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# *Xyloselinum laoticum* (Umbelliferae), a new species from Laos, and taxonomic placement of the genus in the light of nrDNA ITS sequence analysis

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## Abstact

A new species of *Xyloselinum*, *X. laoticum*, endemic to the Vientiane province of Laos, is described and illustrated. Similar to two previously described species of *Xyloselinum* from limestone ridges of Northern Vietnam, the new species is subshrub with 2–3 pinnatisect leaves having petiolulate basal segments and broadly lanceolate terminal segments, solitary or binary mericarp vallecular vittae, almost flat on the commissural side endosperm. The new species is more closer to *X. vietnamense* than to *X. leonidii*. *Xyloselinum laoticum* differs from *X. vietnamense* in irregularly toothed or laciniate terminal leaf segments without bladders on lower surface, solid (not fistulose) petioles, globose umbels and umbellets, almost glabrous (not densely covered by scattered short prickles) pedicels, always entire bracteoles, and conical (not shortly conical) stylopods. It is supported by the nrDNA ITS data that *Xyloselinum* is treated as an independent genus and placed in Selineae Clade together with some S and E Asian genera separated from *Peucedanum* s.l. or *Ligusticum/Selinum* complex.

**Kew words**: Apiaceae, plant morphology, nrDNA ITS phylogeny, plant diversity

## Introduction

*Xyloselinum* Pimenov & Kljuykov (2006: 125), remarkable in its life-form of subshrub, has been recently described from northern Vietnam with two new species, *X. vietnamense* Pimenov & Kljuykov (2006: 126) and *X. leonidii* Pimenov & Kljuykov (2006: 129). The genus is distantly related to *Ligusticopsis* Leute (1969: 66), *Oreocome* Edgeworth (1845: 252) and some other genera of "Ligusticum-alliance" (Apioideae, tribe Apieae). The life-form of *Xyloselinum* (subshrub up to 2 m tall), being not rare in the Umbelliferae of sub-Saharan Africa and Madagascar (van Wyk *et al*. 2013), is almost unknown for Asian representatives of the family.

Surprising findings were made by Averyanov and his Vietnamese colleagues during floristic exploration of mountainous regions of northern Vietnam near the Chinese border. Extension of their field studies to some regions of Laos resulted in the discovery of *Xyloselinum* in Vientiane province of Lao PDR. Umbelliferae of Laos in general are poorly investigated and only 12 indigenous species in 10 genera are known for the country (Newman *et al*. 2007).

The plants collected in two Lao localities by Averyanov in 2013, though being closer to *X. vietnamense* than to *X. leonidii*, differ from the former in some constant morphological characters. We describe them here basing on these findings, as a new (third) species of *Xyloselinum, X. laoticum* Pimenov & Aver.

Features of fruit are the most significant in taxonomy of Umbelliferae, we provide detailed description of fruit morphology and anatomy according to standard umbellifer terminology (Kljuykov *et al.* 2004). To evaluate relationships among the species of *Xyloselinum* and its putative allies, sequence data from the nrDNA ITS region were examined. This marker has been shown as suitable for phylogenetic analyses of Umbelliferae at low taxonomic levels (Downie *et al.* 2010).

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## Materials and Methods

The new species was collected during field work in Vientiane province of Lao PDR by Averyanov and his colleagues. Living plants are cultivated in Botanical Garden of Komarov Botanical Institute, Russian Academy of Sciences.

Mericarp morpology were photographed under stereomicroscope Olympus CZ61. For anatomical investigation, fruits were softened in hot water or in glycerol-alcohol-water; free-hand sections were processed with phloroglucinol-hydrochloric acid, and kept in glycerol. Microphotographs made with Olympus BX41 microscope and camera OlympusDP25; the device RA-4 was used for drawings.

For molecular phylogenetic analysis, the nrDNA ITS sequences of *Xyloselinum leonidii* and of the new species were generated. Unfortunately, we could not investigate DNA of the type species *X. vietnamense*, because the herbarium material appeared to be infected by fungi. Herbarium specimens of *X. leonidii* were also infected, but we managed to extract its DNA from the plants cultivated in the greenhouse at the Komarov Botanical Institute.

Total DNA was extracted from leaf tissue with the NucleoSpin plant isolation kit (Macherey-Nagel, Düren, Germany) following the manufacturer's instructions. The strategies for amplification and sequencing of the ITS region (including primer location and characteristics) are provided in Valiejo-Roman *et al*. (2002). Amplification products were purified using the DNA Cleanup Mini kit (Evrogen, Moscow, Russia). Direct sequencing was performed using an ABI PRISM 3100 Genetic Analyzer (Applied Biosystems, Foster City, CA, USA) and a BigDye Terminator Cycle Sequencing Ready Reaction kit. Both forward and reverse DNA strands of all samples were sequenced. Both newly obtained sequences were deposited in GenBank.

An initial set of taxa for comparison with *Xyloselinum* was determined by using the BLAST option of the GenBank database. This search suggested that following Umbelliferae species were most similar: *Peucedanum dissolutum* (Diels 1901: 499) Wolff (1925: 499)—99%, *Peucedanum japonicum* Thunberg (1783: 38)—98%. These taxa belong to Selineae Clade in currently adopted molecular phylogeny of Umbelliferae (Downie *et al*. 2010). After preliminary analyses, the dataset was designed to cover representatives from Selineae clade and some genera regarded as related to *Xyloselinum* based on morphology.

The trees were rooted with *Physospermum cornubiense* (Linnaeus 1756: 13) Candolle (1830: 246). In total, 84 ITS accessions obtained from GenBank and two studied at the first time, representing 49 genera and 85 species (Table 1). Only the ITS1 and ITS2 regions were included in the analysis, because sequence data for the ITS 5.8S region were unavailable for many previously published taxa. The ITS data matrix was analyzed using both maximum parsimony (MP) and the Bayesian inference (BI).

**TABLE 1.** Species names, according to current use, and GenBank accession numbers of DNA ITS sequences used in this study.

| Species | GenBank accession number, ITS |
|---|---|
| *Acronema paniculatum* H.Wolff | FJ385031 |
| *Angelica acutiloba* (Siebold & Zucc.) Kitag. var. *iwatensis* (Kitag.) Hikino | AB697607 |
| *Angelica decursiva* Franch. & Sav. | JX022912 |
| *Angelica purpurascens* (Avé-Lall.) Gilli | AF008611 |
| *Angelica sylvestris* L. | HQ256681 |
| *Angelica tatianae* Bordz. | AF008610, AF009089 |
| *Cenolophium denudatum* (Hornem.) Tutin | AF077879 |
| *Cervaria rivinii* Gaertn.<br>[=*Peucedanum cervaria* Cusson ex Lapeyr.] | AF009087, AF008608 |
| *Conioselinum acuminatum* (Franch.) Lavrova<br>[= *Ligusticum acuminatum* Franch.] | KF725063 |
| *Conioselinum chinense* Britton, Sterns & Poggenb. | (1) GU395145<br>(2) U78374 |
| *Conioselinum pteridophyllum* (Franch.) Lavrova<br>[= *Ligusticum pteridophyllum* Franch..] | KF806581 |

*...Continued on next page*

**TABLE 1.** (Continued)

| Species | GenBank accession number, ITS |
|---|---|
| *Conioselinum scopulorum* J.M.Coult. & Rose | AF008634, AF009113 |
| *Conioselinum tataricum* Hoffm. | AF008623, AF009102 |
| *Conioselinum vaginatum* (Spreng.) Thell. | FJ385041 |
| *Cortia depressa* (D.Don) Leute | AY328943, AY330509 |
| *Dethawia splendens* (Lapeyr.) Kerguélen | KC676167 |
| *Dichoropetalum achaicum* (Halácsy) Pimenov & Kljuykov [= *Peucedanum achaicum* Halácsy] | AF164832, AF164857 |
| *Dichoropetalum carvifolia* (Vill.) Pimenov & Kljuykov [= *Holandrea carvifolia* (Vill.) Reduron, Charpin & Pimenov] | AF495828, AF495829 |
| *Dichoropetalum caucasicum* (M.Bieb.) Soldano, Galasso & Banfi [= *Peucedanum caucasicum* (M.Bieb.) K.Koch] | AF008618, AF009097 |
| *Dichoropetalum golestanicum* (Rech.f.) Pimenov & Kljuykov [= *Johrenia golestanica* Rech.f.] | EU169289 |
| *Endressia castellana* Coincy | AH003545 |
| *Ferulopsis hystrix* (Bunge ex Ledeb.) Pimenov | EU169271 |
| *Halosciastrum melanotilingia* (H.Boissieu) Pimenov & V.N.Tikhom. | AY328937, AY330503 |
| *Haloselinum falcaria* (Turcz.) Pimenov [= *Peucedanum falcaria* Turcz.] | FJ489365, FJ489366 |
| *Harrysmithia heterophylla* H.Wolff | GQ379321 |
| *Imperatoria ostruthium* L. | AF077896 |
| *Kitagawia terebinthacea* (Fisch. ex Trevir.) Pimenov [= *Peucedanum terebinthaceum* (Fisch. ex Trevir.) Ledeb. | JF977820 |
| *Kuramosciadium corydalifolium* Pimenov, Kljuykov & Tojibaev | GU306178 |
| *Levisticum officinale* W.D.J.Koch | KC812809 |
| *Ligusticopsis brachyloba* (Franch.) Leute | AY328944, AY330510 |
| *Ligusticopsis coniifolia* (DC.) Pimenov & Kljuykov | AY328928, AY330494 |
| *Ligusticopsis daucoides* (Franch.) Lavrova ex Pimenov & Kljuykov [= *Ligusticum daucoides* Franch.] | EU236173 |
| *Ligusticopsis dielsiana* (H.Wolff) Pimenov & Kljuykov | AY328945, AY330511 |
| *Ligusticopsis wallichiana* (DC.) Pimenov & Kljuykov | AY328929, AY330495 |
| *Ligusticum canadense* (L.) Britton | AF008635, AF009114 |
| *Ligusticum porteri* J.M.Coult. & Rose | U78375 |
| *Ligusticum scothicum* L. | AH006062 |
| *Lithosciadium multicaule* Turcz. | AF164831, AF164856 |
| *Meeboldia achilleifolia* (DC.) P.K.Mukh. & Constance | AY038206, AY038220 |
| *Mutellina purpurea* (Poir.) Thell. | AY328934, AY330500 |
| *Oreocome arguta* (Lindl.) Pimenov & Kljuykov [= *Selinum vaginatum* C.B.Clarke] | AY328931, AY330497 |
| *Oreocome candollei* Edgew. | AY328924, AY330490 |

*...Continued on next page*

**TABLE 1.** (Continued)

| Species | GenBank accession number, ITS |
|---|---|
| *Oreocome involucellata* Pimenov & Kljuykov | AY328926, AY330492 |
| *Oreocome limprichtii* (H.Wolff) Pimenov & Kljuykov | AY328925, AY330491 |
| *Oreocomopsis stelliphora* (Cauwet & Farille) Pimenov & Kljuykov | GQ379322 |
| *Oreoselinum nigrum* Delarbre [= *Peucedanum oreoselinum* (L.) Moench] | AF495836, AF495837 |
| *Ormosolenia alpina* (Sieber ex Schultes) Pimenov | HQ269391 |
| *Ostericum sieboldii* (Miq.) Nakai | AY548219 |
| *Pachypleurum mutellinoides* (Crantz) Holub | AY328940, AY330506 |
| *Pachypleurum xizangense* H.T.Chang & R.H.Shan | KJ660841 |
| *Paulita ovczinnikovii* (Korovin) Soják | AY328936, AY330502 |
| *Peucedanum coriaceum* Rchb. | AF495824, AF495825 |
| *Peucedanum dissolutum* (Diels) H. Wolff | EU418388 |
| *Peucedanum gallicum* Latour. | AM408882 |
| *Peucedanum japonicum* Thunb. | AF495826 |
| *Peucedanum ledebourielloides* K.T.Fu | JF977809 |
| *Peucedanum morisonii* Besser ex Schult. | AF077903 |
| *Peucedanum officinale* L. | AF495820, AF495821 |
| *Peucedanum praeruptorum* Dunn | DQ132871 |
| *Peucedanum rubricaule* R.H.Shan & M.L.Sheh | KF806574 |
| *Peucedanum tauricum* M.Bieb. | AM408884 |
| *Peucedanum zedelmeyeranum* Manden. | AF164834, AF164859 |
| *Physospermum cornubiense* DC. | AF077904 |
| *Pternopetalum davidii* Franch. | EU236205 |
| *Pterocyclus rivulorum* (Diels) H.Wolff | AY038205, AY038219 |
| *Pteroselinum austriacum* (Jacq.) Rchb. [= *Peucedanum austriacum* (Jacq.) W.D.J.Koch] | AF495842, AF495843 |
| *Pterygopleurum neurophyllum* (Maxim.) Kitag. | AY509127 |
| *Rivasmartinezia vazquezii* Fern. Prieto & Cires | KC676176 |
| *Rupiphila tachiroei* (Franch. & Sav.) Pimenov & Lavrova | AY328952, AY330518 |
| *Saposhnikovia divaricata* (Turcz.) Schischk. | AF495838, AF495839 |
| *Selinum broteroi* Hoffmanns. & Link | AY179029 |
| *Selinum carvifolia* (L.) L. | AY328930, AY179028 |
| *Seseli hippomarathrum* Jacq. | AY179033 |
| *Seseli krylovii* (V.N. Tikhom.) Pimenov & Sdobnina | AF077908 |
| *Seseli tortuosum* L. | AY179031 |
| *Silaum silaus* Schinz & Thell. | EF560689 |
| *Sinodielsia thibetica* (H. Boissieu) Kljuykov & P.K.Mukh. | FJ469969, FJ483507 |
| *Sphaenolobium coriaceum* (Korovin) Pimenov | GU306177 |

*...Continued on next page*

**TABLE 1.** (Continued)

| Species | GenBank accession number, ITS |
|---|---|
| *Sphaenolobium tianschanicum* (Korov.) Pimenov | AF008622, AF009101 |
| *Spuriopimpinella calycina* (Maxim.) Kitag. | GQ379330 |
| *Thysselinum palustre* (L.) Hoffm. | AY179035 |
| *Tilingia ajanensis* Regel & Tiling | AY328939, AY330505 |
| *Xanthoselinum alsaticum* (L.) Schur | AF495834, AF495835 |
| *Xyloselinum laoticum* Pimenov & Aver. (voucher: Laos. *L. Averyanov et al. LA-VN 778,* LE) | KR996797 |
| *Xyloselinum leonidii* Pimenov & Kljuykov (voucher: Vietnam, L.Averyanov *et al*. *CPC 1903*, LE) | KR996798 |

The parsimony analysis involved a heuristic search conducted with PAUP* (version 4.0b8; Swofford 2003) using TBR branch swapping and equal weighting of characters, and treating gaps as missing data. Five-hundred replicates with random taxon addition were performed and all shortest trees were saved. Bootstrap analysis (Felsenstein 1985) was performed to assess the degree of support for particular branches on the tree, and bootstrap values were calculated using 500 replicates with TBR branch swapping and random addition of taxa. One thousand of most parsimonious trees from each replicate were saved.

Bayesian inference was explored using MrBayes version 3.2.4 (Ronquist *et al*. 2012). The GTR+G model of sequence evolution was selected using the Akaike information criterion from an analysis using the program Modeltest version 3.7 (Posada & Crandall 1998). A total of 25,000,000 generations were performed and trees from the first 500,000 generations were discarded. The number of generations to be discarded was determined using cold chain log-likelihood observation using Tracer version 1.5 (Rambaut & Drummond 2007).

## Results and Discussion

### A new species of *Xyloselinum*

***Xyloselinum laoticum*** Pimenov & Aver., sp. nov. (Fig. 1–7).

Species nova e *Xyloselino vietnamensi* Pimenov & Kljuykov, qui proxima est, lobis terminalibus foliorum magis profunde incisis, subtus sine vesiculis, petiolis solidis (non fistulosis), petiolibus longioribus, umbellis umbellulisque ambitu sphaericis, radiis umbellarum subglabris (non pilis brevibus dense tectis), bracteolis lineatibus, edentatis, radiolis valde brevibus, fructibus 4.5–5.5 mm (non 7–7.5 mm) longis, stylopodiis conicis (non breveconicis) bene differt.

Type:—LAOS. Vientiane province: VangVieng district, Nam Pe village, about 12 km to the W of Vang Vieng town, around point 18°58’41.0”N, 102°18’54.1”E. Dry broad-leaved primary and secondary evergreen and semideciduous forest on very steep rocky slopes and on vertical cliffs of remnant highly eroded rocky limestone mountains composed of solid crystalline limestone at elevation 500–1000 m. Lithophytic undershrub to 1.5 m tall on rocky steep slope near mountain top. Very rare. 14 March 2013. *N.T.Hiep, L.Averyanov, K.Chantthavongsa, N.S.Khang, P.V.The & S.Lopphengsy LA-VN 557* (holotype: LE, Fig. 2; isotypes: CPC Herbarium, HNL, FOF).

Subshrub, deciduous, 0.5–1.5 m tall. Stems solitary, woody in lower part, 3–4 cm in diam., round in cross-section, finely ribbed. Leaves 2- or 3-pinnatisect, glabrous; sheaths narrow triangular, amplexicaul, ribbed; petioles solid, 3–8 cm long; leaf blades broadly triangular in outline, 20–26 × 15–18 cm; primary and secondary segments petiolulate, petiolules of basal segments up to 5 cm long; terminal segments ovate to broadly lanceolate, 4–7 × 1.5–3.5 cm, truncate to slightly attenuate at apex, irregularly toothed along the margin or sometimes laciniate, with prominent central veins and without bladders on lower surface. Synflorescence branched, loosely divaricate; umbels with peduncles 3–6 cm long, globose, 5.5–9 cm in diam.; rays 12–15, subequal, rigid, thin ribbed, almost glabrous; bracts absent. Umbelets globose, 1.4–2 cm in diam. (without fruits), with several short (considerably shorter than umbellet rays), linear, entire bracteoles; pedicels 10–18 subequal, rigid divaricate, covered with short prickles. Calyx teeth short, triangular, persistent

in fruits. Petals unknown. Fruits (Figs. 5–7) with carpophore bipartite at the base. Mericarps dorsally compressed, 4.5–5.5 x ca. 4 mm, ovate in outline, slightly convex at dorsal side; dorsal ribs low keeled, marginal ribs narrowly winged; stylopods conical; styles short, slightly flattened, reflexed. Exocarp of small cells, interrupts near the end of marginal ribs (commissure broad). Mesocarp partly parenchymatous, partly sclerenchymatous (whole commissural side and between secretory ducts on dorsal side). Parenchyma of marginal ribs consisting of cells with pitted slightly lignified walls. Vittae rather large, solitary between dorsal ribs, 2 or 3 between dorsal and marginal ribs, 6 on commissural side. Rib secretory ducts inconspicuous. Endocarp and seed coat in mature fruits destroyed. Endosperm on commissural side flat, on dorsal side sulcate under vittae.


**FIGURE 1.** *Xyloselinum laoticum* in natural habitats (paratype—*LA-VN 778*). A. Habitat. B, C. Mature plants, view from above. D, E. Mature plants, side view. F. Young leaves. G. Leaves at apical rosette [All photos of N.S. Khang, image correction and design by L. Averyanov].

**Phenology**:—The type specimen with mature fruits was collected in March. The paratype specimen with young green leaves and no fruits was collected approximately at the same time in similar habitat but at a much higher elevation.


**FIGURE 2.** Photograph of holotype specimen of *Xyloselinum laoticum (LA-VN 557)*.


**FIGURE 3.** Photograph of paratype specimen of *Xyloselinum laoticum (LA-VN 778).*


**FIGURE 4.** Photograph of paratype specimen of *Xyloselinum laoticum (LA-VN 778).*

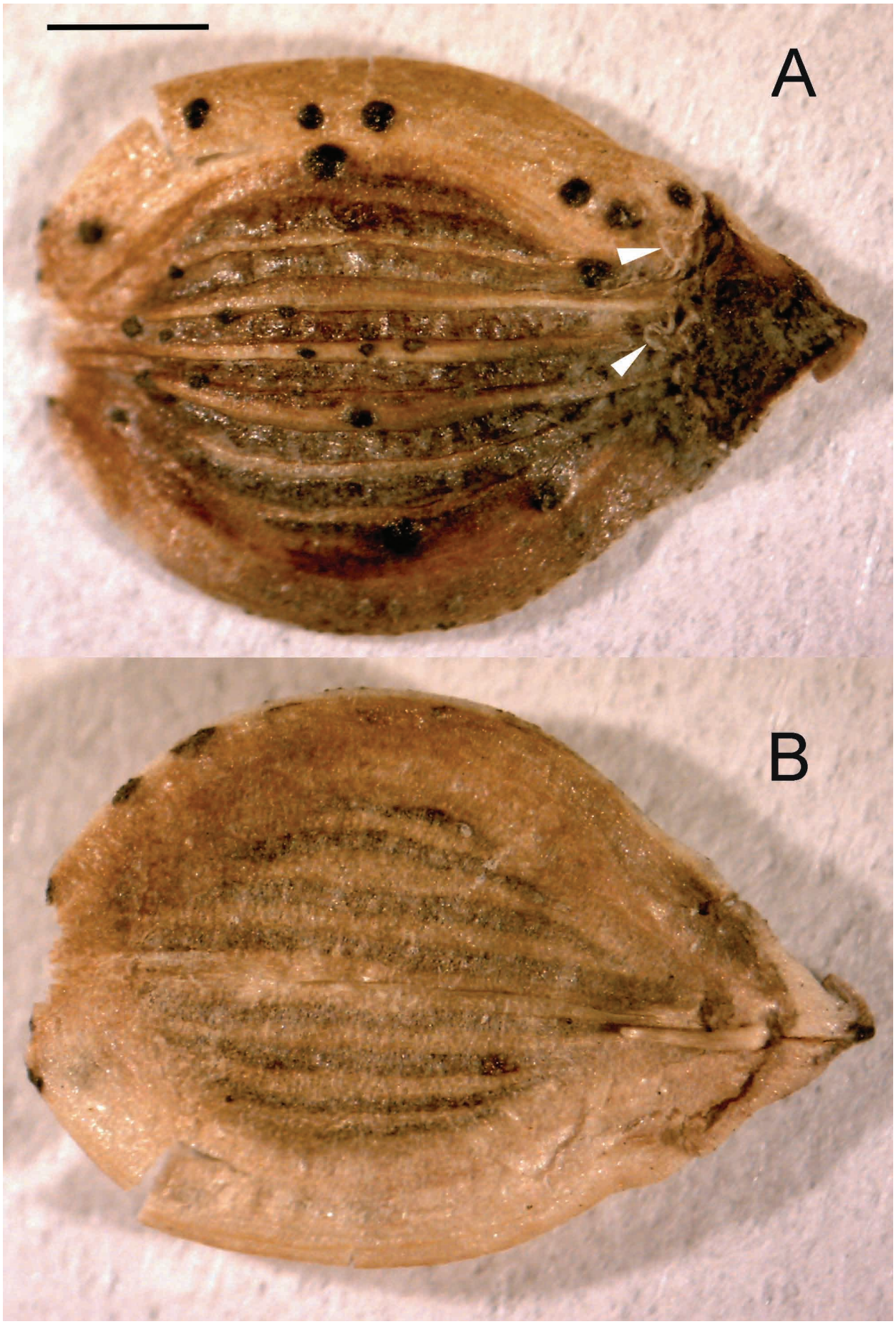


**FIGURE 5.** Mericarps of *Xyloselinum laoticum*. A. dorsal view with calyx teeth (arrowheads), B. commissural view. Scale bar = 1 mm.

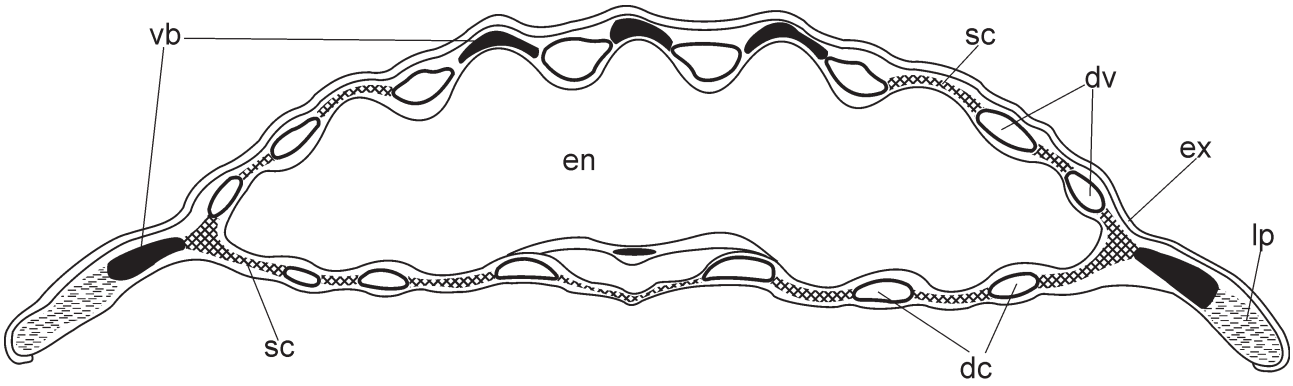


**FIGURE 6.** Mericarp transection in *Xyloselinum laoticum*, schematic. Abbreviations: dc—commissural secretory ducts, dv—vallecular secretory ducts, en—endosperm, ex—exocarp, lp—lignified parenchyma with pitted walls, sc—sclerenchyma, vb—vascular bundle. Scale bar = 1 mm.

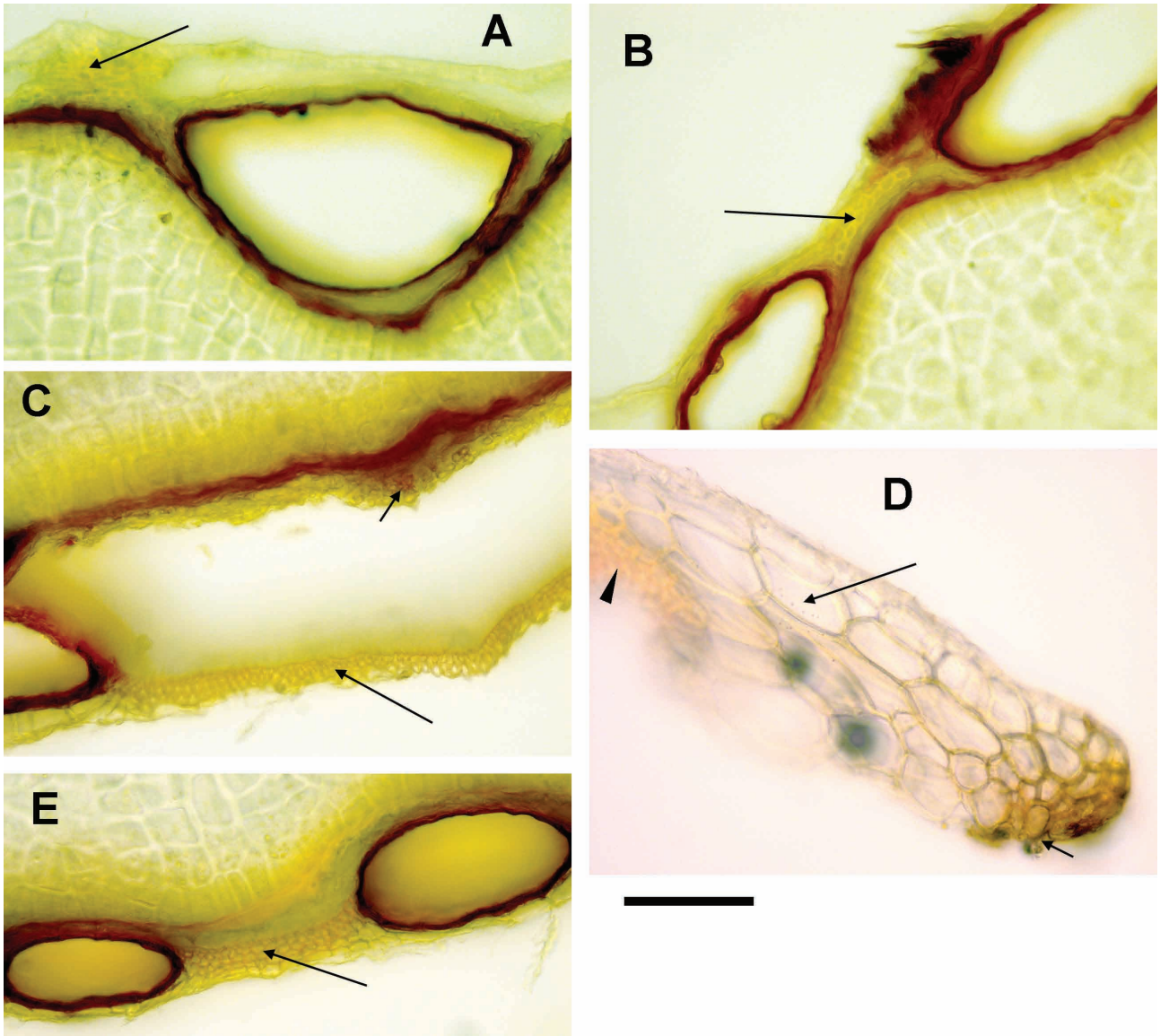


**FIGURE 7.** Fruit anatomical details in *Xyloselinum laoticum*. A. median rib with vascular bundle (arrow) and vallecular secretory duct; B. lateral vallecula with secretory ducts and sclerenchyma layer (arrow) between them; C. the middle part of commissura with funicular bundle (short arrow) and sclerenchymatic pericarp (long arrow); D. distal part of marginal rib with vascular bundle (arowhead), pitted lignified parenchyma (long arrow), exocarp border (short arrow); E. commissural secretory ducts and sclerenchyma layer (arrow) between them. Scale bar = 0.1 mm.

**Diagnostic characters:—**Similar to two previously described species, *X. laoticum* is subshrubby plant with 2–3-pinnatisect leaves having petiolulate basal segments and broadly lanceolate terminal segments, mericarp vallecular vittae solitary or binary, endosperm almost flat on the commissural side. It is more closely related to *X. vietnamense* than *X. leonidii*. *Xyloselinum laoticum* differs from *X. vietnamense* in irregularly toothed or sometimes laciniate terminal leaf segments without bladders on lower surface, solid (not fistulose) petioles,globose umbels and umbellets, almost glabrous (not densely covered by scattered short prickles umbel rays, entire bracteoles, and conical (not shortly conical) stylopods. *X. laoticum* differs from *X. leonidii* in terminal leaf segments lanceolate, 4–7 cm long, irregularly toothed or laciniate (not deeply lobed, 1.5–2.5 cm long), globose umbels and umbellets, umbel rays 12–15 (not 20–25), entire bracteoles, carpophore bipartite at the base (not reduced), pedicels 10–18, covered with short prickles (not 20–22, glabrous), mericarps 4.5–5.5 x 4 mm, with narrow winged marginal ribs (not 6.5–6.7 x 2.8–3 mm, with broadly winged marginal ribs).

**Distribution and habitat**:—The species is known only from Vientiane province of Lao PDR, where it grows in rather dry primary and secondary broad-leaved evergreen and semi-deciduous forests on very steep rocky slopes and on vertical cliffs at the tops of highly eroded rocky mountains composed of solid crystalline limestone at an elevations of 500–1750 m (Fig. 1).

**Etymology**:—The specific epithet refers to the geographical origin of the species.

**Additional specimen examined (paratypes)**:—LAOS. Vientiane Province: Kasi District, Namken village, Phachao Mt., around point 19°18’45.5”N, 102°22’31.4”E, primary broad-leaf evergreen forest on very steep rocky slopes of remnant mountain composed of highly eroded solid crystalline limestone at elevations 1500–1750 m. Lithophytic undershrub 0.5–0.8 m tall with woody stem 3–4 cm in diam on exposed rocks on mountain top. Very common. 24 March 2013, *L. Averyanov, N.S. Khang & S. Lorphengsy LA-VN 778* (CPC Herbarium, LE, NHL, FOF).

**Molecular data:**—Maximum parsimony analyses recovered 61,960 shortest trees with 1,075 steps (CI = 0.4753, RI = 0.7856). The Bayesian tree is consistent with the most parsimonious trees, but it seemed resolve the relationships between different clades better than the parsimony analysis, where many of the groups demonstrated large polytomy. Thus, only the Bayesian 50% majority rule tree with posterior probabilities values (PP) and parsimony bootstrap percentage (BS) is shown in Fig. 8. In both, maximum parsimony and Bayesian trees our new species belongs to a clade with the other species of *Xyloselinum*, *X. leonidii*, and this grouping is strongly supported (PP 1; BS 99%). The third *Xyloselinum* species, *X. vietnamense*, was not included in analysis. A Bayesian tree indicates differences in the ITS sequence among two *Xyloselinum* species.

## Taxonomic position of *Xyloselinum* in the light of nrDNA ITS sequence analysis

The independent generic status of *Xyloselinum* (subshrubby life-form among all East Asian Umbelliferae taxa) has been also confirmed by molecular data as both species analyzed group together. According to the ITS data, *Xyloselinum* is a part of a broader clade, containing several taxa, mainly of Asiatic origin. Among the nearest ones (with the most similar sequences) there is *Peucedanum dissolutum*, little known herbaceous plant distributed in SW China.

Neighbouring to *Xyloselinum* small clades are composed by representatives of *Kitagawia* Pimenov (1986: 943), an East Asian genus, and *Peucedanum japonicum*, with an addition of unrelated species of *Seseli* Linnaeus (1753: 259) and monotypic *Saposhnikovia* Schischkin (1951: 359). *Kitagawia* was separated from *Peucedanum* s.l. (Pimenov 1986). *Peucedanum japonicum* is also not closely related to *Peucedanum* s.str., being more similar morphologically to *Kitagawia.* A paradoxic affinity *Seseli* and *Saposhnikovia* to this clade could have been be due to accidental incomplete selection of species for inclusion in molecular phylogenetic analysis. To elucidate more precise and reliable affinity for *Xyloselinum*, it is necessary to enlarge the set of presumably related genera and species, mainly of East Asian origin. Among such desirable species particular attention is to paid to *Peucedanum guangxiense* Shan & M.L. Sheh in Shan *et al.* (1986: 308), which has a life-form of subshrub, as *Xyloselinum* species have.

Based on morphology the E and SE extratropical Asia genera *Ligusticopsis* and *Oreocome* were presumably regarded as closely related to *Xyloselinum* (Pimenov & Kljuykov 2006) through the similarities in leaf dissection, synflorescence characters and partly in fruit secretory system structure. These genera are segregates of widely treated *Ligusticum* Linnaeus (1753: 250) and *Selinum* Linnaeus (1762: 350), respectively. Both genera differ from *Xyloselinum* in herbaceous life-form and absence of bladders on the lower surface of terminate leaf lobes. *Ligusticopsis* differs also in dense umbells rays in fruits, three or more vittae in each mericarp vallecula, narrowly winged marginal ribs of mericarps. *Oreocome* differs also in well developed calyx teeth, broadly winged marginal mericarp ribs and narrow

commissure. On the ITS tree, the studied species of *Ligusticopsis* and *Oreocome* form separate clade and the placement of this clade partly confirms the preliminary considerations on *Xyloselinum* affinity as both clades represent two of three clades in polytomy.

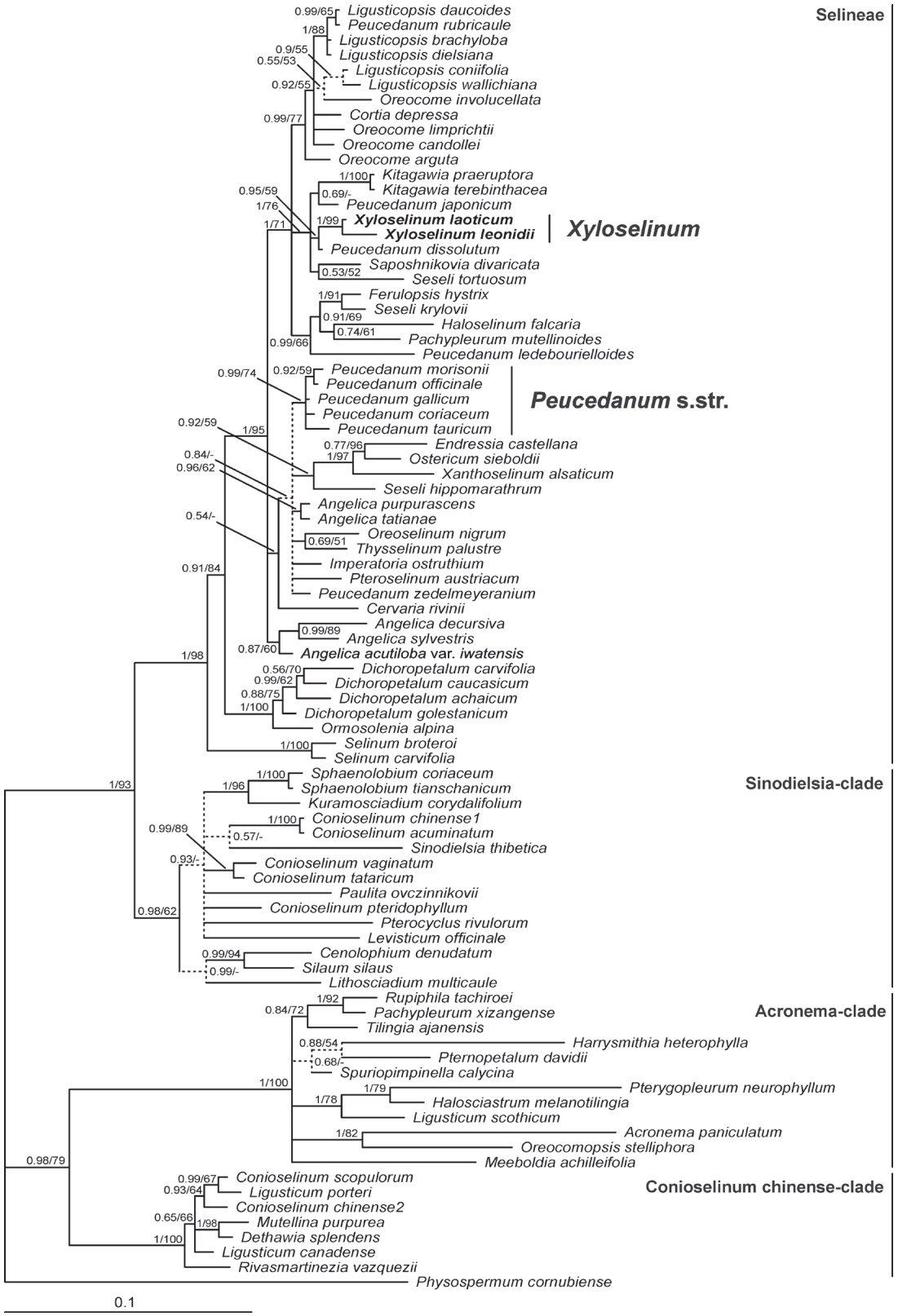


**FIGURE 8.** The Bayesian tree obtained from analysis of 86 nrITS sequences. Branch lengths are proportional to the number of character changes. Maximum parsimony bootstrap support and Bayesian posterior probabilities are indicated above nodes. Branches that collapse in the strict consensus tree are shown as dashed lines. The names of main clades recognized in currently adopted molecular phylogeny of Umbelliferae (Downie *et al.* 2010) as well as *Peucedanum* s.str. group are indicated. *Xyloselinum* species are shown in bold.

*Peucedanum* in a narrow sense (*P. officinale* Linnaeus (1753: 245) and allies), as well as *Selinum* species are in other clades, evidently distant. As compared with some earlier separated segregates, *Xanthoselinum* Schur (1866:264), *Pteroselinum* (Reichenbach. 1827: 450) Reichenbach (1832: 453), *Oreoselinum* Miller (1754: unpaged), *Thysselinum* Adanson (1763: 100), *Cervaria* Wolf (1776: 28) and *Imperatoria* Linnaeus (1753: 259), the genus *Xyloselinum* seems to be well isolated taxonomically from *Peucedanum* s.str.

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