

Notes on the genus *Usnea* (lichenized *Ascomycota*, *Parmeliaceae*). V.

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Abstract. Type material of twelve species of *Usnea* related to Asia and South Africa were studied and one species from North America is newly described. Holotype specimens of eight Chinese taxa described in 1975 were synonymized as follows: *U. mengyangensis* is lectotypified and synonymized with *U. aciculifera*. *Usnea recurvata* and *U. subrectangulata* are synonymized with *U. baileyi*. *Usnea kirinensis* is synonymized with *U. barbata* s.str. *Usnea crassiuscula* and *U. yunnanensis* (= *U. australis* J.D. Zhao et al., nom. illeg. non Fr.) are synonymized with *U. bismolliuscula*. *Usnea iteratocarpa* is synonymized with *U. cristatula* (new to Asia, China). *Usnea decumbens* is synonymized with *U. intumescens* (new to Asia, China). *Usnea entoviolata* and *U. roseola* are synonymized with *U. fragilis* (new to Asia, China, India, Japan). The lectotype of *Usnea trichodeoides* was found to belong to the *Usnea pectinata* aggr. and consequently *U. montis-fuji* was resurrected for *U. trichodeoides sensu* Ohmura. *Usnea ceratina* and *U. trichodeoides* are excluded from the Japan lichen flora. *Usnea macaronesica* a recently described Macaronesian and South American species is synonymized with the Asian taxa *U. pycnoclada*. *Usnea chicitae* is described as a new species endemic of the Southern Appalachian Mountains. It is characterized by stipitate efflorescent soralia, a *tenuicorticata*-type of CMA and the presence of salazinic and psoromic acid in the medulla.

Key words: Appalachian Mountains, Asia, China, Japan, systematics, taxonomy, types, *Usnea chicitae* sp. nov.

Introduction

Usnea Adans. is a hyperdiverse lichen-forming fungal genus that forms a strongly supported monophyletic lineage within the *Parmeliaceae* (Crespo et al. 2007; Divakar et al. 2015). It is a fruticose lichen genus with radial symmetric branches containing usnic acid in the cortex and a central axis (seen by stretching a branch). Although the genus is easily recognizable, the species are often difficult to characterize and distinguish. This is due to their high plasticity towards environmental variations (Clerc 1998). Motyka's monograph (Motyka 1936–1938) was an early milestone in the worldwide knowledge of this genus. Microcrystal tests developed by Asahina (1956) and later the advent of thin layer chromatography (Culberson & Kristinsson 1970; Culberson 1972) provided a first insight into the chemical diversity of the genus, especially through the work of Swinscow & Krog (1974, 1975,

1976a–c, 1978, 1979) on East African *Usnea* species. CMA measurements developed by Clerc (1984, 1987) and based on Asahina's observations (Asahina 1956) added important characters to distinguish species (Clerc & Naciri 2021). Recently DNA sequencing opened a new area in the systematics of this genus (Articus et al. 2002; Ohmura 2002, 2008, 2020; Wirtz et al. 2006; Kelly et al. 2011; Truong et al. 2013, Mark et al. 2016; Gerlach et al. 2019; Ohmura & Clerc 2019, 2021, 2023; Lücking et al. 2020), bringing to light a high, and so far, hidden variability (Gerlach et al. 2019, 2020). Nowadays, the species number of this genus is truly uncertain. Numbers between 300 (Kirk et al. 2008) and 600 species (Wirtz et al. 2006) were mentioned without real evidence. As a matter of fact, there are more than 1,200 species names published (Clerc unpublished). Many of these names are synonyms (Clerc 1998), but many species were recently described and still more await descriptions. The screening and study of the type material of these 1,200 species is a long and tedious work. Modern accounts of the genus *Usnea* on the Asian continent were published by Awasthi (1986) for India, Ohmura (2001, 2012), Ohmura et al. (2010), and Lin (2007) for Japan and Taiwan, Golubkova et al.

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(1996) for Russia and Ohmura et al. (2017) for the Far East Russia. Zhao et al. (1975) described 12 new species occurring in China. One aim of the present study was to examine these taxa in light of the most recent knowledge on the systematics of the genus. We focused here mainly on sorediate species described by these authors. Some taxa described by Zhao et al. (1975), especially the apotheciate ones, need further investigations and will be treated in a forthcoming paper. Furthermore, studies of some Asian and African type material of old names allowed us to reconsider the status of today's accepted names. Finally, a new species based mainly on material collected in 1989, endemic in the Appalachian Mountains, is here described as new.

Material and methods

The type specimens of the species studied here and deposited in BM, DUKE, G, H, HMAS, LBL, TNS, TUR, UPS, and W were studied morphologically, anatomically and chemically. Morphology and anatomy were studied with a Leica stereomicroscope. Anatomical measurements of the cortex, medulla and central axis were carried out in longitudinal sections of branches at 40 \times magnification. The percentage thickness of cortex/medulla/axis of the total branch diameter (CMA), as well as the ratio axis/medulla (A/M) and the ratio medulla/cortex (M/C) of all the cited specimens were calculated according to Clerc (1987) and (Clerc & Naciri 2021). For measurements of the fistulose axis in eumitrioid species, the %TBA value was used (Truong & Clerc 2013).

Chemical analyses were performed by thin-layer chromatography (TLC), following Culberson & Ammann (1979), with solvent B modified according to Culberson & Johnson (1982).

Taxonomy

Usnea aciculifera Vain., Bot. Mag. Tokyo 35: 45. 1921.

Fig.: Clerc (2016, fig. 5)

Type: [Japan] Honshu, Prov. Kozuke, in arboribus, 4 August 1913, A. Yasuda 195 (TUR-V00620! – lectotype!). Chemistry: usnic, stictic, constictic, cryptostictic, menegazziaic and norstictic acids. %C/M/A/: 9.5/22.5/35, A/M=1.6, M/C=2.4.

= *Usnea mengyangensis* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 97. 1975, syn. nov. (Fig. 1A–C)

Type: [China] Yunnan, Mengyang, 24 November 1960, Zhao Ji-ding & Chen Yu-ben 3723 (HMAS-2508, thallus 3 – lectotype, selected here). Chemistry: usnic, stictic, constictic, cryptostictic, menegazziaic and norstictic acids (TLC-P. Clerc 2018/10). %C/M/A/: 7.0/27.5/31, A/M=1.1, M/C=4.

Notes. For a description of *U. aciculifera*, see Ohmura (2001). Diagnostic characters for this species are the shrubby to subpendent thallus, the basal part that is pale or concolorous with branches, the non-constricted lateral branches, the small, punctiform soralia that are \pm even with the cortex, often building irregular patches where

soralia are more concentrated, the short and numerous isidiomorphs and the stictic acid gr. in the medulla.

The holotype of *Usnea mengyangensis* (Fig. 1A) contains six thalli of which four correspond to *U. fragilis* Stirt. one to *U. aciculifera* Vain. and one to *Usnea* sp. The protologue indicates “soredia isidiosa” and “K–, Pd–” as usable, diagnostic characters. The only thallus (thallus 3) glued on the holotype cardboard with “soredia isidiosa” is *U. aciculifera* (Fig. 1B). Although this species is K+ yellow, Pd+ orange (stictic acid gr.) we decided to lectotypify on thallus 3 because of the obvious character “isidiose soredia” (Fig. 1C). Soralia with isidiomorphs are totally absent in all five other thalli glued on the cardboard.

Usnea aciculifera is a common corticolous, more rarely saxicolous species in Japan (Ohmura 2001), China (Wei 2020), India and Nepal (Awasthi 1986) and Taiwan (Ohmura 2001, 2012).

Usnea baileyi (Stirt.) Zahlbr., Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 83: 182. 1909.

Basionym: *Eumitria baileyi* Stirt., Scottish Naturalist 6: 100. 1882.

Figs: Truong & Clerc (2013, Figs 3 & 4), Temu et al. (2019, Fig. 4), Nadel & Clerc (2022, Fig. 8).

Type: Australia, Queensland, near Brisbane, Bailey 164 (BM – lectotype!). Chemistry: usnic, eumitrins A₂ and B, zeorin, salazinic and norstictic acids (Ohmura 2001). %C/M/A/: 3.5/3/87, TBA=85%, A/M=29, M/C=0.9.

= *Usnea recurvata* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 92. 1975, syn. nov.

Type: [China] Yunnan, Simao City, 20 November 1960, Zhao Ji-ding & Chen Yu-ben 3334 (HMAS 2509 – holotype!). Chemistry: usnic, norstictic and barbatic acids, zeorin, eumitrins A₂ & B. %CMA: 4.5/7.5/76, TBA=54%, A/M=10.1, M/C=1.7. (Fig. 1D–F)

= *Usnea subrectangulata* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 92. 1975, syn. nov.

Type: [China] Yunnan, Simao City, 20 November 1960, Zhao Ji-ding & Chen Yu-ben 3290 (HMAS 2513 – holotype!). Chemistry: usnic and norstictic acids, zeorin, eumitrins A₂ & B. %CMA: 4/6.5/79, TBA=85%, A/M=12.2, M/C=1.7. (Fig. 1G–I)

Notes. Full descriptions and pictures of *U. baileyi* can be found in Truong & Clerc (2013) and Ohmura (2001, 2012). Diagnostic characters for this species are the erect-shrubby to subpendulous thallus, the punctiform soralia with short isidiomorphs, the thin cortex and the thin medulla (1.5–3%) with red subcortical pigmentation and the tubular central axis. The chemistry is quite variable (Swinscow & Krog 1974; Rogers & Stevens 1988; Ohmura 2001; Truong & Clerc 2013; Temu et al. 2019), but the presence of zeorin and eumitrins seem to be diagnostic for this species (Ohmura 2001; Truong & Clerc 2013). Both type specimens of *U. recurvata* (Fig. 1D–F) and *U. subrectangulata* (Fig. 1G–I) correspond morphologically and chemically well to *Usnea baileyi*. Diagnostic characters mentioned by Zhao et al. (1975) fit in the variability of *U. baileyi*. Temu et al. (2019) and Lücking et al. (2020) showed that *U. baileyi*

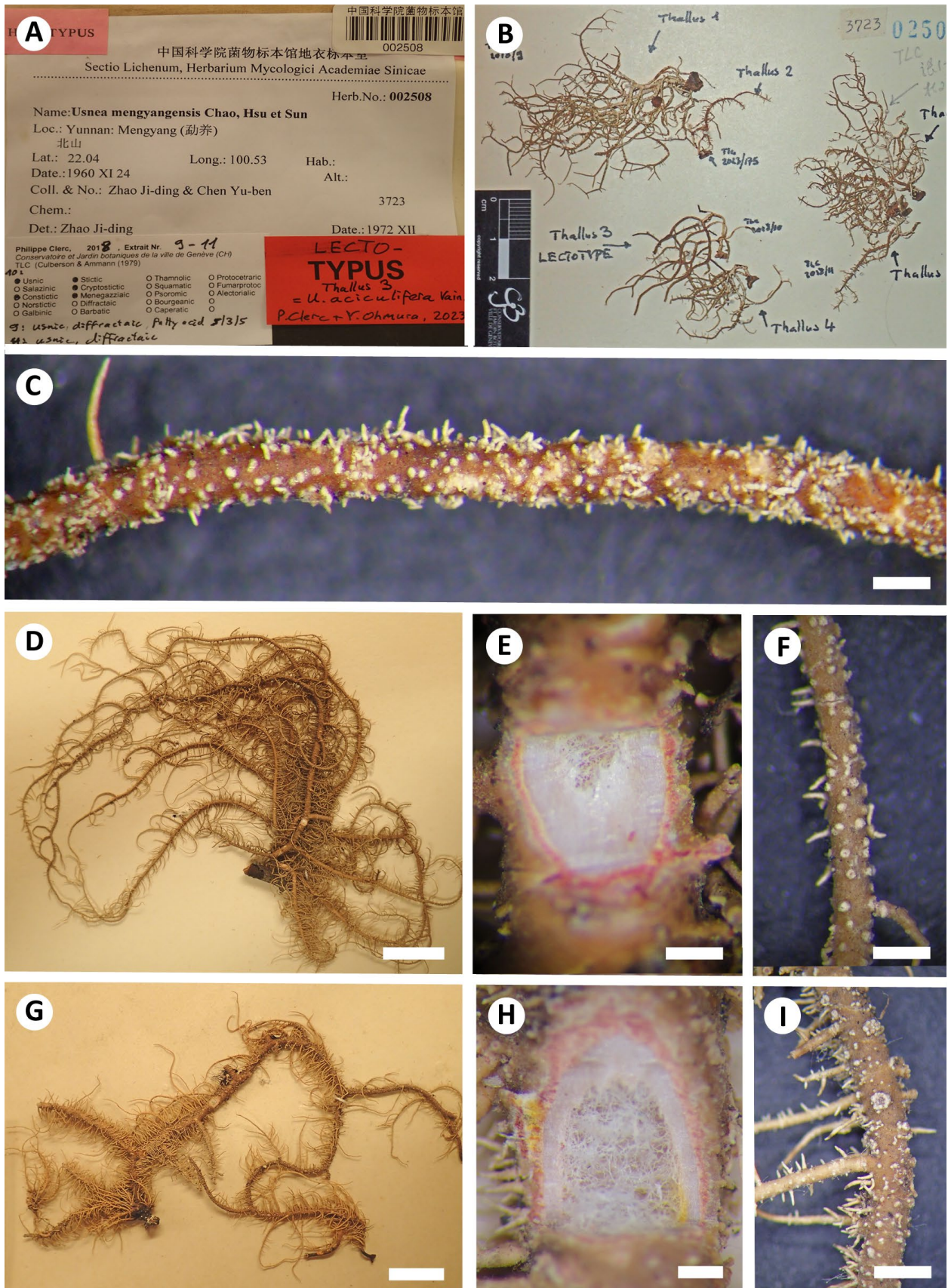


Figure 1. A – *Usnea mengyangensis*, label of the lectotype; B – *U. mengyangensis*, type collection with indication of lectotype (thallus 3); C – *U. mengyangensis*, “Soredia isidiiosa”: punctiforme soralia with isidiomorphs; D – *U. recurvata*, holotype; E – *U. recurvata*, longitudinal section of main branch; F – *U. recurvata*, young fibrils and fiberclcs possibly producing soredia; G – *U. subrectangulata*, holotype; H – *U. subrectangulata*, longitudinal section of main branch; I – *U. subrectangulata*, young fibrils and fiberclcs possibly producing soredia. Scales: C, E, F, H = 0.3 mm; D, G = 10 mm; I = 0.4 mm.

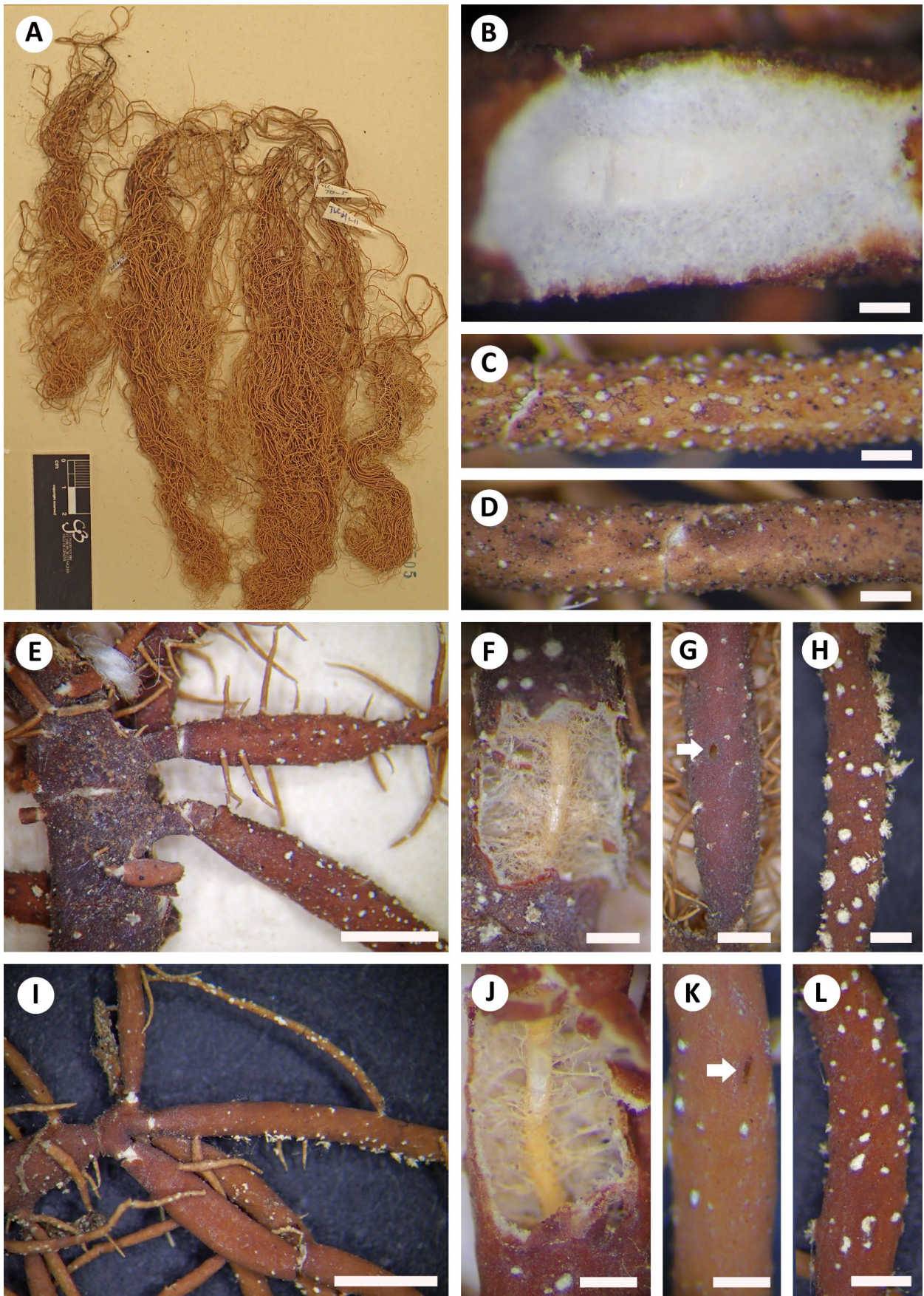


Figure 2. A – *Usnea kirinensis*, holotype; B – *U. kirinensis*, longitudinal section of main branch; C – *U. kirinensis*, fiberclerles possibly producing soredia; D – *U. kirinensis*, depressions in the branches; E – *U. crassiuscula*, holotype showing constricted lateral branches; F – *U. crassiuscula*, longitudinal section of main branch; G – *U. crassiuscula*, branch showing a perforation of the cortex; H – *U. crassiuscula*, soralia with isidiomorphs; I – *U. yunnanensis*, holotype showing constricted lateral branches; J – *U. yunnanensis*, longitudinal section of main branch; K – *U. yunnanensis*, branch showing a perforation of the cortex; L – *U. yunnanensis*, soralia with isidiomorphs. Scales: A = 10 mm; B = 0.2 mm; C–D = 0.25 mm; E, I = 2 mm; F, J = 0.6 mm; G–H, K–L = 0.5 mm.

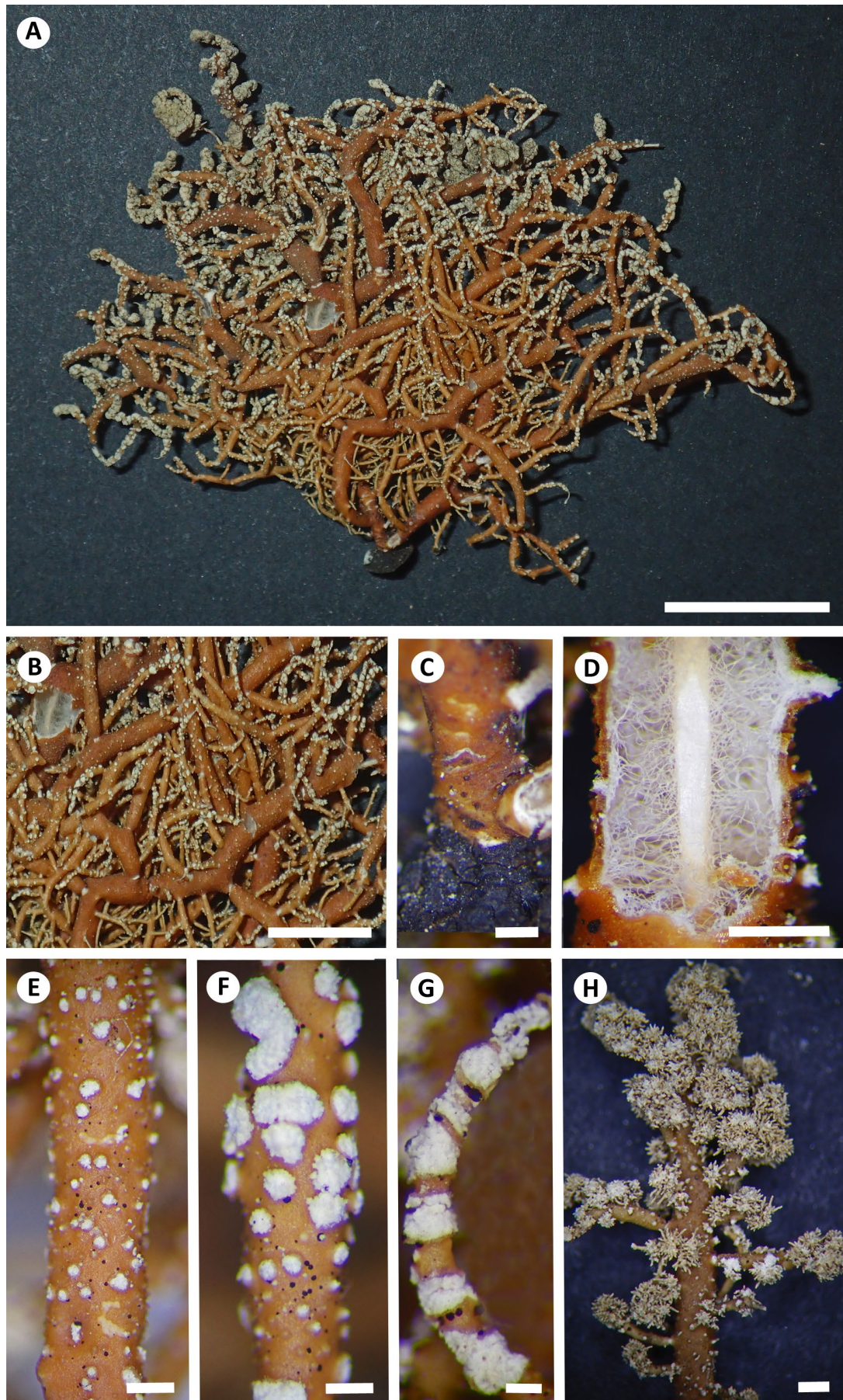


Figure 3. *Usnea chicitae*, A – holotype; B – holotype showing strongly irregular branches; C – holotype, basal part; D – isotype, longitudinal section of main branch; E – holotype, young and stipitate soralia; F – holotype, larger and aggregating soralia; G – holotype, thin branches with encircling and \pm concave soralian; H – isotype, capitate consoralia covered with isidiomorphs on terminal branches. Scales: A = 10 mm; B = 5 mm; C = 0.4 mm; D–G = 0.2 mm; H = 0.5 mm.

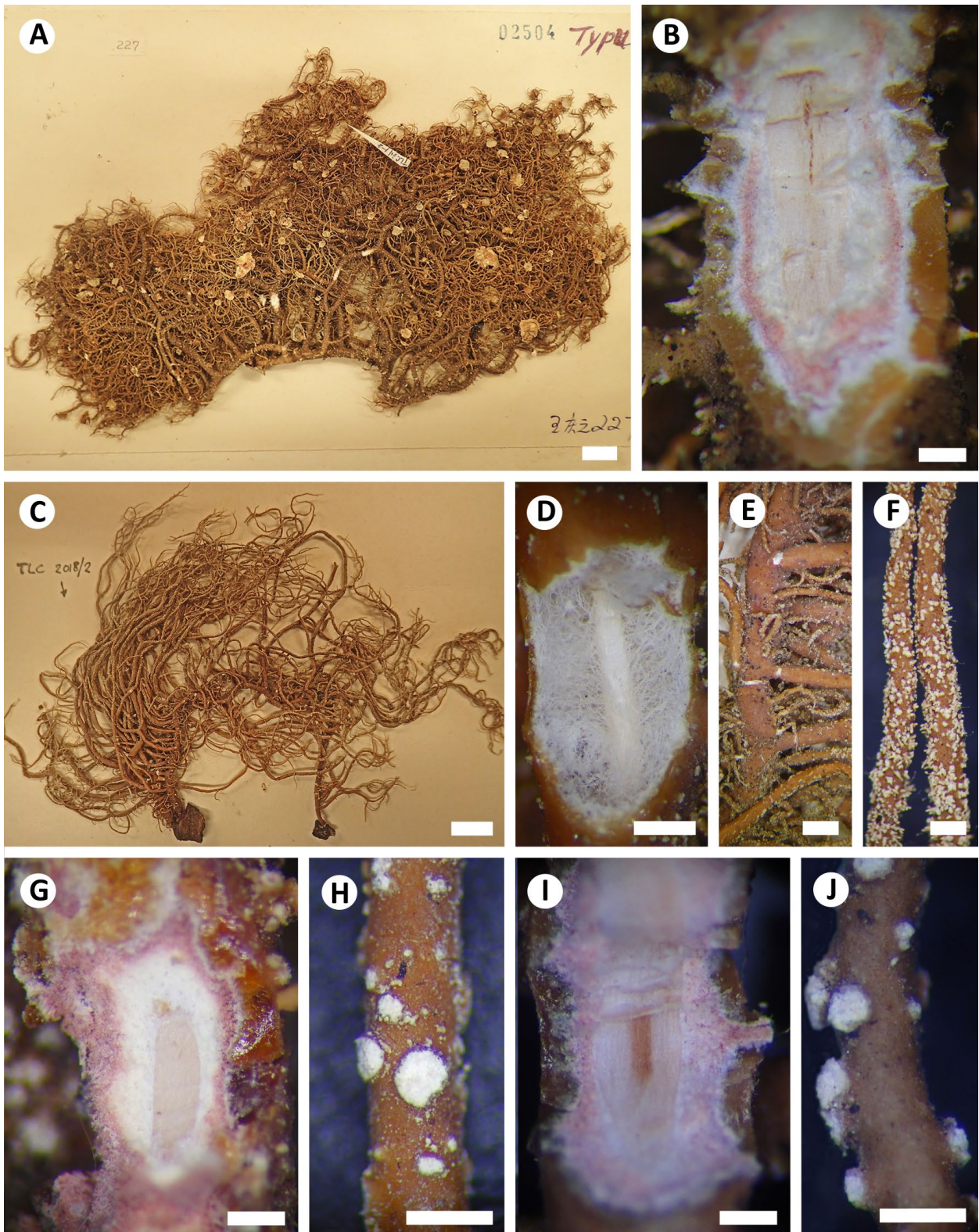


Figure 4. A – *Usnea iteratocarpa*, holotype; B – *U. iteratocarpa*, longitudinal section of main branch; C – *U. decumbens*, holotype; D – *U. decumbens*, longitudinal section of main branch; E – *U. decumbens*, holotype showing strongly irregular branches and constricted lateral branches; F – *U. decumbens*, holotype showing punctiform soralia with isidiomorphs; G – *U. fragilis*, holotype, longitudinal section of main branch; H – *U. fragilis*, holotype, large soralia; I – *U. roseola*, holotype, longitudinal section of main branch; J – *U. roseola*, holotype, large soralia. Scales: A, C = 10 mm; E = 1.0 mm; B, D, F–J = 0.5 mm.

most probably represents a complex of several species. A worldwide integrative study is needed to unravel the diversity in this complex.

Usnea baileyi is a common subtropical-tropical species occurring in Africa (Swinscow & Krog 1974; Nadel

& Clerc 2022), the Americas (Clerc 2007; Herrera-Campos 2016; Truong & Clerc 2016), Asia (Awasthi 1986; Ohmura 2001) and Australasia (Rogers & Stevens 1988; Elix & McCarthy 1998; Galloway 2007).

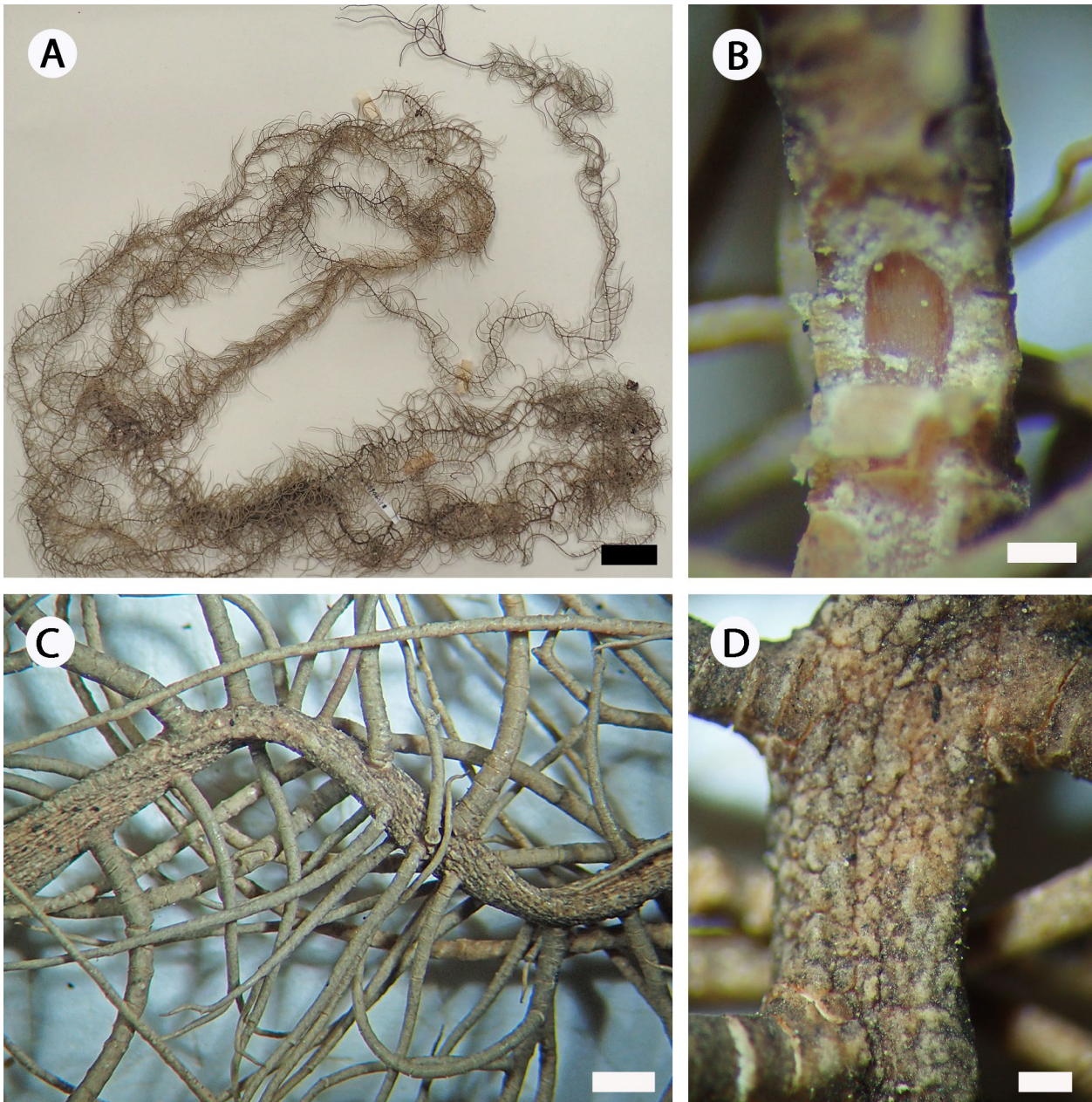


Figure 5. A – *Usnea montis-fuji*, isotype; B – longitudinal section of main branch; C – *U. montis-fuji*, isotype, main branches flattened; D – *U. montis-fuji*, isotype, typical areolate cortex of main branches. Scales: A = 2 cm; B, D = 0.2 mm; C = 1 mm.

Usnea barbata (L.) Wigg., Primitiae Florae Holsaticae: 91. 1780.

Basionym: *Lichen barbatus* L., Species Plantarum 2: 1155. 1753.

Figs: Clerc (2011b, p. 167), Clerc (2016, Fig. 1), Clerc & Naciri (2021, Figs 5 & 6).

Type: Tab. XII, fig. 6 in Dillenius, Historia muscorum – lectotype!, selected by Jørgensen, James & Davis, Botanical Journal of the Linnean Society 115: 37. 1994. Sweden, Västmanland, Kila par., Torpruin SO om Granmuren, pa Malus domestica, 20 July 1962, Nordin 1449 (UPS – epitype!, G – isoeotype!), selected by Jørgensen, James & Davis, Botanical Journal of the Linnean Society 115: 37. 1994. Chemistry: usnic, salazinic acids. %CMA: 4.5/33/26, A/M=0.8, M/C=7.7 (G – isoeotype).

= *Usnea kirinensis* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 99. 1975, syn. nov.

Type: [China] Jilin, Antu County, August 1960, Yang

Yu-chuan & Yuan Jun-rong 923 (HMAS 2505 – holotype!). Chemistry: usnic, salazinic acids. %CMA: 5/32/26, A/M=0.8, M/C=6.2. (Fig. 2A–D)

Notes. Full descriptions and pictures of *U. barbata* can be found in Clerc (2011b) and in Clerc & Naciri (2021). The holotype of *U. kirinensis* (Fig. 2A) has the typical long pendulous thallus with irregular, ± swollen branches (Fig. 2D), the CMA values (Fig. 2B) (Clerc & Naciri 2021) and the chemistry of *U. barbata* s.str. (salazinic acid). Small punctiform soralia (Fig. 2C) are present but not well developed and isidiomorphs were not observed. Wei (2020) mentions the species for China only in Zhejiang. New to Jilin. This is a species of the temperate forests of the northern hemisphere, occurring in North America (unpubl. res.), Europe (Motyka 1936–1938; Clerc 2011b) and Asia (Golubkova et al. 1996; Volker & Türk 2017). It is one of the most frequent *Usnea* species in the Alps.

Usnea bismolliuscula Zahlbr., Catalogus Lichenum Universalis 6: 542. 1923.

Fig.: Ohmura (2012, Fig. 7)

Type: Japan, Prov. Harima, on *Pinus densiflora*, 19 November 1916, A. Yasuda 232 (TUR-V 880 – holotype!). Chemistry: usnic, norstictic, menegazziaic, stictic and constictic acids. %CMA: 3/34.5/25, A/M=0.7, M/C=12.2.

= *Usnea crassiuscula* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 93. 1975, syn. nov.

Type: [China] Yunnan, Simao City, 20 November 1960, Zhao Ji-ding & Chen Yu-ben 3327 (HMAS 2502 – holotype!). Chemistry: usnic, norstictic (faint), stictic and constictic acids (thalli 2 & 3). %CMA: 2.5/41.5/12, A/M=0.3, M/C=15.4 (thallus 2); 3.5/38/17, A/M=0.5, M/C=10.2 (thallus 3). (Fig. 2E–H)

= *Usnea yunnanensis* J. Wei, Enumeration of Lichens in China (Beijing): 261. 1991. Syn.: *Usnea australis* J.D. Zhao, L.W. Hsu & Z.M. Sun, Acta Phytotaxonomica Sinica 13: 94. 1975, nom illeg., non *Usnea australis* Fr., Systema Orbis Vegetabilis (Lundae) 1: 282. 1825, syn. nov.

Type: [China] Yunnan, Simao City, 20 November 1960, Zhao Ji-ding & Chen Yu-ben 3327 (HMAS 2501 – holotype!). Chemistry: usnic and stictic acids (all three thalli). %CMA: 2.5/40/15, A/M=0.4, M/C=16.1 (average of the three thalli). (Fig. 2I–L)

Notes. Full descriptions and pictures of *U. bismolliuscula* can be found in Ohmura (2001, 2012). The four small specimens of the holotype of *U. crassiuscula* (Fig. 2E–H) and the three specimens of the holotype of *U. yunnanensis* (Fig. 2I–L) share the glossy inflated branches with typical perforations, the constricted lateral branches, the numerous fiberclles at the top of which soralia develop and the stictic acid group. Furthermore, the CMA value of both taxa fit well inside the variability of *U. bismolliuscula* [*U. bismolliuscula* (n=22): %C=(2.0–)2.8–3.9–5.0(–6.5), %M=(3.1–)33.7–36.3–38.9(–40), %A=(14–)15.2–19.8–24.4(–29), A/M=0.4–0.6–0.8(–0.9), M/C=(5.4–)6.8–10.6–14.4(–19.1)]. All these characters are diagnostic for *U. bismolliuscula* (Ohmura 2001). Soralia of these specimens are larger than those of typical *U. bismolliuscula*. Such large soralia are found in *U. leucospilodea* Nyl. that was synonymized with *U. bismolliuscula* by Ohmura (2001). For China, Wei (2020) mentions *U. bismolliuscula* in Fujian and Taiwan. New to Yunnan. *Usnea bismolliuscula* is further known from Russia (Golubkova et al. 1996), India (Awasthi 1986), South Korea (Jayalal et al. 2013), Japan (Ohmura 2001), Taiwan (Ohmura 2001, 2012; Lin 2007) and New Guinea (Awasthi 1986).

Usnea chicitae P. Clerc, sp. nov. (Fig. 3A–H)

Mycobank MB849791

Diagnosis: Differs from *U. cornuta* Körb. by its stipitate soralia with a distinct cortical rim when young, then enlarging, becoming convex and covered with isidiomorphs or, when eroded, slightly to distinctly concave and encircling the thin branches; by the lax medulla and the thin cortex and central axis (*tenuicorticata*-type of CMA) and by the presence of psoromic acid in the medulla.

Type: USA, North Carolina, Yancey County: Mt. Mitchell, Commissary Ridge, sur *Sorbus* mort dressé dans la pente, en exposition ESE, 1070 m, 26 June 1989, P. Clerc 89/595 (G0026135

– holotype!). Chemistry: usnic, salazinic and psoromic acids. %CMA: 2.5/42/12, A/M=0.3, M/C=17.9.

= *Usnea confusa sensu* Dey, The Bryologist 81: 76. 1978.

Description (n=92). Thallus erect, short, 1–3.5(5) cm long, forming dense, shrubby tufts with anisotomic-dichotomous ramifications (Fig. 3A); basal part short, 1–3 mm, with some jet black pigmentation close to the holdfast or concolorous to the main branches (Fig. 3C); main branches 1–1.6 mm diameter, irregular and ± articulated or fusiform (Fig. 3B); segments terete, sometimes ± flattened; lateral branches strongly constricted at attachment points; terminal branches short and thick, sparsely branched, axils nearly 90°, often with numerous soralia and then distinctly curved; foveolae or depressions always present on mature thalli; pseudocyphellae and maculae absent; tubercles absent; true papillae present, small, verrucous (up to 50 × 70 µm), mainly on secondary branches, ± evenly distributed, sometimes barely distinct; fibrils few and short (1–2 mm), unevenly distributed, mainly on secondary branches and apices; fiberclles present mostly on terminal branches; soralia a) size: larger than ½ branch diameter at maturity, sometime at the apices even larger than the branch bearing them (Fig. 3F–G), b) shape (top view): ± circular to mostly irregular, c) shape (side view): distinctly stipitate when young (Fig. 3E) then becoming capitate, efflorescent or flat to excavate if eroded at maturity (Fig. 3G), d) cortical rim: distinct in young stipitate soralia, disappearing in convex, efflorescent soralia, e) density: dense, 5–8 soralia/0.25 mm², often fully covering the apices, f) individuality: remaining distinct and well separated (especially when young) except on terminal parts where they fuse together forming large and capitate consoralia (Fig. 3H), g) localization: mostly located on terminal branches; isidiomorphs mostly present on large consoralia developing on terminal branches (Fig. 3H); cortex thin [(2.5–)2.8–3.9%–5.0(–6.5), n=74] and shiny (Fig. 3D), sometimes perforate; medulla thick [(28–)33.6–36.9%–40.2(–42.5)] and loose (Fig. 3D); axis thin [(10–)12.9–18.4%–23.9(–36)] (Fig. 3D), CMA of the *tenuicorticata* type. A/M=(0.2–)0.3–0.5–0.7(–1.3), M/C=(4.3–)7.2–10.2–13.4(–16.8).

Chemistry. 1. Usnic, salazinic, ± protocetraric acids (traces) (n=15). 2. Usnic, salazinic, ± protocetraric (traces) and psoromic (n=6). Medulla K+ yellow then red.

Distribution and habitat. *Usnea chicitae* is so far known only from the Appalachian Mountains in North Carolina, Tennessee and Virginia, mostly in the Great Smoky National Park. This species was found between 1,070 and 1,930 m of elevation, mostly at high altitude between 1,750 and 1,930 m, in spruce-fir forests on dead or living specimens of *Abies*, *Betula*, *Fagus*, *Picea*, *Prunus*, *Sorbus* and *Viburnum* species. It is a highly heliophilous lichen.

Etymology. This Appalachian taxon is dedicated to Chicita Culberson (1931–2023). Chicita was a pioneer in developing thin layer chromatography as a routine method to study lichen chemistry. Her paper, co-authored

by H. Kristinsson and published in 1970 (Culberson & Kristinsson 1970), opened a new area and initiated a revolution in lichen taxonomy, shaping most of the subsequent work in this domain. This allowed, among others, the species of the genus *Usnea* to be better understood, especially through the pioneer work of T.D.W. Swinscow and H. Krog in East Africa (see references). Besides being passionately dedicated to lichenology, Chicita was a wonderful and generous person keen of helping others.

Diagnostic characters. Inside the *U. cornuta* aggr. (Gerlach et al. 2020), *U. chicitae* is a small erect-shrubby species (1–3 cm long), characterized by the distinctly constricted lateral branches (Fig. 3B), the strongly irregular main branches with depressions, the soralia that are stipitate when young (Fig. 3E), enlarging (Fig. 3F–G) and becoming capitate, efflorescent, and often covered with isidiomorphs at maturity (Fig. 3H), the *tenuicorticata* type of CMA and the lax and large medulla (Fig. 3D) containing salazinic, ± psoromic acids.

Variation. The feature showing the most striking variation is the soralia: some thalli have terminal branches with few and very distinct stipitate soralia bearing few isidiomorphs while others (mostly well exposed, extreme morphotypes) have terminal branches covered with numerous, convergent and capitate soralia bearing numerous isidiomorphs (Fig. 3E–H). The density of branching and the development of papillae are very variable characters as well. Chemistry appears to be variable regarding the presence of psoromic acid in the medulla (in a little more than 25% of the specimens studied).

Discussion. Dey (1978) misidentified this taxon as the Japanese species “*U. confusa*” Asahina. He based his identification on the description given in the protologue (Asahina 1956) and did not study the original material in TNS (Dey, personal communication). The lectotype of *U. confusa* Asahina [Japan, Honshu, Prov. Suruga: Subashiri-guchi, 7.7.1952, Y. Asahina, no. 5277, thallus C (TNS!)] does not correspond to the Appalachian taxon, but is close to or identical with *U. cornuta* Körb. (Ohmura & Clerc 2019). Gerlach et al. (2019, 2020) highlighted the importance of chemistry, soralia morphology and type of CMA in the *U. cornuta/brasiliensis* aggregates. *Usnea chicitae* belongs to the *U. cornuta* aggr. (Gerlach et al. 2020). It differs from all other species of the *U. brasiliensis* aggr. (Gerlach et al. 2020) by the presence of salazinic acid and the absence of protocetraric acid as main substances. *Usnea chicitae* differs chemically from the other known species of the *U. cornuta* aggr. by the occasional presence of psoromic acid in the medulla and several other morphological and anatomical characters: *U. cornuta* Körb. has small punctiform, never stipitate soralia aggregating in consoralia that are ± even with the cortex and a *cornuta* type of CMA; *U. arianae* P. Clerc, E. Caviro & A. Gerlach has similar soralia although not distinctly stipitate, a *cornuta* type of CMA and a different chemistry; *U. boomiana* P. Clerc has similar soralia, but with caperatic acid in the medulla and a *cornuta* type of CMA (van den Boom et al. 2015); *U. dasaea* Stirt. has

a different type of soralia, some branches partly densely covered with spinulose fibrils and galbinic acid in the medulla (Clerc & Herrera-Campos 1997); *U. fragilescens* Lynge is a larger species with large and circular soralia, a distinct jet-black basal part and stictic acid in the medulla (Clerc 1987); *U. stipitata* A. Gerlach & P. Clerc is a larger species with stipitate soralia remaining small, never enlarging, never forming consoralia (Gerlach et al. 2020); *U. subpectinata* Stirt. is a larger species with similar soralia, but with numerous fibrils and isidiofibrils ± regularly disposed on main branches, a *cornuta* type of CMA and the stictic acid group in the medulla (Gerlach et al. 2020); and finally, *U. trachyclada* (Müll. Arg.) Zahlbr. a larger South American species with thamnolic acid in the medulla (Gerlach et al. 2020).

Since the specimens on which this new taxon is based were collected more than 30 years ago, we were not successful in sequencing its DNA. Further studies based on freshly collected material will be necessary to know about the position of *U. chicitae* in the *Usnea* phylogeny.

Selected specimens examined. USA. Avery Co: High area between Calloway Peak and McCrae Gap of Grandfather Mountain, 1750 m, spruce-fir forest, on *Abies*, 1972, J. Dey 1780 (DUKE), Grandfather Mountain, on rock, 1700 m, 30 August 1971, T. Esslinger 3608 (DUKE); Haywood and Jackson Co: Water Rock Knob in the Plott Balsam Mountains, 1850 m, spruce-fir forest, on *Sorbus*, 1972, J. Dey 4223 (DUKE); Mitchell Co: Roan High Bluff of Roan Mountain, 1850 m, spruce-fir forest, on *Abies* twigs, 1973, J. Dey 1921 (DUKE); Swain Co: Great Smoky Nat. Park, Mt. Ambler, along the Appalachian trail, le long de la crête, 1800 m, sur un *Abies* mort, 27 June 1989, P. Clerc 89/985 (G); Yancey Co: Mt. Mitchell, entre l’entrée du parc et le sommet du Mt. Mitchell, au bord de la route, 1890 m, sur *Abies*, 26 June 1989, P. Clerc 89/930 (G); Mt. Mitchell, Commissary Ridge, 1870 m, sur *Sorbus* mort, dressé dans la pente en exp. ESE, 26 June 1989, P. Clerc 89/573 (G).

Usnea cristatula Motyka, Lichenum Generis Usnea Studium Monographicum Pars Systematica 2: 641. 1938.

Fig.: Clerc (2011a, Fig. 1)

Type: Mexico, Michoacan, Morelia, Cerro Azul, 3300 m, Brouard (LUB – holotype!). Chemistry: usnic, diffractaic and squamatic acids. %CMA: 13/16.5/41, A/M=2.5, M/C=1.3.

= *Usnea iteratocarpa* J.D. Zhao, L.W. Hsu & Z.M. Sun, *Acta Phytotaxonomica Sinica* 13: 95. 1975, syn. nov.

Type: [China] Yunnan, Xichou County, 19 May 1959, Wang Qing-zhi 227 (HMAS 2504 – holotype!). Chemistry: usnic and diffractaic acids. %CMA: 10.5/22/35, A/M=1.6, M/C=2.1. (Fig. 4A–B)

Notes. Full description and pictures of *U. cristatula* can be found in Herrera-Campos et al. (1998). The strawberry pigmented medulla (Fig. 4B), the shiny cortex and the presence of diffractaic acid in the medulla make this species easily recognizable among apotheciate *Usnea* taxa (Fig. 4A). The type specimen of *U. iteratocarpa* shares all of these diagnostic characters and is thus synonymized with *U. cristatula*. *Usnea cristatula* is known for South America (Truong & Clerc 2012; Gerlach et al. 2017), North America, Mexico (Motyka 1936–1938; Herrera-Campos et al. 1998), the United States, Texas (Knudsen

& Lendemer 2006) and Great Smoky Mountains National Park (Lendemer et al. 2013) and Portugal (Clerc 2011a). *Usnea cristatula* is new to Asia (China, Yunnan).

Usnea intumescens Asahina, Lichens of Japan 3: 81. 1956.

Type: [Japan] Honshu, Prov. Kai, Lakeside of Yamanaka, Mt. Fuji, 11 August 1952, Asahina 52816 & Togashi (TNS – holotype!). Chemistry: usnic, protocetraric and salazinic acids. %CMA: 3.5/36.5/20, A/M=0.6, M/C=10.4.

= *Usnea decumbens* J.D. Zhao, L.W. Hsu & Z.M. Sun, *Acta Phytotaxonomica Sinica* 13: 102. 1975, syn. nov.

Type: [China] Yunnan, Kunming City, 4 November 1960, Zhao Ji-ding & Chen Yu-ben 2292 (HMAS 2503 – holotype!). Chemistry: usnic and salazinic acids. %CMA: 5/33/25, A/M=0.8, M/C=6.8 (average values measured on the four thalli present as type material). (Fig. 4C–F)

Notes. Full descriptions and pictures of *U. intumescens* can be found in Ohmura (2001) and Ohmura et al. (2017). *Usnea decumbens* displays all the diagnostic characters of *U. intumescens*: the subpendent thallus (Fig. 4C), the smooth and inflated branches (Fig. 4E), the lateral branches broadened at the base (Fig. 4E), the numerous minute soralia with isidiomorphs (Fig. 4F), the thin cortex and lax medulla (Fig. 4D) as well as the presence of salazinic or psoromic acids in the medulla. So far, this taxon was known only from central Japan (Ohmura 2001) and southern far east Russia in the Primorsky Krai, close to Japan (Ohmura et al. 2017). It is new to China (Yunnan).

Usnea fragilis Stirt., Scottish Naturalist 6: 293. 1882 [1881–1882]. (Fig. 4G–H)

Figs: Clerc (2004, Figs 4–6, as *U. entoviolata*), Ohmura (2012, Fig. 8, as *U. ceratina*).

Type: [India] Ad arbores in montibus Nilgherrensibus Indiae Or., Dr. G. Watt s.n. (BM 97568 – holotype!). Chemistry: usnic, barbatic acids. %CMA: 9.5/31.5/19, A/M=0.6, M/C=3.3.

= *Usnea ceratina* sensu Ohmura (2001) non Ach. Taxonomic study of the genus *Usnea* (lichenized *Ascomycetes*) in Japan and Taiwan. *Journal of the Hattori Botanical Laboratory* 90: 38.

= *Usnea entoviolata* Motyka, Lichenum Generis *Usnea* Studium Monographicum Pars Systematica 2: 411. 1938, syn. nov.

Type: [USA] Ins. Sandwich [Hawaii]. D.D. Bailey s.n. (W – holotype!). Chemistry: usnic, diffractaic, barbatic and squamatic (trace) acids]. %C/M/A: 9.5/28.5/24, A/M=0.8, M/C=3.1.

= *Usnea roseola* Vain. *Botanical Magazine (Tokyo)* 35: 46. 1921, syn. nov.

Type: [Japan] Prov. Rikuzen, Sendai, 22 June 1913, A. Yasuda 138 (TUR-V 875 – holotype!). Chemistry: usnic, barbatic, diffractaic, baecomycesic (trace) and squamatic (trace) acids, and US5 (Ohmura 2001). %CMA: 11.5/18.5/40, A/M=2.2, M/C=1.6. (Fig. 4I–J)

Notes. A detailed description of *U. fragilis* is given by Ohmura (2001, as *U. ceratina* Ach.)

Clerc (2004) discussed the difference between *U. entoviolata* and *U. ceratina* focusing on the development and the morphology of the soralia. *Usnea entoviolata* was considered to have a distribution centered on North and South America with few occurrences in Europe and

Africa (Clerc 2016). A careful study of the type specimen of *Usnea roseola*, described by Vainio and collected in Japan, with a partly pinkish medulla (Fig. 4G), showed that it has exactly the same type of soralia (Fig. 4H) as *U. entoviolata* and that it contains the barbatic/diffractaic acid complex in the medulla as well. The CMA values of the type of *U. roseola* are somewhat extreme for *U. entoviolata*, but fit nevertheless in the variability of this species [*U. entoviolata* (n=21): %C=(7.5–)8.4–10.2%–12(–14.5), %M=(15–)19.6–25%–30.4(–33.5), %A=(15–)20.6–29.3%–38(–46), A/M=(0.4–)0.6–1.3%–2.0(–3.1), M/C=(0.4–)0.6–1.3%–2.0(–3.1)]. At this time, we were ready to synonymize *U. entoviolata* under the earlier name *U. roseola*. However, a recent study of the Stirtonian types housed at the BM brought to light a still older name for this taxon. *Usnea fragilis*, collected in India, characterized by a pinkish medulla (Fig. 4I), large and circular soralia (Fig. 4J), a CMA almost identical to *U. entoviolata* and the presence of barbatic acid in the medulla fits completely in the concept of *U. entoviolata* as discussed by Clerc (2004). This led to the synonymization of both *U. entoviolata* and *U. roseola* with *U. fragilis*. A search in the TNS herbarium revealed that all Japanese specimens labelled as “*U. ceratina*” correspond in fact to *U. fragilis*. As a matter of fact, and to the best of our knowledge, *U. ceratina* does not occur in Japan. *Usnea mengyangensis* J.D. Zhao, L.W. Hsu & Z.M. Sun was described based on a collection made in China, Yunnan (Zhao et al. 1975). The holotype collection contains six thalli of which four correspond to *U. fragilis* (see under *U. aciculifera*).

Usnea fragilis is a pantropical-temperate species known to occur in North and South America, Hawaii, Europe, Africa (Clerc 2016). It is new to Asia (India, Japan and China).

Usnea montis-fuji Motyka, Lichenum Generis *Usnea* Studium Monographicum Pars Systematica 2: 420. 1938. (Fig. 5A–D)

Type: [Japan] Honshu, Prov. Suruga, Mt. Fuji, 1925, Y. Asahina s.n. (LBL – holotype!, TNS – Isotype!). Chemistry: usnic, salazinic and protocetraric (minor) acids. %CMA: 11.5/15/47, A/M=3.2, M/C=1.3.

= *Usnea trichodeoides* sensu Ohmura (2001) non Vain. Taxonomic study of the genus *Usnea* (lichenized *Ascomycetes*) in Japan and Taiwan. *Journal of the Hattori Botanical Laboratory* 90: 85.

Fig.: Ohmura (2001, Fig. 4C, as “*U. trichodeoides*”).

Notes. Ohmura (2001) provided a full description of *U. montis-fuji* (as “*U. trichodeoides*” Vain.), a pendulous, filamentose taxa (Fig. 5A) resembling *U. longissima* Ach. A thorough study of the type material of *U. trichodeoides* Vain. (H!) by the second author showed the absence of annular pseudocyphellae and the presence of a brownish pigmented central axis. This last character correlated with the presence of protocetraric acid indicates that the type material of *U. trichodeoides* belongs to the *Usnea pectinata* aggr. (Nadel & Clerc 2022; Temu et al. 2022). *Usnea montis-fuji* with annular pseudocyphellae,

punctiform maculae on the surface of lateral branches, strongly flattened main branch with areolate cortex (Fig. 5C–D) and salazinic acid in the medulla is thus a well distinct species when well-developed (Ohmura 2001, as ‘*U. trichodeoides*’), so far only known from China, India, Japan, Korea, Nepal and Taiwan (Ohmura 2001; Wei 2020). *Usnea montis-fuji* is the sister species of *U. longissima* Ach. (Ohmura 2002). It is morphologically closely related to *U. longissima* as well. Well-developed specimens of *Usnea montis-fuji* differ from *U. longissima* by the punctiform (and not twisted) maculae at the surface of lateral branches, by the strongly flattened main branches over many centimeters (Fig. 5C), by the areolate cortex (Fig. 5D) (more powdery in *U. longissima*), with areoles often arranged in a linear manner and by the chemistry (salazinic or fumarprotocetraric instead evernic or diffractaic acids). The central axis seems to be thinner in *U. montis-fuji* (Fig. 5B) than in *U. longissima*, but more data are here needed. Furthermore, *U. montis-fuji* has apothecia with brown discs (pale yellow in *U. longissima*) and a thinner hypothecium, a thinner epihymenium and a thicker hymenium (Ohmura 2001).

Usnea pycnoclada Vain., Philippine Journal of Science, C, Bot. 4(5): 653. 1909.

Type: [Philippines] Luzon, prov. Laguna, Mt. Banajao, November 1907, Curran & Merritt 8000 (TUR-V00833 – lectotype!). Chemistry: usnic, protocetraric, and barbatic acids. %C/M/A: 4.5/34.5/22. A/M = 0.6. M/C = 8.

= *Usnea subglabrata* Truong & P. Clerc. The Lichenologist 48: 86. 2016 (Gerlach et al. 2020).

= *Usnea macaronesica* P. Clerc. The Lichenologist 38: 202. 2006, syn. nov.

Type: Espagne, Iles Canaries, El Hierro, Frontera, Montaña Hoya de la Vaca, 500 m au nord du Mirador de Jinama, en descendant sur El Golfo, dans la pente escarpée en exp. SW, 1200–1220 m, sur *Erica arborea* dans le Fayal-Brezal, 1 October 1986, Clerc 11763 (G – holotype!, BM, UPS – isotypes). Chemistry: usnic and barbatic acids (holotype). %CMA: 6/34/20 (holotype).

Figs: Clerc (2006, fig. 3 as “*U. macaronesica*”), Ohmura et al. (2010, fig. 3), Truong & Clerc (2016, fig. 7, as “*U. subglabrata*”).

Notes. Full descriptions of *U. pycnoclada* were given by Clerc (2006, as “*U. macaronesica*”), Ohmura et al. (2010) and Truong & Clerc (2016, as “*U. subglabrata*”).

Usnea pycnoclada belongs to the *Usnea cornuta* aggr. (Gerlach et al. 2019). This aggregate, previously called the *U. fragilesceus* aggr. by Clerc (1987), is one of the most difficult taxonomic groups in *Usnea* because of the polyphyly of species showing a similar morphology. It was characterized by their shrubby-erect to subpendulous thallus, ± inflated branches constricted at the ramification point, minute soralia of various shapes ± covered with isidiomorphs (Clerc 1987, 2011b; Gerlach et al. 2019) and a CMA of the *cornuta*- or *tenuicorticata*-types (Truong et al. 2011; Gerlach et al. 2019) which are i.e., a thin cortex (4–7% of the branch diameter), a thick, loose to dense (30–38% of the branch diameter) and often heterogeneous (i.e., with a dense zone just below the

cortex) medulla, and thin axis (15–23% of the branch diameter). The conspecificity of *U. macaronesica* with *U. pycnoclada* was suspected for quite a long time by the first author. Ohmura & Clerc (2023) recently examined the taxa having protocetraric and/or barbatic acids as main medullary substances in the *U. cornuta* aggr., i.e., *U. jezoformosana* Y. Ohmura & P. Clerc, *U. macaronesica* P. Clerc and *U. pycnoclada*. ITS molecular data of these species confirmed this suspicion (Ohmura & Clerc 2023). As a matter of fact, both taxa share: 1. The same morphology with anisotomic-dichotomic ramifications, irregular main branches, strongly constricted lateral branches, large, ± excavate soralia often with isidiomorphs; 2. The same anatomy with a *tenuicorticata/cornuta* type of cortex, a glossy cortex and a loose medulla; 3. A similar chemistry with the production of barbatic acid and protocetraric acid in the medulla; 4. The same clade in a phylogenetic tree based on ITS rDNA (Ohmura & Clerc 2023, fig. 1). *Usnea macaronesica* is therefore considered here as a synonym of *U. pycnoclada*.

Usnea pycnoclada is quite a variable species in terms of soralia morphology. Soralia are always larger than ½ branch diameter, but they can be almost capitate (Ohmura et al. 2010, fig. 3d) to excavate and encircling the branch (Clerc 2006, fig. 3d, e, as *U. macaronesica*) to strongly excavate (Truong & Clerc 2016, fig. 7 f, g, as *U. subglabrata*). Isidiomorphs might be present or not. The chemistry is variable too with at least four chemotypes: 1. barbatic (main) and protocetraric (main); 2. barbatic acid; 3. barbatic acid and the stictic ac. group; 4. stictic acid group (Clerc 2006; Ohmura et al. 2010; Truong & Clerc 2016; Gerlach et al. 2020). For differences with other taxa see Clerc (2006), Ohmura et al. (2010), Truong & Clerc (2016), Gerlach et al. (2020) and Ohmura & Clerc (2023).

Usnea pycnoclada is a tropical species known in Eastern Asia (Ohmura et al. 2010), Macaronesia (Clerc 2006), Central and South America (Truong & Clerc 2016; Gerlach et al. 2020).

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