V. Sapozhnikov [LE]; Semipalatinsk, Zaysan, Saur ridge, the watershed of Bolshoy and Maly Dzhemeney. 6.07.1930. No. 324, N. Goncharov, A. Borisova [LE]; ibidem, river Bolshoy Dzhemeney. 1.07.1914. B. Schishkin [LE]; Semipalatinsk, Zaysan, Saur ridge, S slope of Tokash. 15.07.1914. B. Schishkin [LE]; Semipalatinsk, Zaysan, Mustau, Verkhny Ulkun-Ulasty. 28.07.1914. V. Sapozhnikov [LE]; Zaisan, Saur ridge, dividing of Bolshoy et Malay Dzhemeney. 6.07.1930. No. 324, N. Goncharov, A. Borisova [MW]. **Soongoria**: Tarbagatay. 17.06.1841. No. 295/152, Schrenk [LE]; Tarbagatay. 05.1844. No. 2990, A. Schrenk [LE]; Soongoria, Dshillkaragay, 20.06.1840. A. Schrenk [LE]; Soongoria, Alatau. 6.09.1843. Schrenk [LE]; Semirechie, Lepsinsk u., Tagbagatay ridge, pass Say-asu. 21.06.1915. V. Sapozhnikov, T. Tripolitova [LE]; ibidem, mt. Aby-Tau, near Glinovsky. 7.07.1928. No. 541, N. Pavlov [LE]; ibidem, Bel-Terek. 20.06.1928. No. 241, S. Lipshits [LE]; ibidem. 20.06.1928. No. 2. S. Lipshits [MW]; Lepsinsk d., the summit of Abl-Tau near Glinovsky, 7.06.1928. No. 541, N. Pavlov [LE]. **Mongolia**: Khabsugulsky aimag, Tsetserlekh somon, Valley of Tesiyn-Gol river, 40 km to W from Tsetselekh. 20.08.1978. No. 4416, I. Gubanov [MW]; Ara-Khangaysky aimag, the valley of river Urd-Tamir-Gol, 10 km below Tsenkher. 11.07.1978. No. 710, I. Gubanov [MW]; Mongol Altay, Basin of the river Yelt-Gol (the riverhead of Chorny Irtysh) 30 km to S from Altay-Bayan-Ulegeisky aimag, 22.07.1988. No. 2105, R. Kamelin [MW]; Mongol Altay, Baly-Ulygey aimag, pass from the lake Dayan-Nur to basin of the Irtysh, 2400–2500 m. 15.07.1988. No. 1449, R. Kamelin [MW]; Mongol, Arhaisky aimag, 25 km to S from Bat-Tsengel, the river Urd-Tamir. 29.07.1980. No. 1074, I. Gubanov [MW]; Khangay, near Zaingegen. 2.08.1926. No. 553, N. Pavlov [MW].

Besides the typical variety, *P. cognatum* includes at least two more varieties, *P. cognatum* var. *serpyllaceum* (Jaub. et Spach) O. V. Yurtseva and *P. cognatum* var. *myrtillifolium* (Kom.) O. V. Yurtseva. *P. cognatum* subsp. *chitralicum* Rech. et Schiman-Czeika, known from Iran and Pakistan, differs in digonous achenes, but dimeric achenes occur in *P. cognatum* var. *serpyllaceum* as well.

### 3.1. *P. cognatum* var. *serpyllaceum* (Jaub. et Spach) O. V. Yurtseva, comb. nova.

≡ *P. serpyllaceum* Jaub. et Spach, Illustr. Pl. Or. II: 24 (1844–1846); Czuk. in Fl. Tadzh. SSR. 3: 262 (1968); Rech. f. & Schiman-Czeika in Rech. f., Fl. Iran. 56: 69 (1968); Czuk. in Consp. Fl. Asiae Mediae, 2: 210 (1971); Icon. Defin. plant. Badachshan.: 131 (1979); Seyfulin, Opred. rast. Turkmenist. 2: 39 (1980); Nikit., Geldikhan., Opred. rast. Turkmenist.: 163 (1988).

**Lectotype**: (Iran) “In Persia borealis alpinus Elamouth-Dagh, Aucher-Eloy, 5274” [FI-2632, in Herbarium Webbianum: photo!].

**Isolectotypes**: [K000568196: photo!; G00330053; G00303482; G00303485: photos!].

= *P. pamiroalaicum* Kom. Fl. URSS, 5: 609, Add. 719 (1936); Zak. in Izv. Akad. Nauk Uzbeksk. S.S.R. 1: 12 (1948); Bajten. et Pavl. in Fl. Kazakhst. 3: 153 (1960); Chuk. Izv. Akad. Nauk

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

Tadzhikisk. S.S.R., Otd. Biol. Nauk. 1(8): 140 (1962); Ikon. in Acta Statio biol. Pamir. Bot. Inst. Acad. Sci. Tadz. SSR, 20: 93 (1963); Rech. & Schiman-Czeika, in Rech., Fl. Iran. 56: 67 (1968).

**Type:** (Tajikistan) “Flora zeravshanica. In valle Kumar supra pag. Varsaminor (Varzimonor), ad fl. Seravshan, Phon (Phan), alt. 10000 pd (=3300 m supra mare), alpine zone, 21.VIII.1892. leg. V.L. Komarov” [LE!, TBI?].

= *P. kudriashevii* Vasilkovsk. in Bot. Mater. Gerb. Bot. Inst. Uzbekistansk. Fil. Akad. Nauk S.S.S.R. 2: 3 (1940); Sumn. in Fl. Uzbek. 2: 183 (1953).

**Type:** (Uzbekistan) Kashkadarya distr., mt. Besh-Nau [TASH].

= *P. radicosum* Boiss. Diagn. Pl. Or. nov. ser. 1, 7: 84 (1846); Boiss. Fl. Or. 4.: 1039 (1879), nomen illeg.

**Lectotype:** (Iran) “Ad latera in sept. speciantia cacuminis m. Kuh-Daëna. 01.08.1842. Th. Kotchy, No. 779, det. P.E. Boissier” [W, HAL 011469, typified by N. Tkach: photo!].

**Isolectotypes:** [P00734363, P00734364, P00734365, P00734366, P00734367: photos!].

**Icon.:** Jaub. et Spach, Ill. Pl. Or. 2: tab. 117 (1844–1846); Fl. URSS, 5: tab. 39, Fig. 1 (1936) sub. *P. pamiroalaicum* Kom.; Sumn. in Fl. Uzb. 2: tab. 18, Fig. 4 (1953) sub. *P. kudriashevii*; Icon. Defin. plant. Badachshan.: tab. 8, 3 (1979) sub. *P. serpyllacaeum*.

Figs 7C, D, H, K, L, 8D, 9B, C, 10E, F, 11E, F, 12F.

Fl. VI–VIII, fr. VII–IX.

**Ecology:** stony screes, tramped places, wet sedge meadows, wastelands, near snow patches in alpine and subnival mountain belt (3200–4600 m a.s.l.).

**Distribution:** West Iran (the Kopet-Dagh), Pakistan, Afghanistan (Badakhshan), Tajikistan (Badakhshan), Kyrgyzstan (Tien Shan, Talas-Alatau), Kazakhstan (Dzhungar Alatau).

Perennial herb with lignified many-headed compact caudex and dense pillow-like bunch of numerous ascending or prostrate shoots 3–5 cm long with internodes 5–7 mm long. Ochreas 3–10 mm long, ovate or lanceolate with obtuse, dentate or acuminate top, later lacerate, without veins or with 2(4) fulvous veins included. Leaves 5–10(12) mm long and 2–5 mm wide, longer than internodes, narrowed in petiole 1–2 mm long, single-veined, revolute in margin. Flowers (1)2–5 in axillary clusters. Pedicels 1–4 mm long, filiform, equal in diameter, perianth 2–3 mm long in flowers, 3–4.5 mm long in fruits, oval-oblong, divided to  $\frac{1}{2}$ – $\frac{2}{3}$  in 5 green or reddish lobes with white or pink borders. Achene 2.5–3 mm long, 0.8–1.4 mm wide, trigonous, ovate or oblong-ovate, acuminate, black, shining. Ultrasculpture smooth, smooth-wavy or smooth-foveolate.

**Specimens examined:** Kyrgyzstan: *Talas-Alatau*: Syr-Darya reg., Chimkent u., the river head of Dzhebogly-su, 31.07.1908, No. 1160, Z. v. Minkvits [LE]; Talas-Alatau, Syr-Darya d., Aulie-Ata (Talas) u., in cliff Arabik, pass Ashu-Tur, 9.06.1909, No. 584, Z. v. Minkvits [LE]; Talas-Alatau, pass Ulkun-Kaindy 2900 m, 6.07.1933, No. 321, I. Linchevsky [LE]; West Tien-Shan, Talas-Alatau, Tulkubass d., Novonikolaevka, the riverhead of Kish-Koindy, Voroshilov [MHA]; Tulkubass d., Novonikolaevka, West Tian-Shan, Talas Alatau, the riverhead of Kish-Koindy, 2800 m. 20.08.1947. No. 1999, Voroshilov [MHA]; West Tien Shan, Talas Alatau, the reservation Aksu-Dzhabagly, the basin of the river Ak-su.

24.07.1958. V. Golubev [MHA]; Djalal-Abad reg., Chatkal Ridge, pass Chapchyma, 2840 m. 05.08.2009. No. 47813, P. Uotila [MW]; Gyssar ridge, Myn-Chukur, 3550 m, 16.08.1935. No. 181, P. Gordienko. **Central Tien Shan:** Semirechensk reg., S slope of Alexandrovsky (Kyrgyz) ridge, W Karakol, 8.07.1917, No. 359, M. Sovetkina [LE]; Semirechensk. reg., Przhevalsk u., pass Kopur-Ulen, 29.06.1913. P. Ivanov [LE]; Semirechensk, Sary-Bulak, 29.07.1903. E. Pojarkov [LE]; Semirechensk reg., pass Karaldzhigany, 8.07.1908. No. 1441. B. Fedchenko [LE]; Semirechensk, pass Karadgyl-gan. 8.07.1908. B. Fedchenko [LE]; S of Tokmak, the riverhead of Karygaman. 7.07.1913. P. Ivanov [LE]; [MW]; **Kazakhstan: Dzhungar Alatau:** Semirechensk reg., Kopal u. pass Alty-Bay 3000 m. 26.06.1909. No. 1686, V. Lipsky [LE]; Semirechie, Dzharkent u, pass Ketmen, the riverhead of Ketmen. 6.07.1912. V. Sapozhnikov [LE]; ibidem, mt. Kaska-Bulak, 24.07.1961. No. 701, V. Makarov [MHA]; **Uzbekistan:** Baysun d., 3435 m. 27.08.1933. No. 388, A. Yarmolenko [LE]. **Tajikistan: Turkestan Ridge:** S slope, Say Ruhshif. 3.09.1959. No. 11841, A. Czukavina, N. Kushikova [LE]; ibidem, N slope, Kusavli, 2850 m. 18.06.1958. No. 1114, Khohlov [LE]; West Pamir, N from the lake Zor-Kul, 8.08.1953. E. Lavrenko [LE]. **Badakshan:** Pamir, Badakshan, Andarob, the valley of Garm-Chashma et Khoz-Guni, 3950 m. 17.07.1971. No. 711, Sultanov [LE]; ibidem, the valley of Garm-Chashma et Gosto, in cliff Kofary, 4150 m. 23.07.1971. No. 975, Sultanov [LE]; Badakshan, Dzhaushangoz, the valley of Kok-Bay river, 4100 m. 29.07.1959. S. Ikonnikov [LE]; Badakshan, Yuzhno-Alichursky ridge, the road Lyangar-Alichur, pass 3900 m. 13.07.1983. Yu. Maytulina [MHA]; Pamir, the river Tokuz-Bulak, 6 km to S from Dzhelondy, 3800–4000 m. 23.07.1992. T. Konovalova, N. Shevyreva [MHA]; Pamir, Shugnan, pass Koy-Tezek. 3.08.1931. No. 03, S. Lipshits [MW]; Khodzha-Barku, 07.1930. No. 533, V. Botchtntsev, A. Vvedensky [MW].

### 3.2. *P. cognatum* var. *myrtillofolium* (Kom.) O. V. Yurtseva, comb. nova

≡ *P. myrtillofolium* Kom. Fl. URSS, 5: 608, Add. 718 (1936); Rech. & Schiman-Czeika, in Rech. Fl. Iran. 56: 67 (1968); Chuk. in Fl. Tadzh. SSR, 3: 260 (1968); Chuk. in Consp. Fl. Asiae Mediae, 2: 208 (1971).

**Type:** (Tajikistan) Fl. Zeravchanica. Prope Langlif. In valle Langlif in de cursu superiore fl. Seravchan influentis., Alt. 9000 ft. 1.08.1893. legit V. L. Komarov [LE!].

= *P. longipedicellatum* Zak. in Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. S.S.R. 10: 6 (1948); id. in Izv. Akad. Nauk Uzbeksk. S.S.R. 1: 11 (1948); Chuk. in Izv. Akad. Nauk Tadzhikisk. S.S.R., Otd. Biol. Nauk 1(8): 140 (1962).

**Type:** In montibus Pamiralaj in valle fl. Zeravschan, pr. pag. Musa-bazar. 8.VII.1929. fl. et fr. Enileev [TASH].

**Icon:** Fl. URSS, 5: tab. 39, Fig. 3 (1936); Fl. Tadzh. SSR, 3: tab. 46, Fig. 7 (1968). Figs 3 D, 4 E, F; 7 E, F, I, 8 E, 11 G, H, 12 D.

Small semi-shrub 10–40 cm high with branched rhizome to 0.5 mm thick and erect, prostrate or ascending elongated shoots 10–15 cm long with internodes equal to leaves, papillate below nodes. Basal parts of reddish shoots 3–6 cm long covered by grey cork and bear the ochrea rests, adventitious roots and renewal buds. Leaves 10–15 mm long, 5–7(10) mm wide, elliptic, oval or rounded, flat, mucronate. Ochreas 3–10 mm long, ovate or lanceolate with obtuse, dentate or acuminate top, with 2(4) veins included. Flowers 1–2 in axillar clusters with red bend pedicels 2–5(8) mm long. Perianth 2–2.5(3) mm long tubulate-campanulate, divided to  $\frac{2}{3}$ – $\frac{3}{4}$  in 5 lobes, dark-purple, a bit lighter at tepal borders, papillate at tube. Achene 2–2.5 mm long, 0.8–1.4 mm wide, trigonous, broad-ovate, with convex ribs and  $\pm$  concave faces, black, shining. Ultrasculpture smooth-wavy or smooth-foveolate.

Fl. VII–VIII, fr. VIII–IX.



Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

**Ecology:** Slate or gravely screes, herb groupings, alpine mountain belt at 2900–3600 m a.s.l.

**Distribution:** Tajikistan (Pamir-Alay, Badakhshan), Kyrgyzstan (Tien Shan).

**Specimens examined:** **Tajikistan:** **Pamir:** Vakhn-Ishkashim d., in cliff. Darshoy. 26.07.1935. No. 1543, P.Ovczinnikov, K.Afanasiev [LE]; [Pamir] Shugnan ridge, pass Yamg. 25.07.1904. B.Fedchenko [LE]; Shugnan ridge, raise to Badzham-Kutamo. 27.07.1904. B.Fedchenko [LE]; Pamir, Kyzil-Rabat, the valley of Karikol, 4600 m. 11.08.1966. No. 17787, Ikonnikov [LE]; Sary-Darvaz, Verkhny Jailau, 3200–3500 m, Dehause. 14.09.1945. Zakirov [LE]; Pamir-Alay, Alay valley, Bardaba, Bor-Debe [MW]; Alay Valley, Bardaba, 3400 m. 23.07.1964. V.Grubov, Yunusov [MHA]; Badakhshan, Andarob, valley of Garm-Chashma et Khoz-Guni, in cliff Shamady, 3900 m. 19.07.1971. No. 850, S.Sultanov [LE]; **Kyrgyzstan:** Issyk-Kul, sandy terrace river Karasay. 29.07.1965. I.Chikun, N.Kozhevnikova [MHA]; Turkestan ridge, Leninabad, Schakhristan pass, 3390 m. 27.08.1960. S.Kurganskaya et al. [MHA]; Turkestan ridge, NW slope, riverhead of Novali, 3620 m. 18.08.1934. No. 522 (= *P. longipedicellatum* Zak.) N.Afanasiev [LE]; ibidem, 3410 m. 20.08.1934. No. 555, N.Afanasiev [LE]; Turkestan ridge, N slope, the riverhead of Kusavli, 3000 m. 30.07.1959. No. 438, A.Chukavina [LE]; ibidem, 2900 m. 21.08.1956. No. 609; Riverhead of Zeravshan, valley of the river Roch, 9000 pd. 9.08.1893. V.Komarov [LE]; Central Tien-Shan, valley of the river Big Naryn, the river Karch-say, below Egizitor. 14.07.1960. N.Kozhevnikova [LE]; Semirechensk reg., Pishpek (Bishkek) d., Alexanrovsky (Kyrgyz) ridge, the river Kenkol, the river Chichka. 20.07.1930. No. 203, M.Ilyin [LE]; Terskey-Alatau, basin of Chon-Kzyl-su, Karabashkak. 22.05.1949. T.Gordeeva [LE].

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Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

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**Appendix: Voucher Information for sequences ITS 1-2 generated for this study**

The following information is given for each sequence elaborated in Department of Evolutionary Biochemistry of A. N. Belozersky Institute of Physicochemical Biology, Lomonosov Moscow State University: species, location, data, collection number, collector, [Herbarium code], Genbank accession number. Sequences of ITS 1-2 obtained from GenBank are given with GenBank accession number.

*Aconogonon* sp., AF189731; *A. jurii* (A. K. Skvortsov) Holub, Moscow, in culture. 6.06.2003. No. 2, O. Yurtseva [MW], GQ339915; *A. panjutinii* (Kharkev.) Soják, Moscow, from the Caucasus, in culture. 21.06.2003. No. 3, O. Yurtseva [MW], GQ339916; *A. relictum* (Kom.) Soják, Moscow, in culture. 6.06.2003. No. 4, O. Yurtseva [MW], GQ339917; *Atraphaxis frutescens* (L.) Eversm., West Mongolia, Mongol Altay, Bayan-Ulgii aimag, basin of Bulgan river. 27.07.1988. No. 2298, R. Kamelin et al. [MW], JQ288749; *A. replicata* Lam. The Crimea, to W of Karadagh, Lisy Bukhta, at rocks. 6.06.2009. I Schanzer, A. Vagina [MW], JQ288752; *A. spinosa* L., Volgograd reg., Kirov distr., Bolshaya Otrada. 7.05.09. No. 2, G. Klinkova, N. Suprun [MW], JQ288750; *A. spinosa* L., Volgograd reg., Kirov distr., Bolshaya Otrada. 7.05.09. No. 4, G. Klinkova, N. Suprun [MW], JQ288751; *A. spinosa* L., FJ154463.1; *Bistorta major* S. F. Gray, Russia, Bashkortostan, Bursyan distr. 30.06.2003. No. 5, Yulina [MW], GQ339918; *B. vivipara* (L.) S. F. Gray, Russia, Karelia, Loukhi, the gulf Kiv. 23.08.2002. No. 6, Ptushenko [MW], GQ339919; *Calligonum microcarpum* Borszcz. GQ206244.1; *Calligonum consens5* – is a consensus sequence of *Calligonum molle* GQ206245.1, *C. microcarpum* GQ206244.1, *C. junceum* GQ206243.1, *C. eriopodum* GQ206242.1 and *C. aphyllum* GQ206241.1; *Fagopyrum esculentum* Moench EF653685.1; *F. tataricum* Gaertn. AB000339.1; *F. pleioramosum* Ohnishi AB000336.1; *Fallopia convolvulus* (L.) Á. Löve, Moscow reg., Istra distr., Dedovsk, in the garden. 5.09.2009. O. Yurtseva [MW], JQ288753; *F. convolvulus* (L.) Á. Löve, Buryatia, Kurumkan distr., Argada river, 15 km upstream Verhknyaa Argada. 13.08.2009. A. Babytsky [MW], JQ288754; *F. convolvulus* (L.) Á. Löve, AF040064; *F. japonica* (Houtt.) Ronse Decr., AF040071; *F. sachalinensis* (F. Schmidt Petrop.) Ronse Decr. AF040073; *F. sachalinensis* (F. Schmidt Petrop.) Ronse Decr. AF040074; *Emex spinosa* (L.) Campd., Spain, Granada, the castle Alhambra. 9.07.2004. T. Fedorova [MW], JQ288755; *E. spinosa* (L.) Campd., FJ154471.1; *Eriogonum alatum* Torr. FJ54472.1; *E. clavellatum* Small GQ206247.1; *E. inflatum* Torr. GQ206249.1; *Koenigia cyanandra* (Diels) Mesicek & Soják, DQ406626; *Muehlenbeckia platyclada* (F. Muell.) Meisn. AF189738.1; *Oxyria digyna* Hill FJ154474.1; *Persicaria filiformis* Nakai PFU51276.1 sub *Polygonum virginiana* var. *filiformis*; *P. filiformis* Nakai EF653697.1; *P. hydropiper* (L.) Spach, Moscow reg., Istra distr., Dedovsk, Miitovskaya, in the forest W of Dedovsk. 13.09.2009. O. Yurtseva [MW], JQ288748; *P. hydropiper* (L.) Spach, DQ346665.1; *P. lapathifolia* (L.) Gray, Russia, Moscow reg., Dedovsk. 08.1997. No. 7, Yurtseva [MW], GQ339920; *P. minor* (Huds.) Opiz, Moscow reg., Istra distr., Dedovsk, Miitovskaya, in the forest W of Dedovsk. 13.09.2009. O. Yurtseva [MW], JQ288747; *P. neofiliformis* Ohki, PNU51273 sub *Polygonum neofiliforme* Nakai; GQ339920; *P. virginiana* (L.) Gaertn. PVU51274.1; *P. virginiana* (L.) Gaertn. EF653698.1; *Polygonella articulata* Meisn., EF653683; *Polygonum acerosum* Ledeb. ex Meisn., Afghanistan, Bamian, Bandi-Amir. 22.07.1974. No. 707, Gubanov et al. [MW], GQ339946; *P. achoreum* S. F. Blake, The USA, Missouri, St. Genevieve Co. 4.10.2001. No. 3689, Darigo [MO], GQ339955; *P. alpestre* C. A. Mey., Russia, Daghestan, Kurush, Akhty. 23.07.1986. [LE], GQ339922; *P. alpestre* C. A. Mey., The Ukraine, Kherson. 29.10.1999. Mayssino, Tzvelev [LE], GQ339923; *P. alpestre* C. A. Mey., Georgia, Mtskheta, Dzhvari. 21.05.1985. No. 33, Tzvelev [LE], GQ339957; *P. alpestre* C. A. Mey., Armenia, Razdan, Ankavan. 7.08.1986. Menitsky et al. [LE], GQ339958; *P. arianum* Grig., Turkmenistan, Kushka, Morgunovsky. 25.04.1988. Gorelova [LE], GQ339970; *P. atraphaxiforme* Botsch., Kyrgyzstan, Alay Ridge, Kadamzhay. 19.07.2005. Lazkov [FRU], GQ339980; *P. atraphaxiforme* Botsch., Uzbekistan, Turkestan Ridge, the Isphar. 07.1970. No. 532, Kamelin [LE], GQ339981; *P. aviculare* L., Russia, Primorsky Kray, Vladivostok, isl. Russky. 23.09.2007. No. 27, Petrova [MW], GQ339982; *P. aviculare* L., Russia, Moscow reg., Dedovsk. 19.08.1997. No. 29, Yurtseva [MW], GQ339928; *P. biaristatum* Aitch. et

Morphology and taxonomy of *Polygonum cognatum* Meisn. and *P. alpestre* C.A.Mey.

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O. V. YURTSEVA, M. S. LEVINA, E. E. SEVEROVA &amp; A. V. TROITSKY

GQ340055; *P. thymifolium* Jaub. et Spach, Tajikistan, W. Pamir, Khorugh, Shugnan Ridge. 18.07.1992. Konovalova, Shevireva [MHA], GQ340056; *P. thymifolium* Jaub. et Spach, Kyrgyzstan, Alay Ridge, south. slope In cliff of Koksu river, at rocks. 29.08.2004. G. Lazkov [MW], JQ288772; *P. toktogulicum* Lazkov, Kyrgyzstan, Susamyr Ridge, Kara-Dzhigach. 7.07.2005. Lazkov [FRU] GQ340057; *P. vvedenskyi* Sumnev., Kyrgyzstan, Fergana Ridge, Sary-Tash river (basin of Kara-Ungur river). 19–22.06.2005. G. Lazkov [MW], JQ288769; *P. vvedenskyi* Sumnev., Uzbekistan, Chatkal Ridge, Chatkal st. reserve, 10.07.1976. No. 94, Kamelin, Levicheva [LE], GQ339986; *Pteroxygonum giraldii* DQ406627.1; *Rheum officinale* Baill. FJ980443.1; *Rh. rhabarbarum* L., Moscow reg., Istra distr., Dedovsk, in the garden. 6.09.2009. O. Yurtseva [MW], JQ288756; *Rumex acetosa* L., Moscow reg., Istra distr., Dedovsk, Miitovskaya, in the forest W of Dedovsk. 13.09.2009. O. Yurtseva [MW], JQ288759; *R. acetosa* FJ503011.1; *R. confertus* Willd., Moscow, Leninskiye Gory, Botanical Garden of MSU. 10.09.2009. O. Yurtseva [MW], JQ288758; *R. crispus* L., Russia, Vladimir reg., Gus-Khrustalny distr., Zakolpye. 28.09.2009. V. Choob [MW], JQ288757; *R. crispus* L., AF338221.1; *R. obtusifolius* L., Russia, Moscow reg., Dedovsk. 13.08.2006. No. 1, O. Yurtseva [MW], GQ340059; *R. thyrsiflorus* Fingerh., Buryatia, Kurumkan distr., Argada river, 15 km upstream Verhkny Argada. 12.08.2009. A. Babytsky [MW], JQ288760.







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