

Amomum odoratum: an additional species for the flora of Vietnam and its anatomical traits

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ABSTRACT

The present study provides *Amomum odoratum* as an additional species for the flora of Vietnam with occurrence noted in Dur K'Mal Commune, Daklak Province, Vietnam. In addition, the micro-morphological traits of the various organs of *A. odoratum*, including root, rhizome, leaf, leaf sheath, and petiole are also provided for the first time.

KEYWORDS: *Amomum*, anatomy, new record, Vietnam.

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INTRODUCTION

Amomum Roxb. is one of the larger genera belonging to the family Zingiberaceae. This genus occurs extensively across subtropical and tropical regions of Asia (Xia *et al.*, 2004; Leong-Škornicková & Newman, 2015), especially, widely found in Indochina and Peninsular Malaysia–Borneo (Larsen, 2005). Boer *et al.* (2018) revised the taxonomy of the genus *Amomum* using a comprehensive analysis combining molecular and morphological data. Accordingly, a large number of former species within the genus *Amomum* were reclassified into other genera within the family Zingiberaceae, including *Epiamomum* A.D.Poulsen & Škorníček., *Wurfbainia* Giseke, *Meistera* Giseke, *Conamomum* Ridl., *Lanxangia* M.F.Newman & Škorníček., and *Sundamomum* A.D.Poulsen & M.F.Newman. Meanwhile, several species from other genera were

transferred into *Amomum*, most notably approximately 30 species formerly belonging to the genus *Elettariopsis* Baker. As a result, the genus *Amomum* currently comprises approximately 60 species (Boer *et al.*, 2018).

Vietnam is considered as one of the countries with high species diversity within the family Zingiberaceae, particularly in the genus *Amomum* (Leong-Škornicková & Newman, 2015; Nguyen, 2017; Leong-Škorníková *et al.*, 2019). According to the classification system proposed by Boer *et al.* (2018), 17 *Amomum* species have already been recorded in Vietnam, including *A. dealbatum* Roxb., *A. longipetiolatum* Merr., *A. odontocarpum* D.Fang, *A. sericeum* Roxb., *A. subcapitatum* Y.M.Xia (Lamxay & Newman, 2012), *A. lacteum* Ridl., *A. kwangsiense* D.Fang & X.X.Chen, *A. mengtzensense* H.T.Tsai & P.S.Chen, *A. maximum* Roxb.,

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A. repoeense Pierre ex Gagnep. (Nguyen, 2017), *A. glabrum* S.Q.Tong (Nguyen *et al.*, 2019), *A. trilobum* Gagnep., *A. unifolium* Gagnep., *A. cinnamomeum* Škorničk., Luu & H.Đ.Trần, *A. corrugatum* Škorničk., H.Đ.Trần & Luu, *A. lutescens* Luu & Škorničk., *A. miriflorum* Škorničk. & Q.B.Nguyen (Leong-Škorničková *et al.*, 2019).

In the book “Plant diversity, flora and vegetation of Hin Nam No National Protected Area”, Averyanov *et al.* (2019) described *Amomum odoratum* Škorničk. & Aver. as a new species to science which the type specimens were collected from Nong Seng Village, Boualapha District, Khammouane Province, Laos. Furthermore, no documented occurrences of this species have been reported outside Laos so far. The present study, thus records *A. odoratum* as an additional species for the flora of Vietnam and provides the first comprehensive description of its micromorpho-logical characteristics.

MATERIALS AND METHODS

The specimens of *Amomum odoratum* were gathered from Dur K'Mal Commune, Daklak Province, Vietnam, coordinates: 12°27'20.2"N 108°03'50.5"E, altitude 502 m above sea level. The specimen of this species was deposited at the Herbarium of University of Science, Vietnam National University-Ho Chi Minh City, Vietnam (PHH). Procedures for collecting samples and preparing specimens were adhered to the standards provided by the Royal Botanic Gardens, Kew (Bridson & Forman, 1999). The comparative morphological method was used to identify the species using the reproductive and vegetative traits in comparison with descriptions of other species belonging to the genus *Amomum* from prior reports (Nguyen, 2017; Lý & Leong-Škorničková, 2018; Averyanov *et al.*, 2019; Leong-Škorničková *et al.*, 2019; Nguyen *et al.*, 2019).

Thin slices of the cross sections of different organs of *Amomum odoratum* were soaked in sodium hypochlorite (NaClO) solution for 15 minutes and rinsed three times with distilled water to remove residual solution. The sections were then treated with 10% acetic acid for 3 mins to neutralise any remaning hypochlorite, followed by three rinses with distilled water to remove excess acid. The iodine

green-carmine double staining method was used to stain these samples. The sections were rinsed multiple times with water and preserved in 10% glycerol (Truong *et al.*, 2007). Observations were made with the Olympus BX53 Digital Upright Microscope.

RESULTS

TAXONOMIC TREATMENT

Amomum odoratum Škorničk. & Aver. Pl. Diversity Fl. Veg. Hin Nam No: 157. 2019. Type: Laos, Nong Seng Village, Boualapha District, Khammouane Province, Laos, 3 May 2018, L. Averyanov, K.S. Nguyen, T. Maisak, L. Xaiyavongsa & S. Keovankham AL 587 (holotype LE [LE 01049193]). Fig. 1.

Rhizomatous spreading herb up to 70 cm high. *Rhizome* 2.5–3 cm long, 1–1.5 cm in diameter, dark brown outside, pale yellow to brownish yellow inside. *Leafy shoots* with 8–9 leaves per shoot, 5–10 cm apart, leaves higher up more elongate; leafless sheaths 2–3; ligule 3.5–5 mm, cream to brownish green, hyaline, pubescent, apex obtuse to slightly bilobed; petiole 2.5–12.5 cm long, pale green, glabrous; lamina visibly plicate, abaxially light green, adaxially dark green, glabrous on both sides, ovate to lanceolate, 15–30 cm long, 3–6.5 cm wide, base attenuate, apex caudate, cauda 0.8–4.5 cm long. *Inflorescence* radical, emerging from base of leafy shoot; peduncle 4–6 cm long, 2.5–4 mm in diameter, white to cream; peduncle scales 2–5 cm long, 4–6 cm wide, cream to pale yellow; spike 2–4.5 × 0.6–1.5 cm (excl. exserted flowers). *Flower* 5.5–6.5 cm long; calyx tubular, 2.5–3 cm long, 3.5–4.5 mm wide, cream to pale yellow, 3-toothed, ciliate; floral tube 3–3.5 cm long, white cream, ciliate; dorsal corolla lobe 15–18 × 4.5–5.3 mm, semi-translucent white, with translucent stripes, apex slightly hooded, ciliate; lateral corolla lobes 16–17.5 × 4–4.5 mm, apex slightly hooded, ciliate, labellum 23–28 mm long, 22–26 mm wide at broadest point, widely obovate in shape, cream to pale yellow coloration on the sides, orange yellow in the center, the basal half with distinctly red line, densely hairy, apex prominently trilobed, undulate, reflexed; lateral staminodes absent or very short (ca 0.5 mm). *Stamen* 12–14 mm long; filament 2.5–3.5 mm long, ca 2–3 mm wide, cream with slightly red tinge, abaxially with a few hairs at base, adaxially densely hairy; anther ca 9.5–11 mm long (including crest), connective

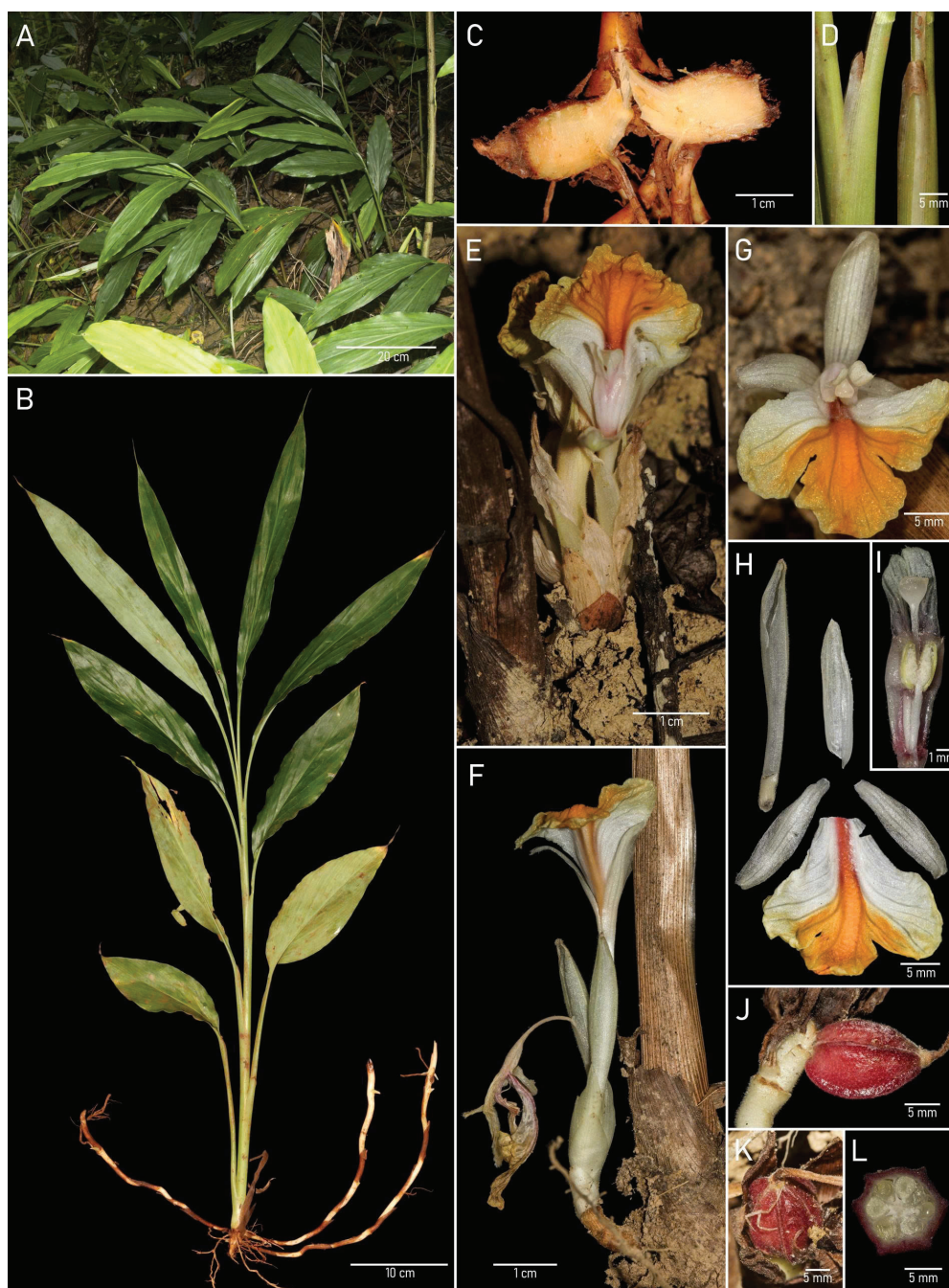


Figure 1. *Amomum odoratum* Škorničk. & Aver. A: habit, B: whole plant, C: rhizome, D: ligule, E-F: inflorescences, G: flower from front view, H: dissection of flower (from left, up to down): calyx, corolla lobes and labellum, I: stamen and stigma from front view, J: fruit (side view), K: fruit (top view), L: fruit in the cross section. Photos: Quang Diep Dinh & Nga Nguyen-Phi.

tissue slightly red tinge, apex ciliate; anther crest 2-lobed, 5–5.5 mm, anther thecae 2–3 mm long, 1–1.5 mm wide, oblong to ovoid, light yellow, dehiscing longitudinally almost for entire length, pollen cream to pale yellow. *Epigynous glands* two. *Ovary* 2–2.5 × 2.5–3.5 mm, cylindrical, cream to pale yellow, puberulous. *Style* white, with sparse hairs at base and more densely near the stigma; stigma cup-shaped, ca 1.8 × 2 mm, ostiole densely ciliate. *Fruit* obovate to ovoid, 3–4 mm long, 2.5–3.5 mm wide, light red with densely ciliate, with about 5–6 longitudinal convex grooves.

Specimen examined.— VIETNAM: Daklak Province [Dur K'Mal Commune, 12°27'20.2"N 108°03'50.5"E, elevation 502 m above sea level, 23 Apr. 2025, *Dinh & Nguyen K032 (PHH)*].

Distribution.— The species is found in Nong Seng Village, Boualapha District, Khammouane Province, Laos; Dur K'Mal Commune, Daklak Province, Vietnam.

MICRO-MORPHOLOGICAL CHARACTERISTICS

Roots (Fig. 2)

The cross-section has a nearly circular shape divided into 2 regions, the cortex occupies 2/3 of the cross-sectional radius, the stele occupies 1/3 of the cross-sectional radius. Cortex: piliferous layer has 1 layer of polygonal cells, fairly uniform in size, thin cellulose walls or sometimes impregnated with cork. Exodermis layer includes 1–3 layers of polygonal cells, walls impregnated with suberin, arranged haphazardly. The cortical parenchyma consists of 3–4 layers of outer polygonal, irregular cells, closely packed or with small spaces; 5–7 layers of inner cells arranged in concentric rings and radial rows, gradually decreasing in size. The endodermis is U-shaped. Stele: the pericycle consists of a layer of polygonal cells with cellulose walls, fairly uniform in size, arranged alternately with the endodermis. The vascular system consists of 13–15 phloem bundles alternating with 13–15 protoxylem bundles in a ring, separated by medullary rays. Phloem bundles consist of irregular, polygonal cells, arranged in a disorderly manner. Protoxylem bundles consist of 1–4 polygonal, centripetally differentiated protoxylem vessels; 12–15 metaxylem vessels located below primary phloem and

proto-xylem; the medullary ray consists of 1–2 rows of horizontally flattened polygonal cells with cellulose walls. The medullary parenchyma consists of 12–16 layers of polygonal cells with cork-impregnated walls, irregularly, and closely arranged. In the parenchyma region of the root, there are often scattered secretory cells.

Leaf sheath (Fig. 3)

The cross-section is trough-shaped, the upper surface is deeply concave, the middle area is thick and gradually thinner towards 2 edges. Epidermis consists of 1 layer of rectangular cells, with a cellulose wall. Vascular bundles are arranged in a row and located 4–5 layers of parenchyma cells away from the lower epidermis; the vascular bundles are evenly spaced and gradually smaller towards the two margins of the leaf sheath; vascular bundles include xylem above, phloem below; each xylem bundle has 2–5 protoxylem vessels, 1–3 larger metaxylem vessels located above the protoxylem; sclerenchyma is located at the 2 ends of the vascular bundle, 1–2 layers of cells on the xylem side and 3–5 layers of cells on the phloem side. The middle zone of the cross-sectional is usually thicker and has 2–3 additional rows of small vascular bundles, 1 row is close to the lower epidermis, 1–2 rows lie in the middle of the parenchyma area. Parenchyma consists of cells arranged closely together or forming small intercellular spaces. The parenchyma area is often destroyed, forming air cavities, arranged in a row between the vascular bundles. There are several small clusters of sclerenchyma, scattered close to the lower epidermis.

Petiole (Fig. 4)

The upper surface is concave, the lower surface is convex, the middle part is thick, the two edges are slightly elongated into thin wings. The upper and lower epidermis consist of 1 layer of rectangular cells, cellulose wall. The vascular bundles include xylem above, phloem below, arranged in a row, evenly spaced and gradually smaller towards the 2 wings; each vascular bundle consists of 2–5 small protoxylem vessels and 1–3 large metaxylem vessels, located on the protoxylem. Sclerenchyma arranges at both ends of the vascular bundle, 1–2 cell layers on the xylem side and 4–10 cell layers

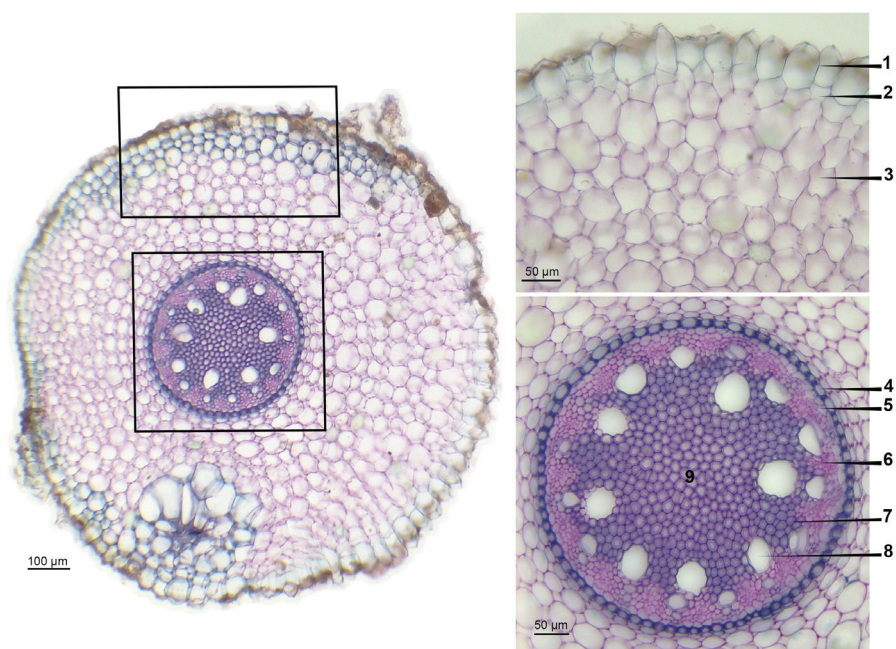


Figure 2. Cross-section of root. 1: piliferous layer, 2: exodermis, 3: cortical parenchyma, 4: endodermis with U-shaped thickening, 5: pericycle, 6: phloem, 7: protoxylem, 8: metaxylem, 9: medullary parenchyma.

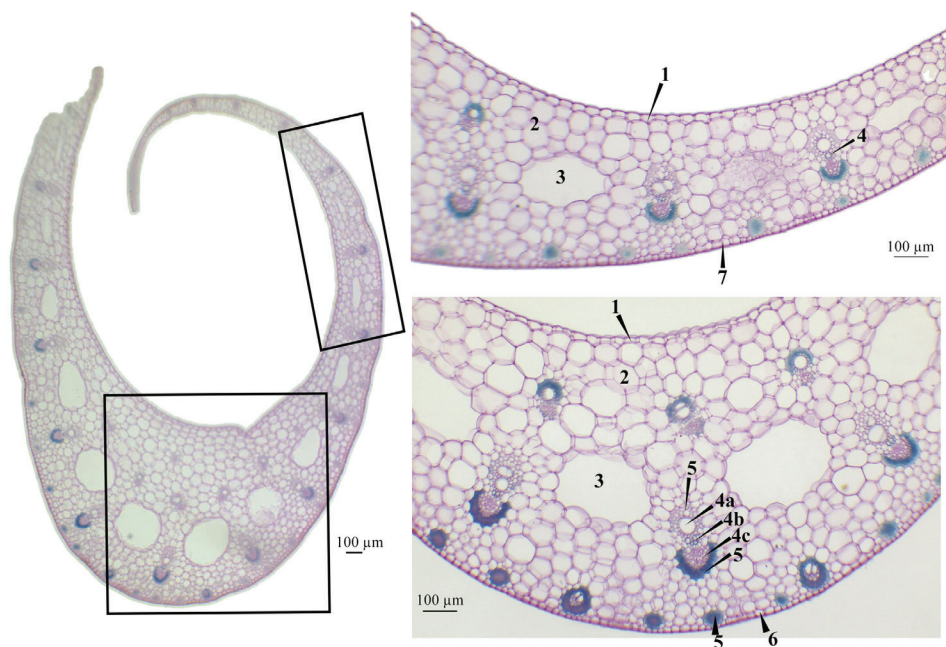


Figure 3. Cross-section of leaf sheath. 1: upper epidermis, 2: parenchyma, 3: air cavity, 4: vascular bundle, 4a: metaxylem, 4b: protoxylem, 4c: phloem, 5: sclerenchyma, 6: lower epidermis.

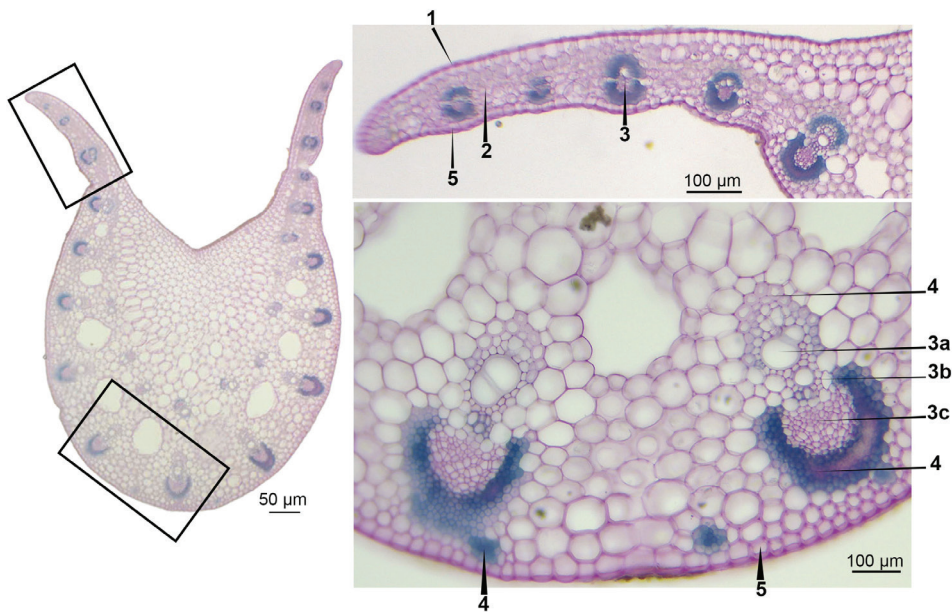


Figure 4. Cross-section of petiole. 1: upper epidermis, 2: chlorenchyma, 3: vascular bundle, 3a: metaxylem, 3b: protoxylem, 3c: phloem, 4: sclerenchyma, 5: lower epidermis.

on the phloem side. The middle zone of the cross-section is usually thicker and has an additional row of small vascular bundles located between the parenchyma areas. Parenchyma consists of cells arranged in a disorderly, irregular manner; the parenchyma region surrounding the vascular bundles contains many chloroplasts and is often destroyed, forming air cavities arranged in rows between the vascular bundles. There are several small, scattered clusters of sclerenchyma close to the lower epidermis.

Leaf blade (Fig. 5)

The leaf blade consists of the midrib and the primary lamina on both sides. Midrib: upper surface is concave, lower surface is convex; upper and lower epidermis consist of 1 layer of rectangular cells, cellulose wall. The vascular bundles include xylem above, phloem below, arranged in 2 rows in the midrib region, the lower bundle is larger than the upper one; each xylem bundle consists of 2–5 small protoxylem vessels and 1–2 large metaxylem vessels, located on the protoxylem. The sclerenchyma is

located at both ends of the vascular bundle, 1–2 cell layers on the xylem side and 4–10 cell layers on the phloem side. Parenchyma consists of irregular, disorderly cells; around the vascular bundles, the parenchyma contains many chloroplasts and is often destroyed, forming air cavities lying in rows between the vascular bundles.

Rhizome (Fig. 6)

The cross-section divides into 2 regions. Cortex: the epidermis consists of a single layer of rectangular cells with cellulose walls, fairly even. Parenchyma consists of polygonal, irregular cells, arranged haphazardly with small intercellular spaces. The vascular bundles are scattered and disorderly in the parenchyma area. The vascular bundle include xylem above, phloem below; the xylem bundle has very few protoxylem vessels (0–1 vessel), many large metaxylem vessels (2–5 vessels), and sclerenchyma consists of 1–3 layers of cells surrounding the vascular bundle; endodermis with casparian strip. Stele: pericycle is not clearly visible; many vascular bundles are arranged in an orderly

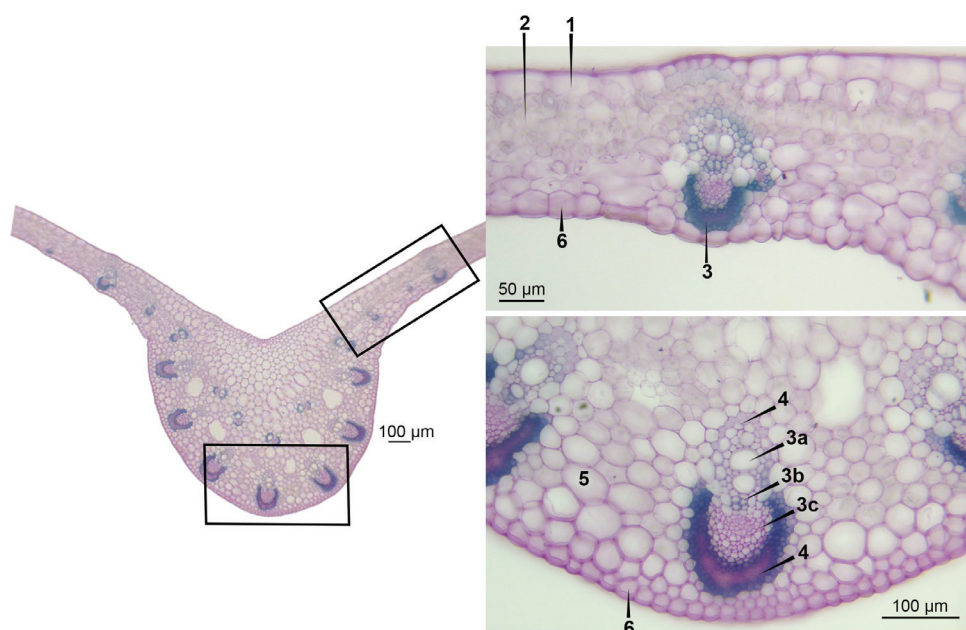


Figure 5. Cross-section of leaf blade. 1: upper epidermis, 2: chlorenchyma, 3: vascular bundle, 3a: metaxylem, 3b: protoxylem, 3c: phloem, 4: sclerenchyma, 5: parenchyma, 6: lower epidermis.

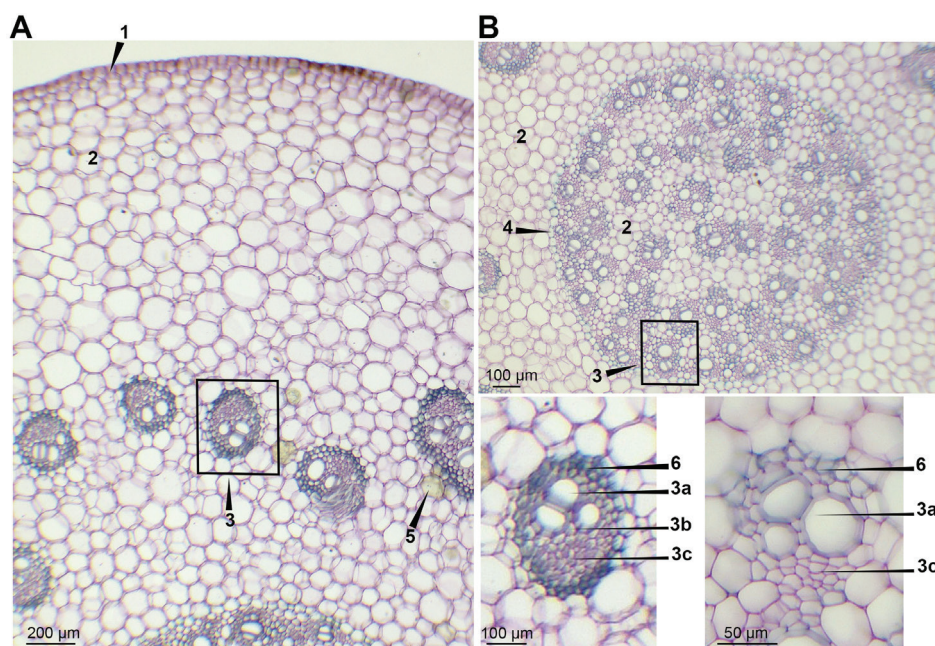


Figure 6. Cross-section of rhizome with cortex (A) and stele (B). 1: epidermis, 2: parenchyma, 3: vascular bundle, 3a: metaxylem, 3b: protoxylem, 3c: phloem, 4: endodermis with casparian strip, 5: secretory cell, 6: sclerenchyma.

manner, scattered in the parenchyma area, the differentiation and position of the phloem and xylem bundles are often indeterminate. Vascular bundles have little or no surrounding by sclerenchyma, the inner bundle is larger than the outer bundle. In the parenchyma region of the rhizome, there are often scattered secretory cells.

DISCUSSION

The anatomical traits of the species belonging to the genus *Amomum* remain poorly documented. More recently, Nguyen *et al.* (2023) described the micromorphological characteristics of *Conamomum vietnamense* N.S.Lý & T.S.Hoang, a species of the genus *Conamomum*, which was formerly included within *Amomum* (Boer *et al.*, 2018). Accordingly, the cross-section of the leaf blades of *A. odoratum* and *C. vietnamense* have the following similar characteristics in common: the vascular bundles arranged in rows from the midrib to both sides of the leaf blade; vascular bundles with xylem positioned above phloem, sclerenchyma at both ends, less developed on the phloem side; some air cavities located between the vascular bundles, becoming indistinct toward both margins of the lamina. However, the cross-section of the leaf blade of *C. vietnamense* can be distinguished from those of *A. odoratum* in having: 8–9 small vascular bundles surrounded by sclerenchyma, located below the upper epidermis; oil cells scattered throughout the parenchyma; unicellular protective hairs present on both upper and lower surfaces (no vascular bundles located below the upper epidermis; no oil cells scattered throughout the parenchyma; no unicellular protective hairs present on both upper and lower surfaces in *A. odoratum*)(Nguyen *et al.*, 2023).

The root cross-section of *Amomum odoratum* has characteristics like those of *Conamomum vietnamense* including: cortex occupying 2/3 and the stele occupying 1/3 of the cross-section, uniform tissue structure from outer to inner regions, oil cells present in the cortical parenchyma of both species. However, the cross-section of *C. vietnamense* root differs from those of *A. odoratum* by having: numerous linear intercellular spaces in the cortical parenchyma, many vascular bundles (34–36 bundles and 16–18 metaxylem vessels) present in the stele,

the medullary parenchyma divided into two regions: outer region with sclerenchyma, inner region with cellulose-walled (no linear intercellular spaces in the cortical parenchyma, fewer vascular bundles (12–15) and 12–15 metaxylem vessels, the sclerenchyma predominant in the medullary parenchyma in *A. odoratum*)(Nguyen *et al.*, 2023).

The rhizome cross-sections of *Amomum odoratum* and *Conamomum vietnamense* exhibit similarity in the following characteristics: irregular arrangement of vascular bundles in cortical and medullary parenchyma regions, the cortical bundles surrounded by sclerenchyma fibers, and secretory cells dispersed within the cortical and medullary parenchyma regions. However, the cross-section of *C. vietnamense* rhizome is different from that of *A. odoratum* in having: the cortex and middle regions clearly divided, the casparian strip not clearly visible in endodermis (casparian strip clearly visible in endodermis in *A. odoratum*)(Nguyen *et al.*, 2023).

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