THAI FOR. BULL. (BOT.) 32: 159–167. 2004.

Dioscorea petelotii Prain & Burkill (Dioscoreaceae): A new record for Thailand and the discovery of male and female flowers

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ABSTRACT. *Dioscorea petelotii* Prain & Burkill, previously known only from the type specimen collected in Vietnam, has been discovered growing in hill evergreen forest in N and NE Thailand. The type consists only of terminal shoot stems, leaves, and immature capsules. The collection of specimens with underground organs, stem bases and inflorescences of both sexes has allowed a full description and illustrations of this species to be provided. The possible relationships of *D. petelotii* are re-evaluated using the newly available morphological data.

INTRODUCTION

Dioscorea petelotii Prain & Burkill was first described from Vietnam by Prain and Burkill (1933). They named the new species in honour of the French collector Pételot, who collected several duplicate specimens of it in Vietnam in August 1932. Pételot's specimens were taken from a female plant, which possessed only immature capsules, so the morphology of both the male and female flower of *D. petelotii* remained unknown. In September 1996, a sterile specimen from Doi Phu Kha National Park, Pua District, Nan Province in Northern Thailand was collected by the second author (*Wilkin* 908). He collected it again in sterile condition in October 1998 at both Doi Phu Kha and Phu Luang Wildlife Sanctuary, Loei District, in North-eastern Thailand. Preliminary study suggested that the sterile specimens from Doi Phu Kha and Phu Luang might be *D. petelotii* from Vietnam because they shared the distinctive subdeltate shape of the terminal stem leaves and the vertically oriented spiny flange on the swollen nodes of the lower stems. For this reason, the first author went to Doi Phu Kha National Park in November 2001 and located two female plants of *D. petelotii* Prain & Burkill which had mature capsules. Photographs of these plants were sent to the second author who was able to confirm that they matched the type material.

Following this discovery, our main goal was to collect flowers of both sexes and the underground parts of this species in order to provide complete descriptive information. Because it appeared to be restricted to hill evergreen forest, it was assumed that it flowered in March or April like *D. cirrhosa* Lour., which is found in the same habitat. Thus in April 2002, a joint Royal Forest Department/Naresuan University/Royal Botanic Gardens, Kew team visited five mountains in N and NE Thailand and collected

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both male and female flowering specimens from four of them. We were also able to excavate the underground parts of this yam for more detailed morphological investigation.

During the trip, we also looked for previously collected herbarium specimens of *D. petelotii* in Thai herbaria. At BKF and CMU we discovered that J. F. Maxwell had already collected male specimens from Thailand at Doi Suthep-Pui National Park, Chiang Mai in 1992, 1993 and 1997, but he had misidentified them as *Dioscorea esculenta* (Lour.) Burkill. In the checklist of Doi Suthep-Pui (Maxwell & Elliott 2001) they are listed as *D. esculenta* var. *fasciculata* (Roxb.) Prain & Burkill.

Thus it became evident that this species was found in much of the hill evergreen vegetation of the N and NE of Thailand, and represents *D. petelotii*, a new record for the flora which is fully described and illustrated below.

MATERIALS AND METHODS

The Dioscoreaceae treatment for the Flora of Thailand is based on examination of 1220 specimens from Thailand at the following herbaria or on loan: AAU, B, BK, BKF, BM, CMU, E, K, L, P, Biology Department, Naresuan University, Phitsanulok (abbreviated as PNU here), QSBG and TCD. Abbreviations follow Holmgren & Holmgren (1990). Comparative morphology was used to delimit species in all cases.

DESCRIPTION

Dioscorea petelotii Prain & Burkill, Kew Bull. 1933: 240. 1933; Prain & Burkill in Fl. Gén. I.-C.: 717. 1933; Prain & Burkill in Ann. Roy. Bot. Gard. (Calcutta) 14(1): 97. 1936. Type: Vietnam, Province of Lao-Kay, between Cha-Pa and Muong Hoa, ♀ fr. Aug. 1932, *Pételot* 4395 (holotype K!; isotype P!). Figs 1–3.

Large forest climber to at least 30 m. *Tubers* (Fig. 1M, 3J) to 40 cm in diam. and at least 5 kg in mass, shape variable, usually globose to subglobose with several shallow lobes, perennially replaced, shallowly vertically buried but sometimes approaching horizontal when growing in shallow soil on a steep slope; crown of tuber bearing slender rigid roots, very hard and woody, not clearly differentiated from tuber, tuber periderm hard to corky, often dark brown or grey-brown in colour, parenchyma pale yellow to pinkish (Fig. 3K) with a little mucilage. *Indumentum* (Fig. 1B) present on all parts, hairs simple, 0.2–0.6 mm long, brown to red-brown in colour, dense on young shoots and inflorescences, becoming glabrous with age. Stems 7–15 mm in diam. towards base, reducing to 2–5 mm in diam. on upper stem, twining to the left, towards base stems woody and very spiny (Fig. 3J), with 6–8 hard, vertically orientated flanges at each swollen stem node (Fig. 1C), upper stems with few spines (Fig. 3B) or unarmed except paired lateral nodal spines (see Fig. 1D, 3C and description of petiole below), terete with shallow longitudinal ridges, yellowish-green to mid-green. *Leaves* simple, alternate, blades 5–18.5 by 2.3–11.5 cm, broadly sagittate-ovate to broadly ovate towards stem base (Fig. 3A), subdeltate to ovate on the upper stems (Fig. 1A, 3F), base cordate to sagittate, truncate or rounded, basal sinus (where present) to 27 mm deep, apices 8–12 mm long, acuminate, margins entire; 5–7 nerved, only main vein and first

vein pair reaching apex; coriaceous, yellow-green to dark green and glossy above, paler below; petioles (Fig. 3B, 3C), 2.5–10.5 cm long, slender, terete, shallowly channelled above, colour as stem but usually pinkish-brown to violet on pulvinii at base and apex; forerunner tips 5–12 mm long, dark brown; lateral nodal spines (Fig. 1D, 3C) recurved, on either side of each node. Bulbils absent. *Inflorescences* pendent, axes slender, terete, colour as stem; all bracts and tepals chartaceous; tepals inserted on cup-shaped torus, fused at base, ascending, pale green to yellow-green, apices recurved. *Male inflorescences* (Fig. 1E, 3D) simple or compound, compound inflorescences 8.5–20 cm long, 1 per axil, primary bracts (Fig. 1F) 3.3–4.4 by 0.8–1.3 mm, narrowly lanceolate, apices acuminate, 0.6–2.3 mm long; simple/partial inflorescences racemose with cymules of 1–3 flowers, 1–2 (– 3) per axil, peduncles 1.2–5.3 cm long, axes 2.3–16(–25) cm long. *Male flowers* 3.5–4.2 mm in diam. at anthesis (Fig. 1G, 3E), pedicels 1.1–2.5 mm long; floral bracts (Fig. 1I) 1.1–2.5 by 0.6–1.2 mm, narrowly ovate to lanceolate, apex acuminate, 0.1–0.3 mm long; bracteoles (Fig. 1J) 0.8–2.0 by 0.5–1 mm, lanceolate, apices to 0.2 mm long, acute to acuminate. *Tepals* in two whorls of three, inserted on a cup-shaped torus (Fig. 1G, 1H); outer tepals (Fig. 1K) 1.2–2.6 by 0.7–1.4 mm, ovate-oblong, apex acute to obtuse; inner tepals (Fig. 1L) 1.8–2.5 by 1.1–1.5 mm, ovate to ovate-oblong, apex acute to obtuse; stamens 6 (Fig. 1G, 1H), inserted on tepal bases, filaments 0.6–1.1 mm long, incurved towards apices so that the anthers are grouped above the centre of the flower; anthers 0.2–0.4 by 0.2–0.3 mm, ovate; pistillodes 3 (Fig. 1H), 0.5–0.6 by 0.9–1.1 mm, fused for their entire length along inner surfaces, broadly ovoid with 3 shallow longitudinal lobes. *Female inflorescences* (Fig. 2N, 3F) spicate, simple, 1 per axil, peduncles 1.7–6.6 cm long, axes 3.5–12.5 cm long. *Flowers* (Fig. 3G) orientated at angle of 30°–90° to axis when receptive; floral bracts (Fig. 2R) 1.1–1.8 by 0.7–1.1 mm, lanceolate, apices 0.3–1.0 mm long, acuminate; bracteoles (Fig. 2S) 1.1–1.6 by 0.4–0.5 mm, narrowly ovate to lanceolate, apices to 0.3 mm long, acute to acuminate. *Outer tepals* (Fig. 2T) 1.8–2.9 by 1–1.4 mm, narrowly elliptic to elliptic-oblong, apex obtuse; inner tepals (Fig. 2U) 1.6–2.6 by 1.1–1.5 mm, oblong, apex obtuse; ovaries (Fig. 2O) 6.5–13 by 1.3–2.2 mm, terete or cylindric in outline, pale green to brownish-green; staminodes 6 (Fig. 2Q), 0.5–0.8 mm long, staminiform; styles 1.3–1.6 by 0.4–0.7 mm, fused for most of their length into an erect column; stigmas 0.5–0.7 by 0.4–0.8 mm long, recurved, bifid. *Infructescences* (Fig. 2V, 3H) 7–20 cm long. *Capsules* (Fig. 2X, 3I) 33–58 by (13–)16–23 mm, oblong to narrowly obovate in outline, base truncate to shallowly retuse, sinus to 1.2 mm deep, apices retuse with 0.05–0.2 mm deep sinus, margin shallowly lobed, persistent tepals (where present) 1–2 mm long, capsular stipes 4.5–6 by 2–2.5 mm, obconic; immature capsules colour as ovary; mature capsules becoming glabrous, reflexed at an angle of 90°–150° to axis. *Seeds* (Fig. 2Y, 3I) 10–13.5 by 5–7.5 mm, lenticular-ovoid; wing oblong, apex truncate to rounded, extending from seed apex, outer margin often lobed, upper seed wings 18–25 by 7.5–10.2 mm, lower seed wings (11–)15–22 by 6.5–11.5 mm.

Thailand.— NORTHERN: Chiang Mai [Doi Suthep-Pui National Park, East side of Doi Pui, near Chang Kian (Maeo) Village, ♂ fl. 8 April 1992, *Maxwell* 92-125 (CMU, E, L); idem, ♂ fl. 20 April 1993, *Maxwell* 93-340 (CMU, BKF); idem, ♂ fl. 1 April 1997, *Maxwell* 97-326 (CMU, BKF); idem, ♂ fl., 23 April 2002, *Thapyai et al*. 404 (BK, BKF, NU, QSBG)]; Nan [Doi Khun Sathan, about 1–2 km before Ban Khun Sathan along the road from Na Noi to Wiang Sa, 18° 16' 39.5" N, 100° 30' 19" E, ♂ fl.

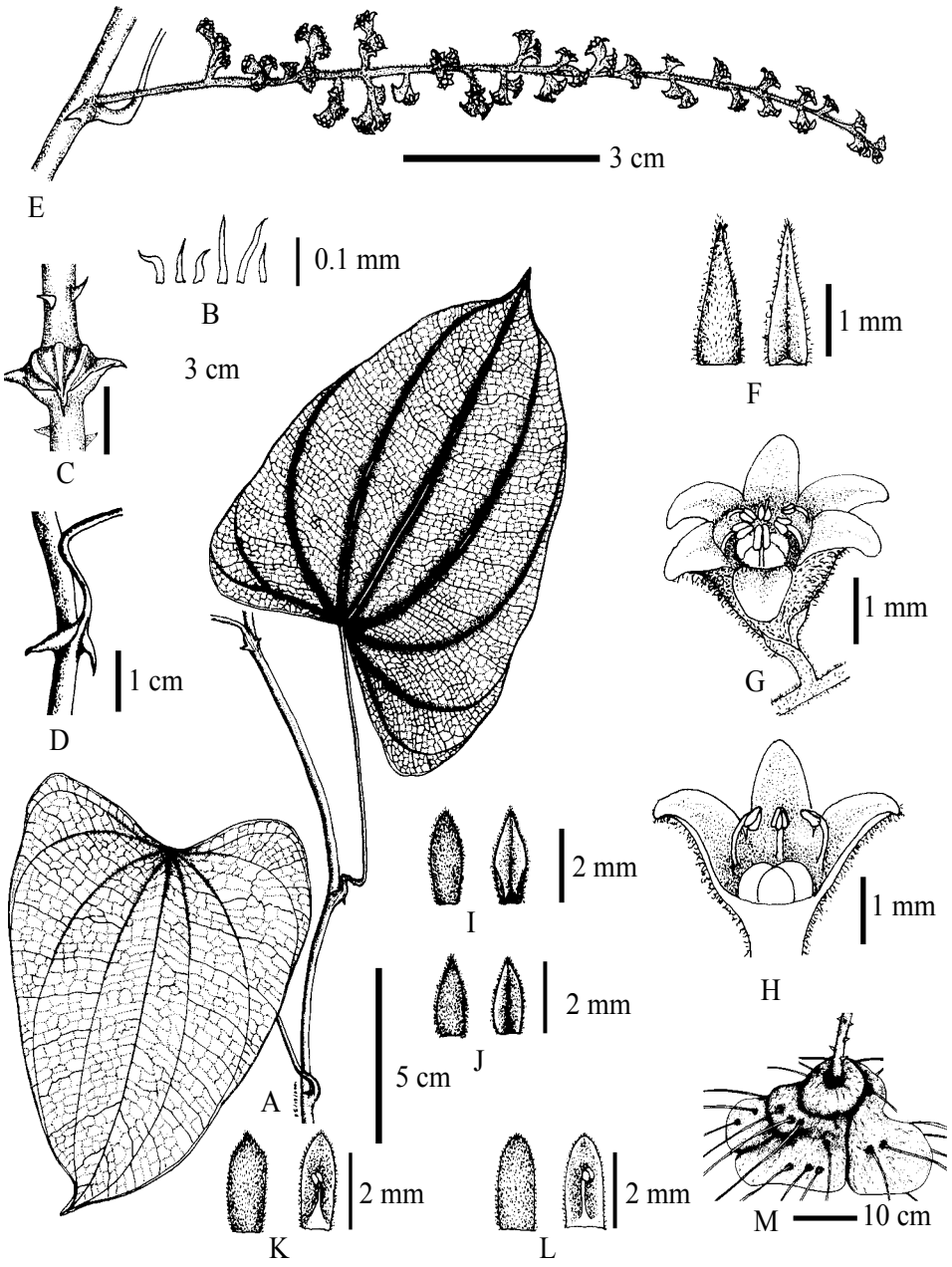

Figure 1. The morphology of *Dioscorea petelotii*: A. upper stem and leaves; B. hairs; C. a node from the stem base, showing the vertically orientated flanges; D. lateral nodal spines from the upper stem; E. simple male inflorescence showing flowers arranged in cymules; F. primary bract; G.–L. male flower; G. side view; H. longitudinal section showing stamens and 3-lobed pistillode; I. floral bract; J. bracteole; K. outer tepal; L. inner tepal. A.–D. from *Thapyai* 303; E.–L. from *Thapyai et al*. 388; M. from *Thapyai et al*. 370. Drawn by C. Thapyai.

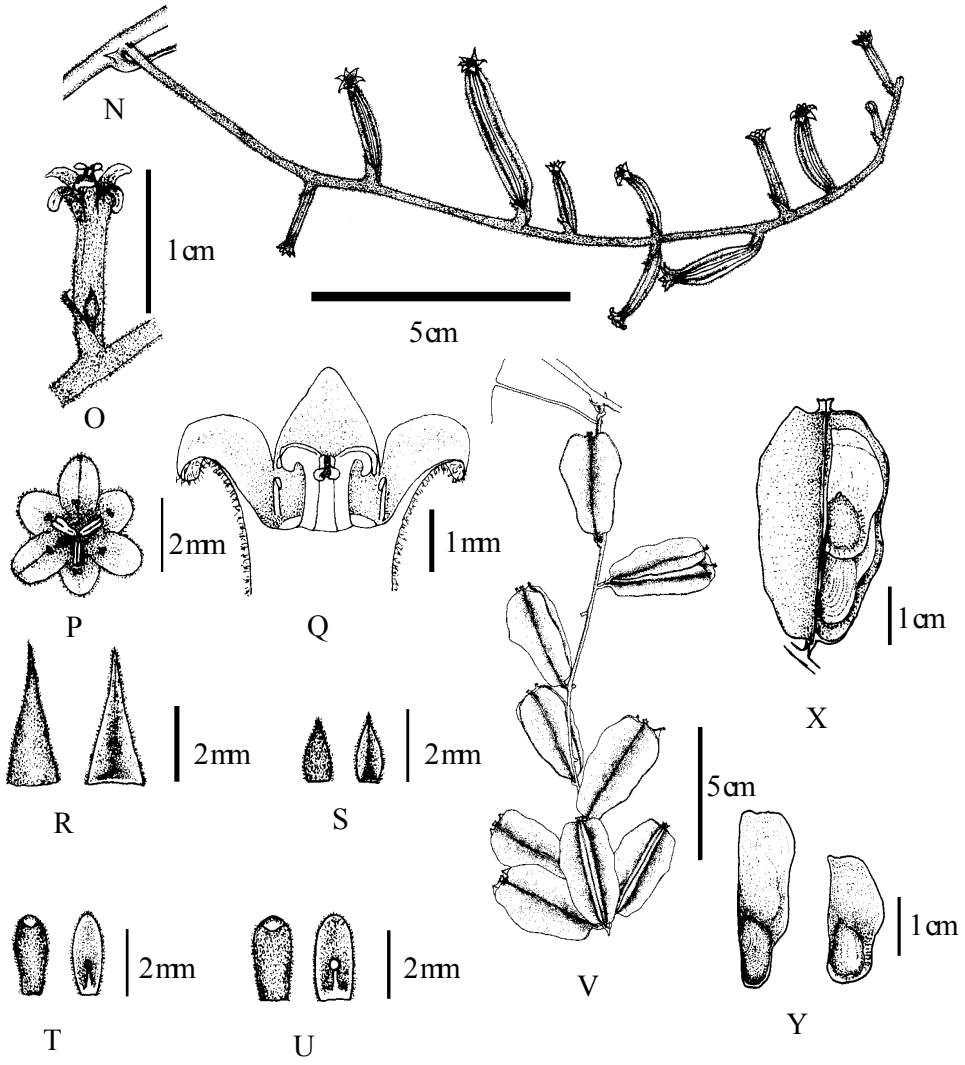

Figure 2. The morphology of *Dioscorea petelotii* Prain & Burkill (continued): N. female inflorescence. O.–U. female flower; O. side view showing terete ovary; P. view from above; Q. longitudinal-section (excluding ovary) showing staminodes, style and stigmas; R. floral bract; S. bracteole; T.&U. outer and inner tepals respectively, showing staminode insertion; V. mature infructescence; X. mature capsule, l-section showing seed position; Y. seeds. N.–U. from *Thapyai et al*. 372; V.–Y. from *Thapyai* 303: drawn by C. Thapyai.

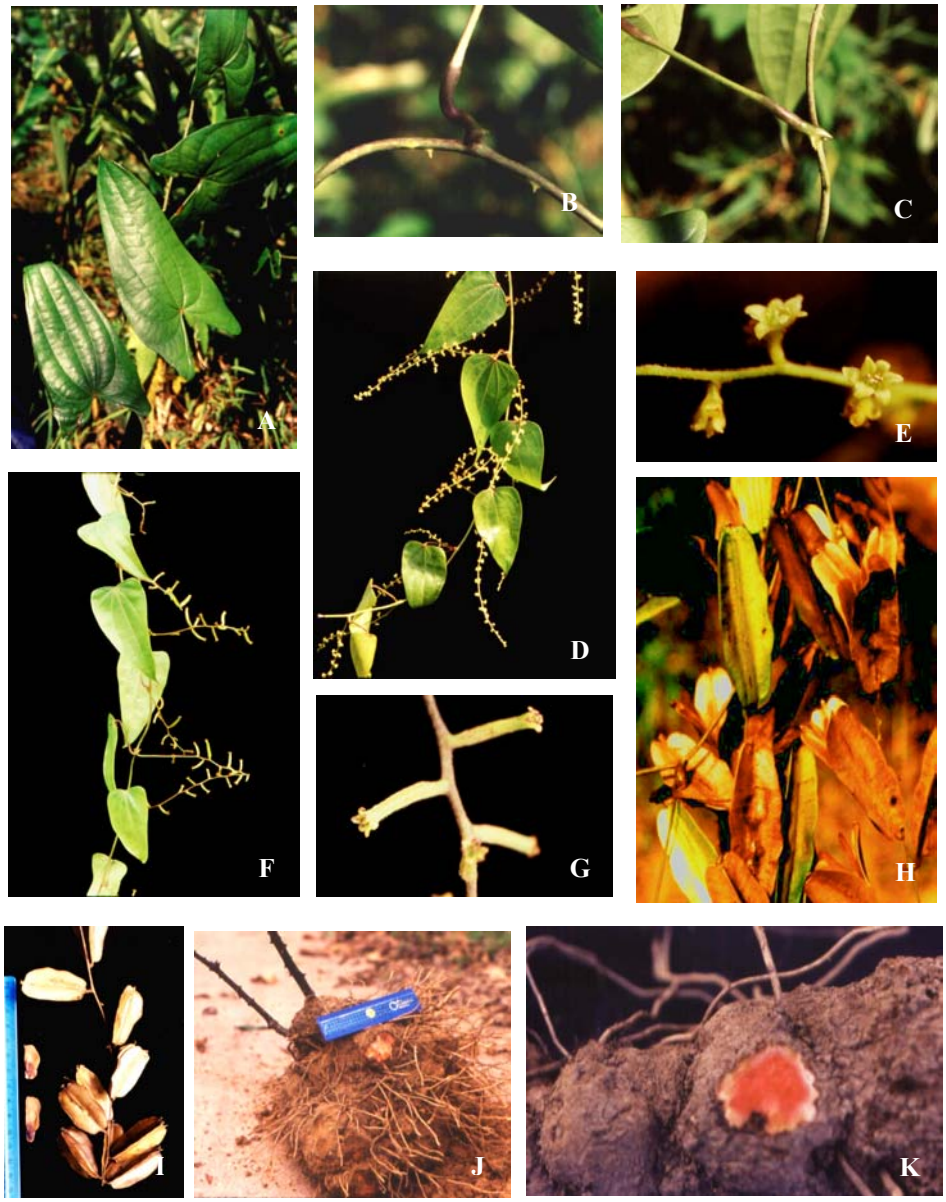

Figure 3. Colour photographs of *Dioscorea petelotii*: A. sterile plant showing the leaves and growth habit; B. stem spines; C. lateral nodal spines; D. male inflorescences and upper stem leaves; E. male flowers; F. female inflorescences and upper stem leaves; G. female flowers; H–I. infructescences with immature (pre-dehiscence) and mature (dehiscing) capsules and seeds; J.–K. perennial tuber, showing the periderm and pink parenchyma; Photographed by C. Thapyai.

14 April 2002, *Thapyai et al*. 381 & 382 (BK, BKF, NU, QSBG); Doi Phukha National Park, circular trail from Headquarters Buildings, 19° 22' 1.1" N, 101° 4' 57.2" E, sterile 23 Sept. 1996, *Wilkin* 908 (BKF, K); idem, 19° 12' 05" N, 101° 05' 14" E, sterile 1 Nov. 1998, *Wilkin et al*.1055 (BKF, K); idem, ♂ fl. 16 April 2002, *Thapyai et al*. 388 (BK, BKF, NU, QSBG), idem, ♀ fl. 16 April 2002, *Thapyai et al*. 390 (BK, BKF, NU, QSBG), idem, ♀ fr. 21 Nov. 2001, *Thapyai* 303 & 306 (BK, BKF, NU, QSBG)]; Uttaradit [Phu Soi Dao National Park, trail to pine rich plateau, about 5 Km from Visitor Centre, sterile 19 Nov. 2001, *Thapyai* 295 (BKF, NU, QSBG)]; NORTH-EASTERN: Loei [Phu Luang Wildlife Sanctuary, about 0.7–1 km along the road from Khok Nok Kraba to Headquarters, 17° 17' 3.3" N, 101° 31' 17.7" E, ♂ fl. 12 April 2002, *Thapyai et al*. 370, 371 & 373 (BK, BKF, NU, QSBG); idem, ♀ fl. 12 April 2002, *Thapyai et al*. 372 (BK, BKF, NU, QSBG); idem, 17° 16' 45" N 101° 31' 05" E, sterile 26 Oct. 1998, *Wilkin et al*. 1023 (BKF, K)].

Distribution.— Vietnam (only known from the type locality in Lao-Kay Province) and on mountains in N and NE Thailand.

Ecology.— Hill evergreen forest, between 1,100–1,500 m in altitude. Flowering from April to May, fruiting from August to November.

Vernacular name.— Man doi (มันดอย), or mountain yam in English.

Conservation.— Restricted to hill evergreen forest, but appearing abundant where that habitat is encountered. It is therefore vulnerable to habitat loss, as is occurring, for example, at Doi Khun Sathan in Nan Province. IUCN red list category VU B2ab(iii) (IUCN 2001).

Notes. —This species is easily distinguished by means of its swollen lower stem nodes with 6–8 vertically oriented flanges, alternate, coriaceous leaves which are ovate to subdeltate on terminal shoots and 33–58 mm long, male flowers with cup-shaped tori and incurved stamens and oblong fruits with seeds winged at the apex only.

DISCUSSION

Two questions are pertinent to the rediscovery of this yam in Thailand. Firstly, why has it been collected so infrequently when it appears to be relatively common in hill evergreen forest in N and NE Thailand? Secondly, what does the newly available character data tell us about its relationships with other *Dioscorea* species?

We think that there are several answers to the first question. It has remained unknown in part because it lacks a use, unlike many other yams. It flowers at an unusual time of year, at the end of the dry season in April when fewer collectors are active, instead of the rainy season in September/October. Its occurrence at relatively high altitudes, which are perhaps less frequently botanised, may be a third explanation. We suspect that it could be found in similar habitats in the Lao PDR and Vietnam in much greater abundance than the single collection to date from those countries suggests. In fact, it could almost be an "indicator species" of hill evergreen forest based on our observations in N and NE Thailand.

Prain & Burkill (1936) placed *D. petelotii* in *D.* sect. *Paramecocarpa* Prain & Burkill with *D. flabellifolia* Prain & Burkill and *D. piscatorum* Prain & Burkill, two species from Malaysia and the Philippines. They did so on the basis of the similar fruit morphology of *D. flabellifolia* and *D. petelotii*. Its closest relatives in Thailand appear to be *D. esculenta* Lour. and *D. birmanica* Prain & Burkill, based on similarities in inflorescence and floral morphology (see Table 1). Prain & Burkill, however, placed *D. esculenta* in its own section (*D.* sect. *Combilium* Prain & Burkill) and placed *D. birmanica* in the rhizomatous *D.* sect. *Stenophora* Uline. Despite the differences in underground organ morphology and fruit morphology, the authors believe that the similarities in all five taxa in indumentum (they also all tend to be glabrescent except *D. piscatorum*), climbing direction, and male and female inflorescence and floral morphology suggest that all of these taxa may form an infrageneric taxon. This hypothesis is currently under investigation using molecular systematic methods.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the QSBG-DANCED Program for providing the funds to conduct this research. The authors would like to thank the staff of BKF for all their help, particularly Somran Suddee, Rachun Pooma, Pachok Puudjaa, Thankongsak Jonganurak, and Voradol Chamchumroon. We must also thank the directors of Doi Khun Sathan Watershed Research Station, Doi Phukha National Park and Huai Kaeo Arboretum for their hospitality. Research on Thai Dioscoreaceae was made possible by all the herbarium curators who gave access to specimens through loans, visits or electronic means. Thanks also go to Dr Phillip Cribb for his comments on an earlier version of this manuscript, and to Lauren Raz for her helpful review comments.

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Table 1. A comparison of the morphological characters of *D. petelotii*, *D. esculenta* and *D. birmanica* with those of *D. flabellifolia* and *D. piscatorum*

	D. petelotii	*D. esculenta*	*D. birmanica*	*D. flabellifolia*	*D. piscatorum*
Underground parts	Perennial tuber; not starchy	Perennial to annual tubers from a woody crown; starchy	Thick horizontal branching "rhizome"; not starchy	Unknown	Poorly known (see Prain & Burkill 1936)
Direction of twining	LH	LH	LH	LH	LH
Indumentum	Simple hairs, dense on young shoot apices, leaf lower surfaces and inflorescences	Simple hairs, dense on leaf lower surfaces and inflorescences	Simple hairs, glabrous to pubescent on vegetative parts, inflorescences pubescent	Simple hairs, puberulous to glabrescent	Glabrous
Leaf shape	Broadly sagittate-ovate or cordate or subdeltoid to ovate	Orbicular to broadly ovate	Orbicular to very broadly ovate	Ovate to very broadly so	Ovate
Male (partial) inflorescence	Racemose, 2 or 3-flowered cymules towards base, flowers solitary above	Racemose, flowers solitary, occasionally with cymules of 2-3 flowers	Racemose, 2 or 3-flowered cymules towards base, flowers solitary above	Racemose, flowers solitary, occasionally with 2-flowered cymules	Unknown
Male flower	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	Unknown
Female inflorescence	Spike	Raceme	Raceme	Raceme	As *D. flabellifolia* (Prain & Burkill 1936)
Female flower	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	Cup-shaped torus, reflexed tepals	As *D. flabellifolia* (Prain & Burkill 1936)
Fruit shape in outline	Oblong	Ovate-oblong, very rarely produced	Ovate-oblong	Oblong to elliptic-oblong	Unknown
Seed	Winged at apex only	Winged all round margin, very rarely produced	Winged all round margin but wing irregular	Winged at apex only	Unknown