



## New taxa of *Peliosanthes* and *Tupistra* (Asparagaceae) in the flora of Laos and Vietnam and supplemental data for *T. patula*

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### Abstract

Three new taxa, *Tupistra gracilis*, *Peliosanthes griffithii* var. *breviracemosa* and *P. hirsuta*, are described and illustrated. The first two taxa are local endemics of northern Vietnam and the last species is endemic to karstic limestone areas of central Laos. *Tupistra fungilliformis* and *P. yunnanensis* are recorded for the first time for Vietnam. A recently described species *T. patula* from northern Vietnam is supplemented with new data on its morphology, ecology and distribution.

**Key words:** plant diversity, plant taxonomy

### Introduction

*Peliosanthes* Andrews (1808: 605) belongs to the tribe Ophiopogoneae (Dahlgren *et al.* 1985, Conran & Tamura 1998) or Peliosantheae (Takhtajan 2009, under the subfamily Ophiopogonoideae) of the family Convallariaceae. It is preliminarily estimated to comprise 60 or some more species and distributed widely over South and Southeast Asia. *Tupistra* Ker Gawler (1814: 1655) is classified in the tribe Convallarieae (Conran & Tamura 1998) or Aspidistreeae (Dahlgren *et al.* 1985; Takhtajan 2009, under Convallarioideae) of Convallariaceae. It consists of approximately 27 species (Tanaka 2010, Averyanov, Tanaka 2012, Hu *et al.* 2013, Vislobokov *et al.* 2014, Averyanov *et al.* 2015, 2016a, 2016b), ranging over South and Southeast Asia. More recently, both genera are often referred to the subfamily Nolinoideae (Chase *et al.* 2009) of the family Asparagaceae (APG 2009).

Recent surveys on the flora or biodiversity of eastern Indochina (Cambodia, Laos and Vietnam) resulted in the discovery of more than 20 new species of *Peliosanthes* (e.g. Averyanov *et al.* 2015, 2016a, 2016b, Vislobokov 2016) and five new species of *Tupistra* (Averyanov & Tanaka 2012, Vislobokov *et al.* 2014, Averyanov *et al.* 2015, 2016a). The rapid increase in the number of such novelties suggests that both genera are greatly diversified there and that the flora of this area still remains insufficiently explored.

In our recent field surveys in central Laos and northern Vietnam, we collected several species of *Peliosanthes* and *Tupistra* that are unusual or new to the country concerned. A closer survey proved that one species of *Tupistra* and two taxa of *Peliosanthes* are new to science, and two other species, each of *Tupistra* and *Peliosanthes*, are new to the flora of Vietnam. We also encountered the recently described *T. patula* Averyanov *et al.* (2016a: 34) at several localities (other than type locality) in northern Vietnam. The original description of this species was based solely on plants bearing a rather aged inflorescence, therefore we provide here supplemental data based on new collections with younger inflorescences. All of them will be reported here in detail from a taxonomical standpoint.

## Material and methods

Specimens used for this study were originally collected in the field in central Laos and northern Vietnam during the years 2013–2016. Some were cultivated as living materials at the Komarov Botanical Institute (Russia). Specimens of new taxa from the wild or the cultivated plants are kept as type materials at HN and/or LE. Inflorescences or flowers of some live plants were fixed and stored in 70% ethanol for further laboratory studies. Measurements of floral parts for description were made on both living and fixed materials. We found that fleshy parts of the live flowers shrink up to 20–30% in the drying process of making herbarium specimens. This was taken into account in identification of materials. In describing quantitative characters, infrequent extreme values, i.e. rarely occurring minimal and maximal values, of a variation range were parenthesized respectively before and after a normal variation range.

## Descriptions of new taxa

*Peliosanthes hirsuta* Averyanov & N.Tanaka, *sp. nov.* (Figs. 1, 2).

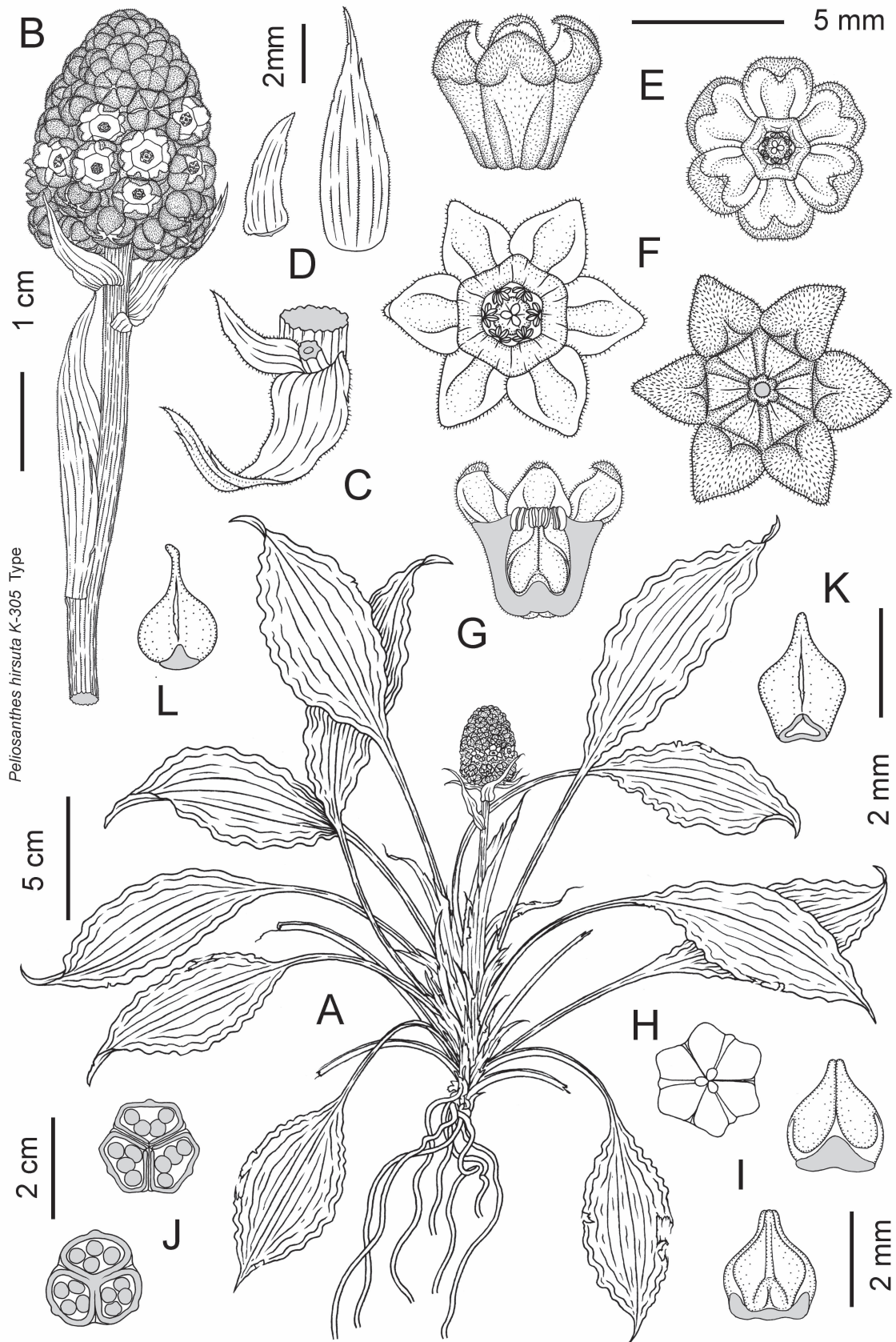
**Type:**—LAOS. Vientiane province, Kasi town area, about 40 km to the north by old road Kasi—Louangphabang, evergreen shady forest on slope of Nam Kean River at lower western slope of Ph. Phaday Mountain at elevation about 700 m a.s.l., 30 November 2014, *E. Konstantinov*, K-305 (holotype, LE!).

Terrestrial or lithophytic perennial herb. Stem erect or oblique, to (2–)3–4(–5) cm high, covered with many whitish scales that are irregularly imbricate, cuneate, papyraceous and incised. Roots several, rigid, wiry, straight or slightly flexuose, Ø 1.5–2 mm. Leaves proteranthous, petiolate; petiole rigid, often curved or suberect, (3–)4–8(–10) cm long; leaf blade elliptic to broadly elliptic, acute to shortly acuminate, (6–)9–13(–15) cm long, (2.5–)3.5–5.5(–6.5) cm wide, leathery, glabrous, rugulose, often finely undulate along margin, adaxially uniformly dark green and glossy, abaxially light green to whitish green; longitudinal veins (5–)6–9(–11), prominent; secondary transverse veinlets almost invisible. Floriferous stem bearing a terminal raceme; peduncle erect, (3.5–)4–8(–9) cm long, Ø 2.5–3 mm, herbaceous, white, finely ridged longitudinally, hirsutulous to almost glabrous, bracteate; sterile bracts (1–)2–3(–4), loose, ensiform, acuminate, papyraceous, whitish, (1.5–)2–5(–6) cm long, (3–)4–6(–8) mm wide (when flattened for measuring); raceme ovoid, densely many-flowered, (1.5–)2–3.5(–4) cm long, Ø (1.2–)1.5–1.8(–2) cm; rachis thick, straight. Floral bracts 2 per flower, 2-whorled, whitish, scarious to papyraceous, narrowly triangular-ovate, acute, finely ciliate along margin and hirsutulous on abaxial surface, often somewhat descendent, slightly concave to almost flat; outer bract lying below flower, (4–)6–10(–12) mm long, (1.5–)2–3(–3.5) mm wide; inner one (bracteole) lying lateral to flower, elongate, twice smaller, oblique. Flowers solitary on very short, knob-like cylindrical pedicel, not widely open, broadly campanulate, (5.5–)6–7(–8) mm across. Perigone adaxially dark dirty brown-purple, distally 6-lobed; proximal syntepalous (tubular) part broadly obconical, 6-ribbed, (2–)2.5–3(–3.5) mm long, (3.8–)4–4.2(–4.4) mm wide, abaxially white, sparsely hirsutulous; segments subsimilar, almost triangular, (2.2–)2.5(–2.7) mm long and broad, blunt to rounded at apex, adaxially thickened medially, abaxially densely hirsute, greenish, rimmed with purple along ciliate margin. Corona slightly convex to almost flat, to 0.5 mm high, obscurely hexagonal, Ø (3.3–)3.5–4(–4.2) mm, apical opening indistinctly hexagonal to irregularly circular, Ø (1.4–)1.6–1.8(–2) mm. Anthers 6, nearly vertically attached to orifice of corona, sessile, ovoid to broadly ovoid, (0.7–)0.8(–1) mm long and wide, introrse, almost black; pollen dull pale yellow. Pistil 1, tricarpeal, dirty purplish, deeper in color distally; carpels hemispheric, distally shortly attenuate into style, adjoining carpels fused at base, at middle and apex closely juxtaposed or loosely connate along ventral sutures, ventral suture of each carpel slightly open in middle portion; ovary almost superior, broadly ovoid to almost globular, 1.4–1.5 mm high and broad; style 0.4–0.5 mm long and wide, deep dirty purple-violet; stigmas narrowly obovate, finely papillose; ovules 4 per locule, borne on basal placentae, narrowly oblong-ovoid.

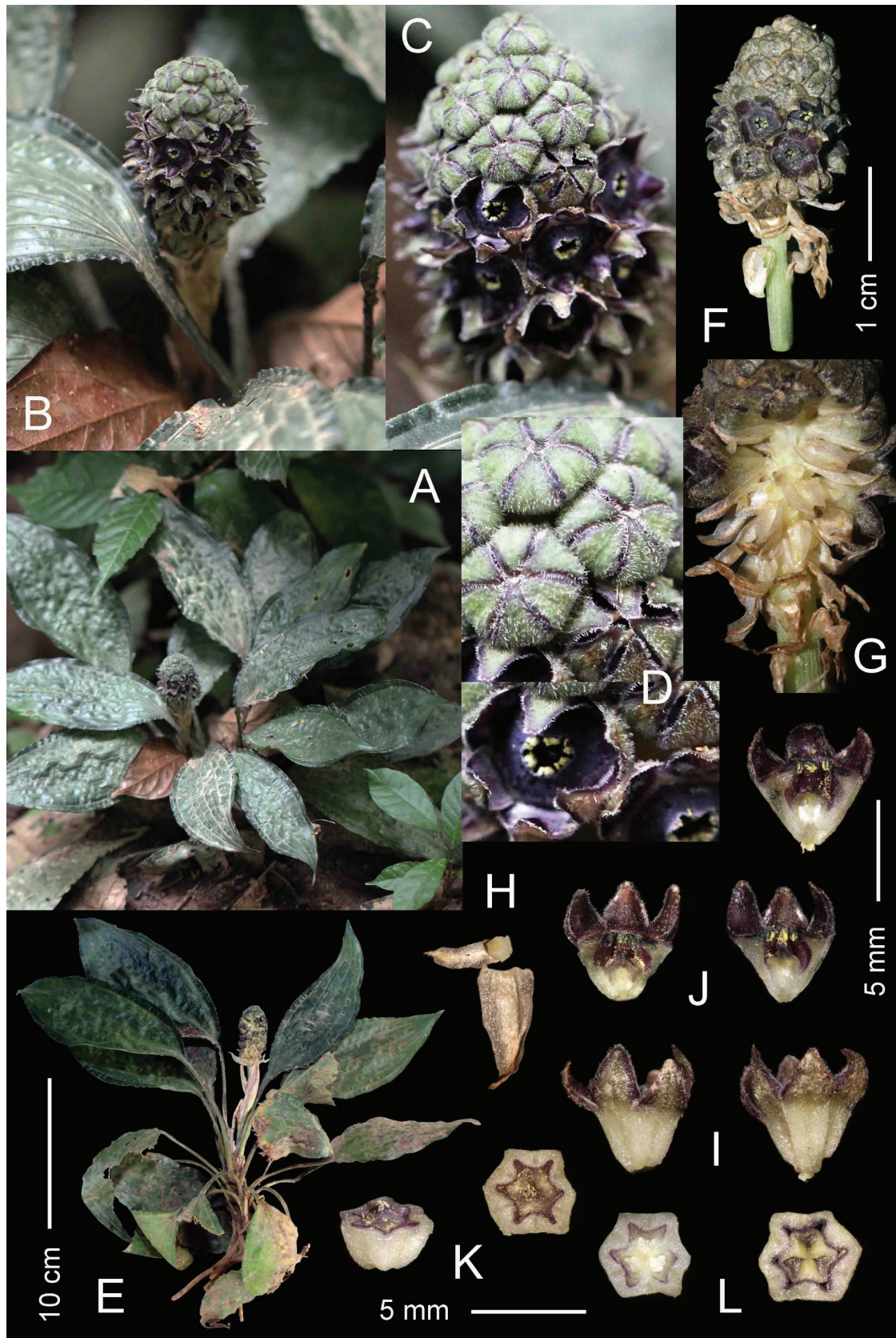
**Etymology:**—The specific epithet refers to the hairy state of the perigones, bracts and floriferous stems.

**Habitat and phenology:**—Primary and secondary broad-leaved evergreen forests on rocky, highly eroded, crystalline limestone at elevation 700–1000 m a.s.l. Terrestrial or lithophytic herb on shady rocky slopes. Flowering in November–December.

**Distribution:**—Central Laos (Vientiane province, Kasi district). Local endemic to central Laos.



**FIGURE 1.** *Peliosanthes hirsuta*. A. Flowering plant. B. Inflorescence. C. Portion of rachis with floral bracts subtending a pedicel. D. Flattened floral bract and bracteole. E. Flower, side (left) and frontal (right) view. F. Flowers with flattened tepals, frontal (left) and rear view (right). G. Flower, sagittal section. H. Ovary, view from above. I. Ovary, side views. J. Ovary, transversal section at base (below) and in middle part (above). K, L. Separated singular carpels, adaxial views. All drawn from the type –E. Konstantinov, K-305 by L. Averyanov and T. Maisak.



**FIGURE 2.** *Peliosanthes hirsuta* sp. nov. A, B. Flowering plant. C. Inflorescence. D. Flower buds and flowers. E. Flattened plant. F. Inflorescence. G. Rachis with floral bracts (bract and bracteole), flowers removed. H. Bract and bracteole. I. Flowers, side view. J. Flowers, sagittal sections. K. Transversal section of perigone tube with intact ovary, side view (left) and view from above (right). L. Basal portion of flower in transversal section, showing basal portion (left; with ovules) and apical portion (right) of ovary. Photos of E. Konstantinov and L. Averyanov, correction and design by L. Averyanov [A–E—photos from the type *E. Konstantinov* K-305; F–L—photos from paratype *Averyanov et al.*, LA-VN 840].

**Taxonomic relationships:**—*Peliosanthes hirsuta* is superficially similar to *P. argenteostriata* Averyanov & Tanaka (2012: 153) occurring in calcareous regions of central and northern Vietnam (Averyanov & Tanaka 2012). However, it differs by the hairy flowers and the erect or oblique stem without accompanying any markedly developed plagiotropic rhizome. The new species is also unusual in having an almost apocarpous gynoecium. To our knowledge, there has been no report of such a gynoecium and hairy flowers in other members of *Peliosanthes*, or even of Ophiopogoneae (Dahlgren *et al.* 1985, Conran & Tamura 1998) or Ophiopogonoideae (Takhtajan 2009) including *Liriope*, *Ophiopogon* and *Peliosanthes*.

**Additional specimens studied (paratypes):**—LAOS. 21 October 2016 and 1 November, *L. Averyanov*, LA-VN 840a (LE!). Specimen prepared from cultivated plant originally collected in central Laos (Vientiane province, Kasi district, Namken village, Phachao Mountain, around point 19°18'45.5" N 102°22'31.4" E, primary broad-leaved evergreen forest on very steep rocky slopes of mountain composed of highly eroded solid crystalline limestone at elevations 700–1000 m. a.s.l., terrestrial herb on shady place, leaves uniformly dark green and glossy, common, 24 March 2013, *L. Averyanov*, *N.S. Khang*, *S. Lorphengsy*, LA-VN 840).

***Peliosanthes griffithii* Baker var. *breviracemosa* Averyanov & N.Tanaka, var. nov.** (Fig. 3).

**Type:**—VIETNAM. 2 November 2015, *L. Averyanov*, CPC 5402b/TM 1065/13391 (holotype, LE!). Type specimen prepared from cultivated plant originally collected in northern Vietnam (Cao Bang province, Nguyen Binh district, Ca Thanh municipality, Cao Lu village, around point 22°42'47.7" N, 105°51'50.8" E, primary coniferous forest with *Pseudotsuga sinensis* along highly eroded rocky limestone ridge at elevation about 1300 m a.s.l., 4 October 2013, *L. Averyanov*, *N.T. Hiep*, *L.M. Tuan*, *N.S. Khang*, *T. Maisak*, *L. Osinovets*, CPC 5402b/TM 1065).

Herb rosulate, terrestrial or lithophytic. Rhizome plagiotropic, short, (1–)2–3(–4) cm long, Ø (3–)3.5–4(–4.5) mm, simple or few branching. Roots many, grayish, cord-like, rigid. Stems sub-erect, (5–)6–10(–12) mm tall, covered loosely with narrowly triangular sheath leaves (cataphylls). Cataphylls light greenish when young, conduplicate, (1.5–)2–5(–6) cm long, (0.5–)1–1.5(–2) cm wide, soon becoming whitish to light yellowish-brown, scarious, eventually disintegrating into fragmented papery remains. Leaves arching to suberect, petiolate, (8–)10–16(–18) cm long; petiole rigid, straight to arching, shallowly channeled in basal part, (3–)4–10(–14) cm long; blade elliptic to broadly elliptic, shortly acuminate, entire, glabrous, uniformly green and glossy on both sides, (5–)7–10(–12) cm long, (2–)2.5–4(–4.5) cm wide; often longitudinally pleated, longitudinal veins many, crossed subperpendicularly with many secondary transversal veinlets. Inflorescence a terminal, erect, subdense raceme, Ø (1.2–)1.5–1.6(–2) cm; peduncle erect, straight, stout, (2–)2.5–3(–3.5) cm long, Ø (2–)2.2–2.5(–3) mm, light violet, often with greenish tint, with (2–)3–5(–6) sterile bracts; bracts on peduncle narrowly triangular, 3-veined (midvein quite distinct, lateral veins more or less obscure), acuminate or attenuate into linear apical part, cordate at base, papyraceous or scarious, (8–)10–14(–15) mm long, (0.5–)1–2(–3) mm wide; rachis longitudinally ribbed, many-flowered, (3.5–)4–6(–8) cm long, apically with dense tuft of bracts each subtending floral bud. Floral bracts 2 per flower, antrorse, narrowly triangular, acuminate, 1-veined, middle part greenish, subherbaceous, marginally scarious, whitish; outer bract located below flower, (3–)6–10(–11) mm long, (1–)1.5–3(–3.5) mm wide; inner bract (bracteole) situated lateral to flower, slightly oblique, much smaller, (0.5–)1–2(–2.5) mm long. Flowers solitary in bracteal axil on short pedicel, dark purple-violet to almost black, not widely open, rather campanulate, (5–)5.5–6(–6.5) mm across; basal (syntepalous) part hemispheric, (1.8–)2–2.5(–2.8) mm across, 0.8–1(–1.2) mm long, circular in cross section. Pedicel finely ribbed, white to violet, horizontal, cylindrical, terete, straight, (1–)1.2–1.5(–1.6) mm long, about 1 mm across. Perigone segments subsimilar, narrowly ovate to ovate, usually incurved, subobtuse, (2–)2.2–2.8(–3) mm long, (1.2–)1.5–1.8(–2) mm wide; margins revolute, entire or slightly irregularly nibbled at apex. Corona shortly cylindrical or broadly conoid, almost circular in section, (2.4–)2.5–2.6(–2.8) mm across, (1–)1.2–1.5(–1.6) mm high, the orifice obscurely 6-dentate, Ø (1.5–)1.6–1.8(–2) mm. Anthers 6 on apical inner surface of corona, ovoid, introrse, sessile, dorsifixed, dull yellow to almost white, 0.5–0.6 mm long. Ovary half inferior, distal free part dark purple-violet, broadly pyramidal, 0.9–1.1 mm high, 2.2–2.4 mm across, obscurely 3-lobed in cross section, the interior partitioned into 3 locules by 3 fleshy septa almost touching each other along inward edges in center; each locule slightly open along ventral suture of carpel, containing 4 ovules on basal placenta; style broadly conoid, short, 0.4–0.5 mm long; stigma 3-partite, black, the lobes ovate, 0.3–0.4 mm long, glabrous.

**Etymology:**—The varietal epithet refers to the short raceme of this plant.

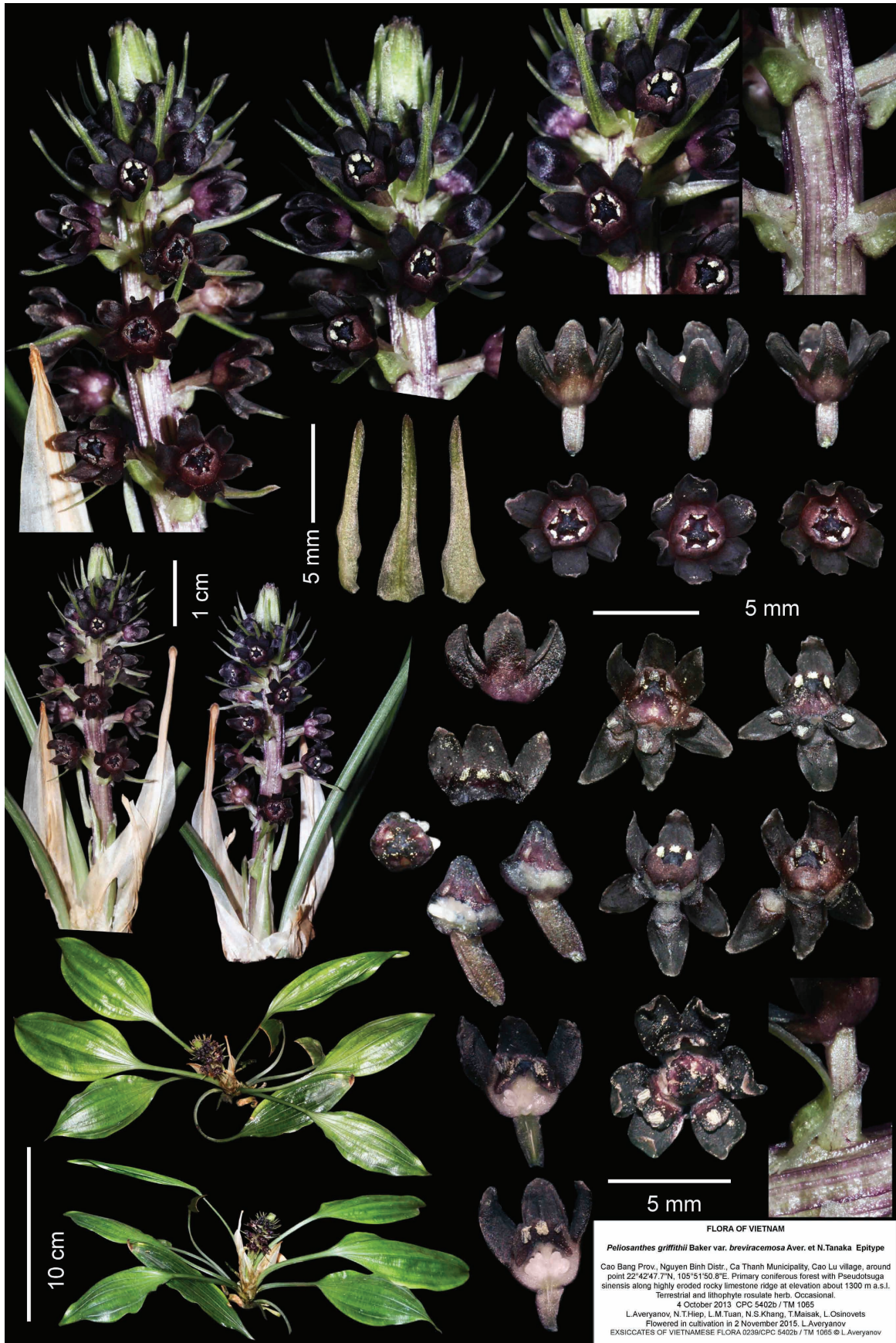


FIGURE 3. *Peliosanthes griffithii* var. *breviracemosa*. Digital epitype, L. Averyanov, CPC 5402b /TM 1065 /13391. Photos, correction and design by L. Averyanov.

**Habitat and phenology:**—Terrestrial and lithophytic herb on shady slopes covered with primary coniferous forest with *Pseudotsuga sinensis* on highly eroded rocky limestone near ridge top at elevation about 1300 m a.s.l. Not common. Flowering October–November.

**Distribution:**—Northern Vietnam (Cao Bang province, Nguyen Binh district). Endemic to northern Vietnam.

**Taxonomic relationships:**—The variety is distinguishable from *Peliosanthes griffithii* var. *griffithii* distributed in NE India and N Vietnam (Averyanov *et al.* 2016a) by the short, somewhat compact, ovoid raceme, floral bracts much exceeding flowers, prominently ribbed rachis and short ribbed pedicels. In our plant cultivated, the apical part of inflorescence is cristate with young floral bracts. It is not certain at present if this character is also stable in plants in the wild.

**Additional specimens studied (paratypes):**—VIETNAM. 15 October 2015, *L. Averyanov*, CPC 5402a/TM 1100/13393 (LE!). Specimen prepared from cultivated plant originally collected in northern Vietnam (Cao Bang province, Nguyen Binh district, Ca Thanh municipality, Cao Lu village, around point 22°42'47.7" N, 105°51'50.8" E, primary coniferous forest with *Pseudotsuga sinensis* along highly eroded rocky limestone ridge at elevation about 1300 m a.s.l., 4 October 2013, *L. Averyanov*, *N.T. Hiep*, *L.M. Tuan*, *N.S. Khang*, *T. Maisak*, *L. Osinovets*, CPC 5402a/TM 1100).

*Peliosanthes yunnanensis* F.-T.Wang & Tang in Chang (1978: 254), Chen & Tamura (2000: 262); non Averyanov (2011: 143, Fig. 1 & 2), (Fig. 4A–G).

**Type:**—CHINA. Yunnan, Mar-li-po, Hwang-jin-in, 6 November 1947, *K.M. Feng* 12962 (holotype, PE [286816—00036763]!).

Paratype:—CHINA. Yunnan, Mar-li-po, Hwang-ging-ying, 15 January 1940, *C.W. Wang* 83890 (PE [83890—00036764]!).

**Studied sample:**—VIETNAM. Lao Cai province, Sapa district., Khoang village, Hoang Lien Son Range, primary evergreen broad-leaved forest on slopes of sandstone mountain at elevation 1800 m a.s.l. around point 22°22'55" N 103°46'43" E, terrestrial herb, very common, 2 November 2016, *N.S. Khang*, *B.H. Quang*, NSK 840 (HN!, LE—photo).

**Habitat and phenology:**—Terrestrial herb on shady slopes covered with primary broad-leaved evergreen forests on sandstone, granite and quartzite at elevation 1500–2200 m a.s.l. Locally very common. Flowering October–December.

**Distribution:**—Northwestern Vietnam (Lao Cai province, Sapa town Area). Southern China (SE. Yunnan).

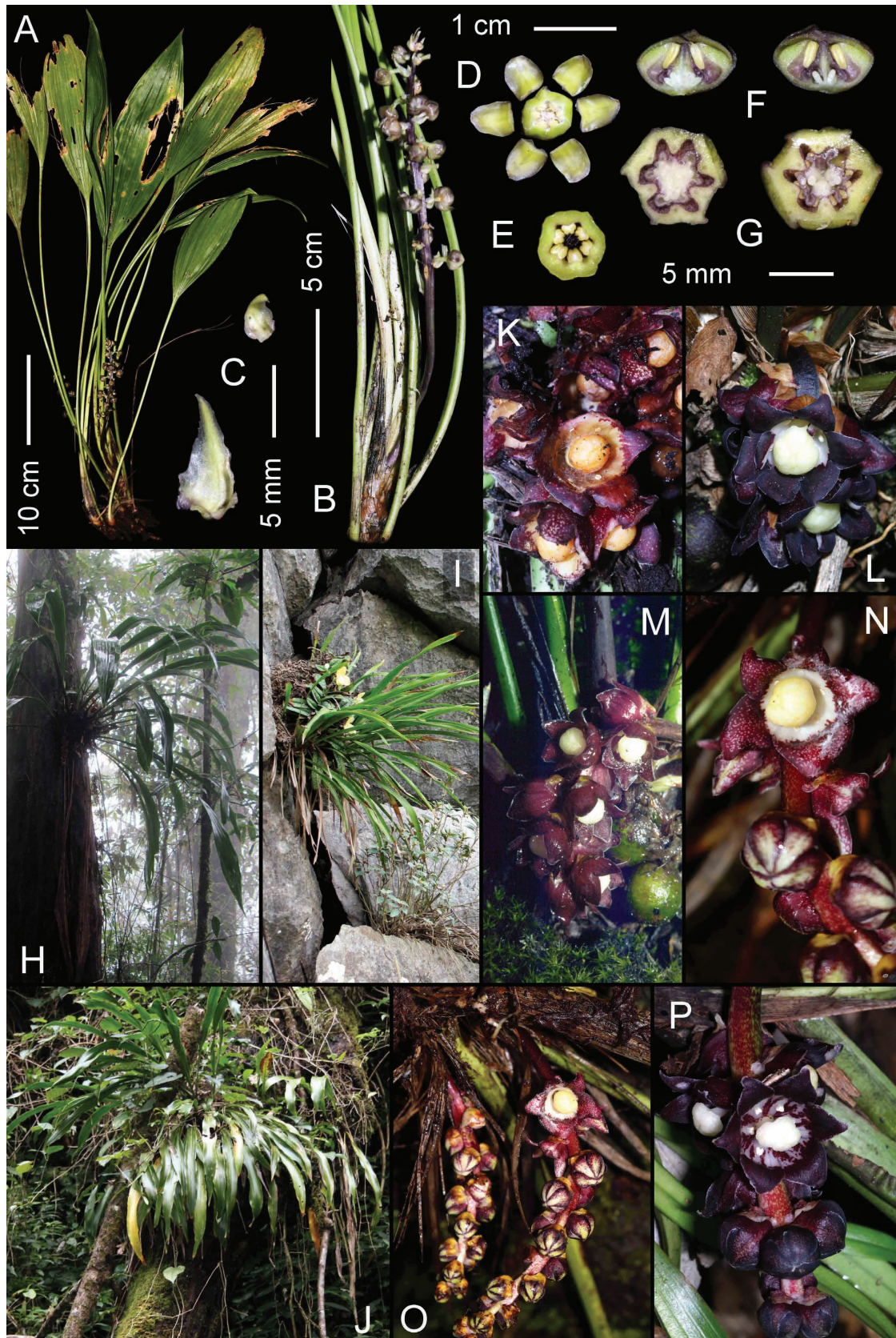
**Notes:**—The plants from northern Vietnam previously reported as *Peliosanthes yunnanensis* in Averyanov (2011) were later recognized as a new species—*P. grandiflora* Averyanov & Tanaka (2012: 156). In our survey in Sapa town area of Lao Cai province, we found plants referable to *P. yunnanensis* (new record). This species occurs there as a typical understory herb of the highland broad-leaved mountain forests spreading over the Hoang Lien Son Range at elevations 1500–2200 m a.s.l.

*Tupistra fungilliformis* F.T.Wang & S.Yun Liang in Liang (1978: 249, pl. 5, f. 1–4), Liang & Tamura (2000: 240), s.l. (Fig. 4H–P).

**Type:**—CHINA. Yunnan, Ping-bien, Bai-jwu-chien, 13 December 1939, *C.W. Wang* 83061 (holotype, PE [349272—00035390]!).

Paratype:—CHINA. Yunnan, Mar-li-po, 3 January 1940, *C.W. Wang* 86158 (PE [286792—00593230]!).

**Studied samples:**—VIETNAM. Cao Bang province, Bao Lac district, Hong An municipality, Mi Lung village, primary broad-leaved and mixed humid evergreen forest along rocky ridge composed of solid crystalline highly eroded limestone, 1500–1550 m a.s.l., 22°49'15.4" N 105°49'53" E, epiphyte on old tree in shady humid karst funnel, dull yellow to almost white, perigone segments dirty purple-brown, anthers and stigma dull yellowish, very rare, 21 November 2014, *L. Averyanov et al.*, CPC 7576 (Herbarium of the Center for Plant Conservation, Hanoi, LE!, LE—photo), fig. 4J, K; Cao Bang province, Bao Lac district, Dinh Phung municipality, Ban O village, primary mixed and coniferous evergreen humid forest on mountain tops composed of solid highly eroded limestone, 1200–1300 m a.s.l., 22°45'24.8" N 105°46'47.9" E, terrestrial and lithophytic herb on steep rocky slope, fruits green with purple marks, very common, 24 November 2014, *L. Averyanov et al.*, CPC 7640 (Herbarium of the Center for Plant Conservation, Hanoi, LE—photo); Ha Giang province, Quan Ba district, Bat Dai Son municipality, Bat Dai Son protected area, on limestone ridge of degraded forest, 13°09'13" N 104°59'36" E, 1064 m, rare, lithophytic, bracts on young shoots green with red, outer bracts brown, red at base, tepals with white spot at base inside; anther dull white-yellow, fruit



**FIGURE 4.** *Peliosanthes yunnanensis*: A. Flowering plant. B. Inflorescence. C. Bract and bracteole. D. Flattened flower. E. Corona, transversal section, view from below. F. Flower, sagittal section. G. Flower and ovary, transversal section. Different morphological forms of *Tupistra fungilliformis* s.l.: H–J. Plant habit (H–N.Q. Hieu *et al.*, CPC 4967; I–N.S. Khang, NSK 517; J–L. Averyanov *et al.*, CPC 7576). K–P. Inflorescences and flowers (K–L. Averyanov *et al.*, CPC 7576; L–L. Averyanov *et al.*, HAL 8577; M–D.K. Harder *et al.*, DKH 6057; N, O–N.S. Khang, B.H. Quang, NSK 817; P–N.T. Hiep *et al.*, HAL 9729). All photos by N.S. Khang and L. Averyanov, correction and design by L. Averyanov.



dull green, fruit flesh white, 10 February 2001, *D.K. Harder et al.*, *DKH 6057* (HN, MO!, LE—photo), fig. 4M; Ha Giang province, Meo Vac district, Pa Vi municipality, Pa Vi Thuong village, 23°11'05" N 105°24'04" E, 1450 m a.s.l., remnants of coniferous forest on rocky tops of remnant ridges composed of highly eroded marble-like limestone, lithophytic herb, flowers black-violet, stigma white, fruits green with dirty-violet tint, not common, 13 December 2005, *L. Averyanov et al.*, *HAL 8577* (Herbarium of the Center for Plant Conservation, Hanoi, MO, LE—photo), fig. 4L; Ha Giang province, Quan Ba district, Tung Vai commune, Thang village, Suoi Can Mountain, 23°03'14" N 104°50'54" E, 1390 m a.s.l., limestone primary broad-leaved evergreen closed forest, epiphytic herb, occasionally, 11 April 2013, *N.Q. Hieu et al.*, *CPC 4919* (Herbarium of the Center for Plant Conservation, Hanoi, LE—photo); Ha Giang province, Quan Ba district, Tung Vai commune, Thang village, 23°03'16" N 104°50'28" E, 1345 m a.s.l., limestone primary broad-leaved evergreen closed forest, epiphytic perennial herb, occasional, 13 April 2013, *N.Q. Hieu et al.*, *CPC 4967* (Herbarium of the Center for Plant Conservation, Hanoi, LE—photo), fig. 4H; Ha Giang province, Bac Me district, Phiang Luong municipality, Phiang Day village, degraded primary broad-leaved humid evergreen forest along rocky canyon of small stream at the base of mountains composed of solid crystalline highly eroded limestone, 900–1000 m a.s.l., 22°38'43.8" N 105°19'19.8" E, epiphytic herb on old mossy tree on steep stream slope, fruits dark green, very rare, 14 November 2014, *L. Averyanov et al.*, *CPC 7464* (Herbarium of the Center for Plant Conservation, Hanoi, LE—photo); Ha Giang province, Quan Ba district, Can Ty commune, Dau Cau 1 village, around point 23°05'45.1" N, 105°01'02.7" E, 1050 m a.s.l., primary evergreen mixed forest at the top of rocky limestone mountain, epiphytic, very rare, 17 December 2016, *N.S. Khang et al.*, *VP 24* (HN, LE—photo); Lao Cai province, Bat Xat district, Y Ty commune, Nheu Co San Mountains, primary mixed forest on slopes of sandstone mountain, 2000 m a.s.l., 22°36'34.3 N 103°37'29.3 E, epiphyte on big tree, flower red-purple with small white dots inside petal and large white pattern along the triangular petals outside, stigma globose, yellow, very rare, 26 October 2016, *N.S. Khang, B.H. Quang, NSK 817* (HN, LE—photo), fig. 4N, O; Son La province, Thuan Chau district, Co Ma municipality, Hua Ty village, Copia nature reserve, 21°20'07" N 103°35'07" E, remnants of primary coniferous forest on rocky tops of ridge composed of clay shale, 1500–1600 m a.s.l., epiphyte on tall tree, flowers dirty purple-violet, fruits dark dirty green, not common, 12 November 2006, *N.T. Hiep et al.*, *HAL 9729* (HN, MO, LE—photo), fig. 4P; Thanh Hoa province, Yen Dinh district, Quy Loc commune, around point 20°03'41.2" N 105°33'32.8" E, 105 m a.s.l., scattered under scrub or on cliffs of evergreen broad-leaved lowland forests on limestone, common, 25 April 2013, *N.S. Khang, NSK 517* (HN, LE—photo), fig. 4I.

**Habitat and phenology:**—Primary and old secondary broad-leaved and coniferous humid forests (with *Fokienia*, *Nageia*, *Pinus*, *Podocarpus*, *Pseudotsuga*, *Tsuga* and *Xanthocyparis*) preferably on highly eroded rocky limestone, rarely on shale and sandstone, at elevations (100)1000–1800(2000) m a.s.l. Large epiphytes or clustering lithophytes, rarely terrestrial herbs, common on moist rocky steep slopes, often on exposed mossy rocks near mountain tops or along streams in ravines. Rare. Flowering October–February.

**Distribution:**—Northern Vietnam, provinces: Cao Bang (Bao Lac district), Ha Giang (Bac Me, Meo Vac and Quan Ba districts), Lao Cai (Bat Xat district), Son La (Thuan Chau district) and Thanh Hoa (Yen Dinh district). Southern China (SE Yunnan).

**Notes:**—Plants identified here as *T. fungilliformis* from Vietnam (new record) are highly variable especially in the color of perigone (purple or blackish purple), whitish pattern of the inside of perigone tube, and the shape, color, and size of stigmas relative to open campanulate perigone (Fig. 4K–P). The stigmas tend to considerably shrink with ageing. Further studies on the variation of this species are needed.

*Tupistra gracilis* Averyanov & N. Tanaka, *sp. nov.* (Fig. 5).

**Type:**—VIETNAM. 22 November 2016, *L. Averyanov, CPC 6721a* (holotype, LE!). Type specimen prepared from cultivated plant originally collected in northwestern Vietnam (Thanh Hoa province, Thuong Xuan district, Bat Mot municipality, Duc village, Xuan Lien Natural Reserve, primary broad-leaved evergreen forest on rocky, highly eroded, crystalline limestone at elevation 800–1000 m a.s.l. around point 20°01'11.6"N, 104°57'47.5"E, 4 November 2013, *L. Averyanov, N.T. Hiep, N.S. Khang, N.D. Thang, L.V. Tien, CPC 6721*).

Terrestrial and lithophytic rosulate perennial rhizomatous herb. Rhizome thick, creeping, ascending at apex, usually simple, terete, stout, yellowish–brown, (5–)10–25(–40) cm long, Ø (2–)2.5–3(–3.5) cm, covered with black, coriaceous or papyraceous, partially disintegrated remnants of bracts and leaf sheaths. Roots sparse, cord-like, almost straight in basal part, fleshy, Ø (5–)6–8(–10) mm, densely covered throughout with white to light gray root hairs. Stem erect, short, (3–)4–6(–10) cm long, covered with distichous, conduplicate leaf bases and cataphylls. Cataphylls straight,

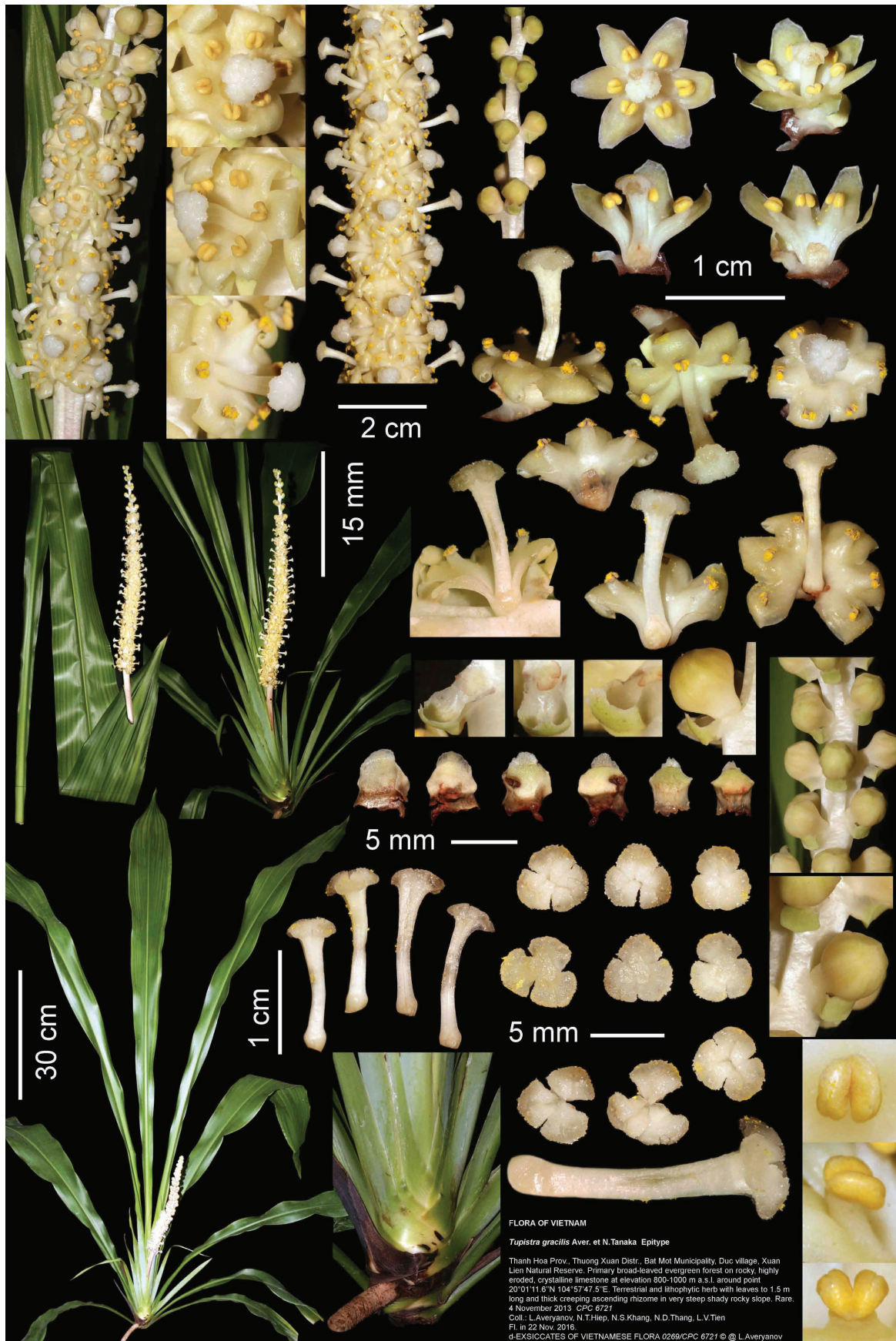


FIGURE 5. *Tupistra gracilis*. Digital epitype, L. Averyanov, CPC 6721a. Photos, correction and design by L. Averyanov.

ensiform, acute, (6–)8–20(–22) cm long, (0.4–)0.5–1.5(–2) cm wide (when flattened), base abruptly widened to 6 cm wide, conduplicate, light green, slightly glaucous, soon becoming dry, coriaceous or papyraceous, and almost black, withering earlier than foliage leaves. Leaves (5–)6–8(–10), basal, erect to oblique, equitant, indistinctly petiolate, narrowly oblanceolate, gradually tapering to rigid, canaliculate, petiole-like base, acute at apex, (0.6–)1–1.4(–1.6) m long, (4–)7–9(–11) cm wide, rigid, leathery, uniformly green, glossy, midvein strongly prominent abaxially, persistent 2 or more years. Peduncle arising from apical part of stem, axillary, erect, straight, becoming slightly thicker upward, irregularly angled, naked, fleshy, rigid, (4.5–)6–7(–8) cm long, Ø (4–)5–6(–7) mm (Ø 3–4 mm when dry), white with pink tint. Inflorescence a dense spadix-like spike of many flowers, (20–)22–26(–30) cm long, Ø 1.5–2.5 cm; rachis irregularly several-angled longitudinally, fleshy, with shallow flower pits. Floral bracts (usually) 1 per flower, lying below flower, bail-shaped, rather fleshy, white or greenish, transversely rectangular, during anthesis 3.5–4 mm long and wide, truncate to acute at apex, in fruit becoming dry, black, coriaceous. Flowers many, sessile, shallowly campanulate, broadly open, (0.8–)1–1.2(–1.4) cm across; perigone 6-cleft distally, dull yellowish, fleshy, the proximal syntepalous (tubular) part 2–2.5 mm long (high), the distal segments triangular ovate, obtuse, flat, strongly recurved apically, (2.8–)3–4(–4.2) mm long and wide. Stamens 6; filaments shortly cylindrical, slightly incurved, 1–1.2 mm long, Ø 0.8–1 mm, fleshy, dull yellowish; anthers positioned at sub basal portion of perigone segments, dorsifixed, broadly ovoid, (0.8–)0.9–1(–1.1) mm long and wide, rich yellow. Pistil mushroom-shaped, usually slightly ascending, (9–)10–12(–14) mm long. Ovary externally indistinct, slightly inflated and broader than style, glossy, 1.5–1.8 mm long and wide, 3-loculed, each locule with 1–2 ovoid ovules on axial placentae. Style columnar, slightly broadened upward, (8–)9–10(–11) mm long, Ø (0.8–)0.9–1(–1.8) mm, white to dull yellowish, much exceeding anthers in height. Stigma white to slightly yellowish, almost circular or obscurely 3-lobed, convex, papillulate, Ø (3.4–)3.5–4.5(–5) mm, irregularly splitting into 3 lobes at late stage of anthesis. Fruit berry-like, indehiscent.

**Etymology:**—The specific epithet refers to the slender, elegant spike.

**Habitat and phenology:**—Primary and secondary broad-leaved evergreen forests on rocky, highly eroded, crystalline limestone at elevations 800–1000 m a.s.l. Terrestrial and lithophytic herb on shady rocky steep limestone slopes. Plant sometimes grows on ground of rocky slopes covered by rather open forests and in large pockets filled with soil, namely not truly epilithic. Flowering in November–December.

**Distribution:**—Northern Vietnam (Thanh Hoa province, Thuong Xuan district). Local endemic of northern Vietnam.

**Taxonomic relationships:**—*Tupistra gracilis* is close to *T. khangii* Averyanov, N.Tanaka & Vislobokov in Vislobokov *et al.* (2014: 288), but differs in its stronger preference for limestone areas (vs. non-limestone areas) and by the creeping rhizome (vs. erect, suberect or ascending rhizome), slenderer spike of slightly smaller, yellowish flowers subtended (usually) by one bract (vs. two), and smaller stigmas, Ø 3.4–5 mm (vs. Ø 5.5–7 mm). It also resembles *T. hongheensis* Hu & Li (2013: 230) described from southern Yunnan, China (Hu *et al.* 2013), but is distinguishable by the shorter rhizome to 0.4 m long (vs. to 1 m), longer spike 20–30 cm long (vs. 11–13 cm), flowers subtended by a single bract (vs. 2 bracts per flower, including 1 bracteole), shorter proximal tubular part of perigone to 2.5 mm high (vs. 4 mm high), shorter perigone segments 2.8–4.2 mm long (vs. 7–8.5 mm long), and slightly smaller stigmas to Ø 5 mm (vs. Ø 6–7 mm).

## Supplemental data for a recently described species

*Tupistra patula* Averyanov *et al.* (2016a: 34, Fig. 3h–m & 7). (Fig. 6).

**Type:**—VIETNAM. Ha Giang province, Bac Me district, Thuong Tan municipality, humid primary forest of evergreen broad-leaved trees on very steep slopes and along rocky ridge composed of solid crystalline highly eroded limestone at elevations 1200–1285 m a.s.l. around point 22°38'19.0" N, 105°17'06.5" E, not common, 16 November 2014, L. Averyanov, T.H. Nguyen, K.S. Nguyen, T. Maisak, L. Osinovets, CPC 7492 (holotype, Herbarium of the Center for Plant Conservation, Hanoi!; isotype, LE!).

**Studied specimens:**—VIETNAM. Ha Giang province, Quan Ba district, Tung Vai commune, Ban Thang village, secondary evergreen broad-leaved forest on rocky limestone mountain, under shaded places around point 23°03'18.8" N, 104°52'51.6" E, at elevation of 1100 m a.s.l., terrestrial or lithophytic perennial herb, flower white-purple, not common, 27 December 2016, N.S. Khang *et al.*, NSK 845, Fig. 6 (HN!); Ha Giang province, Quan Ba district, Can Ty commune, Dau Cau 1 village, around point 23°05'27.3" N, 105°01'02.9" E, at elevation of 1120 m a.s.l., primary



FIGURE 6. *Tupistra patula*. Digital epitype, N.S. Khang et al., NSK 845. Photos, correction and design by L. Averyanov.

evergreen broad-leaved forest mixed with conifers (*Xanthocyparis vietnamensis*, *Nageia fleuryi*, *Pseudotsuga sinensis*, *Calocedrus rupestris*) at the top of rocky limestone mountain, usually in shaded places at the base of mountains, terrestrial or lithophytic perennial herb; inflorescence white-purple, tepals dull-green at tip and white at base when young, and dull-yellowish to white when old, common, 16 December 2016, *N.S. Khang et al.*, VP 21 (HN!); Ha Giang province, Quan Ba district, Can Ty commune, Dau Cau 1 village, around point 23°05'27.2" N, 105°01'03.0" E, at elevation of 1160 m a.s.l. Primary evergreen broad-leaved forest mixed with conifers (*Xanthocyparis vietnamensis*, *Nageia fleuryi*, *Pseudotsuga sinensis*, *Calocedrus rupestris*) at the top of rocky limestone mountain, usually in shaded places at the base of mountains, terrestrial or lithophytic perennial herb; inflorescence white-purple, tepals dull-green at tip and white at base when young, and dull-yellowish to white when old, common, 16 December 2016, *N.S. Khang et al.*, VP 22 (HN!); Ha Giang province, Quan Ba district, Can Ty commune, Dau Cau 1 village, around point 23°05'45.1" N, 105°01'02.7" E, at elevation of 1050 m a.s.l., primary evergreen broad-leaved forest mixed with conifers (*Xanthocyparis vietnamensis*, *Nageia fleuryi*, *Pseudotsuga sinensis*, *Calocedrus rupestris*) at the top of rocky limestone mountain, usually in shaded places at the base of mountains, terrestrial or lithophytic perennial herb; inflorescence white-purple, tepals dark brown to black when dried, common, 17 December 2016, *N.S. Khang et al.*, VP 25 (HN!); Ha Giang province, Quan Ba district, Thanh Van commune, Ma Hong village, around point 23°06'24.1"N, 104°58'42.1"E, at elevation of 1000 m a.s.l., primary evergreen broad-leaved forest of rocky limestone mountain, in shaded places at base of mountains, terrestrial or lithophytic perennial herb; inflorescence white-purple, tepals dark brown to black when dried, not common, 18 December 2016, *N.S. Khang et al.*, VP 031 (HN!); Ha Giang province, Quan Ba district, Can Ty commune, Dau Cau 1 village, around point 23°06'20.5" N, 105°01'04.5" E, at elevation of 1100 m a.s.l., Primary evergreen broad-leaved forest mixed with conifers (*Xanthocyparis vietnamensis*, *Nageia fleuryi*, *Pseudotsuga sinensis*, *Calocedrus rupestris*) at the top of rocky limestone mountain, in shaded places at the middle of mountains, terrestrial or lithophytic perennial herb; inflorescence white-purple, tepals dark brown to black when dried, very common, 19 December 2016, *N.S. Khang et al.*, VP 52 (HN!).

**Habitat and phenology:**—Primary and secondary evergreen broad-leaved, mixed and coniferous forests (with *Xanthocyparis vietnamensis*, *Nageia fleuryi*, *Pseudotsuga sinensis*, *Calocedrus rupestris*) on rocky solid highly eroded karstic limestone at elevations 1100–1300 m a.s.l. Lithophytic herb on mossy rocks on rocky steep slopes, often in shady and humid places. Flowering in October–December.

**Distribution:**—Northern Vietnam (Ha Giang province, Bac Me & Quan Ba districts). Local endemic to northern Vietnam.

**Notes:**—The original description of *Tupistra patula* was based on specimens with rather aged inflorescences. The perigone was reported as dull yellow (Averyanov *et al.* 2016a). In December 2016, we collected plants of this species again at several localities in Ha Giang province, northern Vietnam. Some of the plants had a small number of floral buds on the distal part of their inflorescence rachis. The buds were white proximally, dull greenish purple distally. The perigones of young fully open flowers were, internally, white proximally and pale green distally including segments, externally white slightly tinged with purple proximally, dull greenish purple distally. Anther-sacs and pollen were yellow. Somewhat faded flowers passing their peak had dull whitish beige perigones (externally slightly tinged with purple). With fading the perigones turn to be darker, and eventually become blackish (Fig. 6; Averyanov *et al.* 2016a). The styles and stigmas were more or less whitish at the early and middle stages of flowering, but later, through beige stages, turn to be darker, as in perigones. The flowering stems were more or less erect and straight, hence the sigmoid, outspreading floriferous stem reported earlier (Averyanov *et al.* 2016a) appears not to be a stable characteristic of this species. All collections hitherto made indicate that the distribution range of this species is confined to Ha Giang province, northeastern Vietnam.

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