

***Cleisostoma schoenorchaeifolium* (Orchidaceae: Vandaeae: Aeridinae), a new species from Lao PDR**

PANKAJ KUMAR¹, STEPHAN W. GALE¹, THATSAPHONE PHAXAYSOMBATH² & GUNTER A. FISCHER¹

¹Flora Conservation Department, Kadoorie Farm and Botanic Garden, Lam Kam Road, Lam Tsuen, Tai Po, New Territories, Hong Kong S.A.R., People's Republic of China; E-mail: pkumar@kfbg.org

²Ministry of Science and Technology, Biotechnology and Ecology Institute, Vientiane, Lao People's Democratic Republic

Abstract

Cleisostoma schoenorchaeifolium is described as a new species from limestone karst in Lao PDR. A detailed description with photographs, line drawings and a conservation assessment are presented. Due to the presence of a combination of unique characters (namely, semi-terete leaves with a subulate apex, a two-chambered spur and a complex pollinarium structure), this species cannot be satisfactorily placed in any of the existing sections of the genus. Accordingly, a new section, *Teretisculum*, is proposed. To aid correct placement of this and other species in their respective sections, a key to infrageneric taxonomy of *Cleisostoma* is provided.

Keywords: *Teretisculum*, critically endangered, Indo-Burma biodiversity hotspot, limestone mountains

Introduction

Situated in the heart of the Indo-Burma biodiversity hotspot, Lao PDR has gained growing research attention due to its comparatively under-explored floristic diversity and rapidly intensifying threats to its diversity (Newman *et al.* 2007, Schuiteman *et al.* 2008, Kumar *et al.* 2016, 2018, Gale *et al.* 2018). During the period 2012–2017, Kadoorie Farm and Botanic Garden (Hong Kong, China) and the Biotechnology and Ecology Institute, Ministry of Science and Technology (Vientiane, Laos), conducted joint field surveys so as to improve understanding of the orchid flora and identify conservation priorities within it (Kumar *et al.* 2016). This collaborative effort generated a collection of over 1460 accessions from across the country, comprising both living and preserved specimens. These included many new national records as well as several species new to science (Kumar *et al.* 2016, 2017, 2018, Gale & Phaxaysombath 2017, Souvannakhoummane *et al.* 2018). In this paper, we describe one more species previously unknown to science, namely, *Cleisostoma schoenorchaeifolium*. Given the presence of unique vegetative and floral traits, a new section is proposed to accommodate it.

Taxonomic Treatment

***Cleisostoma* Blume (1825: 362)**

Type species:—*Cleisostoma sagittatum* Blume (1825: 363)

Seidenfaden (1975: 7), Averyanov *et al.* (2015: 108), O'Byrne (2009: 77, 2010: 89), Wood (2014: 161), Ponert *et al.* (2016: e0150631).

Echioglossum Blume (1825: 364).

Sarcanthus Lindley (1826: t. 39B), nom. illeg.

Carteretia Richard (1834: 10. t. 4).

Garayanthus Szlachetko (1995: 136).

Raciborskanthos Szlachetko (1995: 135).

Blumeorchis Szlachetko (2003: 68).

Ormerodia Szlachetko (2003: 68).

Monopodial epiphytic or lithophytic herbs. Stem usually branched, erect or pendent, creeping. Leaves flat, terete or semi-terete, often conduplicate at base. Inflorescences lateral, short to long, racemose or paniculate, bearing one to many flowers with floral parts shorter than the pedicel and ovary. Petals and sepals similar although sepals usually narrower, spreading, free. Labellum trilobed, basally attached to the base of the column or a distinct column foot, immobile, spurred; side lobes erect to porrect, triangular; midlobe deltoid or sagittate; spur cylindrical, conical or saccate, with a callus projecting from the inner back wall, sometimes with another callus on the inner front wall close to the entrance, sometimes with a median septum inside. Column short, with or without distinct foot, with or without wings; anther cap terminal, operculate. Pollinia 4, grouped into two unequal masses, waxy, connected by a stipe; stipe and viscidium morphology variable.

The genus comprises around 110 species distributed from tropical and subtropical Asia to the western Pacific (Pridgeon *et al.* 2014, Averyanov *et al.* 2015, Govaerts *et al.* 2018). Of these, 51 species are found in the Indo-Burma biodiversity hotspot (Li *et al.* 2018), including 12 species known to occur in Laos. Wood (2014) recognised seven sections within the genus, to which two new sections have recently been added (Averyanov *et al.* 2015).

The new species conforms to be generic concept in possessing an immotile, trilobed labellum that is attached directly to the base of the column, an inverted y-shaped callus on the back wall of the spur, a tooth-shaped, truncate rostellum and four pollinia grouped in two semi-globular masses placed on either side of the stipe. However, it differs markedly from other members of the genus in certain vegetative (semi-terete leaves with a subulate apex) and floral (complex stipe structure, two-chambered spur) attributes, precluding its satisfactory placement in any one of the existing sections. Hence, a new section, sect. *Teretisculum*, is described to accommodate it. A key is provided to all ten sections.

Key to sections of *Cleisostoma*

- | | | |
|-----|--|---------------------------------------|
| 1a. | Leaves terete or semi-terete..... | 2 |
| 1b. | Leaves dorsoventrally compressed..... | 6 |
| 2a. | Leaves semi-terete, apex subulate; column not winged; spur septate..... | <i>Teretisculum</i> sect. <i>nov.</i> |
| 2b. | Leaves terete, apex rounded; column winged; spur aseptate..... | 3 |
| 3a. | Stipe longer than broad in outline, linear or tapering, flat, apex not forming a hood..... | 4 |
| 3b. | Stipe broader than long in outline, flap-like or hooded, margins rolled forwards or entire structure curved backwards..... | 5 |
| 4a. | Stipe triangular, margins gradually tapering to placement of pollinia at apex; viscidium semicircular or disc-shaped..... | <i>Pilearia</i> |
| 4b. | Stipe ovate, abruptly constricted into a slender tip below placement of pollinia at apex; viscidium sub-quadrangular..... | <i>Gastrochilopsis</i> |
| 5a. | Stipe mitre-shaped, margins rolled forwards; viscidium semicircular, narrower than the width of the stipe..... | <i>Mitriformes</i> |
| 5b. | Stipe not mitre-shaped, entire structure curved backwards; viscidium horseshoe-shaped with two recurved arms, broader than width of stipe..... | <i>Complicatum</i> |
| 6a. | Leaf apex acute..... | <i>Subulatum</i> |
| 6b. | Leaf apex bilobed..... | 7 |
| 7a. | Stipe linear, clavate or ovate, flat; viscidium subglobose..... | <i>Cleisostoma</i> |
| 7b. | Stipe flap-like, margins rolled forwards or entire structure curved backwards; viscidium collar- or crescent-shaped..... | 8 |
| 8a. | Labellum without appendage at apex..... | <i>Paniculatum</i> |
| 8b. | Labellum with appendage at apex..... | 9 |
| 9a. | Labellum appendage bifurcate; column wings triangular..... | <i>Echioglossum</i> |
| 9b. | Labellum appendage entire; column wings quadrangular or ovate..... | <i>Pterogyne</i> |

Teretisculum Kumar & S.W.Gale, sect. *nov.*

Type species:—*Cleisostoma schoenorchaeifolium* Kumar & S.W.Gale

Leaves with a single longitudinal groove, semi-terete in cross-section, apex subulate, distinctly constricted a few millimeters before the apex. Column without wings. Spur cavity septate, divided longitudinally into two parallel chambers. Stipe convoluted, broadest at base along the viscidium, abruptly contracted and recurved above, tapering into a pointed hood at apex. Pollinia attached dorsally on either side of the hood at stipe apex, held parallel to the viscidium. Viscidium collar-shaped.

Etymology:—Meaning ‘somewhat terete’ in reference to the morphology of the leaves, which are round but in fact distinctly grooved.

Taxonomic notes:—The new section *Teretisculum* is currently represented by a single member, *C. schoenorchaeifolium*. The leaves of this sole member are semi-terete and terminate in a subulate apex. This combination

of leaf characters has not previously been described in *Cleisostoma*. *Cleisostoma* section *Subulatum* (Seidenfaden 1975: 23) contains species with subulate leaf tips, but leaves in that section are dorsoventrally compressed, the spur is aseptate and the stipe is simple. A divided, two-chambered spur cavity is known in one other member of the genus, *C. elegans* Seidenfaden (1975: 46), which is placed in section *Mitriiformes* Seidenfaden (1975: 45), but the leaves of that species are terete and its stipe is mitre-shaped. Comprehensive sampling of species representing this and other sections of *Cleisostoma* is advocated to test the phylogenetic validity of current infrageneric classification.

Cleisostoma schoenorchaeifolium Kumar & S.W.Gale, *sp. nov.* (ເອື້ອງສ໌ອ໊ມະນັດອກນົບ; Figs. 1, 2)

Type:—LAOS. Xayaboury Province: Parklai District, Mouang Pa Village, Pha Pheung Mountain, 30 June 2016, 455 m, *Fischer, Kumar, Phaxaysombath & Sysouphanthong* HNL-KFBG 0729 (holotype: HNL; isotype: KFBG).

Cleisostoma schoenorchaeifolium is clearly distinguished from all other known members of the genus by its semi-terete, subulate leaves, septate (two-chambered) spur and complex pollinarium structure. Superficially, the new species most closely resembles *C. chantaburiense* of section *Complicatum* in having an elongated, scrotiform spur and a similarly structured pollinarium, but it can be differentiated on the basis of its semi-terete (versus terete) leaves, septate (versus aseptate) spur with an inverted v-shaped (versus finger-like) callus on the back wall and wingless (versus winged) column.

Pendent-arching epiphytic herb. Roots vermiform, branched, often thicker than the stem, up to 20 cm long, 3.0 mm in diameter. Stem terete, branched, up to 50 cm long, 1.5–2.0 mm in diameter. Leaves alternate, dark green, distinctly grooved and semi-terete in cross-section, 15.0–24.0 cm long, 2.0–2.5 mm in diameter, with a persistent sheathing base up to 1.0–1.2 cm long, apex subulate with a constriction 1.0–1.5 cm from the tip. Inflorescences lateral, pendent, glabrous, peduncle terete, rachis ribbed, 4.0–5.0 cm long, up to 1.0 mm in diameter, bearing 1 or 2 sterile bracts near the base and up to 5 flowers arranged in a lax raceme. Flowers 1.4–1.7 cm long, 1.0–1.5 cm across, petals and sepals spreading, dark yellowish green with dark reddish brown spots, column pale yellow. Pedicel and ovary 6.0–7.0 mm long, yellowish green with reddish brown spots, obscurely ribbed. Petals and sepals spotted reddish brown towards basally, yellowish green apically. Dorsal sepal obovate, 6.0–7.0 × 2.0–2.5 mm, acute, 3-veined, slightly concave. Lateral sepals obliquely obovate, 6.5–7.5 × 3.0–3.5 mm, obtuse, 3-veined, slightly convex. Petals narrowly obovate, oblique, 5.0–5.5 × 2.0–2.5 mm, acute, 2-veined, slightly convex, slightly bent backwards. Labellum trilobed, spurred, 7.5–8.5 mm (from tip of spur to tip of midlobe) × 5.0–6.0 mm, minutely white-papillose basally; lateral lobes pointing forwards, 2.5–3.0 × 2.0–2.5 mm, acute, with an inconspicuous triangular appendage on the apical margin and a prominent wing-like flap near the base; triangular appendage up to 0.5 mm tall, pointing upwards; wing-like flap up to 1.5 × 1.2 mm, apex rounded, pointing inwards; midlobe triangular, 2.0–2.3 × 2.5–3.0 mm, spreading forwards, base constricted, apex slightly notched. Spur slightly scrotiform at apex, pointing backwards, 5.0–5.5 × 2.0–2.5 mm, longitudinally ridged underneath, septate inside. Column up to 2.5 mm long, up to 2.5 mm wide; rostellum tooth-shaped, truncate at apex; anther cap hemispherical, ca. 2.0 mm in diameter, 1.2–1.4 mm wide across truncate apex; pollinia 4, arranged in 2 units, yellow, held parallel to the viscidium, 0.7–0.8 × 0.6–0.7 mm, each unit comprising one larger and one smaller pollinium, the larger hemispherical and 0.5 mm wide, the smaller discoid and 0.3 mm wide; viscidium collar-shaped, 1.3–1.4 mm wide; stipe attached to top of viscidium, 1.3–1.5 × 1.0–1.3 mm, broadest basally, flap-like and recurved above, slightly constricted at middle, terminating in a pointed hood 0.4–0.5 mm long and to which the pollinia are attached on both sides.

Flowering:—July–August.

Habitat:—Epiphytic on trunks of small trees in semi-evergreen forest on limestone mountains.

Etymology:—The epithet '*schoenorchaeifolium*' refers to the morphology of the leaves, which look similar to those of certain species of *Schoenorchis* Reinwardt (1825: 5), such as *S. juncifolia* Blume (1825: 361).

Taxonomic notes:—*Cleisostoma schoenorchaeifolium* is distinguished by the unique morphology of its leaves, which are longitudinally grooved and so not fully terete and as such unlike those of any of the truly terete-leaved members of the genus. Superficially, its flower resembles those of *C. chantaburiense* Seidenfaden (1975: 70), but the new species can be distinguished on the basis of leaf morphology (semi-terete with subulate apex versus terete with rounded apex), column morphology (wingless versus with rounded wings), spur morphology (septate and 2-chambered versus aseptate), and the shape of the callus on the back wall of the spur (inverted v-shaped and apically pointed versus divided into two curved, finger-like projections).

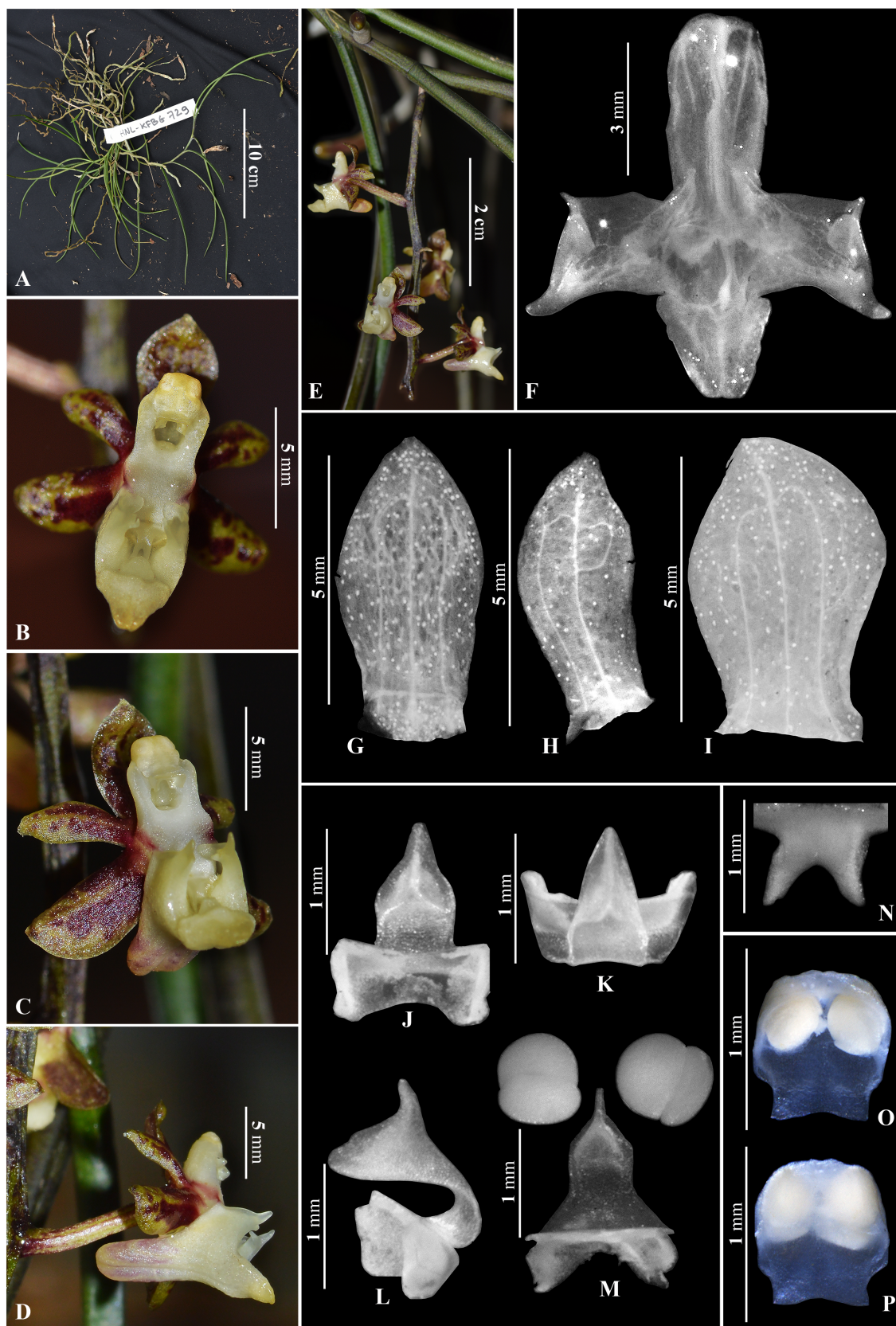


FIGURE 1. *Cleisostoma schoenorchaeifolium*. A. Plant. B. Front view of flower. C. Oblique view of flower. D. Side view of flower. E. Inflorescence. F. Labellum, flattened and with spur cut longitudinally to show septum and two internal chambers. G. Dorsal sepal. H. Petal. I. Lateral sepal. J. Front view of stipe. K. Top view of stipe. L. Side view of stipe. M. Pollinarium. N. Callus on the back wall of spur. O. Ventral view of anther cap with pollinia. P. Dorsal view of anther cap. Photograph by Pankaj Kumar (A, F–P) & Thatsaphone Phaxaysombath (B–E).

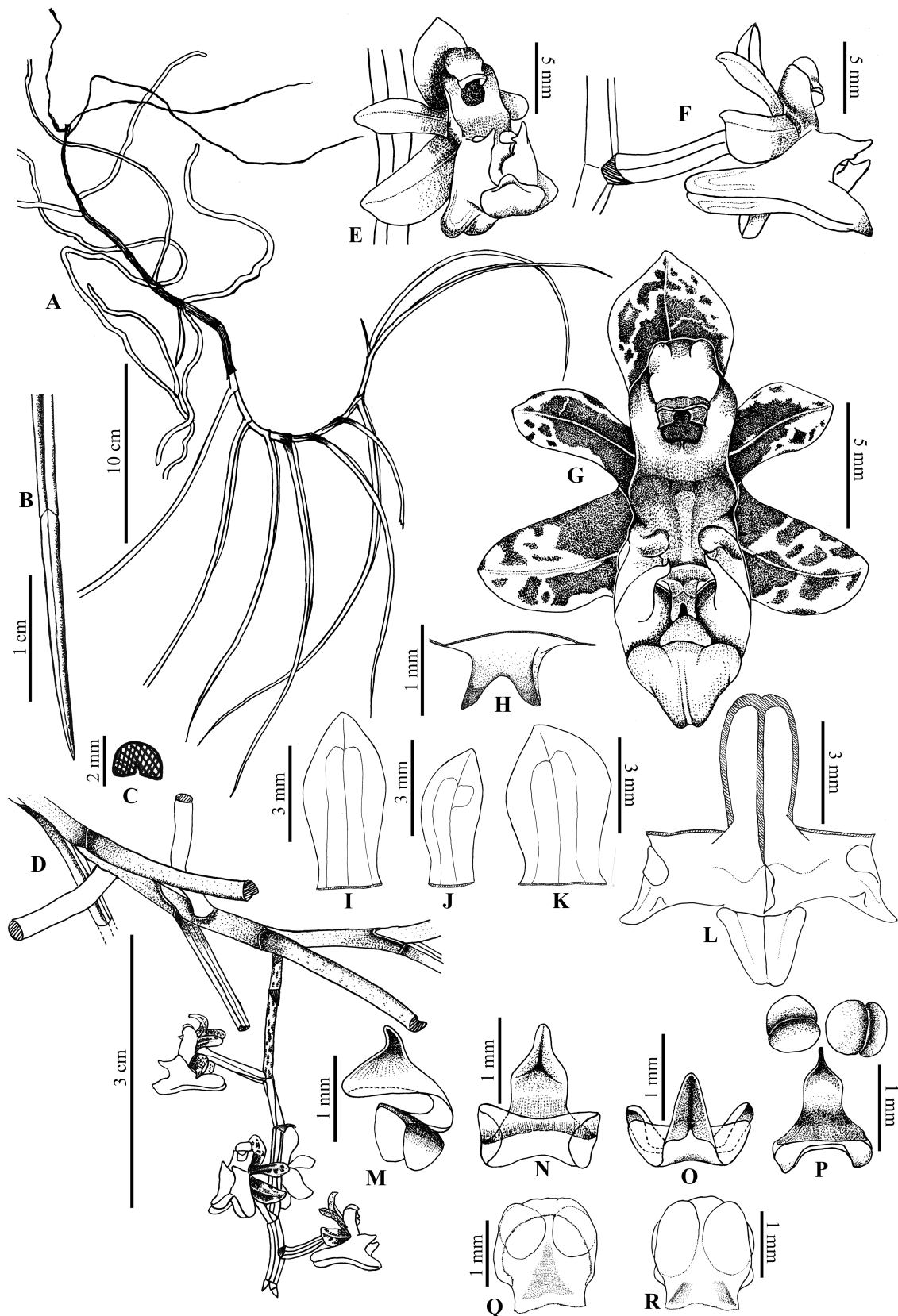


FIGURE 2. *Cleisostoma schoenorchaeifolium*. A. Plant. B. Leaf apex. C. Transverse section of leaf. D. Inflorescence. E. Oblique view of flower. F. Side view of flower. G. Front view of flower. H. Callus on the back wall of spur. I. Dorsal sepal. J. Petal. K. Lateral sepal. L. Labellum, flattened and with spur cut longitudinally to show septum and two internal chambers. M. Side view of stipe. N. Ventral view of stipe. O. Top view of stipe. P. Pollinarium. Q. Ventral view of anther cap with pollinia. R. Dorsal view of anther cap. Drawn by Pankaj Kumar from HNL-KFBG 0729.

The subulate leaf apex of *C. schoenorchaeifolium* is an unusual character in *Cleisostoma* that is otherwise found only among species of *C.* section *Subulatum* Seidenfaden (1975: 23). However, all members of that section possess flattened leaves. In addition, they have a simple, linear or clavate stipe borne on a tiny, disk-like viscidium, and their anther cap is beaked.

The septate, two-chambered spur of *C. schoenorchaeifolium* is also unusual, having previously been described only in *C. elegans*, a member of *C.* section *Mitriiformes* Seidenfaden (1975: 45). However, members of that section are terete-leaved, their stipe is mitre-shaped, their viscidium is disc-shaped, their labellum has a clavate midlobe and rounded side lobes and the callus on the back wall of the spur is inverted, y-shaped and papillose.

Conservation assessment:—Despite comprehensive surveys in the area, fewer than 20 individuals were seen at the type locality on Pha Pheung Mountain in Xayaboury Province, presently the only known locality for this species. The known area of occurrence (AOO) therefore amounts to just 4 km², using a grid cell of 2 × 2 km in GeoCAT (Moat 2007). The karst landscape of northern and central Laos is increasingly under threat for quarrying and cement production (Gale *et al.* 2018). At present, only 10% of the Lao limestone belt is under statutory protection (Day & Ulrich 2000, Delang *et al.* 2013), despite it harbouring disproportionately great phytodiversity (Clements *et al.* 2006, Kumar *et al.* 2016, Li *et al.* 2018). Additionally, illegal collection for the horticultural trade remains an intense threat (Schuiteman 2013). We therefore project future decline in population size and habitat quality. Hence, based on IUCN (2018) guidelines, the new species is assessed as critically endangered (B1+B2ab(iii,v); C2a(i); D).

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References

- Averyanov, L.V., Tich, N.T. & Canh, N.V. (2015) New species of the genus *Cleisostoma* in the flora of Vietnam. *Taiwania* 60: 107–116.
<https://doi.org/10.6165/tai.2015.60.107>
- Blume, C.L. (1825) *Bijdragen tot de flora van Nederlandsch Indië*. Ter Lands Drukkerij, Batavia, 434 pp.
<https://doi.org/10.5962/bhl.title.6656>
- Clements, R., Sodhi, N.S., Schilthuizen, M. & Peter, K.L.N. (2006) Limestone karsts of Southeast Asia: imperiled arks of biodiversity. *BioScience* 56: 733–742.
[https://doi.org/10.1641/0006-3568\(2006\)56\[733:LKOSAI\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2006)56[733:LKOSAI]2.0.CO;2)
- Day, M.J. & Ulrich, P.B. (2000) An assessment of protected karst landscapes in Southeast Asia. *Cave and Karst Science* 27: 61–70.
- Delang, C.O., Toro, M. & Phommachanh, M.C. (2013) Coffee, mines and dams: conflicts over land in the Bolaven Plateau, southern Lao PDR. *The Geographical Journal* 179: 150–164.
<https://doi.org/10.1111/j.1475-4959.2012.00481.x>
- Gale, S., Kumar, P. & Phaxaysombath, T. (2018) *A guide to orchids of Laos*. Natural History Publications (Borneo), Kota Kinabalu, and Kadoorie Farm & Botanic Garden, Hong Kong, 204 pp.
- Gale, S.W. & Phaxaysombath, T. (2017) Studies in Asian *Nervilia* (Orchidaceae) VII: *Nervilia kasiensis*, a new Lao endemic. *Blumea* 62: 1–5.
<https://doi.org/10.3767/000651917X694732>
- Govaerts, R., Campacci, M.A., Baptista, D.H., Cribb, P.J., George, A., Kreutz, K. & Wood, J.J. (2018) *World checklist of Orchidaceae*. The Board of Trustees of the Royal Botanic Gardens, Kew. Published on the Internet: <https://www.kew.org/wcsp/monocots/> (accessed 6 August 2018)
- IUCN (2018) *Guidelines for using the IUCN Red List categories and criteria, version 3.1, second edition*. Available from: <https://www.iucnredlist.org/> (accessed 6 August 2018)
- Kumar, P., Gale, S.W., Schuiteman, A., Bouamanivong, S. & Fischer, G.A. (2016) Identifying orchid hotspots for biodiversity conservation in Laos: the limestone karst vegetation of Vang Vieng District, Vientiane Province. *Journal of Threatened Taxa* 8: 9397–9417.
<https://doi.org/10.11609/jott.2826.8.12.9397-9417>
- Kumar, P., Gale, S.W., Li, J.H., Bouamanivong, S. & Fischer, G.A. (2017) *Thismia nigricoronata*, a new species of Burmanniaceae

- (Thismieae, Dioscoreales) from Vang Vieng, Vientiane Province, Laos, and a key to subgeneric classification. *Phytotaxa* 319: 225–240.
<https://doi.org/10.11646/phytotaxa.319.3.2>
- Kumar, P., Gale, S.W., Pedersen, H.Æ., Phaxaysombath, T., Bouamanivong, S. & Fischer, G.A. (2018) Additions to the orchid flora of Laos and taxonomic notes on orchids of the Indo-Burma region. *Taiwania* 63: 61–83.
<https://doi.org/10.6165/tai.2018.63.61>
- Li, J., Gale, S.W., Kumar, P., Zhang, J. & Fischer, G.A. (2018) Prioritizing the orchids of a biodiversity hotspot for conservation based on phylogenetic history and extinction risk. *Botanical Journal of the Linnean Society* 186: 473–497.
<https://doi.org/10.1093/botlinnean/box084>
- Lindley, J. (1826) *Collectanea botanica*. Taylor, London, 106 pp.
- Moat, J. (2007) *Conservation assessment tools extension for Arc View 3.x, version 1.2*. GIS Unit, Royal Botanic Gardens, Kew. Available from: <http://www.rbgbkew.org.uk/gis/cats> (accessed 2 November 2018)
- Newman, M., Ketphanh, S., Svengsuksa, B., Thomas, P., Sengdala, K., Lamxay, V. & Armstrong, K. (2007) *A checklist of the vascular plants of Lao PDR*. Royal Botanic Garden, Edinburgh, 394 pp.
- O’Byrne, P. (2009) Notes on Malesian *Cleisostoma*: Part 1. *Malesian Orchid Journal* 4: 77–98.
- O’Byrne, P. (2010) Notes on Malesian *Cleisostoma*: Part 2. *Malesian Orchid Journal* 5: 89–114.
- Ponert, J., Trávníček, P., Vuong, T.B., Rybková, R. & Suda, J. (2016) A new species of *Cleisostoma* (Orchidaceae) from the Hon Ba Nature Reserve in Vietnam: a multidisciplinary assessment. *PLoS ONE* 11: e0150631.
<https://doi.org/10.1371/journal.pone.0150631>
- Reinwardt, C.G.C. (1825) *Schoenorchis*. In: Hornschuch, C.F. (Ed.) *Sylloge plantarum novarum itemque minus cognitarum* 2. Brenck, Regensburg, 256 pp.
- Richard, A. (1834) *Carteretia*. In: Dumont d’Urville, J.S.C. (Ed.) *Voyage de la corvette l’Astrolabe* 2. Tastu, Paris, pp. 10.
- Schuiteman, A., Bonnet, P., Svengsuksa, B. & Barthelémy, D. (2008) An annotated checklist of the Orchidaceae of Laos. *Nordic Journal of Botany* 26: 257–316.
<https://doi.org/10.1111/j.1756-1051.2008.00265.x>
- Schuiteman, A. (2013) *Orchids of Laos*. In: Elliott, J., Kurzweil, H.F., Bryne, P.O., Tan, K.W., van der Schans, A.S., Wong, S.M. & Yam, T.W. (Eds.) *Proceedings of 20th World Orchid Conference Singapore 2011*. National Parks Board & Orchid Society of South East Asia, Singapore, pp. 523–533.
- Seidenfaden, G. (1975) Orchid genera in Thailand II. *Cleisostoma* Bl. *Dansk Botanisk Arkiv* 29: 1–80.
- Souvannakhoumane, K., Kumar, P., Gale, S.W., Lanorsavanh, S. & Lamxay, V. (2018) Three new additions to the orchid flora of Lao PDR. *Thai Journal of Botany* (in press).
- Szlachetko, D.L. (1995) Systema orchidalium. *Fragmenta Floristica et Geobotanica, Supplement* 3: 3–152.
- Szlachetko, D.L. (2003) Genera et species orchidalium, 7, Vandaeae. *Annales Botanici Fennici* 40: 67–70.
- Wood, J.J. (2014) *Cleisostoma*. In: Pridgeon, A.M., Cribb, P.J., Chase, M.A. & Rasmussen, F. (Eds.) *Genera orchidacearum, volume 6, Epidendroideae (part 3)*. Oxford University Press, Oxford, pp. 161–166.