

## Cetrarioid lichen genera and species in NE China

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Twenty-five species in ten cetrarioid lichen genera belonging to the family Parmeliaceae are reported for the lichen flora of NE China. Keys to the genera and species as well as short descriptions are given. *Cetrelia japonica*, *Tuckermannopsis americana* and *T. ulophylloides* are reported as new to China. Seven additional species are new to NE China. *Nephromopsis endocrocea* is excluded from the lichen flora of China.

Key words: Asia, biodiversity, floristics, lichenized Ascomycetes

Professor Ming-Jou Lai, the first author of the present article, sadly passed away soon after submitting the manuscript to *Annales Botanici Fennici*. From the hospital in Taipei in April 2007 he wrote to the author TA, under whom Lai prepared his Ph.D. thesis, asking him to complete editing of his manuscript. Now it has been done, although regrettably with some delay.

The first reports of the cetrarioid lichens in Parmeliaceae from NE China were made by Asahina (1952) and Sato (1952). Five species were known by that time: *Cetraria crispa* var. *japonica*, *C. cucullata*, *C. delisei*, *C. nivalis* and *C. chrysantha*. X. L. Chen *et al.* (1981) listed nine cetrarioid species among the 195 species for the lichen flora of NE China. C. B. Chen (1986) reported five species of the genus *Cetrelia* for the present area, *viz.*, *C. braunsiana*, *C. cetrarioides*, *C. chicitae*, *C. olivetorum* and *C. pseudolivatorum*. Wei (1991) recognized 22 species of

cetrarioid lichens for NE China.

Geographically NE China comprises the eastern part of Neimenggu (Inner Mongolia) Autonomous Region, Liaoning, Jilin and Heilongjiang Provinces. The whole broad area is connected to Siberia and northern Eurasia in the north, adjacent to Russian Far East and North America in the east, neighbouring Korea and North China in the south, and also linked to Mongolian steppe in the west.

Located in the northern temperate climatic zone, the present area is predominantly temperate in its floristic features, with 88.5% of seed plants, 89.1% ferns, and over 90% bryophytes are fundamentally temperate species (Fu *et al.* 1995, Zhou & Zu 1997). Floristically, NE China is located in a transitional region where the floras of the Changbai Floristic Region, the Northern China Floristic Region, the Daxinganling Floristic Region and the Mongolia Steppe Floristic Region intermix.

The present study is based on ca. 500 specimens of cetrarioid lichens kept at the herbarium of the Institute of Applied Ecology (formerly the Institute of Forestry and Pedology, IFP), Chinese Academy of Sciences, Shenyang. The lichen collections were extensively made by the second author and his colleagues from various localities in NE China during the past fifty years. Some collections deposited in Botanical Museum, University of Helsinki, Finland (H) were added by T. Ahti. Ming-Jou Lai was invited as a visiting scholar to Shenyang in the summer of 2002 by Academia Sinica and was offered the opportunity to study the lichen collections in the nice herbarium facilities with all kinds of assistance during his stay.

We are using the present-day taxonomy of the cetrarioid lichens primarily based on morphological and chemical characters. However, recent phylogenetic studies of cetrarioid lichens with molecular methods have shown that some of the genera appear to be non-monophyletic and some species need nomenclatural recombinations (Thell *et al.* 2002, 2004, 2005, 2008). The taxonomic changes will be published in the near future. Most changes are not expected to concern the species-level taxonomy. Lai *et al.* (2007) also made some new proposals, e.g. describing the new genus *Usnocetraria*, but unfortunately many new combinations were published invalidly.

### Key to the cetrarioid genera in NE China

1. Upper cortex contains usnic acid ..... 2
1. Upper cortex lacks usnic acid ..... 7
2. Medulla bright yellow (contains pinastric and vulpinic acids) ..... *Vulpicida*
2. Medulla white, occasionally pale yellow or orange (various medullary substances present, but never contains pinastric and vulpinic acids) ..... 3
3. Lobes usually narrow, 2–8(10) mm wide, elongate. Pseudocyphellae indistinct on the lower surface, or completely lacking. Pycnoconidia bifusiform ( $5\text{--}6 \times 1 \mu\text{m}$ ). Mainly terricolous ..... *Flavocetraria*
3. Lobes usually wider, 8–15(30) mm, not elongate. Pseudocyphellae present on the upper or lower surface, or on both surfaces. Pycnoconidia always bifusiform ( $4\text{--}5 \times 1\text{--}2 \mu\text{m}$ ). Terricolous or corticolous ..... 4
4. Usnic acid and atranorin present in the upper cortex. Pseudocyphellae present on the ridges of upper surface; lower surface without rhizines. Terricolous .... *Asahinea*
4. Only usnic acid present in the upper cortex. Pseudocyphellae present on the lower surface or on both

- surfaces; lower surface usually with rhizines, or rarely lacking. Mainly corticolous ..... 5
5. Pseudocyphellae present on both surfaces; medulla Pd+ red (contain fumarprotocetraric and protocetraric acids) ..... *Cetreliaopsis*
5. Pseudocyphellae present on the lower surface; medulla Pd- ..... 6
6. Lobe margins ciliate; ascospores globose ( $7\text{--}10 \mu\text{m}$  in diameter) to subglobose ( $6\text{--}9 \times 5\text{--}7 \mu\text{m}$ ); thallus margins sorediate ..... *Tuckneraria*
6. Lobe margins eciliate; ascospores ellipsoid ( $6\text{--}12 \times 3\text{--}7 \mu\text{m}$ ); soredia not present ..... *Nephromopsis*
7. Thallus erect, fruticose; lobes distinctly canaliculate, dorsiventral; lower surface without rhizines. Terricolous ..... 8
7. Thallus adnate, wide or narrow, foliose; lobes not canaliculate; lower surface normally with rhizines. Mainly corticolous ..... 9
8. Asci normally widely clavate; pycnoconidia sublageniform ..... *Cetrariella*
8. Asci normally narrowly clavate; pycnoconidia oblong-citriform ..... *Cetraria*
9. Upper surface pale to dark brown, with or without scattered pseudocyphellae; lobe margins ciliate or eciliate .. *Tuckermannopsis*
9. Upper surface ashy white or tan, distinctly pseudocyphellate; lobe margins eciliate ..... *Cetrelia*

### *Asahinea* W.L. Culb. & C.F. Culb.

Brittonia 17: 183. 1965.

Thallus foliose, large, loosely attached to the substrate; lobes thin, wrinkled, with or without pseudocyphellae; lower surface black, shiny, rhizines lacking. Apothecia rare, marginal to laminal, imperforate; ascospores ellipsoid. Pycnidia laminal; pycnoconidia bifusiform. Key references: Culberson and Culberson (1965), Trass *et al.* (1985), Randle and Saag (1989), Gao (1991).

### *Asahinea chrysantha* (Tuck.) W.L. Culb. & C.F. Culb.

Brittonia 17: 184. 1965. — *Cetraria chrysantha* Tuck., Amer. J. Sci. Arts 2, 15: 423. 1858.

Thallus yellow to pale greyish brown, lobes rounded, broad, 10–30 mm wide, usually with a network of ridges and depressions on the upper surface; pseudocyphellae located mainly on the ridges; soredia and isidia lacking; rhizines

entirely lacking. Apothecia not found. Pycnidia laminal, emergent, in scattered black patches; pycnoconidia bifusiform,  $3\text{--}5 \times 1\text{--}1.5 \mu\text{m}$ .

CHEMISTRY: usnic acid ( $\pm$ ) and atranorin contained in the cortex; aleatoronic acid in the medulla; medulla Pd $-$ , K $-$ , KC $+$  red, C $-$ .

Pycnoconidia of *Asahinea* were described by Thell (1995) as bacillariform, but indicated with a question mark. We have examined a number of specimens of *A. chrysantha* and found that they are clearly bifusiform (Daxinganling, Zhao 1101).

DISTRIBUTION: China (Heilongjiang, Jilin, Neimenggu, Taiwan), Mongolia, Korea, Japan, Russia, Scandinavia, North America. This species was reported from Daxinganling, Neimenggu by Sato (1952). We have found it also in Heilongjiang and Jilin.

SPECIMENS EXAMINED. **Neimenggu:** Daxinganling, Eergunazuqi, Aokeliduishan, alt. 1530 m, Zhao C. F. 2967; Alongshan, alt. 1460 m, Wang Z. 1925. **Heilongjiang:** Daxinganling, Huzhong District, Dabaishan, alt. 1100–1400 m., Zhao C. F. 1101, 1125-4; Ding T. Y. 8502, 8506; Nan Y. H. 97825. **Jilin:** Antu, Changbaishan south slope, Xie Z. X. 5985.

### ***Cetraria* Ach.**

Meth. Lich. 292. 1803.

Thallus fruticose, subfruticose or erect foliose, yellowish to reddish brown or olive-brown; lobes  $\pm$  canaliculate, flattened or cylindrical, normally with conspicuous, marginal or laminal pseudocyphellae on the lower surface; margins with branched or unbranched cilia. Apothecia lecanorine, marginal or subterminal; ascospores ellipsoid. Pycnidia black, located in conspicuous marginal projections; pycnoconidia usually oblong-citriform. All species contain fatty acids, and many have fumarprotocetraric acid as well. Anatomy of the thallus with 2-layered cortex and asci with small axial body and a distinctive amyloid ring structure are the most important characters of these 16 brown species group (including also four species that were transferred from the formerly recognized genus *Coelocaulon*). Key references: Kärnefelt (1979, 1986), Kärnefelt *et al.* (1993).

### **Key to the species**

1. Thallus foliose, lobes narrow,  $\pm$  concave; Pd+ yellow ...  
..... *C. hepatizon*
1. Thallus fruticose, branches cylindrical; Pd+ red .....  
..... *C. laevigata*

### ***Cetraria hepatizon* (Ach.) Vain.**

Természetr. Füzetek 22: 278. 1899. — *Lichen hepatizon* Ach., Lich. Suec. Prodr. 110. 1799. — *Tuckermannopsis hepatizon* (Ach.) Kurok., J. Jap. Bot. 66: 158. 1991. — *Melanelia hepatizon* (Ach.) A. Thell, Nova Hedwigia 60: 419. 1995.

Thallus foliose, up to 20 cm in diameter, loosely adnate; lobes 1–2 mm wide,  $\pm$  concave; upper surface greenish brown to black, glossy; lower surface black,  $\pm$  pale near the margins; soredia and isidia lacking; pseudocyphellae occur on the upper surface, marginal and laminal. Apothecia marginal or submarginal; ascospores ellipsoid. Pycnidia marginal or laminal, pycnoconidia bifusiform.

CHEMISTRY: norstictic and stictic acids; medulla K+ yellow, C $-$ , KC $-$ , Pd+ yellow.

This species has been transferred to *Tuckermannopsis* (Kurokawa 1991) and *Melanelia* (Thell 1995), but the generic status is still disputed (Blanco *et al.* 2004). In size and colour of thalli, species of *Tuckermannopsis* resemble *Melanelia*, but species of *Melanelia* are normally more closely appressed, have laminal apothecia, often have conspicuous pseudocyphellae, ascospores are ellipsoid and pycnoconidia are bifusiform, upper cortex thick, paraplectenychmatous.

DISTRIBUTION: Widely distributed in arctic-alpine regions. First reported by Sato (1939) from Heilongjiang. The records of *C. islandica* and *C. ericetorum* from Jilin (Chen *et al.* 1981) must also belong here. However, the similar *C. islandica* subsp. *orientalis* may also occur in the area, because it is known from Korea (Kärnefelt 1959).

SPECIMENS EXAMINED. **Heilongjiang:** Daxinganling, Huzhong District, Dabaishan north slope, Zhao C. F. 1274; Dahailin, Laotudingzishan, Zhang G. C. & Gao Q. 9159. **Jilin:** Antu, Changbaishan north slope, Wenquan, East mountain, Chen X. L. 4702.

### *Cetraria laevigata* Rass.

Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 5: 133. 1945; Lai, Quart. J. Taiwan Mus. 33: 216. 1980.

*Cetraria crispa* (Ach.) Nyl. var. *japonica* Asahina in Sato, J. Jap. Bot. 14: 787. 1938.

Lobes of thallus narrow, 1–3 mm wide, upper surface smooth, shiny; pseudocyphellae marginal, forming a distinct continuous line along the lobe margins from lobe tip to base, rather broad, white, scattered laminal pseudocyphellae very few. Apothecia marginal or submarginal; ascospores ellipsoid. Pycnidia on marginal projections, pycnoconidia oblong.

CHEMISTRY: fumarprotocetraric acid, licheterinic-protolicheterinic type fatty acids. Medulla Pd+ red, K–, KC–, C–. Sometimes Pd– individuals may be found.

DISTRIBUTION: An arctic-alpine and boreal species, NE, SW China, Taiwan, Japan, Korea, North America, Siberia, Kamchatka, Sakhalin, NW India, Nepal. First reported by Sato (1939, as *C. crispa* var. *japonica*) from Heilongjiang. The records of *C. islandica* and *C. ericetorum* from Jilin (Chen et al. 1981) must also belong here. However, the similar *C. islandica* subsp. *orientalis* is expected to reach the area, because it is known from the neighbouring areas of Korea (Kärnefelt 1979).

SPECIMENS EXAMINED. **Neimenggu:** Daxinganling, Ganhe, Liu S. E. 8880; Yingjilishan, alt. 1480 m, Wang Z. 1937; Mangue, alt. 900 m, Chen X. L. 3144, 3146-4; Eergunazuqi, Aluguya, Ewenke Country, alt. 700 m, Zhao C. F. 3038; Mangui, alt. 860 m, Zhao C. F. 3065, 311; Xiguituqi, Tulihe, alt. 750 m, Zhao C. F. 3161; Aokeliduishan, alt. 1530 m, Zhao C. F. 2942, 2975; Aoluguya Country, alt. 800 m, Gao D. E. 0117; Gulian, Wei 3263 (Lich. Sin. Exs., fasc. 1: 23.).

**Heilongjiang:** Daxinganling, Huzhong District, Xionguan forest station, Chen X. L. 7470; Dabaishan north slope, alt. 1200–1400 m, Zhao C. F. 1115, 1116, 1117; Huyuan forest station, alt. 1400 m, Ding T. Y. 8512; Nan Y. H. 97825; Xiaoxinganling, Hongsing, Tang Hong Ling, Ding T. Y. 820038; Mudanjiang, north gully of Laoyeling, alt. 500 m, Gao C. et al. 1043-1; Shangzhi County, Daguokuishan, Li Q. T. 101. **Jilin:** Antu. Changbaishan, on the way from Tizihe to Motianyu, alt. 2500 m, Liu S. E. 1549; 7.5 km from Wenquan, alt. 1200 m, Liu S. E. 4064, 5097, 4219; Fusong, Neidaoli to Wenquan, alt. 1700 m, Wang S. G. & Li S. X. 437; Hengshan forest station, along by the Yalujiang, alt. 1800 m, Chen X. L. 2068, 2070, 2080, 2081, 2082, 2102; Changbaishan south slope, alt. 2100 m, Chen X. L. 2249, 2250; Changbaishan north slope, Bingchang, East mountain, alt. 2200 m,

Chen X. L. 4680, 4713, 4721-4; Changbaishan north slope, Xiaotianchi, alt. 1750 m, Chen X. L. 4925; Changbaishan, Wenquan, roadside, alt. 1700 m, Hou J. L. 78157, 78267; 78294-2, 78300, 78302, 78329; Xiaotianchi, alt. 1750 m, Hou J. L. 78348, 78349; Changbaishan, tundra, alt. 2100 m, Zhao C. F. 21, 200, 3549, 4182; Changbaishan north slope, 2 km to Baishan station, alt. 1190 m, Zhao C. F. 0426; below waterfall, the bridge, Zhao C. F. 3508; Tianchi, meteorological station, alt. 2620 m, Zhao C. F. 3328; Wenquan, alt. 1800 m, Zhao C. F. 3347, 3385; Changbaishan, crater rim of Tianchi, tundra, alt. 2150 m, Zhao C. F. 3457-1, 3468, 3481; Xiaotianchi, alt. 1800 m, Zhao C. F. 3591-1, 3631, 3680-1; Changbaishan, *Betula ermanii* forest, Cao T. 90-61; Huang R. H. 90-61; Changbaishan, alt. 2000 m, Zhao S. D. 006; Changbaishan, tundra, alt. 2000 m, Qian H. 3-10; Changbaishan, valley of river Erdo Baihu, alt. 1900 m, Koponen T. 36816 (H), alt. 2200 m, Koponen T. 36667b, 36671 (H).

### *Cetrariella Kärnefelt & A. Thell*

Bryologist 96: 402. 1993.

Thallus erect-foliose, dark to pale brown; lobes ± canalculated or almost subtubular, sometimes becoming expanded toward apical portions, pseudocyphellae marginal or laminal on the lower surface; cortex paraplectenchymatous, composed of 1–3 layers of pachydermatous and rather large cells. Apothecia terminal on lobe tips; asci broadly clavate; ascospores ellipsoidal. Pycnidia developed on tips of marginal projections; pycnoconidia sublageniform. Key references: Kärnefelt (1979), Kärnefelt et al. (1993).

### *Cetrariella delisei* (Bory ex Schaer.) Kärnefelt & A. Thell

Bryologist 96: 403. 1993; Sato, Bot. Mag. Tokyo 65: 174. 1952; Wei, Lich. Sin. Exs., fasc. 1: 22. 1981. — *Cetraria islandica* δ *delisei* Bory ex Schaer., Enum. Crit. Lich. Europ. 114. 1850. — *Cetraria delisei* (Bory ex Schaer.) Nyl., Lich. Lapp. Orient. 114. 1866.

*Cetraria hiascens* (Fr.) Th. Fr., Lich. Scand. 1: 99. 1871.

Thallus lobes 1–5 mm wide, pale yellowish brown, mottled with darker brown, tips branched and dissected, ± concave, not strongly curled, with few marginal projections; pseudocyphellae laminal and marginal. Apothecia marginal, at lobe ends; ascospores ellipsoid. Pycnidia at ends of marginal projections, pycnoconidia sublageniform.

CHEMISTRY: medulla contain gyrophoric acid; medulla Pd–, K–, KC+ red, C+ pink.

DISTRIBUTION: Widespread in temperate and arctic regions of the northern hemisphere, and in cold temperate regions in the southern hemisphere. First reported by Sato (1952) from Neimenggu.

SPECIMEN EXAMINED. **Neimenggu:** Mangui, Morgan, alt. 800 m, *Wei J. C. 3370* (Lich. Sinic. Exs., no. 22).

### *Cetrelia* W.L. Culb. & C.F. Culb.

Contr. U.S. Natl. Herb. 34: 490. 1968.

Thallus foliose, broad-lobed; upper surface greenish grey or ashy white, often uniformly brown or tan in old herbarium specimens, pseudocyphellate, often sorediate or isidiate, lobe margins lack cilia; lower surface black, punctate in some species, rhizines sparse; upper cortex prosoplectenchymatous; medulla white. Apothecia lecanorine, submarginal, usually perforate; ascospores ellipsoid. Pycnidia marginal; pycniconidia rod-shaped. Key references: Culberson and Culberson (1968), Chen (1986), Randle and Saag (1991a), Lai (2001), Obermayer and Mayrhofer (2007).

### Key to the species

1. Thallus sorediate or isidiate ..... 2
1. Thallus neither sorediate nor isidiate ..... 6
2. Thallus sorediate along the lobe margins ..... 3
2. Thallus isidiate ..... 5
3. Medulla C+ pink or pinkish orange, contain olivetoric acid ..... *C. olivetorum*
3. Medulla C–, olivetoric acid lacking ..... 4
4. Medulla KC+ bright pink to red, UV+ blue-white, contains alectoronic and  $\alpha$ -collatolic acid; pseudocyphellae abundant and often large (0.15–0.6 mm in diameter) .....  
..... *C. chicitae*
4. Medulla KC– or rarely KC+ faint pink, contains perlatolic or imbricatic acid; pseudocyphellae small and inconspicuous ..... *C. cetrarioides*
5. Isidia accompanied by conspicuous dorsiventral lobulae in tufts on the upper surface or as a fringe along the margins of the lobes ..... 7
5. Isidiate thalli without dorsiventral lobulae .....  
..... *C. braunsiana*
6. Thallus with dorsiventral lobulae in tufts on the upper surface or as a fringe along the margins of the lobes ... 7
6. Thallus without lobulae ..... 9

7. Medulla C–; lobulae well developed and abundant ..... 8
7. Medulla C+ pink or pinkish orange, contains olivetoric acid; lobulae well or poorly developed, infrequent, granular, and isoid ..... *C. pseudolivetorum*
8. Microphyllinic acid present ..... *C. japonica*
8. Imbricatic acid present ..... *C. sinensis*
9. Medulla KC+ pink, contains alectoronic and  $\alpha$ -collatolic acids ..... *C. nuda*
9. Medulla KC–, contain imbricatic acid ..... *C. collata*

### *Cetrelia braunsiana* (Müll. Arg.) W.L. Culb. & C.F. Culb.

Contr. U.S. Natl. Herb. 34: 493. 1968.

Thallus large, 15–25 cm broad; lobes 0.5–1.8 cm. wide, the margins  $\pm$  ascending; upper surface grey or ashy-white, isidiate, isidia often coralloid, the tips pruinose, pseudocyphellae small, irregular to punctiform; lower surface black, the margins brown or greyish, not punctate, rhizines black. Apothecia submarginal, perforate, ca. 0.5 cm in diameter. Pycnidia marginal, black; pycniconidia rod-sharped,  $1 \times 4\text{--}6 \mu\text{m}$ .

CHEMISTRY: atranorin in the cortex; alectoronic and  $\alpha$ -collatolic acids in the medulla; medulla K–, C–, KC+ pink, Pd–, UV+ blue-white.

Specimens of this species with poorly developed isidia may resemble *C. nuda*, but they have very small pseudocyphellae, while *C. nuda* has large aggregate pseudocyphellae.

DISTRIBUTION: Japan, China (Yunnan, Taiwan), Philippines, Himalayas. New to NE China.

SPECIMENS EXAMINED. **Neimenggu:** Daxinganling, Ganhe, West-south Mountain, alt. 700 m, *Chen X. L. 3272, 3277, 3282*. **Heilongjiang:** Dedu County, Wudaliangchi, Longmenshan, alt. 300 m, *Chen X. L. 3533-1*; Xiaoxinganling, Dailing, alt. 350 m, *Liu S. E. 1357, 1363*; Dailing, Liangshuigou, alt. 350 m, *Chen X. L. 3652, 3689, 3695, 3697, 3699, 3829, 3847, 3864, 3916, 3922, 3937, 3963-1, 3989, 4022, 4086*; Xiaoxinganling, Wuying, 40th Branch District, alt. 462 m, *Chen X. L. 5149, 5176, 5221, 5240, 5486*; Wuying Town, *Chen B. J. et al. 503*; Xiaoxinganling, Wuminhe, Anquan, *Chen X. L. 5322, 5333, 5360, 5416-1*; Raoh County, Qi Yuan forest station, alt. 250 m, *Zhao C. F. 728, 733, 755, 775*; Ningan County, Xiaobeihu forest station, alt. 800 m, *Zhao C. F. 982, 998*; Hengdaohezi, Beishilazi, *Gao C. et al. 6103, 6113*. Muling County, Sanxinshan, alt. 600 m, *Chen X. L. 4200, 4201, 4258*; Dongjiangcheng, nearby power plant station, *Chen X. L. 4404*. **Jilin:** Changbaishan, Fusong County, Donggang to shenyuan, alt. 780 m, *Liu S. E. 1298*; Changbaishan, the Natural Reserves Administration, upper reaches of the power station, alt. 780, *Hou J. L. 78085, 78086*;

Dunhua Forest Administration, Dapuchai forest station, 8th branch line, alt. 650 m, *Zhao C. F. 4116, 4114*; 10 km west-south of Antu Town, alt. 550 m, *Gao C. 1364*. Liaoning: Benxi County, Heshangmao, alt. 150–250 m, *Chen X. L. et al. 6011, 6217*; Kuandian County, on the way from Xiangshuigou to Gaoligou, alt. 780 m, *Chen X. L. et al. 6909*; Futanggou, alt. 570–720 m, *Chen X. L. et al. 6937*.

***Cetrelia cetrarioides* (Delise ex Duby) W.L. Culb. & C.F. Culb.**

Contr. U.S. Natl. Herb. 34: 498. 1968. — *Parmelia perlata* β *cetrarioides* Delise ex Duby, Bot. Gall. ed. 2, 601. 1830. — *Parmelia cetrarioides* (Delise ex Duby) Nyl., Flora 52: 289. 1869.

Thallus medium to large, 7–16 cm wide; lobes 1–1.5 cm wide, the margins finely and densely sorediate; upper surface tan or pale, pseudocypbellae small, not exceeding 0.5 mm in size; lower surface jet-black, the margin brown, punctate, rhizines sparse, black. Apothecia extremely rare.

CHEMISTRY: atranorin in the cortex; perlatolic or imbricatic acid in the medulla; medulla K–, C–, KC– or KC+ pinkish, Pd–.

This species is the only *Cetrelia* spotted with larger white pseudocypbellae on both surfaces. It is the most widely ranging species in the genus, with some internal chemical variation (Culberson & Culberson 1968, Randlane & Saag 1991a).

DISTRIBUTION: Eastern North America, western Europe, Japan, Sikkim, China (SW, NE).

SPECIMENS EXAMINED. **Heilongjiang:** Daxinganling, Tahe District, Xiluoqingling, alt. 920 m, *Zhao C. F. 1370*; Xiaoxinganling, Wuminhe, Anquan, *Chen X. L. 5320*; Dailing, Liangshuigou, *Chen S. L. 4021*; Wandashan, Raohe County, Bukaishan, alt. 820 m, *Zhao C. F. 797, 830*; Yichun County, 26 km NNW of Tailing, Liang Shui, alt. 400 m, Hämet-Ahti L. 3240 (H). **Jilin:** Changbaishan, nearby Tizihe Wenquan, alt. 1710 m, *Liu S. E. 1524*; Changbai County, Hengshan, along the Yalujiang, alt. 1450 m, *Chen X. L. 2041, 2060, 2110, 2194, 2332-1*; Antu County, Changbaishan, Hepingyingzi, west main line, alt. 1100 m, *Chen X. L. 4640*; 1 km west-north of Bingchang, alt. 1700 m, *Hou J. L. 78245-1*; nearby Bingchang, alt. 1720 m, *Zhao C. F. 0064, 0219*; Antu County, Heping forest station, alt. 1080 m, *Zhao C. F. 3244*; Changbaishan, Xiaotianchi, alt. 1800 m, *Zhao C. F. 3640, 3650, 3688, 3702*; Changbaishan, No. 2 sample field, *Huang Y. H. 9062-1*. **Liaoning:** Kuandian County, Baishilazi to Heigou, alt. 500 m, *Chen X. L. 7408*.

***Cetrelia chicitae* (W.L. Culb.) W.L. Culb. & C.F. Culb.**

Contr. U.S. Natl. Herb. 34: 504. 1968. — *Cetraria chicitae* W.L. Culb., Bryologist 68: 95. 1965.

Thallus medium to large, 10–15 cm wide, lobes 1.0–2.0 cm wide, ascending, the margins erupting with fine soredia, pseudocypbellae small, white, irregular, mostly 0.15–0.6 mm in size; upper surface light grey or ashy, smooth, often pruinose at the tips; lower surface jet-black, the margins brown or concolorous with the upper surface, rhizines sparse, black. Apothecia rare.

CHEMISTRY: atranorin in the cortex; alecortronic and α-collatolic acids in the medulla; medulla K–, C–, KC+ pink, Pd–, UV+ blue-white.

This species is often indistinguishable morphologically from *C. cetrarioides*. Pseudocypbellae are often larger and abundant in this species, while small and inconspicuous in *C. cetrarioides*. For their morphological distinction see also Obermayer and Mayrhofer (2007).

DISTRIBUTION: North America, Sakhalin, Japan, Philippines, Sabah, Java, China (SW, E, NE, Taiwan), Siberia, Europe.

SPECIMENS EXAMINED. **Heilongjiang:** Daxinganling, Huzhong District, Dabaishan, alt. 1000 m, *Zhao C. F. 1107, 1111*; Tahe District, Xiluoqingling, alt. 920 m, *Zhao C. F. 1367-1*; Xiaoxinganling, Yichun, *Zhang Y. L. 1467*; Xiaoxinganling, Dailing, Liangshui, alt. 350 m, *Chen X. L. 3922, 3941-1, 3945, 3963*; Wuying, alt. 462 m, *Chen X. L. 5200, 5271*; Wuminhe Forest Administration, Anquan, *Chen X. L. 5291, 5326*; Wandashan, Roahe County, Bukaishan, alt. 825 m, *Zhao C. F. 853, 854, 871*. **Jilin:** Changbaishan south slope, Sizhuangfang, alt. 1870 m, *Chen X. L. 2140*; Changbai County, 15th Daogou to Xigangding, alt. 1650 m, *Chen X. L. 2163, 2276*; Antu County, Changbaishan, Bingchang, alt. 1700 m, *Chen X. L. 4455, 5043*; Changbaishan, 14 km south of Baishan Station, alt. 1270 m, *Zhao C. F. 106, 487*; Changbaishan, nearby Tianchi, alt. 2150 m, *Zhao C. F. 3479*; Xiaotianchi, alt. 1800 m, *Zhao C. F. 3613*; Helong County, Zhenfengshan, alt. 1360 m, *Zhao C. F. 3836, 3857*; Dunhua County Dapuchai forest station, 7th branch line, alt. 700 m, *Zhao C. F. 4005*.

***Cetrelia collata* (Nyl.) W.L. Culb. & C.F. Culb.**

Contr. U.S. Natl. Herb. 34: 505. 1968. — *Platysma collatum* Nyl., Flora 70: 134. 1887. — *Cetraria collata* (Nyl.) Müll. Arg., Nouv. Giorn. Bot. Ital. 24: 192. 1892.

Thallus medium, to 15 cm wide, lobes 0.6–2.5 cm wide, smooth, pseudocyphellae large, sometimes becoming confluent and exceeding 1 mm in size; upper surface whitish grey; lower surface jet-black,  $\pm$  punctate, the margins dark brown or concolorous with the upper surface, rhizines sparse. Apothecia 0.8–2.0 cm in diameter, perforate or entire, the thalline exciple pseudocyphellate; ascospores ellipsoid, 15–20  $\times$  8–12  $\mu$ m. Pycnidia marginal; pycnoconidia rod-shaped, the ends  $\pm$  inflated.

CHEMISTRY: atranorin in the cortex; imbricarinic acid in the medulla; K–, C–, KC– or KC+ pinkish, Pd–.

DISTRIBUTION: Nepal, China (SW). New to NE China.

SPECIMEN EXAMINED. **Jilin:** Changbaishan, tundra, alt. 2000–2300 m, *Qian H.* 69-15.

### ***Cetrelia japonica*** (Zahlbr.) W.L. Culb. & C.F. Culb.

Contr. U.S. Natl. Herb. 34: 511. 1968. — *Cetraria japonica* Zahlbr., Ann. Mycol. 14: 60. 1916.

*Platysma collatum* Nyl. f. *microphyllum* Hue, Nouv. Arch. Mus., sér. 4, 1: 209. 1899.

Thallus medium to very large, 10–25 cm wide; lobes 0.5–1.5 cm wide, the margins densely fringed with tiny branched lobulae or dorsiventral isidia; upper surface greyish-white or ashy-white, smooth, pseudocyphellae punctiform to elongate, small, ca. 1 mm in size; lower surface jet-black, the margins brown to whitish, not punctate, rhizines black. Apothecia not found.

CHEMISTRY: atranorin in the cortex; microphyllinic acid in the medulla; medulla K–, C–, KC– or KC+ pink, Pd–.

This species is distinctive in the well developed tiny branched lobulae along the lobe margins, and in containing the rare lichen substance microphyllinic acid.

DISTRIBUTION: Japan, South Korea, Borneo, Java, Taiwan. New to mainland China.

SPECIMENS EXAMINED. **Liaoning:** Xinbin County, Gangshan forest station, Laotudingzi, alt. 1250 m, *Chen X. L.* 5633; Kuandian County, Baishilazi, Futangou, alt. 570–

720 m, *Chen X. L.* 6971, Heigou, Houshi, alt. 940 m, *Chen X. L.* 7235.

### ***Cetrelia nuda*** (Hue) W.L. Culb. & C.F. Culb.

Contr. U.S. Natl. Herb. 34: 513. 1968. — *Platysma collatum* Nyl. f. *nudum* Hue, Nouv. Arch. Mus., IV, 1: 208. 1899. — *Cetraria collata* (Nyl.) Müll. Arg. f. *nuda* (Hue) Zahlbr., Catal. Lich. Univ. 6: 285. 1930.

*Parmelia yunnana* Hue f. *subnuda* Zahlbr., Hedwigia 74: 210. 1934.

Thallus large, 15–24 cm. broad, lobes 0.5–1.8 cm wide; upper surface greyish or ashy-white, smooth, pseudocyphellae with large pores, conspicuous, irregular, confluent, the largest aggregates could be more than 1 mm in size; lower surface black, punctate, the margins of some lobes concolorous with the upper surface. Apothecia common, submarginal to laminal, perforate, 1.2–1.5 cm in diameter. Pycnidia large, often pruinose, marginal or laminal; pycnoconidia rod-shaped, the ends slightly inflated, 5.7  $\times$  1  $\mu$ m.

CHEMISTRY: atranorin in the cortex; alectronic and  $\alpha$ -collatolic acids in the medulla; medulla K–, C–, KC+ pink, Pd–, UV+ blue-white.

This species is often conspicuous with large thalli, lobes broad and often with large aggregate pseudocyphellae.

DISTRIBUTION: Japan, China (Yunnan, Taiwan). New to NE China.

SPECIMENS EXAMINED. **Jilin:** Changbaishan, nearby Huapihezi, Wenquan, alt. 1710 m, *Liu S. E.* 1524; Antu, Changbaishan, Wenquan, East Mountain, alt. 2200 m, *Chen X. L.* 4722.

**Liaoning:** Huanren County, Laotudingzi, Xiangbizigou, alt. 1000 m, *Chen X. L.* 6607; Kuandian County, Baishilazi, Futangou, alt. 900 m, *Chen X. L.* 7078.

### ***Cetrelia olivetorum*** (Nyl.) W.L. Culb. & C.F. Culb.

Contr. U.S. Natl. Herb. 34: 515. 1968. — *Parmelia olivetorum* Nyl., Lich. Lapp. Orient. 180. 1866.

Thallus small to medium-sized, 6–15 cm. wide, lobes 0.5–1.8 cm. wide, the margins densely sorediate; upper surface light tan or brownish, pseudocyphellae abundant, very small, less than 0.3 mm in size; lower sur-

face black, the margins brown or concolorous with the upper surface, rarely punctate, rhizines sparse, black. Apothecia not found.

CHEMISTRY: atranorin in the cortex; olivetoric acid in the medulla; medulla K–, KC+ red, C+ pink or red, Pd–.

This species resembles *C. cetrarioides* and *C. chicitae*, but is recognized by its slightly convex lobes, abundant but extremely minute pseudocyphellae, the distinctly fine marginal soredia, and the total absence of laminal soredia. Only this species gives a positive reaction with C due to the presence of olivetoric acid.

DISTRIBUTION: North America, Europe, Japan, Nepal and China (SW, NE, Taiwan).

SPECIMENS EXAMINED. **Heilongjiang:** Daxinganling, Tahe District, Xiluoqing, alt. 920 m, *Zhao C. F.* 1366, 1368, 1369, 1371, 1373, 1379-2, 1418; Wandashan, Ningan County, Xiaobeihu forest station, west-north 30 km, alt. 800 m, *Zhao C. F.* 980, 995; Dedu County, Wudalianchi, Laoheshan, alt. 300 m, *Chen X. L.* 3462; Muling, Sanxinshan forest station, alt. 600 m, *Chen X. L.* 4199, 4293. **Jilin:** Fusong County, Daoli, Sipingjie, alt. 1700 m, *Zhang Y. L. et al.* 581; Changbaishan, Hepingyingzi west line, alt. 1100 m, *Chen X. L.* 4598, 4599; Changbaishan, nearby Bingchang, alt. 1750 m, *Chen X. L.* 4982; nearby Bingchang, alt. 1700 m, *Hou J. L.* 78139; Changbaishan, 14 km south of Baishan station, *Zhao C. F.* 135; nearby Wenquan, alt. 1800 m, *Zhao C. F.* 3386, 3662, 3683; on the way from Tianchi to the waterfall, alt. 2080 m, *Zhao C. F.* 3505; Helong County, Xujiadong forest station, alt. 920 m, *Zhao C. F.* 3747, 3798; Helong County, Zhenfengshan, alt. 1400 m, *Zhao C. F.* 3867; Duhua County, Dapuchai forest station, alt. 650 m, *Zhao C. F.* 4064; Changbaishan north slope, alt. 2450 m, *Zhao C. F.* 4181. **Liaoning:** Huanren County, Laotudingzi, nearby the Natural Reserves Administration, alt. 600 m, *Chen X. L.* 6808; Xiangshuigou, alt. 900 m, *Chen X. L.* 6906; Gaoligou, alt. 780 m, *Chen X. L.* 6911-1; Heigou, alt. 650 m, *Chen X. L.* 7457.

***Cetrelia pseudolivatorum* (Asahina) W.L. Culb. & C.F. Culb.**

Contr. U.S. Natl. Herb. 34: 519. 1968. — *Parmelia* (*Amphigymnia*) *pseudolivatorum* Asahina, *J. Jap. Bot.* 27: 16. 1952.

Thallus small to large, 0.7–18 cm broad, lobes 0.5–1.5 cm wide, the margins and sometimes the surface with granular, simple or coral-oid isidia, often grading into dorsiventral, dissected lobulae; upper surface greyish or greyish-white, pseudocyphellae small, 0.5 mm. in size, punctiform or slightly elongate; lower surface

black, the margins brown or concolorous with the upper surface, not punctate, rhizines sparse, black. Apothecia rare, 0.5–1.8 cm. in diameter, perforate; ascospores ellipsoid, 15–20 × 9–12 μm.

CHEMISTRY: atranorin in the cortex; olivetoric acid in the medulla; medulla K–, KC+ red, C+ pink or red, Pd–.

This species is characterized by the lobulae along the lobe margins, but the marginal lobulae are less well developed as in *C. japonica*.

DISTRIBUTION: Japan, Himalayas and China (SW, NE, Taiwan).

SPECIMENS EXAMINED. **Jilin:** Fusong County, on the way from Donggong to Shenyuan, alt. 780 m, *Liu S. E.* 1298; Antu County, 7.5 km north of Wenquan, alt. 1200 m, *Liu S. E.* 4013, 4018-1. **Liaoning:** Benxi County, Caohezhang, Tanggou, Gaolaopodingzi, *Li S. X.* 680; Xinbin County, Gangshan forest station, Laotudingzi alt. 1200 m, *Chen X. L. et al.* 5703; Huanren County, Laotudingzi, Sandaogou, alt. 800 m, *Chen X. L.* 6693; Kuandian County, between Heigou to Egugang, alt. 1245 m, *Chen X. L.* 6783, 6787; Futanggou, alt. 570–720 m, *Chen X. L.* 6973, 6983; Tianqiaolazi alt. 1000 m, *Chen X. L.* 7105, 7116.

***Cetrelia sinensis* W.L. Culb. & C.F. Culb.**

Contr. U.S. Natl. Herb. 34: 523. 1968.

Thallus very large, 18–25 cm wide, lobes 1–2 cm wide, the margins densely fringed with palmately divided lobulae, sometimes isidioid or broadly expanded into lobelike, so dense that the thalli become cristate; upper surface light brown (greyish white when fresh), smooth, pseudocyphellae punctiform or elongate, small, ca. 0.5 mm. in size; lower surface jet-black, margins concolorous with the upper surface, not punctate, rhizines black. Apothecia not found. Pycnidia black, produced at lobulae margins; pycnoconidia rod-shaped, 6 × 1.5 μm.

CHEMISTRY: atranorin in the cortex; imbricatic acid in the medulla; medulla K–, C–, KC–, Pd–.

DISTRIBUTION: China (Yunnan, Taiwan). New to NE China.

The only distinction of this species from *C. japonica* is in the chemistry.

SPECIMENS EXAMINED. **Jilin:** Changbai County, Changbaishan south slope, alt. 1440 m, *Chen X. L.* 2276-1. **Liaoning:**



Kuandian County, the summit of the Baishilazi, alt. 1230 m, *Chen X. L.* 2768; Futanggou alt. 940 m, *Chen X. L.* 7199.

### ***Cetrellopsis* M.J. Lai**

Quart. J. Taiwan Mus. 33: 218. 1980.

Thallus broad foliose, large; lobes rotund, upper surface yellowish grey or straw-yellow, shiny, sorediate along the margins or lacking, pseudocyphellate; upper cortex prosoplectenchymatous; medulla white; lower surface black, pseudocyphellate, with sparse rhizines. Apothecia nephroid, produced along the lobe margins, disc pale brown, almost perpendicular to the thallus; ascospores ellipsoid. Pycnidia marginal; pycnoconidia bifusiform.

The genus is morphologically close to *Cetrelia* but is distinguished by containing usnic acid in the upper cortex and fumarprotocetraric and protocetraric acids in the medulla (Pd+ red). Moreover, *Cetrelia* usually has submarginal and perforate apothecia. Key references: Lai (1980), Randlane *et al.* (1995), Lai and Elix (2002).

### ***Cetrellopsis asahinae* (Sato) Randlane & A. Thell**

Cryptog. Bryol. Lichénol. 16: 49. 1995. — *Cetraria asahinae* Sato, Res. Bull. Saito Ho-On Kai Mus. 11: 12. 1936. — *Nephromopsis asahinae* (Sato) Räsänen, Kuopion Luonnon Ystävien Yhdistyksen Julkaisuja, ser. B, 2(6): 50. 1952.

*Cetraria asahinae* Sato f. *inermis* Asahina ex Sato, in Nakai & Honda, Nov. Fl. Jap. 5: 44. 1939.

Thallus foliose, up to 10 cm in size; lobes 8–15 mm, with ascending margins; upper surface yellowish green; lower surface black near central parts, margins pale brown; pseudocyphellae occur on both surfaces, on upper surface surrounded with a black rim and bearing black emergent projections, on lower surface less conspicuous, in the form of white patches situated on ridges; cortex 3–4 layers; medulla white. Apothecia marginal or submarginal, 10–15 mm in diameter; disc brown; exciple 2-layered; ascospores ellipsoid, 8–10 × 4–7 μm. Pycnidia laminal or marginal, on emergent projections; pycnoconidia bifusiform, ca. 4 × 1 μm.

CHEMISTRY: usnic acid in the cortex; protocetraric (major), fumarprotocetraric and physodalic (±) acids in the medulla; medulla Pd+ red.

DISTRIBUTION: China (SW, NE (new), Taiwan), India, Nepal, Japan, Russian Far East, South Korea, Vietnam. New to NE China.

SPECIMENS EXAMINED. **Jilin:** Changbaishan, on the way from Huapihe to Liujiatangai, alt. 1100 m, *Liu S. E.* 1397; Antu, Changbaishan, on the way from Sipingjie to Tizihe, alt. 1700 m, *Liu S. E.* 1645; Changbaishan, Natural Reserves Administration, the upper reaches of the power station, alt. 780 m, *Hou J. L.* 78092; Helong County, Xujiadong forest station, east gully, alt. 950 m, *Zhao C. F.* 3792; Dunhua County, Dapuchai forest station, 8th branch line, alt. 650 m, *Zhao C. F.* 4101.

### ***Flavocetraria* Kärnefelt & A. Thell**

Acta Bot. Fennica 150: 81. 1994.

Thallus subfoliose, small to medium-sized, erect, main lobe once to twice dichotomously branched; lobes canaliculate, subtubular or sometimes flat; upper surface yellow, smooth and glossy, marginal projections lacking, marginal projections lacking, lower surface smooth, the same colour as the upper surface, with sparse white pseudocyphellae along the margins, rhizines lacking; cortical layers paraplectenchymatous, composed of 2–3 layers of pachydermatous cells of different size; medulla white. Apothecia brown, produced along the margins at lobe ends; ascospores ellipsoidal. Pycnidia black, marginal, pycnoconidia ± bifusiform. Key reference: Kärnefelt *et al.* (1994).

### **Key to the species**

1. Lobes flat with a network of depressions and sharp ridges, or wrinkled ..... *F. nivalis*
1. Lobes curled inward, canaliculate, smooth, or undulate and crisped at the margins ..... *F. cucullata*

### ***Flavocetraria cucullata* (Bellardi) Kärnefelt & A. Thell**

Acta Bot. Fennica 150: 81. 1994. — *Lichen cucullatus* Bellardi, Osservaz. Bot. 54. 1788. — *Platysma cucullatum* (Bellardi) Hoffm., Descr. Pl. Cl. Crypt. 3: 17. 1801. — *Cetraria cucullata* (Bellardi) Ach., Meth. Lich. 293. 1803. — *Alloce-*

*traria cucullata* (Bellardi) Randle & Saag, Mycotaxon 44: 492. 1992.

Thallus subfoliose, erect, 2.5–6 cm high, main lobe once to twice dichotomously branched, lobes 5 mm wide, ruffled at the margins, distinctly canaliculate, or strongly curled inward and almost becoming subtubular; upper surface yellow, smooth, glossy, old basal parts becoming red-violet; lower surface pale yellow, smooth, sparsely pseudocyphellate along the margins, pseudocyphellae round or linear. Apothecia brown, marginal, produced at lobe ends, 1–2 mm wide, exciple 2-layered; ascospores ellipsoidal,  $5\text{--}10 \times 3\text{--}5 \mu\text{m}$ . Pycnidia black, marginal; pycnoconidia  $\pm$  bifusiform,  $5 \times 1 \mu\text{m}$ .

CHEMISTRY: usnic acid in the cortex; licheterinic and protolicheterinic acids in medulla; anthraquinones in medulla and cortex in the lower parts of thalli; medulla Pd–, K–, KC–, C–.

DISTRIBUTION: Widely spread in temperate, boreal and arctic regions in the northern hemisphere, and in cold temperate regions in southernmost South America.

SPECIMENS EXAMINED. **Neimenggu:** Eergunazuqi, Aokeliduishan, alt. 1530 m, *Zhao C. F.* 2941. **Heilongjiang:** Daxinganling north slope, Huzhong District, Dabaishan, alt. 1200–1400 m, *Zhao C. F.* 1118, 1119.

### *Flavocetraria nivalis* (L.) Kärnefelt & A. Thell

Acta Bot. Fennica 150: 84. 1994. — *Lichen nivalis* L., Sp. Pl. 1145. 1753. — *Cetraria nivalis* (L.) Ach., Meth. Lich. 293. 1803. — *Platysma nivale* (L.) Frege, Deutsch. Bot. Taschenbuch 2. Theil. 161. 1812. — *Allocetraria nivalis* (L.) Randle & Saag, Mycotaxon 44: 492. 1992.

Thallus subfoliose, 3–6 cm high, lobes divided dichotomously, 1.5–6 mm wide, erect or prostrate,  $\pm$  flat with depressions and ridges; upper surface yellow, smooth, glossy, basal parts becoming yellow-orange; lower surface pale yellow, foveolate, pseudocyphellae round, slightly convex. Apothecia rare, marginal, produced at lobe ends, disc brown; exciple 2-layered; ascospores ellipsoidal. Pycnidia black, located on or close to the lobe margins, slightly

raised but not on projections; pycnoconidia  $\pm$  bifusiform,  $5\text{--}6 \times 1.5 \mu\text{m}$ .

CHEMISTRY: usnic acid in cortex, no medullary substances.

DISTRIBUTION: Widely distributed in arctic-boreal areas in the northern hemisphere, and in cold temperate regions in southernmost South America.

SPECIMENS EXAMINED. **Neimenggu:** Eergunazuqi, Aokeliduishan, alt. 1530 m, *Zhao C. F.* 2940. **Heilongjiang:** Daxinganling, Huzhong District, Dabaishan north slope, alt. 1200–1400 m, *Zhao C. F.* 1120, 1125-2; Huyuan forest station, alt. 1400 m, *Ding T. Y.* 8517.

### *Nephromopsis* Müll. Arg.

Flora 74: 374. 1891.

Thallus foliose, large-sized, up to 20 cm in diameter, sometimes distinctly rugose or reticulated; upper surface greenish yellow, lobe margins lacking isidia, soredia and cilia, but often with numerous black, laminal and marginal, emergent projections bearing pycnidia at their tops; lower surface light to dark brown or even black, pseudocyphellae occur either in the form of small white dots or larger regular patches, plain, concave or convex, often produced on the ridges or on the special plug-like outgrowths, rhizines sparse or numerous; cortical layers paraplectenchymatous; medulla white or in some species pale yellow or orange. Apothecia marginal, produced on the lower surface but the disc often turns upwards; disc brown, rounded or reniform,  $\pm$  stalked; exciples usually distinctly 3-layered; ascospores ellipsoid. Pycnoconidia bifusiform. Distributed in Himalayan to East Asian regions. Key references: Randle and Saag (1991b, 1992, 1998), Randle *et al.* (1995, 2001), Thell *et al.* (2005).

### Key to the species

1. Medulla pale yellow ..... *N. ornata*
1. Medulla white ..... 2
2. Thallus strongly rugose, with concentric rings; epilithic ..... *N. komarovii*
2. Thallus smooth; epiphytic ..... *N. laii*

***Nephromopsis komarovii* (Elenkin) J.C. Wei**

Enum. Lich. China 158. 1991. — *Cetraria komarovii* Elenkin, Izv. Imp. S.-Peterburgsk. Bot. Sada 3: 51. 1903. — *Cetraria perstraminea* Zahlbr., Trudy Troitskos.-Kyakhtinsk. Otd. Priamursk. Otd. Imp. Russk. Geogr. Obshch. 12: 88. 1911.

Thallus foliose, large, up to 15 cm in diameter, lobes rounded, 1–2 cm wide; upper surface yellow to yellowish green, distinctly rugose in a  $\pm$  concentric pattern; lower surface brown, smooth or  $\pm$  rugose, with laminal white pseudocyphellae, rhizines scattered; medulla white. Apothecia marginal, rarely laminal, rounded or reniform, up to 15 mm in diameter, marginal juvenile apothecia frequent; disc brown, facing upwards; exciple 3-layered; ascospores oblong. Pycnidia (Obermayer 2004) submarginal, on short thallus projections; pycnosporos dumbbell-shaped, (6–)7–8(–10)  $\mu$ m.

CHEMISTRY: usnic acid in the cortex; fumarprotocetraric (Huneck *et al.* 1984), stictic, constictic acids (Randlane & Saag 1998), lichesterinic and protolichesterinic-type fatty acids, and unknowns (Obermayer 2004).

DISTRIBUTION: Russia (eastern Siberia and Far East), Mongolia, China.

SPECIMENS EXAMINED. **Neimenggu:** Daxinganling, Ganhe, West-south mountain, alt. 700 m, *Chen X. L.* 3270. **Heilongjiang:** Daxinganling Huzhong District, Dabaishan north slope, alt. 1200–1400 m, *Zhao C. F.* 1236. **Jilin:** Antu, Changbaishan, 7.5 km from Wenquan, alt. 1200 m, *Liu S. E.* 4018; Tianchi, waterfall, alt. 1500 m, *Liu S. E.* 4118; Changbaishan, Bingchang, alt. 1700 m, *Chen X. L.* 4458; Bingchang, east slope, alt. 2200 m, *Chen X. L.* 4684; Xiaotianchi, alt. 1750 m, *Chen X. L.* 4757; Wenquan, roadside, alt. 1700 m, *Hou J. L.* 78130, alt. 1900 m, *Wei J. C.* 2902 (H).

***Nephromopsis laii* (A. Thell & Randlane) Saag & A. Thell**

Bryologist 100: 111. 1997. — *Cetrariopsis laii* A. Thell & Randlane, Cryptog. Bryol. Lichénol. 16: 56. 1995.

Thallus foliose, up to 8 cm in diameter, lobes 8–15 mm, often with secondary marginal lobules; upper surface yellowish grey,  $\pm$  rugose;

lower surface pale brown to brown and pale whitish at the margins, distinctly reticulated, with white, small, rounded pseudocyphellae developed on the ridges; rhizines sparse, brown; medulla white. Apothecia marginal, numerous, often juvenile only, sometimes situated on the secondary marginal lobules, up to 5 mm in diameter; disc brown, oblong or reniform; exciple 2-layered; ascospores oblong.

CHEMISTRY: usnic acid in the cortex; alectronic and/or lichesterinic and protolichesterinic-type fatty acids in the medulla.

This species is characterized by the rugose upper surface and reticulated lower surface with pseudocyphellae situated on the ridges, and presence of secondary marginal lobules forming a fringe along the margins of lobes in many specimens.

DISTRIBUTION: Russian Far East, China (SW, Taiwan), India, Japan and Vietnam. New to NE China.

SPECIMENS EXAMINED. **Heilongjiang:** Xiaoxinganling, Daling, south of Liangshuigou, alt. 350 m, *Chen X. L.* 3718, 3739, 3988, 4067, 4111; Wuyin, alt. 462 m, *Chen X. L.* 5178; Wandashan, Ningan County, Dahailin Forest Administration, Qifeng forest station, *Gao C. et al.* 6876. **Jilin:** Changbai County, Hengshan, along by the Yalujiang alt. 1450 m, *Chen X. L.* 2039, 2321, 2331; Antu County, Changbaishan, Baishan station, alt. 1270 m, *Zhao C. F.* 100, 305, 371; 1 km northwest of Bingchang, alt. 1700 m, *Hou J. L.* 78244-1. **Liaoning:** Kuandian County, Baishilazi, Futanggou, alt. 570–720 m, *Chen X. L.* 6942.

***Nephromopsis ornata* (Müll. Arg.) Hue**

Nouv. Arch. Mus. Hist. Nat., Sér. 4, 2: 90. 1900. — *Cetraria ornata* Müll. Arg., Nuovo Giorn. Bot. Ital. 23: 122. 1891.

*Nephromopsis delavayi* Hue, Nouv. Arch. Mus. Hist. Nat., Sér. 4, 1: 219. 1899. — *Cetraria delavayi* (Hue) Sato in Nakai & Honda, Nov. Fl. Jap. 5: 48. 1939.

*Nephromopsis endoxantha* Hue, Nouv. Arch. Mus. Hist. Nat., Sér. 4, 1: 220. 1899. — *Tuckermannopsis endoxantha* (Hue) Gyeln., Acta pro Fauna et Fl. Univ., Ser. II, Bot. 1, 5/6: 6. 1933. — *Cetraria endoxantha* (Hue) D. D. Awasthi, Bull. Bot. Surv. India 24: 9. 1983.

Thallus foliose, large, up to 16 cm in diameter, lobes ascending, 1–1.5 cm wide; upper surface yellowish grey, smooth or slightly wrinkled; lower surface brown or dark brown to

almost black, reticulated; pseudocyphellae white, on ridges or at marginal part on the lower surface; rhizines sparsely scattered; medulla pale yellow. Apothecia rounded or reniform, ca. 20 mm in diameter, produced along the margins of the lower surface; disc brown, facing upwards; exciple 3-layered; ascospores oblong,  $7\text{--}8 \times 4\text{--}5 \mu\text{m}$ ; pycnidia marginal and laminal, produced on the black emergent projections; pycnoconidia bifusiform,  $5 \times 1 \mu\text{m}$ .

CHEMISTRY: usnic acid in the cortex, fumarprotocetraric acid and secalonic acids A or C, trace of endocrocin and some fatty acids in the medulla; medulla K+ deep yellow.

This species is closely related to *N. endocrocea*, but differs by containing secalonic acid A or C. Yosioka *et al.* (1972) also reported a joint occurrence of trace endocrocin in This species. Chen *et al.* (1981) reported *Cetraria endocrocea* (Asahina) Sato (= *N. endocrocea* Asahina) from Mt. Changbai, but the cited specimens (Chen 2016, 2337) are redetermined as *N. ornata*. Thus, *N. endocrocea* must be excluded from the lichen flora of China (Wei 1991).

DISTRIBUTION: China, Japan, Russian Far East, South Korea.

SPECIMENS EXAMINED. **Jilin:** Antu County, Changbaishan, Hengshan, along by the Yalujiang, alt. 1450 m, Chen X. L. 2016, 2275, 2297, 2337; Changbaishan north slope, Hepingyinzhi, west main line, alt. 1100 m, Chen X. L. 4600, 4651; nearby Bingchang, alt. 1700 m, Hou J. L. 78202, 78244.

### *Tuckermannopsis Gyeln.*

Acta pro Fauna et Flora Univ., ser. II, I (5–6): 6. 1933.

Thallus subfoliose or almost fruticose, lobes narrow, weakly canaliculate, with or without cilia along the margin; upper surface brown to olive, weakly wrinkled, pseudocyphellae sparse or lacking; soredia present or lacking; isidia lacking; upper cortex paraplectenchymatous; lower surface pale brown, with sparse rhizines; medulla white. Apothecia lecanorine, produced on the underside of reflexed lobe margins, or submarginal; ascospores subglobose to globose. Pycnidia on the lobe margins; pycnoconidia bifusiform. Distributed in North America and

East Asiatic temperate regions. Key references: Lai (1980), Thell (1998), Kärnefelt and Thell (2001). — Ought to be spelled *Tuckermannopsis* rather than ‘Tuckermanopsis’, as proposed by some recent authors; *see* Ahti (2007).

### Key to the species

1. Thallus sorediate along the lobe margins ..... *T. ulophylloides*
1. Thallus esorediate ..... *T. americana*

### *Tuckermannopsis americana* (Spreng.)

Hale

Bryologist 90: 164. 1987. — *Nephroma americanum* Spreng., Kongl. Vetensk. Akad. Handl. 28: 49. 1820.

*Cetraria halei* W.L. Culb., Bryologist 70: 161. 1967. — *Tuckermannopsis halei* (W.L. Culb. & C.F. Culb.) M.J. Lai, Quart. J. Taiwan Mus. 33: 26. 1980. — *Cetraria ciliaris* var. *halei* (W.L. Culb. & C.F. Culb.) Ahti in Brodo, Bryologist 87: 100. 1984

Thallus foliose, lobes 1–4 mm wide, with scattered cilia along the margins; upper surface pale brown to greenish, ± wrinkled; soredia lacking; pseudocyphellae scattered. Ascospores globose,  $4\text{--}5 \mu\text{m}$  in diameter; pycnoconidia bifusiform,  $5 \times 1 \mu\text{m}$ .

CHEMISTRY: atranorin (inconstant) in the cortex; alectoronic and (usually)  $\alpha$ -collatolic acids in medulla; medulla C -, KC+ pink or red, UV+ blue-white.

The identity of *Cetraria ciliaris* reported by Chen *et al.* (1981) from Neimenggu must be *Tuckermannopsis americana*.

DISTRIBUTION: North America, Europe, from S Finland east through northern Asia to Kamchatka, China and Japan. New to China.

SPECIMENS EXAMINED. **Neimenggu:** Eergunazuqi, Mangui, alt. 800 m, Gao D. E. 100; Alongshan, alt. 800 m, Gao D. E. 177; Morgan, alt. 800 m., Wei 3379-2 (Lich. Sin. Exs., fasc. 1: 26, as *Cetraria microphyllica*); Xingan league, Keyouqianqi, Yiershi Town, Tagebin, Chen X. L. 1747. **Heilongjiang:** Daxinganling, Xinlin, West mountain, alt. 590 m, Chen X. L. 3360; Huzhong District, Dabaishan north slope, alt. 100 m, Zhao C. F. 1285-2, 1287, 1343; Tahe District, Xiluoqing, alt. 920 m, Zhao C. F. 1379-1, 1392, 1413; Xilinji District, Gulion Country, alt. 600 m, Zhao C. F. 1460; 42 km from Xilinji to Mohe, Zhao C. F. 1510, 1512.

***Tuckermannopsis ulophylloides* (Asahina) M.J. Lai**

Quart. J. Taiwan Mus. 33: 226. 1980. — *Cetraria ulophylloides* Asahina, J. Jap. Bot. 11: 19. 1935.

Thallus foliose, lobes 3–5 mm wide, branched, ciliate and sorediate along the margins; pseudocyphellae lacking; upper surface olive or brown, smooth; lower surface pale, ± rugose, rhizines sparse. Apothecia not found.

CHEMISTRY: protolichesterinic acid in the medulla.

DISTRIBUTION: Japan. New to China.

SPECIMENS EXAMINED. **Heilongjiang:** Xiaoxinganlin, Dailing, Liangshuigou, alt. 340 m, *Chen X. L.* 4043. **Liaoning:** Kuandian, summit of Baishelazi, alt. 1230 m, *Nan Y. H.* 6319-1.

***Tuckneraria* Randalne & A. Thell**

Acta Bot. Fennica 150: 144. 1994.

Thallus foliose, medium-sized, upper surface smooth or slightly rugose, light yellow, yellowish-green or yellowish-grey; lobes elongate or rounded, normally with marginal cilia; with or without marginal soredia; lower surface pale, light to dark brown or black, pseudocyphellate, rhizines sparse; both cortices paraplectenchymatous; cortical hyphae strongly gelatinized. Apothecia marginal, rounded or reniform; disc brown; exciples 2-layered; ascospores globose-subglobose. Pycnidia on marginal (or occasionally laminal) emergent projections; pycnoconidia bifusiform. Five species so far known, mainly in eastern and southeastern Asia. Key references: Randalne *et al.* (1994, 2001), Thell *et al.* (1995). Thell *et al.* (2005) included *Tuckneraria* again in the genus *Nephromopsis*, but we still want to keep it separate.

**Key to the species**

1. Lobe margins isidiate ..... *T. togashii*
1. Lobe margins sorediate ..... *T. laureri*

***Tuckneraria laureri* (Kremp.) Randalne & A. Thell**

Acta Bot. Fennica 150: 149. 1994. — *Cetraria laureri* Kremp., Flora 34: 673. 1851. — *Nephromopsis laureri* (Kremp.) Kurok., J. Jap. Bot. 66: 156. 1991.

Thallus foliose, lobes rounded, 3–5 cm wide, the margin ascending, sorediate along the margins, and bearing scattered cilia; upper surface pale yellow; lower surface white to pale brown, pseudocyphellae white, rounded or irregular, lacking in some specimens, rhizines scattered; medulla white. Apothecia found only in Xizang (Obermayer 2004).

CHEMISTRY: usnic acid in the cortex; lichesterinic and protolichesterinic-type fatty acids in the medulla; medulla K–, C–, KC–, Pd–.

DISTRIBUTION: Central and NE Europe (recently found in Karelia and Leningrad Region, Russia), Russian Far East, China, Mongolia, Japan, Nepal, South America (Venezuela, Colombia). New to NE China.

SPECIMENS EXAMINED. **Neimenggu:** Xinganleague, Baiaxian, Tagebin, *Chen X. L.* 1656, 1770. **Jilin:** Changbaishan south slope, alt. 1200 m, *Chen X. L.* 2288.

***Tuckneraria togashii* (Asahina) Randalne & A. Thell**

J. Hattori Bot., Lab. 78: 238. 1995. — *Cetraria togashii* Asahina, J. Jap. Bot. 28: 136. 1953. — *Nephromopsis togashii* (Asahina) Saag & Thell, Mycol. Progr. 4: 311. 2005.

Thallus up to 10 cm in diameter, lobes rounded, ± concave, 2–5 mm wide; upper surface yellow; cilia sparse, along the margins; lower surface light brown to yellowish white; isidia coral-loid, mainly marginal, occasionally laminal; pseudocyphellae scanty, white, produced on the lower surface; rhizines scattered. Apothecia not found.

CHEMISTRY: usnic acid in the cortex; lichesterinic and protolichesterinic type fatty acids in the medulla; cortex K+ yellow; medulla K–, C–, KC–, Pd–.

DISTRIBUTION: Japan, China (Heilongjiang, Jilin, Liaoning, Tibet, Yunnan, Hubei, Taiwan). New to NE China.

SPECIMENS EXAMINED. **Heilongjiang:** Xiaoxinganling, Dailing, Liangshuigou forest station, alt. 350 m, *Chen X. L.* 3915, 3982. **Jilin:** Dunhua Forest Administration, Dapuchai forest station, 7th branch line, alt. 750 m, *Zhao C. F.* 4025. **Liaoning:** Zhuanghe, Buyunshan, north gully, alt. 270 m, *Gao C.* 5731.

### *Vulpicida* J.-E. Mattsson & M.J. Lai

Mycotaxon 46: 427. 1993.

Thallus foliose to almost fruticose, small to medium-sized, bright golden yellow to dark yellowish green; lobes flat, dorsiventral, appressed to ascending or erect; upper surface usually distinctly ridged, pseudocyphellae lacking; medulla bright yellow to orange. Apothecia lecanorine, borne close to the lobe margins, disc shiny, red-brown, often with crenulate margin; ascospores broadly ellipsoid. Pycnidia marginal or laminal, black, on projections, raised or immersed; pycnoconidia citriform (lemon-sharped) or sublageniform. The main diagnostic character of the genus is the presence of pinastric and vulpinic acids in the medulla. Ascomatal and pycnidial characters differ among the six species. Distributed in the arctic-boreal-temperate regions of the northern hemisphere. Key references Mattsson (1993), Mattsson and Lai (1993).

#### Key to the species

1. Soredia present on the lobe margins; pycnidia sparse or very inconspicuous ..... *V. pinastris*
1. Soredia lacking; pycnidia abundant and conspicuous ....  
..... *V. juniperina*

### *Vulpicida juniperina* (L.) J.-E. Mattsson & M.J. Lai

Mycotaxon 46: 427. 1993. — *Lichen juniperinus* L., Sp. P. 2: 1147. 1753. — *Cetraria juniperina* (L.) Ach., Meth. Lich. 298. 1803. — *Tuckermannopsis juniperina* (L.) Hale, Bryologist 90: 164. 1987.

Thallus dorsiventral, bright yellow to greenish yellow on both surfaces, medulla bright yellow. Soredia lacking. Apothecia usually abundant. Pycnidia abundant, on marginal projections: pycnoconidia sublageniform,  $6-8 \times 2 \mu\text{m}$ .

CHEMISTRY: usnic acid in the cortex; vulpinic and pinastric acids in the medulla.

DISTRIBUTION: northern Europe, NE Asia: China (Jilin, Neimenggu, Xinjiang), Japan, Mongolia, Russia. On *Pinus pumila* in NE China.

SPECIMENS EXAMINED. **Neimenggu:** Eergunazuqi, Aokeliduishan, alt. 1500 m, *Zhao C. F.* 2973; Alongshan, alt. 1400 m, *Gao D. E.* 0061. **Jilin:** Changbaishan, Lenggou, Sizhuangfang, alt. 1870 m, *Chen X. L.* 2133; Changbaishan, Huontoushan, alt., 950 m., *Hu Y. S.* (also in Wei, Lich. Sin. Exs. no. 25).

### *Vulpicida pinastris* (Scop.) J.-E. Mattsson & M.J. Lai

Mycotaxon 46: 428. 1993. — *Lichen pinastris* Scop., Fl. Carniolica (ed. 2) 2: 382. 1771. — *Cetraria juniperina* (L.) Ach. var. *pinastris* (Scop.) Ach., Meth. Lich. 298. 1803. — *Cetraria pinastris* (Scop.) Gray, Nat. Arrang. Brit. Plants 1: 432. 1821. — *Tuckermannopsis pinastris* (Scop.) Hale, Bryologist 90: 164. 1987.

Thallus forming appressed or ascending rosettes, upper surface greenish yellow to bright yellow; lobes 1.5–5 mm wide, the margins  $\pm$  divided or ruffled, dissolving into bright yellow, farinose soredia; lower surface pale yellow to white, pseudocyphellae lacking, rhizines almost absent to sparse; medulla yellow. Apothecia very rare (not found); pycnidia rare, on projections.

CHEMISTRY: usnic acid in the cortex; vulpinic and pinastric acids as well as zeorin and other triterpenes in the medulla.

DISTRIBUTION: Arctic-boreal-temperate regions of the northern hemisphere.

SPECIMENS EXAMINED. **Neimenggu:** Daxinganlin, Ganhe, nearby Kengaili, alt. 990 m, *Liu S. E.* 8876; Xingan league, Keyouqianqi, Yiershi, Tianchi, *Chen X. L.* 1376; Yiershi, Xingan, *Chen X. L.* 1560-2, 1568; Mangui Forest Administration, alt. 900 m, *Chen X. L.* 3106-1, 3107; Eergunazuqi, Alongshan Town, Aokeliduishan, alt. 1300 m, *Zhao C. F.* 2928, 2983; 9 km from Alongshan, alt. 850 m, *Zhao C. F.* 2997, 3018; Xiguituqi, Tulihe, alt. 750, *Zhao C. F.* 3136; Alongshan, alt. 800 m, *Gao D. E.* 0061, 0093, 0178; Mangui, alt. 800 m, *Gao D. E.* 0097, 0108, 0124, 0159; Xiguituqi, Tulihe, alt. 800 m, *Gao D. E.* 0191. **Heilongjiang:** Daxinganling, Xinlin, West Mountain, alt. 590 m, *Chen X. L.* 3365, 3419, Huzhong District, Dabaishan north slope, alt. 900-1000 m, *Zhao C. F.* 1114, 1121, 1122, 1253-1, Huzhong District, nearby Kamalanqiao, alt. 850 m, *Zhao C. F.* 1294,

131-1, 1344, 1345, Tahe District, Xiluoqingling, alt. 920 m, Zhao C. F. 1379-1, 1386-1, 1402, 1422-1, 1432-1; Muling County, Sanxinshan forest station, alt. 600 m, Chen X. L. 4263; Xiaoxinganlin, Hongxin, Zheng Q. Z. 003; Liangshui forest station, Zheng Q. Z. 004, Ningan County, Dahailin, Qifeng forest station, alt. 1200 m, Gao C. et al. 6730; Mishan County, on the way from Mishan to Peide, alt. 170 m, Zhao C. F. 578. **Jilin:** Changbai County, Hengshan forest station, alt. 1180 m, Chen X. L. 2289; Antu County, Bingchang, alt. 1700 m, Chen X. L. 4449, 4475; Hepingyingzi, alt. 1100 m, Chen X. L. 4563, 4561; Wenquan, along the roadside, alt. 1700 m, Hou J. L. 78134, Antu, Changbaishan, alt. 1380 m, Zhao C. F. 156; Changbaishan, Huangsongpu, alt. 1380 m, Zhao C. F. 0246; Changbaishan, Xiaotianchi, alt. 1800 m, Zhao C. F. 3636; Antu, 15 km N of Changbaishan, alt. 1400 m, Koponen T. 37011 (H); 30 km N of Changbaishan, alt. 1250 m, Koponen T. 36975 (H).

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