



Sillaphyton, a new genus of the Umbelliferae, endemic to the Korean Peninsula

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ABSTRACT

Sillaphyton, a monotypic Korean genus, is described here for the first time. The new genus, based on the rare species *Peucedanum podagraria* H. Boissieu (= *P. insolens* Kitag.), is clearly distinct from *Peucedanum* s. str. (*P. officinale* L. and its closest relatives) as well as from *Peucedanum* s. l. segregate genera in fruit and leaf characters, as well as in nrDNA ITS sequence data. The carpological differences relate to the pericarp structure and secretory system. On the other hand, according to molecular data *Sillaphyton* appeared to be closer to *Arcuatopterus* Sheh Menglan & Shan Renhwa than to *Peucedanum* and any its segregates. *Arcuatopterus*, described as the Chinese endemics, belonging to Peucedaneae, now numbers six species of Sino-Himalayan distribution. The latter differs from *Sillaphyton* in a set of morphological and carpoanatomical characters.

Keywords: Apiaceae, Eastern Asia, fruit anatomy, nrDNA ITS, Korea, morphology, taxonomy, *Peucedanum*, *Arcuatopterus*

РЕЗЮМЕ

Пименов М.Г., Остроумова Т.А., Дегтярева Г.В., Самигуллин Т.Х. *Sillaphyton* – новый род зонтичных, эндем Корейского полуострова. Описан новый монотипный корейский род *Sillaphyton*, основанный на редком виде *Peucedanum podagraria* H. Boissieu (= *P. insolens* Kitag.). Новый род хорошо отличается от *Peucedanum* s.str. (*P. officinale* L. и ближайшие к нему виды) и от сегрегатных родов, выделенных из *Peucedanum* s.l., по строению плодов (структура перикарпа и особенности секреторной системы) и листьев, а также по последовательностям ITS ядерной рибосомной ДНК. С другой стороны, по молекулярным данным *Sillaphyton* ближе к *Arcuatopterus* Sheh Menglan & Shan Renhwa, чем к *Peucedanum* и любым его сегрегатам. *Arcuatopterus*, описанный как китайский эндемичный род, принадлежащий к Peucedaneae, ныне насчитывает 6 видов, распространенных в Сино-Гималайской флористической области. *Arcuatopterus* отличается от *Sillaphyton* рядом морфологических и карпоанатомических признаков.

Ключевые слова: Апиасеае, Восточная Азия, анатомия плодов, nrDNA ITS, Корея, морфология, таксономия, *Peucedanum*, *Arcuatopterus*

To date, five vascular plant genera from different families are known to be Korean endemics (Park 2004): *Mankyua* B.-Y. Sun, M.H. Kim & C.H. Kim (Ophioglossaceae), *Megaleranthus* Ohwi (Ranunculaceae), *Echinosophora* Nakai (Fabaceae), *Abeliophyllum* Nakai (Oleaceae), and *Hanabusaya* Nakai (Campanulaceae). The monotypic Umbelliferous genus, described here, is the sixth. It belongs to one of the most complicated and disputed groups within the subfamily Apioideae, namely the *Peucedanum* s.l. alliance. Its only species was twice independently described under the genus *Peucedanum* – as *P. podagraria* H. Boissieu (1903) and *P. insolens* Kitag. (Kitagawa 1972). However, neither name is included in modern Korean “floras” (Lee 1989, Lee W.-T. 1996, Lee Y.N. 1996, Im 1998, Lee & Yoon 2007); *P. podagraria* was cited only in Nakai’s flora (Nakai 1919). Its absence (under any name) in recent critical accounts of Korean vascular plant genera suggest that the species is rare and probably is not represented in Korean herbaria. There

are two gatherings that represent this taxon, both in foreign herbaria. The exact localities of both collections would have been impossible to determine without the help of our Korean colleagues, particularly Ms. Kyeonghe Kim from Seoul National University.

Peucedanum podagraria was described on the basis of a specimen from the large East-Asian herbarium of Abbé U. Faurie, collected during September 1901. The exact locus classicus was not indicated on the herbarium label (“Mont. de l’interieur de la Corée, à 1000 m”). As the label information was inadequate, we referred to a special publication on the Korean collections by Faurie (Chang et al. 2004). However, Faurie’s itinerary report is in Korean, so we were reliant on Ms. Kim’s kind help. She concluded that the plant could have been collected only in Gangwon-do province. Some characters were marked in the protologue as being especially important (“Fructus valde compressi, ovato-elliptici, alati, nigrescens, ...calicis dentibus coronati[s]. Vittae in

valleculis plures”). The author noted a similarity between the plant’s habit and that of *Aegopodium podagraria* L. (hence the specific epithet), and the fruits to those of *Ferula*. In general, the new species was compared with the Japanese *Peucedanum multivittatum* Maxim. (hence, probably, its generic attribution).

Peucedanum insolens was described by Kitagawa (1972) on the basis of a comparatively recent collection (“Korea: Prov. Kô-gen: in monte Toku-gyû-zan, H.J. Chi. 07. Jun. 1969”). Kô-gen, according to Ms. Kim, refers to a district of Hamkyung-namdo Province, North Korea. “This curious plant” (as is emphasized in its specific epithet: *insolens* = unusual) was compared in the protologue, most likely because of its large terminal leaf lobes, with *Peucedanum cervaria* (L.) Lapeyr., and attributed to *Peucedanum* section *Oreoselinum* (Adans.) Rechb. Such an affinity between the two species seems to be “curious”, due to an enormous geographical disjunction between their areas, as *P. cervaria* is a mainly Central European species, extending to N. Spain, C. Italy, Albania, Ukraine and Lithuania (Tutin 1968). When describing his new species, Kitagawa seems to have been uncertain about its generic position, as we found in the Tokyo University herbarium (TI) his hand-written note, on which the plant was referred to as “*Diplopleurum insolens*”. The name “*Diplopleurum*” occurs only on herbarium labels in TI and has not been found in Kitagawa’s publications, and the most probably was not accepted by him. The origin of the name, nevertheless, is clear from Kitagawa’s detailed description, in which he paid attention to the most distinctive carpological character, namely “all the dorsal ridges of mericarp split up perfectly into 2 pieces in the unripe stage but [are] connate with each other in the age of maturity”.

A few additional notes on the species can be found (under the name of *Peucedanum insolens*) in publications connected with its usage as a Korean medicinal diaphoretic and antipyretic plant. Two coumarins (isoimperatorin and oxypeucedanin methanolate) were extracted (Chi & Kim 1981a, b) from plant material collected in central Korea (Prov. Kang-won or Gangwon-do). The Plant DNA Bank in Korea (PDBK) contains information on *P. insolens*, collected in Myo-bong, Myeon-san, Gagong-myeon, Samcheok-si (Gangwon-do).

The genus *Peucedanum* s. ampl. is one of the most complex groups in the Umbelliferae. A world taxonomic revision of all species (approximately 120) and names (according to the International Plant Name Index, 852 records of species and subspecies names) attributed to it, is hardly feasible in the foreseeable future especially as *Peucedanum* species are distributed in Asia, Europe, Africa and Oceania. While all have dorsally compressed mericarps, such a polycentric distribution as well as considerable polymorphism in many characters may suggest the polyphyletic nature of *Peucedanum*. Comparative studies of DNA sequences have also called into question the monophyly of *Peucedanum*. Many botanists thus regard *Peucedanum* as an unnatural taxon (Pimenov 1987, Frey 1989, Pimenov & Leonov 1993, Ostroumova & Pimenov 1997, Reduron et al. 1997, Spalik et al. 2004, Winter et al. 2008). Unfortunately, the splitting of *Peucedanum* on the basis of morphological, karyological or

molecular data is rarely supported by other characters. Before more is known about the biodiversity in *Peucedanum* s.l. and a global revision becomes possible, it seems rational to separate, step-by-step, some of the most distinctive taxa; otherwise, a satisfactory revision of the whole “*Peucedanum*-alliance” may never be practicable. There are valid reasons to consider *P. podagraria* as one such deviate group, having no close relatives in adjacent or remote territories.

Carpological information has proven to be of particular value in the Umbelliferae systematics, and any revision in the family should be accompanied by a carpological study if no detailed description of fruit structure was previously given. Boissieu presented an incomplete description of *Peucedanum podagraria* fruits, and Kitagawa described them more carefully but without detailed histological data.

We used for investigation of relationships of this *Peucedanum* species also molecular-phylogenetic methods to obtain independent evidence for its taxonomic placement.

MATERIAL AND METHODS

Herbarium materials from P, G, and TI herbaria were studied, including lectotype and isolectotype specimens and additional incomplete sheets and content of pockets at some collections. Fruit morphology was studied with the stereomicroscope Olympus SZ61. For anatomical investigations mericarps were softened in warm water, free-hand sections were processed with phloroglucinol and hydrochloric acid to reveal lignification, camera lucida drawings were carried out.

DNA extraction, purification, and sequencing

For molecular phylogenetic analysis, the nrDNA ITS sequences of *Peucedanum insolens*, *P. multivittatum* and three *Arcuatopterus* Sheh Menglan & Shan Renhwa species (*A. barae* (Pimenov) Pimenov & Ostr., *A. filipedicellus* Sheh Menglan & Shan Renhwa, *A. sikkimensis* (C.B. Clarke) Pimenov & Ostr.) were generated. Total DNA was extracted from fruits or leaf tissue using 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 were sequenced for all samples. The newly obtained sequences were deposited in GenBank. The aligned data matrix was submitted to TreeBASE (study number S16827).

Molecular-Phylogenetic Analysis

A set of taxa for comparison with *Peucedanum insolens* was determined by using the BLAST option of GenBank database. This search suggested that no Umbelliferae species have identical or very similar sequences. Similarity values from BLAST search were: *Conioselinum chinense* (L.) Britton, Sterns & Poggenb. (*Conioselinum chinense* clade) – 88 %, *Arcuatopterus thalictroides* Sheh Menglan & Shan Renhwa

(*Arcuatopterus* clade) – 87 %, *Ligusticum porteri* J.M. Coult. & Rose (*Conioselinum chinense* clade) – 87 %, *Aciphylla glacialis* (F. Muell.) Benth. (clade *Aciphyllaeae*) – 88 %. This result shows that ITS sequence of *Peucedanum insolens* belongs to Umbelliferae family, but without obvious similarities. For *Peucedanum multivittatum*, similarity values from BLAST search were: *Angelica acutiloba* and *Angelica decurrens* – 99 %, which belong to Selineae clade. After preliminary analyses, the dataset of published sequences was compiled to include representatives from clades revealed by the classification proposed by Downie et al. (2010) based on ITS, with special attention to the Selineae clade, which includes most of the currently recognized *Peucedanum* species. The trees were rooted with *Chamaesium paradoxum* H. Wolff. In total, 112 ITS accessions obtained from GenBank along with the five newly generated for this study, representing a total of 118 species in 87 genera (see Appendix). 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), the Bayesian inference (BI) and maximum likelihood (ML) methods.

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 most parsimonious trees from each replicate were saved.

Bayesian inference was explored using MrBayes version 3.2.3 (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 20 million generations were performed and trees from the first 500,000 generations were discarded. The number of generations to be discarded was determined using cold chains log-likelihood observation using Tracer version 1.6 (Rambaut et al. 2014).

Maximum likelihood analysis was conducted using the RAxML program (version 7.2.6; Stamatakis 2006) with the GTRGAMMA model. Bootstrapping was done using the rapid bootstrapping algorithm implemented in RAxML with 100 replicates.

RESULTS AND DISCUSSION

Morphological Data

The type materials and accompanying sheets of *Peucedanum podagraria* were studied in P and G, and of *P. insolens* in TI respectively, and shown to be conspecific (Figs. 1, 2). The name of *P. podagraria* has priority, despite the fact that Kitagawa's description was better grounded.

Three fruiting specimens are available of *Peucedanum podagraria* from P, G, and TI (the latter under the name of *P. insolens*), none of which is ideal. The lectotype collection of

P. podagraria, kept in P (isoelectotype in G), has unripe fruits with inseparable mericarps, whereas the collection of *P. insolens* is represented by plants at a later stage of fruit development, but the fruits are very fragile. The fruits of *P. podagraria* are typical of those of Apioideae–Peucedaneae with bifid carpophores (see Kitagawa's description) and two mericarps which are flattened dorsally. Immature fruits are oblong to ovate-oblong, mature fruits are broadly ovate or orbicular (Fig. 3, 4). The calyx teeth are discernible, triangular, 0.2–0.5 mm long. The stylopodia are conical; the styles are medium sized, up to 2 mm long, with a broad base (0.4–0.5 mm) and pointed apex with the stigma recurved on the dorsal side of the mericarp. The mericarps are glabrous, 6–8 mm long, 3.5 mm broad when immature and 6 mm broad at maturity; the marginal ribs are narrowly winged, slightly thickened and considerably narrower than the seed; the dorsal ribs are filiform or rounded and subinconspicuous. The dorsal surface of the mericarps is not plane, being covered by longitudinal, rather shallow furrows. Splitting of the dorsal ribs, as described by Kitagawa, does not, in fact, occur as there is no splitting of the rib vascular bundles. The longitudinal groove along the rib is probably a flattened, large rib secretory duct. On transection (Fig. 5A, B) the exocarp consists of small isodiametric cells; it is interrupted near the ends of the marginal ribs. The commissure is broad. The mesocarp is composed of thin-walled, frequently crumpled parenchymatous cells; sometimes cells with lignified pitted walls are also observed (poor mesocarp lignification in our transections could be connected with immature fruits). The vascular bundles in the dorsal ribs are small, located close to the seed cavity, consisting of a few vessels, usually without sclerenchymatous sheaths; in the marginal ribs, the bundles split into separate groups of vascular elements. Vallecular vittae are small, often dorsally compressed, and differ in number; they are solitary in median vallecules and 1–3 in lateral vallecules. The commissural vittae are 2–4 in number; they sometimes seemingly becoming obsolete close to maturity. The rib secretory ducts are solitary and large, sometimes exceeding the vallecular vittae in size. The endocarp is uniserial, composed of medium-sized, thin-walled cells, sometimes with yellow inclusions, later becoming crumpled. The seed coat is composed of small cells, sometimes crushed. The endosperm is flat on the commissural side.

Along with a superficial similarity of dorsally compressed fruits those of *Peucedanum podagraria* differ from fruits of *P. officinale* and closely related species (sect. *Peucedanum*) in well developed triangular persistent calyx teeth, mesocarp composed of frequently crumpled cells, not lignified in inner layer, vascular bundles in marginal ribs, which are split into groups of vascular elements, double lines along dorsal ribs and large rib secretory ducts.

Large secretory ducts in the dorsal ribs of fruits are rather rare in *Peucedanum* and its allies. They have only been observed in some unrelated species of *Peucedanum* s. ampl., for instance, in fruits of *P. alsaticum* L. (Klan 1947, Kowal & Wójterska 1973), i.e. in the segregate genus *Xanthoselinum* Schur, and in the South African *P. capense* (Thunb.) Sond. (Ostroumova & Pimenov 1997), now treated as *Notobubon laevigatum* (Aiton) Magee (Magee et al. 2009).



Figure 1 Photograph of the holotype of *Peucedanum podagraria* (P)

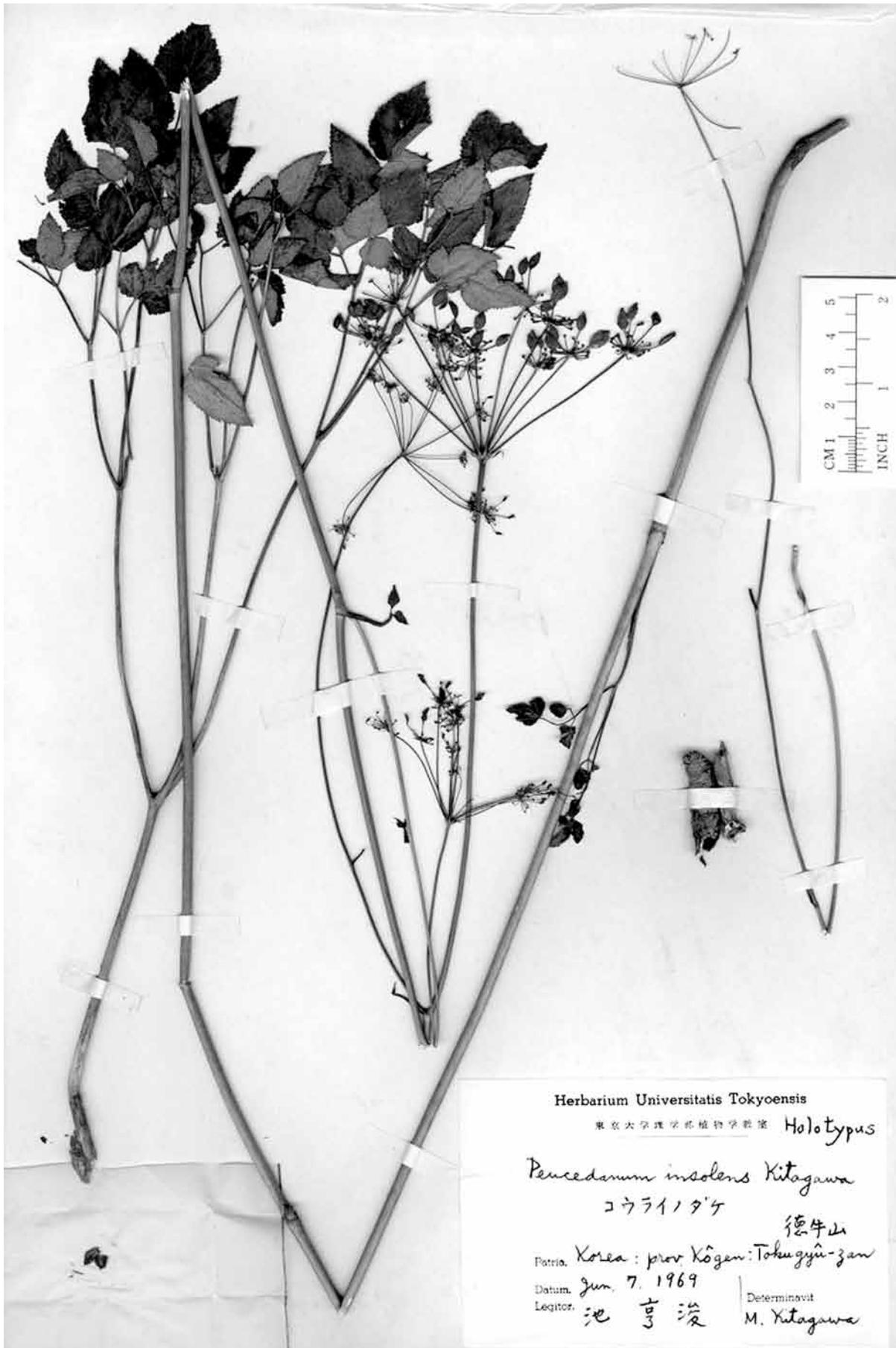


Figure 2 Photograph of the holotype of *Peucedanum insolens* (II)



Figure 3 Fruit of *Peucedanum podagraria* with calyx teeth (arrowhead) and flat style, isotype (G). Scale bar = 1 mm



Figure 4 Fruit of *Peucedanum insolens* with double lines on the dorsal ribs (asteric), calyx teeth (arrowhead) and flat style, holotype (II). Scale bar = 1 mm

The pericarp structure in *Peucedanum multivittatum* (Fig. 5C) differs from that of *P. podagraria*: vascular bundles are large and sclerenchymatic, the dorsal bundles are located at the top of ribs, the secretory ducts are small, numerous, scattered in vallecules and located beneath vascular bundles. The mesocarp is composed mostly of lignified parenchyma with pitted walls (mature fruits).

Extra-carpological characters also differ from those found in *Peucedanum* s.str. Kitagawa compared his new species with *P. cervaria*, which also has broad terminal leaf lobes, but differs in fruit structure specifically in the absence of large rib secretory ducts and presence of secretory ducts between vascular bundles and endocarp (Klan 1947, Kowal & Wojterska 1973, Pimenov & Ostroumova 2012). There are some broad-leaved species of Umbelliferae found in remote parts of the world which have dorsally compressed mericarps (hence frequently referred to as *Peucedanum* species) and, at the same time, have broad, petiolulate terminal leaf segments. Examples include some European and SW Asian species, now placed into the satellite genera *Cervaria* N.M. Wolf, *Macroselinum* Schur and *Oreoselinum* Adans., some E. African tropical species (Townsend 1989), as well as *P. sandwicense* Hillebr. from Hawaii (Degener & al., 1959-1960) and *P. multivittatum* Maxim. from Japan (Hiroe & Constance 1958). The presence of such leaves cannot be regarded as a reliable marker of

taxonomic affinity, and could evolved independently multiple times.

Peucedanum multivittatum was compared with *P. podagraria* in the protologue by Boissieu (1903) and found to differ in having pinnate (not biternate) leaves, and fruits with different vascular and secretory systems.

Molecular Data

The alignment of 118 ITS (ITS1, ITS2) sequences resulted in a matrix of 435 nucleotide positions after excluding 101 ambiguous positions. Of the remaining sites, 337 characters were potentially parsimony-informative, 43 variable in only a single taxon and 55 constant. Maximum-parsimony analyses resulted in 5,642 shortest trees each of 2,710 steps (CI = 0.288, RI = 0.634). The Bayesian tree is consistent with the most parsimonious trees and maximum likelihood tree, but has better resolution of the relationships between different clades. Thus, only the Bayesian 50 % majority rule tree with posterior probabilities values (PP), parsimony (PBS) and likelihood (LBS) bootstrap percentages are shown in Fig. 6. Within the ingroup, 21 major clades are recognized, many of which correspond to previously identified clades (Downie et al. 2010), with the exception of the *Conioselinum chinense* clade, one member of which, *Meum atbamanticum*, is placed far away from the other members of this group. In all three cases – the maximum parsimony, maximum likelihood and Bayesian trees the closest relative to *Peucedanum insolens* are *Arcuatopteris* species from *Arcuatopteris* clade, and this relationship is strongly supported (PP 0.99; PBS 88 %; LBS 90). The close relationship between *P. insolens* and *P. multivittatum* suggested by Boissieu (1903) on the basis of morphological characters was not supported by ITS data.

Both molecular and morphological data suggest that *P. podagraria* (= *P. insolens*) is not a member of *Peucedanum*, even in the broadest sense. Moreover, the molecular data place this Korean species far from any member of *Peucedanum* s.l. Four species of *Arcuatopteris* Sheh & Shan (1988), a genus of SW China and Eastern part of Indian Himalaya with 6 species (Pimenov & Ostroumova 2000) appeared to be related to (situated in the same clade as) *Peucedanum podagraria*. All studied species of *Arcuatopteris* (*A. filipedicellatum* Sheh Menglan & Shan Renhwa, *A. harae* (Pimenov) Pimenov & Ostr., *A. sikkimensis* (C.B. Clarke) Pimenov & Ostr., and *A. thalictrioideum* Shen Menglan & Shan Renhwa), form in molecular tree a compact cluster without alien taxa. The molecular data support a previous classification in a single genus of four species, initially described or regarded in *Angelica* L., *Arcuatopteris*, and *Peucedanum*. This affinity was rather unexpected for us. These two taxa, *P. podagraria* and *Arcuatopteris*, although they are in a lineage, are not especially close relatives as both have long branches within this clade. Morphologically they are not similar; for instance, in species of *Arcuatopteris* rays of umbels are thread-like, the styles are not broadened at the base, the vallecular mericarp vittae are solitary, rib ducts and prominent calyx teeth are absent. *Arcuatopteris* and *P. podagraria* are distributed in dis-

tant parts of Eastern Asiatic floristic kingdom (Wu & Wu 1996). We conclude *P. podagraria* (= *P. insolens*) is to be separated as an independent genus. The name “*Diplopleurum* Kitag.” cannot be restored as Kitagawa’s concept would be misinterpreted. Moreover, it may not be in agreement with the true mericarp structure, as the species has the usual number of dorsal ribs with no doubling of vascular bundles observed thus far.

Taxonomic treatment

Sillaphyton Pimenov, gen. nov.

Type: *Sillaphyton podagraria* (H. Boissieu) Pimenov

Basionym: *Peucedanum podagraria* H. Boissieu.

Affinitas: A *Peucedanis veris* (*P. officinale* L. et alii) laminis foliorum lobis terminalibus planis, latis, ovalibus, pilosiusculis (non linearibus vel filiformibus), dentibus calycinis bene evolutis, triangulatis, persistentibus, mericarpiis stratis mediis mesocarpii maturitate partim destructis, stratis internis mesocarpii cellulis non ligniscentibus, canalibus secretoriis jugalibus latis (non angustis vel nullis), fasciculis conductoriis jugorum marginalium fissis differt. Ab *Angelicae* speciebus mericarpiis commissuris latis (non angustis), jugis dorsalibus subinconspicuis, canalibus secretoriis jugalibus latis (non angustis vel nullis), fasciculis conductoriis jugorum marginalium fissis bene discrepans. Ab *Arcuatopteris* speciebus radiis umbellularum rigidis (non filiformibus), dentibus calycinis bene evolutis, triangulatis, persistentibus, stylis basi dilatatis, mericarpiis canalibus secretoriis jugalibus latis, vallecularibus lateralibus binis-ternis (non solitariis) facile dignoscitur.

Plantae perennes, verosimiliter polycarpicae, caulibus solitariis, solidis, foliis longepetiolatis, bi-triternatis, lobis terminalibus longepetiolulatis, planis, ovalibus vel late ovalibus, basi cuneatis vel cordatis, margine dentatis, pilosiusculis, umbellis terminalibus laxis, involucri nullis vel bracteis 1–3, subulato-filiformibus, radiis scabrido-pubescentibus, bracteolis nullis vel 1–4, subulato-linearibus, dentibus calycini triangulatis, persistentibus, petalis albis, apice incurvis, stylopodiis conicis, stylis basi dilatatis, reflexis, fructibus dorso compressis, glabris, carpophoris bipartitis, mericarpiis ambitu late-ovalibus vel orbicularibus, superficie angusto sulcatis, jugis dorsalibus subinconspicuis, marginalibus anguste alatis, commissuris latis, mesocarpiis parenchymaticis, in maturitate partim destructis, fasciculis conductoriis jugorum dorsalium tenuibus, jugorum marginalium in greges nonnullis fissis, vittis vallecularibus parvis, in valleculis centralibus solitariis, in valleculis lateralibus binis-ternis, commissuralibus 2–4, interdum nullis, canalibus secretoriis jugalibus magnis, interdum vittis vallecularibus superantibus, endospermiis ventre planis.

Monotypic genus, endemic to Korean peninsula.

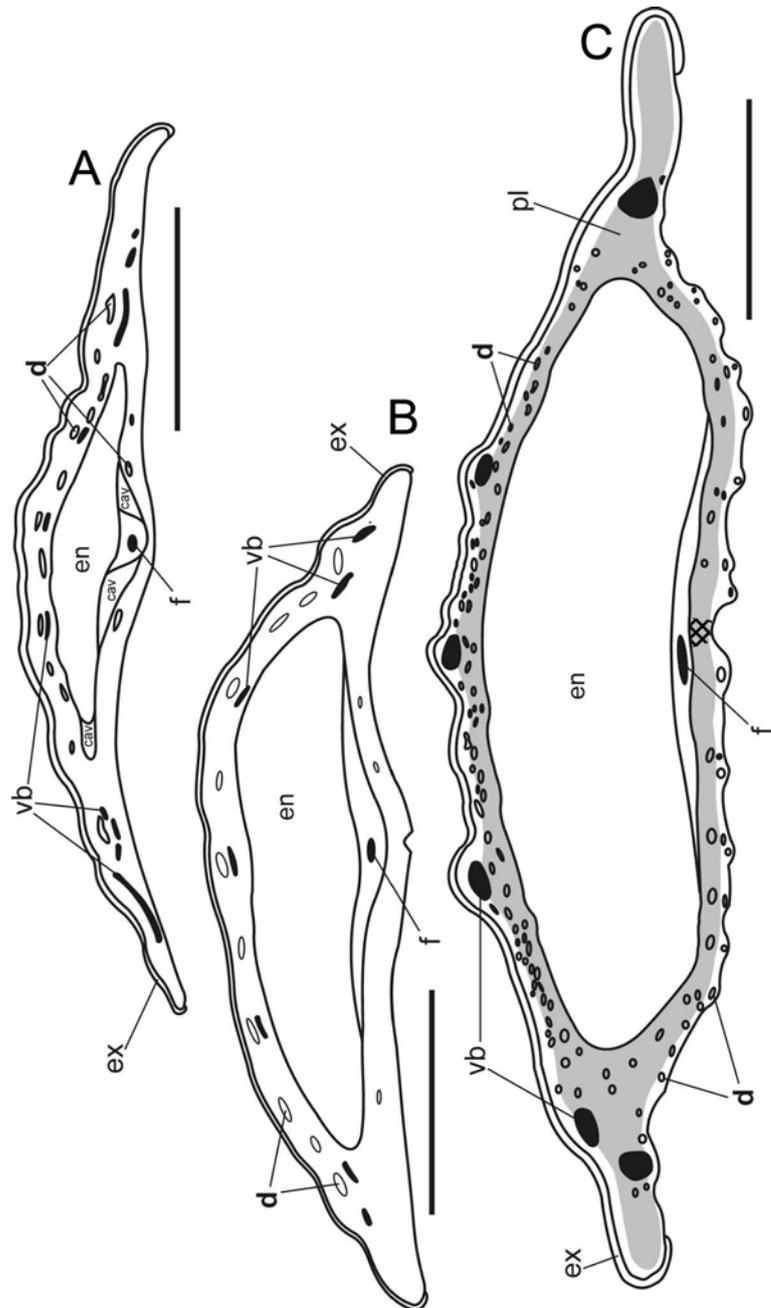


Figure 5 Mericarp transections: A – *Peucedanum insolens*, holotype (TI), immature; B – *P. podagraria*, holotype (P), immature; C – *P. multinitatum*, Japan, Furisi, 9667 (K). Abbreviations: cav – cavity, d – secretory ducts, en – endosperm, ex – exocarp, f – funicular bundle, pl – lignified parenchyma with pitted walls, vb – vascular bundle. Scale bars = 1 mm

Sillaphyton podagraria (H. Boissieu) Pimenov, comb. nov.

Type: KOREA “In montibus Coreae mediae, ad 1000 m, 3 Sept.1901, U. Faurie 257” (lectotype: P! barcode P00753020; designated here by Pimenov; isolectotype G! barcode G00367057)

Homotypic synonym: *Peucedanum podagraria* H. Boissieu, Bull. Herb. Boissier, 2 ser. 11: 957. 1903; Nakai, Tyosen-syokubutu (Fl. koreana) 1: 266. 1909.

Heterotypic synonym: *Peucedanum insolens* Kitag. J. Jap. Bot. 47, 12: 355, fig. 1, photo. 1972. – TYPE: KOREA. Prov. Kô-gen: in monte Toku-gyû-zan. 07 Jun 1969, H.J. Chi “ (holotype: TI!).

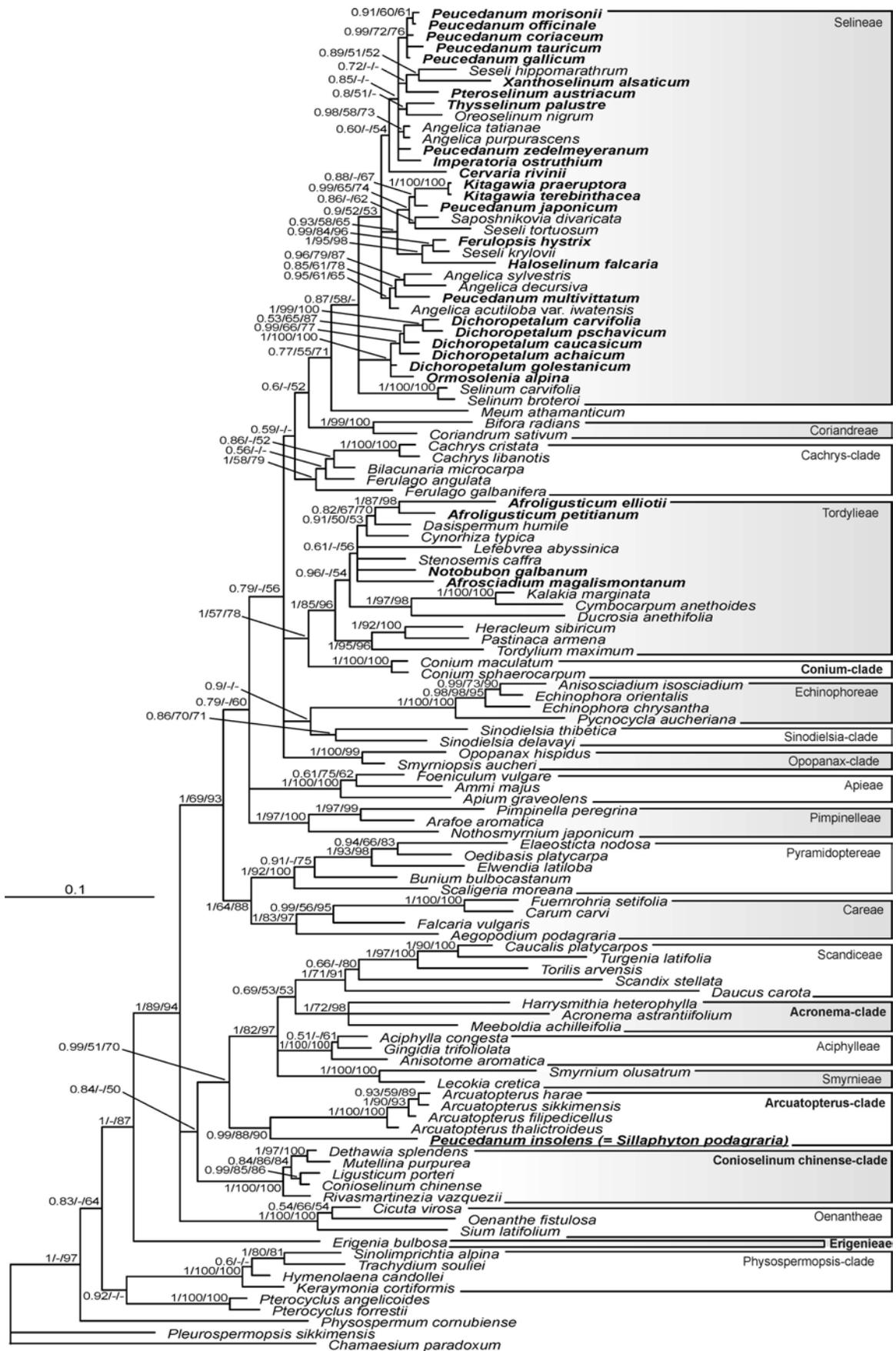


Figure 6 The Bayesian tree obtained from analysis of 118 nrITS sequences. Branch lengths are proportional to the number of character changes. Bayesian posterior probabilities, maximum parsimony bootstrap support and maximum likelihood bootstrap support are indicated above nodes. *Peucedanum* s.l. species are shown in bold; *Sillaphyton podagraria* (= *Peucedanum insolens*) is underlined

Additional specimen: Korea: Hamgyungbuk Do, Bolsan, 3 Aug. 1940. Nakai 17964-b (TI).

Etymology: The genus is named after the medieval Korean realm Silla and the Greek word $\varphi\upsilon\tau\acute{o}\nu$ = plant.

Distribution: Korean endemic (Anonymous 2016) and most likely a relict species. The information on its distribution is scanty up to date. Confirmed localities are few; all them are from the middle part of Korean peninsula: Mt. Toku-gyû-zan (type locality of *P. insolens*; TI); Bolsan (TI); Myo-bong, Myeonsan, Gagongmyeon, Samcheok-si, Gangwon-do (The Plant DNA Bank in Korea; with correct image of plant; KUS). The necessity to study the natural populations and to determine the conservation status of the species is evident.

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

Aciphylla congesta Cheeseman, EU886819; *Acronema astantiifolium* H. Wolff, EU236155; *Aegopodium podagraria* L., Russia, Moscow, MSU, Bot. Gard., Zakharova, s.n., JF807569, JF807549; *Afroligusticum elliotii* (Engl.) C. Norman, DQ516377; *Afroligusticum petitianum* (A. Rich) P.J.D. Winter [= *Peucedanum petitianum* A. Rich], AM408869; *Afroscidium magalimontanum* (Sond.) P.J.D. Winter [= *Peucedanum magalimontanum* Sond.], AM408876; *Ammi majus* L., U78386, U78446; *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 tatarica* Bordz., AF008610, AF009089; *Anisosciadium isosciadium* Bornm., EU169244; *Anisotome aromatica* Hook.f., U78360, U78420; *Apium graveolens* L., FJ986043; *Arafoë aromatica* Pimenov & Lavrova, AF077874; *Arcuatopterus filipedicellus* Sheh Menglan & Shan Renhwa, China, Yunnan, 09 Sep. 1984, Pan Zehui 84-36 (NAS), KR425422; *Arcuatopterus harae* (Pimenov) Pimenov & Ostr., East Nepal, Tuwa-Kiwa-Taplehok, 05 Nov. 1963, Hara et al. s.n. (BM), KR425421; *Arcuatopterus sikkimensis* (C.B. Clarke) Pimenov & Ostr., India, Sikkim, 05 Oct. 1875, Clarke 24987 (LE), KR425423; *Arcuatopterus thalictroides* Menglan & Shan Renhwa, EU236160; *Bifora radians* M. Bieb., U78408, U78468; *Bilacunaria microcarpa* (M. Bieb.) Pimenov & V.N. Tikhom., AY941265, AY941293; *Bunium bulbocastanum* L., HE602464; *Cachrys cristata* DC., JF807572, JF807552; *Cachrys libanotis* L., JF807573, JF807553; *Carum carvi* L., U78377, U78437; *Caucalis platycarpus* L., U78364, U78424; *Cervaria rivinii* Gaertn. [= *Peucedanum cervaria* Cusson ex Lapeyr.], AF009087, AF008608; *Chamaesium paradoxum* H. Wolff, EU236161; *Cicuta virosa* L., AY524766; *Conioselinum chinense* Britton, Sterns & Poggenb., U78374; *Conium maculatum* L., GU266024; *Conium sphaerocarpon* Hilliard & B.L. Burtt, GU265958; *Coriandrum sativum* L., HQ377204; *Cymbocarpum anethoides* DC., GU190156; *Cynorhiza typica* Eckl. & Zeyh. [= *Peucedanum typicum* (Eckl. & Zeyh.) B.L. Burtt], AM408865; *Dasispermum humile* (Meisn.) Magee & B.-E. van Wyk [= *Sonderina humilis* (Meisn.) H. Wolff], AM408873; *Daucus carota* L., HE602376; *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 goletanicum* (Rech.f.) Pimenov & Kljuykov [= *Johrenia goletanica* Rech.f.], EU169289; *Dichoropetalum affine* (C.A. Mey.) Pimenov [= *Peucedanum pschavicum* Boiss.], AF008619, AF009098; *Ducrosia anethifolia* Boiss., AY941268, AY941296; *Echinophora chrysantha* Freyn & Sint., AF077883; *Echinophora orientalis* Hedge & Lamond, EU169267; *Elaeosticta nodosa* (Boiss.) Boiss., AY941271, AY941299; *Eluwendia latiloba* (Korovin) Pimenov & Kljuykov [= *Bunium latilobum* Korovin], DQ435224, DQ435263; *Erigenia bulbosa* Nutt., AF008636, AF009115; *Falcaria vulgaris* Bernh., AF077888; *Ferulago angulata* Boiss., AY941272, AY941300; *Ferulago galbanifera* (Mill.) W.D.J. Koch, AF077889; *Ferulopsis hystrix* (Bunge ex Ledeb.) Pimenov, EU169271; *Foeniculum vulgare* Mill., AY581806; *Fuernorbria setifolia* K. Koch, AF008633, AF009112; *Gingidia trifoliolata* (Hook. f.) J.W. Dawson, GTU72367; *Haloselinum falcaria* (Turcz.) Pimenov [= *Peucedanum falcaria* Turcz.], FJ489365, FJ489366; *Harrysmithia heterophylla* H. Wolff, GQ379321; *Heracleum sibiricum* L., DQ996576; *Hymenolaena candollei* DC., FJ469958, FJ483497; *Imperatoria ostruthium* L., AF077896; *Kalakia marginata* (Boiss.) Alava, EU169293; *Dethawia splendens* (Lapeyr.) Kerguelen, KC676167; *Keraymonia cortiformis* Cauwet & S.B. Malla, FJ469960, FJ483499; *Kitagawia terebinthacea* (Fisch. ex Trev.) Pimenov [= *Peucedanum terebinthaceum* (Fisch. ex Trev.) Ledeb.], JF977818; *Lecokia cretica* (Lam.) DC., EU169294; *Lefeburea abyssinica* A. Rich., DQ516376; *Ligusticum porteri* J.M. Coult. & Rose, U78375; *Meeboldia achilleifolia* (DC.) P.K. Mukh. & Constance, AY038206, AY038220; *Meum athamanticum* Jacq., AF077900; *Mutellina purpurea* (Poir.) Thell., AY328934, AY330500; *Nothosmyrnum japonicum* Miq., DQ516367; *Notobubon galbanum* (L.) Magee [= *Peucedanum galbanum* (L.) Drude], AM408846; *Oedibasis platycarpa* (Lipsky) Koso-Pol., AF009111, AF008632; *Oenanthe fistulosa* L., AY360249; *Opopanax hispidum* Griseb., EU169298; *Oreoselinum nigrum* Delarbre [= *Peucedanum oreoselinum* (L.) Moench], AF495836, AF495837; *Ormosolenia alpina* (Sieber ex Schultes) Pimenov, HQ269391; *Pastinaca armena* Fisch. & C.A. Mey., AF008626, AF009105; *Peucedanum coriaceum* Rchb., AF495824, AF495825; *Peucedanum gallicum* Latour., AM408882; *Peucedanum japo-*

nicum Thunb., AF495826; *Peucedanum multivittatum* Maxim., Japan, Hokkaido, Mt. Kariba-yama, 13 Aug. 1988, Tokehoshi et al. 9155 (MHA), KP278145; *Peucedanum morisonii* Besser ex Schult., AF077903; *Peucedanum officinale* L., AF495820, AF495821; *Peucedanum praeruptorum* Dunn, DQ132871; *Peucedanum tauricum* M.Bieb., AM408884; *Peucedanum zedelmeieranum* Manden., AF164834, AF164859; *Physospermum cornubiense* DC., AF077904; *Pimpinella peregrina* L., AY581797; *Pleurospermopsis sikkimensis* (C.B.Clarke) C. Norman, GQ379347; *Pterocyclus angelicoides* Klotzsch, J469967, FJ483505; *Pterocyclus forrestii* (Diels) Pimenov & Kljuykov, FJ469965, FJ483504; *Pteroselinum austriacum* (Jacq.) Rchb. [= *Peucedanum austriacum* (Jacq.) W.D.J. Koch], AF495842, AF495843; *Pycnocycla aucheriana* Boiss., AF073533; *Rivasmartinezia vazquezii* Fern. Prieto & Cires, KC676176; *Saposhnikovia divaricata* (Turcz.) Schischk., AF495838, AF495839; *Scaligeria moreana* Engstrand, HM229405; *Scandix stellata* Banks & Sol., AH008935; *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; *Sillaphyton podagraria* (H. Boissieu) Pimenov (= *Peucedanum insolens* Kitag.), Korea, prov. Kô-gen, in monte Toku-gyû-zan, 07 Jun. 1969, Chi s.n. (TI), KP278144; *Sinodielsia delavayi* (Franch.) Pimenov & Kljuykov, AY0382, AY038225; *Sinodielsia tibetica* (H. Boissieu) Kljuykov & P.K. Mukh., FJ469969, FJ483507; *Sinolimprichtia alpina* H. Wolff, AY328953, AY330519; *Sium latifolium* L., DQ005671; *Smyrniopsis aucheri* Boiss., EU169318; *Smyrniium olusatrum* L., U30594; *Stenosemis caffra* (Eckl. & Zeyh.) Sond., AM408874; *Thysselinum palustre* (L.) Hoffm. [= *Peucedanum palustre* L.], AY179035; *Tordylium maximum* L., DQ996585; *Torilis arvensis* Link, FJ415110; *Turgenia latifolia* (L.) Hoffm., JF807587, JF807567; *Xanthoselinum alsaticum* (L.) Schur [= *Peucedanum alsaticum* L.], AF495834, AF495835.