

Reexamination of vascular plants in Ullung Island, Korea: I. *Monotropa* L. (Monotropaceae)

Hyunchur Shin, Chong-wook Park and Hyun-Woo Lee

(Department of Biology, Seoul National University, Seoul 151-742, Korea)

울릉도산 관속식물의 재검토: I. 수정난풀속 (수정난풀과)

신 현 철 · 박 종 욱 · 이 현 우

(서울대학교 생물학과)

Abstract

As a part of comprehensive systematic study on the vascular plants in Ullung Island, major morphological characteristics of *Monotropa* species in Korea were examined. The results confirmed that both *M. uniflora* and *M. hypopithys* are distributed in Korea. In Ullung Island, the occurrence of *Monotropa* species was not reported previously, but a population of *M. uniflora* was found along the roadside from Jeodong to Sumgot near Wadal-ri by the authors. *Monotropa uniflora* can be distinguished from *M. hypopithys* by its single-flowered inflorescence, glabrous stem, glabrous pistil, and eciliate stigma. In addition, the pollen grains and seeds are larger than those of *M. hypopithys*.

Introduction

The genus *Monotropa* (Monotropaceae), first recognized by Linnaeus (1753), consists of two species, *M. uniflora* L. and *M. hypopithys* L. (Wallace, 1975). The genus is usually characterized by nodding flowers, polypetalous corollas, pubescent filaments, 4- or 5-loculed ovaries, an axile placentation, and capsular fruits (Wallace, 1975). The species of *Monotropa* are distributed in cool to temperate regions of the Northern Hemisphere, and they usually occupy shady areas in coniferous, evergreen, or mixed forests (Bobrov, 1967;

Wallace, 1975).

In Korea, the occurrence of *Monotropa* species has been reported in several publications (Nakai, 1914, 1921, 1952; Chung, 1957; Park, 1974; Lee, 1979), but the species recognized in these works has been inconsistent; Nakai (1914, 1921, 1952) and Chung (1957) recognized a single species, *M. uniflora*, in Korea, whereas later authors (Park, 1974; Lee, 1979) recognized only *M. hypopithys*. However, no prior attempt has been made to clarify the taxonomic identities of *Monotropa* species in Korea, and their identities remain rather ambiguous.

As a part of comprehensive systematic study on the vascular plants in Ullung Island, morphological characteristics, including microstructures of pollen grains and seeds, of *Monotropa* species in Korea were examined to clarify their taxonomic identities.

Materials and Methods

Morphological characteristics were examined using the specimens collected by the authors in Ullung Island in 1991, and those deposited in SNU, SKK, and SNUA. For microstructures of pollen grains and seeds, samples taken from herbarium specimens were observed and photographed with Akashi SX-40 scanning electron microscope. Specimens used for SEM studies are listed in Appendix.

Genus *Monotropa* L., Sp. Pl. p. 387, 1753. **Type:** *M. hypopithys* L.

Hypopitys Adanson, Fam. Pl. 2: 443, 1763.

Monotropion Saint-Lager, Reform. Nom. Bot. p. 130, 1880.

Korean name: 수정난풀속 (Sujeongnanpul-sok)

Mycotrophic achlorophyllous fleshy perennial herbs, 10-25 cm tall, white or yellowish brown, black when dry; stem erect, unbranched, cylindrical; leaves simple, alternate, sessile, scalelike, oblong to ovate, 0.8-2.0 cm long, 0.4-1.0 cm wide, obtuse at the apex, truncate at the base; flowers solitary or in terminal raceme, bisexual, perfect, actinomorphic, hypogynous, nodding, bracteate; bracts elliptic, 0.7-2.0 cm long, 0.2-1.5 cm wide; sepals 3-5, free, ovate to oblong, 0.7-1.2 cm long, ca. 5 mm wide; petals 3-6, free, white or reddish, obovate to oblong, 0.8-2.0 cm long, truncate at the apex, somewhat saccate in lower portion, often ciliate at the margin; inner surface of the petal usually pubescent with simple unicellular hairs; stamens 8-10, included; filaments filiform, 0.5-1.5 cm long, moderately pubescent with simple unicellular hairs; anthers 2-locular, dehiscent by a single terminal slit; pollen grains monad, tricolpate, circular to weakly triangular in polar view, compressed oval in equatorial view, 26-30 μm x 22-25 μm , scabrate; ovary 1, plurilocular with 4-5 united carpels, ovoid, with distinct grooves along the sutures; placentation axile; stigma 1,

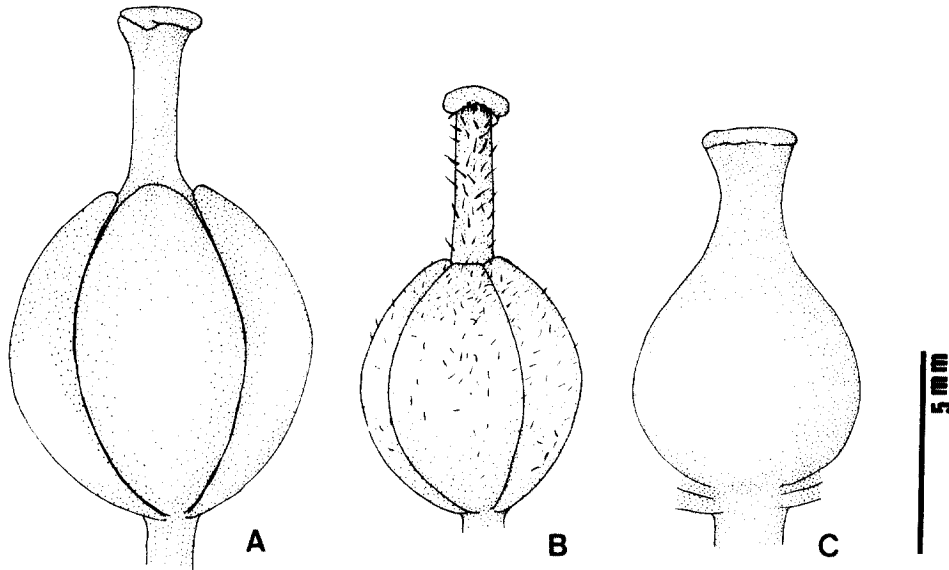


Fig. 1. Mature pistils of *Monotropa* and *Monotropastrum* species. A: *Monotropa uniflora*; B: *Monotropa hypopithys*; C: *Monotropastrum humile*.

funnelform; style 1, cylindrical, short, 2–7 mm long, with distinct articulation between style base and ovary; fruits capsule, becoming erect, ovoid in outline, longitudinally dehiscent; seeds numerous, minute, cylindrical in overall shape, with elongate testa at both ends, 0.6–2.0 mm long, 0.1–0.2 mm wide, reticulate with distinct ridges.

Distribution: In shady areas, usually in rich soils of coniferous, evergreen, or mixed forests; in cool to temperate regions of the Northern Hemisphere, extending south to Colombia (Wallace, 1975); in Korea, from Pyungbuk to Cheju, and eastward to Ullung Island.

The genus *Monotropa* is closely related to *Monotropastrum* Andres, and the plants of *Monotropa* are very similar to those of *Monotropastrum* in overall appearance. However, it is distinct from the latter in having distinct articulation between the style base and the ovary (Fig. 1), an axile placentation, erect capsules, and cylindrical seeds (Table 1). SEM studies

Table 1. A morphological comparison of *Monotropa* and *Monotropastrum* species

	<i>Monotropa</i>		<i>Monotropastrum</i>
	<i>uniflora</i>	<i>hypopithys</i>	<i>humile</i>
stem	glabrous	pubescent	glabrous
flower number	1	4-6 (1)	1
placentation	axile	axile	parietal
pistil	glabrous	pubescent	glabrous
stigma	eciliate	ciliate	eciliate
articulation between style and ovary	present	present	absent
pollen			
aperture type	tricolpate	tricolpate	triporate
surface	scabrate	scabrate	psilate
equatorial length (μm)*	30.6 \pm 1.67	26.9 \pm 1.57	29.3 \pm 1.87
polar length (μm)*	25.5 \pm 1.62	23.3 \pm 0.75	24.3 \pm 1.11
fruit	erect capsule	erect capsule	nodding berry
seed			
shape	cylindrical	cylindrical	obovoid
length (mm)*	1.12 \pm 0.05	0.70 \pm 0.07	0.33 \pm 0.02
width (mm)*	0.15 \pm 0.03	0.13 \pm 0.01	0.17 \pm 0.02

* mean \pm standard deviation.

also showed that they differ fundamentally in microstructures of pollen grains and seeds (Fig. 2). Pollen grains of *Monotropa* are tricolpate and scabrate (Fig. 2A-C), whereas those of *Monotropastrum* are triporate and psilate (Fig. 2D, E). Seeds of *Monotropa* are somewhat cylindrical with a spindle-shaped central core containing the endosperm and embryo (Fig. 2F, G), but in *Monotropastrum*, they are obovoid with a distinct, short stalk at the base (Fig. 2H). In addition, the ridges on the seed surfaces are more distinct and relatively uniform in thickness in *Monotropa* as compared to those in *Monotropastrum* (Fig. 2F-H).

In his recent monograph of the subfamily Monotropoideae, Wallace (1975) recognized two species in the genus, *M. hypopithys* and *M. uniflora*. In Korea, the occurrence of *M. uniflora* was first reported from Cheju Island by Nakai (1914), and the species was later included in 'Synoptical Sketch of Korean Flora' (Nakai, 1952) and 'Korean Flora Part II' (Chung, 1957). However, in more recent Korean floristic treatments of the genus (Park, 1974; Lee, 1979), only *M. hypopithys* is listed. Critical examination of *Monotropa* collections in SNU, SNUA, and SKK confirmed that both species are distributed in Korea. In Ullung Island, only *M. uniflora* is found.

Fig. 2. Scanning electron micrographs of pollen grains (A-E) and seeds (F-H) of *Monotropa* and *Monotropastrum* species. A, B, F: *Monotropa uniflora*; C, G: *Monotropa hypopithys*; D, E, H: *Monotropastrum humile*.

Key to the species of the genus *Monotropa*

Although only *M. uniflora* occurs in Ullung Island, a comprehensive key to the species is provided for identification of *Monotropa* species in Korea.

1. Flowers several, in terminal raceme, very rarely solitary; stem usually pubescent with simple unicellular hairs; pistil pubescent with simple unicellular hairs; stigma ciliate at the margin. *M. hypopithys*.
2. Flowers solitary; stem usually glabrous; pistil glabrous; stigma eciliate. *M. uniflora*.

Monotropa uniflora L., Sp. Pl. p. 387, 1753. *Hypopithys uniflora* (L.) Cranz, Inst. Rei. Herb. 2: 467, 1766.

Monotropa morisoniana Michaux, Fl. Bor.-Amer. ed 1, 1: 266, 1803.

Monotropa morisoni Pers., Syn. Pl. 1: 469, 1805.

Monotropa coccinea Zucc., Flora 15: 100, 1832. *M. uniflora* ssp. *coccinea* (Zucc.) Andres, Abh. Bot. Ver. Prov. Brand. 52: 94, 1910. *M. uniflora* var. *coccinea* (Zucc.) Domin, Sitzungsber. Königl. Böhm. Ges. Wiss. Prag. Math.-Naturwiss. Cl. Abt. I. 54: 5, 1915.

Monotropa australis Andres, Abh. Bot. Ver. Prov. Brand. 52: 94, 1910, nom. nud.

Monotropa brittonii Small, J. New York Bot. Gard. 28: 7, 1927.

Monotropa nipponica Hara, J. Jap. Bot. 14: 810, 1938, nom. nud.

Korean name: 수정난풀 (Sujeongnanpul; Chung, 1957)

Fleshy white herb; stem 10-25 cm tall, glabrous; leaves oblong, 1-2 cm long, 0.6-1.0 cm wide, obtuse at the apex, truncate at the base, upper ones usually larger than lower ones, often irregularly toothed in upper portion, glabrous; flowers solitary, terminal, campanulate, 1-2 cm long; bracts elliptic, acute at the apex, 0.7-2.0 cm long, 0.2-1.0 cm wide; sepals 3-5, oblong, ca. 1 cm long, ca. 6 mm wide, obtuse at the apex; petals 3-6, oblong, 1.5-2.0 cm long, 0.5-1.5 cm wide, usually white, rarely reddish, truncate at the apex, broadly saccate in lower portion, often ciliate at the margin; inner surface of the petal moderately pubescent with simple unicellular hairs; stamens 8-14; filaments 0.7-1.5 cm long, moderately pubescent with simple unicellular hairs; pollen grains tricolpate, circular to weakly triangular in polar view, compressed oval in equatorial view, 30 μm x 25 μm , scabrate; ovary ovoid, 0.6-1.2 cm long, glabrous; stigma 1, funnelform, eciliate; style 1, 2-7 mm long, glabrous; capsules becoming erect when mature, ovoid, glabrous, 1-2 cm long; seeds cylindrical with a spindle-shaped central core containing the endosperm and embryo, reticulate with ridges, 1-2 mm long, ca. 0.2 mm wide; ridges distinct, relatively uniform in thickness.

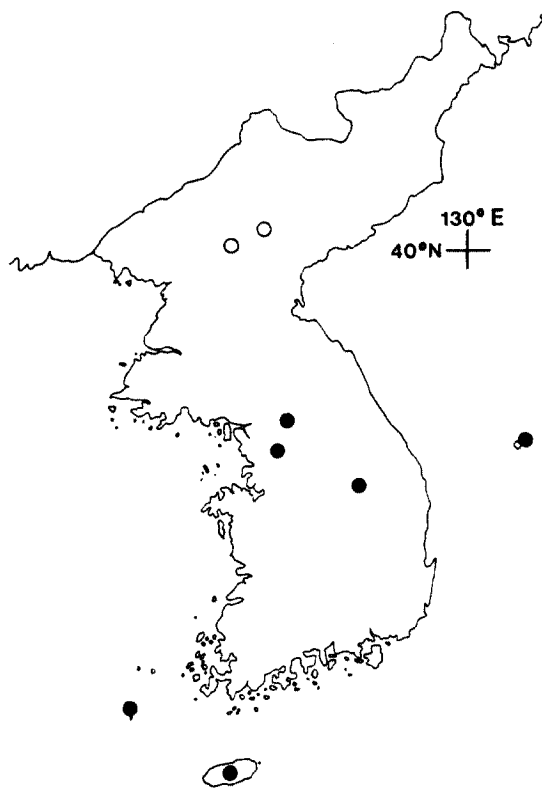


Fig. 3. Distribution of *Monotropa uniflora* in Korea (open circles: localities from the literature).

Distribution: In shady areas, usually in rich soils of moist coniferous forest; confined to North America and eastern Asia; with isolated populations in Central America and Colombia (Wallace, 1975); in Korea, from Mt. Myohyang in Pyungbuk to Mt. Halla in Cheju, and eastward to Ullung Island (Fig. 3). The species was not reported previously from Ullung Island, but a population was found along the roadside from Jeodong to Sumgot near Wadal-ri by the authors.

Monotropa uniflora can be distinguished from its close relative, *M. hypopithys*, by its single-flowered inflorescence, glabrous pistil, eciliate stigma, and glabrous stem. In addition, the pollen grains and seeds are larger than those of *M. hypopithys* (Table 1).

Monotropa uniflora superficially resembles *Monotropastrum humile* (D. Don) Hara (= *Monotropastrum globosum* Andres ex Hara) in overall appearance, including a single-flowered inflorescence. As a result, it is frequently confused with the latter species, and most of the collections are determined as *Monotropastrum humile* in Korean herbaria.

Monotropa uniflora was included in the 'Korean Flora Part II' (Chung, 1957), however,

the illustration provided by Chung (1957) does not match his description. In his description, Chung pointed out that the fruit type of *M. uniflora* is a capsule, but the fruit in the illustration is apparently a berry, an unique characteristic of *Monotropastrum humile*. Chung (1957) also placed *Monotropastrum globosum* (= *Monotropastrum humile*) in synonymy under *M. uniflora*, however, it is distinct from *Monotropa uniflora* in having a parietal placentation, triplicate, psilate pollen grains, a nodding berry, and obovoid seeds (Table 1, Fig. 2).

Specimens examined. JAPAN. Fukushima: Ishikawa, 25 Oct 1936, *Col.?* (SNU [2 sheets]). **KOREA.** Without specific locality and date, *Lee et al. s.n.* (SNUA); specific locality unknown ("Kwang-reung or Mt. Seolak"), 3 Sep 1963, *Lee et al. s.n.* (SNUA [4 sheets]); specific locality unknown ("Kwang-reung or Mt. Seolak"), Oct 1963, *Lee et al. s.n.* (SNUA [2 sheets]). **Cheju:** Without specific locality, 7 Jun 1975, *Lee 2510* (SNUA); Mt. Halla, without date, *Hyun s.n.* (SNU); Mt. Halla, 3 Oct 1964, *Lee et al. s.n.* (SNUA [3 sheets]). **Chungbuk:** Danyang-gun, Maepo-myeon, Sangsi-ri, under *Pinus densiflora* forest, in Aug 1990, *Lee & Kim s.n.* (SNU). **Chunnam:** Shin An Gun, Huksan Myon, Sohuksan Island, NE-facing slope of Tokshil Mt. ascent from Taepung-ri, 34° 04'N 125° 06'E, rising from an underground mass of tissue mixed with soil in dense shade of forest floor, with *Quercus acuta*, *Machilus*, alt. ca 350 m, 20 Sep 1985, *Yinger et al. 3563* (SNUA). **Kyungbuk:** Ullung Island, near Wadal-ri, along the roadside from Jeodong to Sumgot, alt. 350 m, 17 Oct 1991, *Shin et al. 1001* (SNU [2 sheets]). **Kyunggi:** Kwang-reung, 14 Oct 1954, *Chung s.n.* (SKK); Kwang-reung, 27 Jun 1916, *Ishidoya s.n.* (SKK 895); Kwang-reung, 10 Aug 1972, *Kim s.n.* (SNU); Kwang-reung, 10 Aug 1972, *Kim & Chai s.n.* (SNU); Mt. Kwang-gyo, Sep 1957, *Lee s.n.* (SNUA [2 sheets]); Kwang-reung, 10 Aug 1972, *Lee s.n.* (SNU); Kwang-reung, 10 Aug 1972, *Lee & Choi s.n.* (SNU); Kwang-reung, Soribong, 25 Aug 1964, *Lee et al. 3902* (SNUA [6 sheets]).

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적 요

울릉도산 관속식물의 분류학적 연구의 일환으로 수정난풀속(*Monotropa* L.) 식물의 형태학적 특징을 재검토하였다. 그 결과, 한반도에는 수정난풀(*M. uniflora*)과 구상난풀(*M. hypopithys*) 2종이 분포하며, 이중 수정난풀 한 종이 울릉도 와달리 근처 길가에서 분포하고 있음이 처음으로 확인되었다. 수정난풀과 구상난풀은 화서에 달리는 꽃의 수, 암술에서의 털의 유무 등의 외부형태학적 형질뿐만 아니라 화분과 종자의 미세구조에 의해서도 구분되는 것으로 밝혀졌다.

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Appendix

Specimens used for SEM studies of pollen grains and seeds.

Monotropa uniflora L.

JAPAN. Fukushima: Ishikawa, 25 Oct 1936, *Col. ?* (SNU; pollens). **KOREA. Kyungbuk:** Ullung Island, near Wadal-ri, along the roadside from Jeodong to Sumgot, alt. 350 m, 17 Oct 1991, *Shin et al. 1001* (SNU; seeds)

Monotropa hypopithys L.

KOREA. Chungbuk: Mt. Weolak, main ridge, 9 Sep 1988, *Lee s.n.* (SNU; pollens).
Chungnam: Mt. Taejo, 15 Apr 1988, *Kim s.n.* (SNU; seeds).

Monotropastrum humile (D. Don) Hara

JAPAN. Toyama: Mitsutoge, 16 Jun 1935, *Col. ?* (SNU; pollens). **KOREA. Kangwon:** Noinbong, 5 Jul 1988, *Chung & Lee s.n.* (SKK; seeds)