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RESEARCH ARTICLE

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Derris solorioides (*Fabaceae*), a new limestone species with true-paniculate inflorescences from North-Central Thailand

Y. Sirichamorn[1], F.A.C.B. Adema[2], P.C. van Welzen[2,3]

Key words

Derris
limestone
Solori
Thailand
true panicle

Abstract *Derris solorioides* is described as a new species and illustrated. This species is only the second calciphilous and true-paniculate species of *Derris* ever recorded. The species was found in isolated and protected limestone areas surrounded by agricultural areas in Nakhon Sawan province, North-Central Thailand. It is characterized by its rather smaller flowers but with more ovules than other species of *Derris*, and 1-winged pods showing a dark-coloured pericarp around the seeds without thickening of the pericarp. The characters of the pods are similar to those found in *Solori*, a genus once synonymized with *Derris* and, therefore, the epithet '*solorioides*' was assigned. This species appeared to be a distinct taxon in the molecular phylogeny, separate from its morphologically highly similar species, *D. marginata*. It is also a member of a lineage of *Derris* consisting of species with a deviating type of inflorescence: intermediate forms and true panicles, which is quite uncommon in this genus. The relationship with its closely related species is discussed, and a key to the species of *Derris* in the 'deviating type of inflorescence' clade is presented.

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INTRODUCTION

Derris Lour. is one of the most problematic genera in tribe *Millettieae* of the *Fabaceae* due to the similarity and overlap in morphological characters with other related genera in the same tribe, such as *Aganope* Miq., *Paraderris* R.Geesink and *Solori* Adans. (also known as *Brachypterum* (Wight & Arn.) Benth.). Bentham (1860) united all *Derris*-like taxa into a large, heterogenous genus called *Derris* sensu lato (s.l.), which was considered later as an inappropriate, polyphyletic taxon by some authors (e.g. Geesink 1984, Adema 2000, Sirichamorn et al. 2012a). The most recent molecular phylogenetic studies of *Derris* (Sirichamorn et al. 2012a) suggested a new generic circumscription, by reinstating *Solori* at generic level but synonymizing *Paraderris* with *Derris*, which changes were effected by Sirichamorn et al. (2014). The molecular and morphological phylogenetic reconstruction by Sirichamorn et al. (2014) indicated that the genus *Solori* was characterized by several synapomorphies, i.e., presence of stipellae, more than five flowers per brachyblast, tubular and (or) lobed floral disk, 7–12 ovules, 1-winged pods and the presence of 'seed chambers' in dry pods, which are dark-colour areas of thickened pericarp around seeds. The genus *Derris*, in contrast, only had two synapomorphies: the liana habit and 2-winged pods.

According to Geesink (1984), *Derris* only has pseudoracemes and pseudopanicles: inflorescences with brachyblasts or short, reduced lateral axes bearing flowers in fascicles. However, Adema (2003) also mentioned intermediate forms where both paniculate and pseudoracemoid parts occur in the same inflorescences. Sirichamorn et al. (2012b) found many more deviating specimens, even true panicles (brachyblasts completely absent, all flowers solitary on elongate axes) in *D. marginata* (Roxb.) Benth. Interestingly, the species with the intermediate inflorescences and true panicles form a moderately to highly supported clade (Sirichamorn et al. 2012a; Fig. 1). The molecular phylogeny of the genus also suggested that this characteristic evolved in parallel more than once (Sirichamorn et al. 2014).

At first only a fruiting specimen, *Maxwell 50-75*, was collected from an isolated limestone hill of low altitude (100–375 m) in Tham Phet Tham Thong Forest Park, Nakhon Sawan province, North-Central Thailand and it was previously incorrectly identified as *Aganope thyrsiflora* (Benth.) Polhill, because of its paniculate inflorescences, although the pods were not *Aganope*-like. Later, when photos of inflorescences and flowers and finally flowering specimens (collected from three different plants 10–200 m apart at more or less the same locality on the limestone hill) became available it was obvious that a new species of *Derris* was found as the flowers are *Derris*-like. Morphologically, the inflorescences appeared to be true panicles as in *D. marginata*, but the flowers are smaller (see notes above the formal description for the differences between both species). Also, the molecular phylogeny (Sirichamorn et al. 2012b)

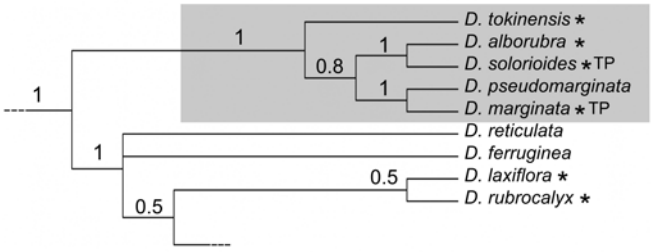

Fig. 1 Part of the majority rule cladogram of *Derris* after a Bayesian analysis of all combined molecular datasets as presented by Sirichamorn et al. (2012a). The numbers above the branches are Bayesian posterior probabilities (PP). Taxa with 'deviating inflorescence types' are marked with a grey box. Species with intermediate inflorescences are indicated with asterisks (*), note the parallel development in the clade *D. laxiflora* Benth. (endemic to Taiwan) and *D. rubrocalyx* Verdc. (endemic to Papua New Guinea); *TP indicates the taxa with true panicles.

[1] Department of Biology, Faculty of Science, Silpakorn University, Sanam Chandra Palace Campus, Nakhon Pathom 73000, Thailand; corresponding author e-mail: yotsawate@su.ac.th; y.sirichamorn@gmail.com.
[2] Naturalis Biodiversity Center, section Botany, P.O. Box 9517, 2300 RA Leiden, The Netherlands.
[3] Institute of Biology Leiden, Leiden University, P.O. Box 9505, 2300 RA Leiden, The Netherlands.

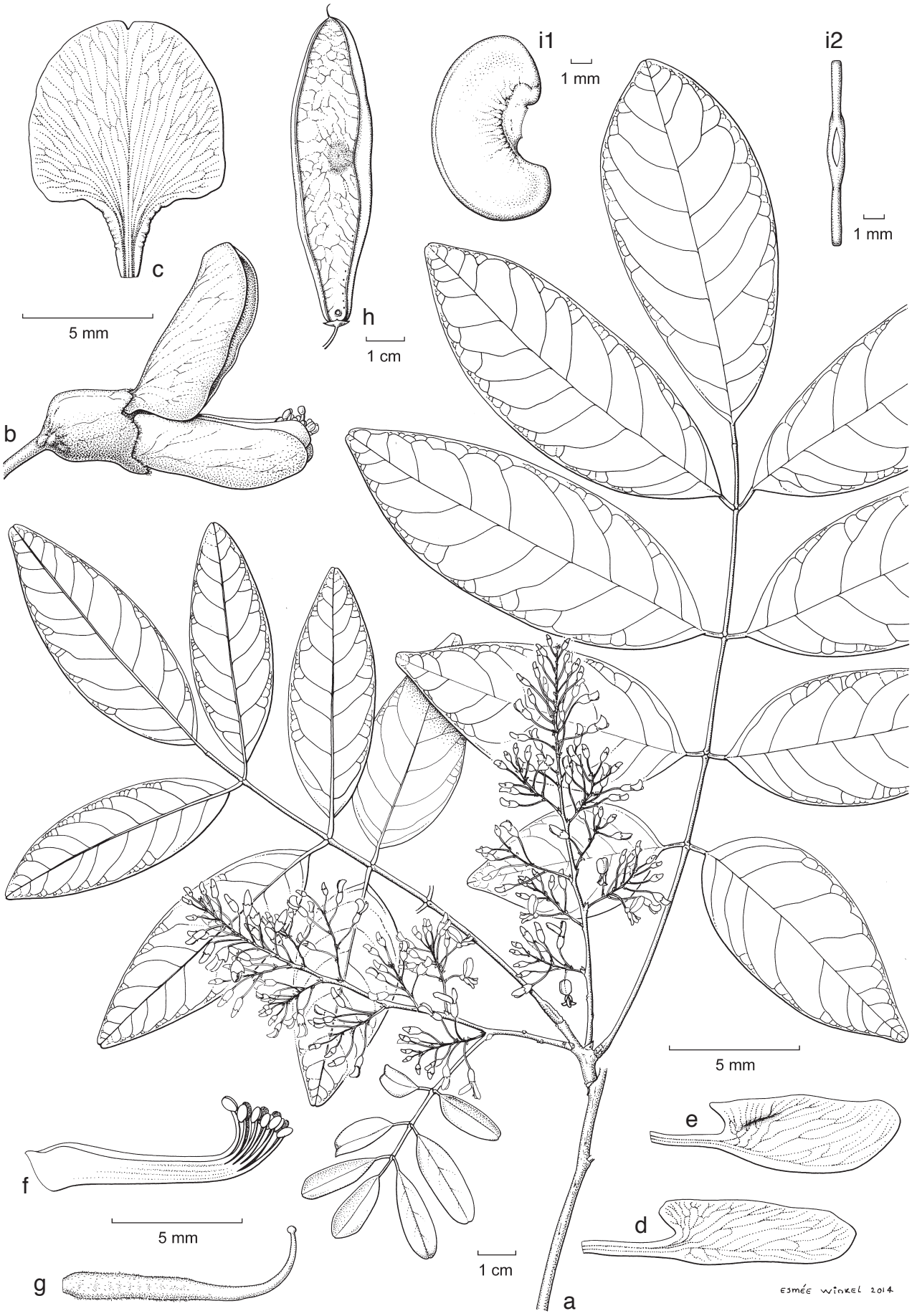

Fig. 2 *Derris solorioides* Sirich. & Adema. a. Habit; b. flower; c. standard, inside view; d. wing petal; e. keel petal; f. stamens; g. pistil; h. pod; i1. seed, side view; i2. seed, front view. — Drawing by Esmée Winkel (L), 2014.

Fig. 3 *Derris solorioides* Sirich. & Adema. a. Habit and habitat; b. young pod; c. flower; d. young inflorescence, showing the leaf-like bracts subtending the lowermost lateral branches; e. mature pods, showing a seed and the dark area of the pericarp around seed; f. inflorescences. — Photos by Y. Sirichamorn.

confirmed the status of new species, sister to *D. alborubra* Hemsl. (Fig. 1), but distinct from *D. marginata*. The floral disc of this species is indistinct or annular, which is common in *Derris.* The pods are the most typical character, because they are similar to the pods found in the genus *Solori* by having only one wing along the upper suture and the presence of darker areas of the pericarp around seeds in dry pods, similar to the seed chambers of *Solori*. However, they are not true seed chambers as the darker pericarp around the seeds is not thickened as in all *Solori* species. Another link with *Solori* is the number of ovules (c. 8 per ovary), which is higher than other species of *Derris*, but typical for *Solori*. For these reasons, the specific epithet '*solorioides*' was selected to stress the similarities with *Solori*. Another typical character of the new species are the bracts subtending the lateral branches, which are sometimes leaf-like (Fig. 2), a character uncommon in *Derris.* A reddish or brownish colour of the young leaves is not present in this species.

Tham Phet Tham Thong Forest Park is located at Chon Dua limestone Mountain, Nakhon Sawan Province, covering an area of 4.80 km^2 of mixed deciduous forest and dry evergreen forest, at 100–375 m altitude (Head of Park, pers. comm.). In Thailand, Forest parks are not as strictly protected as National parks. Part of Tham Phet Tham Thong Forest Park has been disturbed for tourism or academic purposes. Moreover, there is no buffer area around the park, as the land adjacent to the Forest Park has been converted to agriculture. Only five mature plants of *Derris solorioides* were found, and the estimated population size seems to be fewer than 20 individuals. The species probably has some problems in reproduction or germination as undeveloped seeds are usually found in the mature pods, and no new seedlings could be found near the mother plants or anywhere else in the Forest Park (personal observation by first author). For the above-mentioned reasons, *Derris solorioides* is regarded as a critically endangered species (CR B1a+2a; D) according to the red list criteria of the IUCN (2012). However, more data of its actual population size and geographic range should be gathered to ensure the precise IUCN status of this species.

Derris solorioides is the second species of *Derris* found on limestone. Isolated limestone areas often exhibit high degrees of endemism (Clements et al. 2006), which can promote speciation via small-scale habitat vicariance. The first recorded calciphilous species of *Derris* was *D. tonkinensis* Gagnep., found in limestone areas in south China, northern Vietnam, and northern Thailand at higher altitudes (550–1625 m; Phan & Vidal 2001, Sirichamorn et al. 2012b) and it is also the first diverging species in the subclade of species with intermediate/true panicle inflorescences (Fig. 1).

ADDITIONS TO THE KEY TO THE THAI SPECIES OF DERRIS

The new taxon can be included in the key to the Thai species of *Derris* as published by Sirichamorn et al. (2012b: 411) by partly adjusting couplet 8 and inserting an additional couplet (9') provided here.

8. Inflorescences intermediate forms partly paniculate and partly pseudoracemoid 9
8. Inflorescences true panicles. Pedicels 7–12 mm long, mostly glabrous . . . . . 9'
9. Young leaves reddish or brownish. Leaflet apex obtuse and slightly emarginate. Brachyblasts present near apex of the inflorescence. Wings petals not curved backward to the calyx . . . . . *D. alborubra*
9. Young leaves light green. Leaflet apex shortly acuminate. Brachyblasts sometimes absent near apex of the inflorescence and then flowers solitary. Wings petals curved backward to the calyx . . . . . *D. tonkinensis*
9' Standard petals 8–9 by 7–7.5 mm. Ovary with 4–5 ovules Pods 2-winged. — Absent from limestone . . . *D. marginata*
9' Standard petals 5.5–7 by 5–5.7 mm. Ovary with c. 8 ovules. Pods 1-winged. — Limestone . . . . . ***D. solorioides***

Derris solorioides Sirich. & Adema, *sp. nov.* — Fig. 2, 3

Morphologically highly similar to *Derris marginata* but growing on rugged limestone terrain. *Inflorescences* basal lateral branches sometimes subtended by leaf-like bracts. *Flowers* white with pale greenish hue, obviously smaller than *D. marginata*. *Ovary* with more (c. 8) ovules than *D. marginata* (4–5). *Pods* with only a single wing along the upper suture, pericarp around seeds darker in dry pods, but without thickening. — Type: *Sirichamorn YSM 2013–1* (holo L; iso BK, BKF, L), Thailand, Nakhon Sawan, Tham Phet Tham Thong Forest Park, Doi Chawn Duea, Takli Subdistrict, in flowers & young fruits, 8 Jan. 2013.

Lianas. *Twigs* up to 10 mm diam, glabrous, lenticellate. *Stipules* caducous, triangular, 1–1.5 by c. 1.5 mm, outside glabrous or thinly sericeous, inside glabrous. *Leaves* with 5–9 leaflets; young leaves light green; petiole 3–9.5 cm long, striate, glabrous; rachis 4.5–11 cm long, striate, glabrous; pulvinus 5–10 mm long, glabrous. *Stipellae* absent. *Leaflets* chartaceous to subcoriaceous, broader leaflets usually found in plants growing in shadier areas; terminal one (narrowly) elliptic or (narrowly) obovate, 6–12.5 by 2.7–5.5 cm, length/width ratio 1.6–2.2, base cuneate, obtuse to rounded, apex obtuse or slightly emarginate, upper and lower surface glabrous, midrib slightly raised in a furrow above, distinctly raised below, veins raised on both sides, 7–15 per side, 5–20 mm apart, not reaching the margin but curving upwards, sometimes anastomosing near the margin, venation reticulate; lateral leaflets (narrowly) elliptic to (narrowly) ovate or (narrowly) obovate, 4.5–11 by 2.2–5.5 cm, length/width ratio 1.8–2.2; pulvinus of petiolules 4–6 mm long. *Inflorescences* axillary panicles or sometimes terminal, 11–21 cm long, peduncle 5–20 mm long, glabrous or thinly strigose, striate; lateral branches 1–10 cm long. *Bracts* subtending lateral branches ovate-triangular, 0.8–1.2 by 0.8–1.3 mm, outside glabrous to thinly sericeous, inside glabrous but with some hairs at base, margin ciliate, sometimes leaf-like. *Brachyblasts* absent. *Bracts* subtending flowers elliptic to ovate, 0.8–1 by 0.3–0.4 mm, both sides glabrous or with few hairs, margin ciliate. *Pedicels* slender, 7–10 mm long, glabrous. *Bracteoles* at the upper part of pedicels, narrowly elliptic to ovate, 0.6–0.7 by 0.2–0.3 mm, both sides glabrous, margin ciliate. *Calyx* greenish, cup-shaped, 2.5–3 mm high, outside glabrous, with hairs near the lobes, inside glabrous, margin ciliate, tube 2–2.5 mm high, upper lip indistinct or with two short lobes, 0.2–0.3 by 0.7–1 mm; lateral lobes triangular or semi-circular, 0.5–0.7 by 1.2–1.7 mm; lower lobe triangular or semi-circular, c. 0.7 by 1.5–1.6 mm. *Corolla* white or slightly with pale green hue. *Standard*: claw 3.3–3.5 mm long; blade broadly obovate to orbicular, 5.5–7 by 5–5.7 mm, basal callosities absent, apex emarginate, both sides glabrous. *Wings*: claw 3–3.5 mm long; blade elliptic, 6–7 by 1.7–2.3 mm, apex rounded, both sides glabrous, upper auricle c. 1 mm long, lower auricle indistinct, lateral pocket 0.7–1 mm long, sometimes indistinct. *Keel petals*: claw 2–2.5 mm long; blade boat-shaped, 5.5–6 by 2–2.5 mm, apex rounded, outside glabrous except for the apical part with few hairs, inside glabrous, upper auricle indistinct, lateral pocket 1–2 mm long. *Stamens* monadelphous, with basal fenestrae, 8–9.5 mm long, free part 2.5–3 mm long, glabrous; anthers 0.4–0.5 by 0.3–0.45 mm, glabrous. *Disc* annular or indistinct.

Ovary 4–5 mm long, stipe indistinct, slightly hairy; ovules c. 8; style 4–4.5 mm long, slightly hairy. *Pods* elliptic to strap-like, 4.5–8 by 1.8–2.2 cm, glabrous, with a wing along the upper suture, 2–4 mm wide, seed chamber absent but darker area around seed present in pericarp of dry pods, without thickening of the pericarp. *Seeds* 1–2 per fruit or sometimes immature, discoid, flat, 13–14 by 10–11 by 1–2 mm; hilum central, 1–1.4 mm long.

Distribution — This species is endemic to North-Central Thailand.

Habitat & Ecology — This species is found in deciduous forest, seasonally damaged by fire, on rugged limestone terrain in a partly open place at 100–375 m altitude. Flowering: December to February; fruiting January to April.

Vernacular names — Hang Lai Khao, Hang Lai Khao-Khao Poon.

Additional material. Thailand, Nakhon Sawan, Tham Phet Tham Thong Forest Park, Doi Chawn Duea, Takli Subdistrict, *Maxwell 05-75* (L), mature infructescence, 25 Jan. 2005.

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