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RESEARCH ARTICLE

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Ficus pongumphaii (*Moraceae*), a new species from Thailand, compared with the ambiguous species *F. talbotii*

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Key words

Ficus
leaf anatomy
Moraceae
new species

Abstract A deciduous shrub previously included in *Ficus talbotii* for many years, is now regarded as a new species, *Ficus pongumphaii*. It is morphologically distinct from *F. talbotii* with as typical characters the densely brown pubescent to tomentose or villous on leafy twig; the elliptic, suborbicular to obovate leaf blades that are brown tomentellous on the upper surface and brown floccose tomentose to villous underneath; the pedunculate figs are obovate, brown floccose or villous outside and have internal hairs. The leaf anatomy shows a multiple epidermis on both surfaces; enlarged lithocysts on both sides of the lamina, which are more abundant adaxially and with very few abaxially. The species, endemic to Thailand, is named after the great Thai dendrologist, Associate Professor Somnuek Pongumphai.

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INTRODUCTION

During field trips in Thailand in 2010, a limestone hill in Lop Buri province, central Thailand, was visited by the first author, where a shrubby fig inhabiting a limestone crack was found. Morphologically, it shows several diagnostic characters in a combination unknown so far. Young twigs are brown pubescent to tomentose to villous. The leaf blades are ovate to nearly globose and abaxially covered with brown floccose hairs. The figs are pedunculate, solitary or in pairs in the leaf axils (or just below the leaves). Specimens of this plant were collected and placed in herbarium collections but remained unidentified. In 2011, Berg et al. (2011) identified a brown floccose specimen, *Pooma et al. 3820*, as *Ficus talbotii* King, but added a note: "more attention is needed". Later, in 2013, the first author visited the National History Museum (BM) in London to study *Ficus* L. specimens and he found a sample collected by A. Marcan in 1924 from a limestone hill in the province Ratchaburi (*A. Marcan 143*). The specimen is very similar to the fig found in Lop Buri and to *Pooma et al. 3820*.

MATERIAL AND METHODS

Macromorphology

In 2015 the first author began to study *Ficus* subsection *Conosycea* (Miq.) Corner. The morphology of *Pooma et al. 3820* and the samples collected in Lop Buri were carefully studied together with and in comparison to specimens of *F. talbotii* using classical taxonomical techniques.

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Leaf anatomy

The leaf anatomical procedures followed are consistent with the ones used in Chantarasuwan et al. (2014). Six samples were selected, three from the new species, *F. pongumphaii* and three from *F. talbotii*.

Dried leaves were rehydrated and cross sections were then made using a Reichert slide microtome. Sixteen transverse sections including margin, midrib and petiole were collected. Free hand paradermal sections were taken from the adaxial and abaxial leaf surfaces. Half of the sections and paradermal sections were bleached and stained with safranin/haematoxylin. All sections were dehydrated and mounted in Euparal. Cuticular macerations were made by placing a leaf sample in a 1 : 1 mixture of hydrogen peroxide (30 %) and acetic acid (99–100 %) at 60 °C overnight. The cuticle was cleaned the following day and the sections were then placed in a mixture of 0.5 % Sudan IV in 70 % alcohol at 40 °C for 2–3 h and mounted in glycerine jelly. The slides were observed for 11 microscopic characters similar to the ones used as diagnostic features by Chantarasuwan et al. (2014): Indumentum, cuticle, epidermal cells, mesophyll, the stomatal complex, lithocysts, silicified cells, crystals, petiole and midrib vascularization, veins and bundle sheaths, and sclerenchyma fibres and sclerified ground tissue. Descriptions of both species were made and they were compared for consistent differences in character states.

RESULTS AND DISCUSSION

The new species differs in several character states from *F. talbotii* (see Table 1 for morphological differences and Table 2 for leaf anatomical differences). The new species is a shrub that normally grows up to 3 m tall, while *F. talbotii* is a tree of up to 22 m high (Table 1). The periderm of the leafy twigs is persistent in the new species but flaking off in *F. talbotii*. The fig peduncles are 2–3 mm long in the new species and absent to up to 2 mm long in *F. talbotii*. The new species has obovate syconia with outside a normally brown floccose indumentum and inside internal hairs are present, *F. talbotii* has subglobose (to obovate), normally glabrous or rarely puberulous syconia,

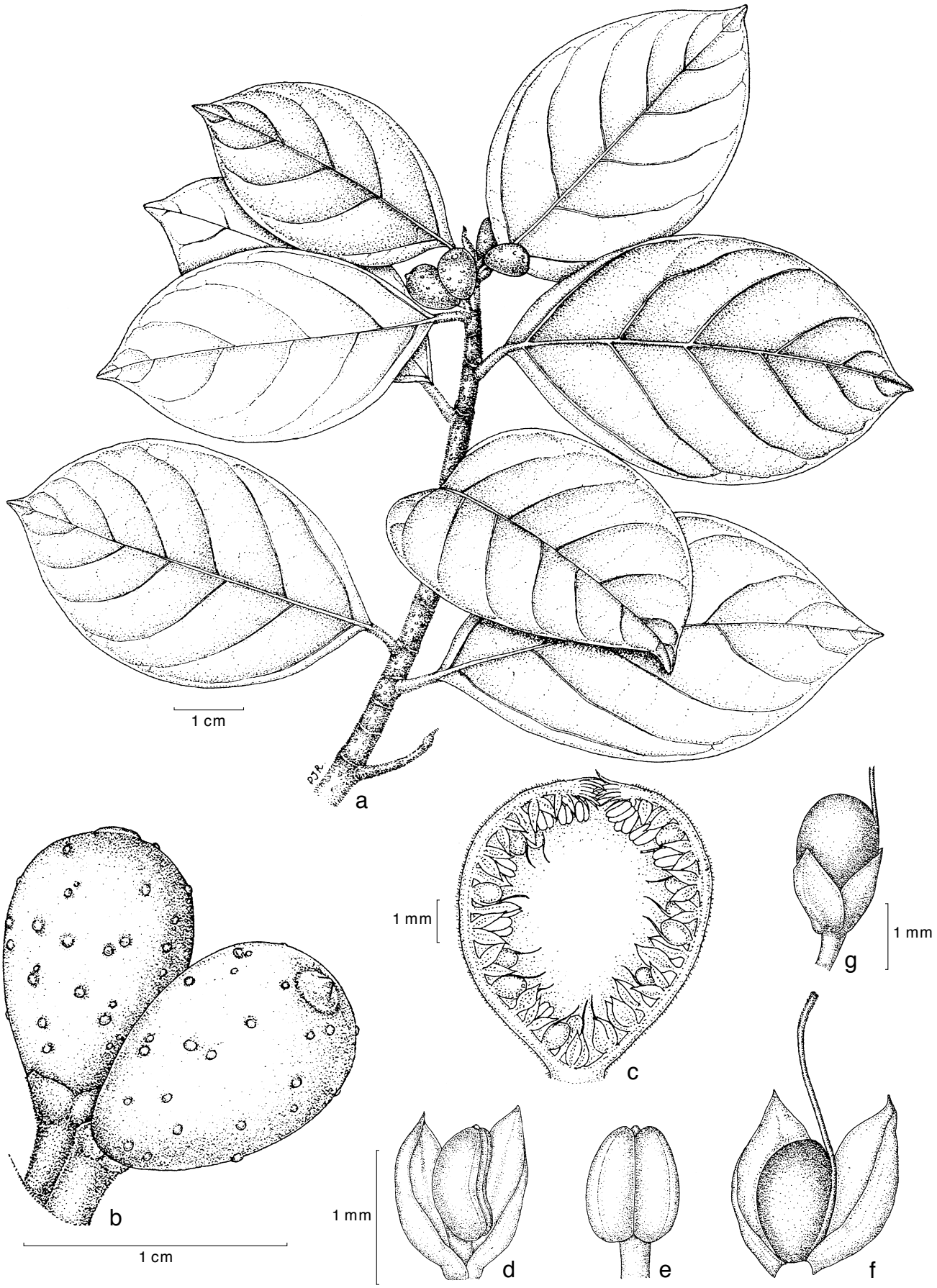

Fig. 1 *Ficus pongumphaii* Chantaras. & Sungkaew. a. Twig with leaves and figs; b. figs; c. fig in longitudinal section; d. staminate flower; e. stamen; f. sessile pistillate flower; g. pedicelled pistillate flower (*B. Chantarasuwan 180910-4*, THNHM). — Drawing: Pajaree Inthachup, 2015.

Table 1 Comparison of some morphological differences between *F. pongumphaii* Chantaras. & Sungkaew and *F. talbotii* King.

Characters	*F. pongumphaii*	*F. talbotii*
Habit	Shrub, normally up to 3 m tall	Tree, up to 22 m tall
Indumentum of leafy twig	Brown pubescent to tomentose to villous	Glabrous or whitish puberulous
Periderm of leafy twig	Persistent	Flaking off
Petiole length	0.8–1 cm	1–1.6 cm
Ending of basal lateral veins	Basal pairs up to 2/5–1/2 the length of the lamina	Basal pairs up to 1/5–1/3 the length of the lamina
Foliar indumentum	Upper surface brown tomentellous Lower surface brown tomentose	Upper surface glabrous Lower surface glabrous or minutely puberulous on midrib and main veins
Fig peduncle	Peduncle 2–3 mm long	Absent (–2 mm long)
Receptacle (Syconia)	Obovate, brown floccose or villous	Subglobose (to obovate), glabrous (or puberulous)
Synconial internal hairs	Present	Absent
Tepals of staminate flowers	2 (or 3)	3

Table 2 Comparison of leaf anatomical characters between *F. pongumphaii* Chantaras. & Sungkaew and *F. talbotii* King.

Characters	*F. pongumphaii*	*F. talbotii*
Glandular hairs	Hairs with ellipsoid-capitate 1- or 2-celled heads and discoid-capitate hairs with 4-celled heads (Fig. 3c2))	Only hairs with ellipsoid-capitate 1- or 2-celled heads
Cristarque cells	Absent	Present
Silicified cell groups	Present in epidermis and mesophyll	Present in mesophyll only
Enlarged lithocysts	More abundant adaxially	Abundant on both sides
Sclerification of sub-epidermal ground tissue	Absent	Abaxially of midrib

which lack internal hairs. The new species resembles *F. calcicola* Corner, treated as a form within the *F. talbotii* complex by Berg et al. (2011), but differs in foliar indumentum, figs peduncle, and indumentum on receptacle (syconia).

The leaf anatomy yields supporting evidence for the distinction between *F. pongumphaii* and *F. talbotii*, with the presence/absence of glandular hairs with discoid, 4-cellular heads (Fig. 3c2) and the relative frequency of lithocysts on upper and lower leaf surfaces(Fig. 4) as the most important distinguishing features. However, these differences, and the other differentiating characters (Table 2) have to be tested in more material, because they can be dependent on the (unknown) age of the persistent leaves.

Morphologically and anatomically the new species, *F. pongumphaii*, is clearly distinct from *F. talbotii* with which it was confused. Table 1 and 2 show that the new species is easy to identify based already on habit and indumentum.

The leaf anatomy (a multiple epidermis and the presence of lithocysts on both sides of the lamina) supports the position of both species in subsection *Conocyea* (see Chantarasuwan et al. 2014, for subsectional divisions).

TAXONOMY

Ficus pongumphaii Chantaras. & Sungkaew, *sp. nov*. — Fig. 1, 2, 3a2, b2, c2, d2, 4a2, b2

Shrub, at least up to 3 m high. Leafy twig brown pubescent to tomentose to villous. Leaf lamina elliptic to suborbicular to obovate, upper surface whitish or brown tomentellous, lower surface brown floccose tomentose to villous. Fig pedunculate, basal bracts persistent, strigose. Receptacle obovate, brown floccose or villous. Synconial internal hairs present. Epidermis multi-layers. Enlarged lithocysts abundant adaxially and only few abaxially. — Type: *B. Chantarasuwan 180910-4* (holo THNHM; iso L), Thailand, Lop Buri, Thawung, Wat Khao Samorkhorn, 18 Sept. 2010.

Deciduous shrub, up to 3 m tall, intermittent growth not prominent. *Leafy twig* 1.5–2.5 mm thick, brown pubescent to tomentose to villous, periderm persistent. *Leaf* spirally arranged, lamina elliptic to suborbicular to obovate, 2.7–6.5 by 1.9–4.8 cm, apex apiculate, the acumen blunt, base cuneate, upper surface whitish or brown tomentellous, lower surface brown floccose tomentose to villous, lateral veins 5–7 pairs, usually branching (furcated away from margin), basal pairs ending up to 2/5–1/2 the length of the lamina, usually branching. *Petiole* 0.8–1 cm long, brown tomentose, drying brown, epidermis persistent. *Stipule* 0.4–0.6 cm long, persistent, brown strigose or tomentose, epidermis of bud scale persistent. *Figs* in axils of leaves or just below the leaves, solitary or pairs, peduncle 2–3 mm long, tomentose; basal bracts 3, 1–1.5 mm long, brown strigose, persistent. *Receptacle* obovate, 0.6–0.7 cm diam when dry, brown floccose or villous, apex convex, ostiole c. 2 mm diam, upper ostiolar bracts glabrous; internal hairs present. *Staminate flowers* dispersed, sessile to pedicellate, tepals 2 (or 3), ovate, obovate or spatulate, free, red-brown. *Pistillate flowers* sessile to pedicellate, ovary red-brown, tepals 3, ovate, obovate or spatulate, free, red-brown.

Distribution & Habitat — A species seemingly endemic to Thailand, occurring on limestone hills at a 30–600 m elevation.

Specimens examined. Thailand, *P. Palee 278* (L), Chiang Mai, Sanh Gahm Pang, 2 May 1995; *A. Marcan 1437* (BM), Ratchaburi, 15 July 1924; *R. Pooma, K. Phattahirankanok, S. Sirimongkol, M. Poopath 3820* (BKF, L), Lopburi, Tha Wung, Wat Khao Samorkhorn, 20 Apr. 2004; *P. Phonsena, D. Chusithong, N. Loetsombunsuk 5718* (BK, BKF, L), Lopburi, Tha Wung, Wat Khao Samorkhorn, 21 Dec. 2007; *B. Chantarasuwan 180910-4* (L, THNHM), Lopburi, Tha Wung, Wat Khao Samorkhorn,18 Aug. 2010; *B. Chantarasuwan 081212-2* (L), Lopburi, Tha Wung, Wat Khao Samorkhorn, 8 Dec. 2012; *Put 2394* (BK), Saraburi, Hin Lap, 18 Aug. 1929; *Nai Noe 130* (BK), Muak Lek, Kao Mak Kok, 17 July 1925; *C.F. van Beusekom & T. Smitinand 2036* (BKF, L), Chon Buri, Sriracha, Sri Chang island, 7 Nov. 1969.

Ficus talbotii King — Fig. 3a1, b1, c1, d1, 4a1, b1

Ficus talbotii King (1887) 51, t. 63; Talbot (1911) 511, t. 521; Corner (1965) 19; (1977) 139, t. 14; C.C. Berg (2007) 24; C.C. Berg et al. (2011) 647. — Type: *W.A. Talbot 1100* (lecto CAL), India, N. Kanara District.

Ficus pierrei Gagnep. (1927) 93; (1928) 763. — Type: *Pierre n° 1676* (holo P), Cambodia, Sonrong Tong, montibus Kréév, Apr. 1870.

Ficus calcicola Corner (1960) 392; Kochummen (1978) 142; C.C. Berg & Corner (2005) 636. — Type: *M. Nur SFN 34388* (holo SING; iso L), Malay Peninsula, Selangor, Kaching, Batu Takun.

Tree, up to 22 m tall, deciduous, intermittent growth not prominent. *Leafy twig* 1.5–2 mm thick, glabrous or whitish puberulous or brown subtomentose, periderm flaking off. *Leaves* spirally arranged to subdistichous, lamina ovate to elliptic, 4.5–9 by 1.5–3.5 cm, apex acuminate, the acumen blunt, base rounded to cuneate, upper surface glabrous or minutely puberulous on midrib and main veins, lower surface glabrous to puberulous or subtomentose on midrib and main veins, lateral veins 6–7 pairs, furcated away from margin, basal pairs ending up to 1/5–1/3 the length of the lamina, usually branching. *Petiole* 1–1.6 cm long, glabrous or minutely and sparsely puberulous, drying blackish, epidermis persistent. *Stipule* 0.4–0.5 cm long, caducous, puberulous, brown strigose or subtomentose. *Figs* in axillary, solitary or in pairs, sessile (or peduncle up to 2 mm

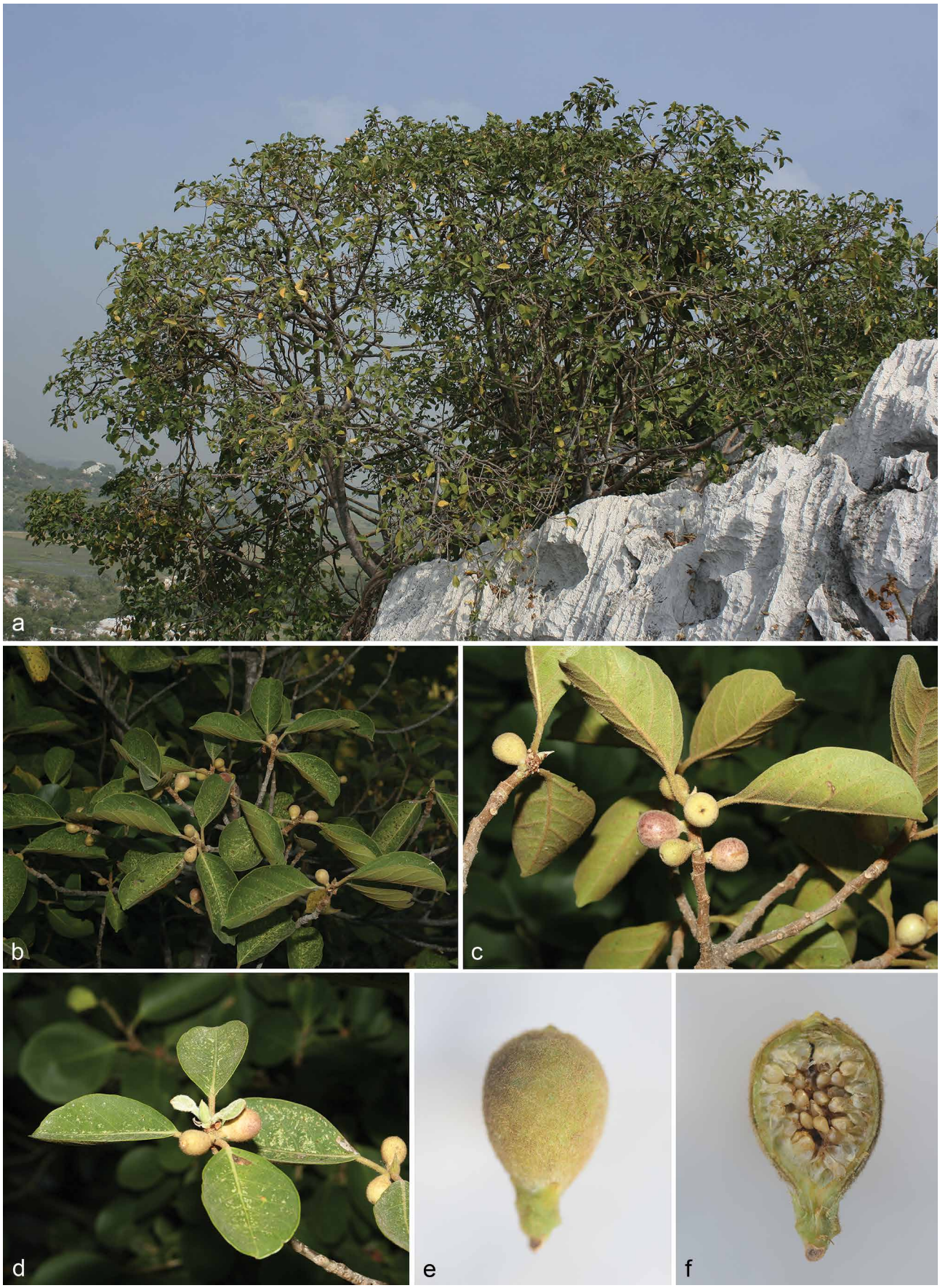

Fig. 2 Photos of live *Ficus pongumphaii* Chantaras. & Sungkaew. a. Habit in natural habitat; b–d. twigs with leaves and figs; e. fig; f. fig in longitudinal section. — Photos by Bhanumas Chantarasuwan.

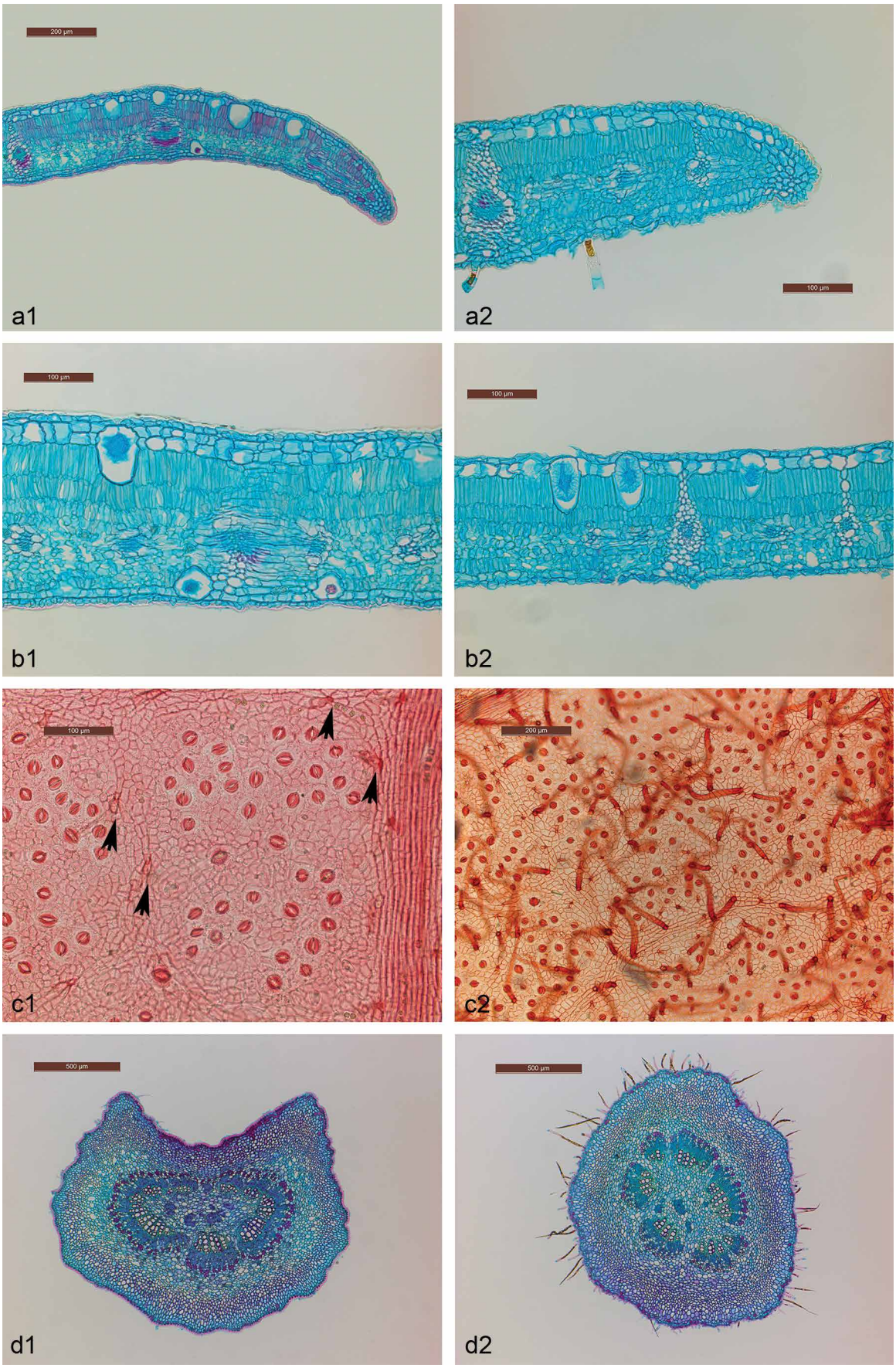

Fig. 3 Cross sections and cuticular macerations of the leaf laminas of *Ficus talbotii* King (left column) and *Ficus pongumphaii* Chantaras. & Sungkaew (right column). a1. Leaf margin without indumentum of *F. talbotii*; a2. leaf margin with indumentum of *F. pongumphaii*; b1. lamina of *F. talbotii* showing multi-layered epidermis on both sides and enlarged lithocysts on both surfaces; b2. lamina of *F. pongumphaii* showing multi-layered epidermis on both sides and enlarged lithocysts adaxially; c1. abaxial cuticular maceration of *F. talbotii* showing few hairs (black arrows); c2. abaxial cuticular maceration of *F. pongumphaii* showing many hairs; d1. petiole of *F. talbotii* with few hairs; d2. petiole of *F. pongumphaii* with an abundant hairs (a1, b1, d1: *M. Nur SFN 34388*, L; a2, b2, c2: *R. Pooma et al. 3820*, L; c1: *M.F. Newman et al. 1148*, L; d2: *B. Chantarasuwan 180910-4*, THNHM). — Photos by Bhanumas Chantarasuwan.

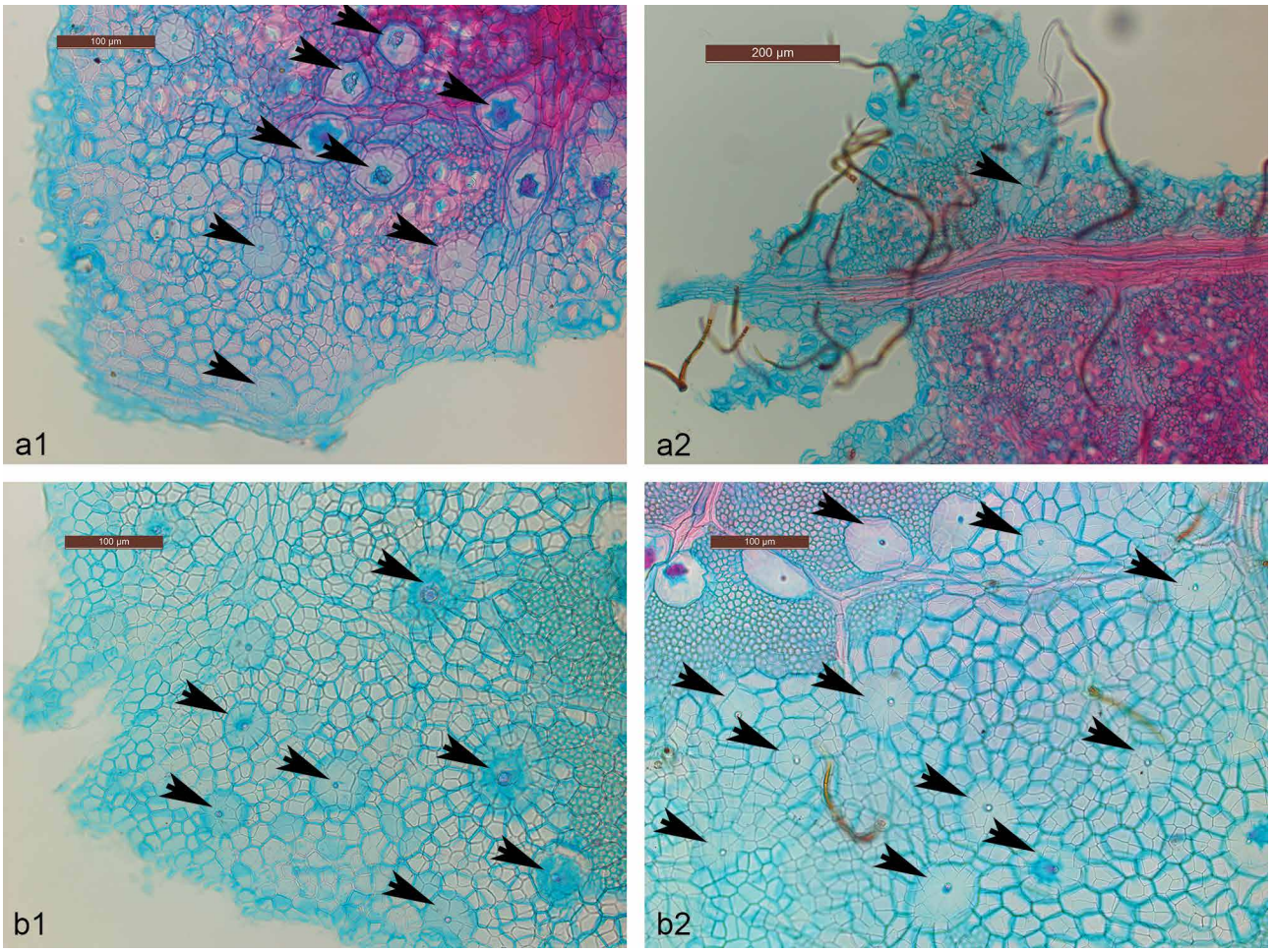

Fig. 4 Free hand paradermal leaf surfaces of *Ficus talbotii* King (left column) and *Ficus pongumphaii* Chantaras. & Sungkaew (right column). a1. Abaxial paradermal leaf surface of *F. talbotii* showing radiating epidermal cells around lithocysts (black arrows); a2. abaxial paradermal leaf surface of *F. pongumphaii* showing a few radiating epidermal cells around lithocysts (black arrows) and abundant hairs; b1. adaxial paradermal leaf surface of *F. talbotii* showing radiating epidermal cells around lithocysts (black arrows) and no indumentum; b2. adaxial paradermal leaf surface of *F. pongumphaii* showing radiating epidermal cells around lithocysts (black arrows) (a1, b1: *M.F. Newman et al. 1148*, L; a2, b2: *P. Palee 278,* L). — Photos by Bhanumas Chantarasuwan.

long); basal bracts 3, 2–3 mm long, brown puberulous, persistent. *Receptacle* subglobose (to obovate), 0.6–0.8 cm diam when dry, glabrous or minutely puberulous, apex convex, ostiole c. 2 mm diam, upper ostiolar bracts glabrous; internal hairs absent or few. *Staminate flowers* dispersed, sessile to pedicellate, tepals 3, ovate, free, red-brown. *Pistillate flowers* sessile to pedicellate, ovary white with red dot, tepals 3(–4), ovate, obovate or spatulate, free, red-brown.

Distribution & Habitat — Distributed in Sri Lanka, India, Myanmar, China(Yunnan), Laos, Vietnam, Cambodia, Thailand and Malay Peninsula. Found in mixed deciduous, evergreen and dry evergreen forests, and on limestone hills, up to 1 100 m elevation.

Specimens examined. Cambodia, *L. Pierre 1676* (P), Sonrong Tong, montibus Kéréev, Apr. 1870. – India, *K.M. Matthew RHT25340* (L), Tamilnadu, Namakkal, Kolli hill, Salem, 21 Dec. 1979. – Malay Peninsula, *M. Nur SFN34388* (L, SING), Selangor, Kaching, Batu Takun, 3 Nov. 1937; *T.C. Whitmore FRI 12162* (L), Selangor, Anak Takun, 31 July 1968; *T.C. Whitmore FRI 15633* (L), Selangor, Batu Caves, 20 Sept. 1970. – Myanmar, *N. Tanaka, T. Sugawara, S. Sakai, K. Aoki, A. Tanaka, H. Miwa, Than Than Aye, Khin Myo Htwe 021824* (L), Mandalay, Peik-Chin-Myaung, E96°37'12" N22°05'32", 13 Jan. 2002. – Thailand, *Put 4024* (BK, L), Lampang, Maung Ngao, 17 July 1929; *A.F.G. Kerr 19843* (BK); Prachin Buri, Kabin Buri, 10 Nov. 1930; *M.F. Newman, T. Boonthavikoon, C. Hemrat, D.J. Middleton 1148* (L), Chumphon, Kaw Weing, 11 Jan. 1927; *A.F.G. Kerr 11376* (BK), Prachuap Kiri Khan, Pranburi, Sam Roi Yot, 30 June 2000.

LEAF ANATOMY

Ficus pongumphaii Chantaras. & Sungkaew — Fig. 3a2, b2, c2, d2, 4a2, b2

Material studied. *B. Chantarasuwan 180910-4*; *R. Pooma, K. Phattahirankanok, S. Sirimongkol, M. Poopath 3820*, *P. Palee 278* (see above for localities).

Surface view — Indumentum present abaxially and adaxially, consisting of glandular ellipsoid-capitate hairs with 1- or 2-celled heads, discoid-capitate glandular hairs with 4-celled heads and simple septate and non-septate hairs. Cuticle smooth. Anticlinal walls straight on both surfaces. Radiating epidermal cells around lithocysts 5–8 on both surfaces. Stomata actinocytic to anomocytic, 20–30 µm long and 17–25 µm wide; giant stomata 28–38 µm long and 25–30 µm wide.

Transverse section — Cuticle less than 2 µm thick above the lamina, above midrib 2–3 µm thick and marginally 2.5–3 µm thick. Epidermis multi-layered on both sides, cells in outer layer smaller than in the inner layer. Stomata slightly sunken, only outer cuticular ledges present. Enlarged lithocysts abundant adaxially, few abaxially. Mesophyll dorsiventral; silicified cell groups present in mesophyll and epidermis especially near the stomata of the abaxial epidermis. Palisade 2-layered. Midrib with two opposing arcs surrounded by fibre caps. Petiole with a cylinder of separate bundles, without a fibre cap (or rarely with a small fibre cap); peripheral ground tissue not sclerified. Pith bundles present in midrib and petiole. Veins vertically

transcurrent; minor veins embedded in mesophyll. Marginal sclerenchyma strands absent. Druses present in mesophyll, ground tissue parenchyma and phloem parenchyma of midrib and petiole, few in the bundle sheaths around the veins; prismatic crystals absent or extremely rare in the parenchyma of midrib and petiole.

Ficus talbotii King — Fig. 3a1, b1, c1, d1, 4a1, b1

Material studied. *M.F. Newman, T. Boonthavikoon, C. Hemrat, D.J. Middleton 1148*; *M. Nur SFN34388*; *T.C. Whitmore (KEP) FRI 15633* (see above for localities).

Surface view — Indumentum present, consisting of ellipsoid-capitate glandular hairs with 1- or 2-celled heads and simple septate and non-septate hairs abundant on the petiole. Cuticle smooth. Anticlinal walls straight on both surfaces. Radiating epidermal cells around lithocysts 5–8 on both surfaces. Stomata actinocytic to anomocytic, 25–28 µm long and 17–25 µm wide; giant stomata 30–38 µm long and 25–30 µm wide.

Transverse section — Cuticle 2–4 µm thick above the lamina, c. 4 µm above midrib and marginally 5–8 µm thick. Epidermis multi-layered on both sides, cells in outer layer smaller than in the inner layer. Stomata level with epidermis, inner and outer cuticular ledges present. Enlarged lithocysts present in comparable frequencies on both sides. Mesophyll dorsiventral; silicified cell groups present, especially in mesophyll. Palisade 2-layered. Midrib with two opposing arcs surrounded by fibre caps; subepidermal ground tissue sclerified abaxially. Petiole with a cylinder of separate bundles with fibre cap; peripheral ground tissue not sclerified. Pith bundles present in midrib and petiole. Veins vertically transcurrent; minor veins embedded in mesophyll. Marginal sclerenchyma strands absent. Druses present in mesophyll, the bundle sheaths around the veins, ground tissue parenchyma and phloem parenchyma of midrib and petiole; prismatic crystals (partly in cristarque cells) present in periphery of the bundle sheaths above and below the veins and in the parenchyma of midrib and petiole.

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