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Notes on some Sino-Himalayan species of *Angelica* and *Ostericum* (*Umbelliferae*)

Abstract

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Based on own field observations and collections as well as on material from various herbaria, Sino-Himalayan species of *Angelica* and *Ostericum* were studied, emphasizing fruit anatomy. *A. indica* from NW Himalaya, Uttar Pradesh, a species allied to *A. glauca*, is described as new to science. Three combinations, *Ostericum longipedicellatum* and *O. muliense*, for two species here transferred to that genus, and *Heraclium oncosepalum*, for a species excluded from *Angelica*, are validated. The known distribution range of the Himalayan *A. nubigena* is extended to SE Tibet, and, inferred from fruit anatomy, the species is shown to be closely allied to *A. cyclocarpa*. Reconsideration and comparison of Chinese *Angelica* species described by European botanists prior to the mid 1930s and by Chinese botanists in the 1960s finally led to the recognition of new synonyms of *A. duclouxii*, *A. laxifoliata*, *A. nitida* and *A. wilsonii*.

Introduction

The Himalayas are the southern delimitation of the distribution area of *Angelica* and numerous other temperate genera of the northern hemisphere. *Angelica* has its highest species diversity in E Asia, particularly in the Chinese provinces of Sichuan and Yunnan. The species numbers quickly diminish westwards. From Xizang (Tibet) only five species are known, growing mainly in the extreme southeast of this autonomous region. Another centre of species diversity is in Middle Asia, but there the genus is represented by only five species, belonging to *A.* subg. *Archangelica* and *Mesangelica*.

Four species of *Angelica* are known from the Himalayas: *A. oreadum* Diels (see Pimenov & Kljuykov 2001), closely related to the Middle Asian species of *A.* sect. *Archangelica*, *A. glauca* Edgew., distributed in the NW Indian Himalaya, N Pakistan and E Afghanistan, *A. cyclocarpa* (C. Norman) M. Hiroe, endemic to Nepal, Sikkim, Bhutan and S Tibet, and *A. nubigena* (C. B. Clarke) P. K. Mukh., a poorly known species from Sikkim. The taxonomic position of the last three species within the genus was not firmly established. *A. sikkimensis* (C. B. Clarke) P. K.

Mukh. had been recently transferred to the genus *Arcuatopterus* M. L. Sheh & R. H. Shan (Pimenov & Ostroumova 2000).

Material and methods

We studied the herbarium collections of different Sino-Himalayan species of *Angelica*, *Ostericum* and related genera, including their nomenclatural types, preserved in the herbaria BM, CDBI, E, G, GB, GOET, K, KUN, LE, NAS, OSL, P, PE, UPS, US, W (abbreviations according to Holmgren & al. 1990). We studied some Himalayan species in their natural habitats during our excursions in Nepal and W Himalaya in 1999 and 2000, and used also our collections and field observations of Chinese species in Sichuan and Yunnan between 1996 and 1998. For our morphological and anatomical studies emphasizing carpoanatomical features, we employed standard techniques.

Results

The results of our studies are presented below in a series of taxonomic notes. They include the description of a new species from W Himalaya, three new combinations and critical synonymisation of previously described taxa.

A new species of *Angelica* (*Umbelliferae*) from the Indian Himalaya

During our trip to NW Himalaya in 2000, we found a rather distinctive undescribed species of *Angelica* in Uttar Pradesh (India), which is described here:

Angelica indica Pimenov & Kljuykov, *sp. nova*

Holotype: India, Uttar Pradesh, Chamoli distr., main Himalayan range, basin of Alaknanda River, valley of Hem Ganga near Ghangaria. 30°37'N, 79°34'E, 3000-3300 m, 18.9.2000, Pimenov & Kljuykov 234 (MW; isotype: B). – Fig. 1.

Angelicae glaucae Edgew. plus minusve similis, sed foliis biternatis, atroviridis, vaginis angustis, elongatis, lobis terminalibus margine regulariter serratis, apice breviter mucronatis (in *A. glaucae* triternatis, glaucis, vaginis inflatis, lobis terminalibus margine irregulariter incis, apice vulgo attenuatis), caulibus tenuibus, basi ad 6 mm in diametro (caules in *A. glaucae* 1.5-2.5 cm in diametro), atroviridis concoloribus (non glaucis albostriatis), rhizomatibus brevibus palariibus cum radicibus adventiciis numerosis funiformibus (in *A. glaucae* partes hypogaeae caudices sat amplos radicibus verticalibus prebent) et umbellis paucis (7-9 cm in diametro, in *A. glaucae* 10-15 cm), pauciradiatis (radii 6-11, non 20-40) bene differt.

Herbae perennes polycarpicae, caudicibus brevibus, verticalibus, in collo residuis fibrosis petiolorum foliorum tectis; *radix* primaria non evoluta; *radices* adventiciae numerosae, funicularia. *Caulis* in parte superiore corymbose ramosus, solitarius, 100-130 cm altus, basi ad 6 mm in diametro, fistulosus, fere glaber, sub umbellis vix scaberulus, costulatus. *Folia radicalia* longepetiolata; *petioli* (Fig. 2E) sectione transversali fistulosi, fasciculis conductoriiis periphericis, collenchymis angularis et parenchymis cellululis membranibus lignescentibus; *laminis* rhomboideis vel late-triangularis, 20-25 × 20-25 cm, bipinnatisectis; *segmentis basalibus* longepetiolulatis, petiolulis 5-6 cm longis; *lobis terminalibus* inaequalibus (lateralibus minoribus), ovatis vel ellipticis, inaequilateralibus, 7-11 × 3.5-7 cm, serratis, supra fere glabris, subtus nervis scaberulis. *Folia caulina* foliis radicalibus similia sed sursum sensim reducta, infera longepetiolata, vaginis minoribus triangularibus, superiora vaginis angustis longis, laminis ternatis. *Umbellae* 7-9 cm in diametro, 6-11-radiatae, radii subaequalibus, tenuibus, costulosis, minute scabris; *involucrum* nullum vel bracteis solitariis linearibus; *umbellulae* 20-25-florae, pedicellis glabris, teretibus, ad 1 cm longis, subaequalibus, bracteolis 5-6, anguste linearibus, herbaceis, integribus, margine minute



Fig. 1. *Angelica indica* Pimenov & Kljuykov, holotype specimen (MW).

scabris, fructificatione reflexis. *Fructus* (Fig. 2A-B) glabri, carpophoris fere basin bifidis; *mericarpia* obovata, 12-14 × 6-7 mm, dorso valde compressa; *stylopodia* breve conica, styli 1.5-1.8 mm longi, dorso reflexi; *juga* marginalia late alata, 2.5-2.7 mm longa, dorsalia brevia, triangularia vel carinata; *valleculae* angustae; *exocarpium* cellulis minutis leptodermaticis, interruptum prope carpophorum (commissura angusta); *mesocarpium* cellulis aerenchymis subsodiametricis, membranis tenuibus, lignescentibus, fissuratum porosis; interdum mesocarpium in juga et a facie commissurali cavitatibus aeriferis; *vittae* valleculares solitariae, commissurales 2; *endocarpium* et *spermoderma* cellulis minutis; *endospermium* ventre planum.

Distribution. – Known only from the type locality.

Note. – The closest ally of *Angelica indica* seems to be the W Himalayan *A. glauca* Edgew., which shows some differences in root, stem, leaf and umbel structure (see Latin diagnosis, above) but is similar in all essential fruit features. Probably the specimens from Uttar Pradesh (Hemkund and Pindari Moraine) cited by Mukherjee & Constance (1993) under *A. glauca*, actually belong to *A. indica*.

Mericarps of *A. glauca* (Fig. 2C-D) are glabrous, obovoid, strongly compressed dorsally, 10-14 × 6-8 mm; the stylopodium is low conical, the styles are 1.3-1.5 mm long and reflexed on the dorsal side of the mericarp; calyx teeth are absent; the dorsal ribs are shortly keeled, the marginal ribs broadly winged, 2.8-3.1 mm wide; secretory ducts are solitary in the valleculas, large, two on the commissural face; the exocarp is of one layer, interrupted near the carpophore (commissure narrow); the mesocarp is of subsodiametrical aerenchyma cells with thin lignified pitted walls, endocarp and spermoderma are of small cells; the commissural face of the endosperm is flat.

The similarity of *A. indica* and *A. glauca* in all essential fruit characteristics probably indicates that they form a separate infrageneric taxon (section or subsection) within *Angelica*. However, the separation of similar taxa will be possible only when the taxonomy of the E Asian species is better understood and their carpological diversity is described according to modern standards.

Angelica cyclocarpa* and *A. nubigena

These two Himalayan species form a second species pair in *Angelica*. *A. nubigena* is a poorly known species, originally described in *Heracleum* (Clarke 1879) and later transferred to *Angelica* by P. K. Mukherjee (1983). It seems to be represented in herbaria by only two or three collections so identified. *A. cyclocarpa* was originally described in *Archangelica* (Norman 1929) and transferred to *Angelica* by M. Hiroe (1979). It is regarded as endemic to Nepal by Mukherjee & Constance (1993) or to Nepal, Sikkim, Chumbi (S Xizang) and Bhutan by Watson (1999). We collected *A. cyclocarpa* on the southern slopes of the Annapurna Mt in central Nepal with completely mature fruits.

Mukherjee & Constance (1993: 212) distinguish these two species in leaflet shape (“ovate-lanceolate to oval, acute or acuminate” in *A. nubigena*, “lanceolate, longly acuminate” in *A. cyclocarpa*) and stylopodium form (low conical in the first, conical in the second). Watson (1999: 495) has established more reliable differences: decurrent instead of petiolulate leaflets and greatly enlarged instead of narrow sheaths in *A. cyclocarpa*. He described, however, the fruit shape in both species as practically being the same.

We investigated the fruit structure of both species. Our own collections from Annapurna permitted us to study mature fruit and also to observe the variation in shape and size both within a population and individual plants. Of the very limited material of *A. nubigena*, we investigated fruits from G, collected by J. D. Hooker in Sikkim. It is questionable whether this sheet is an isotype as its label does not completely match the data in the protologue, but it may belong to the original material.

The fruit size in *A. cyclocarpa* clearly varies even within one individual but is always bigger than in *A. nubigena*. The mericarps (Fig. 3A, C) are glabrous, obovoid, strongly compressed dor-

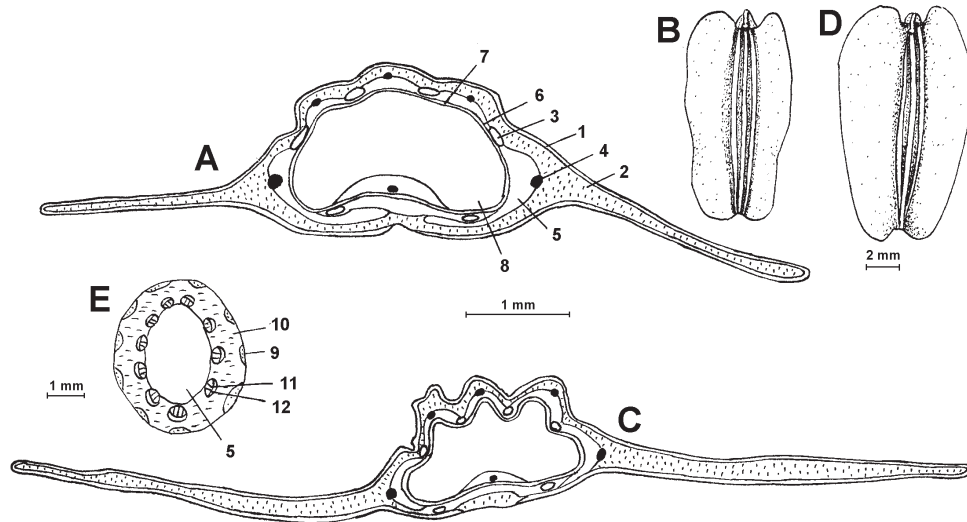


Fig. 2. A, B, E: *Angelica indica* Pimenov & Kljuykov (18.9.2000, Pimenov & Kljuykov 234, MW); C, D: *Angelica glauca* Edgew. (Pakistan, Hazara, NW Himalaya, Lower Kaghan Vy., Shogran-Shogran ridge, 34°35'N, 73°29'E, 2680 m, 12.9.1995, Dickore 13056, GOET). – A, C: transect of mericarp; B, D: dorsal view of mericarp; E: transect of petiole. – 1 = exocarp, 2 = parenchyma cells of mesocarp with lignified pitted walls (aerenchyma), 3 = secretory ducts, 4 = vascular bundles, 5 = cavity, 6 = endocarp, 7 = spermoderma, 8 = endosperm, 9 = collenchyma, 10 = lignified parenchyma, 11 = xylem of vascular bundle, 12 = phloem of vascular bundle.

sally, 8-12 × 6-8 mm; the stylopodium is low conical, the styles are 1.3-1.5 mm long and reflexed on the dorsal side of mericarp; calyx teeth are absent; the dorsal ribs are shortly keeled, the marginal ribs broadly winged and up to 2.7 mm wide; secretory ducts are solitary in the vallecules, large, on the commissural face absent; the exocarp is of one layer, interrupted in the central part of the ventral face (commissure rather broad); the mesocarp is of large parenchymatous cells with lignified pitted walls, the endocarp and spermoderma of small cells; the commissural face of the endosperm is flat.

Mericarps of *A. nubigena* (Fig. 3B, D, E) are glabrous, broadly obovoid, strongly compressed dorsally, 5.5 × 5.4 mm; the stylopodium is low conical, the styles are 1-1.3 mm long and reflexed on the dorsal side of the mericarp; calyx teeth are absent; the dorsal ribs are short, obtuse, the marginal ribs broadly winged and up to 1.8 mm wide; secretory ducts are solitary in vallecules, large, on the commissural face absent; the exocarp is of one layer, interrupted in the central part of the marginal ribs on the ventral face (commissure rather broad); the mesocarp is of large parenchymatous cells with lignified pitted walls, endocarp and spermoderma are of small cells; the commissural face of the endosperm is flat.

We studied additionally a small series of herbarium sheets in BM and E, determined as *Porphyroscias longipedicellata* H. Wolff and *Angelica longipedicellata* (H. Wolff) M. Hiroe, respectively, all originating from SE Tibet: "SE Tibet: Kongbo: Tripe Valley near Namchu Barwas. In juniper forest amongst grass by the track, F. Ludlow & G. Sheriff 12234" (BM); Tibet, Tsari, Kirindong Dzong, 11000-12000 ft., F. Kingdon-Ward 11998" (BM); "Kongbo (SE Tibet): Tripe Valley near Hamil Borwa, alt. 11500', 12.9.1947, F. Ludlow & G. Sheriff 13234" (BM); Kongbo (SE Tibet): Dzala, Paum Chu, alt. 12500'. Meadows. 3.7.1947, F. Ludlow & G. Sheriff 14069" (BM); "Tibet, Songachu Dzong: Zayul. 12000-13000 ft., F. Kingdon Ward 10151a" (BM); "SE Tibet, Kongbo province, Lusha, Tsangpo Valley. 29°27'N, 94°35'E,

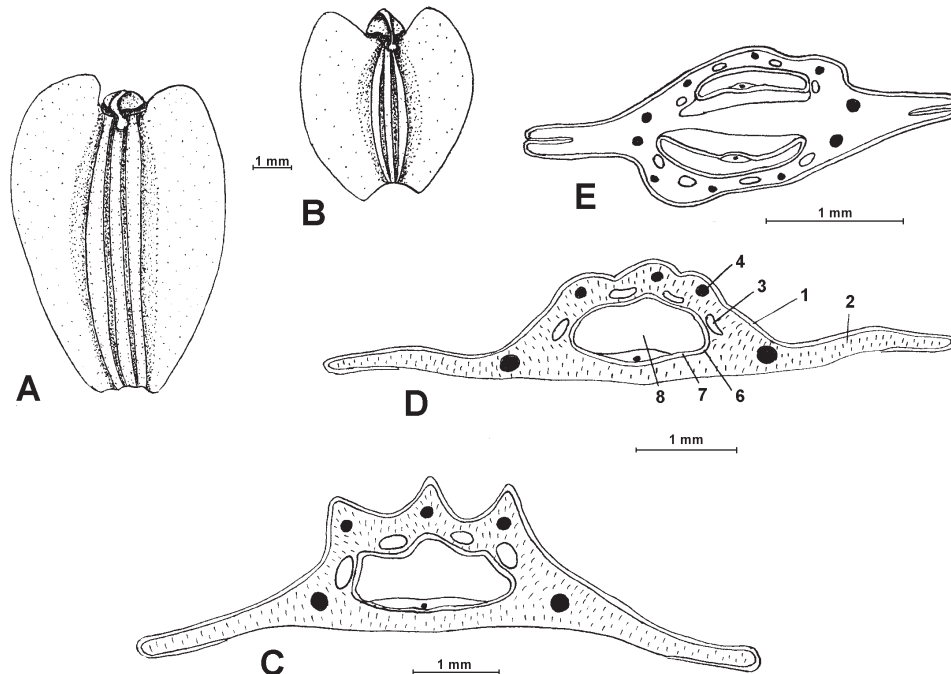


Fig. 3. A, C: *Angelica cyclocarpa* (C. Norman) M. Hiroe (Central Nepal, south slope of Annapurna, 22.10.1999, Pimenov & Kljuykov 11, MW); B, D, E: *Angelica nubigena* (C. B. Clarke) P. K. Mukh. B, D: Sikkim, reg. temp. 6-11000 ft. *Hooker* (G); E: SE Tibet, 21.8.1994, *Dickoré 11561* (GOET). – A, B: dorsal view of mericarps, C, D: transect of mericarps, E: transect of immature fruit. – For explanation of the numerals see Fig. 2.

9500 ft., 16.6.1938, *F. Ludlow, G. Sheriff & C. Taylor 4836*" (E, BM); "Tibet, Gyamda Valley, 11000-12000 ft. In thickets in the shady cliffs, 23.8.1935, *F. Kingdon Ward 12225*" (BM).

Comparing these gatherings with the type of *P. longipedicellata* from Yunnan kept in E (see below), we came to the conclusion that all these SE Tibetan gatherings actually have to be referred to *A. nubigena*, which thus is distributed also in SE Tibet. The rich Tibetan collection by *B. Dickoré* (GOET), kindly sent to us for determination, contains an additional sheet of the same species also from SE Tibet ("China, Xizang, SE Tibet, Gyala Peri N, Bong Chu - Gyala Peri - N Glacier, 29°55'N, 94°53'E, 3350 m, upper mont. *Rhododendron* forest, scrub, and wet clearings, tall forbs, 21.8.1994, *Dickoré 11561*).

Taxonomic position of *Porphyroscias longipedicellata*

After all Tibetan gatherings of *Porphyroscias longipedicellata* known to us actually represent *Angelica nubigena* (see above), *P. longipedicellata* is represented only by a few collections from Yunnan made by G. Forrest, one of them being the holotype (*Forrest 10949*, E; isotype: K). Another sheet from the same place is *Forrest 17051* (Oct. 1918, E).

Investigation of the fruit anatomy of both gatherings at E revealed structures characteristic to *Ostericum* Hoffm. but not to *Angelica* proper. *Ostericum* has been regarded for a long time as a section or subgenus of *Angelica*, a tradition we also followed (Pimenov, 1968, Vasil'eva & Pimenov 1991). New phytochemical (Harborne & al., 1986) and molecular data (Shneyer & al. 2003), together with the known carpological data (Koso-Poljansky 1914, Suk & al. 1974, Yuan & Shan 1985), showed, however, that *Ostericum* is more distant to *Angelica* than some other seg-

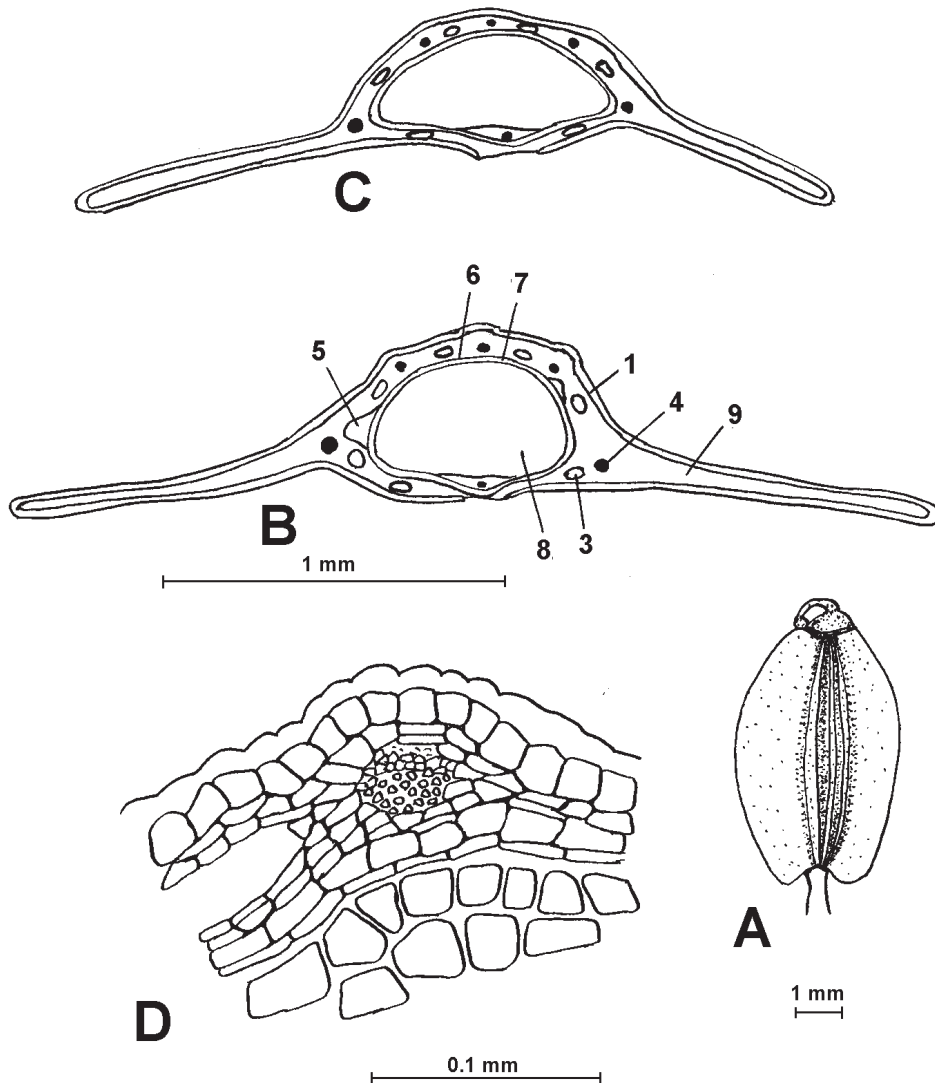


Fig. 4. *Ostericum longipedicellatum* (H. Wolff) Pimenov & Kljuykov – A: dorsal view of mericarp, B, C: transect of mericarps, D: dorsal rib of mericarp. – A, B, D: 10.1918, *Forrest 17051* (E); C: Jangtze bend, 8.1913, *Forrest 10949* (K). – 1-8 see Fig. 2, 9 = parenchyma cells of mesocarp.

regate genera such as *Archangelica*, *Coelopleurum*, *Czernaevia*. The most evident carpological feature of *Ostericum* is the exocarp structure. It consists of large cells with convex, thickened outer walls, while parenchyma mesocarp cells are frequently destroyed. Such a fruit structure has also been found in *Porphyroscias longipedicellata*.

Mericarps of *Porphyroscias longipedicellata* (Fig. 4 A-D) are ellipsoidal, strongly compressed dorsally, 4.5×2.8 mm; the stylopodium is low conical, the styles are 0.5-0.7 mm long and reflexed on the dorsal side of the mericarp; calyx teeth are absent; the dorsal ribs are subinconspicuous, the marginal ribs broad, winged, 1 mm wide; secretory ducts are solitary in valliculas and 2(3-4) on the commissural face; the exocarp is of one layer, consisting of large

cells with thickened outer walls and covers the ventral face of the mericarp up to the carpophore (commissure very narrow); the mesocarp is parenchymatous, of small cells, the endocarp is of large cells with slightly lignified walls, the spermoderma of small cells; the commissural face of the endosperm is flat.

Consequently, we transfer the species to *Ostericum*:

Ostericum longipedicellatum (H. Wolff) Pimenov & Kljuykov, **comb. nova** \equiv *Porphyroscias longipedicellata* H. Wolff in Feddes Repert. 27: 306. 1929 \equiv *Angelica longipedicellata* (H. Wolff) M. Hiroe, Umbell. World: 1430. 1979. – Holotype: China, “Yunnan, on the Tong-Shan in the Yangtze bend. Lat. 27°20', 10000', 8.1913, *Forrest 10949*” (E!; isotype: K!).

Distribution. – China (SW: Yunnan).

Ref. – Under *Angelica longipedicellata*: Wu (1984: 905).

Porphyroscias (with the type *P. decursiva* \equiv *Angelica decursiva*) is regarded by the majority of specialists as part of *Angelica*. The habit of *A. decursiva* is quite typical for *Angelica*, but it possesses one carpological feature unusual in *Angelica*. This is the commissure width, on which the traditional separation between *Angelica* and related genera (*Peucedanum* s.l. and others) was based. Actually this holds true for European as well as for most other species, but there are some exceptions, for instance in E Asia. Besides *A. decursiva* (see below), some E Asian species have a commissure being intermediate between these extremes: the exocarp is interrupted near the bases of the marginal ribs and even nearer so to their distal ends.

Another species of *Ostericum*, distributed in the same region, is *O. scaberulum* (Franch.) C. C. Yuan & R. H. Shan. Both species differ very well in the following characters: stems of *O. scaberulum* are thinner, up to 7 mm in diam. at base; leaflets in *O. scaberulum* are petiolulate but sessile in *O. longipedicellatum*, terminal ones are trifid in *O. longipedicellatum* but entire in *O. scaberulum*; umbels in *O. scaberulum* are of 11-17 rays, in *O. longipedicellatum* of up to 30 rays; pedicels in *O. longipedicellatum* (see epithet) are significantly longer (up to 25 mm) than in *O. scaberulum* (no longer than 12 mm).

Ostericum scaberulum var. *longinvolucratum* Z. Y. Wu & F. T. Pu (see Pu 1998) (holotype: “Yunnan, Bai-mar-shan, A-tun-tze, alt. 3400 m, in mountain slope. 9.1935, C. W. Wang 69408”, KUN; isotype NAS!) is identical with *Oreocromopsis aromatica* (W. W. Smith) Pimenov & Kljuykov (\equiv *Pleurospermum aromaticum* W. W. Smith).

Ostericum muliense

Yuan & Shan (1985) described *Ostericum maximowiczii* var. *alpinum* R. H. Shan & C. C. Yuan from Sichuan, SW China. Investigation of the type (*Pu Fa Ting & Yao Gan 386*) shows that this taxon is a separate species, differing from *O. maximowiczii* in a combination of characters (tap root vs. long thin horizontal rhizomes; 4-pinnatifid vs. bipinnatifid lower leaves; 3-pinnatifid vs. pinnate upper leaves; inflate vs. not inflate sheaths of upper cauline leaves; 4 vs. 2 vittae on the commissural mericarp side). *O. maximowiczii* (Maxim.) Kitag. proper is also geographically separated from var. *alpinum*, occurring in Russian Far East, Nei Mongghol, NE China and Korea.

Our investigations also revealed that *Pachypleurum muliense* R. H. Shan & F. T. Pu, described from the Muli range in SW Sichuan, represents the same species as *O. maximowiczii* var. *alpinum*. The fruits of both type gatherings (Fig. 5A-C and D) confirm their conspecificity and attribution to *Ostericum*. The mature fruits are glabrous, ellipsoidal, strongly compressed dorsally, 6.5-7.5 \times 3.5-5 mm; the stylopodium is low conical, the styles are 1-1.2 mm long and reflexed on the dorsal side of the mericarp; the calyx teeth are linear; the dorsal ribs are shortly winged, thin, the marginal ribs are broadly winged, 0.9-1.3 mm wide; secretory ducts are solitary in valliculas, 4 on the commissural face; the exocarp is of one layer, of very large cells with thickened outer walls, interrupted near the carpophore (commissure very narrow); the mesocarp is of small

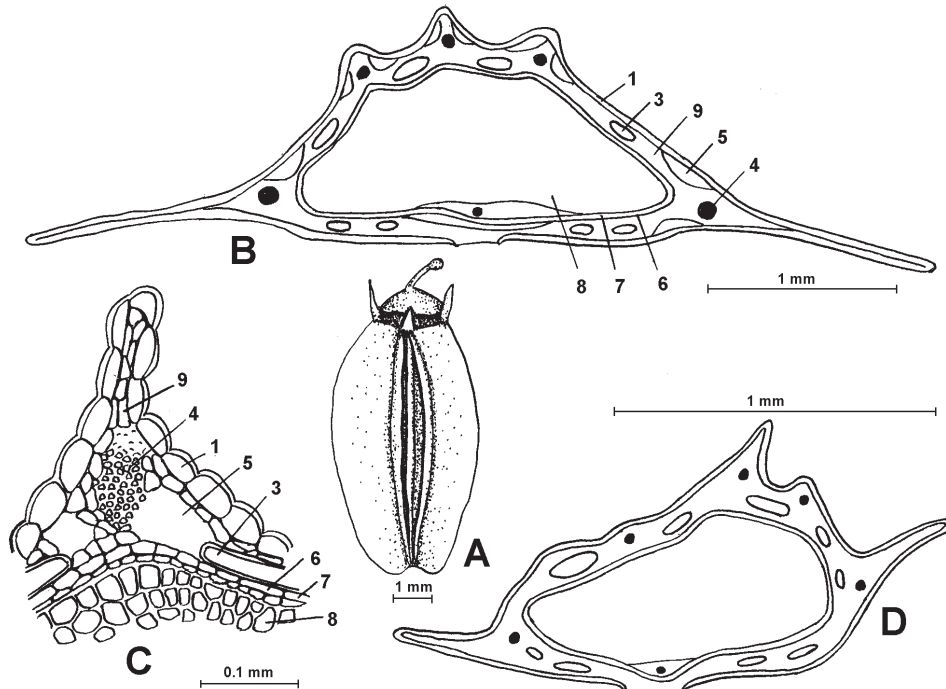


Fig. 5. A, B, C: *Ostericum maximoviczii* var. *alpinum* R. H. Shan & C. C. Yuan (holotype, NAS); D: *Ostericum muliense* (R. H. Shan & F. T. Pu) Pimenov & Kljuykov (holotype, CDBI). – A: dorsal view of mericarp, B, D: transect of mericarp, C: dorsal rib of mericarp. – Explanation of numerals see Fig. 2 and 4.

parenchymatous cells, partly destroyed, the endocarp of slightly lignified cells, the spermoderma of small cells; the commissural face of the endosperm is flat.

At species rank the epithet “*muliense*” has priority and has to be adopted for the combination in *Ostericum*:

Ostericum muliense (R. H. Shan & F. T. Pu) Pimenov & Kljuykov, **comb. nova** \equiv *Pachypleurum muliense* R. H. Shan & F. T. Pu in Acta Phytotax. Sin. 27: 62, fig. 1. 1989. – Holotype: China “Sichuan, Muli, alt. 2600, in bush-woods by streams, 19.8.1978, *Qing-Heng Zhao 1569*” (CDBI!).

= *Ostericum maximoviczii* var. *alpinum* R. H. Shan & C. C. Yuan in Bull. Nanjing Bot. Gard. Mem. Sun Yat Sen 1984-85: 3. 1985. – Holotype: China “Sichuan: Hatoowan, Muli Xian, alt. 2250 m, 23.10.1982, *Fa Ting Pu & Yao Gan 386* (NAS!; isotype: CDBI!).

Distribution. – China (SW: Sichuan).

Ref. – Under *Pachypleurum muliense*: Pu & al. (1992: 255), Pu (1993: 1343).

A new synonym of *Angelica apaensis*

Shan & Yuan (1966) described *Angelica apaensis* from Sichuan. The species is distributed in Sichuan, Yunnan and SE Xizang. Recently it was transferred to *Heracleum* (Wang 1992, Pu 1993). Another *Heracleum* species described from Sichuan is *H. xiaojinense* (Pu & He 1993);

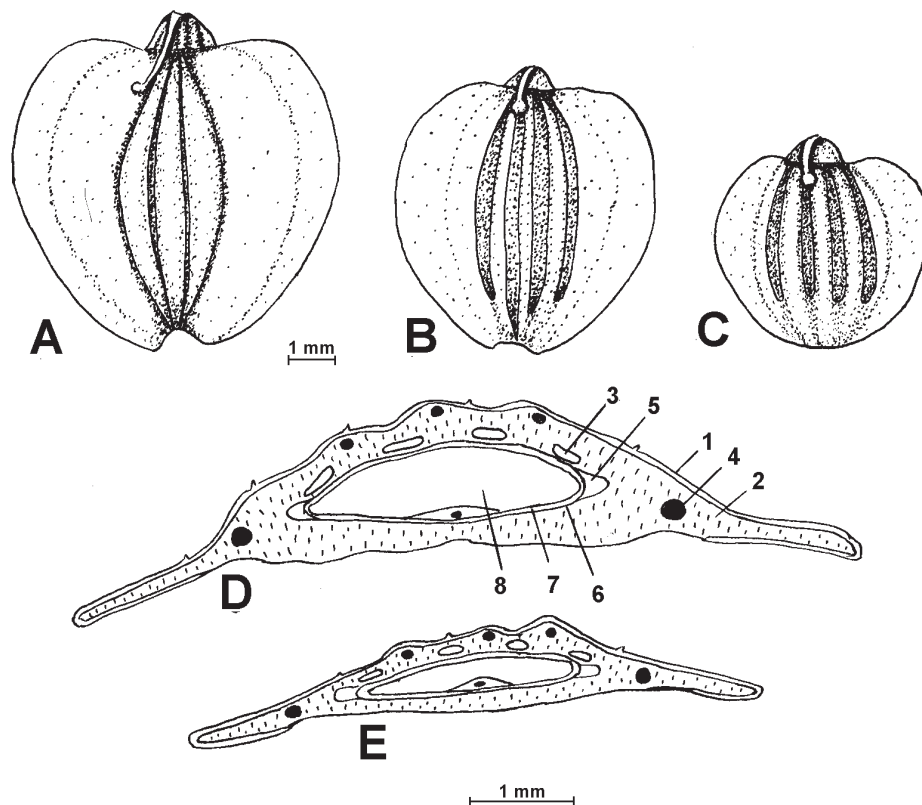


Fig. 6. A, B, D: *Angelica apaensis* R. H. Shan & C. C. Yuan (A, D: Sichuan, between Xinduqiao and Kangding, 21.9.1998, Pimenov & al. 289, MW; B: Sichuan, Barkam, 4.10.1994, Miehe & Wundisch 94-4923, GOET); C, E: *Heracleum xiaojinense* F. T. Pu & X. J. He (holotype, CDBI). – A, B, C: dorsal view of mericarps, D, E: transect of mericarps. – For explanation of the numerals see Fig. 2.

whereas it differs in fruit structure from other Chinese *Heracleum* species, as is evident from He & al. (1998), it has no differences from *A. apaensis*, as the type material in CDBI confirmed.

In 1998 we collected some instructive material (plants with mature fruits) in Sichuan between Kanding and Xinduqiao, what permitted us to review the *Angelica-Heracleum* controversy employing fruit anatomical characters. Fruit anatomy in fact confirms the initial attribution of the species to *Angelica* by Shan & Yuan (1966). *A. apaensis* is rather similar in fruit structure with *A. nubigena* and *A. cyclocarpa*, see above; in particular, the fruits of all three species have no secretory ducts on the commissural side. *A. apaensis*, however, cannot be regarded as a close relative of the other two species, but occupies a rather isolated position in SW Chinese *Angelica*.

The fruits of *A. apaensis* (Fig. 6) are covered by rare hairs, the mericarps are broadly obovoid, strongly compressed dorsally, 4.5-8 × 5-7 mm; the stylopodium is low conical, the styles are 1.4-1.7 mm long, reflexed on the dorsal side of the mericarp; calyx teeth are absent; the dorsal ribs are short, obtuse, the marginal ribs broadly winged; secretory ducts are solitary in vallecules, large, visible on the dorsal surface or sometimes hardly so, absent on the commissural face; the exocarp is interrupted in the central part of the ventral face (commissure rather broad); the mesocarp is of large parenchymatous cells with lignified pitted walls, the endocarp and spermoderma are of small cells; the commissural face of the endosperm is flat.

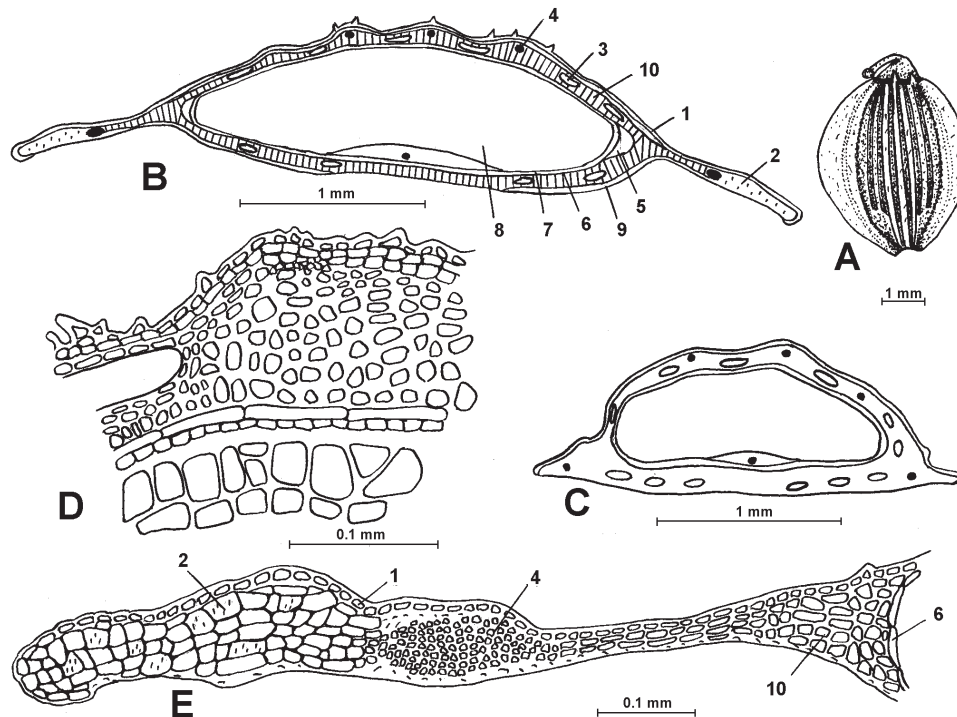


Fig. 7. *Angelica oncosepala* Hand.-Mazz. – A: dorsal view of mericarp; B, C: transect of mericarps; D: dorsal rib of mericarp, E: marginal rib of mericarp. – A, B, D, E: Mekong-Salween, 3600 m, 11.10.1936, *N* 22794, KUN; C: Yunnan, 12.8.1940, *N* 6561, PE. – 1-8, see Fig. 2; 9 = parenchyma cells of mesocarp, 10 = sclerenchyma cells of mesocarp.

It should be noted that the fruits are somewhat variable. Sometimes the vittae in dorsal furrows are hardly visible, and sometimes they do not reach the mericarp basis, what probably was a reason to transfer the species to *Heracleum*. The absence of a lignified layer of prosenchyma cells in the inner mesocarp and the rather narrow commissure clearly indicate that this is not a *Heracleum*:

Angelica apaensis R. H. Shan & C. C. Yuan in Acta Pharm. Sin. 13, 5: 329, fig. 21-24. 1966 (n.v.) ≡ *Heracleum apaense* (R. H. Shan & C. C. Yuan) R. H. Shan & T. S. Wang in Fl. Reip. Pop. Sin. 55, 3: 184, t. 79, fig. 1-8. 1992. – Type: China “Szechuan: Apa, *T. S. Yue 64066*” (n.v.). = *Heracleum xiaojinense* F. T. Pu & X. J. He in Acta Phytotax. Sin. 31, 4: 372, fig. 3. 1993. – Holotype: China “Sichuan: Xiaojin, alt. about 3800 m, under forests or in shrub-meadows, 16.8.1975, *Wang Jing Auo 9765*” (CDBI!), **syn. nov.**

Distribution. – China (Tibet: Xizang; SW: Sichuan, Yunnan).

Ref. – Under *Angelica apaensis*: Yuan & Shan (1985: 7), Yuan (1986: 510). – Under *Heracleum apaense*: Pu (1933: 1351).

What is *Angelica oncosepala*?

Angelica oncosepala was described by Handel-Mazzetti (1933) from the extreme NW of Yunnan and appears to be endemic to this SW Chinese province. The species was accepted by Yuan & Shan (1985), Wu (1984), Yuan (1992) and Pu (1993), always in *Angelica*.

The mericarps of *A. oncosepala* (Fig. 7) are covered by rare hairs, they are ellipsoidal, strongly compressed dorsally, 4.8-5 × 2.6-2.8 mm; the stylopodium is low conical, the styles are 0.6-0.7 mm long and reflexed on the dorsal side of the mericarp; calyx teeth are absent or unequal, linear; the dorsal ribs are keeled, the marginal ribs broadly winged, 0.6-0.7 mm wide, slightly swollen in the distal part; secretory ducts are solitary in dorsal vallecules, by two in lateral vallecules, four on the commissural face; the exocarp is of one layer, interrupted near the end of marginal ribs (commissure broad); the mesocarp consists mainly of vertically oriented sclerenchyma; the vascular bundles in dorsal ribs are submerged into sclerenchyma, in marginal ribs they are situated in the centre of the rib; the endocarp is of small, slightly lignified cells, the spermoderma is of small cells, the commissural face of the endosperm is flat.

This description corresponds very well to the carpological characteristics of *Heracleum* (incl. *Tetrataenium*) but not of *Angelica*, and we transfer the species to *Heracleum*:

Heracleum oncosepalum (Hand.-Mazz.) Pimenov & Kljuykov, **comb. nova** ≡ *Angelica oncosepala* Hand.-Mazz. in Symb. Sin. 7(3): 726. 1933. – Holotype: China “Yunnan bor.-occid.: in montium inter fluvios Langsang-djiang (Mekong) & Lu-djiang (Salween), c. 28°9', regione alpinis inter lacum et jugum Yigoru, 4200-4300 m, 6.8.1916, *Handel-Mazzetti 9713*” (W!).

Distribution. – China (SW China: Yunnan).

Ref. – Under *Angelica oncosepala*: Yuan & Shan (1985: 9), Wu (1984: 905), Yuan (1992: 41, t. 17, fig. 1-4), Pu (1993: 1345).

Angelica dissoluta* or *Peucedanum dissolutum

Diels (1901) described *Angelica dissoluta* from S Sichuan (Nan-ch'uan). The species was later transferred to *Peucedanum* (Wolff 1925) and adopted under the name *P. dissolutum* (Diels) H. Wolff in the “Flora Reipublicae Popularis Sinicae” (Sheh 1992). The species is regarded as a Sichuan endemic.

We collected the species in the Diancang Shan Mts near Tali in Yunnan, probably at the first time outside Sichuan. In LE is a sheet from Yunnan (*Handel-Mazzetti 747*) determined as *Peucedanum dissolutum* and also as *Selinum tenuifolium*, but its identification seems to be hardly verified. The identity of our collection was established by comparison with a syntype at OSL and with a photo of a specimen from B kept in LE. Later we confirmed during carpological investigations that the fruits of *A. dissoluta* in both collections have an unusual character, noted in the protologue, i.e. the large solitary secretory ducts in the marginal mericarp ribs.

The fruits of *A. dissoluta* (Fig. 8) are glabrous, ellipsoidal to obovoid, strongly compressed dorsally, 5.7-6 × 3.3-4 mm; the stylopodium is low conical, the styles are 0.9-1.1 mm long and reflexed on the dorsal side of the mericarp; the calyx teeth are linear to linear-lanceolate; the dorsal ribs are shortly keeled, the marginal ribs broadly winged, 1.1-1.3 mm wide, slightly thickened; the secretory ducts are 1-2 in vallecules, 4 on the commissural face, solitary and large in marginal ribs, small in dorsal ones; the exocarp is of one layer, of very small cells, interrupted near the bases of the marginal ribs on the ventral face (commissure narrow); the mesocarp in marginal ribs is of large parenchymatous cells with lignified pitted walls, endocarp and spermoderma are of small cells; the commissural face of the endosperm is almost flat.

This carpological structure corresponds well to fruit characters of *Angelica* but not of *Peucedanum*. In particular, a rather narrow commissure is decisive for the placement in *Angelica*:

Angelica dissoluta Diels in Bot. Jahrb. Syst. 29: 499. 1901 ≡ *Peucedanum dissolutum* (Diels) H. Wolff in Feddes Repert. 21: 247. 1925. – Lectotype (designated here): China, “Suchuan, Nan ch'uan: Ken ao p'ing, Abhänge, *A. von Rosthorn 659*” (OSL!). Paralectotype: “Suchuan, Nan ch'uan: Ch'ang ling kian, Erdhügel, *A. von Rosthorn 652*” (OSL).

Distribution. – China (SW: Sichuan, Yunnan).

Ref. – Under *Peucedanum dissolutum*: Sheh (1992: 162, t. 71, fig. 1-4).

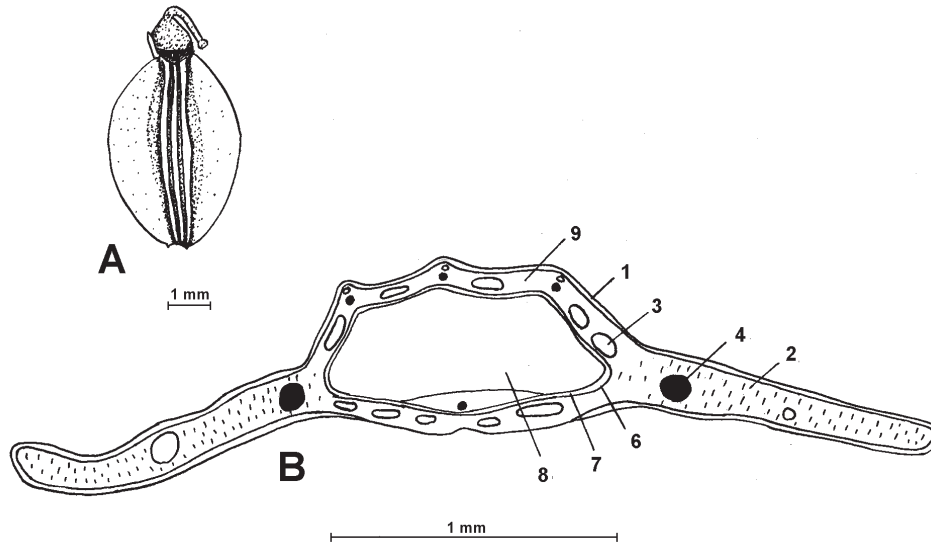


Fig. 8. *Angelica dissoluta* Diels (A. von Rosthorn 659, OSL) – A: dorsal view of mericarp; B: transect of mericarp. – 1-8 see Fig. 2, 9: parenchyma cells of mesocarp.

From *Angelica* to *Notopterygium*

When describing *Angelica tsinlingensis* from the N Chinese province of Shaansi, Fu (1981: 461) correctly noted its fundamental differences from all other species of this genus in some essential characters (“nostra species valde praecipua, a speciebus ceteris generis mericarpii jugis dorsaliibus protuberantibus aliformibus; vittis vallecularibus 2-3, commissuralibus 4 recedit”). We found that in these carpological features *A. tsinlingensis* corresponds well to the genus *Notopterygium* H. Boissieu, and regarding other characters it is well within the range of variation of this small Chinese genus, which contains six species of considerably varying habit. *A. tsinlingensis* is most similar to *N. forbesii* H. Boissieu, widely distributed from SW to N China and even extending to the province of Gansu. In fruit structure the species of *Notopterygium* are similar to each other, and their carpoanatomy is just the same as described by Fu for *A. tsinlingensis*. Comparing the plates 99 (*N. forbesii*) in Chang (1979) and 6 (*A. tsinlingensis*) in Yuan (1992), one has to conclude that these species differ slightly in the shape of the leaflets (attenuate in *A. tsinlingensis* and obtuse in *N. forbesii*). The studies of leaf variation in *N. forbesii* shows, however, that leaves quite similar to those of *A. tsinlingensis* are found outside Shaansi, e.g. in Sichuan. Thus, the last difference is negligible and *A. tsinlingensis* appears to be conspecific with *N. forbesii*, as is also (Yuan 1992) *A. rubrivaginata* H. Wolff:

Notopterygium forbesii H. Boissieu in Bull. Herb. Boiss., ser. 2, 10: 840. 1903. – Holotype: China, “Prov. Hupeh, 5.1889, A. Henry 6629” (P; isotype LE!).

= *Notopterygium franchetii* H. Boissieu in Bull. Herb. Boiss., ser. 2, 10: 839. 1903. – Syntypes: China “Tan-Ken-Cheou, sous-préfecture de Ta-Lin-Hoen, alt. 2500 m, 7.1893, P. R. Farges 1268” (P); *ibid.*, alt. 2200 m, 7.1898, P. R. Farges 1421” (P).

= *Angelica rubrivaginata* H. Wolff in Acta Horti Gothob. 2: 318. 1926. – Holotype: China, “Sze-ch’uan bor.: Ch’un-ch’e, Nadelwald, 3200 m, 1.8.1922, H. Smith 4124” (GB).

= *Angelica tsinlingensis* K. T. Fu in Fl. Tsinling. 1, 3: 420,461, fig. 358. 1981, **syn. nov.** – Holotype: China “Shenxi, Hwa-in Hsien, Hwa-shan, Ta-pai-yang-cha, alt. 1500 m, 22.9.1974, Fu Kun Tsun 17242” (WUK, n.v.).

Distribution. – China (NW: Gansu; Tibet: Qinghai; N: Neimenggu A. R., Shaanxi, Shanxi; Central: Hubei; SW: Sichuan, Yunnan).

Ref. – Under *Notopterygium forbesii*: Chang (1975: 85, fig. 1), Ma (1979: 154, t. 71), Fu (1981: 381), Pu (1993: 1298), Vinogradova (1994: 59). – Under *Angelica rubrivaginata*: Vinogradova (1994: 24). – Under *Angelica tsinlingensis*: Yuan & Shan (1985: 5), Yuan (1992: 18, t. 6, fig. 1-5).

New synonyms in Chinese *Angelica*

In this part we summarize the synonymy of some SW Chinese species, mainly on the basis of type examination in the herbaria G, GB, OSL, P, etc. A number of *Angelica* species were independently described by Franchet, Boissieu, Diels, Wolff and other western botanists before the middle of 1930s, another series of species was described in the middle of 1960s by the Chinese botanists R. H. Shan, C. C. Yuan, Z. H. Pan, K. T. Fu and F. T. Pu. When describing new species, modern authors were sometimes limited to comparison with old descriptions, which mainly are not illustrated. The type material in several significant European herbaria, e.g. in P, has remained unexplored. Some species, described from China, were included at the “Flora Republicae Popularis Sinicae” without pictures, others being commented but not included in the keys, because the contributors could not find corresponding collections inside China, despite intensive herbarisation. Such doubtful species were in the focus of our work in herbaria with rich Chinese collections.

Angelica laxifoliata Diels in Bot. Jahrb. Syst. 29: 499. 1901 – Holotype: China “Suchuan: Tsaku lao, K’ou chan, 28.8.1891, A. von Rosthorn 2571” (OSL!).

= *Angelica fargesii* H. Boissieu in Bull. Herb. Boiss., ser. 2, 10: 850. 1903. – Holotype: China “Su-tchuen oriental, district de Tchen-keou-tin, 1895-97, R. P. Farges” (P!; isotypes: E, PE!), **syn. nov.**

= *Angelica dielsii* H. Boissieu in Bull. Herb. Boiss., ser. 2, 10: 850. 1903. – Holotype: China “Su-tchuen oriental, district de Tchen-keou-tin, R. P. Farges 38” (P!), **syn. nov.**

= *Angelica erythrocarpa* H. Wolff in Acta Horti Gothob. 2: 316. 1926. – Syntypes: China “Sze-ch’uan bor.: Sung-pan, auf Hochstaudenwiesen, 3000-3300 m, 16.7.1922, H. Smith 2798” (UPS!); “Sze-ch’uan bor.: nach Südwesten auf trockenen Wiesen, 3400 m, 30.7.1922, H. Smith 3579” (UPS!).

Distribution. – China (NW: Gansu; N: Shaanxi; SW: Sichuan, Yunnan).

Angelica laxifoliata is rather variable in leaflet shape and serration. It is easily recognizable by rather thin stems and multiradiate umbels with thin rays. *A. fargesii*, *A. dielsii* and *A. erythrocarpa* fully match *A. laxifoliata* also in leaf characters, the last species being described without mature fruits. They all were described from N Sichuan, although the area of *A. laxifoliata* is larger. The closest relative is *A. maowenensis* C. C. Quan & R. H. Shan, which perhaps could also be conspecific with *A. laxifoliata*. A merely teratic form of *A. laxifoliata* seems to be described under the name *A. pinnatiloba* R. H. Shan & F. T. Pu, also from Sichuan. The picture of *A. likiangensis* in Yuan (1992: t. 10) actually refers to *A. laxifoliata*, both species are, however, clearly different.

Ref. – Under *Angelica laxifoliata*: Boissieu (1906: 435), Fu (1981: 422), Yuan & Shan (1985: 12), Yuan (1992: t. 23, fig. 1-4), Pu (1993: 1345). – Under *Angelica fargesii*: Yuan (1992: 62). – Under *Angelica dielsii*: Yuan (1992: 59).

Angelica nitida H. Wolff in Acta Horti Gothob. 2: 317. 1926. – Holotype: China “Sze-ch’uan bor.: Huang-ch’en-kuan, in silva mixta herbosa, c. 3300 m, 19.8.1922, H. Smith 4069” (GB!; isotype: PE!).

= *Angelica wulsiniana* H. Wolff in Feddes Repert. 27: 334. 1930. – Holotype: China “Kansu: Kar Ching K’ou, near Old Taochow, 3100-3400 m, 27.8.1923, R. C. Ching 848” (US!), **syn. nov.**

= *Angelica chinghaiensis* R. H. Shan ex K. T. Fu in Fl. Tsinling. 1, 3: 421, 462. 1981. – Holotype: China “Tsinghai: Mem-yang Hsien, Sien-mi-sze, alt. 2450 m, 6.9.1936, Liou Ki Mou 7006” (WUK, n.v.).

= *Angelica songpanensis* R. H. & F. T. Pu in Acta Phytotax. Sin. 33, 5: 480, fig. 3. 1995. – Holotype: China “Sichuan, Songpan, Huanglong, Xue-bao-ding Mt, alt. 4000 m, in subalpine forests, 14.10.1983, Pu Fa Ting & al. 159” (CDBI!).

Angelica nitida is characterized by, in particular, very short peduncles (internode between upper branch and umbel) and rather thick and short umbel rays. The name *A. kangdingensis* R. H. Shan & F. T. Pu probably refers to the same species.

Distribution. – China (NW: Gansu; Tibet: Qinghai; SW: Sichuan).

Ref. – Under *Angelica nitida*: Yuan (1992: 21, t. 7, fig. 1-5). – Under *Angelica wulsiniana*: Walker (1941: 646), Yuan (1992: 61). – Under *Angelica chinghaiensis*: Yuan & Shan (1985: 5), Pu (1993: 1344).

Angelica duclouxii Fedde ex H. Wolff in Feddes Repert. 28: 111. 1930. – Holotype: China “Yunnan: Lou-pou, près Tong-tchouan, 8.1909, F. Ducloux 6499” (P!).

= *Angelica balangshanensis* R. H. Shan & F. T. Pu in Acta Phytotax. Sin. 33, 5: 467, fig. 1. 1995. – Holotype: China “Sichuan: Xiaojin, Balang Mt, alt. 3500 m, alpine bushwoods, 7.9.1984, Pu Fa Ting & al. 287” (CDBI!; isotype: NAS !), **syn. nov.**

Distribution. – China (SW China: Sichuan, Yunnan).

Ref. – Under *Angelica duclouxii*: Wu (1984: 905), Yuan (1992: 26, t. 10, fig. 1-3).

Angelica wilsonii H. Wolff in Feddes Repert. 27: 335. 1930. – Holotype: China “West Szechuan, E. H. Wilson 201” (GH!).

= *Angelica omeiensis* C. C. Yuan & R. H. Shan in Bull. Nanjing Bot. Gard. Mem. Sun Yat Sen 1983: 6, fig. 2. 1985. – Holotype: China “Sichuan: Xixiangchi, Omei Mons, Omei Xian, alt. 2100 m, 31.7.1977, J. S. Yue & Y. F. Dong 7701” (NAS!), **syn. nov.**

Distribution. – China (SW China: Sichuan).

Angelica wilsonii and *A. omeiensis* both have leaves that are more dissected than in the majority of local *Angelica* species; they appear also very similar in their fruit anatomy.

Ref. – Under *Angelica wilsonii*: Yuan (1992: 61). – Under *Angelica omeiensis*: Yuan (1992: 24, t. 9, fig. 1-5); Pu (1993: 1346).

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References

- Boissieu, H. 1906: Notes sur quelques Ombellifères de la Chine, d’après les collections du Muséum d’Histoire naturelle de Paris. – Bull. Soc. Bot. France **53**: 418-437.
 Chang, H. T. 1975: Revision of *Notopterygium* (*Umbelliferae*). – Acta Phytotax. Sin. **13(3)**: 83-87.

- 1979: *Notopterygium*. – Pp. 188-192 in: Shan, R. H. & Sheh, M. L. (ed.), *Flora Reipublicae Popularis Sinicae* **55(1)**. – Beijing.
- Clarke, C. B. 1879: *Umbelliferae*. – Pp. 665-720 in: Hooker, J. D., *Flora of British India* **2**. – London.
- Diels, L. 1901: Die Flora von Central-China. – *Bot. Jahrb. Syst.* **29**: 161-304.
- Fu, K. T. 1981: *Umbelliferae*. – Pp. 372-432, 456-465 in: Fu, K. T. & Chang, C. W. (ed.), *Flora tsinlingensis* **1(3)**. – Beijing.
- Handel-Mazzetti, H. F. 1933: *Umbelliferae*. – Pp. 706-730 in: Handel-Mazzetti, H. F. (ed.), *Symbolae sinicae* **7**. – Wien.
- Harborne, J. B., Heywood, V. H. & Chen, X. Y. 1986: Separation of *Ostericum* from *Angelica* on the basis of leaf and mericarp flavonoids. – *Biochem. Syst. Ecol.* **14**: 81-83.
- He, X. J., Wang, Y. P., Pu, F. T., Wang, P. L. & Xu, J. M. 1998: Anatomical studies on fruits of the genus *Heracleum* from China and its revision of systematics. – *Acta Bot. Yunnan.* **20**: 295-302.
- Hiroe, M. 1979: *Umbelliferae of the World*. – Tokyo.
- Holmgren, P. K., Holmgren, N. H. & Barnett, L. C. 1990: *Index herbariorum I. The herbaria of the world*, ed. 8. – *Regnum Veg.* **120**.
- Koso-Poljansky, B. 1914: O filogenii rodov *Umbelliferae* Kavkasa [Essay on the phylogeny of the Caucasian *Umbelliferae*]. – *Acta Horti Tiflis.* **16**: 179-229.
- Ma, Y. C. 1979: *Umbelliferae*. – Pp. 142-203 in: Fu, H. C., Tong, Z. G., Yang, X. L., Ma, Y. C., Ma, E. W. & Shan, C. (ed.), *Nei Menggu-zhiwuzhi [Flora Intramongolia]* **4**. – Huhehaote.
- Mukherjee, P. K. 1983: Nomenclatural transfers in Indian *Umbelliferae*. – *Bull. Bot. Surv. India* **24**: 42-45.
- & Constance, L. 1993: *Umbelliferae (Apiaceae)* of India. – New Delhi, etc.
- Norman, C. 1929: *Umbelliferae* from Nepal. – *J. Bot. (London)* **67**: 245-247.
- Pimenov, M. G. 1968: Sistematičeskaja gruppировka vidov roda *Angelica* L. SSSR po coefficientam shodstva [Systematic grouping of the species of the genus *Angelica* L. of the USSR on the basis of similarity coefficients]. – *Bjull. Moskovsk. Obšč. Isp. Prir. Otd. Biol.* **73(1)**: 124-139.
- & Kljuykov, E. V. 2001: Identity of *Archangelica roylei* Lindl. and its consequences for the nomenclature of some West Himalayan *Umbelliferae*. – *Feddes Repert.* **113**: 335-341.
- & Ostroumova, T. A. 2000: Closest relatives of the Chinese genus *Arcuatopteris (Umbelliferae)* in the Indian subcontinent. – *Feddes Repert.* **111**: 553-558.
- Pu, F. T. 1993: *Umbelliferae*. – Pp. 1276-1355 in: Wang, W. T. (ed.), *Heng duan shan qu wei guan zhi wu [Vascular plants of the Hengduan Mountains]* **1**. – Beijing.
- 1998: New names in Chinese *Apiaceae*. – *Novon* **8**: 70-71.
- , He, X. J., Wang, P. L., Wang, Y. P. & Liu, X. T. 1993: New taxa of *Heracleum (Umbelliferae)* from China. – *Acta Phytotax. Sin.* **31**: 368-373.
- Shan, R. H. 1992: *Pachypleurum*. – P. 255 in: Shan, R. H. & Sheh, M. L. (ed.), *Flora Reipublicae Popularis Sinicae* **55(3)**. – Beijing.
- & Yuan, C. C. 1966: *Angelica apaensis*. – *Acta Pharm. Sin.* **13**: 329 [n.v.].
- Sheh, M. L. 1992: *Peucedanum* L. – Pp. 123-175 in: Shan, R. H. & Sheh, M. L. (ed.), *Flora Reipublicae Popularis Sinicae* **55(3)**. – Beijing.
- Shneyer, V. S., Kutjavina, N. G. & Pimenov, M. G. 2003: Systematic relationships within and between *Peucedanum* and *Angelica (Umbelliferae - Peucedaneae)* inferred from immunological studies of seed proteins. – *Pl. Syst. Evol.* **236**: 175-194.
- Suk, K.-T., Nitta, A. & Konoshima, M. 1974: Studies on origin of Japanese *Chuanxiong* II. *Ostericum*. – *Yakugaku Zasshi* **94**: 1246-1250.
- Vasil'eva, M. G. & Pimenov, M. G. 1991: Karyotaxonomical analysis in the genus *Angelica (Umbelliferae)*. – *Pl. Syst. Evol.* **177**: 117-138.
- Vinogradova, V. M. 1994: *Umbelliferae*. – Pp. 9-99 in: Grubov, V. I. (ed.), *Rastenija Central'noj Azii [Plantae Asiae Centralis]* **10**. – St Petersburg.

- Walker, E. H. 1941: Plants collected by R. C. Ching in southern Mongolia and Kansu Province, China. – Contr. US Natl. Herb. **28(4)**.
- Wang, T. S. 1992: *Heracleum* L. – Pp. 181-212 in: Shan, R. H. & Sheh, M. L. (ed.), Flora Reipublicae Popularis Sinicae **55(3)**. – Beijing.
- Watson, M. F. 1999: *Umbelliferae*. – Pp. 434-504 in: Grierson, A. J. C. & Long, D. G. (ed.), Flora of Bhutan **2(2)**. – Edinburgh.
- Wolff, H. 1925: *Umbelliferae* novae asiaticae II. – Feddes Repert. **21**: 244-249.
- Wu, Z. Y. 1984: *Umbelliferae*. – Pp. 904-930 in: Wu, C. T. (ed.), Index floriae Yunnanensis **1**. – Kunming.
- Yuan, C. C. 1986: *Angelica* L. – Pp. 510-513 in: Wu, C.-Y. (ed.), Xizang-zhiwuzhi [Flora xizangica] **3**. – [Beijing].
- 1992: *Angelica* L. – Pp. 13-63 in: Shan, R. H. & Sheh, M. L. (ed.), Flora Reipublicae Popularis Sinicae **55(3)**. – Beijing.
- & Shan, R. H. 1985: On the genera *Angelica* L. and *Ostericum* Hoffm. (*Umbelliferae*) in China. – Bull. Nanjing Bot. Gard. **1984-85**: 1-5.

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