A new species of *Corydalis* (Fumariaceae): *C. bonghwaensis* M. Kim & H. Jo

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현호색속(현호색과)의 신종: 봉화현호색(*Corydalis bonghwaensis* M. Kim & H. Jo)

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ABSTRACT: A new species, *Corydalis bonghwaensis* M. Kim & H. Jo, is described here. It is found on a mountain slope in Bongwha-gun, Gyeongsangbuk-do, Korea. *Corydalis bonghwaensis* shares several characteristics (white flowers, glabrous pedicels, white tubers, and the polygonal stigma) with related species *C. namdoensis* B. U. Oh & J. G. Kim and *C. albigata* B. U. Oh. However, this new species has flowers which change from pale-yellow to white, a mucronated inner-petal apex, linear leaflets, and fusiform capsules with two-rowed seeds. In contrast, *C. namdoensis* has retuse inner-petal apex, various leaflets, and fusiform capsules with 2-rowed seeds. *C. albigata* has retuse inner-petal apex, elliptical leaflets, and linear capsule with 1-rowed seeds. Also *C. humilis* B. U. Oh & Y. S. Kim has pale-blue purple flowers, elliptical leaflets, inflorescence with 1–5 flowers, and hemispherical lower-outer petal.

Keywords: *Corydalis bonghwaensis*, *C. namdoensis*, new species, Fumariaceae

적 요: 경상북도 봉화에서 현호색속의 신종인 봉화현호색(*Corydalis bonghwaensis* M. Kim & H. Jo)을 새로이 발견하여 기재하였다. 봉화현호색은 꽃이 흰색이고, 소화경에 털이 없으며, 괴경의 내부는 흰색이고, 주두돌기가 다각형이라는 점에서 남도현호색과 흰현호색과 유사하다. 그러나 봉화현호색은 꽃색이 연노랑에서 흰색으로 변하고, 내화피 정단은 약하게 돌출하며, 잎 열편은 가는 선형이고 2열 종자를 가진 방추형 삭과이다. 이에 반하여 남도현호색은 내화피 정단이 오목하게 함몰하고 잎 열편은 다양하며 2열 종자를 가진 방추형 삭과인 반면에, 흰현호색은 내화피는 오목하게 함몰하고 잎 열편은 타원형이며 1열 종자를 가진 선형 삭과이다. 또한 난장이현호색은 꽃색이 하늘빛 보라색이고 소엽은 타원형이며 꽃이 1–5개 달리고 아래 외화피가 반구형인 점에서 봉화현호색과 뚜렷이 구별된다.

주요어: 봉화현호색, 남도현호색, 신종, 현호색과

The genus *Corydalis* DC. (Fumariaceae) consists of approximately 465 species. It is distributed mainly in Northern Hemisphere (Cronquist, 1981; Zhang et al., 2008).

The genus *Corydalis* is characterized by perennial plants with rounded tuber, zygomorphic flowers with spur, and capsule fruit (Oh, 1999).

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The Korean taxa of the genus *Corydalis* were recently revised, and 18 species representing four sections and four subsections were recognized (Oh, 1999). Since then, six species of section *Corydalis* have been described (Oh, 1996; Oh and Jang, 2002; Oh et al., 2004; Oh and Choi, 2006; Kim et al., 2007; Kim et al., 2008; Oh et al., 2010). A total of 11 endemic species are reported among Korean *Corydalis* plants (Oh, 2007; Yang, 2016; Kim, 2017).

A new species of *Corydalis* from Bongwha-gun, Gyeongsangbuk-do in Korea was discovered. This new species shares several characters with its related species, *C. namdoensis* B. U. Oh et J. G. Kim. However, it can be distinguished from *C. namdoensis* based on its flower color (i.e., change from pale-yellow to white), inner-petal apex (i.e., mucronate), leaf lobe (i.e., long-linear), and capsule (i.e., fusiform).

Thus, we named this new species as *Corydalis bonghwaensis* M. Kim & H. Jo.

Taxonomic Treatment

Corydalis bonghwaensis M. Kim & H. Jo, sp. nov. (Figs. 1–3)

TYPE: KOREA. Gyeongsangbuk-do: Bonghwa-gun, 36°51'N, 128°52'E, elev. 298 m, 17 Apr 2013, MKV 20130417 (holotype, JNU; isotypes, JNU, KH, KB).

Korean name: Bong-hwa-hyeon-ho-saek (봉화현호색).

Diagnosis: *Corydalis bonghwaensis* M. Kim & H. Jo can be distinguished from its related species, *C. humilis* B. U. Oh & Y. S. Kim by having flower color (i.e., change from pale-yellow to white), leaf lobe (i.e., long-linear), flower number (i.e., 6–21), and lower-outer petal shape (i.e., slightly flattened) (Fig. 4).

Herbs, perennial. Tuber globose, 1.4–3.0 cm in diam., its inside white. Rhizome with spherical tuber, 5.5–8.5 cm long. Prophyll 1, 2.0–2.8 cm long. Stems 1–4 branches from base of prophyll, 16–34 cm, 1–3 mm in diam., circular in cross section. Cauline leaves 2, biternate (rarely ternate), petiolate; petiole, 1–3 cm long; blade 9–17 cm long, 13–15 cm wide; leaflets linear (rarely ovate-lanceolate), 4.2–9.5 cm long, 2–9 mm wide, apex entire (rarely parted). Raceme 6–21-flowered. Bracts fan-shape or obovate, apex cleft or parted, 0.7–2.7 mm long, 0.3–1.7 mm wide; lower bracts 1.4–2.7 mm long, 1.0–1.7 mm wide; upper bracts smaller. Pedicel slender, 0.4–2.0 cm long, glabrous. Flowers changed from pale-yellow to white. Sepal absent. Outer petals broad, smooth margin, apex V-shape without mucro, 2.1–2.7 cm long; spur 0.9–1.2 cm long; inner petal apex mucronate, 0.9–1.3 cm long. Stamens 2, 6–11 mm

long. Pistil 1, ovary fusiform, 6–11 mm long, stigma with 14 papillae. Capsule broadly flattened fusiform, 1.1–2.1 cm long, 6–7 mm wide. Seeds in 2 rows, ca. 1.9–2.2 mm, smooth.

Flowering: April to May.

Distribution: central Korea (Bongwha-gun).

Etymology: The specific epithet is derived from Bongwha in Korea where this new species is found.

Habitats: Small population of *Corydalis bonghwaensis* M. Kim & H. Jo with two hundreds individuals were found adjacent to the road in Bongwha-gun area. This new species occurs at mountain edge adjacent to the road in forests dominated by *Lonicera japonica* and *Spiraea prunifolia* f. *simpliciflora*. This species also occurs with other herbaceous species dominated by *Artemisia princeps* and *Taraxacum officinale*.

Additional specimens examined (paratypes): KOREA. Gyeongsangbuk-do: Bonghwa-gun, 18 Apr 2015, MKV 20150418 (JNU).

Key to the *Corydalis* species in Korea

1. Stigma J-shape with 4 papillae.
 2. Tuber numerous. Stems erect · *C. ternata* 들현호색
 2. Tuber 1. Stems procumbent · *C. decumbens* 좀현호색
1. Stigma polygonal-shape with 8–14 papillae.
 3. Prophyll with spherical accessory tuber

..... *C. ohii* 선현호색
 3. Prophyll without spherical accessory tuber.
 4. Capsule linear or tubular. Seeds arranged in 1 row.
 5. Flowers white.
 6. Inner petals separated. Stigma 8 papillae

..... *C. filistipes* 섬현호색
 6. Inner petals united. Stigma 14 papillae

..... *C. albigetala* 흰현호색
 5. Flowers blue or purple.
 7. Outer petals waved-margin. Outer petals with mucro.
 8. Tuber yellow.....

..... *C. turtschaninovii* 조선현호색
 8. Tuber white · *C. wandoensis* 완도현호색
 7. Outer petals smooth-margin. Outer petals without mucro.
 9. Outer petals narrow and diamond-margin

..... *C. remota* 현호색
 9. Outer petals wide and round-margin.
 10. Lower-outer petal margin round-shape. Flowers deep-blue

..... *C. ambigua* 왜현호색

Fig. 1. Holotype of *Corydalis bonghwaensis* M. Kim & H. Jo.

10. Lower-outer petal margin rhomboid-shape. Flowers pale-blue
..... *C. misandra* 각시현호색
4. Capsule fusiform. Seeds arranged in 2 rows.
11. Flowers white or pale-yellow.
12. Leaflets linear. Inner-petal mucronated apex. Flowers changed from pale yellow to white and 2.1–2.7 cm. Stigma 14 papillae *C. bonghwaensis* 봉화현호색
12. Leaflets elliptical. Inner-petal retuse apex. Flowers white and 1.2–1.8 cm. Stigma 12 papillae.
13. Peduncle and pedicel glabrous. Inner-petals with short rounded apex
..... *C. namdoensis* 남도현호색
13. Peduncle and pedicel pubescent. Inner-petals with long projected apex
..... *C. hirtipes* 털현호색
11. Flowers blue or purple.
14. Sepals developed.
15. Sepals 3–5 mm ... *C. grandicalyx* 갈퀴현호색
15. Sepals 0.5–3 mm ... *C. caudate* 수염현호색
14. Sepals absent.
16. Lower-outer petal with horn-shaped apex
..... *C. cornupetala* 쇠뿔현호색
16. Lower-outer petal without horn-shaped apex.
17. Lower-outer petal with sagittate base
..... *C. alata* 날개현호색
17. Lower-outer petal with round base.
18. Leaves with white-spots
..... *C. maculata* 점현호색
18. Leaves without white spots.
19. Peduncle and pedicel glabrous. Inner-petals projected apex
..... *C. humilis* 난장이현호색
19. Peduncle and pedicel pubescent. Inner-petals rounded apex
..... *C. hallaisanensis* 탐라현호색

Fig. 2. Photographs of *Corydalis bonghwaensis* M. Kim & H. Jo. **A.** Habitat. **B.** Adult plants with flowers. **C.** Side view of flower and bract. **D.** Shape of stigma (front view). **E.** Membraneous filament and anthers. **F.** Fruit. **G.** Seed.

Fig. 3. *Corydalis bonghwaensis* M. Kim & H. Jo. **A.** Adult plant with flowers. **B.** Flower and bract. **C.** Stigma with 14 papillae (left, front view; right, side view). **D.** Membranous filament and anthers. **E.** Lower part of outer petal (basal view). **F.** Inner petal. **G.** Ovary and ovule arrangement (front view). **H.** Shape of fruit & seed arrangement (up, front view; down, side view). **I.** Seed. **J.** Various shapes of leaflets (common shape, J1).

Fig. 4. Photographs of morphological comparison between *Corydalis bonghwaensis* and *C. humilis* in type locality. **A, C, E, G.** *C. bonghwaensis*. **B, D, F, H.** *C. humilis*. **A, B.** Adult plants with flowers. **C, D.** Inflorescence. **E, F.** Outer petal (side view). **G, H.** Capsule.

Table 1. Comparison of some morphological characters among *Corydalis bonghwaensis* and its related species.

Characters	<i>C. bonghwaensis</i>	<i>C. namdoensis</i>	<i>C. albipetala</i>	<i>C. humilis</i>
Tuber diam. (cm)	1.4–3.0	1–2	0.7–1.2	1.3–2.0
Tuber color	White	White	White	White
Prophyll (cm)	2.0–2.8	0.5–1.7	0.8–1.3	1.3–2.0
Leaf blade shape	Biternate (rarely ternate)	Ternate to biternate	Ternate to biternate	Ternate to biternate
Leaflet shape	Linear (rarely ovate-lanceolate)	Various types	Elliptical	Elliptical
Leaflet apex	Entire (rarely parted)	Entire or lobate or parted	Entire	Entire to parted
Bract shape	Fan-shape or obovate	Elliptical	Elliptical or ovate	Fan-shape
Bract apex	Cleft or parted	Entire or cleft	Entire or dentate	Entire to parted
Flower color	Pale-yellow to white	White or blueish white	White	Pale-blue purple
Flower number	6–21	2–15	2–14	1–5
Flower length (cm)	2.1–2.7	1.2–1.6	1.2–1.8	2.1–2.3
Inner petal apex	Mucronate	Retuse	Retuse	Slightly pointed
Lower outer petal apex	V-shape	V-shape	V-shape	V-shape
Lower outer petal shape	Slightly flattened	Slightly flattened	Slightly flattened	Hemispherical
Stigma papillae	14	12	14	14
Pedicel length (cm)	0.4–2.0	0.5–1.9	0.5–1.4	1.3–1.7
Capsule shape	Fusiform	Fusiform	Linear	Fusiform
Capsule length (cm)	1.1–2.1	1.0–1.2	1.0–1.2	1.2–1.7
Capsule width (cm)	0.6–0.7	0.5–0.6	0.2–0.3	0.4–0.5
Seed arrangement	2 rows	2 rows	1 row	2 rows
Seed size (mm)	1.9–2.2	1.8–2.0	1.8–2.0	1.8
Flowering	April to May	April to May	March to April	March to April
Distribution	Korea (Bonghwa)	Korea (Mt. Seonamsan, Mt. Ilwonsan, Mt. Ulryonsan, Mt. Mandeoksan)	Korea (Mt. Odaesan)	Korea (Mt. Hyeondeungsan, Mt. Sobaeksan, Mt. Tohamsan)

This new species, *Corydalis bonghwaensis* M. Kim & H. Jo was first discovered at Bonghwa-gun, Gyeongsangbuk-do, Korea. *Corydalis bonghwaensis* shares several characteristics (white flowers, glabrous pedicels, white inside tuber, and polygonal stigma shape) with its related species *C. namdoensis* and *C. albipetala*. However, it is distinct from its related species by having flowers changed from pale-yellow to white, mucronated inner-petal apex, lineared leaflets, and fusiform capsule with 2-rowed seeds. Thus, this taxon is described as a new species in genus *Corydalis* (Table 1).

Based on the IUCN Red List Categories and Criteria (IUCN, 2011), *Corydalis bonghwaensis* M. Kim & H. Jo is categorized as Endangered (EN) species because only 200 organisms have been found at roadside of Bonghwa, Korea.

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