A REVISION OF *PEGAEOPHYTON* (*BRASSICACEAE*)

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As delimited here, *Pegaeophyton* is a Sino-Himalayan genus of six species of which three, *P. angustiseptatum* (China), *P. watsonii* (India, Sikkim) and *P. sulphureum* (Bhutan), are described as new. *P. scapiflorum* var. *robustum* is raised to subspecific rank. Keys, detailed descriptions, and distributions are given. The affinities of *Pegaeophyton* are discussed.

Keywords. New taxa, *Pegaeophyton*, *Pycnoplinthopsis*, *Pycnoplinthus*, Sino-Himalaya.

INTRODUCTION

The initial goal of the present study was to prepare a brief account of the two known Chinese species of the genus *Pegaeophyton*, *P. scapiflorum* Hook. f. & Thoms. and *P. minutum* H. Hara, for the forthcoming revision of the *Brassicaceae* for the Flora of China. Examination of all the available material in the major European, North American, and Chinese herbaria showed that previous accounts of the genus were unsatisfactory, and prompted the present revision.

Pegaeophyton consists of Sino-Himalayan perennials with the following characters: caudex well developed; leaves in basal rosettes; flowers solitary, borne on long pedicels originating from the centre of the rosette; fruits eseptate, with a flattened replum. This character combination readily distinguishes the genus from *Braya* Sternb. & Hoppe and *Cochlearia* L., the two genera in which the first described species of *Pegaeophyton* has also been placed. Both *Braya* and *Cochlearia* have cauline leaves, distinct corymbose inflorescences, and fruits with a complete septum and terete replum. Furthermore, *Pegaeophyton* has equal filaments that are distinctly dilated at the base and purplish anthers, whereas the other genera have unequal filaments that are slender at the base and usually yellowish anthers. *Pegaeophyton* has accumbent cotyledons as do most species of *Cochlearia*, whereas in *Braya* they are incumbent. In my opinion, *Pegaeophyton* is unrelated to these genera.

Handel-Mazzetti (1922) suggested that *Pegaeophyton* is allied to the cosmopolitan *Cardamine* L., and Schulz (1936) and subsequent workers have placed the genus in the tribe *Arabideae*. The affinity of *Pegaeophyton* to *Cardamine* is supported by molecular studies (Price, pers. comm.). Two other Himalayan genera, *Pycnoplinthus* O. E. Schulz and *Pycnoplinthopsis* Jafri, resemble *Pegaeophyton* in having solitary flowers arising from the centre of a basal rosette, but they differ in the characters summarized in Table 1.

Although the three genera are closely related, *Pycnoplinthus* and *Pycnoplinthopsis* appear to be more closely related to each other than to *Pegaeophyton*.

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TABLE 1. Diagnostic characters of *Pegaeophyton*, *Pycnoplinthopsis* and *Pycnoplinthus*

Character	*Pegaeophyton*	*Pycnoplinthopsis*	*Pycnoplinthus*
Trichomes	Simple or absent	Branched	Absent
Petiole	Usually caducous	Caducous	Persistent, corky
Anthers	Obtuse	Apiculate	Obtuse
Median nectaries	Present	Absent	Absent
Replum	Flattened	Obtuse	Obtuse
Septum	Absent	Complete, 1-veined	Complete, 3-veined
Cotyledons	Accumbent	Incumbent	Incumbent
Gynophore	Short, or absent	Absent	Absent

Pegaeophyton Hayek & Handel-Mazzetti, Anzeig. Akad. Wiss. Wien, Math.-Nat. 59: 245 (1922).
Type: *Pegaeophyton sinense* (Hemsley) Hayek & Handel-Mazzetti, Anzeig. Akad. Wiss. Wien, Math.-Nat. 59: 246. 1922. (= *P. scapiflorum* (Hook. f. & Thoms.) C. Marquand & Airy Shaw, J. Linn. Soc., Bot. 48: 229. 1929).

Perennial herbs; caudex simple to many branched, somewhat fleshy. *Trichomes* absent or simple, sometimes papillose. *Stems* reduced to tiny portions added annually to apex of caudex or its branches. *Leaves* rosulate at apex of caudex or its branches, somewhat fleshy or not, simple, entire or toothed; petioles distinct, sometimes persistent, slightly flattened at base. *Flowers* borne singly on long pedicels from axils of rosette leaves. *Fruiting pedicels* slender, terete, ascending, straight, or reflexed in geocarpic taxa. *Sepals* broadly ovate to ovate or oblong, free or united, deciduous or rarely persistent, ascending to spreading, glabrous or pubescent, equal, margin membranous, base not saccate. *Petals* white, lavender, pink, purple, blue, or rarely bright yellow, sometimes with greenish centre or with veins darker in colour than rest of blade, ascending, longer than sepals; blade broadly obovate or suborbicular, rarely spatulate, rounded or subemarginate at apex; claw absent or obscurely distinct from blade. *Stamens* 6, included, erect to spreading, subequal; filaments filiform, dilated at base; anthers ovate to oblong, sagittate at base, obtuse at apex. *Nectar glands* confluent, subtending bases of all stamens, well developed around lateral stamens. *Ovules* 2–30. *Fruit* dehiscent, silicles oblong, ovate, orbicular, ovoid, or globose, terete or slightly to strongly flattened and latiseptate or angustiseptate, geocarpic or not; valves membranous or papery, not or obscurely veined, keeled or not, smooth, glabrous or pubescent; replum flattened; septum absent; gynophore absent or to 5mm long; style obsolete to distinct and to 3mm long, subconical; stigma discoid, entire. *Seeds* 1–24 per fruit, uniseriate, wingless, oblong, ovate, or suborbicular, plump or flattened; seed coat obscurely reticulate, not mucilaginous when wetted; cotyledons accumbent.

Key to species

1a. Fruit angustiseptate, geocarpic; valves ± carinate; fruiting pedicel strongly recurved; replum narrow; gynophore absent or obsolete ——— 2

1b. Fruit subterete to latiseptate; valves flat; fruiting pedicel usually straight; replum broadly flattened; gynophore present ——— 3

2a. Sepals free, membranous at margin; petioles not ciliate; fruit sparsely papillose apically, 4–5mm wide; style 1.5–2mm long; fruiting pedicel to 7cm long; leaves entire or minutely toothed, 2–10mm wide ——— **4. P. angustiseptatum**

2b. Sepals united, membranous throughout; petioles ciliate; fruit densely puberulent throughout, 1.5–2mm wide; style 0.1–0.4mm long; fruiting pedicel to 1.5cm long; leaves coarsely dentate or rarely entire, 0.5–2mm wide ——— **5. P. watsonii**

3a. Fruiting pedicel pubescent along one side, persisting for more than one season; fruit narrowly oblong, length 3–5 × width; sepals apically ciliate ——— **1. P. minutum**

3b. Fruiting pedicel glabrous or distally pubescent on all sides, not persistent; fruit oblong, ovate, orbicular, ovoid, to subglobose, length 1–1.5(–2) × width; sepals not ciliate ——— 4

4a. Flowers bright yellow; style (1–)1.5–2 × longer than rest of fruit; sepals persistent ——— **6. P. sulphureum**

4b. Flowers white to lavender or blue; style shorter that rest of fruit; sepals caducous ——— 5

5a. Fruit oblong, orbicular, to ovate, flattened, valves papery; sepals (2–)2.5–6(–10)mm long; petals (3.5–)5–12(–15)mm long; seeds flattened, 1.5–4(–5) × 1–3(–4)mm ——— **2. P. scapiflorum**

5b. Fruit ovoid to subglobose, valves membranous; sepals 1.1–1.3mm long; petals 1.6–2(–2.5)mm long; seeds plump, 1–1.1(–1.3) × 0.5–0.6(–0.8)mm ——— **3. P. nepalense**

1. Pegaeophyton minutum H. Hara, J. Jap. Bot. 47: 270 (1972). Type: India. Sikkim, Oma La-Migothang, c.4200m, 30 v 1960, *H. Hara, H. Kanai, G. Murata, M. Togashi & T. Tuyama* 6344 (holo. TI!; iso. MO!, TI!).

Syn.: *Pegaeophyton garhwalense* H.J. Chowdhery & Surendra Singh, Indian J. Forestry 8: 335 (1985). Type: India. Uttar Pradesh-Garhwal, on way to Vasukital, 3800m, 12 viii 1968, *M.A. Rau* 38676 (holo. CAL, *n.v.*).

Caudex slender, sympodially branched, 0.75–2mm diam. *Leaves* 3–12 per caudex or caudex branch; petiole (3–)5–10(–15)mm long, base 1–1.5mm wide; blade obovate, spatulate, ovate, oblong, to oblanceolate, 1–4(–5)mm long, (0.5–)1–1.5(–2)mm wide, somewhat fleshy, adaxially sparsely puberulent along blade and petiole with trichomes 0.02–0.08mm long, abaxially or rarely both surfaces glabrous, base cuneate to subattenuate, margin entire, apex obtuse to subrounded. *Flowers* (1–)3–10 per caudex branch; floral parts caducous after anthesis. *Pedicels* slender, puberulent with trichomes 0.02–0.08mm along one side of entire length, 0.5–1(–1.5)cm at anthesis;

fruiting pedicels (1–)1.5–2.5(–4)cm long, 0.2–0.4mm wide, persistent for another season. *Sepals* broadly ovate, 1.2–2mm long, 0.8–1.2mm wide, free, ascending, not saccate, glabrous, obtuse, membranous margin 0.05–0.15mm wide, distal margin ciliate with flattened hairs to 0.05mm long. *Petals* white to lilac or violet, broadly obovate to suborbicular, (1.5–)2–3(–4.5)mm long, 1.5–2.5(–3)mm wide, tapering to claw-like base 0.7–1.5mm long. *Filaments* erect, white, greatly dilated at base, (0.9–)1–1.5mm long; anthers purple, broadly ovate to suborbicular, 0.3–0.4mm long, sagittate at base. *Nectar glands* well developed, confluent. *Ovules* 6–10. *Fruit* latiseptate, not geocarpic, narrowly oblong, 3–5mm long, 1–1.2mm wide; valves nearly flat, extending along part of fruit length; gynophore 0.25–0.5mm long; style 0.3–0.4mm long. *Seeds* broadly ovate, brown, plump, 3–5 per fruit, 1–1.2mm long, 0.6–0.7mm wide.

Specimens examined. BHUTAN. Shingbe, Me La, *Ludlow, Sherriff & Hicks* 20764 (BM).

CHINA. Xizang: Sources of the Irrawaddy, Adung Valley, 28°20′N, 97°40′E, *Kingdon-Ward* 9774 (BM).

INDIA. Sikkim: Chapopla, *Ribu & Rhomoo* 5252 (K); West District, Bikbari, E slopes of Choktsering Chhu valley, 27°30′N, 88°08′E, *Long, McBeath, Noltie, & Watson* 318 (CAS, E); West District, N of Chemthang, E side of Onglakthang Glacier, 27°34′N, 88°11′E, *Long, McBeath, Noltie, & Watson* 656 (E); Lamcho, vii 1888, *King s.n.* (E); Mingbil, *Smith* 4074 (E); Tankra Mt., *Gammie* 555 (E); Dobinda Pass, *Cooper* 339 (E); Yampung, *Ribu & Rhomoo* 870 (E). Uttar Pradesh: Garhwal Himalaya, 15 vii 1994, *Rawat s.n.* (TI).

MYANMAR. Chawchi Pass, *Farrer* 1688 (E).

NEPAL. Kasuwa Khola, N of Num, *Stainton* 586 (A, BM, TI); Inukhu Khola, Naulekh Muni, *McCosh* 388 (BM, TI); Dudh Kosi, Puiyan, *Bowes Lyon* 2088 (BM, TI); near Chalike Phar, *Stainton, Sykes & Williams* 3147 (BM); Thahurji Lekh, S of Jumla, *Polunin, Sykes & Williams* 4805 (BM, TI); Lamjung Himal, *Stainton, Sykes & Williams* 6308 (BM); Mul Kaarka, Chilime Khola, *Kanai & Shakya* 672270 (TI); ibidem, *Kanai & Shakya* 156 (TI); Ghopte, *Saman & Bista* 13219 (TI); Saju Pokari, *Kanai, Ohashi, K. Iwatsuki & H.Ohba, Z. Iwatsuki & Shakya* 720533 (TI); Banduke Pokhari, *Kanai, Ohashi, K. Iwatsuki, H.Ohba, Z. Iwatsuki & Shakya* 720514 (TI), upper W Ombula Chu valley, 27°50′N, 87°39′E, *Smith* 146 (BM); Chilime Kharka camp road, *Polunin* 1439 (BM).

Distribution and habitat. Bhutan, China, India, Myanmar, Nepal. On mossy wet ledges, hillsides, mossy granite boulders, steep grassy slope, mossy peat of scree; 3700–4500m. Flowering in late May through July.

Pegaeophyton minutum is readily distinguished from all other species of the genus by its slender, sympodially branched caudex, apically ciliate sepals, and pedicels retrorsely puberulent along one side. The narrowly oblong fruits might suggest placement in *Pycnoplinthus*, however, the lack of a septum and presence of a flattened replum and gynophore clearly support its inclusion in *Pegaeophyton*.

Some comments are required on the identity of *Pegaeophyton garhwalense*. Chowdhery & Singh (1985) stated that *P. garhwalense* has pubescent filaments, a feature not otherwise reported for any of the Himalayan *Brassicaceae* with solitary flowers. Their overall description, especially the measurements of flowers and leaves and 'fimbriate sepals', as well as the overall habit and branching reported by Rawat

et al. (1995), however, agree well with *P. minutum,* and it is almost certain that the two taxa are conspecific. It is surprising that *P. garhwalense* is omitted from the recently published *Flora of India* (Hajra & Chowdhery, 1993).

The branching of *Pegaeophyton minutum* is unique in the genus. As described by Rawat *et al.* (1995), at the end of growing season the caudex terminates in two buds surrounded by a dense rosette of leaves with distinct 'sheathing' bases. In the following growing season, one of the buds produces a determinate shoot that terminates in a rosette of leaves with non-sheathing bases from which few to several one-flowered scapes are produced. The other bud produces a dense rosette of leaves with sheathing bases from the axils of which two buds are produced to repeat the same growth cycle in the next growing season.

The record of *Pegaeophyton minutum* from Myanmar (Burma) is new, and based on a single Farrer collection from Chawchi Pass made on 3 July 1920. He also collected *P. scapiflorum subsp. robustum* from the Chinese (Yunnan) side of the pass.

2. Pegaeophyton scapiflorum (Hook. f. & Thoms.) C. Marquand & Airy Shaw, J. Linn. Soc., Bot. 48: 229 (1929). *Cochlearia scapiflora* Hook. f. & Thoms., J. Proc. Linn. Soc., Bot. 5: 154 (1861). *Pegaeophyton scapiflorum* (Hook. f. & Thoms.) O.E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 11: 229 (1931), *nom. illeg*. Lectotype (by Jafri, 1973): 'Himalaya orientali alpina, Sikkim interiore, alt. 15,000–17,000 ped.', *J.D. Hooker s.n.* (lecto. K!).

Caudex slender to stout, apically branched or unbranched, (0.1–)0.3–1.5(–3)cm diam. *Leaves* 6–40(–60) per caudex or caudex branch; petiole 1–8(–13)cm long, base 1.5–5mm wide; blade ovate, oblong, elliptic, obovate, spatulate, oblanceolate, to narrowly linear, (1–)1.5– 8(–10)cm long, 0.2–1.2(–2.5)cm wide, somewhat fleshy or not, glabrous or adaxially sparsely pubescent with trichomes 0.2–0.5mm long, abaxially glabrous, base cuneate to subattenuate, margin entire or 1–4 (or 5)-toothed on each side, sometimes minutely ciliate, the teeth blunt to acute, sometimes narrow and up to 5×1.5mm, apex obtuse to acute. *Flowers* 4–50(–70) per plant or caudex branch; floral parts usually caducous after anthesis. *Fruiting pedicels* slender to stout, glabrous or rarely sparsely pubescent apically all around with trichomes 0.2–0.5mm, (1.2–)2.5–15(–20)cm long, not persistent. *Sepals* ovate to oblong, (2–)2.5–6(–10)mm long, 1.5–3.5(–4.5)mm wide, free, ascending, not saccate, glabrous or sparsely pubescent, membranous margin 0.1–0.4(–0.5)mm wide, obtuse, not ciliate. *Petals* white to lavender or blue, sometimes white or creamy white with greenish or blue veins, broadly obovate to spatulate or suborbicular, (3.5–)5–12(–15)mm long, (1.5–)2–10(–13)mm wide, tapering to claw-like base (0.5–)1–3(–3.5)mm long. *Filaments* erect, white, dilated at base, (2.5–)3–5(–7)mm long; anthers oblong to narrowly so, (0.5–)1–1.5(–2)mm long, sagittate at base. *Nectar glands* well developed, confluent. *Ovules* 6–15. *Fruit* latiseptate, not geocarpic, oblong, ovate, to orbicular, (4–)5–13(–20)mm long, (2–)4–8(–10)mm wide; valves nearly flat, extending along part of fruit length, papery, glabrous; gynophore

(0.5–)2–5mm long; replum (0.1–)0.2–0.6(–0.8)mm wide; style 1–2(–3)mm long. *Seeds* broadly ovate, brown, flattened, (1–)3–10(–12) per fruit, 1.5–4(–5)mm long, 1–3(–4)mm wide.

1a. Petals (3.5–)5–7mm long, (1.5–)2–3(–3.5)mm wide, length (1.8–)2–2.5(–3) × width; caudex slender, few to many branched, sometimes simple and somewhat stout; seeds 1.5–2(–2.5)mm long, 1–1.6(–1.8)mm wide ——— **2a.** subsp. **scapiflorum**

1b. Petals (6–)8–12(–15)mm long, (5–)6–10(–13)mm wide, length (1–)1.2–1.5 × width; caudex stout, simple or rarely branched at apex; seeds (2–)2.5–4(–5)mm long, (1.5–)2–3(–4)mm wide ——— **2b.** subsp. **robustum**

2a. Pegaeophyton scapiflorum subsp. **scapiflorum**

Syn.: *Pegaeophyton scapiflorum* var. *pilosicalyx* R.L. Guo & T.Y. Cheo, Bull. Bot. Lab. North-East Forest Inst. 6: 28 (1980). Type: China. Tibet: alpine meadows of Woti la, N of Radja, 14000ft, vi 1926, *J. F. Rock* 14236 (holo. NAS!; iso. E!, GH!, K!, US!).

Dilophia sinuata Maximowicz, Fl. Tangut. 72 (1889). Syn. nov. Type: China. N Tibet, 24 v–6 vi 1884, *Przewalski s.n.* (holo. LE!).

Caudex slender, 1–8(–12)mm diam., few to many branched, sometimes simple and somewhat stout. *Petals* (3.5–)5–7mm long, (1.5–)2–3(–3.5)mm wide, length (1.8–)2–2.5(–3) × width. *Seeds* 1.5–2(–2.5)mm long, 1–1.6(–1.8)mm wide.

Specimens examined: BHUTAN. Waitang, Tsampa, *Ludlow & Sherriff* 19246 (BM, E, TI); Tolegang, Bumthang Chu, *Ludlow & Sherriff* 19028 (BM, E, TI); Pangte La, Paro Chu, *Ludlow & Sherriff* 16293 (BM, E, TI); Champa, Pumthang, *Cooper* 4789 (BM); Taasiegem, Pumthang, *Cooper* 4024 (BM, E); Yele La, Timpu, *Cooper* 1871(BM, E); below Yale La, *Kanai* et al. 7278 (MO, TI); below Tremo La, 23 vi 1966, *Nishioka s.n.* (TI).

CHINA. Gansu: Tangut, 1880, *Przewalski s.n.* (LE, P), *Przewalski* 382 (LE). Qinghai: Bayan Har Pass, border between Madoi Xian and Chindu Xian, on road between Madoi and Yushu, 34°8′N, 97°39′E, *Ho, Bartholomew, Watson & Gilbert* 1660A (CAS, MO); Yushu Xian, Go La, at pass S of Yushu on road to Ciao Surmang, 32°34′N, 97°13′E, *Ho, Bartholomew, Watson & Gilbert* 2241 (CAS); Maqin Xian, Nizhuoma Pass, Nizhuoma Xiang, between Maqin and Changmahe (Qamalung), 34°34′N, 99°27′E, *Ho, Bartholomew & Gilbert* 760 (CAS); Tangula Shan, Bi Qu Wenquan-Yanshiping, 33°31′N, 91°58′E, *Dickoré* 4153 (GOET); Tangula Shan pass, 32°53′N, 91°54′E, *G. & S. Miehe* 9443/6 (MO); Tangula Shan, 33°33′N, 91°50′E, *Dickoré* 4242 (MO); Suhurima Xiang, Jiuzhi Xian, *Canvas* 169 (CAS). Sichuan: N of Baurong and E of Yalung River, *Rock* 17779 (E, GH, K, NY, US, W); Mount Konka, Risonquemba, Konkaling, *Rock* 16342 (E, F, NY, US), *Rock* 16859 (GH, K, NY, US, W); Bada Xian, Nian Long Xian, *Jiangsu Inst. Bot. Depart.* 6654 (NAS). Xinjiang: Ruoqiang, Hasheklei River, *Wu, Ohba, Wu & Fei* 4137 (KUN, MO, TI); Kunlun, Pumepa, 24 vi 1894, *Roborowski s.n.* (LE); without locality, *Li & Qian* 11220 (PE). Xizang (Tibet): Baigoin Xian (Pubu), *Wu, Ohba, Wu & Fei* 2696 (KUN, MO, TI); Baingoin, Biyun Mt, N of Whale Lake, *Wu, Ohba, Wu & Fei* 2224 (KUN, MO, TI); Whale Lake, *Wu, Ohba, Wu & Fei* 4087 (KUN, MO, TI);

between Radja and Jupar, above Woti La, *Rock* 14396 (BM, GH, LE, P, W); Pulan Xian, lakeshore, *Qinghai-Xizang Expedition* 76–8544 (KUN); Biru Xian, *Tao* 11170 (KUN); vicinity of Lhasa, *Richardson* 50 (BM); Dawo, *Limpricht* 1975 (WU); Chumolari, *Rhomoo Lepcha* 513 (E); Nyenchengtang La, *Ludlow & Sherriff* 9677 (BM, E); S of Lhasa, *Ludlow & Sherriff* 8671 (BM); Cha La, N of Sanga Choling, *Ludlow & Sherriff* 1588 (BM, E); Du Chu valley, Pasho District, *Hanbury-Tracy* 20 (BM); without locality, *Strachey & Winterbottom* 6 (BM, GH, K, LE, P); Cho La, N side, *Ludlow & Sherriff* 20794 (BM, E); Byrkhan Budda, *Ladygin* 35, 35b (LE); Kam Plateau, 1893, *Potanin s.n.* (LE); Batang, *Soulié* 3562 (P); Nedong-Lhünze, upper Subansiri, Tsangpo-Subansiri pass, 28°38′N, 92°13′E, *Dickoré* 10383 (GOET); Nyainqentangula Shan, N of Damxung, 30°39′N, 91°5′E, *B. & S. Miehe* 9497/10 (GOET); Mekong-Salwin divide, *Forrest* 14110 (E, K, W); Namchabarwa, 29°35′N, 95°1′E, *Dickoré* 5293 (GOET); Mekong-Salween divide, pass E of Zogang/Wangda, 29°42′N, 98°0′E, *Dickoré* 8855 (MO). Yunnan: N flank of Haba Snow Range, *Feng* 2193 (A); E slopes of Likiang Snow Range, Yangtze watershed, *Rock* 8660 (E, GH, P, US, W); Likiang, Sweechan, *Delavay* 2436 (P); E flank of Lichiang Range, 27°35′N, *Forrest* 6225 (E, K).

INDIA. Arunachal Pradesh: Orka La, Bhutan Frontier, *Kingdon-Ward 13741* (BM). Sikkim: Tanka La, *Ribu & Rhomoo* 5030 (BM, E); above Changu, *Cooper* 32 (A, BM, E); without locality, 15,000–18,000ft, *Hooker s.n.* (BM, LE, W); Gamotang-Migotang, *Hara* et al. 6343 (MO, TI); North District, W side of Sebu La, 27°55′56″N, 88°39′01″E, *Long & Noltie* 391 (E); West District, near Goecha La, 37°36′N, 88°11′E, *Long, McBeath, Noltie & Watson* 606 (E); Alukthang, *Ribu & Rhomoo* 6613 (E); Yampung, 1 vii 1922, *Cave s.n.* (E), *Ribu & Rhomoo* 879 (E); Nathiu La, *Smith* 4552 (E).

MYANMAR. Taron Valley, 28°03′N, 98°02′E, *Kaulback* 144 (BM).

NEPAL. Bhurchula Lekh, near Jumla, *Polunin, Sykes & Williams* 4641 (BM, E, TI); Mukdem Khola, Chharkabhot, *Polunin, Sykes & Williams* 1178 (A, BM, E, P); near Jangla Bhanjyang, *Polunin, Sykes & Williams* 2340 (A, BM, E, K, TI); NE of Chalike Pahar, *Stainton, Sykes & Williams* 3112 (A, BM, E, P); Chalike Pahar, *Stainton, Sykes & Williams* 4538 (BM); Gosainkund, *Kanai, Hara & Ohba* 721915 (TI); Gossainkunde upper lake, *Maser* 211 (US); S of Himal Chuli, Dudh Pokhari, 28°20′N 84°30′E, *Stainton* 7365 (BM, TI); Arun Valley, Thudam, E of Chyamtang, *Stainton* 369 (A, BM, E, K, TI); Rambrong, Lamjung Himal, *Stainton, Sykes & Williams* 6135 (BM, E); W of Hongu Khola and Mera, 27°30′N 86°45′E, *McCosh* 373 (BM, E, TI); Rato Pokhari, *Shrestha & Joshi* 309 (BM); Lari, 28°14′N 85°11′E, 7 vii 1974, *Yon s.n.* (BM), Dudh Kund, 27°43′N 86°36′E, *Bowes Lyon* 2004 (BM); Makalu, Barun Valley, *Swan* 25 (CAS); Banduke Pokhari (Duo Tulo Pokhari), *Kanai* et al. 720398 (TI); Topke Gola, *Kanai* et al. 720809 (TI); Phujeng La, *Kanai* et al. 720813 (TI); near Nepal-Tibet border, Makalu Barun National Park, *Tsukaya* 68 (MO).

PAKISTAN. Kashmir: above Tsalezhun Tso, Ladak, *Koelz* 2416C (US); Polokonka La, Rupshu, *Koelz* 2152 (US); Khardong La, *Ludlow & Sherriff* 8415 (BM, E); Khardong Pass, *Burt* 131 (E).

Distribution and habitat. Bhutan, China, India, Myanmar, Nepal, Pakistan. In alpine tundra, alpine meadows, muddy gravelly slopes, gravel near glaciers, grassy slopes, water at lake shore, moist pastures, stony slopes with unconsolidated scree, seepage areas in scree, in moss by streamlet, rock crevices, boggy ground by lakes, sandy soil at edge of stream, in melting snow or running water; 4000–5400(–5600)m [the highest recorded elevation of 18,700ft. is that for *Swan 56* (CAS)]. Flowering May through August; fruiting July through September.

Pegaeophyton scapiflorum is extremely variable in flower and fruit size, leaf shape, size, and margin, petal shape, and plant size, and Guo & Cheo (in Cheo *et al.*, 1980)

recognised three varieties with considerable overlap. Among the most notable variants of this subspecies are some collections from E Nepal (e.g., *Stainton, Sykes & Williams* 6135 (BM); *Shrestha & Joshi* 309 (BM); *McCosh* 373 (BM); *Yon s.n.* (BM)), all of which have narrowly linear to subfiliform leaves 0.5–1mm wide. These populations tend to have smaller flowers than the rest of the subspecies, but no mature fruits have been seen. They represent a reasonably defined entity that probably deserves formal recognition.

2b. Pegaeophyton scapiflorum subsp. **robustum** (O.E. Schulz) Al-Shehbaz, T.Y. Cheo, L.L. Lu & G. Yang, **stat. nov.** Basionym: *Pegaeophyton sinense* (Hemsely) Hayek & Handel-Mazzetti var. *robustum* O.E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 9: 477 (1926). *P. scapiflorum* var. *robustum* (O.E. Schulz) R.L. Guo & T.Y. Cheo, Bull. Bot. Lab. North-East Forest Inst. 6: 29 (1980). Type: China. Yunnan: Mount Lauchünshan, SW of the Yangtze bend at Shiku, swampy meadow, vi 1923, *J.F. Rock* 9577 (holo. B!; iso. E!, GH!, P!, US!, W!).
Syn.: *Braya sinensis* Hemsley, J. Linn. Soc., Bot. 29: 303 (1892). *Pegaeophyton sinense* (Hemsley) Hayek & Handel-Mazzetti, Anzeig. Akad. Wiss. Wien, Math.-Nat. 59: 246 (1922). Type: China. W Sichuan and Tibetan frontier, chiefly near Tachienlu, 9000–13,500ft, *A. E. Pratt* 858 (lectotype (here designated): K!; isolecto. BM!, P!).

Caudex usually stout, (5–)8–20(–30)mm diam., simple or rarely branched at apex. *Petals* (6–)8–12(–15)mm long, (5–)6–10(–13)mm wide, length (1–)1.2–1.5 × width. *Seeds* (2–)2.5–4(–5)mm long, (1.5–)2–3(–4)mm wide.

Specimens examined. BHUTAN. Me La, *Ludlow & Sherriff* 382 (BM), *Ludlow & Sherriff* 21106 (BM, E, TI); Kangla Karchu La, Mo Chu Drainage, *Ludlow & Sherriff* 16589 (BM, E, TI); Kyu La, *Ludlow & Sherriff* 35 (BM); Dungshinggang Ridge, *Bowes Lyon* 3227 (BM); Tashigang-Merak, *Bowes Lyon* 9105 (E).

CHINA. Sichuan: Hi-ma-la, Tsa-wa-rung, *Wang* 65679A (A); Nagaala, Tsa-wa-rung, *Wang* 66077 (A, LE); Litang divide, SW of Muli, *Kingdon-Ward* 4086 (E); Litang, Yalung divide, *Kingdon-Ward* 4387 (E); between Litang and Yalung rivers, between Muli Gomba and Barurong and Wa-Erh-Dje, *Rock* 1131 (P, US); between Baurong and Kalu, W of Yalung River, *Rock* 17836 (A, US); mountains of Kulu, *Rock* 18019 (US); Kanding, Yülingkong, Yachiagan Mts, *Smith* 10649 (CAS, MO); Baurong to Tachienlu, via Hadjha, *Stevens* 138 (F, US); near Tachienlu, *Pratt* 746 (BM); Taofu (Dawo) distr., Haitzeshan, *Smith* 11698 (MO). Xizang (Tibet): Mt. Kenichunpo, E and W slope of Salween and Irrawady divide, *Rock* 21936 (BM, E, GH, MO, NY, US); sources of the Irrawaddy, Adung Valley, *Kingdon-Ward* 9925 (BM); Xizang-Yunnan border, W range of Mekong on Kaakerpo, Dokerla and Tsarung, *Rock* 22925 (BM, E, GH, K, MO, NY, US); Tsarung border, Yundshi Mt., *Rock* 23533 (E, GH, NY); Migyitum, Tsari Chu, *Ludlow & Sherriff* 1729 (A, BM); Kongbo, Deyang La, *Ludlow & Sherriff* 14279 (BM, E, TI), *Ludlow & Sherriff* 15162 (BM, E); Shiuden Gompa, Ata Kang La, *Kingdon-Ward* 10818 (BM); Lusha La, 29°27′N 94°38′E, *Ludlow, Sherriff & Taylor* 4721(BM, E), *Ludlow, Sherriff & Taylor* 4721a (BM, E); Takpo, Langong, 28°45′N 94°0′E, *Ludlow, Sherriff & Taylor* 3924 (BM, E). Yunnan: Tsukuei, Salwin-Kiukiang divide, *Yü* 19366 (A, E); Chialahmuto, upper Kiukiang valley, *Yü* 19750 (A, E); Sila, Mekong-Salwin divide, *Yü* 22121 (A); Ta-li Hsien, *Wang* 63180 (A); Deiqin Xian, *Wang* 68919 (A, NAS); Bai-mar-shan, A-tun-tzw, *Wang* 69589 (A); Dali Xian Chang, *Qing* 25015 (KUN); Ta-li Hsien, *Tsai* 53975 (A); Dali Xian, near summit of Diancang Shan, vicinity of Yinglofeng

Peak, N of Dali city, 25°42′N, 100°05′E, *Bartholomew*, *Boufford*, *Li, Ma, Nicolson, Ying & Yu* 1056 (A, CAS, E, KUN, PE, US); Dali, Dian-chan Shan, *Murata, Kanayama, Murqakami, Ren & Wu 110* (A); Dali, top of Chung Ho Mt, *McLaren 139B* (BM, E, K, P); E flank of Lichiang Range, 27°30′N, *Forrest* 3102 (BM, E, LE, P); E flank of Tali Range, 25°40′N, *Forrest* 7168 (BM, E, K); Tali Range, *Forrest* 11699 (BM, E, K, W), *Forrest* 28112 (BM, E); Si-la, confluence of Landsand-djiang (Mekong) and Lu-djiang (Salween), *Handel-Mazzetti* 8434 (E, K, P, W, WU); Mekong-Salween divide, 28°12′N, *Forrest* 37 (E); near Tibet-Burma border, in confluence of Salween and Djiou-djiang (Irrawadi), *Handel-Mazzetti* 9493 (W, WU); Mount Peimashan, Mekong-Yangtze divide between Atuntze and Pungtzera, *Rock* 9968 (E, GH, P, US, W); Drainage basin of Erhhai (Lake of Talifu), Tsangshan Range, *Rock* 3134 (US); Mountains of Wei-Hsi, *Rock* 17156 (BM, GH, MO, US); Fuchuan range, W of Mekong-Salwin divide and W of Wei-Hsi, *Rock* 22745 (E, GH, NY); Lichiang Range, *McLaren* D313 (BM, E, K); Chawchi Pass, *Farrer* 1729 (E).

Distribution and habitat. Bhutan, China. Among rocks and gravel in stream beds, dry slopes, alpine brooks and wet gravel, swampy ground, glacier stream beds, peat soil, wet scree; 3500–4800m. Flowering late April through October; fruiting early July through mid-November.

Pegaeophyton scapiflorum is one of the most variable Himalayan species, as can be seen from the above description. In addition to high variability in leaf number, shape, size, margin, and indumentum, the species is also very variable in diameter and branching of the caudex, flower size and colour, petal shape, fruit shape and size, seed number and size, and density of indumentum on sepals, adaxial leaf surfaces and pedicels. Except for flower and seed size, and to a lesser extent the degree of branching of the caudex, there is no correlation between other morphological characters and geography. The two subspecies seem to be fairly well defined, and all specimens of subsp. *robustum* seen have been from China or Bhutan.

The type collection of var. *pilosicalyx* represents one extreme in terms of calyx and leaf pubescence, whereas most other collections are glabrous. However, as presence vs absence of leaf and calyx indumentum can be observed within a given population (e.g., *Rock* 18019, *Rock* 9577) there seems no justification for recognising var. *pilosicalyx*.

3. Pegaeophyton nepalense Al-Shehbaz, Arai, & H. Ohba, Novon 8: 327 (1998). Type: Nepal, around Lamni Nama, 4200–4900m, 15 viii 1977, *H. Ohashi, H. Kanai, H. Ohba & Y. Tateishi* 775117 (holo. TI!; iso. MO!).

Caudex slender, c.1mm diam. *Leaves* 5–12 per caudex; petiole (2–)6–10(–14)mm long, slender at base, glabrous or with few trichomes; blade suborbicular to broadly obovate, 2–4(–5)mm long, 1.5–3.5(–4.5)mm wide, somewhat fleshy, adaxially moderately pubescent with trichomes 0.3–0.5mm long, abaxially glabrous, base obtuse, margin entire, apex rounded or subrounded. *Flowers* 3–8 per plant. *Pedicels* slender, distally pubescent with trichomes 0.3–0.5mm all around, 2–5mm at anthesis, not elongated in fruit. *Sepals* oblong, 1.1–1.3(–1.5)mm long, 0.5–0.7mm wide, free, spreading to ascending, not saccate, pubescent on distal half with trichomes to 0.3mm long, membranous margin 0.05–0.1mm wide, obtuse. *Petals* white, broadly obovate

to suborbicular, slightly emarginate, 1.6–2(–2.5)mm long; blade 0.8–1.5mm long, 0.8–1.5mm wide; claw 0.8–1.2mm long. *Filaments* erect, white, slightly dilated at base, 1.2–1.5mm long, persistent to fruit maturity; anthers suborbicular, 0.25–0.3mm long, slightly sagittate at base. *Nectar glands* confluent, appearing as a tooth on each side of lateral stamens. *Ovules* 2–4. *Fruit* latiseptate, not geocarpic, broadly ovoid to subglobose, 2–3mm long, 1.8–2mm wide; valves membranous, rounded, extending along part of fruit length, glabrous or minutely puberulent distally; gynophore 0.1–0.2mm long; replum strongly flattened, 0.4–0.5mm wide, glabrous; style 0.5–0.7mm long. *Seeds* oblong, brown, plump, 2–4 per fruit, 1–1.1(–1.3)mm long, 0.5–0.6(–0.8)mm wide.

Specimens examined. BHUTAN. Narimthang, *Ludlow, Sherriff & Hicks* 21376 (BM); Lingshi, Timpu, *Cooper* 1758 (BM, E); upper Mangde Chu, *Ludlow & Sherriff* 16794 (BM); Shingbe, Me La, *Ludlow & Sherriff* 20756 (BM).

CHINA. Xizang (Tibet): Tsangpo tributary, Nangxian-Mainling, Lilung Chu eastern branch, 29°03′N, 93°59′E, *Miehe & Wündisch* 94–168–7 (GOET); Choqla (Kharta side), *Norton* 186 (K).

NEPAL. Inukhu Khola, Naulekh Mathi, 27°30′N, 86°45′, *McCosh* 335 (BM, TI); Dhudkund, 6 miles E of Timure, *Polunin* 840 (BM); Chilime Kharka camp road, *Polunin* 1439 (BM).

INDIA. Sikkim: West District: near Goecha La, 37°36′N, 88°11′E, *Long, McBeath, Noltie & Watson* 605 (CAS, E, MO); Kangpupehuthang, *Ribu & Rhomoo* 5211 (E).

Distribution and habitat. Bhutan, China, Nepal, India. In stable moraine, amongst moss, under rocks by stream, damp or gravelly scree, alpine grassland, wet sand, stony ground; 3900–5100m. Flowering late June through early September; fruiting mid-August through September.

Pegaeophyton nepalense, reported here for the first time from Bhutan and China, is the smallest member of the genus. It is most closely related to *P. scapiflorum*, from which it is readily distinguished by having orbicular to broadly obovate leaves with rounded to subrounded apex, ovoid to subglobose fruits with membranous valves, sepals 1.1–1.3(–1.5)mm long, petals 1.6–2(–2.5)mm long, and plump seeds 1–1.1(–1.3) × 0.5–0.6(–0.8)mm. In contrast, *P. scapiflorum* has variously shaped leaves (but never orbicular or broadly obovate with rounded apex), ovate to oblong or orbicular, flattened fruits with glabrous, papery valves, sepals (2–)3–10mm long, petals (3.5–)5–12(–15)mm long, and flattened seeds (1.5–)2–4(–5) × 1–3(–4)mm. The latter species is quite variable and has been divided by Schulz (1926) and Guo (1987) into three varieties. *Pegaeophyton nepalense* is easily distinguished from *P. minutum* Hara, a species of Nepal, Sikkim, Bhutan, and Tibet (Hara, 1972), by having ovoid to subglobose instead of narrowly oblong fruits, trichomes 0.3–0.5mm long instead of 0.02–0.08mm long, and pedicels pubescent all around instead of one line along entire length.

One collection, *Polunin* 1439 (BM), includes plants of both *Pegaeophyton nepalense* and *P. minutum*, but none are intermediate. The original description of *P. nepalense*

(Al-Shehbaz *et al.*, 1998) was based only on the type collection, but the present study has shown it to be far more widespread than originally thought.

Pegaeophyton nepalense resembles young plants of *Taphrospermum himalaicum,* and the two can easily be confused. However, *P. nepalense* is always scapose with flowers originating individually from the rosette, and it has globose fruits and often adaxially pubescent entire leaves. By contrast, *T. himalaicum* has flowers in bracteate racemes, oblong, slightly compressed fruits, and glabrous, dentate or lobed leaves.

4. Pegaeophyton angustiseptatum Al-Shehbaz, T. Y. Cheo, L. L. Lu & G. Yang, **sp. nov.** Type: China. Yunnan, Chungtien Plateau, open moist pasture, 14 vii 1939, *K. M. Feng* 1643 (holo. A).

Herba acaulis; folia spatulata vel oblanceolata, 1–2.5cm longa, integra, petiolis 1.5–4.5cm longis; flores 15–25, solitaria; sepala late ovata, 2.5–3 × 1.5–1.8mm, non-saccata; petala alba, late obovata, 4–5 × 2.5–3mm; fructus angustiseptates, geocarpes, suborbiculares vel late oblonges, sessiles, valvis carinatis; stylo 1.5–2mm longo; semina compressa, late ovata vel suborbiculata, 1.6–1.9mm longa.

Caudex thick, unbranched 3–6mm diam. *Leaves* 11–16; petiole 1.5–4.5cm long, glabrous, margin membranous, base to 5mm wide; blade spatulate to oblanceolate, 1–2.5cm long, 2–10mm wide, sparsely pilose adaxially with simple trichomes, glabrous abaxially, base cuneate to subattenuate, margin entire to obscurely 1-or 2-toothed on each side, sparsely ciliate with trichomes to 1mm long, apex obtuse to subrounded. *Flowers* 15–25 per plant, solitary; floral parts usually persisting to fruit maturity. *Pedicels* slender, sparsely to densely pubescent with spreading hairs along distal half, but denser near apex, c.2cm at anthesis; fruiting pedicels strongly recurved, to 7cm long. *Sepals* broadly ovate, 2.5–3mm long, 1.5–1.8mm wide, free, ascending, not saccate, sparsely pubescent on outside with trichomes 0.1–0.3mm long, membranous margin 0.1–0.25mm wide, apex obtuse. *Petals* white, broadly obovate, 4–5mm long, 2.5–3mm wide, tapering to claw-like base c.2mm long. *Filaments* erect, white, dilated at base, 2–2.5mm long; anthers ovate, 0.5–0.6mm long, sagittate at base. *Nectar glands* confluent, more developed around bases of lateral filaments. *Ovules* 10–14. *Fruit* angustiseptate, geocarpic, dehiscent, suborbicular to broadly oblong, 4–7mm long, 4–5mm wide, rounded at base and apex; valves carinate, extending along full fruit length, minutely papillate at apex; replum ± uniformly 0.75–1mm wide; gynophore absent; style 1.5–2mm long. *Seeds* broadly ovate to suborbicular, brown, compressed, up to 10 per fruit, 1.6–1.9mm long, c.1.2mm wide.

Pegaeophyton angustiseptatum, known only from the type gathering, is the most distinctive species of the genus on account of its angustiseptate, geocarpic fruits borne on strongly recurved pedicels.

5. Pegaeophyton watsonii Al-Shehbaz, **sp. nov.** Type: Sikkim. West District: Samiti Lake (Bungmoteng Chho) foot of Onglakthang Glacier, 27°33′33″N, 88°11′25″E, wet shady places on moss on calcareous boulders, 4300m, 23 vii 1992, *D.G. Long, R.J.D. McBeath, H.J. Noltie, & M.F. Watson* 675 (holo E; iso. MO). **Fig. 1.**
Herba acaulis; folia spatulata vel oblanceolata, 2–8cm longa, integra, petiolis 0.5–1.5cm longis, ciliatis; flores 1–8, solitaria; sepala oblonga, connata, 2–3mm longa, nonsaccata; petala alba, late obovata, 3–4 × 1.5–2mm; fructus angustiseptates, geocarpes, anguste oblonges, sessilis, valvis carinatis, dense puberulis; stylo 0.1–0.4mm longo; semina ovoidea, c.0.9 × 0.5mm.

Caudex slender, branched, 1–4mm diam. *Leaves* to 35 per rosette; petiole 0.5–1.5cm long, ciliate with trichomes to 0.5mm, base flattened and to 1mm wide; blade spatulate to oblanceolate, 2–8mm long, 0.5–2mm wide, glabrous, base attenuate, margin coarsely 1- or 2-toothed on each side, rarely entire, glabrous, apex obtuse to subacute.

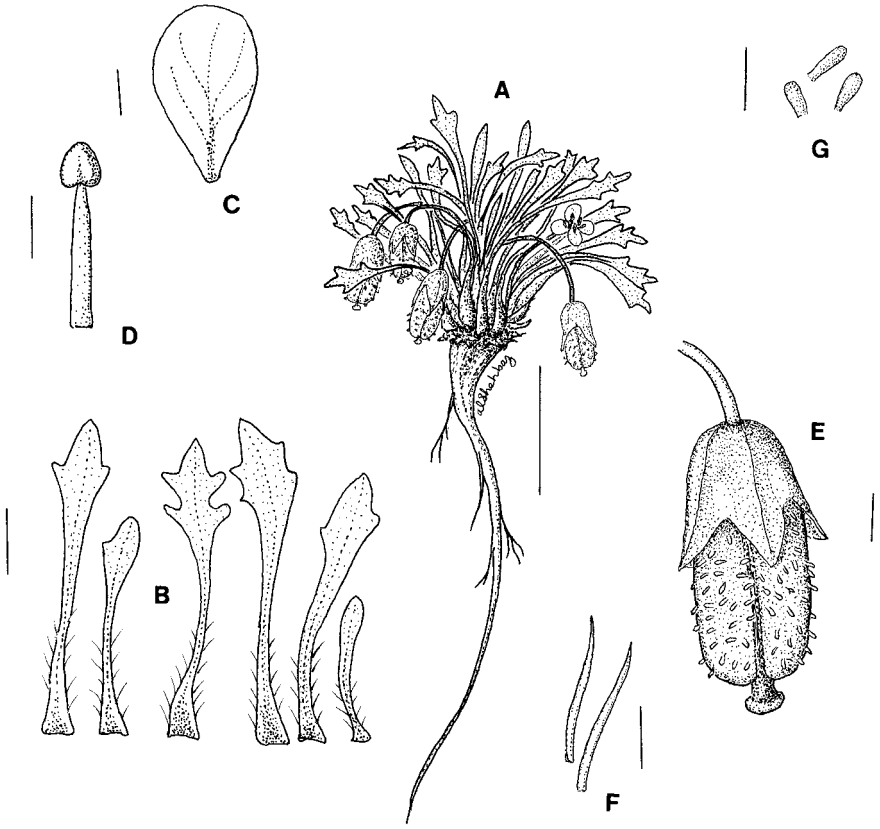

FIG. 1. *Pegaeophyton watsonii* Al-Shehbaz. A, plant; B, leaves; C, petal; D, stamen; E, fruit and gamosepalous fruiting calyx; F, petiolar trichomes; G, fruit trichomes. Scales: A = 1cm; B–E = 1mm; F–G = 0.25mm.

Flowers 1–8 per plant, solitary. *Fruiting pedicels* slender, glabrous, strongly recurved, to 1.5cm long. *Sepals* narrowly oblong, 2–3mm long, united, not saccate, glabrous, membranous throughout, persistent, apex obtuse. *Petals* white, broadly obovate, 3–4mm long, 1.5–2mm wide, not clawed. *Filaments* erect, white, dilated, 2–2.5mm long; anthers ovate, 0.4–0.5mm long, not sagittate at base. *Nectar glands* confluent, more developed around bases of lateral filaments. *Ovules* 20–35. *Fruit* angustiseptate, geocarpic, dehiscent, narrowly oblong, 4–8mm long, 1.5–2.2mm wide, rounded at base and apex; valves carinate, extending along full fruit length, densely puberulent throughout with trichomes to 0.2mm long; replum to 0.8mm wide; gynophore obsolete; style 0.1–0.4mm long. *Seeds* (of previous season) ovoid, brown, plump, c.0.9mm long, c.4mm wide.

Pegaeophyton watsonii, which is named after one of its collectors (Dr Mark F. Watson) is, so far, known only from the type gathering. It resembles *P. angustiseptatum* in its angustiseptate, geocarpic fruits borne on strongly recurved pedicels, but can be readily distinguished from that species by its gamosepalous calyx, puberulent fruits, ciliate petioles, smaller and narrower dentate leaves, and greater number of ovules per locule.

6. Pegaeophyton sulphureum Al-Shehbaz, **sp. nov.** Type: Bhutan: Penge La, Bumtang, 13,800ft, 27 vi 1969, *S. Bowes Lyon* 15106 (holo. BM).
Herba acaulis; folia anguste lineari-oblanceolata, 1–2.5cm longa, integra vel obscure 1- vel 2-dentata, petiolis 1.5–5cm longis, glabris; flores 5–25, solitaria; sepala late ovata, libera, 3–3.5mm longa, subsaccata; petala lutea, late obovato-orbiculata, 5–6 × 4.5–6mm; ovula 8–12; stylo 1.5–3mm longo; fructus ignotes.

Caudex thick, unbranched, 5–10mm diam. *Leaves* 8–20; petiole 1.5–5cm long, base to 5mm wide; blade narrowly linear-oblanceolate, 1–2.5cm long, 2–3mm wide, glabrous, base attenuate, margin entire to obscurely 1- or 2-toothed on each side, apex acute. *Flowers* 5–25 per plant, solitary. *Pedicels* slender, spreading to ascending, 2–6cm long in flower. *Sepals* broadly ovate, 3–3.5mm long, 2–2.5mm wide, free, spreading, persistent, somewhat saccate, glabrous, membranous margin 0.1–0.3mm wide, apex obtuse. *Petals* bright yellow, rarely drying creamy white, broadly obovate-orbicular, 5–6mm long, 4.5–6mm wide, not clawed, rounded at apex. *Filaments* yellow, dilated at base, 3–3.5mm long; anthers ovate, 0.6–0.7mm long, sagittate at base. *Nectar glands* confluent, well developed around bases of all filaments. *Ovary* 1–2mm long; ovules 8–12; style 1.5–3mm long, longer than or rarely as long as fruit. *Fruit* subglobose, c.2.5 × 2mm. *Mature seeds* not seen.

Specimens examined. BHUTAN: Tibdé La,Yatola ridge, Tongsa, 13,000ft, 2 vii 1915, *Cooper* 4093 (BM, E); Tibte-La, *Gould 444* (E); Thimphu District, between Lawgu and Paga La, *Wood* 7070 (E).

Distribution and habitat. Bhutan. In swamp peat, running water, boggy moorland, gravelly flushes; 3900–4450m. Flowering late June and into July; fruiting August.

Collections of *Pegaeophyton sulphureum* were previously identified as *P. scapiflorum*. However, the bright yellow flowers, which are not found in any other species of the genus, including the highly variable *P. scapiflorum*, readily distinguish this novelty.

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