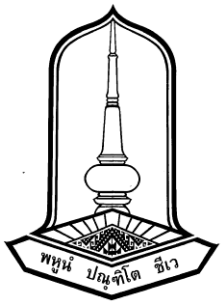

The Medicinal Plants Genus *Caulokaempferia* K. Larsen (Zingiberaceae) in India, China and Vietnam

Kamthorn Intharapichai

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Health Science at Mahasarakham University

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The examining committee has unanimously approved this thesis, submitted by Mr. Kamthorn Intharapichai, as a partial fulfillment of the requirements for the Master of Science in Health Science degree at Mahasarakham University.

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Kamthorn Intharapichai

ชื่อเรื่อง พืชสมุนไพรสกุล *Caulokaempferia* K. Larsen (Zingiberaceae) ในประเทศอินเดีย จีน และเวียดนาม
ผู้วิจัย นายกำธร อินทรพิชัย
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บทคัดย่อ

พืชสมุนไพรสกุล *Caulokaempferia* K. Larsen (Zingiberaceae) มีสมาชิกราว 30 ชนิด กระจายพันธุ์ตั้งแต่เทือกเขาหิมาลัย [อินเดีย (รัฐสิกขิม, รัฐเมฆาลัย, และรัฐมิโซแรม) และภูฏาน] ภาคใต้ของจีน ไทย ลาว และเวียดนาม การศึกษาตัวอย่างพรรณไม้สด (จากสถานที่เก็บตัวอย่างต้นแบบ) และตัวอย่างพรรณไม้แห้ง (จากพิพิธภัณฑ์พืชสำคัญของโลก) ของพืชสกุลนี้ในประเทศจีน เวียดนาม และอินเดีย พบว่ามี 6 แท็กซา (3, 2, และ 1 แท็กซา จากอินเดีย, เวียดนาม และจีน ตามลำดับ) ซึ่งหนึ่งในจำนวนนี้ผู้วิจัยได้รายงานเป็นพืชชนิดใหม่ของโลก (*C. tamdaoensis* Picheans. & Inthar.) ในรายงานนี้ได้จัดทำรูปวิธานจำแนกชนิด คำบรรยายลักษณะ ภาพวาดลายเส้น ภาพถ่ายสี ตลอดจนข้อมูลด้านการกระจายพันธุ์ นิเวศวิทยา และพฤกษศาสตร์พื้นบ้าน ผลการศึกษานี้จะทำให้เข้าใจชนิดพันธุ์ของพืชสกุลนี้ที่พบในไทยและลาวได้ดีขึ้น โดยเฉพาะชนิดที่ใช้เป็นยาสมุนไพร

TITLE The medicinal plants genus *Caulokaempferia* K. Larsen (Zingiberaceae) in India, China, and Vietnam
CANDIDATE Mr. Kamthorn Intharapichai
DEGREE M.Sc. (Health Science)
ADVISORS Professor Dr. Chayan Picheansoonthon, FRI
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UNIVERSITY Mahasarakham University **YEAR** 2015

ABSTRACT

The medicinal plant genus *Caulokaempferia* K. Larsen (Zingiberaceae) comprises about 30 species, distributed from the Himalayan [India (Sikkim, Megalaya, and Mizoram) and Bhutan] through South China, Thailand, Laos to Vietnam. After intensive investigation of both living specimens (all in type locations) and herbarium specimens (from major herbaria) of the genus in India, China and Vietnam, 6 taxa (3, 2, and 1 taxa from India, Vietnam and China, respectively) are recognized, one of which was reported a new taxon (*C. tamdaoensis* Picheans. & Inthar.). Keys to species, plant descriptions, line-drawing and color illustrations, including information on distribution, ecology, and ethnobotany, are reported. The result from this study will lead to better understanding of members of the genus distributed in Thailand and Laos, particularly those taxa with medicinal values.

CONTENTS

List of Figures

List of Abbreviations

BK	Bangkok Herbarium
cm	centimeter
E	Royal Botanic Garden, Edinburgh
K	Royal Botanic Gardens, Kew Herbarium
mm	millimeter
P	Herbier National de Paris

CHAPTER 1

INTRODUCTION

1.1 Background

The genus *Caulokaempferia* K. Larsen is taxonomically placed in the family Zingiberaceae. This genus was established by Larsen (1964), with 7 species in the Himalaya (3 taxa), Thailand (2 taxa), Vietnam (1 taxon) and China (1 taxon). *Caulokaempferia linearis* (Wall.) K. Larsen, one of the species distributed in the Himalayan, was assigned as type for this genus. Descriptions of all taxa given by Larsen (1964) based on available herbarium specimens were then incomplete. Moreover, the flower color of the 3 Himalayan species reported by Larsen (1964) was confusing and uncertain.

Among the 7 taxa originally included in the genus, the Chinese taxon, *Caulokaempferia coenobialis* is the most well understood. However, Wu & Chen (1981) moved this species back to genus *Monolophus* Wall., but move back to genus *Caulokaempferia* K. Larsen in the treatment of Flora of China (Wu & Raven, 2000).

Also, in Larsen (1964)'s original treatment of the genus, he added 1 Vietnamese species, *C. petelotii* (Gagnep) K. Larsen, to botanical science. Similarly, the description of the plants are inadequate for differentiation from other closely related taxa. In addition, the unknown population of Caulokaempferia were reported from in Tam Dao National Park in Vietnam (Kuznetsov, 2005).

Ethnobotanical study in the northeastern Mizoram State of India revealed the use of *C. linearis* (Wall.) K. Larsen by the Chakma tribes for vertigo (Rai & Lalramnghinglova, 2010). Furthermore, Lepcha tribe in India use *C. sikkimensis* (King) K. Larsen for bone dislocation or fracture (Pradhan & Badola, 2008).

To lay out fundamental knowledge of this genus for future study of the genus in Thailand and Lao PDR, where the genus is centrally localized, it is an urgent need to fully understand the taxa distributed in India, China, and Vietnam.

1.2 Research Objectives

To revise taxonomically the species diversity and biogeography of genus *Caulokaempferi*a K. Larsen in India, China and Vietnam

1.3 Scope of Research

The scope of this study includes ethnobotany and taxonomy of the genus *Caulokaempferia* K. Larsen in India China and Vietnam. Plant specimens will be collected from the type location of each species reported in the literature. The specimen will be compared with type specimens and related specimens in major herbaria. Detailed information on plant morphology, including line-drawing and photographic illustrations will be prepared. Indigenous people living around the type locations will be interviewed for their knowledge on the uses of each particular plant.

1.4 Research sites

1.4.1 All of herbarium specimens of the genus *Caulokaemferia* K. Larsen available in major Herbaria

1.4.2 Type locations of the focused taxon in India, China and Vietnam

1.4.3 Faculty of Medicine, Mahasarakham University

1.5 The benefits expected

1.5.1 Ethnobotanical and taxonomic information of genus *Caulokaempferia* K. Larsen in India, China and Vietnam will be comprehensively documented.

1.5.2 Fundamental knowledge on this plant group will be revealed for further studies, particularly for drug development.

CHAPTER 2

LITERATURE REVIEW

2.1 Ethnobotany

In India, the Chakma tribe in Mizoram State of India employs crushed herbs of *Caulokaempferia linearis* (Wall.) K.Larsen for vertigo (Rai & Lalramnghinglova, 2010), while the Lepcha tribe uses *C. sikkimensis* (King) K. Larsen to heal bone fractures, dislocation and wound (Pradhan & Badola, 2008).

In Thailand, *C. pholangkaensis* Picheans. is used as a major ingredient in the treatment of prostatic hyperplasia (enlarged prostate gland) by 'forest' monks, whereas *C. chayaniana* Tiyaw. is used for stomach problems by the Shan Ethnic in Thailand and Myanmar (Tiyaworanant, 2010).

2.2 Taxonomy

In 1820, N. Wallich described 2 new *Kampferia* species: *K. linearis* Wall. and *K. secunda* Wall. and placed them under the group '*caulescent with an entire crest*' (Roxburgh, 1820). He, a decade later, added the third species, *K. elegans* Wall., to this group with an important taxonomic comment that '…*all three ought perhaps to be removed from Kaempferia, and formed into a distinct genus, for which I would propose the name of Monolophus, in allusion to the entire crest of the anther*…" (Wallich, 1830). In this publication, he proposed a provisional generic name, *Monolophus* Wall.

Wallich (1832) used the name, *Monolophus*, in his publication for the above mentioned 3 species: *M. linearis* Wall., *M. secunda* Wall., and *M. elegans* Wall. The name *Monolophus* Wall. was, since then, an except name. After that, the name '*Monolophus*' had been used by several authors: Endlicher (1837), Steudel (1841), and Horaninov (1862). Bentham (1883) treated this plant group in *Kaempferia* L. section *Stachanthesis* Benth. Baker (1894), Schumann (1904) and Loesener (1930) treated *Monolophus* Wall. as a subgenus of the genus *Kaempferia* L.

Larsen (1964) rejected the name *Monolophus* Wall. based on 2 controversial reasons, '*…(1) The type species of WALLICH's Monolophus is a Kaempferia and the description given by WALLICH thus does not hold for the group in its sense for today. (2) The name refers to a character widely distributed also in neighbouring genera…*'. He, therefore, established the new genus, *Caulokaempferia* K. Larsen, and transferred 4 taxa, previously placed either under *Kaempferia* L. or *Monolophus* Wall. to his new genus: 3 Indian [*C. linearis* (Wall.) K. Larsen and *C. secunda* (Wall.) K. Larsen, and *C. sikkimensis* (King) K. Larsen] and 1 Chinese [*C. coenobialis* (Hance) K. Larsen] species. He also added 2 new species (*C. kuapii* K. Larsen and *C. saxicola* K. Larsen) from Thailand and a new taxon (*C. petelotii* K. Larsen) from Vietnam to his account. In this treatment, K. Larsen assigned *C. linearis* (Wall.) K. Larsen as a type specimen for the genus.

Few years later, K. Larsen and his colleague, R.M. Smith, added a new taxon, *C. alba* K. Larsen & R.M. Smith, to the genus *Caulokaempferia* (Larsen & Smith, 1972). They also proposed 2 new sections: section *C. alba* K. Larsen & R.M. Smith (for *C. alba* K. Larsen & R.M. Smith) and section *Pyrgophyllum* [for *C. yunnanensis* (Gagnep.) R.M. Smith, transferred from *Kaemferia yunnanensis* Gagnep]. In 1973, K. Larsen added another 2 new species from Thailand: *C. saksuwaniae* K. Larsen and *C. thailandica* K. Larsen (Larsen, 1973).

T.L. Wu and S. J. Chen (1978) used the generic name *Monolophus* Wall. as an accepted name, and *Caulokaempferia* K. Larsen was placed there under a new synonymous name (*syn. nov.*). He also proposed *M. linearis* Wall. as a lectotype of the genus. However, that same year, he did change his mind since he accepted the name *Caulokaempferia* K. Larsen in his account of family Zingiberaceae in 'Flora Reipublicae Popularis Sinica (Chinese edition)' (Wu, 1978). In Flora of Bhutan, the name *Caulokaempferia* K. Larsen was accepted with only 1 species, *C. sikkimensis* was (Noltie, 1994). In 'Flora of China (English edition)' the name *Caulokaempferia* was accepted by the Chinese group again, but moved *C. yunnanensis* (Gagnep.) K. Larsen to form a new endemic monotypic genus *Pyrgophyllum* T.L. Wu & Z.Y. Wu. (Wu & Larsen, 2000).

In 2003, K. Larsen and his Thai colleagues reported 3 new species from Thailand, *C. appendiculata* K. Larsen & T. Triboun, *C. bracteata* K. Larsen & S.S.

Larsen, and *C. violacea* K. Larsen & S.S. Larsen. It is interesting to note that the type specimen of *C. bracteata* was a purchased specimen from 'Chatuchak Flower Market in Bangkok (brought over from Changwat Nong Khai, a border town to Lao PDR)' (Larsen, 2003). However, in 2008, Picheansoonthon and his co-workers confirmed that *C. bracteata* K. Larsen & S.S. Saksuwan is not a Thai species. It was collected from the the Laotian site, Phou Khao Khouay National Biodiversity Conservation Area (NBCA) across the Mekhong, and transport to sell in the trans-border market in Changwat Nong Khai of Thailand (Picheansoonthon *et al*, 2008*a*).

Picheansoonthon and Mokkamol added another 4 new species, *C. khaomaenensis* Picheans. & Mokkamul (Picheansoonthon & Mokkamul, 2004*a*), *C. phuluangensis* Picheans. & Mokkamul, *C. jirawongsei* Picheans. & Mokkamul (Picheansoonthon & Mokkamul, 2004*b*) and *C. limiana* Mokkamul & Picheans. (Mokkamul & Picheansoonthon, 2004) from Thailand. In this same year, K. Larsen and Jenjittikul (2004) added a new species, *C .burttii* K. Larsen & Jenjitt., from Laos, based on specimen retrieved from Chatuchak Flower Market in Bangkok (brought over from Champasak Province in southern Lao PDR). Furthermore, Suksathan and Triboun (2004) also reported a new species, *C. larsenii* Suksathan & Triboun from north Thailand.

K. Larsen and his Thai colleagues, reported another two new taxa, *C. amplexicaulis* Suksuthan and *C. pedemontana* Triboun & K. Larsen from Thailand (Larsen *et al*, 2005). Picheansoonthon and Mokkamul (2006) described a new species, *C. laotica* Picheans. & Mokkamul, from southern Laos. In 2007, Picheansoonthon and his co-workers further added a new species, *C. satunensis* Picheans., from southern most changwat of Thailand, marked the southernmost distribution limit of the genus. (Picheansoonthon *et al*, 2007).

Picheansoonthon and Koonterm (2008) added *C. bolavenensis* Picheans. & Koonterm from south Laos. They also reported *C. alba* K. Larsen & R.M. Smith a new record for Lao PDR. They also confirmed the type locations of *C. bracteata* K. Larsen & S.S. Larsen and *C. burtii* K. Larsen & Jenjitt. In Lao PDR (Picheansoonthon *et al*, 2008*a*). In same year, 3 others new species *C. phuwoaenensis* Picheans. & Koonterm, *C. phulangkaensis* Picheans., and *C. phutokensis* Picheans. from northeast Thailand were described (Picheansoonthon & Koonterm, 2008).

In 2008, Picheansoonthon and his co-worker established a new genus, *Jirawongsea* Picheans. based on morphological characters and molecular evidence (Picheansoonthon *et al*, 2008*b*). Three non-yellow flowered *Caulokaempferia* species were transferred to this new genus: *J. alba* K. Larsen & R.M. Smith, *J. burtii* (K. Larsen & Jenjitt.) Picheans. and *J. laotica* (Picheans & Mokkamul) Picheans. In this publication, the authors also reported *C. thailandica* K. Larsen and *C. violacea* K. Larsen & T. tribounas synonymous to *J. alba* (K. Larsen & R.M. Smith) Picheans.

Ngamriabsakul (2009) added *C. sirirugsae* Ngamr., a new species from south Thailand. Tiyaworanant (2010) further reported *C. chayaniana* Tiyaw. as a, new taxon from northern Thailand. The genus *Caulokaempferia* K. Larsen in India was revised with more detailed information on all 3 species: *C. linearis* (Wall.) K. Larsen, *C. secunda* (Wall.) K. Larsen, and *C. sikkimensis* (King) K. Larsen (Roy & Barbhuiya, 2013). Recently, a new taxon from Vietnam, *C. tamdaoensis* Picheans. & Inthar. was also described (Intharapichai *et al.*, 2014).

Mood and Velkamp (2014) considered the name *Caulokaempferia* K. Larsen superfluous, and restated *Monolophus* Wall. as accepted generic name. Instead of conserving the name, the authors who only seen few specimens of the genus, unnecessarily combined all the previously described *Caulokaempferia* taxa and created more than 20 plant names with long author names, just because of the nomenclatural ‘technical problem’. They also combined the genus *Jirawongsea* Picheans. with *Boesenbergia* O. Kuntz based, unfortunately, on molecular information of only 1 species (Mood *et al.*, 2014).

CHAPTER 3

METHODOLOGY

3.1 Ethnobotanical studies

Rapid ethnobotanical appraisal (REA) techniques were employed. This technique includes

1) in-depth interview with the locals/traditional healers

2) focused group discussion with the locals/traditional healers

3) participatory observation with the locals/traditional healers

The locals, traditional healers, or informants, live in the distribution areas of the genus *Caulokaempferia* were chosen. Documentation was focused on the uses of the genus used in food, medicine, spiritual belief and ceremony by the locals.

3.2 Taxonomy

This study was based on field plant collections and herbarium specimens.

1) Intensive fieldworks in the type localities of existing taxa were carried on during June-September of 2012-2014.

2) Field notes on plant morphology, distribution and ecology were prepared. Photographs of plant specimens were taken from the collecting location.

3) Specimens were prepared in 95% Ethanol and Glycerin (1:1 ratio).

4) Additional information were retrieved from specimens deposited in major herbaria, e.g. BK, BKF, QBG, K and SING.

CHAPTER 4

TAXONOMIC STUDY

4.1 Taxonomic treatment of genus *Caulokaempferia* K. Larsen

Caulokaempferia K. Larsen

K. Larsen, Bot. Tidsskr. 60(3): 165. 1964; K. Larsen & R.M. Smith in Notes Roy. Bot. Gard. Edinb. 31(2): 287. 1972; T.L. Wu & S. J. Chen, Fl. Reipubl. Popul. Sin. 16(2): 36. 1981; T.L. Wu in F.W. Chen & T.L. Wu, Fl. Guangdong 2: 403. 1991; R.M. Smith in H.J. Noltile, Fl. Bhutan 3(1): 196. 1994; S. Kuma in P.K. Hajra & D.M. Verma, Fl. Sikkim 1: 123. 1996; T.L. Wu & K. Larsen in Z.Y. Wu & P.H. Raven, Fl. China 24: 377. 2000; Intharapichai *et al*, J. Jpn. Bot. 89: 129. 2014; D.K. Roy & H.A. Barbhuiya, NeBIO, 4(6): 1. 2013.—*Monolophus* Wall. [Pl. Asiat. Rar. 1: 24. 1830; nom. prov. Inval.] ex Lindl, Gen. Pl.: 225. 1837; Horan., Monogr.:22. 1862; T.L. Wu. & S. J. Chen in Acta Phytotax. Sin. 16(3): 28. 1978; J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 215. 2014.—*Kaempferia* L. subg. *Monolophus* (Wall. ex Endl.) Wall. ex Baker in Hook.f., Fl. Brit. India 6: 222. 1892; K. Schum. in Engl., Pfanzenr. 20(IV-46): 73. 1904.

Perennial herbs, up to 57 cm high; *Pseudostems* slender, with 2-4 bladeless sheaths at base. *Leaves* sessile to petiolate; ligule membranous, apex acute to acuminate. *Inflorescences* terminal; bract(s) 1-10, distichous, lanceolate, 1-4-flowered, margin free to base; bracteoles membranous. *Flowers* purple, white, or yellow; calyx tubular, split on 1 side, apex 2-3-toothed; corolla tube long, narrowly, widened at mouth; 3-lobed, dorsal lobe, hooded, slightly longer and wider than lateral lobes, purple, white, or yellow; lateral staminodes petaloid, broadly elliptic to suborbicular, purple, white, or yellow; labellum broadly elliptic to suborbicular, apex crenate or 3-lobed, purple, white, or yellow; filament very short or absent; anther basifixed; connective forming a conspicuously reflexed crest; ovary 1- or 3-loculed; stylodes 2, short. *Fruits* capsular, oblong. *Seeds* numerous, arillodes.

3 species in India, 2 species in Vietnam, and 1 species in China.

4.2 Key to the species of *Caulokaempferia* in India, China and Vietnam

4.2.1 Flower white or purple, distributed in India, Bhutan and Bangladesh

1) Leaf blade ovate to elliptic, labellum purple **…….2. C. secunda**

2) Leaf blade lanceolate, labellum white

3) Leaves (4-)5(-6), labellum white, suborbicular, midlobe apex entire

..……..3. C. sikkimensis

4. Leaves 8-12, labellum white with yellow spot at the throat, midlobe apex slightly emarginated **……...1. C. linearis**

4.2.2 Flower yellow, distributed in China and Vietnam

1) Labellum patent, suborbicular with distal median lobe

……6. C. tamdaoensis

2) Labellum saccate, broadly elliptic to obovate, apex rounded or emarginated, concave

3) Ligule 2-4 mm long, corolla tube *ca*. 3 cm long, labellum apex emarginated **……4. C. coenobialis**

4) Ligule 0.5-1 cm long, corolla tube 2-2.2 cm long, labellum apex rounded

…….5. C. petelotii

4.3 Descriptions of *Caulokaempferia* in India, China and Vietnam

4.3.1 Caulokaempferia linearis (Wall.) K. Larsen, Bot. Tidsskr. 60: 170. 1964; A.S. Rao & D.M. Verma in Bull. Bot. Surv. India 14: 125. 1972; D. K. Roy & H.A. Barbhuiya, NeBIO 4(6):1-6, 2013.—*Kaempferia linearis* Wall. in Roxb. Fl. ind. 1: 20. 1820; Baker in Hook.f., Fl. Brit. lndia 6: 223. 1890; K. Schum., in Pflanzenr. (Engler) IV 46: 73. 1904; Loesener in Nat. Pflanzenfam., ed. 2, l 5a: 566. 1930. D.K. Roy & H.A. Barbhuiya, NeBIO 4(6):1-6, 2013.—*Monolophus linearis* Wall. Cat. in Horan. Monogr. 22. 1862; J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 219. 2014. (Fig. 4.1 & Fig. 4.2)

Type: BANGLADESH, Sylhet, W Gomez in Wall. list 6592 (E-image!)

Lithophytic, perennial herb. *Pseudostem* 10.1 -24.2 cm high, green with 1-3 bladeless sheaths at the base. *Leaves* 8-12, sessile; leaf blade ovate-lanceolate, 4.3-6.5

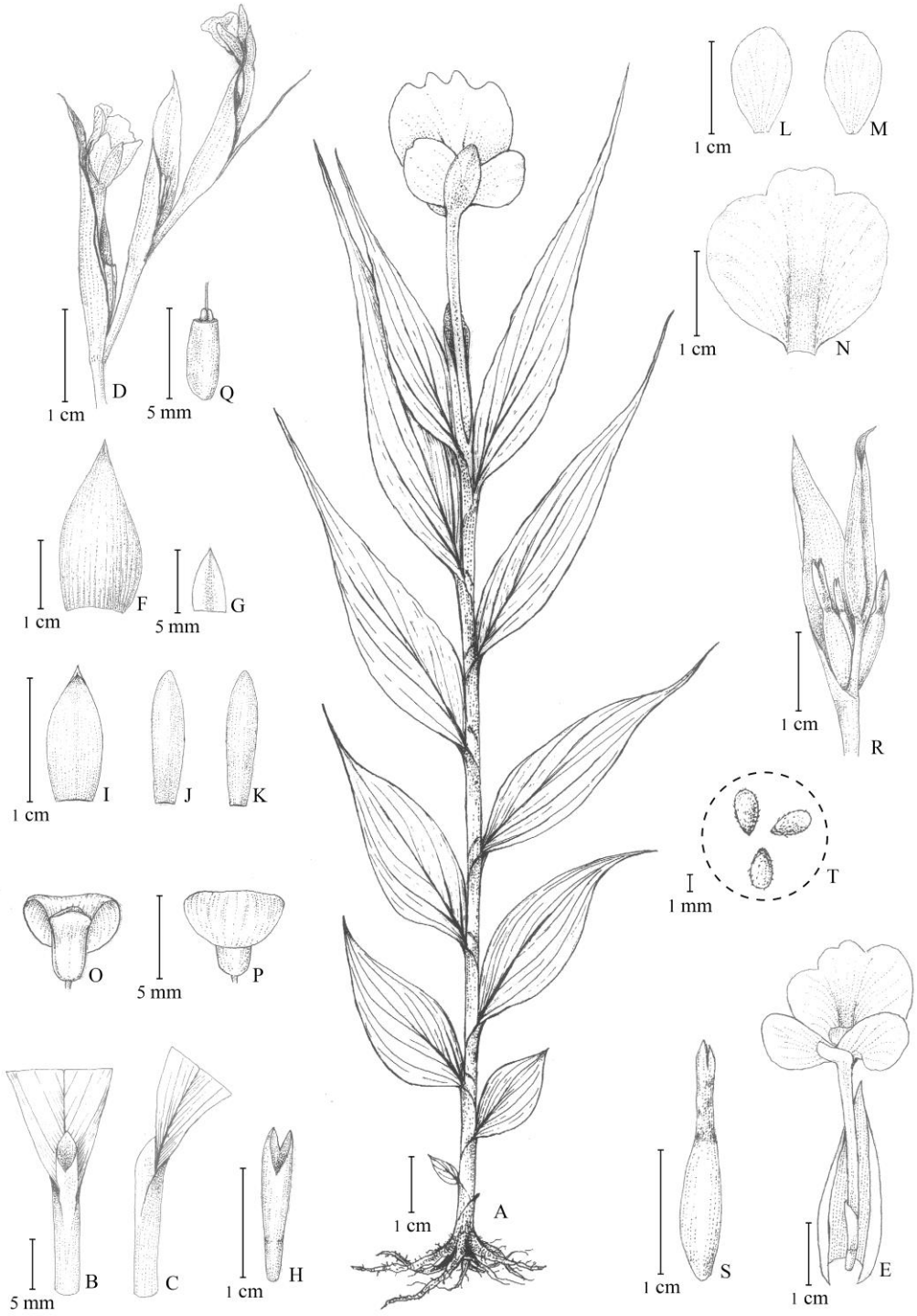
by 1.4-1.6 cm, base attenuate, apex acuminate, margin entire, both surface glabrous, green; ligule membranous, 4-6 mm long, brown, apex acuminate. *Inflorescence* rachis glabrous; with 1-2(-3) bract(s) and some with infertile bract, each bract subtends 1-4 flower(s); bracts green, ovate-lanceolate, 2.2-3.5 cm by 8-13 mm apex acute-acuminate, margin entire, glabrous; bracteoles ovate-lanceolate, ca. 5 mm long, membranous, apex acuminate, green; calyx tubular, 6- 9 mm long, pinkish white, apex 2-lobed; corolla tube slender, 2.1-3.2 cm long, pinkish white; dorsal corolla lobe ovate-lanceolate, hooded, 8-10 by 4-5 mm, pink; lateral corolla lobes lanceolate, 8-12 by 2-3, pink; lateral staminodes, white, obovate, 1-1.3 cm by 6-8 mm, apex round; labellum white, suborbicular, tinged with yellow spot at the throat, 1.5-2.3 by 1.5-2.1 cm, trilobed, median lobe apex slightly emarginate; anther-crest, white, suborbicular, 4-5 by 3-4 mm, recurved, apex rounded; stigma funnel-shaped; ovary cylindrical 4-5 mm. long, ovules numerous; stylodes 2, filiform, ca. 1 mm. long. *Fruits*, oblong, 8-12 mm long. *Seeds* numerous, ellipsoid, ca. 2 by 1 mm, villous.

Phenology: Flowering from July-August, fruiting from September-October.

Distribution: INDIA (Meghalaya, Mizoram (?)) BANGLADESH (?).

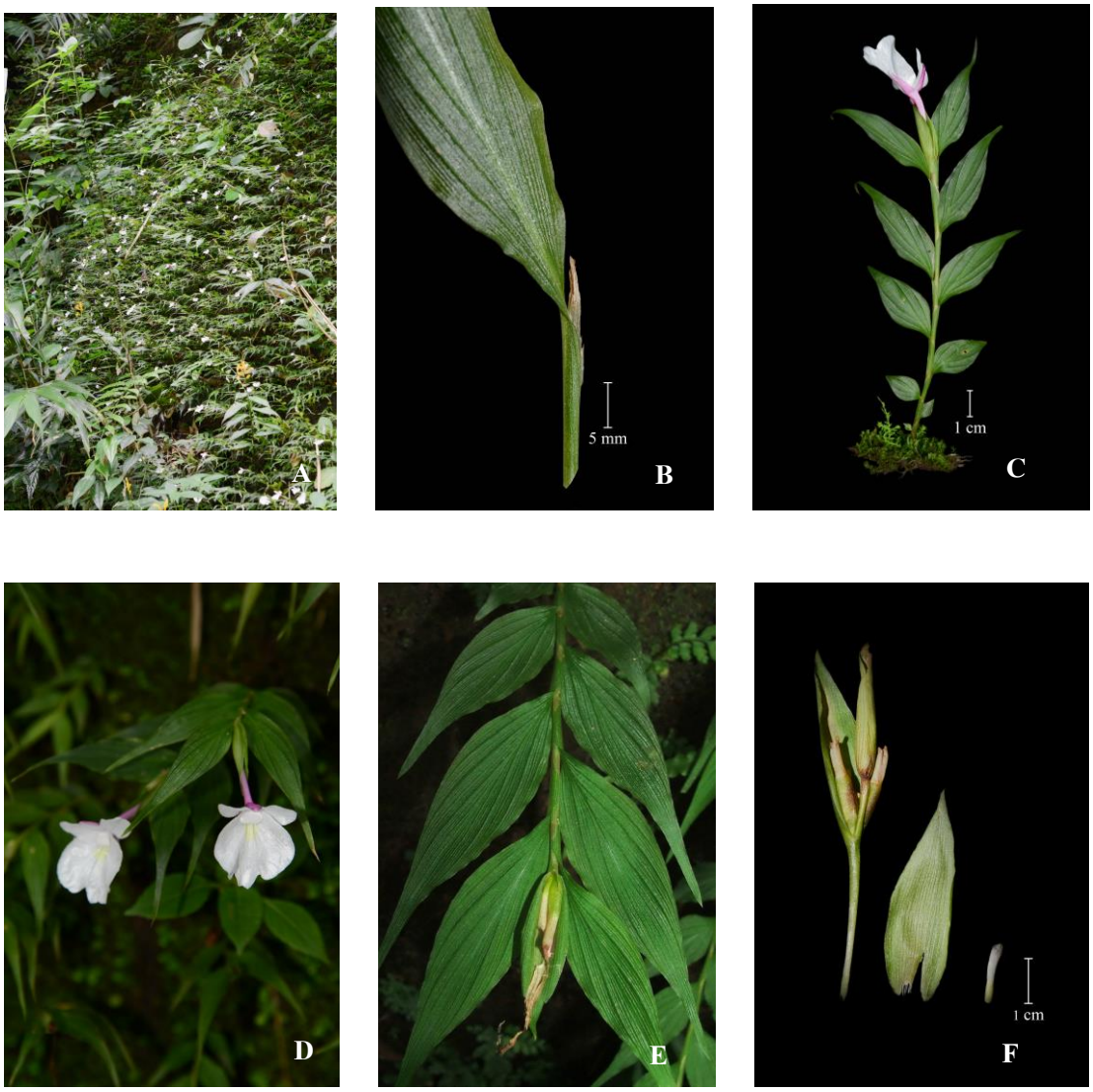
Ecology: On moist rocks in mixed deciduous forest at an altitude of 700 m.

Examined material: INDIA: Meghalaya, Khasi Hills, J D. Hooker & T. Thomson s.n. (E, P-image); Jaintia Hills, ca. 3000 ft., 27.09.1850, Jutin 7388 (K-image); Pongtung forest, 28.08.1935, S.R. Sharma 12180 (ASSAM); Dawki, 06.08.1940, G.K Deka 19598 (ASSAM); Dawki, 11.08.1944, G.K Deka 21872 (ASSAM); Mowlingdong, 18.08.2012, D.K Roy & Santanu Dey 125700 (ASSAM). Meghalaya, Jaintia Hills ca 2000 ft., 23.07.2012, C. Pichean. & K. Inthar. CP230712-1, CP230712-2 (BK).



A. Habit; B & C. Leaf base, showing ligule (B. front view, C. side view); D. Inflorescence; E. Flower with a bract; F. Bract; G. Bracteole; H. Ovary and calyx tube; I - K. Corolla lobes (I. dorsal, J & K. lateral); L & M. Lateral staminodes; N. Labellum; O & P. Anther and anther crest (O. front view, P. rear view); Q. Ovary with stylodes; R. Infructescence; S. Fruit; T. Seeds.

Figure 4.1 Illustrations of *C. linearis* (Wall.) K. Larsen:



A. Plants in location; B. leaf, showing a ligule; C. Plants showing leaves and flowers;
D. Flowers, showing staminodes, labellum and anther crest; E. Plant, showing leaves and infructescence;
F. Infructescence

Figure 4.2 Photograph illustrations of *C. linearis* (Wall.) K. Larsen:

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4.3.2 Caulokaempferia secunda (Wall.) K. Larsen, Bot. Tidsskr. 60: 170. 1964; A.S. Rao & D.M. Verma in Bull. Bot. Surv. India 14: 125. 1972; S. Kumar in Hajra &. D.M. Verma (eds.), Fl. Sikkim 1: 123. 1996; D.K. Roy & H.A. Barbhuiya, NeBIO 4(6):1-6, 2013.—*Kaempferia secunda* Wall. in Roxb. Fl. Ind. 1: 19. 1820; Hook.f., in Bot. Mag. t. 6999. 1888; Baker in Hook.f , Fl. Brit. India 6: 223. 1890; K. Schum., in Pflanzenr. (Engler) IV 46: 74. 1904; Loesener in Nat. Pflanzenfam. ed. 2, 15a: 566. 1930.—*Monolophus secundus* Wall., Pl. As. Rar. 1:24. 1830 & in Horan. Monogr. 22. 1862; J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 227. 2014. (Fig. 4.3 & Fig. 4.4)

Type: BANGLADESH, Sylhet, W. Gomez in Wall. list 6591 (E-image!).

Lithophytic, perennial herb. *Pseudostems* terete, 8.3-29.8 cm high, leaf sheaths purplelish-green with 2-3 bladeless at the base. *Leaves* 4-7, upper ones petiolate, lower ones reduced, sessile; petiole up to 1.5 mm long; leaf blade ovate to epiliptic, 4.7-11.6 by 2.4-5.6 cm, base truncate to rounded, apex caudate up to 3 cm long, both surface glabrous, upper surface dark green, some lower surface purplelish; ligule membranous, 5-12 mm long, apex acuminate. *Inflorescences* terminal, pluriflorus, up to 10 cm long; rachis sparsely hairy with 2-4(-7) bracts; bracts ovate, 2.5-3.4 by 1.1- 1.7 cm, margin entire, apex acuminate, glabrous, green, each bract subtends 2-6 flowers; bracteole ovate, membranous, 6-10 by 4-6 mm, transparent; calyx tubular, up to 1.1 cm long, apex 3-lobed; corolla tube 3-3.5 cm long; dorsal corolla lobe oblong, 9-14 by 4-7 mm, apex hooded; lateral corolla lobe oblong, 8-14 by 3-6 mm; lateral staminodes elliptic to obovate, purple, 1-1.9 by 0.8-1.4 cm; labellum light purple with whitish claw, broadly cuneate, 2-2.8 by 2.2-3 cm, 3-lobed; middle lobe apex emarginate to bifid; anther crest broadly ovate ca. 4 by 5 mm, apex rounded; stigma funnel-shaped; ovary cylindrical 4-5 mm long, glabrous, ovules numerous; stylodes 2, filiform, ca. 1 mm long. *Fruits* capsular, 6-9 mm long. *Seeds* numerous, ellipsoid, 1-2 mm long, villous.

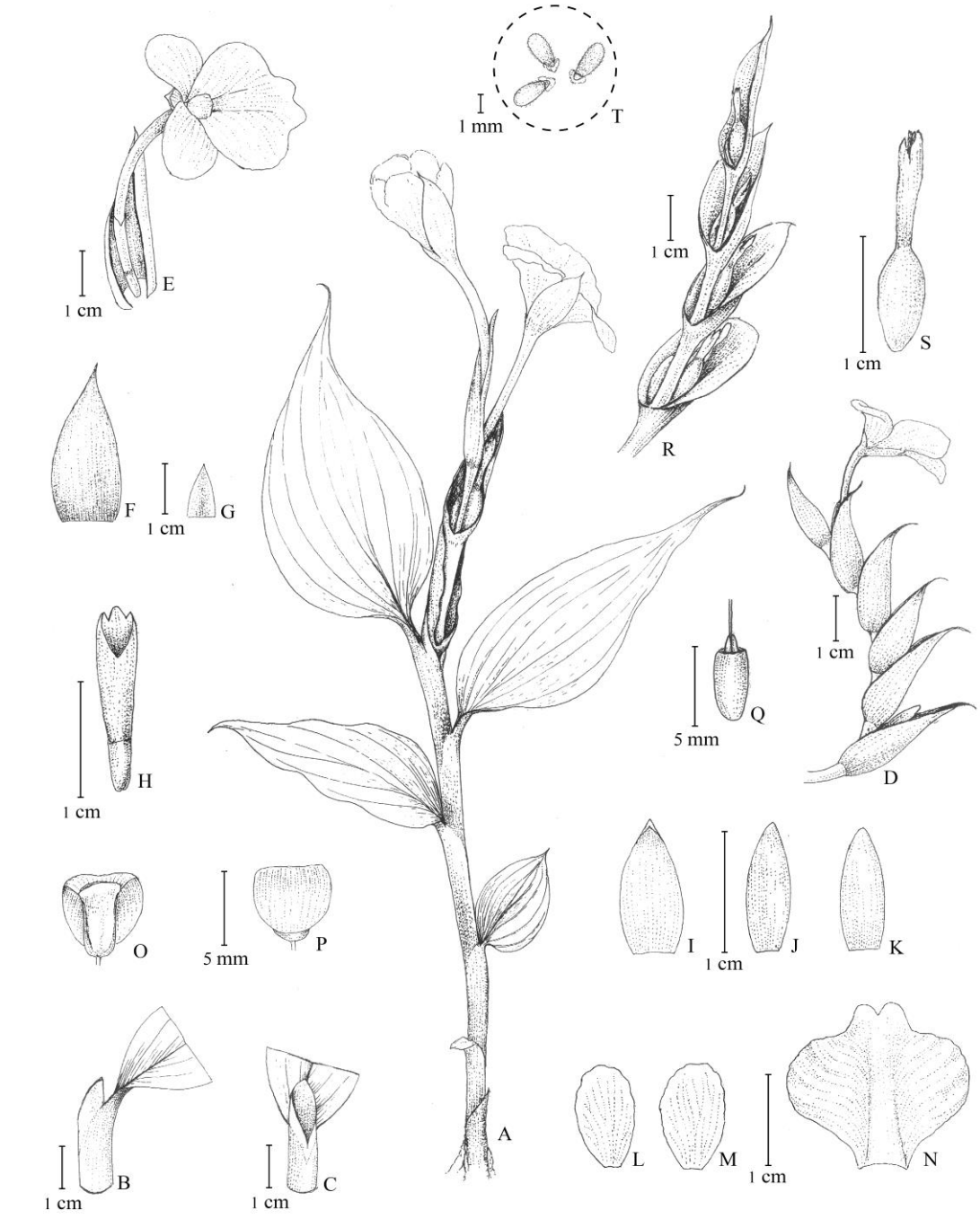
Phenology: Flowering and fruiting from June - September.

Distribution: INDIA (Meghalaya), BANGLADESH (?), MYANMAR (?).

Ecology: On moist rocks in mixed deciduous forest at an altitude of 1000 m.

Examined material: INDIA: Meghalaya, Khasi Hills, ca. 2000 ft., J.D. Hooker & T. Thomson s.n. (E, P-image); Narpuh reserve, 21.07.1957, G.K. Deka 10113 (ASSAM); Pangtunm Forest, 28.08.1935, S.R. Sharma 12188 (ASSAM); Jarain-Syndai,

17.08. 1968, N.P. Balakishnan 46150 (ASSAM); Mahadeo, 02.07.1937, G.K. Deka 15374a (ASSAM); Mawsmai, 22.06.1938, S.R. Sharma 16736 (ASSAM); Jaintia Hills, Sonapur, Near Tunnel, 06.08.2013, H.A. Barbhuiya 129545 (ASSAM); Meghalaya, Shillong ca 4000 ft., 21.07.2012, C. Pichean. & K. Inthar. CP210712-1 (BK).



A. Habit; B & C. Leaf base, showing ligule (B. side view, C. front view); D. Inflorescence; E. Flower with a bract; F. Bract; G. Bracteole; H. Ovary and calyx tube; I - K. Corolla lobes (I. dorsal, J & K. lateral); L & M. Lateral staminodes; N. Labellum; O & P. Anther and anther crest (O. front view, P. rear view); Q. Ovary with stylodes; R. Infructescence; S. Fruit; T. Seeds

Figure 4.3 Illustrations of *C. secunda* (Wall.) K. Larsen:

A. Plants in location; B, Plant, showing pseudostem, leaves and flowers; C. Plant, showing flowers and inflorescence; D. Flower, showing staminodes, labellum and anther crest; E. Inflorescence;
F. Infructescence, showing fruits and with a bract.

Figure 4.4 Photograph illustrations of *C. secunda* (Wall.) K. Larsen:

4.3.3 Caulokaempferia sikkimensis (King ex Baker) K. Larsen, Bot. Tidsskr. 60: 169. 1964; R.M. Smith in H.J. Noltie (ed.), Fl. Bhutan. 3(1): 196. 1994; S. Kumar in Hajra & D.M. Verma (eds.), Fl. Sikkim 1: 123. 1996.—*Monolophus sikkimensis* (King ex Baker) Veldk. & Mood, J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 219. 2014.—*Kaempferia sikkimensis* King ex Baker in Hook.f., Fl. Brit. India 6: 223. 1890; K. Schum., in Pflanzenr. (Engler) IV. 46: 74. 1904; C.E.C. Fisch. in Rec. Bot. Surv. 12(2): 145. 1938. (Fig. 4.5 & Fig. 4.6)

Type: INDIA, Sikkim, August 1886, H.J. Elwes s.n. (K-image!).

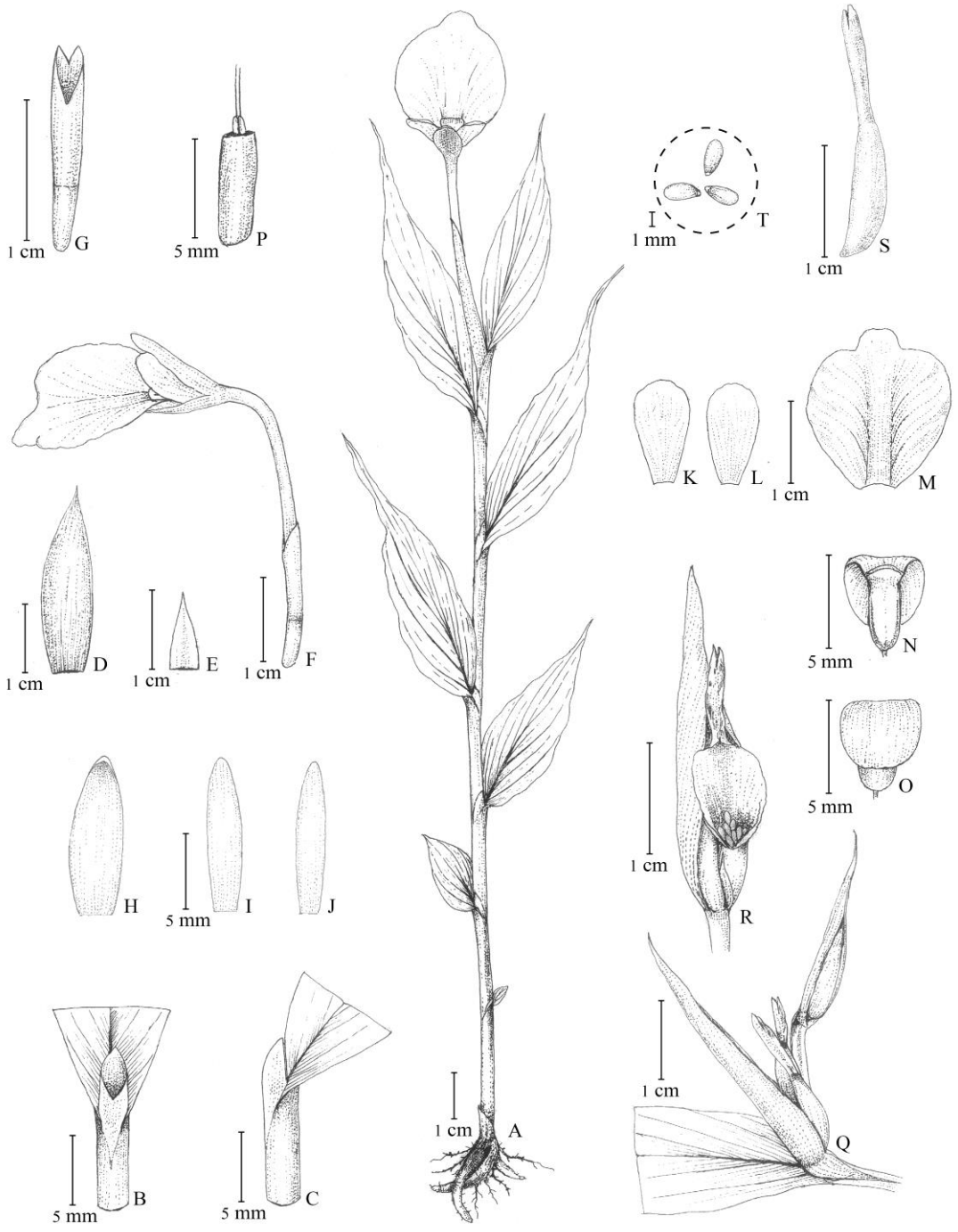
Epilithic, perennial herb. *Pseudostem* 10.3-20 cm long, with 2-3 bladeless sheaths. *Leaves* (4-)5(-6), sessile; leaf blade lanceolate, 4.2-9.5 by 1.5-2.8 cm, base rounded or cuneate, apex caudate; ligule, membranous, 3-5 mm long. *Inflorescence* terminal, with 1-2 bracts; each subtending 1-3(4) flower(s); bract lanceolate, 2.6-4.3 cm by 5-11 mm, green; bracteoles lanceolate, 7-10 mm long; calyx tubular, 8-12 mm long, apex 2-lobed; corolla tube slender, 2.8-4 cm long; dorsal corolla lobe oblong, 1-1.2 cm by 4-5 mm, pink; lateral corolla lobe linear-oblong, 1-1.2 cm by 3-4 mm, pink; lateral staminodes broadly obovate, 1-1.3 cm by 5-7 mm. white; labellum subrobicular, 1.7-2.3 x 1.5-1.7 cm, apex entire, white; anther-crest ovate 4-5 by 5-6 mm, recurved, apex rounded; stigma funnel-shaped; ovary cylindrical 4-6 mm long, ovules numerous; stylodes 2, filiform, ca. 1 mm long. *Fruits* oblong, 1-1.6 cm long. *Seeds* numerous, ellipsoid, ca. 2 by 1 mm.

Phenology: Flowering from July-August, fruiting from September-October.

Distribution: INDIA (Mizoram (?), Sikkim, West Bengal), BHUTAN.

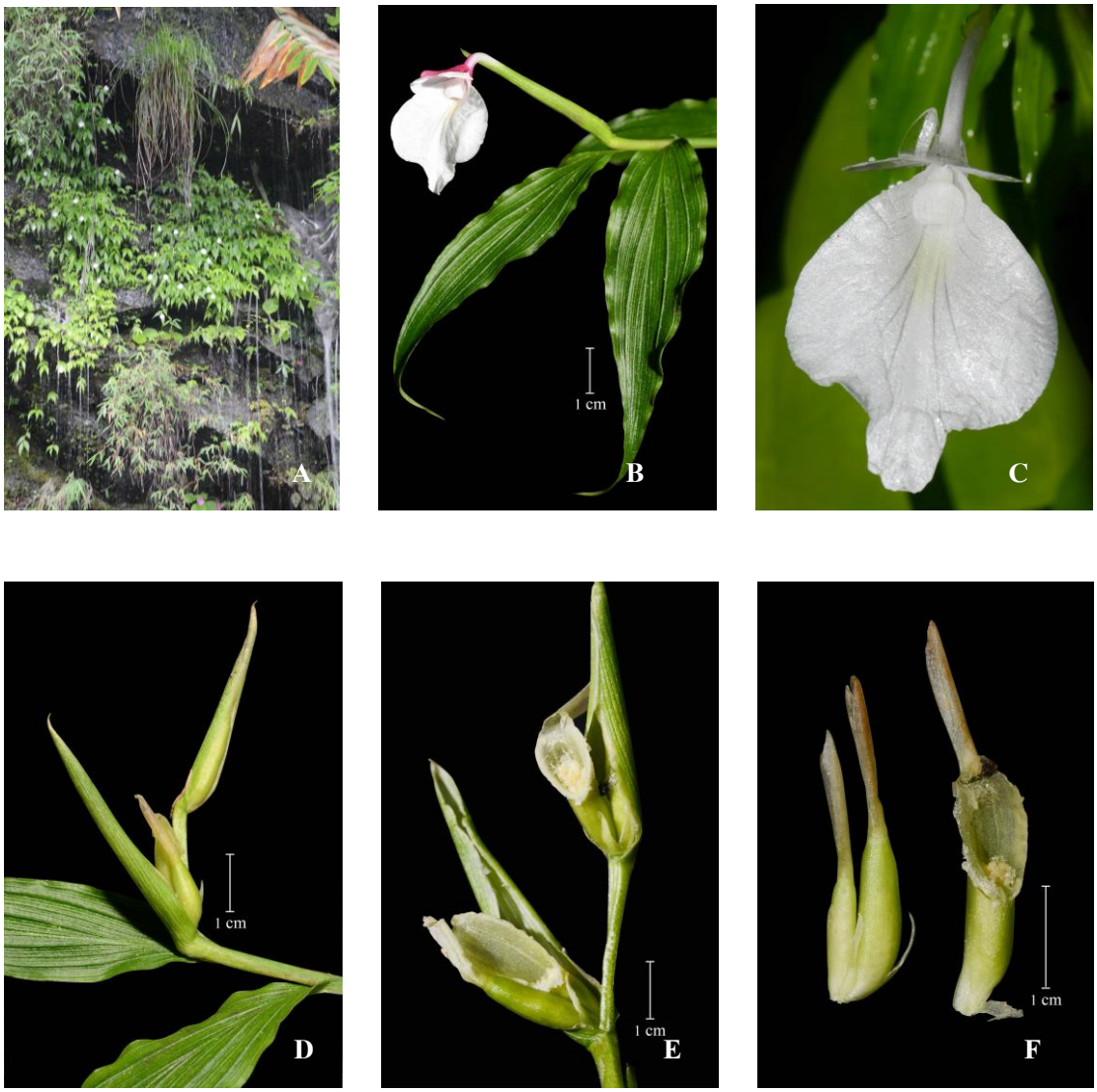
Ecology: On moist rocks in mixed deciduous forest at an altitude of 1500 m.

Examined material: INDIA: Sikkim, East District, South Bank of Rate-Chhu, North of Gangtok, 27°23'N & 88°37'E, ca. 1670 m, 31.07.1992, D.G. Long et al 960 (E-image); Phedonchen, ca. 5000 ft., 01.08.1912, Rohmoo Lepcha 36 (E-image). West Bengal, Darjeeling, H.J. Elwes s.n. (K-image); Darjeeling 09.08.1913, J.M. Cowan s.n. (E-image); Buya, ca. 4000 ft., 28.06.1914, R.E. Cooper 1038 (E-image). Sikkim, Kiswori ca 6000 ft., 20.07.2013, C. Pichean. & K. Inthar. CP200713-1(BK).



A. Habit; B & C. Leaf base, showing ligule (B. front view, C. side view); D. Bract. E. Bracteole; F.Flower; G. Ovary and calyx tube; H- J. Corolla lobes (H. dorsal, I & J. lateral); K & L. Lateral staminodes; M. Labellum. N & O. Anther and anther crest (N. front view, O. rear view); P. Ovary with stylodes; Q. Infructescence; R. Infructescence, showing dehiscing fruit with seeds; S. Fruit. T. Seeds

Figure 4.5 Illustrations of *C. sikkimensis* (King) K. Larsen:



A. Plants in location; B. Inflorescence; C. Flower, showing staminodes, labellum and anther crest; D. Infructescence, showing fruits; E. Infructescence, showing dehiscing fruits; F. Fruits and dehiscing fruit with seeds.

Figure 4.6 Photograph illustrations of *C. sikkimensis* (King) K. Larsen:

4.3.4 Caulokaempferia coenobialis (Hance) K. Larsen, Bot. Tidsskr. 60: 177. 1964.—*Monolophus coenobialis* Hance, J. Bot. 8: 75.1870; J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 219. 2014.—*Kaempferia coenobialis* (Hance) C. H. Wright, J. Linn. Soc., Bot. 36: 68. 1903. (Fig. 4.7 & Fig. 4.8)

Type: CHINA, North River, Fi-loi-tsz Monastery, Sampson 11369 (K-image!)

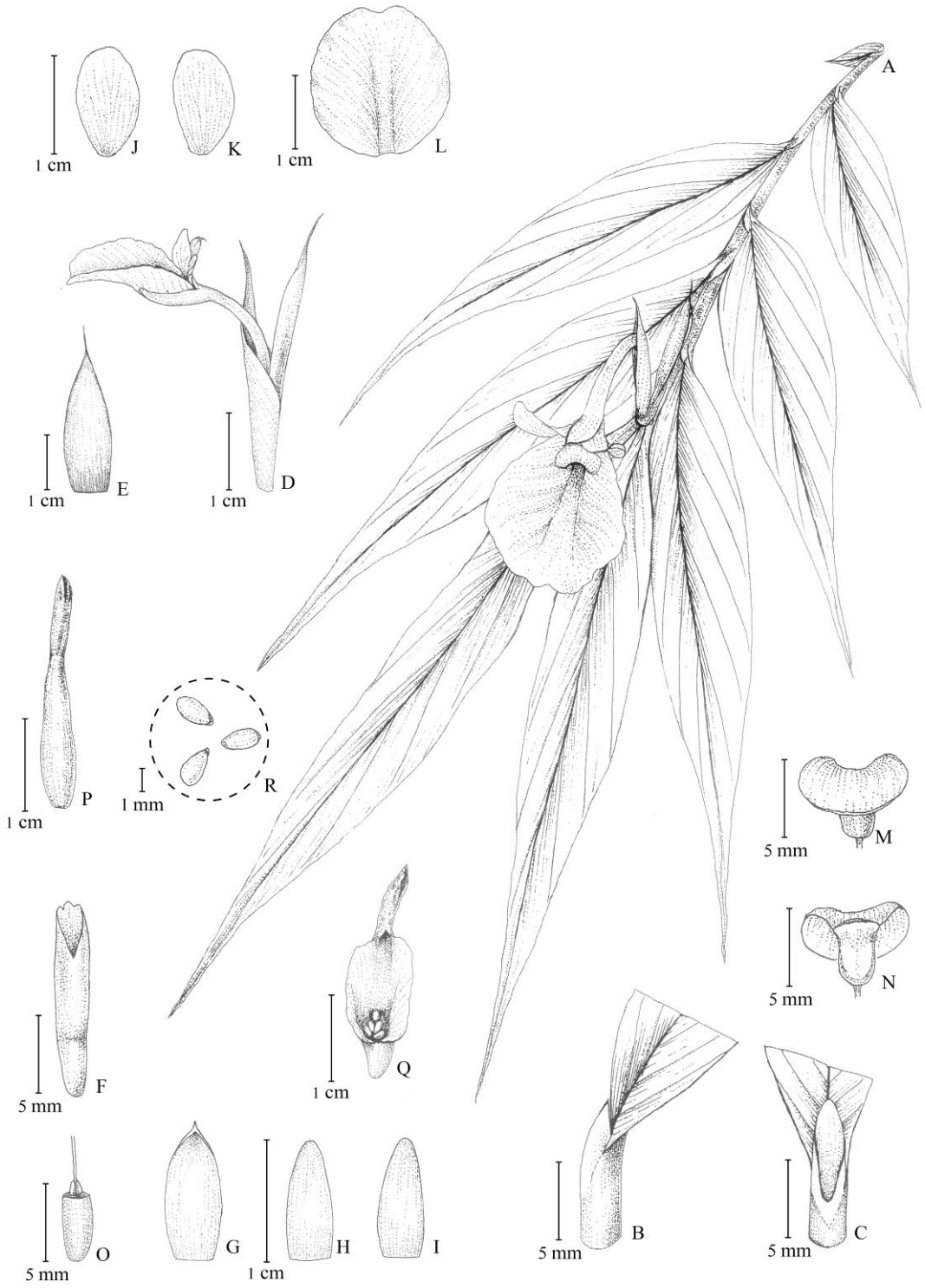
Epilithic perennial herbs. *Pseudostems* slender, tufted glabrous, 13–28 cm, with 2-3 bladeless sheaths. *Leaves* 5–9, sessile or shortly petiolate; ligule membranous, triangular, ca. 2-4 mm long, apex acute, glabrous; leaf blade lanceolate, 5–8 by 1–2 cm, base cuneate, apex acuminate to long caudate, thin, glabrous. *Inflorescences* terminal, 3.5-5 cm long; flowers yellow; bracts (1-)2-3, ovate, apex acuminate to caudate up to 1.2 cm long, 2.9-3.3 by 0.7-1 cm, each subtends (1–)2–3 flowers; calyx tube 1–1.5 cm long, persistent apex 3-lobe each lobe apex acute; corolla tube yellow, 2.3-3.5 cm long; dorsal corolla lobes elliptic, 9-10 by 4 mm, yellow; lateral corolla lobes lanceolate, 1.1-1.3 by 0.3-0.4 cm; lateral staminodes elliptic, 1-1.3 by 0.5-0.7 cm, apex round, yellow; labellum concave, broadly elliptic, 1.8-2.2 x 1.6-1.8 cm. apex emarginated, yellow; anther, 3–4 mm long; anther crest oblong, 3-4 mm, apex rounded; stigma funnel-shaped; ovary cylindrical, 4–7 x 2–3 mm, glabrous, 1-locular, ovules many; stylodes 2, filiform, very slender, ca. 1 mm long. *Friuts* ovate-oblong, 1.1-1.6 cm by 4-5 mm, dehiscing. *Seeds* ellipsoid-ovoid.

Phenology: April-August

Distribution: CHINA, Guangdong, Gaungxi, Hunan

Ecology: On moist rocks near waterfall at an altitude of 300 m.

Examined material: CHINA: Guangdong Province, Longmen, Nan Kun Shan, Guanin Tan ca 1000 ft., 22.06.2012, C. Pichean. & K. Inthar. CP220612-1 (BK).



A. Habit. B & C. Leaf base, showing ligule (B. side view, C. front view). D. Inflorescence. E. Flower with a bract. F. Bract. G. Bracteole. H. Ovary and calyx tube. I - K. Corolla lobes (I. dorsal, J & K. lateral). L & M. Lateral staminodes. N. Labellum. O & P. Anther and anther crest (O. front view, P. rear view). Q. Ovary with stylodes R. Infructescence. S. Fruit. T. Seeds

Figure 4.7 Illustrations of *C. coenobialis* (Hance) K. Larsen:

A. Plants in location; B. Lower part of leaves showing ligules; C. Plants showing leaves and flowers;
D. Flower, showing staminodes, labellum and anther crest; E. Infructescence, showing fruits;
F. Infructescence, showing dehiscing fruit with seeds.

Figure 4.8 Photograph illustrations of *C. coenobialis* (Hance) K. Larsen:

4.3.5 Caulokaempferia petelotii K. Larsen, Bot. Tidsskr. 60(3): 166 (1964); Intharapichai *et al*, J. Jpn. Bot. 89:132 (2014).—*Monolophus petelotii* (K. Larsen) Veldk. & Mood, J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 227. 2014. (Fig. 4.9 & Fig. 4.10)

Type: TONKIN [VIETNAM]. Chapa, July 1924, M. Petelot s.n. (P–holotype).

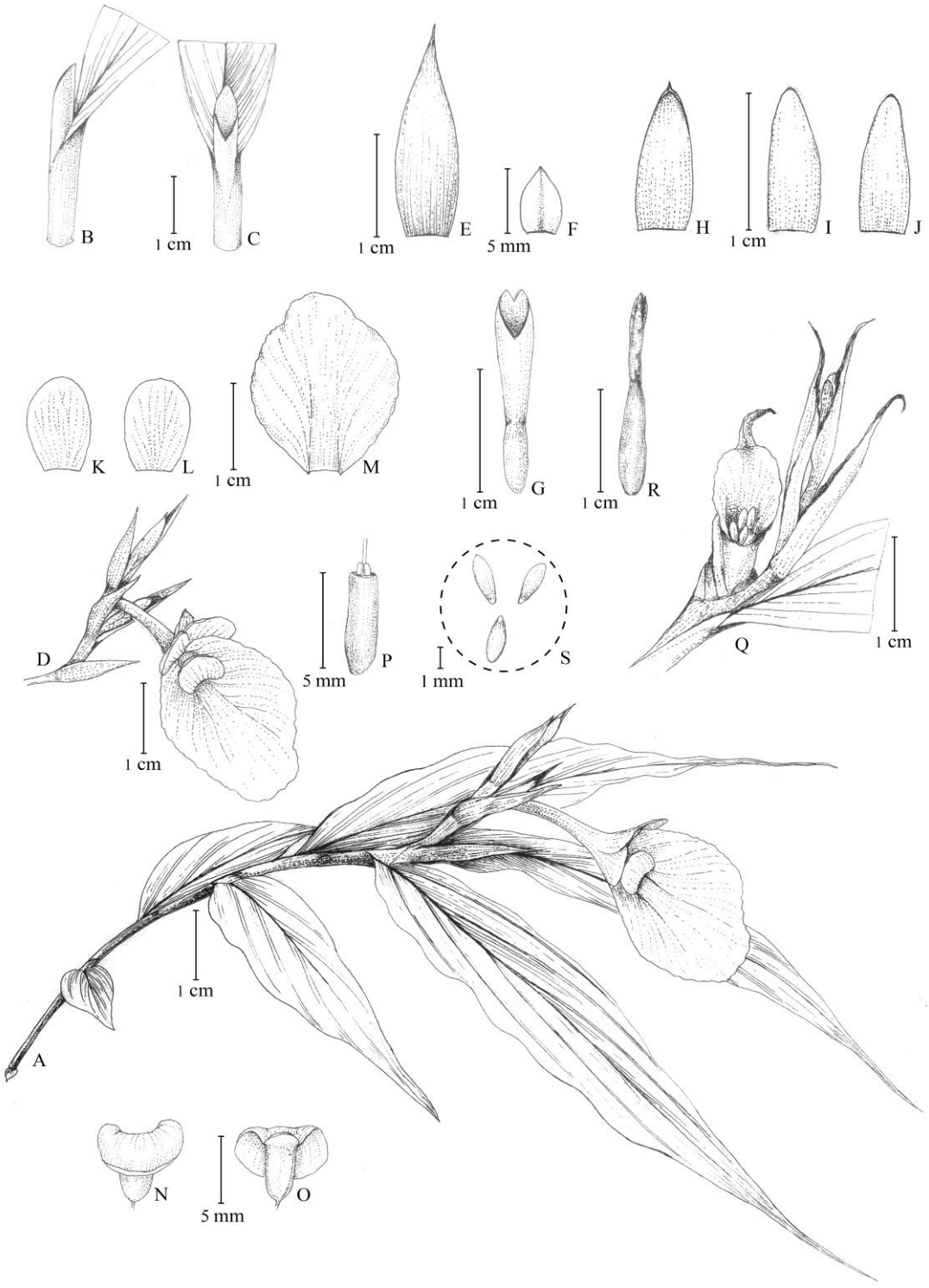
Epilithic perennial herbs, slender, with short rhizome; root fibrous, some form longish tuber. *Pseudostems* 11.5–22.5 cm with 2–3 bladeless sheaths. *Leaves* 5–8, sessile, elliptic, lanceolate to ovate, 1.7–10.5 x 0.5–2.4 cm, base cuneate, apex acuminate to caudate, to 2.2 cm long, glabrous on both sides, lower surface purplish; ligule membranous, 0.5-1 cm long, apex acute to obtuse, glabrous. *Inflorescences* terminal; peduncle, 1.8–3.1 cm long, hidden in the uppermost two leaf sheaths; flowers yellow; bracts (3–)4–6(–10), lanceolate, 1.8–2 cm . 4–5 mm, apex caudate to 3–4 mm long, glabrous, each subtends 1–2(–3) flowers, mostly 2 flowers per bract, green; bracteoles lanceolate to ovate, 5–7 x 4–5 mm, apex acute, glabrous, membranous; calyx tubular, 0.6–1 cm by ca. 2 mm, apex bifid; corolla tube, 2–2.2 cm by ca. 2 mm, glabrous; dorsal corolla lobe oblong, 1–1.2 cm by 4–5 mm, apex hooded; lateral corolla lobes oblong, 1.1–1.5 cm by 3–5 mm, apex acute; staminodes broadly elliptic to suborbicular, 0.8–1.3 cm by 6–8 mm., apex rounded; labellum broadly elliptic to obovate, 2.5–2.8 x 2–2.3 cm, apex rounded; anther, 4–5 mm long; anther crest orbicular, 5–6 mm, apex rounded; stigma funnel-shaped; ovary ovate to oblong, 4–5 x 2–3 mm, glabrous, 1-locular, ovules numerous; stylodes 2, filiform, very slender, ca. 1 mm long. *Fruits* capsular, oblong, 0.8–1 cm x 3–4 mm. *Seeds* numerous, oblong-ovate to ovate, light brownish, ca. 2 x 1 mm.

Phenology: Flowering from July-August, fruiting from September-October.

Distribution: Vietnam, Lao Cai Province, Sapa, Hoang Lien Mountain Range.

Ecology: On moist rocks along waterfalls or streams in mixed forest at an altitude of 1000-2000 m.

Examined material: VIETNAM; Lao Cai, Sapa, ca. 3000 ft., 19.09.2012, C. Pichean. & K. Inthar. CP190912-1 (BK).



A. Habit; B & C. Leaf base, showing ligule (B. side view, C. front view); D. Inflorescence; E. Bract; F. Bracteole; G. Ovary and calyx tube; H - J. Corolla lobes (H. dorsal, I & J. lateral); K & L. Lateral staminodes; M. Labellum; N & O. Anther and anther crest (N. front view, O. rear view); P. Ovary with stylodes; Q. Infructescence, showing dehiscing fruit with seeds; R. Fruit; S. Seeds.

Figure 4.9 Illustrations of *C. petelotii* K. Larsen:

A. Plants in location; B. Lower part of leaves showing ligules; C. Plants showing leaves and flowers;
D. Flower, showing staminodes, labellum and anther crest; E. Infructescence, showing fruits;
F. Infructescence, showing dehiscing fruit with seeds.

Figure 4.10 Photograph illustrations of *C. petelotii* K. Larsen:

4.3.6 Caulokaempferia tamdaoensis Picheans. & Inthar., Intharapichai *et al*, J. Jpn. Bot. 89:132 (2014).—*Monolophus tamdaoensis* (Picheans & Inthar.) Veldk. & Mood, J.D. Mood *et al*, Gard. Bull. Sing., 66(2): 228. 2014. (Fig. 4.11 & Fig. 4.12)
Type: VIETNAM. Vĩnh Phúc Province, Tam Dao National Park, Picheansoonthon & Phokham 180812-1 (BK– holotype).

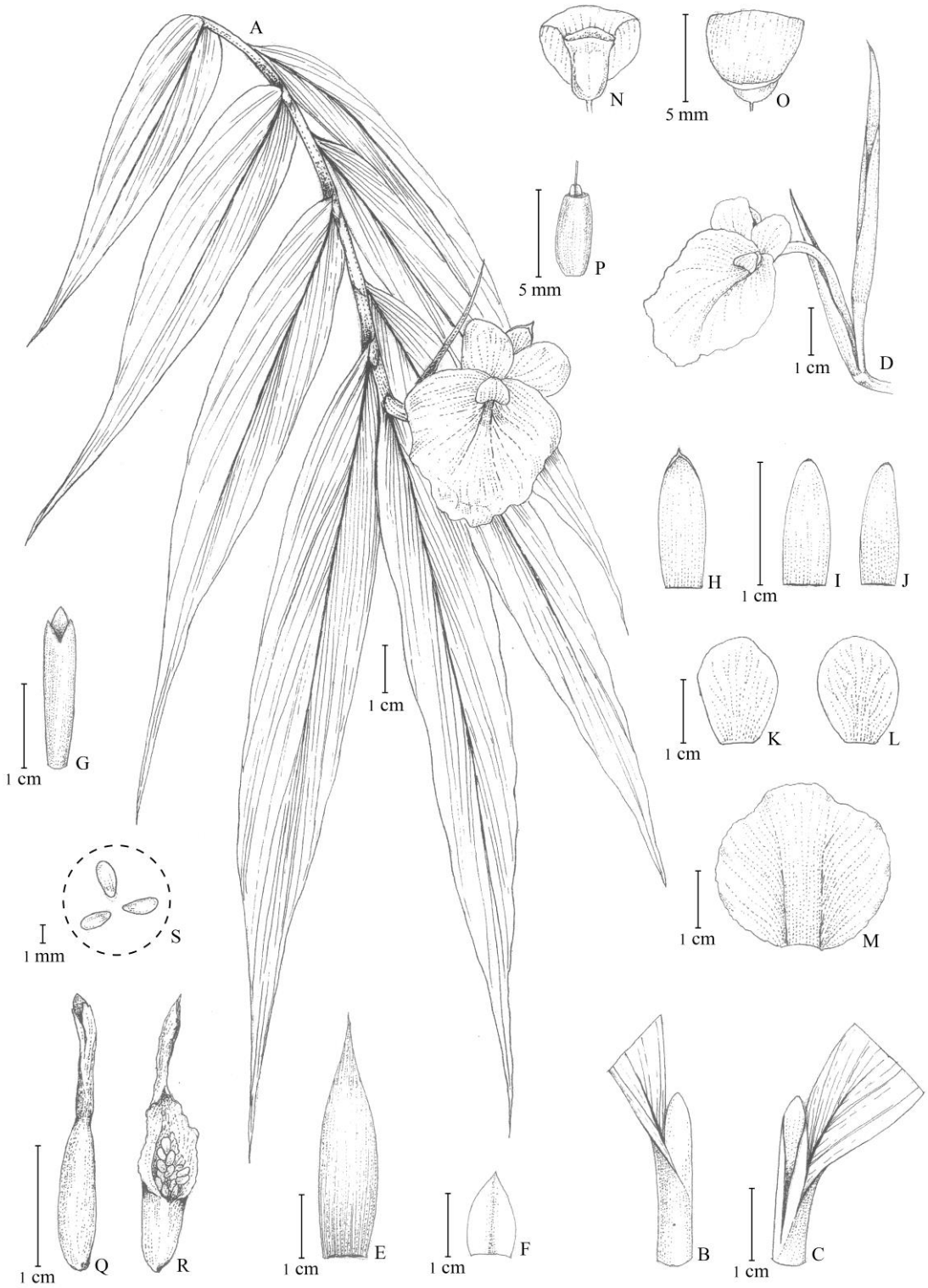
Epilithic perennial herbs, slender, with short rhizome; root fibrous, some form longish tuber. *Pseudostems* tufted, 28.5–43(–57) cm with 3–4 bladeless sheaths. *Leaves* 9–11(–12), sessile, lanceolate, 7.4–17.2 x 1.2–4.2 cm, base cuneate, apex caudate to 4.2 cm long, glabrous on both sides; ligule membranous, triangular, 4–12 by 2–5 mm, apex obtuse or acute, glabrous. *Inflorescences* terminal, 3.5-8 cm; peduncle hidden in the uppermost two leaf sheaths; flowers yellow; bracts (1–)2–3(–4), green, lanceolate, 3.5–5.2 by 0.8–1.2 cm, apex caudate to 1 cm long, glabrous, each subtends (1–)2–3(–4) flowers; bracteoles membranous, lanceolate to ovate, 9–14 by 5–8 mm, apex acute, glabrous; calyx tubular, 1.7–1.9 cm long, apex trifid; corolla tube, 3.6–4.1 cm long, glabrous; dorsal corolla lobe oblong, 1.1–1.3 cm . 4–5 mm, apex hooded; lateral corolla lobes oblong, 1.1–1.5 cm by 3–5 mm, apex acute; staminodes broadly elliptic to suborbicular, 1.2–1.6 by 0.8–1.2 cm, apex rounded; labellum orbicular, 2.7–3.4 by 2.7–3.4 cm, apex crenate; anther, 4–5 mm long; anther crest orbicular, 5–6 mm, apex rounded; stigma funnel-shaped; ovary cylindrical, 4–7 by 2–3 mm, glabrous, 1-locular, ovules numerous; stylodes 2, filiform, very slender, ca. 1 mm long. *Fruits* capsular, oblong, 1.2–1.4 cm by 3–4 mm. *Seeds* numerous, oblong-ovate to ovate, light brownish, ca. 2 x 1 mm.

Phenology: May–September.

Distribution: Vietnam, Vĩnh Phúc Province, Tam Dao National Park

Ecology: On moist rocks in mixed deciduous forest at an altitude of 1000 m

Examined material: VIETNAM; Vĩnh Phúc Province, ca 3000 ft., 19.09.2012, C. Pichean. & K. Inthar. CP190912-1(BK)



A. Habit; B & C. Leaf base, showing ligule (B. rear view, C. front view); D. Inflorescence; E. Bract; F. Bracteole; G. Calyx tube; H - J. Corolla lobes (H. dorsal, I & J. lateral); K & L. Lateral staminodes; M. Labellum; N & O. Anther and anther crest (N. front view, O. rear view); P. Ovary with stylodes; Q. Fruit; R. Dehiscing fruit with seeds; S. Seeds.

Figure 4.11 Illustrations of *C. tamdoaensis* Picheans. & Inthar.:

A. Plants in type location; B. Lower part of a leaf showing ligule; C. Inflorescence; D. Flowers, showing staminodes, labellum and anther crest; E. Infructescence, showing fruits; F. Infructescence, showing dehiscing fruit with seeds.

Figure 4.12 Photograph illustrations of *C. tamdoaensis* Picheans. & Inthar.:

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Nomenclatural Controversy

The name *Caulokaempferia* K. Larsen (1964) was proposed for *Monolophus* Wall. (1820) for 2 reasons, as K. Larsen stated '*...(1) The type species of WALLICH's Monolophus is a Kaempferia and the description given by WALLICH thus does not hold for the group in its sense for today. (2) The name refers to a character widely distributed also in neighbouring genera...*' (Larsen, 1964). The concept of type specimen for the generic and sub-generic levels was not yet developed in early 18th century.

Wallich described 2 new species to the genus *Kaempferia* L., *K. linearis* Wall. and *K. secunda* Wall., in 1820, and placed them under the group '*caulescent with an entire crest*' (Wallich 1820). Ten years later he added a new taxon, *Kaempferia elegans* Wall., and made a note that '*…all three ought perhaps to be removed from Kaempferia, and formed into a distinct genus…*" (Wallich, 1830)'.

Wallich, then, did not point out the 'type' for his provisional new genus. However, one can assumed that *M. elegans* Wall. should be chosen from his statement '*…It is totally different from the species noticed by Dr. Roxburgh in his Flora indica, and belongs to the section, which I have long ago indicated in that work (vol. i. p. 20) as differing from the other in the caulescent habit, absence of tubers, and entire crest. The two other species of that section, Kaempferia secundra and linearis……All three ought perhaps to be removed from Kaempferia...*'. One who reads the paragraph carefully should realizes then if the sense of "type' applied at that time, Wallich would chose *Monolohous elegans* Wall. as a type for his provisional generic name. Larsen (1964) and the other following botanists believed so.

All other botanists of the countries in the distribution area of the genus have accepted Larsen's determination. The treatment of the genus for Flora Reipublicae Popularis Sinica (1978), Flora of Bhutan (1994) and Flora of China (2000) all accepted *Caulokaempferia* K. Larsen. This generic name was also accepted and used in the

revision of the genus for Vietnam (Intharapichai *et al*, 2014) and India (Roy & Barbhuiya, 2014).

This is not because all these botanists are ignorance, nor do not understand taxonomy and nomenclature. I, however, believed that all of them agreed with Larsen (1964). Kai Larsen on his statement, '…*The type species of WALLICH's Monolophus is a Kaempferia and the description given by WALLICH thus does not hold for the group in its sense for today…*' was clearly stated that he recognized *Monolophus elegans* Wall. as 'type' for Wallich's *Monolophus*. Therefore, lectotypification of the genus *Monolophus* Wall. had been done since 1964 by K. Larsen.

T.L. Wu and S. J. Chen (1978) used the generic name *Monolophus* Wall. as an accepted name, and *Caulokaempferia* K. Larsen was placed there under a new synonymous name (*syn. nov.*). He also proposed *M. linearis* Wall. as a lectotype of the genus. However, that same year, he did changed, after realizing that the lectotypification has (*de facto*) been made by K. Larsen in 1964 (as mentioned earlier). He, then, accepted the name *Caulokaempferia* K. Larsen in his account of family Zingiberaceae in 'Flora Reipublicae Popularis Sinica (Chinese edition)' (Wu, 1978), following by their treatment (co-authored with Larsen) of the genus in Flora of China (2000).

In my treatment of the genus for Vietnam, I think I made it clear that the name '*Caulokaempferia* K. Larsen' is conserved (*nom. cons.*) knowing that this is only the technical problem of interpretation (Intharapichai *et al*, 2014). Therefore, it would be inappropriate to put the name of more than 20 plant taxa into a synonymous just because of this technical problem. And, it would be practically unacceptable to place the authorship of the persons who hardly knew or seen all members of the genus (Mood *et al*, 2014).

5.2 Conclusion

This studies resulted in the better understanding of the members of the genus *Caulokaempferia* K. Larsen distributed in the India, China and Vietnam. The knowledge gained will lead ones to better understanding of members of the genus distributed in Thailand and Laos.

In conclusion, 3 species from India, 1 species from China, and 2 species from Vietnam were recognized in this studies, including 1 new taxon (*C. tamdaoensis* Picheans. & Inthar.) from Vietnam. Three species (2 from India and 1 from China) are used ethnomedically.

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Appendices

Appendix A
Author's publication

J. Jpn. Bot. **89**: 129–136 (2014)

The Genus *Caulokaempferia* (*Zingiberaceae*) in Vietnam

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Two species of the genus *Caulokaempferia* (*Zingiberaceae*), *C. petelotii* K. Larsen and *C. tamdaoensis* (sp. nov.), are recorded for Vietnam. The prior taxon was described in 1964, while the latter species is reported here for the first time. Full descriptions, together with line-drawings and color illustrations of both taxa are given. Relationship of these two species with their closely related taxa is also discussed.

Key words: *Caulokaempferia*, *Caulokaemferia petelotii*, *Caulokaempferia tamdaoensis*, Vietnam, *Zingiberaceae*.

The genus *Caulokaempferia* (*Zingiberaceae*) was established by Larsen (1964) with seven species, including *C. petelotii* described from Vietnam. The type specimen of this taxon was collected by M. Pételot in 1924 from Chapa, northern Vietnam adjacent to Yunnan province of China. This taxon was, until now, the only known *Caulokaemferia* from Vietnam.

This genus comprises about 30 species, distributed from the Himalayas (three species) through south China, Indochina and Thailand, with its centre of diversity in Thailand (Chaiyoot 2007). In neighboring countries, two species are recognized for southern China, whereas five taxa are known from Laos. However, so far, none has been reported from Cambodia.

An unknown population of this genus in Vietnam was first reported by Kuznetsov (2005). The report was a result of the Russian-Vietnam joint research project on Rapid Botanical Assessment of Tam Dao National Park ("Tam Dao" literally means "three islands" in Vietnamese), of which a cf. *Caulokaempferia* was found as "monodominant patches on steep mountain rock walls between the tops of Tam Dao 1 and Tam Dao 2" (Figs. 4, A–B). After thorough investigation of this unknown taxon, comparing with other species of the genus, we recognized it as a new species, *C. tamdaoensis* Picheans. & Inthar.

These two taxa from Vietnam can be easily recognized by their epilithic habit and characteristic bright-yellow flowers. Detailed descriptions, line-drawings and color illustrations will be provided in this treatment.

Caulokaempferia K. Larsen, nom. cons.
K. Larsen in Bot. Tidsskr. **60**(3): 165 (1964);

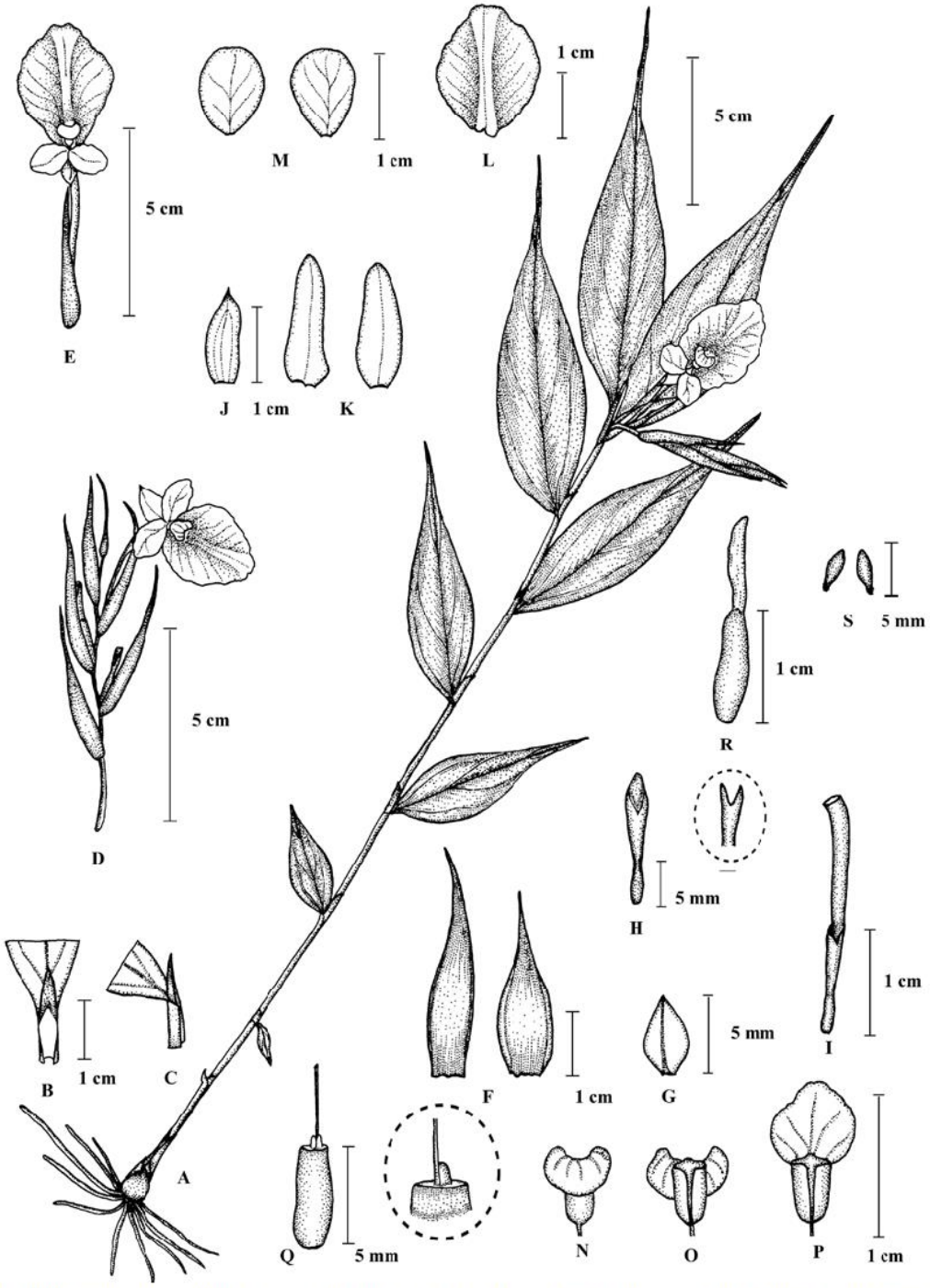

Fig. 1. *Caulokaempferia petelotii* K. Larsen. A. Habit. B, C. Leaf base, showing ligule (B. front view, C. side view). D. Inflorescence. E. Flower with a bract. F. Bracts. G. Bracteole. H, I. Ovary and calyx tube (with lower part of corolla tube). J, K. Corolla lobes (J. Dorsal, K. Lateral). L. Labellum. M. Lateral staminodes. N–P. Anthers and anther crest (N. Rear view, O. Front View, P. Front View with anther crest forced flat). Q. Ovary and stylodes. R. Fruit. S. Seeds. Drawn by Nongnuch Anuraktrakoon.

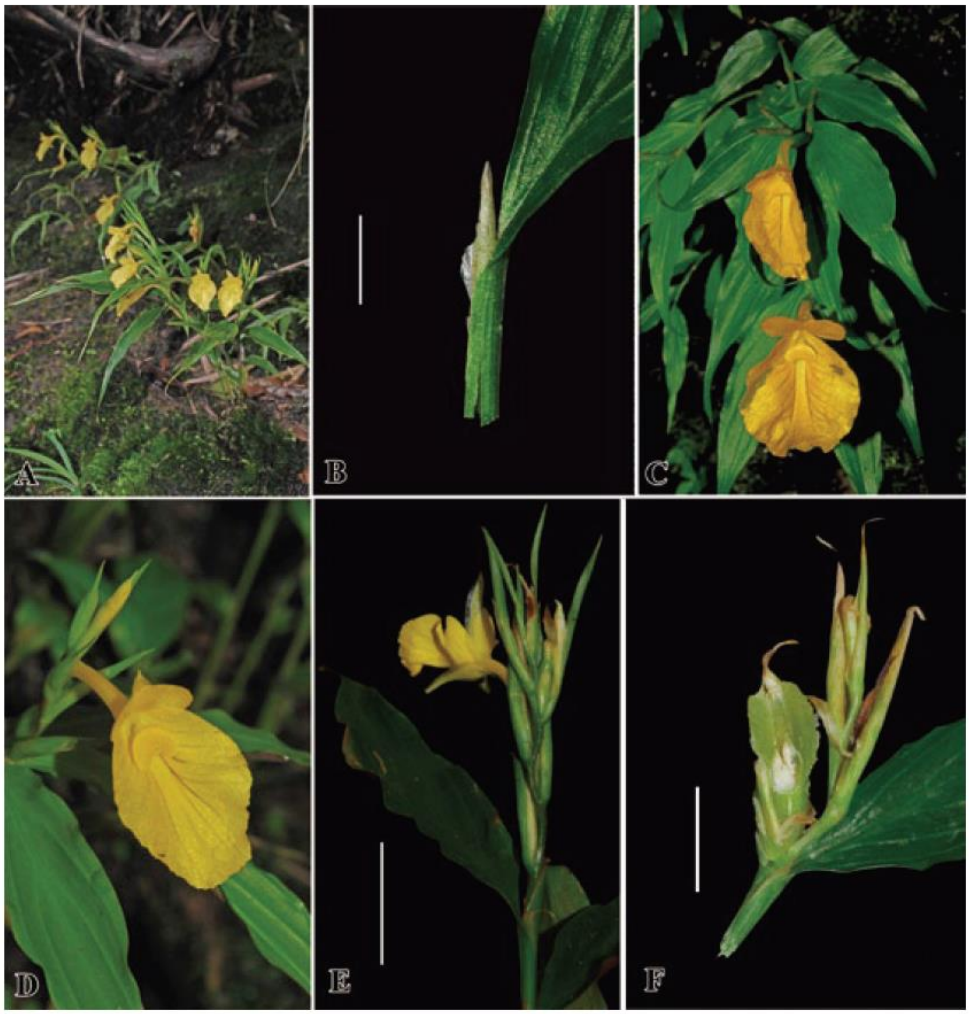

Fig. 2. *Caulokaempferia petelotii* K. Larsen. A. Plants in their natural habitat. B. Lower part of leaves showing ligules. C. Plant showing leaves and flowers. D. Flower showing staminodes, labellum and anther crest. E. Inflorescence showing bracts arrangement, a flower and fruits. F. Seeds. Photographed by Pornpimon Wongsuwan (A, D, E) and Chayan Picheansoonthon (B, C, F). Scale: 5 mm for B; 1 cm for E and F.

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(Wall. ex Endl.) Wall. ex Baker in Hook. f., Fl. Brit. India **6**: 222 (1892); K. Schum. in Engl., Pflanzenr. **20** (**IV–46**): 73 (1904).

Herbs perennial, epilithic. Pseudostems leafy, decumbent. Leaves sessile; ligule membranaceous. Inflorescences terminal; bracts 1–10, distichous, lanceolate, 1–4-flowered, margin free to base; bracteoles absent in specimens with 1-flowered bracts. Calyx tubular, not deeply split on 1 side, apex often 2- or 3-toothed. Corolla tube long, narrow, widened at mouth; lobes 3. Lateral staminodes broadly elliptic to orbicular, large, bright yellow. Labellum broadly elliptic, obovate, or orbicular, large, apex entire or crenate. Filament very short or absent, borne on corolla tube; anther basifixed; anther crest conspicuously reflex, bright-yellow. Ovary 1-loculed. Stylodes 2, short, free. Fruit capsule, oblong, split on one side. Seeds numerous, small.

About 30 species: India, China, Myanmar (?), Thailand, Laos and Vietnam. Two species (both endemic) in Vietnam.

Key to species

A. Leaves 5–8; calyx tube 0.6–1 cm long; corolla tube 2–2.2 cm long; labellum broadly elliptic to obovate, apex rounded ..... 1. *C. petelotii*

A. Leaves 9–11(–12); calyx tube 1.7–1.9 cm long; corolla tube 3.8–4.2 cm long; labellum orbicular with distal median lobe ..... 2. *C. tamdaoensis*

1. ***Caulokaempferia petelotii*** K. Larsen in Bot. Tidsskr. **60**(3): 166 (1964). [Figs. 1, 2]

Type: **TONKIN [VIETNAM]**. Chapa, July 1924, M. Pételot s.n. (P–holotype).

Epilithic perennial herbs, slender, with short rhizome; root fibrous, some form longish tuber. Pseudostems, 11.5–22.5 cm with 2–3 bladeless sheaths. Leaves 5–8, sessile, elliptic, lanceolate to ovate, 1.7–10.5 × 0.5–2.4 cm, base cuneate, apex acuminate to caudate, to 2.2 cm long, glabrous on both sides, lower surface purplish; ligule membranous 3–10 mm long, apex acute to obtuse, glabrous. Inflorescences terminal; peduncle, 1.8–3.1 cm long, hidden in the uppermost two leaf sheaths; flowers yellow. Bracts (3–)4–6(–10), green, lanceolate, 1.8–2 cm × 4–5 mm, apex caudate to 3–4 mm long, glabrous, each subtends 1–2(–3) flowers, mostly 2 flowers per bract. Bracteoles membranous, lanceolate to ovate, 5–7 × 4–5 mm, apex acute, glabrous. Calyx tubular, 0.6–1 cm × ca. 2 mm, apex bifid. Corolla tube, 2–2.2 cm × ca. 2 mm, glabrous; dorsal corolla lobe oblong, 1–1.2 cm × 4–5 mm, apex hooded; lateral corolla lobes oblong, 1.1–1.5 cm × 3–5 mm, apex acute. Staminodes broadly elliptic to suborbicular, 0.8–1.3 cm × 6–8 mm., apex rounded. Labellum broadly elliptic to obovate, 2.5–2.8 × 2–2.3 cm, apex rounded; anther, 4–5 mm long; anther crest orbicular, 5–6 mm, apex rounded. Stigma funnel-shaped. Ovary ovate to oblong, 4–5 × 2–3 mm, glabrous, 1-locular, ovules numerous; stylodes 2, filiform, very slender, ca. 1 mm long. Fruits capsular, oblong, 0.8–1 cm × 3–4 mm. Seeds numerous, oblong-ovate to ovate, light brownish, ca. 2 × 1 mm. Flowering June–July; fruiting July–September.

Distribution: Vietnam, Lao Cai Province, Sapa, Hoang Lien Mountain Range [Golden Stream Love Waterfall (22°20.557'N, 103° 40.100'E, altitude 1122 m), Silver Waterfall (22°21.604'N, 103°46.642'E, altitude 1205 m), along stream near Camp 2 on the way to summit of Fansipan Peak (22°20.526'N, 103°46.568'E, altitude 2050 m)] .

Ecology: On moist rocks along waterfalls or streams in mixed deciduous forest at an altitude of ca. 2000 m.

Note: This species, along with *C. saxicola* K. Larsen (the Thai taxon) and *C. coenobialis* (Hance) K. Larsen (the Chinese taxon) are closely related. In the original description, their inflorescences all had 1-flowered bracts, except some specimens of *C. coenobialis* possess 2-flowered lower bract (Larsen 1964). From our intensive investigation of living populations

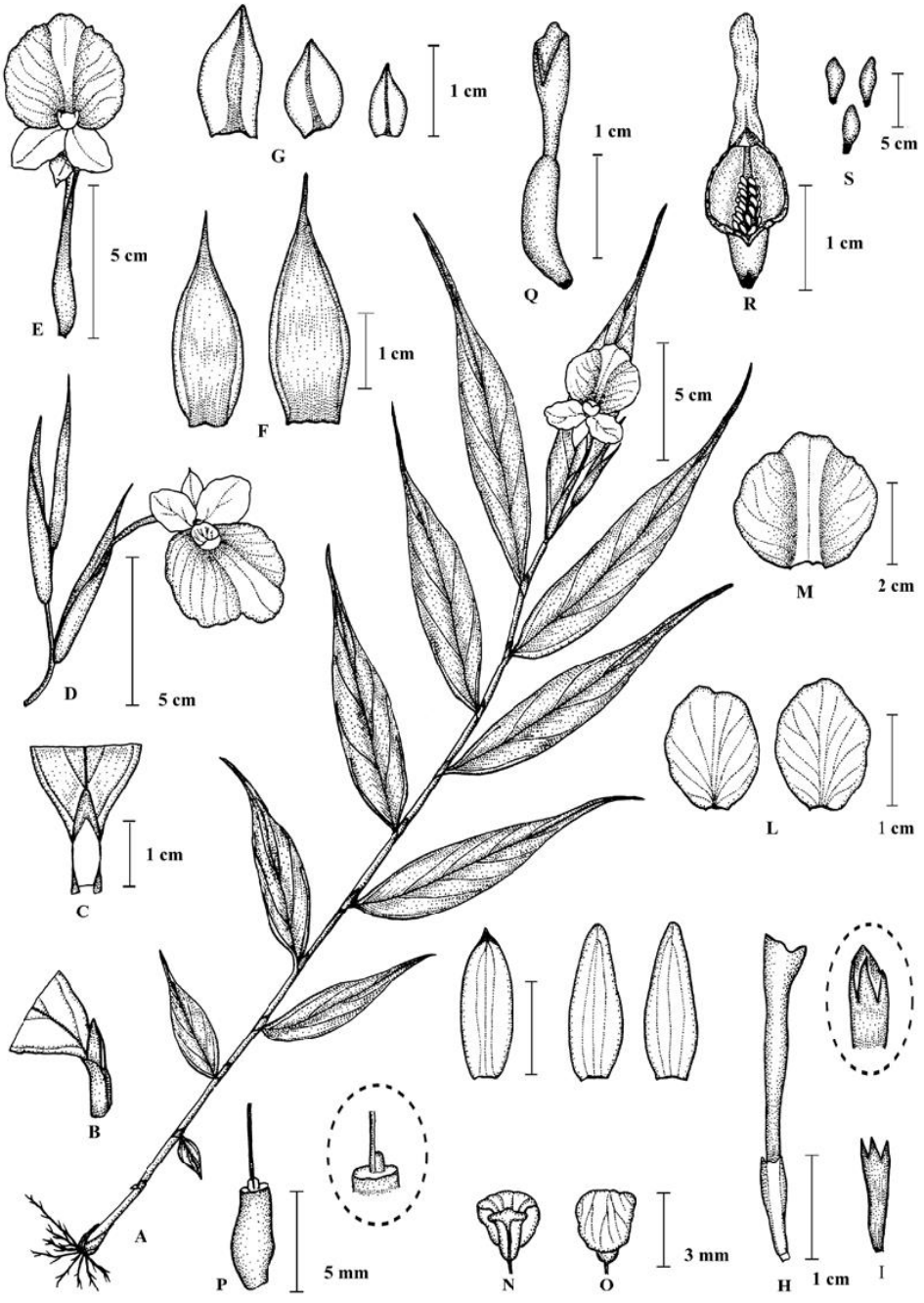

Fig. 3. *Caulokaempferia tamdaoensis* Picheans. & Inthar. A. Habit. B, C. Leaf base, showing ligule (B. side view, C. front view). D. Inflorescence. E. Flower with a bract. F. Bracts. G. Bracteoles. H. Calyx and corolla tubes. I. calyx tube. J, K. Corolla lobes (J. Dorsal, K. Lateral). L. Lateral staminodes. M. Labellum. N, O. Anthers and anther crest (N. Front view, O. Rear View). P. Ovary and stylodes. Q. Fruit. R. Dehiscing fruit, showing seeds. S. Seeds. Drawn by Nongnuch Anuraktrakoon.

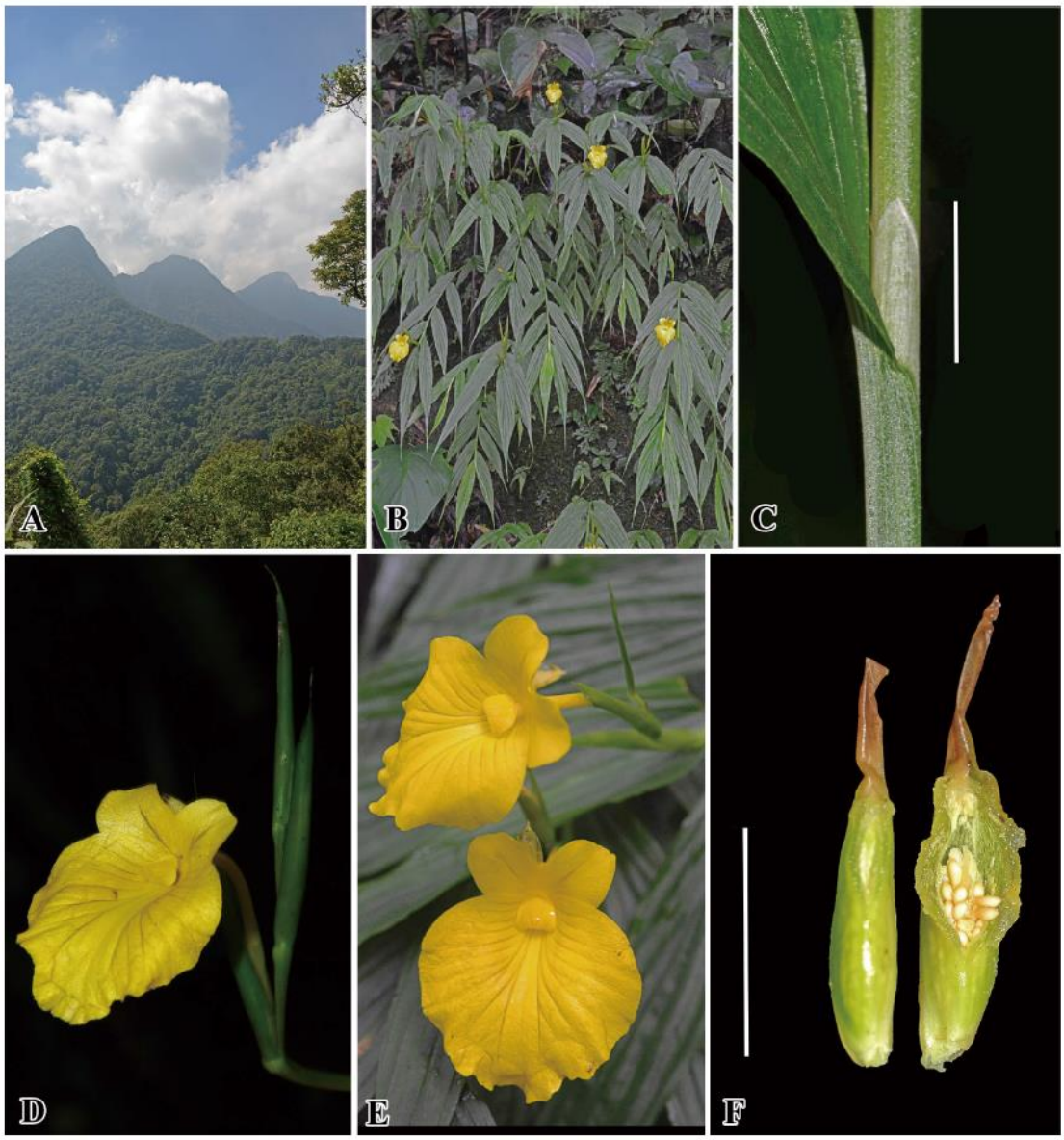

Fig. 4. *Caulokaempferia tamdaoensis* Picheans. & Inthar. A. The type location: Tam Dao (from front to rear, Tam Dao 1, Tam Dao 2, and Tam Dao 3). B. Plants in type location. C. Lower part of a leaf showing ligule. D. Inflorescence, showing bracts arrangement and a flower. E. Flowers, showing staminodes, labellum and anther crest. F. Fruit (left) and dehiscing fruit with seeds (right). Photographed by Chayan Picheansoonthon (A, B, C, E, F) and Pompimon Wongsuwan (D). Scale: 1 cm.

of all three taxa in type localities, however, only inflorescences of *C. saxicola* have strictly 1-flowered bracts. Inflorescences of *C. petelotii* have 1–3-flowered bracts, whereas those of *C. coenobialis* have 1–2-flowered bracts. These two latter taxa can easily be distinguished by the length of the ligule (3–10 mm versus ca. 2 mm long).

2. ***Caulokaempferia tamdaoensis*** Picheans. & Inthar., **sp. nov.** [Figs. 3, 4]

Type: **VIETNAM**. Vĩnh Phúc Province,

Tam Dao National Park, near summit of Tam Dao 1, 21°28.991'N, 105°37.549'E, altitude 1052 m, 18 August 2012, Picheansoonthon & Phokham 180812-1 (BK– holotype).

This species is similar to *Caulokaempferia petelotii* K. Larsen, but differs in the following characters: larger habit, 9–11(–12) lanceolate leaves, much longer calyx tube (1.7–1.9 vs. 0.6–1 cm long) and corolla tube (3.8–4.2 vs. 2–2.2 cm long) and an orbicular labellum with crenate apex.

Epilithic perennial herbs, slender, with short rhizome; root fibrous, some form longish tuber. Pseudostems tufted, 28.5–43(–57) cm with 3–4 bladeless sheaths. Leaves 9–11(–12), sessile, lanceolate, 7.4–17.2 × 1.2–4.2 cm, base cuneate, apex caudate to 4.2 cm long, glabrous on both sides; ligule membranous, triangular, 4–12 × 2–5 mm, apex obtuse or acute, glabrous. Inflorescences terminal, 3.5-8 cm; peduncle hidden in the uppermost two leaf sheaths; flowers yellow. Bracts (1–)2–3(–4), green, lanceolate, 3.5–5.2 × 0.8–1.2 cm, apex caudate to 1 cm long, glabrous, each subtends (1–)2–3(–4) flowers. Bracteoles membranous, lanceolate to ovate, 9–14 × 5–8 mm, apex acute, glabrous. Calyx tubular, 1.7–1.9 cm long, apex trifid. Corolla tube, 3.6–4.1 cm long, glabrous; dorsal corolla lobe oblong, 1.1–1.3 cm × 4–5 mm, apex hooded; lateral corolla lobes oblong, 1.1–1.5 cm × 3–5 mm, apex acute. Staminodes broadly elliptic to suborbicular, 1.2–1.6 × 0.8–1.2 cm, apex rounded. Labellum orbicular, 2.7–3.4 × 2.7–3.4 cm, apex crenate; anther, 4–5 mm long; anther crest orbicular, 5–6 mm, apex rounded. Stigma funnel-shaped. Ovary cylindrical, 4–7 × 2–3 mm, glabrous, 1-locular, ovules many; stylodes 2, filiform, very slender, ca. 1 mm long. Fruits capsular, oblong, 1.2–1.4 cm × 3–4 mm. Seeds numerous, oblong-ovate to ovate, light brownish, ca. 2 × 1 mm. Flowering May–August; fruiting June–September.

Distribution: Vietnam, Vĩnh Phúc Province, Tam Dao National Park (slope ca. 100 m before reaching the summit of Tam Dao 1, and slope between Tam Dao 1 and Tam Dao 2).

Ecology: On moist rocks in mixed deciduous forest at an altitude of 1060–1280 m.

Note: This taxon is closely related to *C. petelotii*, but can readily be distinguished by its larger habit with 9-12 lanceolate leaves. All populations of *C. petelotii* grow on rocks facing the stream or near the waterfalls while *C. tamdaoensis* forms dominant understorey patches on moist rocks in forests between tops of Tam Dao 1 and Tam Dao 2 (altitude 1060–1280 m).

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K. Intharapichai[a], B. Phokham[a, b], P. Wongsuwan[a], C. Picheansoonthon[a, c]：**ベトナム産の *Caulokaempferia* 属（ショウガ科）**

ベトナム産 *Caulokaempferia* 属（ショウガ科）として，2種，*C. petelotii* K. Larsen と *C. tamdaoensis* Picheans. & Inthar. を認めた．前者は1964年に記載された種で，後者は本稿で新種として発表されたものである．ここではこれらの2種について詳しく記載し，線画と写真を付した．また，これらの2種に近縁な種との関係についても議論した．

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Biography

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