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New species, taxonomic renovations, and typifications in *Gaultheria* series *Trichophyllae* (Ericaceae)

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Abstract

Expeditions to the Gaoligong Mountains and Biluo Snow Mountains in western Yunnan Province, China have uncovered new taxonomic information about the species of *Gaultheria* series *Trichophyllae* (Ericaceae) that are known to occur in these ranges. Based on these data, we describe two species as new to science (**G. ciliisepala** and **G. stenophylla**) and elevate four varieties (*Chiogenes suborbicularis* var. *albiflorus*, *G. sinensis* vars. *crassifolia* and *major*, and G. *trichophylla* var. *obovata*) to the species level (as **G. albiflora**, **G. crassifolia**, **G. major**, and **G. obovata**, respectively). We provide a lectotype and a revised description for **G. eciliata** because the type was discovered to also include individuals of *G. albiflora*. Similarly, we provide a lectotype and a revised description for **G. sinensis** because the type was discovered to also include an individual of *G. crassifolia*; moreover, the protologue of *G. sinensis* includes paratypes of three other species. Illustrations and photographic images of living plants in the field are included for all species. Our additions and changes raise the number of species recognized in *G.* series *Trichophyllae* from 10 to 16, with more to be expected as the Himalaya-Hengduan Mountains are further surveyed for these plants.

Introduction

Gaultheria Kalm ex Linnaeus (1753: 395) series *Trichophyllae* Airy Shaw (1941: 308) (Ericaceae: Vaccinioideae: Gaultherieae) is a group of diminutive evergreen shrublets endemic to the Himalaya-Hengduan Mountains of eastern Asia. Like most members of *Gaultheria*, the species of this series possess a capsule that is surrounded by an expanded and fleshy calyx, and most or all contain oil of wintergreen, i.e., methyl salicylate, detectable as a sweet odor or taste upon damage to various organs, typically rhizomes, stems, leaves, or fruits. Within *Gaultheria* the group is characterized by the combination of leaves generally less than 1 cm long, solitary axillary flowers, paired apical bracteoles, and five calyx and corolla lobes. *Gaultheria* series *Trichophyllae* has consistently been recovered as monophyletic in molecular phylogenetic studies (Bush *et al.* 2009; Lu *et al.* 2010; Fritsch *et al.* 2011). In the most recent global classification of *Gaultheria* (Middleton 1991), it is placed together with three other series [*G.* series *Hispidulae* Airy Shaw (1941: 308), series *Novaguineenses* D.J.Middleton (1991: 236), and series *Pernettyoideae* D.J.Middleton (1991: 237)] in *G.* section *Chiogenopsis* D.J.Middleton (1991: 235). In molecular phylogenetic studies, however, the series forms part of a "core East Asian" clade and is sister to a "*G. leucothoides* sensu lato" clade, a group comprising the members of *G.* series *Leucothoides* (Airy Shaw 1941: 308) D.J.Middleton (1991: 254) and those from several smaller series (Lu *et al.* 2010).

The most recent global taxonomic treatment of the taxa comprising *Gaultheria* series *Trichophyllae* is that of Airy Shaw (1941), who recognized seven species and several other vaguely defined varieties. Airy Shaw noted that this treatment was considered to be provisional, in light of the relatively few collections made up to then. Various subsequent taxonomic additions and other changes (see, e.g., Xu 1981; Long 1988; Fang and Stevens 2005; Fritsch *et al.* 2008) have resulted in the current recognition of ten species. Fritsch *et al.* (2008) considered *G. hypochlora* Airy

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Shaw (1941: 324), *G. sinensis* J.Anthony in Anonymous (1933: 19), and *G. trichophylla* Royle (1835: 260) to be in particular need of a detailed taxonomic reevaluation.

The number of collections of plants in this series made since the time of Airy Shaw's treatment has increased, primarily through a large-scale biotic survey of the Gaoligong Mountains, which lie within the group's geographic center of diversity (Zhou *et al.* 2006). For a molecular phylogenetic study of the core East Asian clade, Lu *et al.* (2010) sampled multiple individuals identified as *Gaultheria hypochlora*, *G. sinensis*, or *G. trichophylla* on the basis of what were then the current concepts of these species as delimited by Fang and Stevens (2005). Lu *et al.* (2010) found that the individuals of each of these species did not form a clade but were instead separated into two or more clades with moderate to strong bootstrap values, providing strong evidence that their current circumscriptions are problematic. The authors emphasized that critical diagnostic characters for species delimitation are contained in the fruiting calyx, but that most of these (e.g., calyx size, shape, and color) are rendered largely uninterpretable on herbarium sheets as a result of deformation and other alterations during the process of pressing and drying specimens. Lu *et al.* (2010) asserted that their data warranted a revised species taxonomy, but formal taxonomic changes first required more detailed herbarium study combined with field observations.

In this context, we undertook expeditions to the northern Gaoligong Mountains and the Biluo Snow Mountains in western Yunnan Province, China in September 2013 and June–July 2014 to study, photograph, and collect individuals of *Gaultheria* series *Trichophyllae* in their natural habitats (Fig. 1A–C). These mountains form the divides of the Ayarawaddy-Nujiang (Salween) and Nujiang-Lancang (Mekong) watersheds, respectively, each attaining elevations of over 5000 m, and together form the group's center of diversity. Here we present three outcomes of these expeditions: 1) the discovery of two new species, 2) the elevation of four taxa from variety to species, and 3) the designation of two lectotypes in the series. Based on our field studies and the examination of loaned herbarium material from A, BM, CAS, E, GH, K, KUN, and P collected from throughout the geographic ranges of the species treated herein, we include descriptions, distribution and habitat information, a list of paratypes or additional specimens examined, illustrations, and photographic images of the living plants taken in the field. Because our study is based primarily on herbarium specimens, we employ the morphological species concept for species delimitation, as discussed in Stuessy (2008). These changes increase the number of species recognized in *G.* series *Trichophyllae* to 16. Given that many of the species of the series are narrowly restricted to one or two mountain ranges, we expect additional new species of this group to be discovered as more collections of these plants from the Himalaya-Hengduan Mountains are made.

1. *Gaultheria albiflora* (T.Z.Xu) P.W.Fritsch & Lu Lu, *comb. et stat. nov.*

≡ *Chiogenes suborbicularis* (W.W.Smith in Anonymous 1914: 186) Ching ex T.Z.Xu (1984: 40) var. *albiflorus* T.Z.Xu (1984: 41). Type:—CHINA. Yunnan: Gongshan Xian, Mekong-Salwin divide, Sila, 4000 m, 16 August 1938, *T.T. Yü 22351* (holotype KUN 0482916!, isotype E!, KUN 0482917!).

Prostrate shrublet with stems to 5 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, strongly flushed red above, to 1.8 cm long, not puberulent, with appressed to ascending or uncinate straight setae, longer setae 0.14–0.3 mm long. Internodes among largest leaves averaging ca. 1.0 mm long. Petioles 0.2–0.6 mm long, glabrous, margin entire. Longer leaf blades elliptic or ovate-elliptic, 2.5–5.2 × 1.5–2.8 mm, 1.5–2.4 times as long as wide, subcoriaceous, planar or often cupped, abaxially dull light green except glossy green or occasionally maroon near margin, glabrous, adaxially glossy green, glabrous, midvein abaxially raised, planar, or impressed, not thickened to slightly thickened immediately below apical gland, adaxially impressed, secondary veins abaxially obscure, adaxially obscure or faintly 1- to 3-veined; base cuneate to subrounded; margin serrulate except at very base, not thickened, planar, marginal teeth (setae) 4 to 9 per side, often incurved and lying atop or adjacent to upper leaf surface, or occasionally proximal or all teeth off surface, longer teeth 0.08–0.18 mm long; apex acute to obtuse, tip with planar gland. Overwintering flower bud pedicels 0.8–2.5 mm long, glabrous; overwintering flower buds subglobose, 1.4–1.9 × 1.3–1.6 mm, 1–1.4 times as long as wide, glabrous, bracteoles not keeled, margins eciliolate. Flowers 2.5–4.8 mm long. Calyx green or green flushed red proximally with lobes maroon or purple, paler toward apex, 1.5–3 mm long; lobes deltoid or ovate-deltoid, 1.2–1.8 × 1.3–2.2 mm, adaxially glabrous, smooth, apex obtuse, eciliolate, at least slightly erose. Corolla white, campanulate, 2.4–4.5 × 3–4.2 mm; lobes 0.8–1.6 × 1.4–1.9 mm. Stamens 10; filaments abruptly dilated at middle or gradually dilated to just below middle, 1–1.5 mm long; anther cells 0.4–0.5 mm long, awns 1 or 2 per theca, 0.12–0.3 mm long. Style 1–1.7 mm long; stigma deep pink. Fruiting pedicel 2.2–3.5 mm long. Fruiting calyx oblate, crateriform, widely open, 6–8 × 8–11 mm, outer wall sky blue, inner wall white or white flushed with pink; calyx lobes incurved, broadly deltoid, 2–3.5 mm long, apex eciliolate, not erose. Capsule green, exceeded by calyx lobes.

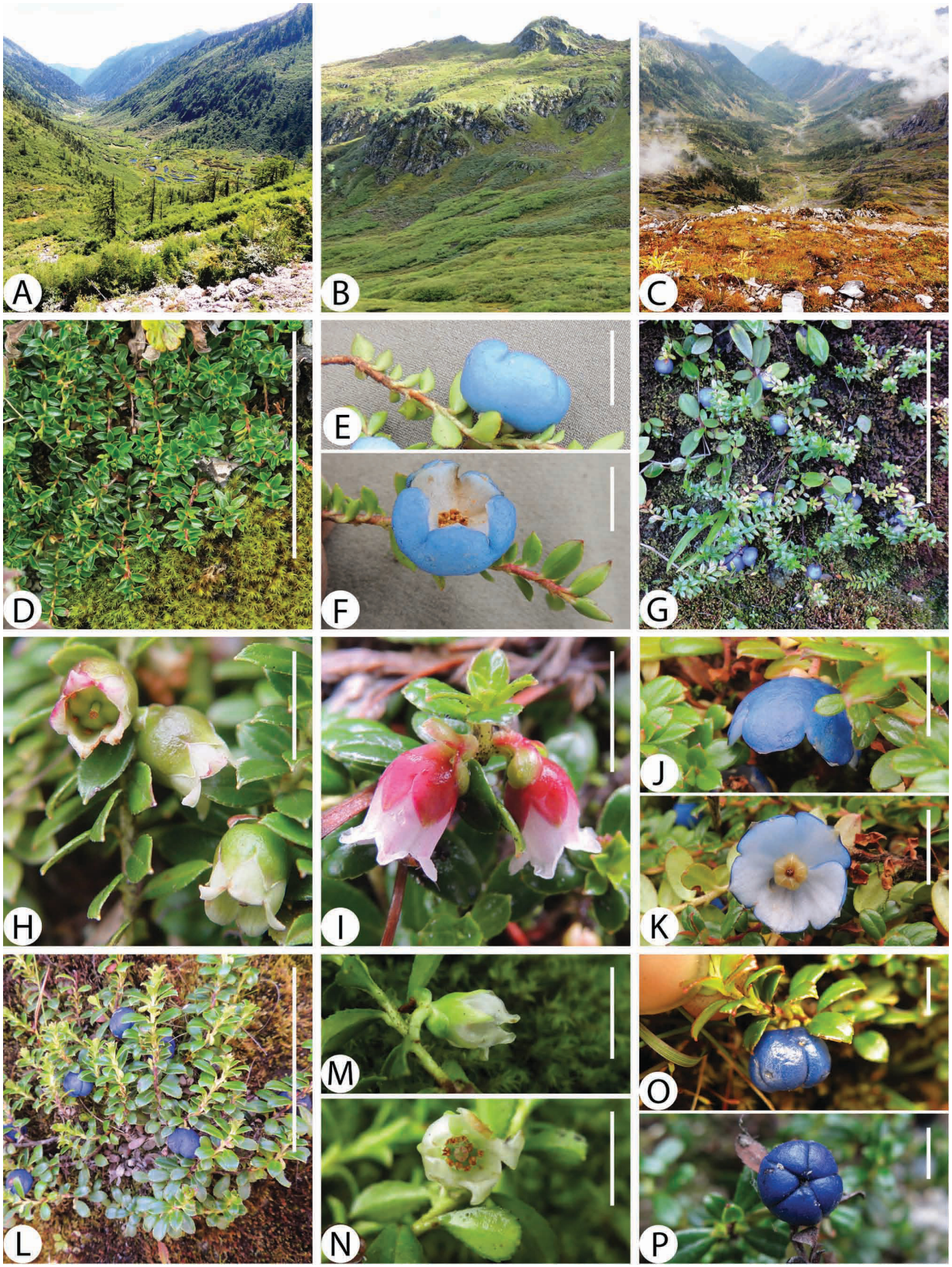

FIGURE 1. Images of *Gaultheria* series *Trichophyllae* habitats, and *G. albiflora*, *G. ciliisepala*, and *G. crassifolia*. **A–C.** *Gaultheria* series *Trichophyllae* habitats: glacially carved valley along road from Gongshan to Dulongjiang, east slope of Gaoligong Shan, ca. 3400 m elev. **(A)**, along trail from Qi Qi Forestry Station to Dong Shao Fang and the pass, east slope of Gaoligong Shan, ca. 3600 m elev. **(B)**, just below Sila Pass, east slope of Biluo Xue Shan, ca. 4000 m elev. **(C)**. **D–F.** *Gaultheria albiflora*, habit **(D)**, fruit, lateral view **(E)** and apical view **(F)** (*L. Lu LL-2013-50*). **G–K.** *Gaultheria ciliisepala*, habit **(G)**, flowers showing variation in size and color **(H–I)**, fruit, lateral view **(J)** and apical view **(K)** (G: *L. Lu & P.W. Fritsch LL-2011-8*; H: *L. Lu 06-15*; I: *L. Lu LL-2014-4*; J–K: *L. Lu LL-2013-20*). **L–P.** *Gaultheria crassifolia*, habit **(L)**, flower, lateral view **(M)** and apical view **(N)**, fruit, lateral view **(O)** and apical view **(P)** (L, P: *L. Lu LL-2013-13*; M–N, *LL-2014-30*; O: *L. Lu LL-2013-33*). Photographs: A, C, E–F, I–L by PWF; B, D, G–H, M–P by LL. Scale bars: D, L, 5 cm; E–F, H–I, M–P, 5 mm; G, 10 cm; J–K, 10 mm.

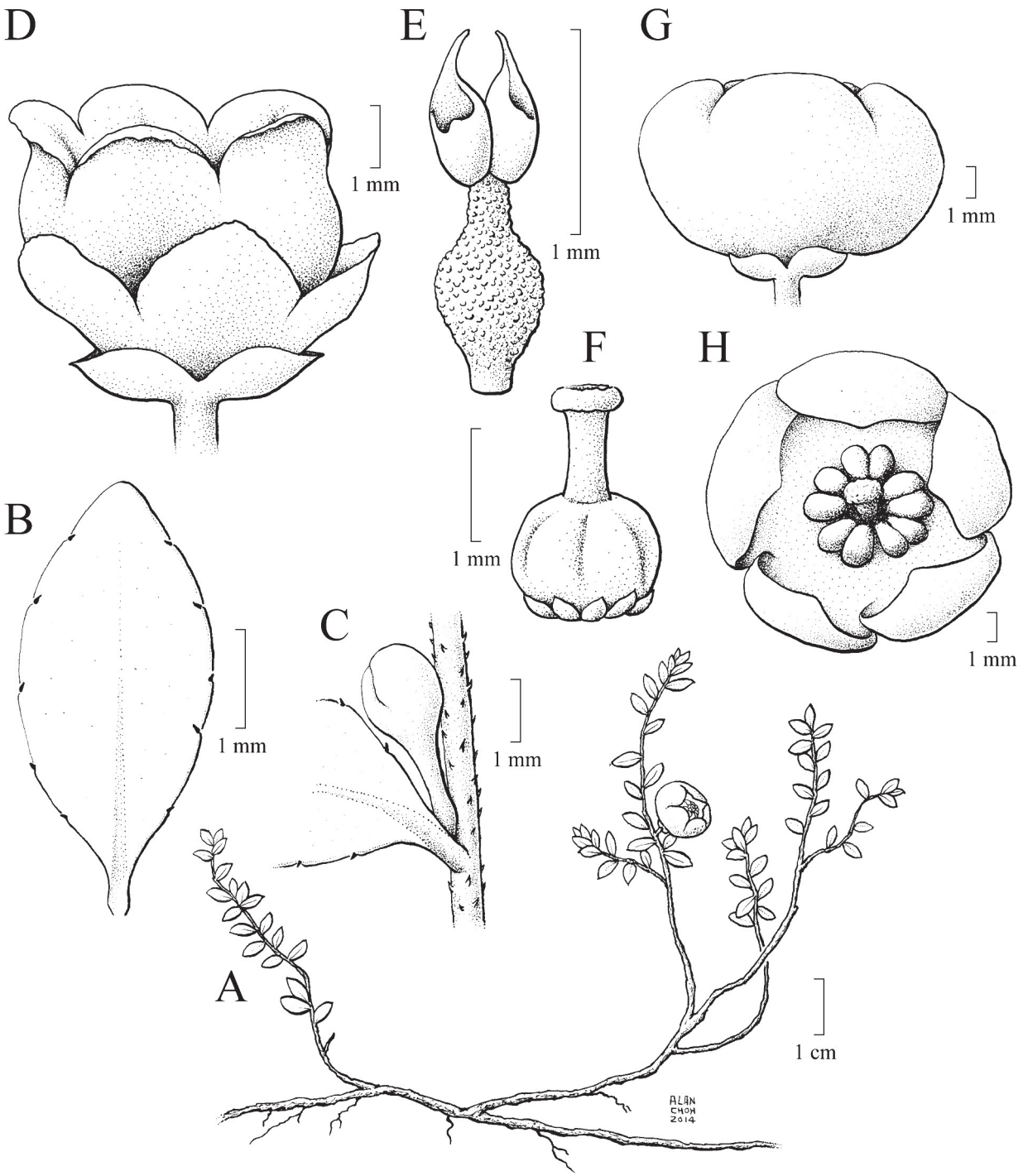

FIGURE 2. *Gaultheria albiflora*. **A.** Fruiting plant. **B.** Leaf, adaxial view. **C.** Section of branchlet with leaf base in abaxial view and flower bud. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A–C, G–H drawn from *L. Lu LL-2013-50*, CAS, and images of the living plant; D–F drawn from *T.T. Yü 19877*, E.)

Illustrations—Figure 2; Fritsch *et al.* 2008: Fig. 13C–F.

Images—Figure 1D–F; Fritsch *et al.* 2008: Fig. 14.

Phenology—Flowering July–August; fruiting August–September.

Habitat and distribution—Alpine meadows, in moss, humus, on rocks, near lakes; 3500–4200 m elev. Bhutan and China (Yunnan, Xizang).

Discussion—*Gaultheria albiflora* was first described at the level of variety under *Chiogenopsis suborbicularis*, a species now recognized in *Gaultheria* [≡ *Gaultheria suborbicularis* W.W. Sm. in Anonymous (1914: 186)]. However, *G. suborbicularis* belongs to *G.* series *Hispidulae* Airy Shaw whereas it is clear to us that the variety belongs to *G.*

series *Trichophyllae* on the basis of its 1-flowered inflorescences (versus several-flowered), 5-parted corolla (versus 4-parted), and blue fruiting calyx (versus red or white), among other characters differentiating the two sections. Because of a similar overall size and other characters, and because they often grow together, the identities of *G. albiflora* and *G. eciliata* (S.J.Rae & D.G.Long in Long 1988: 334) P.W.Fritsch & L.H.Zhou in Fritsch *et al*. (2008: 165) have been conflated and thus they have sometimes been collected together under the same collection number, including the type of *G. eciliata* (see below under the entry for that species). Under close inspection, *G. albiflora* can be distinguished from *G. eciliata* by the absence of leaf trichomes (versus one to several straight translucent trichomes on the petiole and adaxial leaf blade midvein proximally on at least some leaves), subglobose flower buds (versus laterally compressed), eciliate calyx lobe margins (versus ciliate), and larger fruiting calyces (6–8 × 8–11 mm versus 4.3–6 × 5–9 mm). Moreover, the leaf marginal setae of *G. albiflora* are generally more robust than those of *G. eciliata*, they are more often black than reddish brown (versus the opposite) and often mostly lie incurved on the upper leaf blade surface (versus usually off the surface proximally); and the calyx lobes of *G. albiflora* are ovate-deltoid, whereas those of *G. eciliata* are elongate-deltoid.

The E duplicates of *T.T. Yü 19877* and *22292* are cited as paratypes of *Gaultheria trichophylla* var. *eciliata* S.J.Rae & D.G.Long in Long (1988: 334) but these plants are in fact *G. albiflora*, as are the other duplicates of these collections. The illustration of *G. eciliata* in Fritsch *et al.* 2008: Fig. 13 is a mixture of *G. albiflora* and *G. eciliata*. *Gaultheria albiflora* is illustrated in subfigures 13C–F (C and E are drawn from the duplicate of *Yü 19877* at E), and F is drawn from the image of the living fruit in Fig. 14 of Fritsch *et al.* (2008; the caption erroneously states that 13F is based on the CAS specimen of *Gaoligong Shan Biodiversity Survey 16874*). *Gaultheria eciliata* in figures 13A–B in that work is drawn from the duplicate of *Gaoligong Shan Biodiversity Survey 16874* at CAS. Figure 14 in Fritsch *et al.* (2008), showing a fruit image, is indicated as *G. eciliata* but is in fact *G. albiflora*.

Additional specimens examined—**BHUTAN. Mongar:** Pung La, 3660 m, 9 July 1949, *F. Ludlow et al. 20904 p.p.* (BM! mixed with the lectotype of *G. eciliata*, photograph of BM at E!).

CHINA. Yunnan: Deqin Xian. Yanmen Xiang, Biluo Xue Shan, E slope just below Sila Pass, 3936 m, 28°00′8.5″N, 98°47′54.8″E, 24 September 2013, *L. Lu LL-2013-50* (CAS!, KUN!); Mekong-Salwin divide, Sila, 4200 m, *T.T. Yü 22292* (A!, E!, KUN!). **Gongshan Dulongzu Nuzu Zizhixian.** Bingzhongluo Xiang, vicinity of Niwaidanbu, ca. 2.4 direct km SW of Gawagapu Mtn., ca. 1.3 direct km E of Chukuai Lake, and ca. 16.5 direct km WSW of Bingzhongluo, W side of Gaoligong Shan, 3900 m, 27°59′44.8″N, 98°27′43.1″E, 30 August 2006, *Gaoligong Shan Biodiversity Survey 31667* (CAS!); Cikai Zheng, Yipsaka Lake, 2.4 direct km SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3500 m, 27°45′14″N, 98°27′33″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32019 p.p.* (CAS! mixed with *G. eciliata*); Upper Kiukiang Valley, (Clulung) S of Lungtsahmuru, 3900 m, 10 August 1938, *T.T. Yü 19877* (A!, E!, KUN!). **Xizang: Chayu Xian.** Ridong Community, Qimalazha to Xizha, 4300 m, 26 September 1982, *Qinghai-Xizang Expedition 10719* (KUN!); Chawalong, 17 July 2010, *South Tibet Expedition STET-0719* (CAS!, KUN!). **Gongbujiangda Xian.** Nambu La, Kongbo, 14,800 ft, 24 September 1947, *F. Ludlow et al. 15775a* (BM!). **Motuo Xian.** Duoxiongla, trail to Lage, 3700 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07149A* (CAS!, KUN!).

2. *Gaultheria ciliisepala* Airy Shaw ex P.W.Fritsch & Lu Lu, *sp. nov.*

Haec species *Gaultheria hypochlora* Airy Shaw (1941: 324) simillima, sed ab eo laminis longioribus ellipticis vel leviter obovatis, 3.1–5.7 mm latis, setis abaxialibus 1–circa 23, positis secus costam, costa abaxiali leviter vel valde incrassata proxime infra glandem apicalem; calyce rubro vel viridi complano rubro; calyce fructifero crateriformi vel late cupuliformi differt.

Type:—CHINA. Yunnan: Gongshan Dulongzu Nuzu Zizhixian, Dulongjiang Xiang, Sandui, W side of Gaoligong Shan, along Gamolai He on trail from Xishaofang to Bapo, 2570 m, 27°43′00″N, 98°25′20″E, 17 July 2002, *H. Li 15033* (holotype KUN!, isotype CAS!).

Many-branched prostrate-ascending shrublet with stems to 10 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green and occasionally flushed red above, to 7 (to 11) cm long, with sparse to dense white puberulence and with ascending or uncinate straight or often slightly undulate setae, longer setae 0.4–0.8 mm long. Internodes among largest leaves averaging ca. 1.1–3 mm. Petioles 0.4–1 mm long, abaxially glabrous or with sparse ascending or appressed setae, adaxially with sparse white puberulence in a line, margin entire or 1- to 3-toothed per side. Longer leaf blades elliptic or slightly obovate, 6–11.3 × 3.1–5.7 mm, 1.7–2.4 times as long as wide, subcoriaceous to coriaceous, planar, abaxially dull whitish green except glossy deep green near margin, at least some leaves with 1 to ca. 23 ascending setae scattered on midvein or occasionally also on surface but near midvein (longer setae 0.26–0.7

mm long), adaxially glossy deep green, midvein abaxially raised, slightly to strongly thickened immediately below apical gland, adaxially impressed and with white puberulence proximally, secondary veins abaxially obscure or 2 to 5 on each side of midvein, adaxially obscure; base cuneate to rounded; margin serrulate throughout, slightly thickened, slightly to strongly revolute, marginal teeth (setae) 9 to 14 per side, all oriented off leaf surface, longer teeth 0.1–0.46 mm long; apex obtuse to subrounded, tip with planar or usually downward-pointing apical gland. Overwintering flower bud pedicels 0.7–1.5(–2) mm long, glabrous or with white puberulence and/or minute setae; overwintering flower buds slightly to strongly compressed laterally, 1.6–2.8 × 1.3–2.1 mm, 1–1.8 times as long as wide, glabrous, bracteoles keeled, margins glabrous or sparsely ciliolate at apex. Flowers 3.5–7.5 mm long. Calyx red or green flushed red, 2.3–4.5 mm long; lobes ovate-deltoid, 1.3–2.5 × 1.2–2.5 mm, adaxially pubescent, apex acute or slightly obtuse, ciliolate, not erose. Corolla white, white flushed pink, or pink, narrowly campanulate, 3.5–6.5 × 3.5–8 mm; lobes 1.5–3 × 1.4–2.7 mm. Stamens 10; filaments dilated gradually then abruptly constricted toward middle, 0.8–1.5 mm long; anthers cells 0.5–0.74 mm long, awns 2 per theca, 0.3–0.7 mm long. Style 1.4–2.5 mm long; stigma pink. Fruiting pedicel 1.8–3 mm long. Fruiting calyx strongly oblate or occasionally subglobose or slightly prolate, cupuliform, crateriform to broadly cupuliform, widely open, 5–12 × 8–17 mm, outer wall sky blue to deeply so or occasionally white with pale bluish tinge, inner wall white; calyx lobes erect to slightly incurved, broadly deltoid, 2–5 mm long, apex ciliolate, not erose. Capsule green, exceeded by calyx lobes.

Illustration—Figure 3.

Images—Figure 1G–K.

Phenology—Flowering May–June; fruiting June–September.

Etymology—The species is named for its ciliolate calyx lobes.

Habitat and distribution—Mixed conifer forests, evergreen broadleaved forests, deciduous forests, subalpine scrub, meadows, granite or marble, in moss, humus, on rocks, banks of streams, and steep moist banks along roads; 2424–3800 m elev. China (Yunnan) and Myanmar (Kachin).

Discussion—The epithet *ciliisepala* first appears in H.K. Airy Shaw's annotation label on the specimen of *R.J. Farrer 1622* at E: "*Gaultheria sinensis* Anth. var. *ciliisepala* Airy-Shaw, Determinavit H.K.A.S. 9.xi.38." As far as we can tell this name was never published, and the specimen was not cited in Airy Shaw's (1941) taxonomic review of Asian *Gaultheria*. We have taken up the epithet of Airy Shaw's unpublished variety and applied it at the species level. Airy Shaw also identified a specimen of this species, *R.J. Farrer 1191* (E), as *G. hypochlora*, although noting that the leaves are smaller and less green below than is usual for *G. hypochlora*.

Gaultheria ciliisepala, *G. hypochlora*, and the new species *G. stenophylla* (see below) are all close relatives, grouping in a clade that also comprises *G. jingdongensis* R.C.Fang (1999: 166) and, at least in part, *G. eciliata* (Lu *et al.* 2010; P.W.F. & L.L., unpubl. data). These species all share calyx lobes with ciliolate margins apically, a character unique to this group within *G.* series *Trichophyllae*. All species except *G. jingdongensis*, endemic to Jingdong County in Yunnan, can be found growing in the same local area in close proximity, with populations frequently intermixed. The following key serves to distinguish *G. ciliisepala*, *G. eciliata*, *G. hypochlora*, and *G. stenophylla* from one another.

1. Longer stem setae 0.15–0.24 mm long; longer leaf blades 3.5–6.5 × 1.5–2.4 mm, at least some cupped; leaf blade marginal teeth 3 to 8 per side ..... *G. eciliata*
- Longer stem setae 0.28–0.8 mm long; longer leaf blades 6–17 × 2.4–7.2 mm, planar; leaf blade marginal teeth 8 to 17 per side 2
2. Longer leaf blades 2–3.4 times as long as wide, narrowly elliptic to slightly oblanceolate; fruiting calyx usually ellipsoid or long-cupuliform, occasionally cupuliform..... *G. stenophylla*
- Longer leaf blades 1.7–2.4 times as long as wide, elliptic, suborbicular, or slightly obovate; fruiting calyx broadly crateriform to broadly cupuliform, or broadly turbinate 3
3. Longer leaf blades elliptic or slightly obovate, 3.1–5.7 mm wide, abaxial setae 1 to ca. 23, situated along or near midvein, midvein slightly to strongly thickened abaxially immediately below apical gland; calyx red or green flushed red; fruiting calyx crateriform to broadly cupuliform ..... *G. ciliisepala*
- Longer leaf blades obovate or suborbicular, 5–7.2 mm wide, abaxial setae 4 to ca. 100, situated along midvein and usually some spread across surface, often to near margins, midvein usually not thickened or occasionally strongly thickened abaxially immediately below apical gland; calyx green; fruiting calyx broadly turbinate ..... *G. hypochlora*

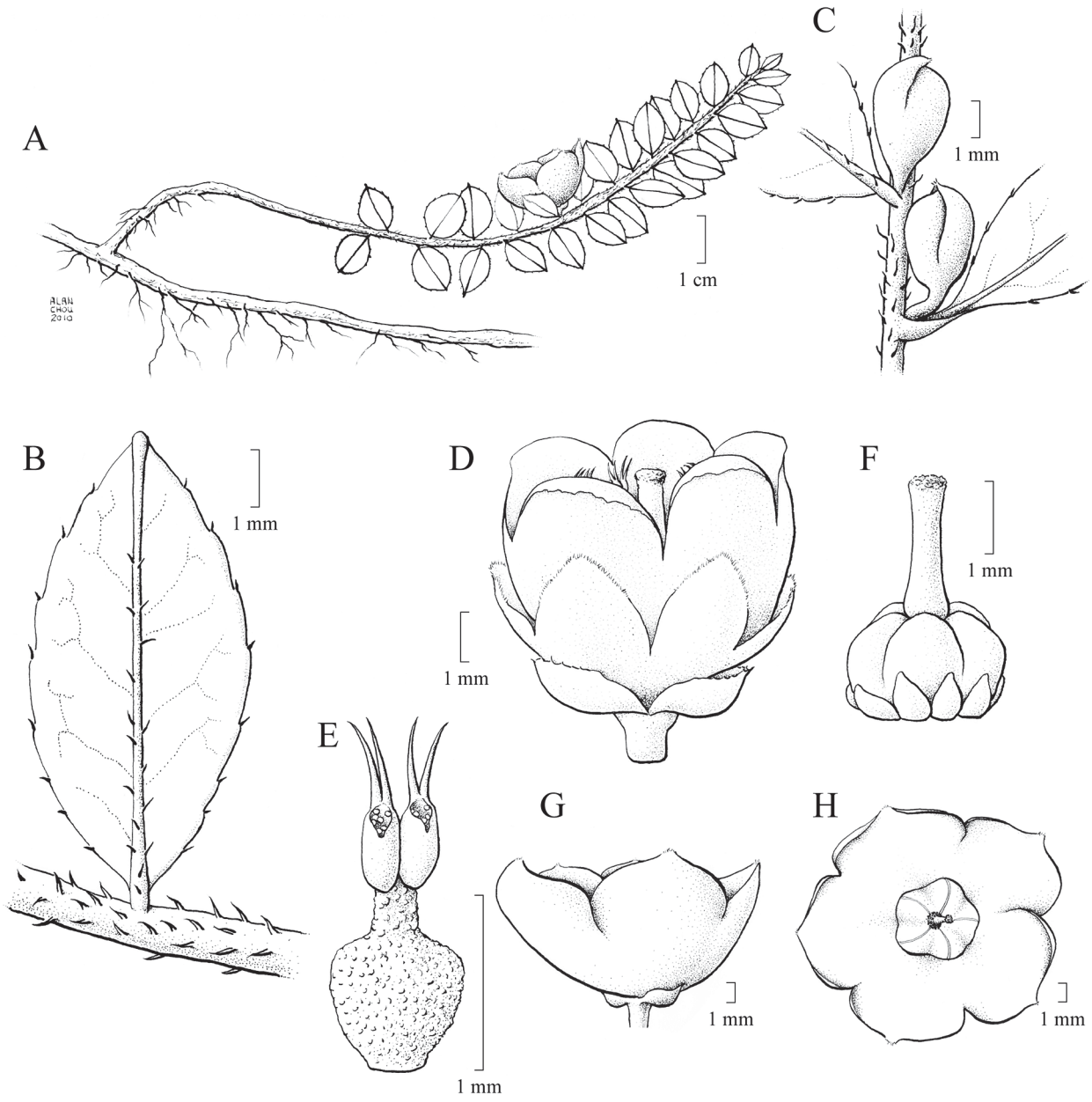

FIGURE 3. *Gaultheria ciliisepala*. **A.** Fruiting plant. **B.** Section of branchlet with leaf in abaxial view. **C.** Section of branchlet with leaf bases in abaxial (left) and adaxial (right) view, and flower buds. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A, C drawn from *L. Lu LL-2013-34*, CAS, and images of the living plant; B drawn from the holotype, *H. Li 15033*, CAS; D–F drawn from *Qinghai-Xizang Expedition 6998*, KUN; G–H drawn from *L. Lu LL-2013-20*, CAS, and images of the living plant.)

Gaultheria ciliisepala exhibits a fruiting calyx color polymorphism, with fruiting calyces colored either blue, or white with a pale bluish tinge on separate plants. *Gaultheria hypochlora* has also been observed to exhibit a similar polymorphism, with either blue or solid white fruiting calyces, as has *G. stenophylla* (see also Discussion under *G. stenophylla*).

***Paratypes*—CHINA. Yunnan: Dali Shi.** E slope of Cang Shan, rd to Zhong-he Peak, 3200 m, N25.68407°, W100.11043°, 6 September 2011, *L. Lu & P.W. Fritsch LL-2011-8* (CAS!, GH!); Cang Shan, Zhonghe Peak, 3000–3700 m, *L. Lu & R.F. Lu 06-0018* (CAS [3]!); Cang Shan, Zhonghe Peak, 3000–3700 m, 17 July 2010, *L. Lu 06-15* (CAS!); Diancang Shan, vicinity of Huadianba Herbal Medicine Farm, 2900–3300 m, 25°53′N, 100°01′E, 18 July 1984, *1984 Sino-American Botanical Expedition No. 1129* (CAS!, KUN!); Dali, Zhonghe Peak, 3000–3600 m, 23 May 1984, *Sino-German Expedition 1984 No. 0665* (KUN!); from Dali Town to television tower, E side of Cang Shan, 3100 m, 20 April 2009, *Z.J. Yin & H.J. Dong 0602* (KUN!); from Dali Town to television tower, E side of Cang Shan,

3800 m, 15 July 2009, *Z.J. Yin et al. 1327* (KUN!). **Fugong Xian.** Lishadi Xiang ["Yaping Xiang"], between Shibali Logging Station and Yaping Pass, ca. 4.1 km W of Shibali, rd from Nujiang [River] to Yaping Pass, E side of Gaoligong Shan, 3007 m, 27°10′33″N, 98°45′22″E, 2 May 2004, *Gaoligong Shan Biodiversity Survey 20140* (CAS!); Yaping Xiang, vicinity of Yaping Pass near Myanmar border, E side of Gaoligong Shan, 3620 m, 27°12′45″N, 98°41′45″E, 5 May 2004, *Gaoligong Shan Biodiversity Survey 20969* (CAS!); Yaping Xiang, vicinity of Yaping Pass near Myanmar border, E side of Gaoligong Shan, 3700 m, 27°12′45″N, 98°41′45″E, 5 May 2004, *Gaoligong Shan Biodiversity Survey 20975* (CAS!); Lumadeng Xiang, Yaping Cun, S side of N fork of Yamu He above Shibali, E side of Gaoligong Shan, 3050 m, 27°10′57″N, 98°43′13″E, 8 August 2005, *Gaoligong Shan Biodiversity Survey 26754* (CAS!); Lishadi Xiang, Yaduo Cun, vicinity of Rimagudi, N side of N fork of Yamu He above Shibali, rd to Myanmar border, E side of Gaoligong Shan, 3560 m, 27°12′28″N, 98°42′32″E, 12 August 2005, *Gaoligong Shan Biodiversity Survey 27029* (CAS!); Lumadeng Xiang, Yaping Cun, below Amero Pass along rd back down to confluence of N and S fork of Yamu He, E side of Gaoligong Shan, 3120 m, 27° 04′50″N, 98°44′52″E, 13 August 2005, *Gaoligong Shan Biodiversity Survey 27161* (CAS!); Lumadeng Xiang, Yaping Cun, vicinity of Shibali, S side of N fork of Yamu He, E side of Gaoligong Shan, 2510 m, 27°10′03″N, 98°46′18″E, 16 August 2005, *Gaoligong Shan Biodiversity Survey 28501* (CAS!); Dayou to Guadi, 3350 m, 1 August 1979, *Q. Lin 79-2037* (KUN [2]!); Lishadi Xiang, Yaduo Cun, N side of N fork of Yamu He above Shibali, rd to Myanmar border, E side of Gaoligong Shan, 3519 m, 27°12′40.1″N, 98°42′25.1″E, 2 July 2014, *L. Lu LL-2014-31* (CAS!, KUN!); Lumadeng, Ouliudi, W slope of Biluo Xue Shan, 3300 m, 28 May 1982, *Qinghai-Xizang Expedition 6998* (KUN [2]!). **Gongshan Dulongzu Nuzu Zizhixian.** Cikai Zheng, E side of Gaoligong Shan, W of Gongshan, along Pula He, trail from Qiqi to Dongshaofang and Dulongjiang Valley, 2770–3050 m, 27°42′28″N, 98°29′49″E, 15 July 2000, *H. Li 12551* (CAS!, KUN!); Cikai Zheng, E side of Gaoligong Shan, W of Gongshan, along the Pula He on the trail from No. 12 bridge to Dong Shao Fang and Dulong Jiang Valley, 2900 m, 27°42′54″N, 98°30′08″E, 1 May 2002, *H. Li 14974* (CAS!); [Dulongjiang Xiang], Gongshan Pass to Dulongjiang, year 1979, *Q. Lin & X.F. Dong 79-0558* (KUN [2]!); [Cikai Zheng], E slope of Gaoligong Shan, trail between No. 12 bridge and Dong Shao Fang Pass, 2800–3000 m, 4 June 2006, *L. Lu 06-0003* (CAS!); [Cikai Zheng], Dong Shao Fang Pass, Gaoligongshan, 3200–3500 m, 4 June 2006, *L. Lu 06-0014 p.p.* [CAS! mixed with *G. sinensis* (see below) and *G. major*]; Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-15A* (CAS!, KUN!); Dulongjiang Xiang, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3357 m, 27°46′30.0″N, 98°26′49.1″E, 15 September 2013, *L. Lu LL-2013-20* (CAS!, GH!, KUN!); Cikai Zheng, Gaoligong Shan, Qiqi River drainage, along trail from No. 12 Bridge to Dong Shao Fang and pass, 3100 m, 27°41′50.3″N, 98°29′18.1″E, 18 September 2013, *L. Lu LL-2013-34* (CAS!, GH!, KUN!); Bangdang Xiang, Biluo Xue Shan, Balagong spur, trail from Dimaluo to Balagong Pass, 3599 m, 27°57′49.8″N, 98°44′26.4″E, 23 September 2013, *L. Lu LL-2013-42* (CAS!, GH!, KUN!); Bangdang Xiang, Biluo Xue Shan, trail from Siwanongba Valley to Sila Pass, 3569 m, 27°59′40.9″N, 98°46′59.0″E, 24 September 2013, *L. Lu LL-2013-48* (CAS!, GH!, KUN!); Dulongjiang Xiang, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, W side of Gaoligong Shan, 3357 m, 27°46′30.0″N, 98°26′49.1″E, 26 June 2014, *L. Lu LL-2014-4* (CAS!, KUN!); Cikai Zheng, Danzhu Cun, rd from Danzhu to Myanmar, along Damawadi He (N branch of W-most origin of Danzhu He), E side of Gaoligong Shan, 2880 m, 27°38′6.5″N, 98°36′25.0″E, 28 June 2014, *L. Lu LL-2014-10* (CAS!, KUN!); [Cikai Zheng], Dongshaofang Pass, Gaoligong Shan, 3100–3200 m, 4 June 2006, *L. Lu 06-0001* (CAS!); [Cikai Zheng], E slope of Gaoligong Shan, trail between No. 12 bridge and Dongshaofang Pass, 2800–3000 m, 4 June 2006, *L. Lu 06-0004* (CAS!); [Cikai Zheng], Dongshaofang Pass, Gaoligong Shan, 3100–3200 m, 4 June 2006, *L. Lu 06-0015* (CAS!); [Dulongjiang Xiang], from Gongshan to Dulongjiang, 2700 m, 9 May 1979, *Nujiang Expedition 79-0086* (KUN [2]!); [Cikai Zheng], Hepu [Heipu] Shan, on rd to Dulongjiang Village, 3200 m, July 2005, *S. Yang Y0010* (CAS!). **Lushui Xian.** Pianma Xiang, W slope of Pianma Yakou, Fengxue Yakou, 3000 m, 27 July 1978, *Bijiang Expedition 1351 p.p.* (KUN 0531321 (as *1351 "A"*, mixed with *G. cardiosepala* Handel-Mazzetti (1924: 185)!, KUN 0532610); Pianma Xiang, Pianma Pass, W side of Gaoligong Shan, 3122 m, 25°58′23.8″N, 98°40′48.2″E, 3 July 2014, *L. Lu LL-2014-39* (CAS!, KUN!); Pianma Xiang, Pianma Pass, W side of Gaoligong Shan, 3122 m, 25°58′23.8″N, 98°40′48.2″E, 3 July 2014, *L. Lu LL-2014-40* (CAS!, KUN!); W side, 3220 m, 4 October 1997, *Gaoligong Shan Expedition 9980* (KUN!); Pianma Yakou, 3300 m, 8 June 2006, *L. Lu 06-0021* (CAS [2]!); Pianma Pass, 3150 m, 4 August 1978, *Nujiang Zhou Investigative Expedition 1834* (KUN [2]!); vicinity of Wan Zhuanghe, 3100 m, 30 June 1964, *S.G. Wu 007333* (KUN [2]!).

MYANMAR. Kachin: Myitkyina District. [Hsawlaw Township], Shing Hong Pass, 10,500 ft, 16 June 1920, *R.J. Farrer 1622* (E!); [Hsawlaw Township], Chimili Woods, 10,800 ft, 4 August 1919, *R.J. Farrer 1191* (E!); [Hsawlaw Township], Chawng Maw Kha drainage, ridge above Laktang (Kang-fang route), 8000–11,000 ft, 19 May 1925, *F. Kingdon Ward 3062* (E!).

3. *Gaultheria crassifolia* (Airy Shaw) P.W.Fritsch & Lu Lu, *comb. et stat. nov.*

≡ *Gaultheria sinensis* J.Anthony in Anonymous (1933: 19) var. *crassifolia* Airy Shaw (1941: 326). Type:—CHINA. Xizang: [Chayu Xian], Salwin-Kiu Chiang divide, 28°40′N, 98°15′E, October 1919, *G. Forrest 19286* (holotype K!, isotype E!).

Ascending-erect shrublet with stems to 10 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, occasionally flushed red, to 3.5 cm long, with sparse white puberulence and ascending or uncinate straight setae, longer setae 0.28–0.54 mm long. Internodes among largest leaves averaging ca. 1.1–1.3 mm. Petioles 0.7–1.5 mm long, abaxially glabrous or with sparse ascending setae, adaxially with sparse white puberulence in a line, margin 1- to 3-toothed per side. Longer leaf blades oblanceolate, 8.9–12 × 4–5.7 mm, 1.9–3 times as long as wide, coriaceous, planar, abaxially dull whitish green except glossy and occasionally flushed maroon near margin, glabrous or occasionally those of some leaves with 1 to 9 appressed or ascending setae scattered on midvein (longer setae 0.26–0.4 mm long), adaxially glossy deep green, midvein abaxially raised, not thickened immediately below apical gland, midvein adaxially impressed and with white puberulence proximally, secondary veins abaxially obscure or occasionally faintly 1 to 3 on each side of midvein, adaxially obscure; base cuneate; margin serrulate throughout, slightly thickened, planar or slightly revolute, often strongly so proximally, marginal teeth (setae) 10 to 15 per side, all oriented off leaf surface, longer teeth 0.14–0.28 mm long; apex obtuse to rounded, tip with strongly downward-pointing apical gland. Overwintering flower bud pedicels 1.2–2.3 mm long, glabrous; overwintering flower buds slightly compressed laterally, 1.7–3.4 × 1.3–2.0 mm, 1.2–1.8 times as long as wide, glabrous, bracteoles slightly keeled, margins eciliate. Flowers ca. 5 mm long. Calyx green, 2.7–3.5 mm long; lobes narrowly ovate-deltoid, 1.5–3.2 × 1–1.8 mm, adaxially glabrous, apex narrowly acute, eciliolate, smooth. Corolla white, urceolate, ca. 4 × 2.5 mm; lobes 1–1.2 × 0.8–1 mm. Stamens 10; filaments gradually dilated toward middle, 0.9–1.2 mm long; anther cells 0.3–0.44 mm long, awns 1 or 2 per theca, 0.33–0.45 mm long. Style 1.4–2.5 mm long; stigma pink. Fruiting pedicel 2–3.5 mm long. Fruiting calyx subglobose, closed, 6–9 × 6–9 mm, outer wall dark bluish purple, inner wall light blue or bluish purple; calyx lobes incurved, long-deltoid, 3.5–5 mm long, apex eciliolate, not erose. Capsule green, exceeded by calyx lobes

Illustration—Figure 4.

Images—Figure 1L–P.

Phenology—Flowering June–July; fruiting August–October.

Habitat and distribution—Coniferous forests, margins of bamboo thickets, alpine meadows and thickets, granite and metamorphics, in humus, banks of roadcuts; 3100–4200 m elev. China (Yunnan, Xizang).

Discussion—Airy Shaw (1941) described this taxon as a variety of *Gaultheria sinensis*. However, we observed it growing alongside *G. sinensis* in both the Gaoligong Mountains and Biluo Snow Mountains, and in each place both entities are morphologically distinct from each other and from the other species of *G.* series *Trichophyllae* growing with them. *Gaultheria crassifolia* is distinct from *G. sinensis* by the following characters: plants ascending-erect (versus prostrate-ascending); leaf blades oblanceolate (versus generally elliptic), coriaceous (versus subcoriaceous), often strongly revolute proximally (versus only slightly so), apex strongly downward-pointing (versus planar or only slightly downward-pointing); and fruiting calyx subglobose (versus crateriform to cupuliform), closed (versus open), outer wall dark bluish purple (versus deep sky blue), and inner wall light blue or bluish purple (versus white).

***Additional specimens examined*—CHINA. Yunnan: Deqin Xian.** SE Tibet, Ka-gwr-pu, Mekong-Salwin divide, 12,000 ft, 28°25´N, July 1917, *G. Forrest 14216 p.p.* (E! mixed with the lectotype of *G. sinensis*). Yanmen Xiang, Biluo Xue Shan, E slope just below Sila Pass, 3936 m, 28°00′8.5″N, 98°47′54.8″E, 24 September 2013, *L. Lu LL-2013-53* (CAS!, GH!, KUN!). **Fugong Xian.** Lishadi Xiang, Yaduo Cun, N side of N fork of Yamu He above Shibali, rd to Myanmar border, E side of Gaoligong Shan, 3519 m, 27°12′40.1″N, 98°42′25.1″E, 2 July 2014, *L. Lu LL-2014-30* (CAS!, KUN!). **Gongshan Dulongzu Nuzu Zizhixian.** Bingzhongluo Xiang, ca. 3.4 direct km S of Gawagapu Mtn. and ca. 15.8 direct km WSW of Bingzhongluo in next basin E of Chukuai lake, E side of Gaoligong Shan, 3710 m, 27°58′46.2″N, 98°28′25.6″E, 30 August 2006, *Gaoligong Shan Biodiversity Survey 31683* (CAS!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-13* (CAS!, GH!, KUN!); Cikai Zheng, Gaoligong Shan, Qiqi River drainage, along trail from No. 12 Bridge to Dong Shao Fang and pass, 3498 m, 27°41′37.6″N, 98°27′38.1″E, 18 September 2013, *L. Lu LL-2013-33* (CAS!, GH!, KUN!); Cikai Zheng, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, E side of Gaoligong Shan, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 26 June 2014, *L. Lu LL-2014-2* (CAS!, KUN!); [Cikai Zheng], Gaoligong Shan, Dongshaofang Pass, 3100–3200 m, 4 June 2006, *L. Lu 06-0001A* (CAS!); rd from Gongshan to Dulong River, 3800 [3300?] m, 16 September 2003, *S.K. Wu et al. 055* (KUN!);

[Dulongjiang Xiang], Salwin-Kiukiang Divide, Parolaka, 3500 m, 13 October 1938, *T.T. Yü 20683* (A!, E!, KUN!). **Xizang: Chayu Xian.** Ri Dong Qu, 4200 m, 8 September 1982, *Qinghai-Xizang Expedition 10107* (KUN!).

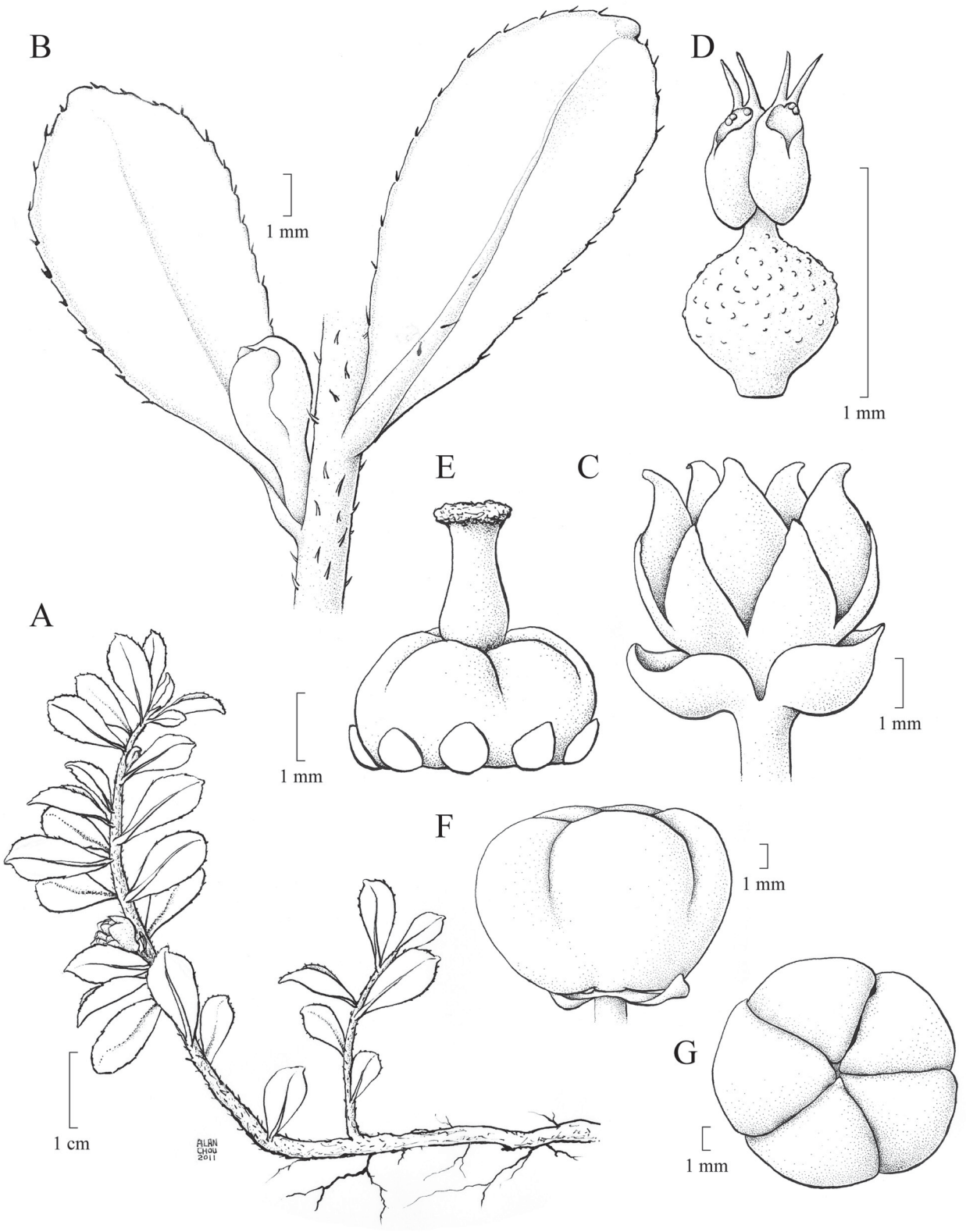

FIGURE 4. *Gaultheria crassifolia*. **A.** Fruiting plant (from herbarium material; calyx is thus open). **B.** Section of branchlet with leaves in abaxial (right) and adaxial (left) view, and flower bud. **C.** Flower. **D.** Stamen. **E.** Nectar glands and gynoecium. **F.** Fruit, lateral view. **G.** Fruit, apical view. (A–B, drawn from the isotype *G. Forrest 19286*, E; C, E drawn from *L. Lu LL-2014-2*, CAS, and images of the living plant; D drawn from *T.T. Yü 20683*, A; F–G drawn from *L. Lu LL-2013-33*, CAS, and images of the living plant.)

4. *Gaultheria eciliata* (S.J.Rae & D.G.Long) P.W.Fritsch & L.H.Zhou in Fritsch *et al.* (2008: 165)

≡ *Gaultheria trichophylla* Royle var. *eciliata* S.J.Rae & D.G.Long in Long (1988: 334). Lectotype (designated here):—BHUTAN. Mongar: Pung La, 3660 m, 9 July 1949, *F. Ludlow, G. Sherriff & J.H. Hicks 20904 p.p.* (BM!, photograph of lectotype at E!).

Prostrate or prostrate-ascending shrublet with stems to 7 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, strongly flushed red above, to 3 cm long, glabrous or with very sparse white puberulence and uncinate straight setae, longer setae 0.15–0.24 mm long. Internodes among largest leaves averaging ca. 1–2.5 mm long. Petioles 0.4–0.8 mm long, glabrous or adaxially with very sparse translucent puberulence in a line, margin entire or 1-toothed per side. Longer leaf blades elliptic, narrowly elliptic, lanceolate, slightly oblanceolate, or slightly rhomboid, 3.5–6.5 × 1.5–2.4 mm, 2–3 times as long as wide, subcoriaceous, at least some cupped, others planar, abaxially glossy pale green except green or occasionally maroon near margin, glabrous or (plants from Dong Shao Fang, Yunnan) rarely with 1 to 3 appressed or ascending setae scattered on midvein (longer setae 0.1–0.2 mm long), adaxially glossy deep green, midvein abaxially planar or raised, not thickened immediately below apical gland, adaxially planar to impressed and glabrous or with very sparse translucent puberulence proximally, secondary veins abaxially obscure or faintly 1 to 4 on each side of midvein, adaxially obscure; base cuneate to subrounded; margin serrulate throughout, planar, marginal teeth (setae) 3 to 8 per side, all teeth oriented off leaf surface or more commonly proximal teeth off surface and distal teeth incurved and lying atop or adjacent to upper leaf surface, longer teeth 0.1–0.14 mm long; apex acute to acuminate or occasionally obtuse, tip with planar apical gland. Overwintering flower bud pedicels 0.6–1.8 mm long, glabrous or with sparse translucent puberulence; overwintering flower buds compressed laterally, 1.3–2.2 × 1–1.3 mm, 1–2 times as long as wide, glabrous, bracteoles keeled, margins often ciliolate at apex. Flowers 3–4.5 mm long. Calyx green, 2.5–3 mm long; lobes deltoid or elongate-deltoid, 1.3–1.9 × 0.9–1.9 mm, adaxially pubescent, apex acute, ciliolate, erose or not. Corolla white, broadly campanulate, 3–3.5 × 3.2–6 mm; lobes 1–2.5 × 1.1–1.8 mm. Stamens 8 to 10; filaments dilated abruptly near middle, 0.8–1.1 mm long; anther cells 0.5–0.6 mm long, awns 1 per theca, 0.16–0.28 mm long. Style 0.7–1.3 mm long; stigma pink. Fruiting pedicel 1.4–3 mm long. Fruiting calyx oblate, crateriform, open, 4.3–6 × 5–9 mm, outer wall light to deep sky blue, inner wall white; calyx lobes erect to incurved, broadly deltoid, 1.5–3.8 mm long, apex ciliolate, not erose. Capsule green, exceeded by calyx lobes.

Illustration—Figure 5.

Images—Figure 6A–E.

Phenology—Fruiting August–October.

Habitat and distribution—Coniferous forests, alpine thickets and meadows with scattered bamboo or shrubs, mixed granite and metamorphics, wet seepages, banks of road cuts, in moss and humus; 3200–4280 m elev. China (Yunnan, Xizang).

Discussion—The type material of *Gaultheria eciliata* as far as we know consists of the single sheet of *F. Ludlow, G. Sherriff & J.H. Hicks 20904* at BM. The plants on this sheet are composed of plants arranged in 18 clusters of branchlets (and more material in the packet). Of these, 16 are one species, and two another. We have lectotypified *G. eciliata* on the 16 branchlet clusters and excluded the two other branchlet clusters (which we have circled on the sheet) from this lectotypification. By lectotypifying *G. eciliata* on these 16 clusters, the name *G. albiflora* can be applied to the two circled branchlet clusters. Alternatively lectotypifying *G. eciliata* on the two circled branchlet clusters would necessitate a new name for what we are calling *G. eciliata*, and require placement of *Chiogenes suborbicularis* var. *albiflora* in synonymy under *G. eciliata*.

See also comments under *Gaultheria albiflora* and *G. ciliisepala*.

Additional specimens examined—**CHINA. Yunnan: Gongshan Dulongzu Nuzu Zizhixian.** Champutong, 3500–3700 m, 10 September 1940, *K.M. Feng 7675 p.p.* (KUN [2]! mixed with *G. sinensis*); Dulongjiang Xiang, N side of pass above tunnel on rd between Gongshan and Kongdang, W side of Gaoligong Shan, 3530 m, 27°46′20″N, 98°26′48″E, 2 October 2002, *Gaoligong Shan Biodiversity Survey 16874* (CAS!); Cikai Zheng, N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into upper reaches of Pula He, 3429 m, 27°47′35″N, 98°27′57″E, 3 October 2002, *Gaoligong Shan Biodiversity Survey 16952* (KUN!); Cikai Zheng, Yipsaka Lake, 2.4 direct km SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3500 m, 27°45′14″N, 98°27′33″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32019 p.p.* (CAS! mixed with *G. albiflora*); Cikai Zheng, Heipu Pass along rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 27°46′19.6″N, 98°26′47.6″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32041* (CAS!); Cikai Zheng, Yipsaka Lake, 2.4 direct km by SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3560 m, 27°45′22.2″N, 98°27′45.4″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32078* (CAS!);

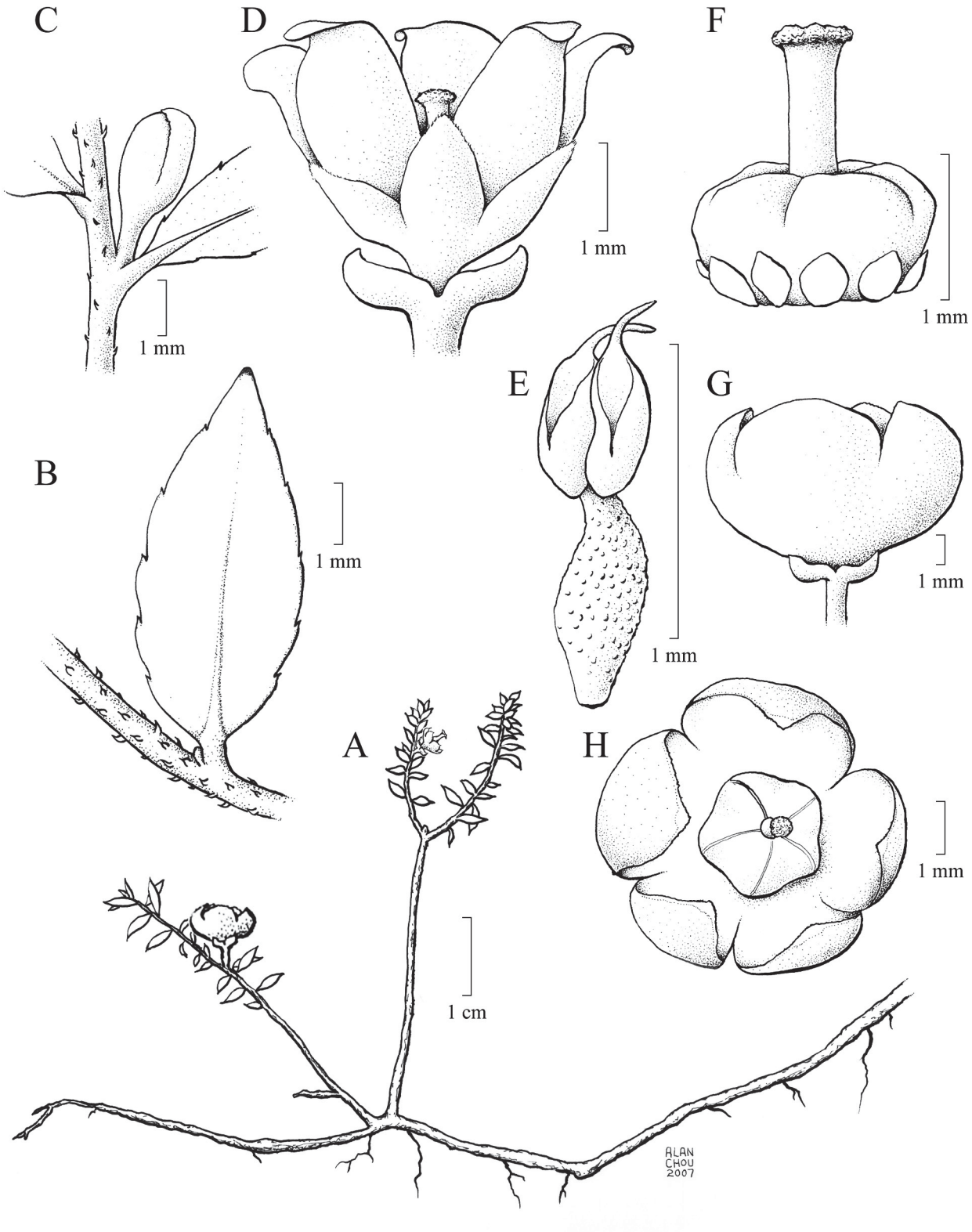

FIGURE 5. *Gaultheria eciliata*. **A.** Fruiting plant. **B.** Section of branchlet with leaf in abaxial view. **C.** Section of branchlet with leaf bases in abaxial (right) and adaxial (left) view, and flower bud. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A–C drawn from *Gaoligong Shan Biodiversity Survey 16874*, CAS; D–F drawn from *L. Lu LL-2014-3*, CAS; G–H drawn from *L. Lu LL-20-13-32*, CAS, and images of the living plant.)

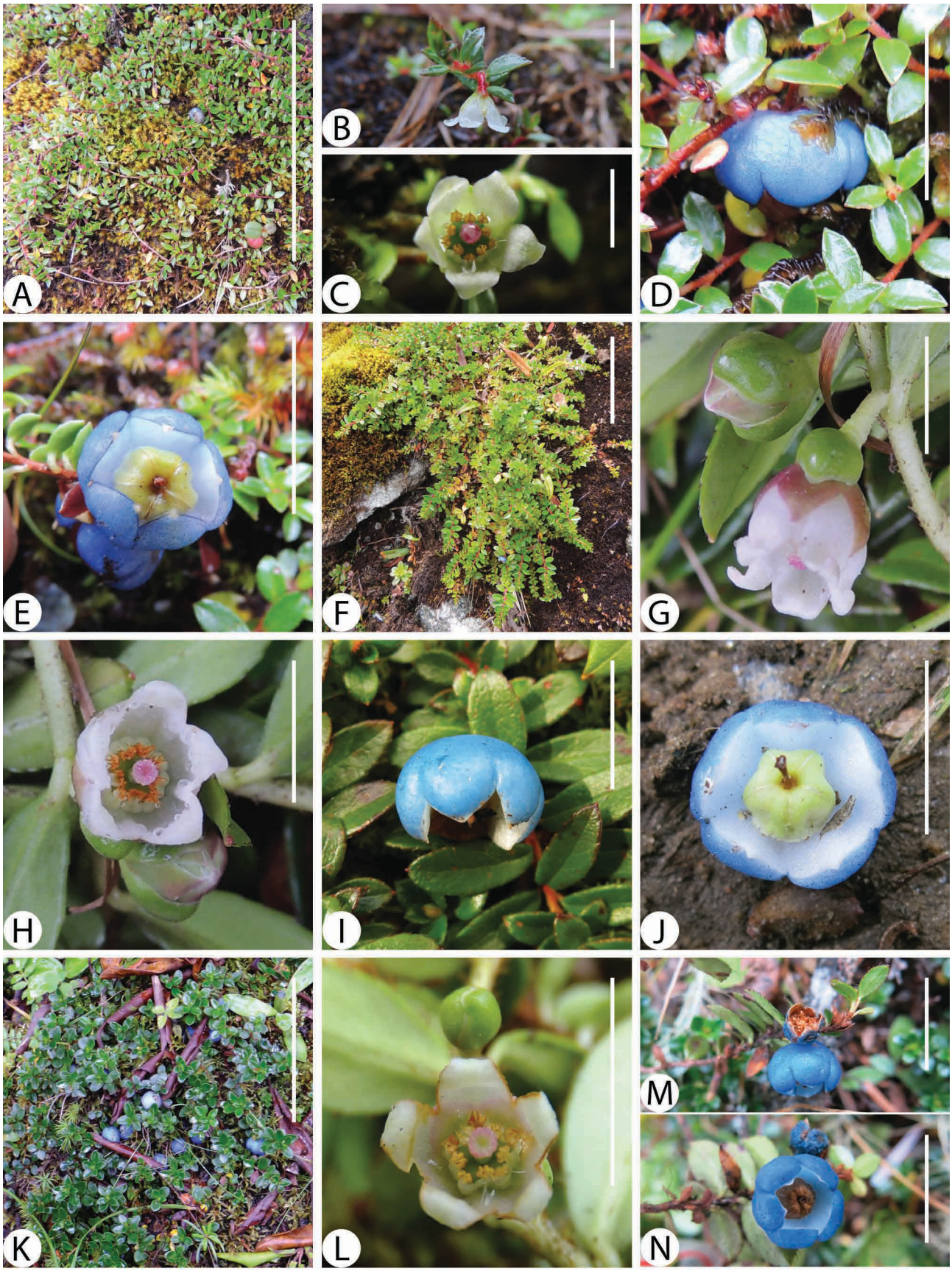

FIGURE 6. Images of *Gaultheria eciliata*, *G. major*, and *G. obovata*. **A–E.** *Gaultheria eciliata*, habit **(A)**, flower lateral view **(B)** and apical view **(C)**, fruit lateral view **(D)** and apical view **(E)** (A: *L. Lu LL-2013-32*; B–C: *L. Lu LL-2014-3*; D–E: *L. Lu LL-2013-21*). F–J. *Gaultheria major*, habit **(F)**, flower bud and flower, lateral view **(G)**, flower, apical view **(H)**, fruit, lateral view **(I)** and apical view **(J)** (F: *L. Lu LL-2013-37*; G–H: *L. Lu LL-2013-51*; I–J: *L. Lu LL-2013-40*). **K–N.** *Gaultheria obovata*, habit **(K)**, flower, apical view **(L)**, fruit, lateral view **(M)** and apical view **(N)** (K–L: *L. Lu & P.W. Fritsch LL-2011-21*; M–N: *L. Lu LL-2013-41*). Photographs: A–B, D–H by PWF; C, I–N by LL. Scale bars: A, F, K, 10 cm; B–C, 3 mm; D–E, I–J, M–N, 10 mm; G–H, L, 5 mm.

Cikai Zheng, ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 27°45′41.7″N, 98°27′2.3″E, 13 August 2006, *Gaoligong Shan Biodiversity Survey 32102* (CAS!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3360 m, 27°47′8.6″N, 98°27′37.4″E, 11 September 2013, *L. Lu LL-2013-3* (CAS!, KUN!); Cikai Zheng, Gaoligong Shan, Ypisaka (= "alpine") Lake (Heipu Yipu Laka), 3463 m, 27°45′21.8″N, 98°27′37.8″E, 12 September 2013, *L. Lu LL-2013-5* (CAS!, KUN!); Dulongjiang Xiang, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3357 m, 27°46′30.0″N, 98°26′49.1″E, 15 September 2013, *L. Lu LL-2013-21* (CAS!, KUN!); Cikai Zheng, Gaoligong Shan, Qiqi River drainage, along trail from No. 12 Bridge to Dong Shao Fang and pass, 3498 m, 27°41′37.6″N, 98°27′38.1″E, 18 September 2013, *L. Lu LL-2013-32* (CAS!, GH!, KUN!); Cikai Zheng, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, E side of Gaoligong Shan, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 26 June 2014, *L. Lu LL-2014-3* (CAS!, KUN!); Cikai Zheng, Danzhu Cun, rd from Danzhu to Myanmar, along Damawadi He (N branch of W-most origin of Danzhu He), E side of Gaoligong Shan, 3243 m, 27°37′25.0″N, 98°34′32.3″E, 3243 m, 28 June 2014, *L. Lu LL-2014-13* (CAS!, KUN!); Dulongjiang Xiang, Salwin-Kiukiang Divide, Lunguailaka, 3200 m, 16 September 1938, *T.T. Yü 20336* (A!, E!, KUN!). **Xizang: Chayu Xian.** Linzhi Prefecture, rd from Bomê to Mêdog, Galongla Pass, 4280 m, 29°45′22″N, 95°42′18″E, 25 September 2009, *H. Sun et al. Sun H-07ZX-2664 p.p.* [KUN! mixed with *G. obovata* (see below) and *G.* cf. *sinensis*]. **Motuo Xian.** Duoxiongla, trail to Lage, 3700 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07149* (KUN!).

5. *Gaultheria major* (Airy Shaw) P.W.Fritsch & Lu Lu, *comb. et stat. nov.*

≡ *Gaultheria sinensis* J.Anthony in Anonymous (1933: 19) var. *major* Airy Shaw (1941: 325) ('*maior*'). Type:—CHINA. Yunnan: Kari Pass, Mekong-Yangtze divide, 3300 m, 27°40′N, August 1914, *G. Forrest 12938* (holotype K!, isotypes E!, BM!).

Many-branched prostrate or prostrate-ascending shrublet with stems to 12 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green and strongly flushed red above, to 8 cm long, with sparse to moderate white puberulence and ascending or uncinate straight or usually undulate setae, longer setae 0.46–0.96 mm long. Internodes among largest leaves averaging ca. 1.1–2.3 mm. Petioles 0.6–1.3 mm long, abaxially glabrous or with sparse uncinate-appressed or ascending setae, adaxially with sparse white puberulence in a line, margin entire or 1-toothed. Longer leaf blades elliptic or narrowly so to slightly oblanceolate, 7.5–18 × 2.8–6.9 mm, 1.5–3.2 times as long as wide, subcoriaceous, planar, abaxially dull whitish green except glossy and occasionally flushed maroon near margin, at least some leaves with 1 to 23 appressed or ascending setae scattered on midvein or rarely also on surface but near midvein (longer setae 0.34–0.8 mm long), adaxially glossy green, midvein abaxially raised, not thickened immediately below apical gland, adaxially impressed and with white puberulence proximally or glabrous, secondary veins abaxially obscure or 2 to 4 on each side of midvein, adaxially obscure; base cuneate to subrounded; margin serrulate throughout, slightly thickened, slightly revolute, marginal teeth (setae) 8 to 15 per side, all teeth oriented off leaf surface, longer teeth 0.34–0.84 mm long; apex acute to rounded, tip with planar apical gland. Overwintering flower bud pedicels 1.8–4.1 mm long, glabrous; overwintering flower buds slightly compressed to subglobose laterally, 1.8–3.7 × 1.7–3 mm, 1–1.6 times as long as wide, glabrous, bracteoles not or slightly keeled, margins eciliolate. Flowers ca. 5.6 mm long. Calyx dull pink, 2.8–3.5 mm long; lobes broadly deltoid, 5–2.2 × 2–2.6 mm, adaxially glabrous, apex acute, eciliolate, not erose. Corolla white, campanulate, 5–5.2 × 7 mm; lobes 2.3–2.6 × 1.8 mm. Stamens 10; filaments dilated gradually then abruptly constricted at apex, ca. 1 mm long; anther cells ca. 0.6 mm long, awns 2 per theca, 0.4–0.5 mm long. Style 1–2.5 mm long; stigma pink. Fruiting pedicel 2.2–4.1 mm long. Fruiting calyx prolate to subglobose, broadly cupuliform, open, 7–10 × 8–18 mm, outer wall deep sky blue, inner wall white; calyx lobes erect or slightly incurved, broadly deltoid, 3–3.5 mm long, apex eciliolate, not erose. Capsule green, exceeded by calyx lobes.

Illustration—Figure 7.

Images—Figure 6F–J, 8F.

Phenology—Flowering May, September; fruiting July–October.

Habitat and distribution—Coniferous forests, alpine thickets, meadows, and pastures, with scattered bamboo, among rocks, limestone, marble, granite and metamorphics; 3000–4200 m elev. China (Yunnan, Xizang).

Discussion—Airy Shaw (1941) described this taxon as a variety of *Gaultheria sinensis*. We observed it growing alongside *G. sinensis* in the Biluo Snow Mountains, where the two entities could be distinguished with relative ease. Characters serving to reliably distinguish *G. major* from *G. sinensis* are the longer stem setae (the longer setae on

individual stems 0.46–0.96 mm versus 0.26–0.48 mm), the longer and more numerous leaf marginal setae (0.34–0.84 mm long and 8 to 15 per side, versus 0.1–0.4 mm long and 6 to 12 per side) and the leaf tip with a planar apical gland (versus at least some leaves with a slightly downward-pointing apical gland). The species also tends to have larger fruiting calyces than *G. sinensis* (7–10 × 8–18 mm versus 5–10 × 7–15 mm; Fig. 8F).

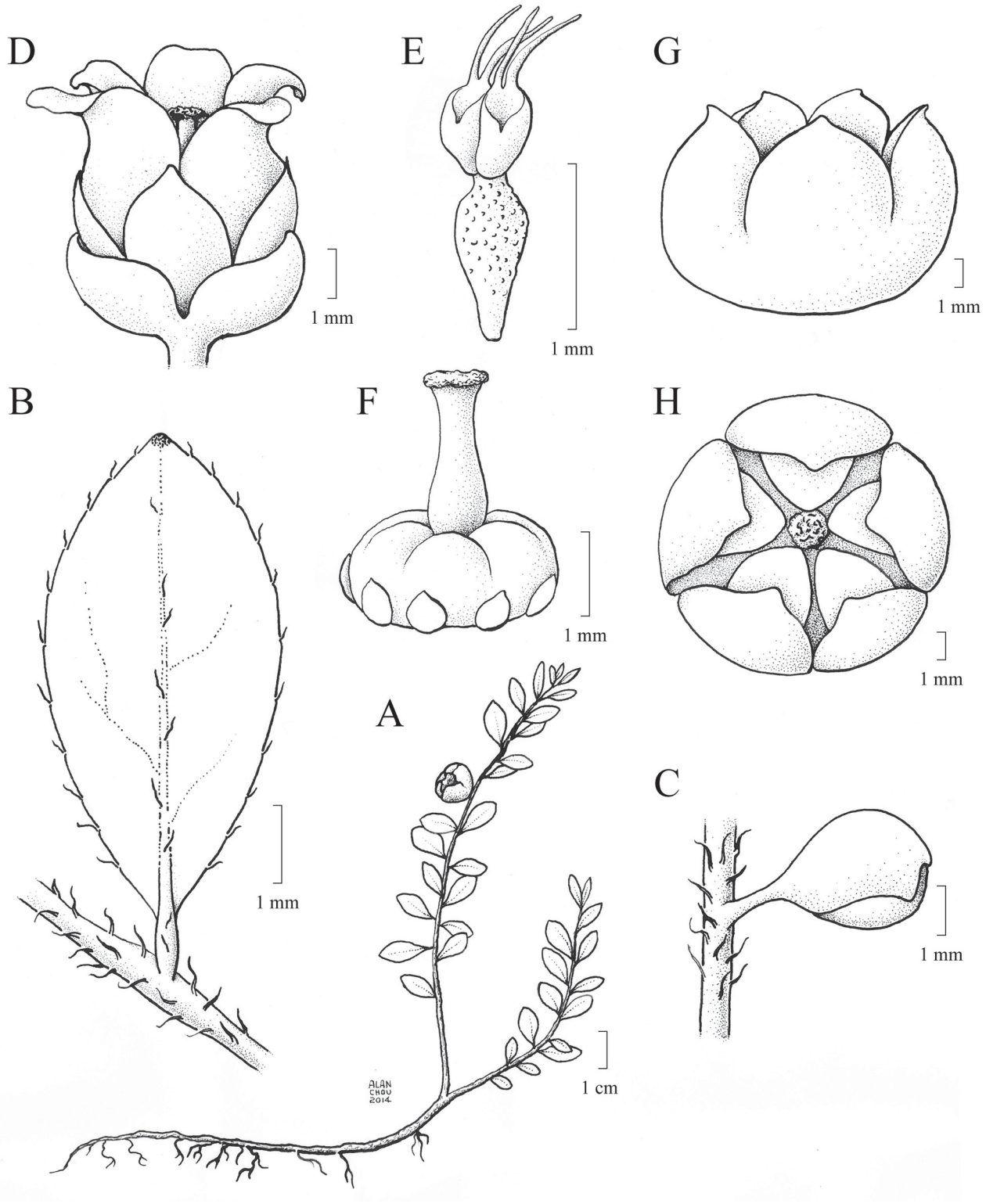

FIGURE 7. *Gaultheria major*. **A.** Fruiting plant. **B.** Section of branchlet with leaf in abaxial view. **C.** Section of branchlet with flower bud. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A–B drawn from *C.W. Wang 68551*, A; C drawn from *H.F. von Handel-Mazzetti 8243*, P; D drawn from *L. Lu LL-2013-51*, CAS, and images of the living plant; E–F drawn from *L. Lu LL-2013-51*, CAS; G–H drawn from *L. Lu LL-2013-40*, CAS, and images of the living plant.)

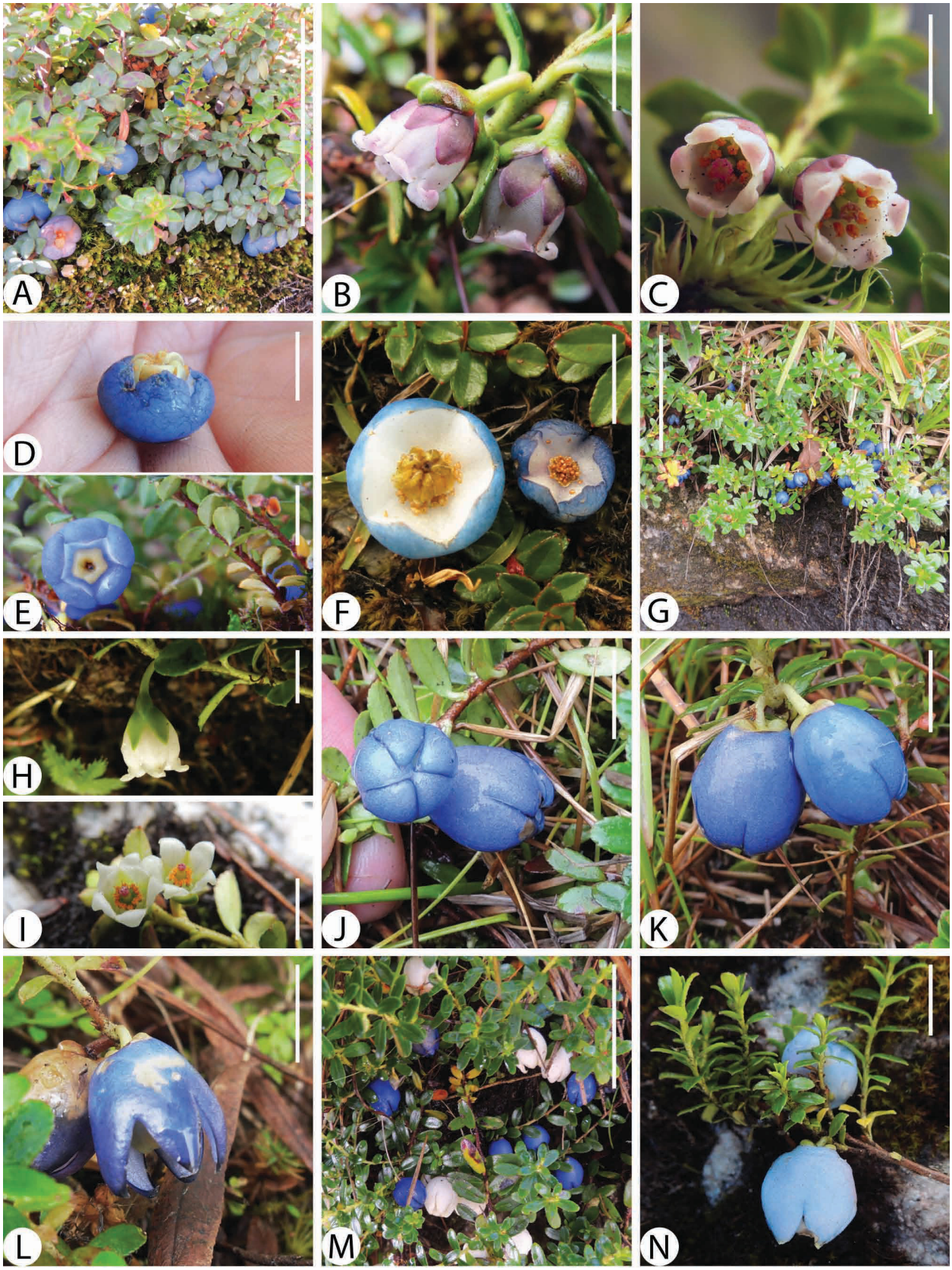

FIGURE 8. Images of *Gaultheria major*, *G. sinensis*, and *G. stenophylla*. **A–E.** *Gaultheria sinensis*, habit **(A)**, flowers, lateral view **(B)** and apical view **(C)**, fruit, lateral view **(D)** and apical view **(E)** (A, D–E: *L. Lu LL-2013-14*; B–C: *L. Lu LL-2013-52*). **F.** *Gaultheria major* (left) and *G. sinensis* (right) fruits from plants growing together, showing differences in size and mature calyx color [*L. Lu LL-2013-51* (left), *LL-2013-52* (right)]. **G–N.** *Gaultheria stenophylla*, habit **(G)**, flowers in lateral view **(H)** and apical view **(I)**, fruit, lateral and apical view **(J)**, fruit, lateral view **(K)**, fruit, lateral view, from a plant with open mature calyces **(L)** (cf. J), plants with dark blue or white mature calyces (the different colors are on separate individuals) **(M)**, plant from same area as those in (M), with light blue mature calyces **(N)** [G, L: *L. Lu LL-2013-7*; H–I: *L. Lu LL-2014-8*; J–K, *L. Lu LL-2013-1*; M, *L. Lu LL-2013-7* (blue) and *LL-2013-9* (white); N, *L. Lu LL-2013-8*]. Photographs A–B, D, G, I–K, M–N by PWF; C, E–F, H, L by LL. Scale bars: A, M, 5 cm; B–E, H–I, 5 mm; F, J–L, N, 10 mm; G, 10 cm.

The type of this species and other plant specimens collected from the region between the Salween and Yangtze rivers have longer branchlets and leaf internodes, and larger leaves, than the rest of the specimens occurring throughout the range of the species. Airy Shaw noted this difference in an annotation label on the collection of *G. Forrest 28035* at E ("small form approaching type of [*Gaultheria sinensis*])." During our field work, we observed only the small plants in the Gaoligong Mountains (*L. Lu LL-2013-37*), whereas in the Biluo Snow Mountains we observed the larger plants at high elevations (*L. Lu LL-2013-40* and *LL-2013-51*, 3599 and 3936 m, respectively) and the smaller plants at lower elevations. The smaller plants, however, have been collected in the Biluo Snow Mountains by others apparently at both high elevations (*T.S. Tsai 58172* at 4000 m) and relatively low elevations (*P.Y. Mao 00138* at 3000 m).

***Additional specimens examined*—CHINA. Province unknown:** without locality, *W.P. Fang 57736* (E!). **Yunnan: Dali Shi.** Tali, Tsang Chan, 3500 m, 10 June 1885, *J.M. Delavay s.n. p.p.* (K! mixed with *G. cardiosepala* and *G. trichophylla*); Tali, Tsang Chan, 3500 m, 10 June 1885, *J.M. Delavay 1877 p.p.* (A! mixed with *G. trichophylla*, K! mixed with *G. cardiosepala* and *G. trichophylla*, P 00546405! mixed with *G. cardiosepala* and *G. trichophylla*); Tali Range, October 1929, *G. Forrest 28035* (E!); Tsangshan Range, W of Talifu, 13,000 ft, August 1922, *J.F. Rock 6325* (A!); no locality indicated, 3000 m, May 1935, *C.W. Wang 63284* (A!). **Deqin Xian.** Cizhong Village, 3800 m, 5 July 1940, *K.M. Feng 5130* (KUN [2]!); mtn. behind Cizhong Village, 3500–3700 m, 9 August 1940, *K.M. Feng 6468* (KUN!); Salwin-Mekong Divide, mtns. behind Yongzi Village, 3700–3800 m, 16 August 1940, *K.M. Feng 6724* (KUN! mixed with *G. sinensis*); Yanmen Xiang, Biluo Xue Shan, E slope just below Sila Pass, 3936 m, 28°00′8.5″N, 98°47′54.8″E, 24 September 2013, *L. Lu LL-2013-51* (CAS!, GH!, KUN!). **Eryuan Xian.** Vicinity of Niujie, near main peak of Maer Shan, 3450 m, 3 July 1963, *Jinsha River Expedition 63-6113* (KUN [2]!). **Fugong Xian.** Che-tse-luo, top of Pi-lo [Biluo] Shan, 4000 m, 25 August 1934, *H.T. Tsai 58172* (A!, KUN!). **Gongshan Dulongzu Nuzu Zizhixian.** Bingzhongluo Xiang. ca. 2.1 direct km S of Gawagapu Mtn. and ca. 15.2 direct km WSW of Bingzhongluo in next basin E of Chukuai Lake, E side of Gaoligong Shan, 4000 m, 27°59′29.3″N, 98°28′36.3″E, 28 August 2006, *Gaoligong Shan Biodiversity Survey 32809 p.p.* (CAS! mixed with *G. sinensis*); [Cikai Zheng], Dongshaofang Pass, Gaoligongshan, 3200–3500 m, 4 June 2006, *L. Lu 06-0014 p.p.* (CAS! mixed with *G. ciliisepala* and *G. sinensis*); Cikai Zheng, Gaoligong Shan, Qiqi River drainage, along trail from No. 12 Bridge to Dong Shao Fang and pass, 3498 m, 27°41′37.6″N, 98°27′38.1″E, 18 September 2013, *L. Lu LL-2013-37* (CAS!, GH!, KUN!); Bangdang Xiang, Biluo Xue Shan, Balagong spur, trail from Dimaluo to Balagong Pass, 3599 m, 27°57′49.8″N, 98°44′26.4″E, 23 September 2013, *L. Lu LL-2013-40* (CAS!, GH!, KUN!); Bangdang Xiang, Mekong-Salwin Divide, Sila, 4000 m, 12 August 1938, *T.T. Yü 22316* (KUN [2]!); Bangdang Xiang, Mekong-Salwin Divide, Sila, 4000 m, 2 October 1938, *T.T. Yü 22748* (A!, E!, KUN [2]!). **Heqing Xian.** Machang, Baishanmu, *R.C. Ching 23490* (KUN!). **Lanping Baizu Pumizu Zizhixian.** Biluo Snow Mtns., Jiumingfang, 4200 m, *S.G. Wu 8767* (KUN [2]!). **Weixi Lisuzu Zizhixian.** Wei-Hsi area, *G. Forrest 30556* (E!); Lidiping, 3000 m, 20 July 1956, *P.Y. Mao 00138* (KUN [2]!); Mt. Shang-Ma-Kou, N of Wei-Hsi, August 1928, *J.F. Rock 17172* (A!); Yeh-Chih Community, 3600 m, August 1935, *C.W. Wang 68551* (A!, KUN!); Yeh-Chih Community, 3600 m, August 1935, *C.W. Wang 68633* (A!, KUN!). **Yulong Naxizu Zizhixian.** W Lijiang, summit of mtns. behind Tamichung, 25 August 1939, *R.C. Ching 21460* (A!, KUN!). **Xizang: Xian undetermined.** Mekong-Salween Divide, Schöndsula, 3850 m, 28°4′N, 22 September 1915, *H.F. von Handel-Mazzetti 8243* (E!, A!, P!). **Chayu Xian.** Tsarong, Salwin-Kiu Chiang divide, 28°24′N, 13,000 ft, 98°24′E, August 1921, *G. Forrest 20040* (A!, E!, K!, P!).

6. *Gaultheria obovata* (Airy Shaw) P.W.Fritsch & Lu Lu, *comb. et stat. nov.*

≡ *Gaultheria trichophylla* Royle (1835: 260) var. *obovata* Airy Shaw (1941: 324). Type:—MYANMAR. Kachin: Upper Burma [Myitkyina District], [Waingmaw Township], Seinghku Wang, 11,000 ft, 28°08′N, 97°24′E, 17 June 1926, *F. Kingdon Ward 6944* (holotype K!).

Prostrate-ascending shrublet with stems to 8 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, strongly flushed red, occasionally brown proximally, to 4 cm long, with sparse white puberulence and appressed to nearly erect straight or slightly undulate setae, longer setae 0.7–1.2 mm long. Internodes among largest leaves averaging ca. 1.7–3.2 mm. Petioles 0.6–1.3 mm long, abaxially glabrous or with sparse ascending to nearly erect setae abaxially, adaxially with sparse white puberulence in a line, margin entire. Longer leaf blades broadly elliptic to slightly obovate, 6.2–12 × 3.5–6.2 mm, 1.4–2.2 times as long as wide, subcoriaceous, planar, abaxially dull whitish green except glossy and occasionally flushed maroon near margin, at least some leaves with 1 to 9 (to 22) ascending to nearly erect setae scattered on midvein or rarely also on surface but near midvein (longer setae 0.64–1.1 mm

long), adaxially glossy deep green, midvein abaxially raised, not thickened immediately below apical gland, adaxially impressed and with white puberulence proximally, secondary veins 1 to 4 on each side of midvein, faint, adaxially impressed; base broadly cuneate to subrounded; margin serrulate except toward very base, planar or slightly revolute, marginal teeth (setae) 8 to 14 per side, all teeth oriented off leaf surface, longer teeth 0.7–1.3 mm long; apex obtuse to rounded, tip with planar apical gland. Overwintering flower bud pedicels 1.7–3.8 mm, glabrous; overwintering flower buds slightly compressed to subglobose laterally, 1–2.1 × 0.8–2 mm, 0.9–1.3 times as long as wide, glabrous, bracteoles not keeled, margins eciliolate. Flowers ca. 5 mm long. Calyx green proximally with lobes green flushed pale pink, 2.7–4.2 mm long; lobes broadly deltoid, 1.2–2 × 1.4–2.1 mm, adaxially glabrous, apex obtuse, eciliolate, erose. Corolla white, campanulate, 3–4 × 3–5.3 mm; lobes 0.9–2.4 × 0.9–2 mm. Stamens 10; filaments dilated gradually then constricted gradually toward middle, 0.8–1 mm long; anther cells 0.4–0.6 mm long, awns 2 per theca, 0.1–0.3 mm long. Style 1–1.7 mm long; stigma pink. Fruiting pedicel 2–4.1 mm long. Fruiting calyx oblate, crateriform to cupuliform, widely open, 4.5–10 × 6–12 mm, outer wall deep sky blue, inner wall white; calyx lobes erect to slightly incurved, broadly deltoid, 2.8–5 mm long, apex eciliolate, slightly erose. Capsule green, exceeded by calyx lobes.

Illustration—Figure 9.

Images—Figure 6K–N.

Phenology—Flowering June; fruiting July–September.

Habitat and distribution—Coniferous forest, alpine thickets and meadows, in humus and moss among rocks, marble and metamorphics; 3200–4484 m elev. China (Yunnan, Xizang), Myanmar (Kachin).

Discussion—Airy Shaw (1941) described this taxon as a variety of *Gaultheria trichophylla*, apparently because it shares with *G. trichophylla* the presence of notably long stem and leaf marginal setae (ca. 0.7–1.3 mm long). The number of morphological character differences between these taxa, however, is more than sufficient to justify the recognition of this variety as a species. *Gaultheria obovata* differs from *G. trichophylla* most consistently in its longer overwintering flower bud pedicels (1.7–3.8 mm versus 0.6–1.2 mm) and shorter calyx lobes (1.2–2 mm versus 2–3 mm). It also has generally larger leaf blades (6.2–12 × 3.5–6.2 mm versus 3.7–8.5 × 2.5–3.5 mm) with more marginal teeth (8 to 14 per side versus 6 to 12 per side), subglobose overwintering flower buds (versus slightly compressed laterally), and an open (versus usually closed) fruiting calyx. Samples of the two species are recovered as widely separated phylogenetically in the molecular study of Lu *et al.* (2010). In that study, the samples *L. Lu 06-0007* and *06-0019*, designated as *G. trichophylla* 4F and 2L, respectively, were found to group with each other but well apart from the clade formed by the samples *L. Lu 07155*, *07308*, and *07400*, designated as *G. trichophylla* 5B, 1C, and 3G, respectively. The first two samples are here identified as *G. trichophylla*, as in Lu *et al.* (2010), and the latter three as *G. obovata*.

Additional specimens examined—**CHINA. Yunnan: Deqin Xian.** Meili Snow Mtns., Yubeng Village, trail to Dabenying, 3600–3800 m, August 2007, *L. Lu LL-07400* (CAS!); E slope of Meili Xue Shan, just below 1991 Sino-Japanese Base Camp at river, W of Upper Yubeng Village, 3563 m, N28.39948°, E98.76363°, 10 September 2011, *L. Lu & P.W. Fritsch LL-2011-21* (CAS!, GH!); Melixueshan (Meili Snow Mtns.), foot trail from Yubeng Village to Xiaonong (sacred meadow), W of Xiaonong, 3800–3900 m, 28°23′56″N, 98°45′09″E, 23 July 2001, *H.H. Schmidt et al. 4097* (CAS!); Tehching (Atuntze), Miyetzimu, 3200 m, 22 June 1937, *T.T. Yü 8702* (KUN!); Zhashibugong, 4100 m, 6 November 1937, *T.T. Yü 10642* (KUN [2]!). **Gongshan Dulongzu Nuzu Zizhixian.** Bangdang Xiang, Biluo Xue Shan, Balagong spur, trail from Dimaluo to Balagong Pass, 3599 m, 27°57′49.8″N, 98°44′26.4″E, 23 September 2013, *L. Lu LL-2013-41* (CAS!, GH!, KUN!); Bangdang Township, Biluo Xue Shan, vicinity of Sila Pass, 3912 m, 27°59′46.0″N, 98°47′23.4″E, 24 September 2013, *L. Lu LL-2013-49* (CAS!, GH!, KUN!); Upper Kiukiang Valley, (Clulung) Chialahmuto, 3600–4000 m, 7 August 1938, *T.T. Yü 19732* (A!, E!, KUN!). **Xizang: Chayu Xian.** Linzhi Prefecture, rd from Bomê to Mêdog, Galongla Pass, 4280 m, 29°45′22″N, 95°42′18″E, 25 September 2009, *H. Sun et al. SunH-07ZX-2664 p.p.* (KUN! mixed with *G. eciliata* and *G.* cf. *sinensis*). **Gongbujiangda Xian.** Nambu La, 14,800 ft, 24 September 1947, *F. Ludlow et al. 15775* (E!). **Motuo Xian.** Duoxiongla, trail to Lage, 3500–3700 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07155* (CAS!); Pailong Village, trail from Linzhi to Pailong, 3700 m, 7 August 2007, *L. Lu LL-07308* (CAS!). **Zuogong Xian.** Pi-tu La, 14,000–15,000 ft, 7 September 1922, *F. Kingdon Ward 5389* (E!). **MYANMAR. Kachin: Putao District.** Nogmung Township, Adung Valley, 12000–13000 ft, 15 June 1931, *F. Kingdon Ward 9639 p.p.* [A; mixed with *G. thymifolia* Stapf ex Airy Shaw (1941: 322)].

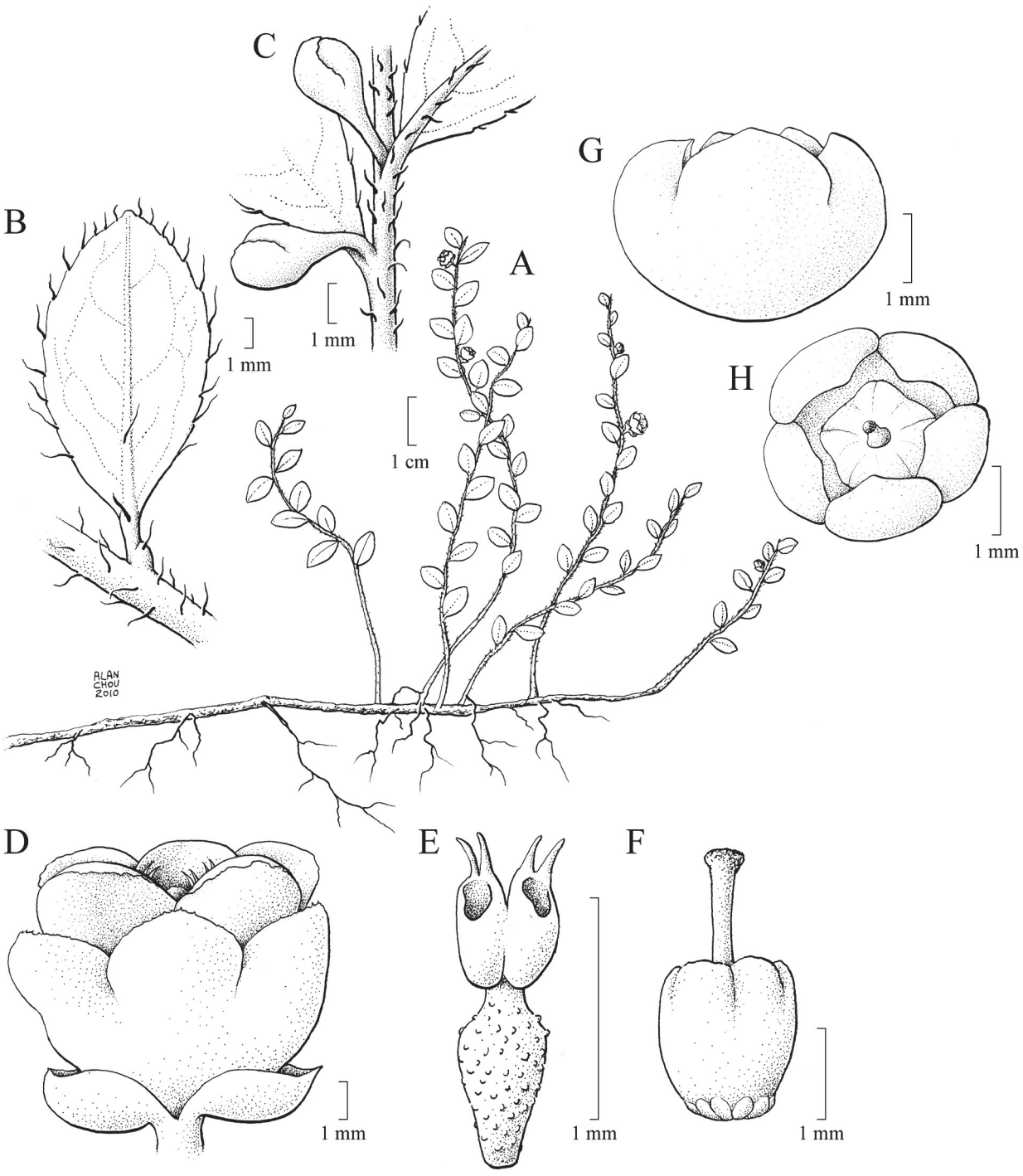

FIGURE 9. *Gaultheria obovata*. **A.** Flowering plant. **B.** Section of branchlet with leaf in abaxial view. **C.** Section of branchlet with leaf bases in abaxial (right) and adaxial (left) view, and flower buds. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A–B, D drawn from the holotype, *F. Kingdon Ward 6944*, K; C drawn from *L. Lu LL-2013-49*, CAS; E drawn from *L. Lu LL-07308*, CAS; F drawn from *L. Lu LL-07155*, CAS; G–H drawn from *L. Lu & P.W. Fritsch LL-2011-21*, CAS, and images of the living plant.)

7. *Gaultheria sinensis* J.Anthony in Anonymous (1933: 19).

Lectotype (designated here):—CHINA. [Yunnan: Deqin Xian], SE Tibet, Ka-gwr-pu, Mekong-Salwin divide, 12,000 ft, 28°25′N, July 1917, *G. Forrest 14216 p.p.* (E [upper plant of two on sheet]!, isolectotype K!).

Many-branched prostrate-ascending shrublet with stems to 10 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, strongly flushed red above, occasionally brown proximally, to 4 cm long, apparently not puberulent or with sparse white puberulence and ascending or uncinate straight setae, longer setae 0.26–0.48 mm long. Internodes among largest leaves averaging ca. 0.8–2.5 mm. Petioles 0.3–1 mm long, abaxially glabrous or with sparse appressed or ascending setae, adaxially with white puberulence in a line, margin entire or 1- to 2-toothed per side. Longer leaf blades broadly to narrowly elliptic, obovate, or oblanceolate, shorter leaves often rounder, 4.5–10.7 × 2.9–4.9 mm, 1.5–2.7 times as long as wide, subcoriaceous or coriaceous, planar or some blades cupped, abaxially dull whitish green except glossy and occasionally flushed maroon near margin, abaxially glabrous or at least some leaves with 1 to 11 appressed to ascending setae scattered on midvein (longer setae 0.34–0.5 mm long), adaxially glossy green, midvein abaxially raised, not thickened immediately below apical gland, adaxially impressed and with white puberulence proximally, secondary veins obscure or faintly 1 to 4 on each side of midvein; base cuneate to subrounded; margin serrulate throughout, slightly thickened, planar or slightly revolute, occasionally more strongly so proximally, marginal teeth (setae) 6 to 12 per side, all teeth oriented off leaf surface or in at least some leaves lying atop or adjacent to upper leaf surface, longer teeth 0.1–0.4 mm long; apex acute to subrounded, at least some leaves with slightly downward-pointing apical gland, other leaves with planar gland. Overwintering flower bud pedicels 2.2–5 mm long, glabrous; overwintering flower buds slightly compressed to subglobose laterally, 1.7–3 × 1.5–2.8 mm, 0.9–1.6 times as long as wide, glabrous, bracteoles not keeled, margins eciliolate. Flowers 4.1–5.5 mm long. Calyx dull pink to pale maroon, occasionally green proximally, 2.5–3.5 mm long; lobes deltoid or ovate-deltoid, 1.5–2.7 × 1.6–2.5 mm, adaxially glabrous, apex acute or short-acuminate, eciliolate, not or slightly erose. Corolla white or white flushed dull purplish pink, campanulate, 3.6–4.5 × 3.3–6 mm; lobes 1–3 × 1.2–2.5 mm. Stamens 10; filaments dilated gradually toward upper middle, 0.8–1.6 mm long; anther cells 0.6–0.8 mm long, awns 2 per theca, 0.2–0.4 mm long. Style 0.7–2.2 mm long; stigma pink. Fruiting pedicel 2.8–5 mm long. Fruiting calyx oblate, crateriform to broadly cupuliform, open, 5–10 × 7–15 mm, outer wall deep sky blue, inner wall white; calyx lobes erect, broadly deltoid, 3–3.5 mm long, apex eciliolate, not erose. Capsule green, exceeded by or often equal to or exceeding calyx lobes.

Illustration—Figure 10.

Images—Figure 8A–F.

Phenology—Flowering June–September; fruiting August–October.

Habitat and distribution—Coniferous forest, alpine meadows and thickets with scattered bamboo, limestone, marble, granite, and metamorphics, rock faces, along banks of road cuts, borders of swamps, in moss and humus, 2870–4400 m elev. China (Yunnan, Xizang), India (Arunachal Pradesh), Myanmar (Kachin).

Discussion—The specimens cited by J. Anthony in the protologue of *Gaultheria sinensis* constitute a mixture of several species. The holotype *G. Forrest 14216* at E contains two plants on one sheet: the upper plant corresponds to what has become the current concept of *G. sinensis*, whereas the lower plant matches the morphology of *G. crassifolia*. We have lectotypified *G. sinensis* on the upper specimen. With the possible exception of two collections not seen by us (*G. Forrest 13428* and *14735*), the paratypes cited all belong to species other than *G. sinensis*: *R.J. Farrer 1191* and *1622* are *G. ciliisepala*, *G. Forrest 12938* is the type of *G. major*, *G. Forrest 20040* and *H.F. von Handel-Mazzetti 8243* are also *G. major*, and *G. Forrest 19286* (cited as *19268*, presumably a transcription error) is the type of *G. crassifolia*. To clarify the circumscription of *G. sinensis*, we provide a revised description of the species and additional specimens examined.

Additional specimens examined—**CHINA. Yunnan: Deqin Xian.** [Yanmen Xiang], Mekong-Salwin Divide, near Cizhong, Sila, 3800 m, 12 July 1940, *K.M. Feng 5333* (KUN! [2]); Salwin-Mekong Divide, mtns. behind Yongzi Village, 3700–3800 m, 16 August 1940, *K.M. Feng 6724* (KUN! mixed with *G. major*); Yanmen Xiang, Biluo Xue Shan, E slope just below Sila Pass, 3936 m, 28°00′8.5″N, 98°47′54.8″E, 24 September 2013, *L. Lu LL-2013-52* (CAS!, GH!, KUN!). **Fugong Xian.** Lishadi Xiang, Yaduo Cun, along trail between rd to Myanmar through Yaping Pass and border marker S of pass, E side of Gaoligong Shan, 3699 m, 27°12′17.5″N, 98°41′45.0″E, 2 July 2014, *L. Lu LL-2014-28* (CAS!, KUN!). **Gongshan Dulongzu Nuzu Zizhixian.** Champutong, 3500–3700 m, 10 September 1940, *K.M. Feng 7675 p.p.* (KUN! mixed with *G. eciliata*); Dulongjiang Xiang, E side of pass of rd from Gongshan to Kongdang, W side of Gaoligong Shan near crest of range, 3670 m, 27°46′18″N, 98°27′02″E, 5 October 2002, *Gaoligong Shan*

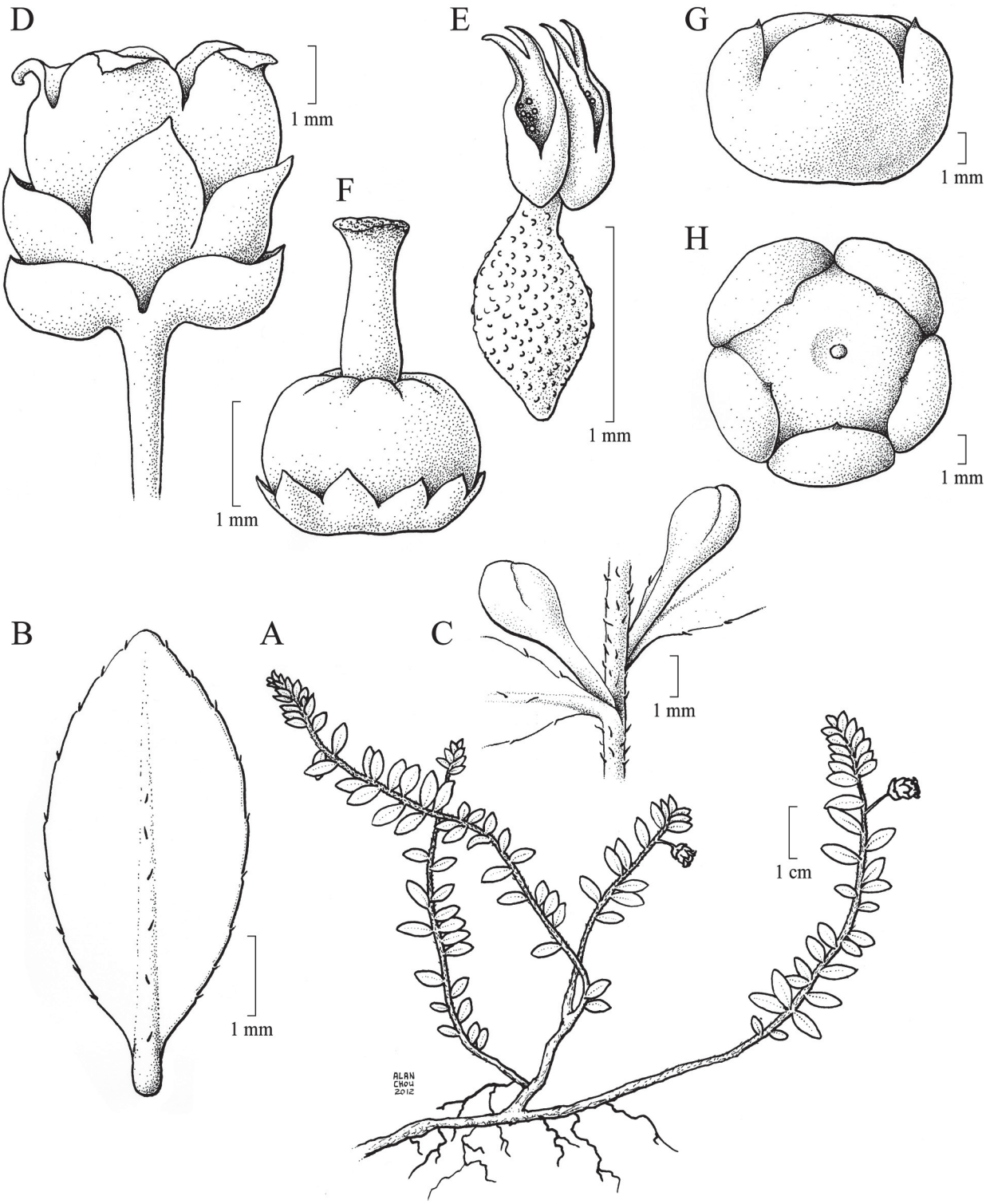

FIGURE 10. *Gaultheria sinensis*. **A.** Flowering plant. **B.** Leaf, abaxial view. **C.** Section of branchlet with leaf bases in abaxial (left) and adaxial (right) view, and flower buds. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A–B, D–F drawn from *F. Ludlow, G. Sherriff & H.H. Elliot 13146*, E; C, G–H drawn from *L. Lu LL-2013-14*, CAS.)

Biodiversity Survey 17007 p.p. (CAS! mixed with *G. hypochlora*, KUN! mixed with *G. hypochlora*); Bingzhongluo Xiang, ca. 3 direct km SSW of Gawagapu Mtn. and ca. 16 direct km WSW of Bingzhongluo in next basin E of Chukuai Lake, E side of Gaoligong Shan, 3770 m, 27°59′2.1″N, 98°28′13.6″E, 29 August 2006, *Gaoligong Shan Biodiversity Survey 31589* (CAS!); Cikai Zheng, ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 27°45′41.7″N, 98°27′2.3″E, 13 August 2006, *Gaoligong Shan Biodiversity Survey 32150* (CAS!); Cikai Zheng, ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from

Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 27°45′41.7″N, 98°27′2.3″E, 13 August 2006, *Gaoligong Shan Biodiversity Survey 32170* (CAS!); [Cikai Zheng], Bingzhongluo Xiang, ca. 2.1 direct km S of Gawagapu Mtn. and ca. 15.2 direct km WSW of Bingzhongluo in next basin E of Chukuai Lake, E side of Gaoligong Shan, 4000 m, 27°59′29.3″N, 98°28′36.3″E, 28 August 2006, *Gaoligong Shan Biodiversity Survey 32809 p.p.* (CAS! mixed with *G. major*); Dongshaofang Pass, Gaoligongshan, 3200–3500 m, 4 June 2006, *L. Lu 06-0014 p.p.* (CAS! mixed with *G. ciliisepala* and *G. major*); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-14* (CAS!, GH!, KUN!); Bangdang Xiang, Biluo Xue Shan, Balagong spur, trail from Balagong Pass to Siwanongba Valley, 3659 m, 27°58′35.3″N, 98°46′3.4″E, 23 September 2013, *L. Lu LL-2013-45* (CAS!, KUN!); [Cikai Zheng], Gongshan to Dulongjiang, E slope of Gaoligong Shan, 3600 m, 26 July 1982, *Qinghai-Xizang Expedition 8726* (KUN [2]!); Binzhongluo Xiang, Lung-pan-la Champutung, 3000 m, October 1935, *C.W. Wang 67099* (A!, KUN!). **Heqing Xian.** Xintun, Dafudi, 2870 m, 5 September 1984, *J.H. Yang 360* (KUN!). **Luquan Yizu Miaozu Zizhixian.** Wumeng Mtn., Daheiqin, 3650 m, 26 May 1952, *P.Y. Mao 1026* (KUN [2]!). **Xizang: Bomi Xian.** Vicinity of Galong Pass, 23 August 1983, *Chen Shuzhi & Li Bosheng 7026* (KUN!). **Chayu Xian.** Deyang La, 13,000 ft, 6 June 1947, *F. Ludlow* & *G. Sherriff 15158* (A!, E [2]!); Ri Dong Qu, 4100 m, 9 September 1982, *Qinghai-Xizang Expedition 10228* (KUN!). **Gongbujiangda Xian.** Lusha Chu, 12,500 ft, 10 June 1938, *F. Ludlow et al. 4750* (A!, E!); Doshang La, 13,000 ft, 17 July 1938, *F. Ludlow et al. 5293* (A!, E!); above Showa Dzong, 11,000 ft, 11 June 1947, *F. Ludlow et al. 13146* (E!). **Motuo Xian.** Gedang, Bengbeng Mtn., S side, 4000–4400 m, 9 October 1982, *B.S. Li & S.Z. Chen 01185* (KUN!); Duoxiongla Mtn., N slope, 4000 m, 13 July 1983, *B.S. Li & S.Z. Chen 05484* (KUN!); Duoxiongla, trail to Lage, 3200–3750 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07128* (CAS!); Duoxiongla, trail to Lage, 3200–3750 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07130* (CAS!); Duoxiongla, trail to Lage, 3200–3750 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07133* (CAS!, GH!, KUN!); Duoxiongla Pass, 3700 m, 30 July 1974, *Qinghai-Xizang Expedition 74-3770* (KUN [2]!). **Bomi or Motuo Xian.** Jingzhula Mtn. Pass, W side, 3800–4300 m, 5 September 1982, *B.S. Li Bosheng & S.Z. Chen 00701* (KUN!).

INDIA. Arunachal Pradesh: Delei Valley, 11,000–12,000 ft, 28°15′N, 96°35′E, 28 August 1928, *F. Kingdon Ward 8605* (K!).

MYANMAR. Kachin: Myitkyina District. Waingmaw Township, Seinghku Wang, 13,000 ft, 28°08′N, 97°24′E, 10 July 1926, *F. Kingdon Ward 7094* (K!).

8. *Gaultheria stenophylla* P.W.Fritsch & Lu Lu, *sp. nov.*

Haec species *Gaultheria hypochlora* Airy Shaw (1941: 324) simillima, sed ab eo laminis longioribus 1–2.4 plo longioribus quam latioribus, angustis ellipticis vel leviter oblanceolatis, setis abaxialibus 1–35, positis secus vel prope costam, calyce fructifero plerumque ellipsoideo vel longo-cupuliformi, interdum cupuliformi differt.

Type:—CHINA. Yunnan: Gongshan Dulongzu Nuzu Zizhixian, Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along road from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-7* (holotype KUN!, isotypes CAS!, GH!).

Ascending-erect or sometimes slightly pendent shrublet with stems to 15 cm long from horizontal stolons, hermaphroditic. Current-year branchlets pale green, occasionally flushed red, to 7 cm long, with sparse white puberulence and appressed or appressed-uncinate straight or curved setae, longer setae 0.28–0.74 mm long. Internodes among largest leaves averaging ca. 1.3–5 mm. Petioles 0.4–1.2 mm long, abaxially glabrous or with sparse uncinate-appressed setae, adaxially with white puberulence in a line, margin entire or 1- or 2-toothed per side; longer leaf blades narrowly elliptic to slightly oblanceolate, shorter leaf blades often less narrow, (6.2–)7–14(–17) × 2.4–5(–5.5) mm, 2–3.4 times as long as wide, subcoriaceous to occasionally coriaceous, planar, abaxially dull whitish green except glossy green and often flushed maroon near margin, at least some leaves with 1 to 35 appressed setae scattered on midvein or occasionally also on surface but usually near midvein (longer setae 0.18–0.4 mm long), adaxially glossy deep green, midvein abaxially raised, not thickened to slightly thickened immediately below apical gland, adaxially impressed and with white puberulence proximally, secondary veins abaxially obscure or 2 or 3 on each side of midvein, adaxially obscure; base cuneate to subrounded; margin serrulate throughout, slightly thickened, slightly to strongly revolute, marginal teeth (setae) 8 to 15 per side, all teeth oriented off leaf surface, longer teeth 0.12–0.2.8 mm long; apex acute to subrounded, tip with planar or occasionally downward-pointing apical gland. Overwintering flower bud

pedicels 0.8–2.2(–3.7) mm long, glabrous or with white puberulence and/or minute setae proximally; overwintering flower buds compressed laterally, 2–3.6 × 1.1–2.1 mm, 1.4–1.9 times as long as wide, glabrous, bracteoles keeled, margins often sparsely ciliolate at apex. Flowers 5–7 mm long. Calyx green, 3.7–4.5 mm long; lobes narrowly ovate-deltoid, 2–3.2 × 1.5–2.4 mm, adaxially (and rarely abaxially at apex) pubescent, apex acute, ciliolate, not erose. Corolla white, campanulate, 4–6.5 × 4.5–9 mm; lobes 2.2–4 × 2–2.9 mm. Stamens 10; filaments dilated gradually then abruptly constricted toward middle, 0.9–1.5 mm long; anther cells 0.7–1.1 mm, awns 2 or occasionally 1 per theca, 0.3–0.7 mm long. Style 1.8–3.5 mm long; stigma pink. Calyx lobes glabrous or sparsely pubescent adaxially, apex sparsely to densely ciliolate, smooth. Fruiting pedicel 1.7–7.2 mm long. Fruiting calyx prolate, usually ellipsoid or long-cupuliform, occasionally cupuliform, open but not widely so and sometimes nearly closed, 8–16 × 10–14 mm, outer wall dark blue or occasionally light sky blue or pure white, inner wall white; calyx lobes erect to incurved, long-deltoid, 3.5–7 mm long, apex sparsely ciliolate, not erose. Capsule green, exceeded by calyx lobes.

Illustration—Figure 11.

Images—Figure 8G–N.

Phenology—Flowering May; fruiting July–October.

Etymology—The species is named for its narrowly elliptic leaf blades.

Habitat and distribution—Mixed evergreen broadleaved or deciduous forests, coniferous forests, alpine meadows and thickets with scattered bamboo, mixed granite and metamorphics, banks of road cuts, among rocks, in humus and moss; 2400–3636 m elev. Bhutan, China (Yunnan, Xizang), India (Arunachal Pradesh, Sikkim).

Discussion—Many collections of *Gaultheria stenophylla* have been made over the last 100+ years, apparently beginning with G.H. Cave's collection from "Kanghasi" in 1912; only now, however, has it been recognized as a distinct species. Fritsch *et al.* (2008) identified several specimens collected from the Gaoligong Mountains and adjacent areas as *G. hypochlora* but noted their aberrantly narrow leaves. On this basis, Fritsch *et al.* (2008) suggested that these specimens might not be conspecific with *G. hypochlora* and that they were deserving of further study. Our field and herbarium observations confirm that these narrow-leaved specimens are distinct from *G. hypochlora* and we thus recognize them here as *G. stenophylla*. See also Discussion under *G. ciliisepala*.

Gaultheria stenophylla exhibits a fruiting calyx color polymorphism, with fruiting calyces colored either dark blue, pale blue, or white on separate plants (Figs. 8M–N).

Depauperate plants of this species with smaller stature, leaves, and fruit have been found growing on a thin moss substrate over sloping flat rock faces (e.g., *Gaoligong Shan Biodiversity Survey 16918* and *L. Lu LL-2013-10*) but match the type of *Gaultheria stenophylla* in all other respects.

The specimen *S. Panda 29940* (CAL not seen), from Sikkim, India, was reported as *Gaultheria sinensis* (Panda 2005) but may be *G. stenophylla*. The leaves in the description and illustration are too long for those of *G. sinensis*, a species otherwise unreported for Sikkim, whereas *G. stenophylla* is known for Sikkim from the collection of *D.G. Long et al.* 742 (E!).

***Paratypes*—COUNTRY UNKNOWN.** East Himalaya, Kanghasi, 11,000 ft, 25 June 1912, *G.H. Cave s.n.* (E!). **BHUTAN.** Rudo La (E side), 10,500–12,000 ft, 18 May 1949, *F. Ludlow et al. 18885* (E!); Lao, Trashiyangsi Chu, 9500 ft, 10 May 1949, *F. Ludlow et al. 20617A* (E!).

CHINA. Yunnan: Fugong Xian. Yaduo Cun, above Shibali to Myanmar border at Yaping Yakou, N side of N fork of Yamu He, E side of Gaoligong Shan, 2750 m, 27°10′23″N, 98°46′03″E, 10 August 2005, *Gaoligong Shan Biodiversity Survey 26921* (CAS!). **Gongshan Dulongzu Nuzu Zizhixian.** Cikai Zheng, rd from Gongshan to Kongdang, E side of Gaoligong Shan, 3340 m, 27°46′50″N, 98°28′06″E, 1 October 2002, *Gaoligong Shan Biodiversity Survey 16817* (CAS!, KUN!); Cikai Zheng, N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into upper reaches of Pula He, 3350 m, 27°47′04″N, 98°27′38″E, 3 October 2002, *Gaoligong Shan Biodiversity Survey 16918* (CAS!, KUN [2]!); Cikai Zheng, N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into upper reaches of Pula He, 3429 m, 27°47′35″N, 98°27′57″E, 3 October 2002, *Gaoligong Shan Biodiversity Survey 16950 p.p.* (CAS! mixed with *G. hypochlora*, KUN! mixed with *G. hypochlora*); Cikai Zheng, E side of Gaoligong Shan at Km 48, rd from Gongshan to Kongdang, 3330 m, 27°47′04″N, 98°27′40″E, 11 November 2004, *Gaoligong Shan Biodiversity Survey 22409* (CAS!); Cikai Zheng, E side of Gaoligong Shan at Km 48 on rd from Gongshan to Kongdang, 3330 m, 27°47′04″N, 98°27′40″E, 11 November 2004, *Gaoligong Shan Biodiversity Survey 23018* (CAS!); Cikai Zheng, Heipu Pass, rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 27°46′19.6″N, 98°26′47.6″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32036* (CAS!); Cikai Zheng, Heipu Pass, rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 27°46′19.6″N, 98°26′47.6″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32053* (CAS [2]!); Cikai Zheng, Heipu Pass, rd from Gongshan

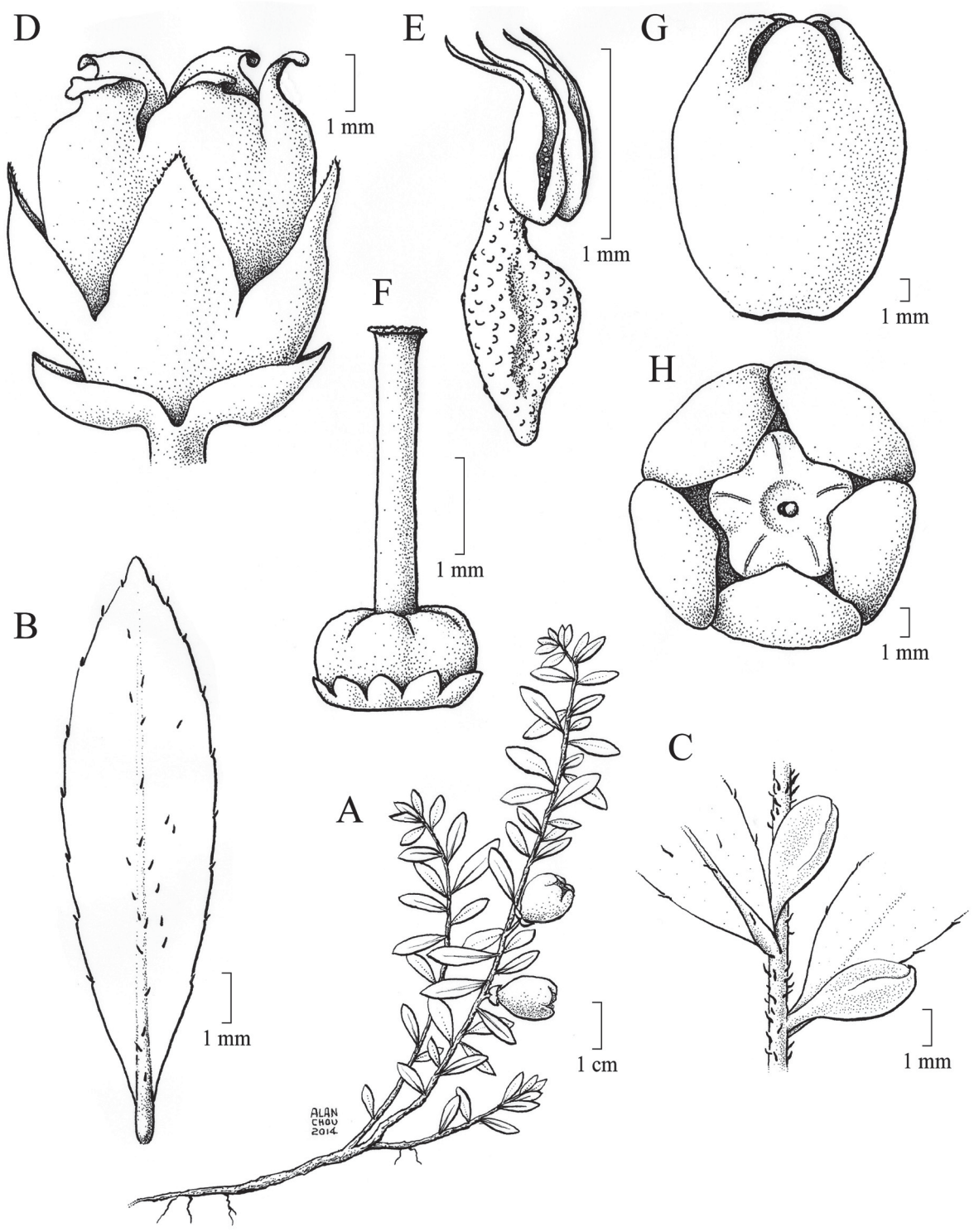

FIGURE 11. *Gaultheria stenophylla*. **A.** Fruiting plant. **B.** Leaf, abaxial view. **C.** Section of branchlet with leaf bases in abaxial (left) and adaxial (right) view, and flower buds. **D.** Flower. **E.** Stamen. **F.** Nectar glands and gynoecium. **G.** Fruit, lateral view. **H.** Fruit, apical view. (A drawn from *L. Lu LL-2013-7*, CAS; B, D–F drawn from *F. Ludlow, G. Sherriff & G. Taylor 3733*, A; G–H drawn from *L. Lu LL-07118*, CAS, and images of the living plant.)

to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 27°46′19.6″N, 98°26′47.6″E, 12 August 2006, *Gaoligong Shan Biodiversity Survey 32060* (CAS!); Cikai Zheng, ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 27°45′41.7″N, 98°27′2.3″E, 13 August 2006,

Gaoligong Shan Biodiversity Survey 32127 (CAS!); Cikai Zheng, ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 27°45′41.7″N, 98°27′2.3″E, 13 August 2006, *Gaoligong Shan Biodiversity Survey 32150A* (CAS [2]!); Cikai Zheng, near Yipsaka Lake, 2.1 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3450 m, 27°45′18.1″N, 98°27′21″E, 13 August 2006, *Gaoligong Shan Biodiversity Survey 32235* (CAS!); [Cikai Zheng], Gaoligongshan, rd from Qiqi to Twelfth Bridge, 2400–2600 m, 3 June 2006, *L. Lu & R.F. Lu 06-0040* (CAS!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3335 m, 27°46′10.4″N, 98°26′49.2″E, 11 September 2013, *L. Lu LL-2013-1* (CAS!, GH!, KUN!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3335 m, 27°46′10.4″N, 98°26′49.2″E, 11 September 2013, *L. Lu LL-2013-2* (CAS!, KUN!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-8* (CAS!, KUN!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3400 m, 27°46′42.4″N, 98°27′29.4″E, 13 September 2013, *L. Lu LL-2013-9* (CAS!, GH!, KUN!); Cikai Zheng, Gaoligong Shan, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, 3360 m, 27°47′8.6″N, 98°27′37.4″E, 13 September 2013, *L. Lu LL-2013-10* (CAS!, KUN!); Cikai Zheng, Gaoligong Shan, Qiqi River drainage, along trail from No. 12 Bridge to Dong Shao Fang and pass, 2770 m, 27°42′54.3″N, 98°30′8.9″E, 17 September 2013, *L. Lu LL-2013-28* (CAS!, KUN!); Dulongjiang Xiang, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, W side of Gaoligong Shan, 3357 m, 27°46′30.0″N, 98°26′49.1″E, 26 June 2014, *L. Lu LL-2014-5* (CAS!, KUN!); Cikai Zheng, vicinity of tunnel at Heipu Pass along rd from Gongshan to Dulongjiang, E side of Gaoligong Shan, 3335 m, 27°46′10.4″N, 98°26′49.2″E, 26 June 2014, *L. Lu LL-2014-8* (CAS!, KUN!); Cikai Zheng, Danzhu Cun, rd from Danzhu to Myanmar, along Damawadi He (N branch of W-most origin of Danzhu He), E side of Gaoligong Shan, 3243 m, 27°37′25.0″N, 98°34′32.3″E, 28 June 2014, *L. Lu LL-2014-11* (CAS!, KUN!); Cikai Zheng, Danzhu Cun, rd from Danzhu to Myanmar, along Damawadi He (N branch of W-most origin of Danzhu He), E side of Gaoligong Shan, 2880 m, 27°38′6.5″N, 98°36′25.0″E, June 28, 2014, *L. Lu LL-2014-12* (CAS!, KUN!); Dulongjiang Xiang, along rd from Gongshan to Dulongjiang, W side of Gaoligong Shan, 3275 m, 27°49′29.1″N, 98°26′56.7″E, 29 June 2014, *L. Lu LL-2014-22* (CAS!, KUN!); from Jidu Forestry Station to Dongshaofang, 2600 m, 22 July 1982, *Qinghai-Xizang Expedition 8345* (KUN [2]!); [Dulongjiang Xiang], Taron-taru divide, Ahtehmai, 2500 m, 29 August 1938, *T.T. Yü 20049* (A!, E!, KUN!); [Dulongjiang Xiang], Salwin-Kiukiang Divide, Lunguailaka, 3600 m, 14 September 1938, *T.T. Yü 20262* (A!, E!, KUN!). [Dulongjiang Xiang], Salween-Kiu Chiang Divide, Lunguailaka, 3200 m, 16 September 1938, *T.T. Yü 20324* (A!, E!, KUN!). **Xizang: Motuo Xian.** Duoxiongla, trail to Lage, 3200–3400 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07118* (CAS!); Duoxiongla, trail to Lage, 29°29′N, 94°55′E, 3200–3400 m, 24 July 2007, *L. Lu LL-07119* (CAS!, GH!, KUN!); Duoxiongla, trail to Lage, 29°29′N, 94°55′E, 3200–3400 m, 24 July 2007, *L. Lu LL-07122* (KUN!); Duoxiongla, trail to Lage, 3200–3750 m, 29°29′N, 94°55′E, 24 July 2007, *L. Lu LL-07134 p.p.* (CAS! mixed with *G.* cf. *sinensis*). Lage, 3250 m, 31 July 1974, *Qinghai-Xizang Expedition 74-3778* (KUN [2]!); Lage, Duoxiongla Mountain, 3300 m, 25 October 1992, *H. Sun, Z.K. Zhou, H.Y. Yü Expedition to Mêdog 0623* (KUN!).

INDIA. Arunachal Pradesh. Pachakshiri District, Nyug La, 8000–9500 ft, 28°45′N, 94°00′E, 11 May 1938, *F. Ludlow et al. 3733* (A!, E!). **Sikkim:** West District, Phedang to Tsoka, S of Dzongri, 3300 m, 27°26′N, 88°10′E, 26 July 1992, *D.G. Long et al. 742* (E!).

Note on conservation assessment—In accordance with IUCN (2014) guidelines, we classify the eight species enumerated in this study as least concern (LC). This is based on the relatively high number of individuals in populations, the tolerance of these plants for disturbance, such as road cuts and low-intensity livestock grazing, and their occurrence in protected areas of the Gaoligong Shan National Nature Reserve and other relatively intact habitats. Proposed large-scale mining in some areas of occurrence, such as in the largely unprotected Biluo Snow Mountains, could eventually warrant reassessment of this categorization for some species.

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