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# A review on subfamily Monotropoideae (Ericaceae) for Thailand: a new genus and species records

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**Abstract**. A revision of Monotropaceae in 2000 for the Flora of Thailand recorded a single species, *Monotropa hypopitys* L. Based on molecular and morphological findings, Monotropaceae was later included in Ericaceae as subfamily Monotropoideae. In this paper, two genera and three species are recognised in Thailand. *Cheilotheca* Hook. f. is a new genus record for Thailand, while *Cheilotheca crocea* L. Wu & Yan Liu and *M. uniflora* L. are new national records. An updated identification key to genera and species of Monotropoideae in Thailand, together with descriptions and illustrations of the genus and new record species, are provided.

**Keywords:** *Cheilotheca*, flora of Thailand, *Monotropa*, Monotropaceae, new national records

## Introduction

The subfamily Monotropoideae within Ericaceae was once considered a distinct family, Monotropaceae, which was established by Nuttall (1818). Subsequently, Lindley (1836), Bentham & Hooker (1876) and Cronquist (1968) accepted Nuttall's proposal and included the family in their taxonomic classifications of flowering plants. However, recent phylogenetic classification based on molecular and morphological evidence has confirmed the placement of Monotropaceae within a larger Ericaceae, better suited as subfamily Monotropoideae (Kron *et al*., 2002; Stevens *et al*., 2004). This subfamily can be distinguished by its myco-heterotrophy and non-photosynthetic or

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achlorophyllous traits, herbaceous habit, with a distribution in the Northern Hemisphere (Wallace, 1975; Stevens, 2001).

A taxonomic monograph on Monotropoideae recognised 10 genera and 12 species (Wallace, 1975). Subsequently, one species, *Monotropastrum sciaphilum* (Andres) G.D. Wallace (= *Eremotropa sciaphila* Andres), has been added (Wallace, 1987). For Asia, Wallace recognised three genera comprising six species, namely *Cheilotheca khasiana* Hook. f., *C. malayana* Scort. ex Hook. f., *Monotropa hypopitys* L., *M. uniflora* L., *Monotropastrum humile* (D. Don) H. Hara and *M. sciaphilum* (Wallace, 1987).

Stevens (2001) divided Monotropoideae into two tribes based on multicellular hair presentation and the number of porate on a pollen, namely Monotropeae and Pterosporeae. As currently circumscribed, Monotropoideae comprises 11 genera and *ca*. 18 species, *i.e*. *Allotropa* Torr. & A. Gray (1 sp.), *Cheilotheca* Hook. f. (4 spp.), *Eremotropa* Andres (1 sp.), *Hemitomes* A. Gray (1 sp.), *Monotropa* L. (4 spp.), *Monotropastrum* Andres (2 spp.), *Monotropsis* Schwein. (1 sp.), *Pityopus* Small (1 sp.), *Pleuricospora* A. Gray (1 sp.), *Pterospora* Nutt. (1 sp.) and *Sarcodes* Torr. (1 sp.) (Wu *et al*., 2016; POWO, 2023; Suetsugu *et al*., 2023).

Few records present on the occurrence of the subfamily in Southeast Asia, such as *C. malayana* from Perak, Malaysia, *C. sleumeriana* H. Keng from Sumatra, Indonesia (Keng, 1974), *M. hypopitys* and *M. uniflora* from Myanmar and *M. humile* from Myanmar, Laos and Vietnam (Kress *et al*., 2003; Qin & Wallace, 2005; Newman *et al*., 2007; POWO, 2023).

Before the molecular findings, Monotropoideae was treated as a distinct family, Monotropaceae, in Thailand with a single species enumerated, *M. hypopitys*, based on *Kerr 678* (K) (Larsen, 2000). Another collection, *Kerr 174* that was cited by Fletcher (1938) for the Florae Siamensis Enumeratio, was also mentioned by Larsen (2000) but it was never traced and found. Moreover, he also mentioned that *C. humilis* (D. Don) H. Keng (= *M. humile*) and *C. malayana* should be looked for in Thailand (Larsen, 2000). Qin & Wallace (2005) and POWO (2023) reported that *M. humile* occurred in Thailand. Unfortunately, no Thai specimen was cited, and we have also not seen any specimens deposited in Thai herbaria. Thus, the existence of *M. humile* in Thailand has yet to be confirmed. Various botanical explorations conducted by botanists from the Queen Sirikit Botanic Garden yielded additional specimens of Monotropoideae in Thailand and these materials were all deposited at the herbarium of the botanic garden (QBG). In July 2001, Monthon Norsaengsri collected *C. crocea* in the mixed deciduous forest at 1,000 m elevation in Ban Lao Wu, Wiang Haeng, Chiang Mai province. Later, Charun Maknoi found the same species occurring in the hill evergreen forest between 1,200 and 1,300 m elevation in Phu Suan Sai, Loei province. In September 2001, another Monotropoideae specimen identical to *M. uniflora* was collected by Piyakaset

Suksathan in the hill evergreen forest of Doi Phi Pan Nam, *ca*. 1,800 m elevation. In September 2011, Rachun Pooma *et al*. found *M. uniflora* in the hill evergreen forest of Doi Inthanon *ca*. 2,150 m. Thus, we intend to fulfil the requirement of publishing new national records officially by citing vouchered specimens as recommended in Rujichaipimon *et al*. (2019).

In this paper, we reviewed and updated the taxonomic account of the subfamily Monotropoideae for the Flora of Thailand. Two genera and three species are enumerated, *i.e*. *Cheilotheca crocea*, *Monotropa hypopitys* and *M. uniflora*. The genus *Cheilotheca* Hook. f. represents a new generic record for Thailand.

## Materials and Methods

Comprehensive field surveys in Thailand were undertaken between 2001 and 2008 with vouchered specimens largely deposited at QBG. Herbarium specimens from AAU, BK, BKF, C, K and QBG were also surveyed and examined (herbarium acronyms cited follow Thiers, 2024). Taxonomic literature on the subfamily Monotropoideae (Ericaceae), *e.g*. Sleumer (1967), Keng (1974), Wallace (1975, 1987), Larsen (2000), Kron *et al*. (2002), Qin & Wallace (2005), Wu *et al*. (2016) and Suetsugu *et al*. (2023), were consulted. Morphological descriptions of the new records were prepared based on the voucher specimens, both dried and preserved in spirit.

## Taxonomic treatment

### ERICACEAE subfamily Monotropoideae (formerly Monotropaceae)

Perennial, myco-heterotrophic and achlorophyllous herbs; roots succulent and highly branched. *Leaves* spiral, scale-like, sessile. *Inflorescences* racemose or 1-flowered, white, yellowish to brownish, or reddish to purplish, develop from adventitious buds on the root system; bracts leaf-like. *Flowers* bisexual, actinomorphic, erect or nodding. *Sepals* (2–)3–5. *Petals* 3–5, imbricate, free or connate at the base. *Stamens* usually twice the number of petals, in 2 whorls; anthers erect, opening by 1–2 slits. *Ovary* superior, various shapes, glabrous to finely pubescent, with axile or parietal placentation, articulated to style or not; disk lobed or entire, with nectaries. *Fruit* a loculicidal capsule or berry; seeds small, numerous.

Eleven genera and *ca*. 18 species (POWO, 2023) distributed in the Northern Hemisphere (Stevens, 2001). Two genera and three species in Thailand.

### Key to the genera of subfamily Monotropoideae

1. Flowers erect at anthesis; style merging imperceptibly with the upper part of the ovary; ovary 1-locular, with parietal placentation; fruit a berry **1. Cheilotheca**
1. Flowers nodding at anthesis; articulation between style-base and ovary evident; ovary 4–5(–6)-locular, with axile placentation; fruit a loculicidal capsule **2. Monotropa**

### 1. CHEILOTHECA

Hook. f. in Benth. & Hook. f., Gen. Pl. 2: 607. 1876; C.B. Clarke in Hook. f., Fl. Brit. India 3: 477. 1882; Keng, Reinwardtia 9(1): 82. 1974; Wallace, Wasmann J. Biol. 33(1–2): 18. 1975; Stevens *et al*. in Kubitzki, Fam. Gen. Vasc. Pl. 6: 168. 2004; Wu *et al*., Phytotaxa 260(2): 194. 2016.— *Wirtgenia* Andres, Verh. Bot. Ver. Brandenb. 56: 61. 1914, *nom. illeg*., non Sch. Bip., 1842.— *Andresia* Sleumer in Steenis, Fl. Males., Ser. I, Spermat. 6: 669. 1967.

Fleshy herbs; stems erect, simple or branched. *Leaves* scale-like, sessile. *Inflorescences* terminal, racemose or 1-flowered, stout; bracts appressed to the stout pedicel; sterile bracts scale-like, sessile, distinctly imbricate. *Flowers* erect. *Sepals* (2–)3–4, sometimes resembling nearby bracts. *Petals* 3(–5), oblong, obtuse to rounded, hooded, free, apex obtuse to rounded, with strongly concave and thickened. *Stamens* 6(–8), in 2 whorls; anthers opening by longitudinal slits. *Ovary* 1-locular, with parietal placentation, not articulated to style-base; stigma 6-lobed; disk prominent or inconspicuous, lobed or entire, with nectaries between stamen-base. *Fruit* a berry, with persistent stigma; seeds minute, numerous, subglobose.

About 3–4 species distributed in India (Assam), Southern China, Malaysia (Perak) and Indonesia (Sumatra). One species in Thailand.

**Cheilotheca crocea** L. Wu & Yan Liu, Phytotaxa 260(2): 194, f. 1–2. 2016. Figs. 1 & 3A–B.

Herbs, white when fresh, 10–20 cm tall; stems simple or 2–5-branched. *Leaves* densely crowded, ovate, 6–23 × 4–15 mm, sessile, apex acute, margin entire, glabrous. *Inflorescences* racemose, 2–10-flowered; bracts white, oblong, 15–20 × 3–12 mm, apex obtuse, margin entire or subentire, glabrous. *Flowers* erect. *Sepals* 3–4, white, oblong, 15–20 × 4–12 mm, apex obtuse, veins 5–7. *Petals* 3–4, orange in the upper half, white in the lower half, narrowly oblong, 20–25 × 6–8 mm, base concave, apex rounded, conspicuously hood-like and thickened, margin entire, veins 5–7, finely pubescent inside. *Stamens* 6(–8), equal, 15–18 mm long; filaments compressed, 10–13 mm long, pubescent; anthers basifixed, 2–5 mm long, confluent at apex, longitudinal dehiscence. *Ovary* 7–12 mm in diam., glabrous, with 6 parietal placentas; style short, *ca*. 5 mm long, glabrous; stigma 1–2 mm in diam., capitate, with 6 lobes; ovule numerous. *Berries* ellipsoid-globose, 18–25 mm long, 7–14 mm in diam., glabrous.

Thailand.— NORTHERN: Chiang Mai [Wiang Haeng, Ban Lao Wu, *ca*. 1,000 m alt., 18 Jul. 2001, *M. Norsaengsri 1590* (QBG!)]; NORTH-EASTERN: Loei [Na Haeo, Phu Suan Sai, 1,200–1,300 m alt., 10 Jul. 2008, *C. Maknoi 2605* (QBG!)].

Distribution.— China (Guangxi).

Ecology and Phenology.— Mixed deciduous and lower montane forests, 1,000–1,300 m alt. Flowering: July.

Notes.— *Cheilotheca crocea* is closely related to *C. malayana* in having six stamens

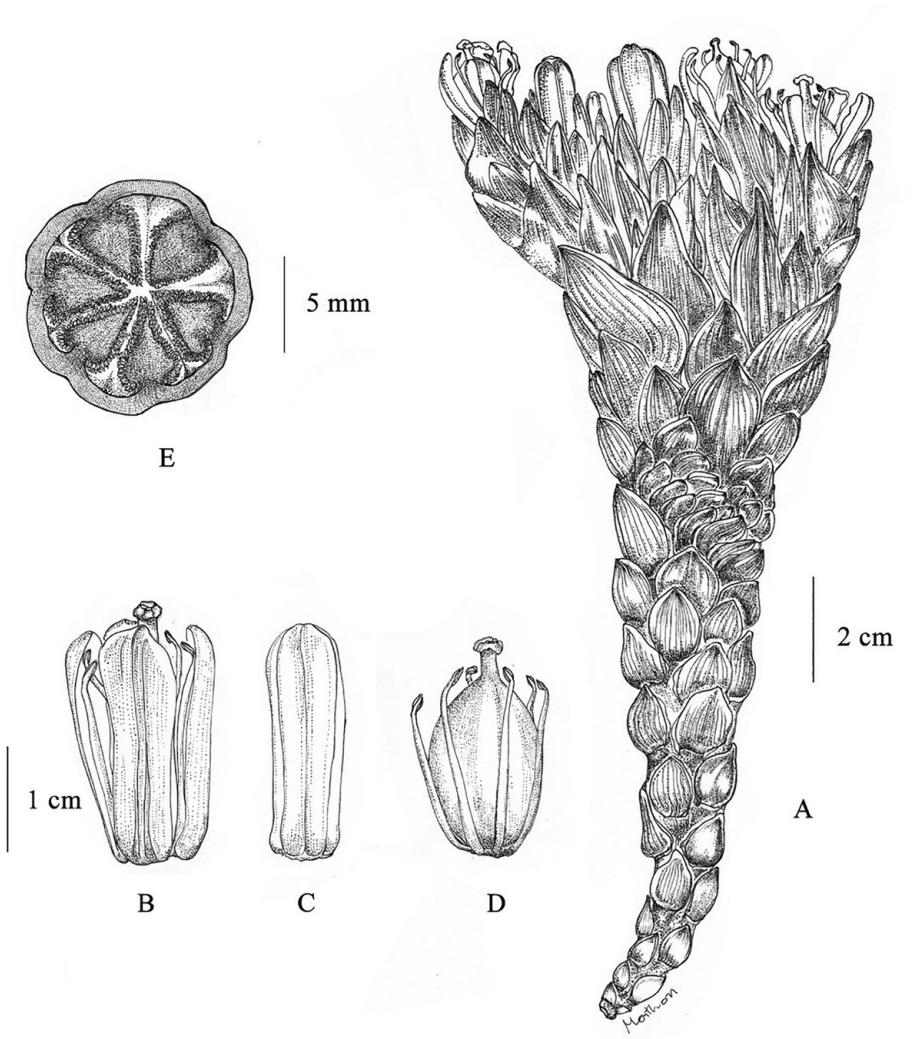


**Figure 1.** *Cheilotheca crocea*: A. flowering plant; B. flower; C. floral bud; D. pistil and stamens; E. ovary, cross-section. Drawn by M. Norsaengsri.

and hippocrepiform anthers with connate apex, but differs from *C. malayana* in having filaments equal in length (vs filaments unequal in length in *C. malayana*), and anthers elongate with 2-longitudinal slits (vs anthers short with a single terminal slit in *C. malayana*) (Wu *et al*., 2016). This species was previously known only from Damingshan National Nature Reserve, Guangxi, China and its conservation status was provisionally assigned as 'Critically Endangered' (CR B2a & C2a i) (Wu *et al*., 2016). This new record of its occurrence outside of China extends its distribution range and a review of its conservation status is necessary. In Thailand, *C. crocea* is extremely rare and has only been collected twice, in July 2001 in Chiang Mai and in July 2008 in Loei provinces, respectively.

## 2. MONOTROPA

L., Sp. Pl. 1: 387. 1753; C.B. Clarke in Hook. f., Fl. Brit. India 3: 476. 1882; Wallace, Wasmann J. Biol. 33(1–2): 29. 1975; Larsen in Santisuk & Larsen, Fl. Thailand 7(2): 266. 2000; Stevens *et al*. in Kubitzki, Fam. Gen. Vasc. Pl. 6: 168. 2004; Qin & Wallace in Wu *et al*., Fl. China 14: 255. 2005.— *Hypopitys* Hill, Brit. Herb.: 221. 1756, *nom. superfl.*— *Monotropion* St.-Lag., Ann. Soc. Bot. Lyon 7: 130. 1880.

Fleshy herbs; stems erect, simple. *Leaves* scale-like, sessile. *Inflorescences* terminal, racemose or 1-flowered; bracts appressed to the pedicel. *Flowers* nodding; pedicels recurved, becoming erect in fruit. *Sepals* 3–5. *Petals* 3–5, usually free with saccate at base. *Stamens* 8–12 or rarely more; anthers opening by longitudinal slits. *Ovary* 4–5(–6)-locular, with axile placentation, articulation between style-base and ovary evident; disk present, with nectaries of 8–10 paired lobes between stamen-base. *Fruit* a loculicidal capsule; seeds spindle-shaped with appendages at both ends.

About 2–4 species widely distributed in the Northern Hemisphere. Two species in Thailand.

### KEY TO THE SPECIES

1. Inflorescence pale yellowish brown, 3–10-flowered **1. M. hypopitys**
1. Inflorescence white, 1-flowered **2. M. uniflora**

**1. Monotropa hypopitys** L., Sp. Pl. 1: 387. 1753; Wallace, Wasmann J. Biol. 33(1–2): 31. 1975 (see also for complete synonymy); Larsen in Santisuk & Larsen, Fl. Thailand 7(2): 266, f. 8. 2000; Qin & Wallace in Wu *et al*., Fl. China 14: 255. 2005.— *Hypopitys lanuginosa* auct. non Nutt.: C.B. Clarke in Hook. f., Fl. Brit. India 3: 476. 1882; Craib, Aberdeen Univ. Studies 57: 122. 1912; Fletcher in Kerr, Fl. Siam. 2: 319. 1938. Type: Specimen in Burser Herbarium (vol. III, fol. 156, UPS, *n.v.*). Figs. 3C–D.

For a complete description of the species, see Larsen (2000).

Thailand.— NORTHERN: Chiang Mai [Doi Suthep-Pui, *ca*. 1,250 m alt., 6 Jun. 1909, *A.F.G. Kerr 678* (K!); ibid., 1,610 m alt., 24 Sep. 1988, *J.F. Maxwell 88-1117* (CMU!); ibid., 1,500 m alt., 1 Jul. 1989, *J.F. Maxwell 89-845* (CMU!); ibid., 1,600 m alt., 27 Jun. 2007, *S. Watthana 2373* (QBG!)].

Distribution.— Widely distributed throughout the circumboreal. In Asia, *M. hypopitys* is found in Iran, Afghanistan, Pakistan, India, Nepal, Bhutan, Myanmar, Mongolia, China, North Korea, South Korea and Japan.

Ecology and Phenology.— Lower montane forest, dominated by Fagaceae and Theaceae, 1,250–1,610 m alt. Flowering: June–July and fruiting: September.

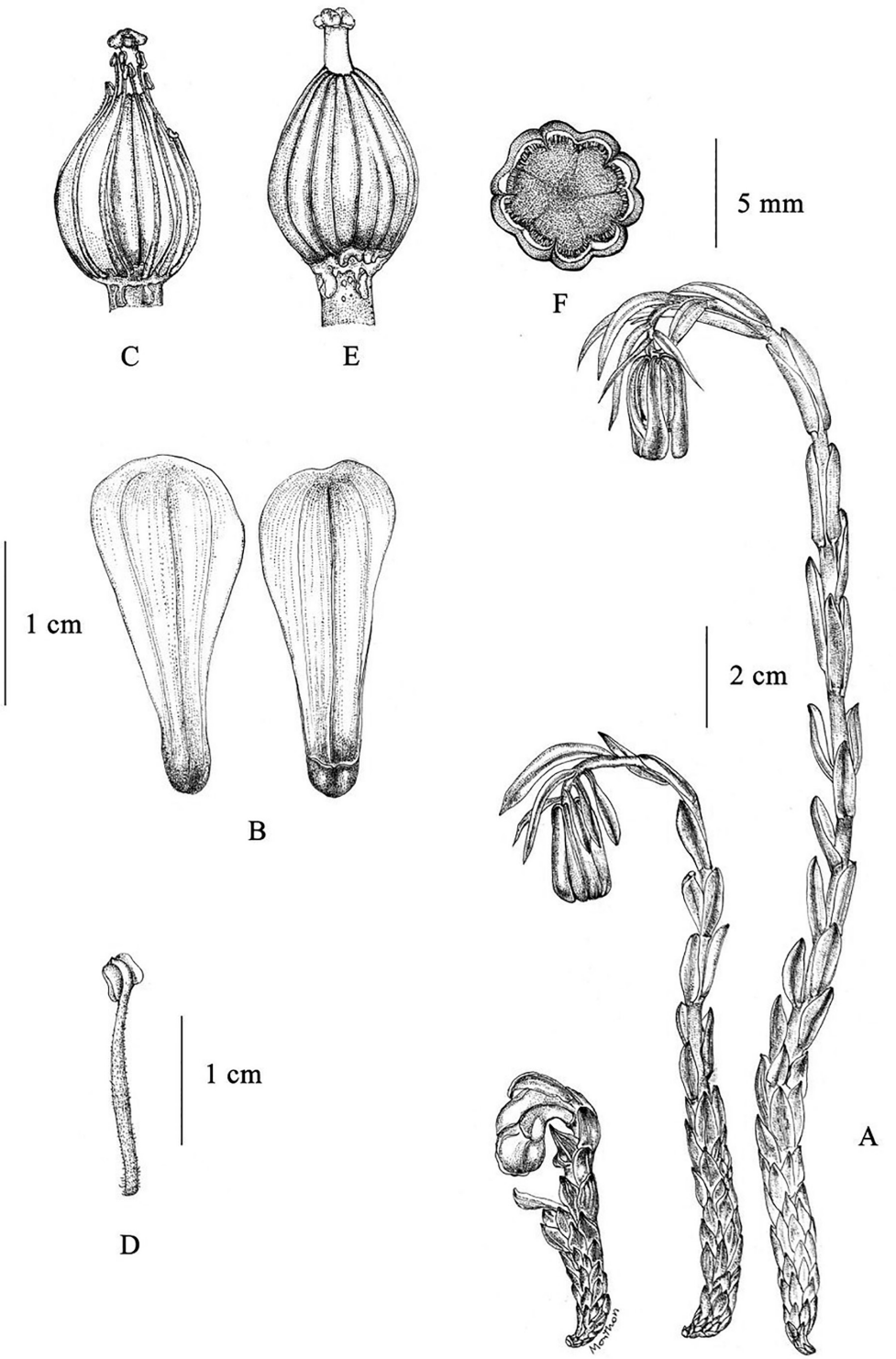


**Figure 2.** *Monotropa uniflora*: A. flowering plant; B. petals, abaxial on left, adaxial on right; C. pistil and stamens; D. stamen; E. pistil; F. ovary, cross-section. Drawn by M. Norsaengsri.


**FIGURE 3.** *Cheilotheca crocea*: A. habit; B. flower; *Monotropa hypopitys*: C. habit; D. inflorescence; *M. uniflora*: E. habit; F. inflorescence. Photos: A–B, E–F by C. Maknoi; C–D by S. Watthana.

Notes.— This species is extremely rare in Thailand and only known for the high elevation of Doi Suthep-Pui.

**2. Monotropa uniflora** L., Sp. Pl. 1: 387. 1753; C.B. Clarke in Hook. f., Fl. Brit. India 3: 476. 1882; Wallace, Wasmann J. Biol. 33 (1&2): 37. 1975 (see also for complete synonymy); Qin & Wallace in Wu *et al*., Fl. China 14: 256. 2005. Type: America, *P. Kalm s.n*. (lectotype LINN, *n.v*., designated by Reveal *et al*., 1987). Figs. 2 & 3E–F.

Herbs, white when fresh, 5–30 cm tall, 4–7 mm diam., at lower part; stem simple, glabrous. *Leaves* crowded towards the base, ovate to oblong, 5–20 mm long, sessile, apex acute, margin entire, glabrous. *Inflorescences* terminal, 1-flowered; bracts white, ovate to oblanceolate or oblong-elliptic, 5–20 × 2–10 mm, thin, apex acute, margin entire or subentire, veins 1–3, much overlapped especially at the basal part of inflorescence, decreasing in size toward the base of inflorescence as scale-like. *Flowers* nodding; pedicel short, 1–2 mm long. *Sepals* 5, white, similar but smaller than bracts. *Petals* 5, white, free, obovate-spathulate, 20–25 × 9–10 mm, base saccate, apex rounded, thin at upper marginal part, inner basal part sparsely hairy, outer surface glabrous. *Stamens* usually 10, unequal, 10–15 mm long, in 2 series of alternating length; filaments terete, 10–20 mm long, scattered pubescent, anthers short, basifixed, *ca*. 2 mm long, yellowish, opening by slits. *Ovary* ovoid, 8–12 × 5–8 mm, glabrous, 5(–6)-locular, forming 5(–6) lobes outside and longitudinal grooves; style stout, 4–5 mm long, 2–3 mm in diam., glabrous; stigma 5 lobes, slightly depressed at apex, 4–5 mm in diam., glabrous. *Capsules* 7–12 × 5–12 mm; seeds small, *ca*. 1 mm long.

Thailand.— NORTHERN: Chiang Rai [Doi Phi Pan Nam, *ca*. 1,800 m alt., 15 Sep. 2001, *P. Suksathan 3056* (QBG)]; Chiang Mai [Doi Inthanon, *ca*. 2,150 m alt., 8 Sep. 2011, *R. Pooma, N. Pattharahirantricin, S. Sirimongkol & N. Silapasorn 7807* (BKF)].

Distribution.— America, Mexico, Pakistan, Tibet, India, Nepal, Myanmar, China, North Korea, South Korea and Japan.

Ecology and Phenology.— Lower montane forest, dominated by Fagaceae and Theaceae, 1,800–2,150 m alt. Flowering: September.

Notes.— *Monotropa uniflora* has a general habit and morphological characteristics similar to *Monotropastrum humile*. It differs in having 5(–6)–locular ovary with axile placentation and fruit in loculicidal capsule (vs 1–locular ovary with parietal placentation and baccate fruit in *M. humile*). In Thailand, *M. uniflora* is extremely rare, as it has only been seen twice in the last two decades.

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