

Ganghwal is a new species, *Angelica reflexa*

Byoung Yoon Lee^{1,*}, Myounghai Kwak¹, Jeong Eun Han¹, Eun-Hee Jung¹ and Gi-Heum Nam²

¹Division of Plant Resources, National Institute of Biological Resources, Incheon 404-170, Korea

²Wildlife Genetic Resources Center, National Institute of Biological Resources, Incheon 404-170, Korea

*Correspondent: bylee80@korea.kr

A new species of Apiaceae, *Angelica reflexa* from Daeamsan, Gangwon-do province, Korea is described and illustrated. This new species is closely related to *A. genuflexa* Nutt. ex Torr. & A. Gray, having such characters as leaf rachis and petiolules refracted strongly, but distinguished from the latter by its regularly serrated leaf margins, glabrous on abaxial leaf veins, and two vittae on the commissural face of the mericarp.

Keywords: *Angelica koreana*, *Angelica reflexa*, Apiaceae, Ganghwal, *Ostericum koreana*

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Roots of an umbel species called Ganghwal in Korea have been used as popular oriental medicines to expel the wind from the body, to relieve pains and dampness (Yoon *et al.*, 2003). In the Korean medicinal stuff market, roots of the Ganghwal are sold in two types; the Northern type (Bug-Ganghwal) and the Southern type (Nam-Ganghwal). Although two types of Ganghwal can be easily identified by different features in the cross cut of roots, they have been considered as the same species, *Angelica koreana* Maxim. or *Ostericum koreana* (Maxim.) Kitagawa (Yoon *et al.*, 2003). Maximowicz (1886) discovered this new taxon at meadows under the shrubs near the border between Korea and Russia, and named it *A. koreana*. Later, Kitagawa (1936) transferred the species into the genus *Ostericum* according to similarities with *Ostericum miquelianum* by the following characters; evident calyx teeth, pericarps with a single cell layer, densely congested leaf segments. However, Kitagawa (1971) recognized the taxonomic identity between *A. koreana* and *Ostericum grosseserratum* because the syntype specimens of *A. koreana*, were exactly identical to *Ostericum grosseserrata*, as noticed by Pimenov (1968). The Kitagawa's treatment of *A. koreana* as the synonym of *O. grosseserratum* was followed in several flora and research papers (Lee, 1998; Sun *et al.*, 2000; Pan and Watson, 2005). However, the identification and taxonomic positions of *A. koreana* were still confusing taxonomically because *A. koreana* was independent from the clade including *O. grosseserratum* in molecular phylogenetic studies in *Angelica* and allied genera from the Hengduan mountains of China (Feng *et al.*, 2009). Furthermore, Sun *et al.* (2000) suggested that the commercially medicinal plants cultivated as Ganghwal were

neither *A. koreana* nor *O. grosseserratum* but *A. genuflexa* on the basis of similarities derived from both external morphological examination and molecular phylogeny using nuclear DNA ITS sequences. Although Ganghwal was uncertain taxonomically, roots of the species have been still sold in the Korean medicinal stuff markets and used in several researches including investigation of chemical components and cytotoxic studies (Tou, 1970; 1971; Choi and Park, 1995), and recognition analysis of the species (Yoon *et al.*, 2003). After careful observation of morphological and anatomical characters, and examination of some relevant specimens, it became clear that these plants represented a new species of *Angelica*. A taxonomic description, illustration, and other relevant detailed morphological features of this new species are presented below.

Angelica reflexa B.Y.Lee sp. nov. Type: Korea. Gangwon-do, Inje-gun, Seohwa-myeon, Seohwa-ri, Mt. Daeam, along a stream flowing from the top lake of the mountain, Yong-neup. 19 Sep. 2009. Byoung Yoon Lee BYLee 090919-11 (holotype, KB; isotype KB). Fig. 1. Korean local name, Ganghwal. Paratypes. Korea. Inje-gun, Seohwa-myeon, Seohwa-ri, Mt. Daeam, 23 Oct. 2009. Byoung-Yoon Lee BYLee091023 and 06 Aug. 2011. Byoung Yoon Lee BYLee110806 (KB); Korea. Pyeongchang-gun, Daegwallyeong-myeon, Seonja valley, 25 Sep. 2011. Byoung Yoon Lee BYLee110925 (KB).

Herbs perennial. Rhizomes thick. Stem erect, stout, glabrous, 80-120 cm high. Radical and lower cauline leaves petiolate, blades twice ternate pinnately dissected, apex acuminate, base narrowed; leaflets glabrous,

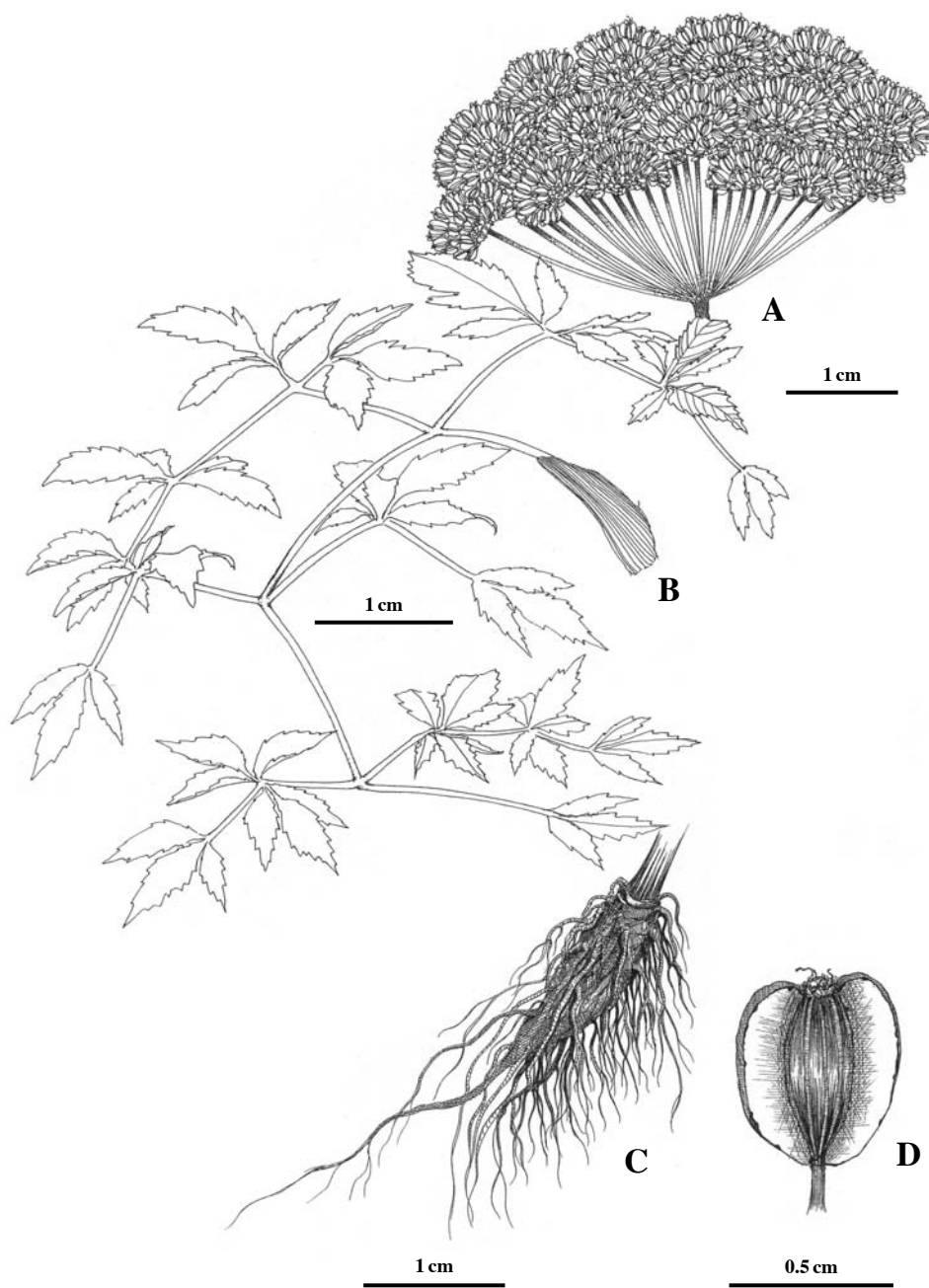


Fig. 1. *Angelica reflexa* B.Y.Lee. A. Inflorescence. B. Leaf. C. Root. D. Mericarp.

with regular acute dentation, lower leaflets ovate, often 3-cleft to -parted, upper ones oblong, lobed, often subequal at the base; petioles sheathing at base, petiolules of primary leaflets strongly bent down. Inflorescence compound umbels, numerous; peduncles densely papillate at apex; rays 20-25, more or less equal, bracts none or rarely 1, linear if present; pedicels 15-20, slender, 3-9 mm long; bracteoles slender, as long as pedicels, not deflexed in flowering and fruiting. Flowers bisexual; calyx teeth obsolete; petals white, apex incurved, styles

subconical, filaments exerted, almost two times longer than petals. Fruits oblong; mericarps compressed dorsally. 5-6 mm long; dorsal ridge somewhat prominent but narrow in its width, lateral ridges broadly winged; vittae solitary on the valley between two dorsal ridges, 2 on commissure. Flowering in August to late September, and fruiting during October. *Angelica reflexa* grows on wet places along mountain streams at an altitude 880-1,200 m high and a relatively large group of individuals are vegetated in populations.

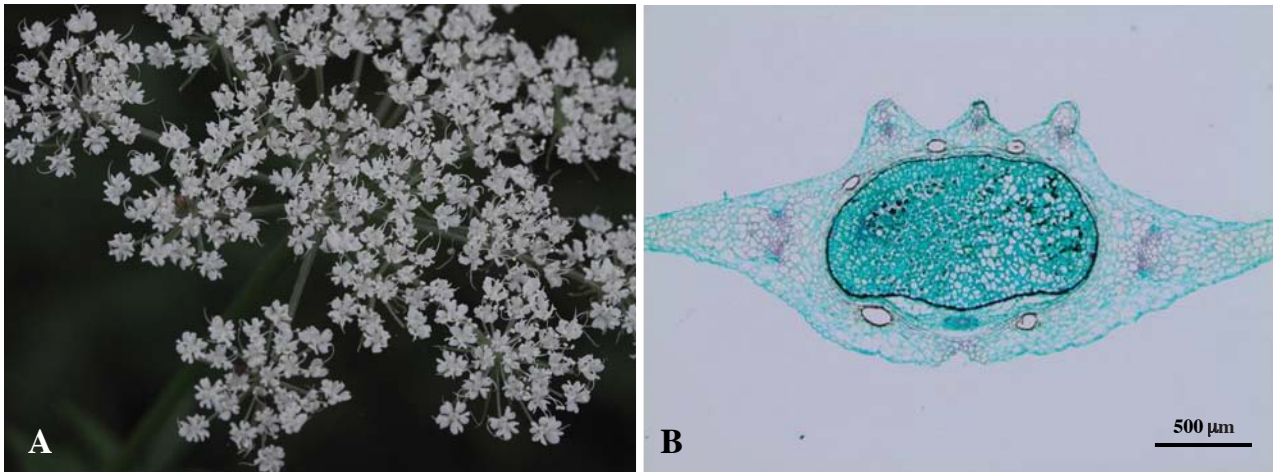


Fig. 2. Flowers (left) and fruits (right) of *Angelica reflexa*. Vittae numbers on the commissural face of the mericarp were two in *A. reflexa* (shown in B) and four in *A. genuflexa*, not shown in this figure, but written in Ohba (1999).

DISCUSSION

The roots of the Ganghwal have been still sold in Korean medicinal stuff markets, but taxonomy of the medicinal plant is not clear. The reason we chose a Korean common name “Ganghwal” instead of any other scientific name is that there have been considerable taxonomic confusion and debates in the nomenclature of this economically important taxon. Although Ganghwal was treated to be a synonym to *Ostericum grosseserrata* by Kitagawa (1971), the taxon is totally different in its external morphology (e.g., pericarps with multiple cell layers shown in fig. 2B) from the latter. Local farmers can even identify easily the morphological differences between these two taxa. The preliminary phylogeny derived from nuclear DNA ITS sequences revealed that all the investigated samples of Ganghwal were nested within ‘*Angelica*’ clade, not within ‘*Ostericum* clade’ (Lee *et al.*, in prep.). Some Korean researchers might have identified this wild species of Ganghwal as *A. genuflexa* because of quite similarity by the presence of leaf rachis and petiolules reflexed strongly (Sun *et al.*, 2000). They suggested that the commercially medicinal plant cultivated as Ganghwal was neither *A. koreana* nor *O. grosseserrata* but *A. genuflexa* on the basis of similarities derived from both external morphological examination and molecular phylogeny using nuclear DNA ITS sequences. They might have not obtained a satisfactory result on a taxonomic position of *A. koreana* because they did not include into their experiments enough materials of *A. genuflexa* collected from its wild habitats. Also, a limited number of morphological characters were not enough to suggest that a wild collection of Ganghwal would be identical to *A. genuflexa*. Alth-

ough they look like the same due to leaf rachis and petiolules refracted strongly, margins of leaflets were different; regular serrate in Ganghwal vs. irregular serrate in *A. genuflexa*. Furthermore, Fig. 2 shows that vittae numbers on the commissural face of the mericarp were two in Ganghwal and four in *A. genuflexa* (Ohba, 1999). The conclusion of present discussion on Ganghwal’s taxonomic identity is that it is a new taxon, not *A. koreana*, *A. genuflexa*, or *O. grosseserrata*.

Key to the species of Korean *Angelica* L.

1. Leaflets 1- to 2-pinnate *A. cartilaginomarginata*
1. Leaflets ternate or ternately pinnate
 2. Leaf sheaths densely pubescent *A. anomala*
 2. Leaf sheaths glabrous
 3. Petiolules of primary leaflets more or less reflexed, geniculate
 4. Leaflet margins irregular dentation, densely papillated on leaf abaxial veins, numbers of rays 40-60, vittae on commissure 4 *A. genuflexa*
 4. Leaflet margins irregular dentation, glabrous on leaf abaxial veins, numbers of rays 20-25, vittae on commissure 2 *A. reflexa*
3. Petiolules of primary leaflets rarely or slightly reflexed, non-geniculate
 5. Petals dark purple to red, rarely white
 6. Umbels spherical; petals dark purple *A. gigas*
 6. Umbels hemi-spherical; petals purple or rarely white *A. decursiva*
 5. Petals white
 7. Petals of each flower unequal in size, vittae more than 3 on the valley between two dorsal ridges, more than 6 on the commissure
 8. Leaflet base cuneate, margins irregularly double serrate, ultimate leaflet segment oblong,

- acute *A. acutiloba*
 8. Leaflet base rounded, margins regularly serrate, ultimate leaflet segment narrowly oblong, acuminate *A. czernaevia*
 7. Petals of each flower equal in size, vittae 1-2 on the valley between two dorsal ridges, 2-4 on the commissure
 9. Seaside plants with white juice *A. japonica*
 9. Inland plants with colorless juice or no juice
 10. Leaflet margin double serrate
 *A. polymorpha*
 10. Leaflet margin single serrate
 11. Leaf sheath slightly inflated, often purple colors at the junction between petioles and stems, bracteoles absent *A. amurensis*
 11. Leaf sheath strongly inflated, no purple colors, bracteoles few, lanceolate
 *A. dahurica*

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REFERENCES

- Choi, E.G. and H.B. Park. 1995. High frequency somatic embryogenesis and plant regeneration from cultured immature seeds of *Ostericum koreanum* Kitagawa and *Angelica purpuraeifolia* Chung. Korean J. Plant Tissue Culture 22(5): 299-305.
 Feng, T., S.R. Downie, Y. Yu, X. Zhang, W. Chen, X. He and

- S. Liu. 2009. Molecular systematics of *Angelica* and allied genera (Apiaceae) from the Hengduan mountains of China based on nrDNA ITS sequences: phylogenetic affinities and biogeographic implications. J. Plant Res. 122:403-414.
 Kitagawa, M. 1936. *Ostericum* and *Angelica* from Manchuria and Korea. Journ. Jap. Bot. 12: 229-246.
 Kitagawa, M. 1971. On the syntype specimens of *Angelica koreana* Maximowicz. Journ. Jap. Bot. 46: 367-372.
 Lee, S.J. 1998. Apiales Nakai. In: Flora Coreana 5. Im, R.-J. (ed.), The Science and Technology Publishing House, Pyongyang. pp. 120-253.
 Maximowicz, C.J. 1886. Diagnoses plantarum novarum Asiaticarum. Bulletin de l'Académie impériale des sciences de St.-Petersbourg 31:48-54.
 Ohba, H. 1999. Umbelliferae. In Flora of Japan, vol. 2c. Iwatsuki, K. et al. (ed.), Kodansha, Tokyo. pp. 268-303.
 Pan, Z. and M.F. Watson. 2005. *Ostericum* Hoffmann. In: She, M.-L. et al. (ed.), Flora of China. Science Press, Beijing. pp. 158-169.
 Pimenov, M.G. 1968. Systematic grouping of the species of the genus *Angelica* L. of the USSR on the basis of similarity coefficients. Bjull. Moskovsk. Obsc. Isp. Prir. Otd. Biol. 73(1):124-139.
 Sun, B.-Y., T.J. Kim, S.T. Kim, Y.B. Suh and C.H. Kim. 2000. Systematics of *Ostericum* (Apiaceae) in Korea. Kor. J. Plant Tax. 30(2):93-104.
 Tou, C.A. 1970. Cytotaxonomic studies on the Umbelliferae plants - cytological study on some species of *Angelica*. Kor. J. Pharmacog. 1(1):19-24.
 Tou, C.A. 1971. Cytotaxonomic studies on the Umbelliferae plants - cytological study and fertility of pollen in Umbelliferae. Kor. J. Pharmacog. 2(1):29-34.
 Yoon, W., B. Choi, W. Baek, K. Heo, Y. Suh and H. Choi. 2003. Cluster analysis of Korean Gangwhal by RAPD analysis. Kor. J. Herbology 18(4):141-145.

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