

**CETRARIOID LICHENS CONTAINING USNIC ACID  
FROM THE TIBETAN AREA\***

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**ABSTRACT:** A floristic survey of the yellow cetrarioid lichens containing usnic acid (fam. Parmeliaceae, lichenized Ascomycota) which are found in Tibet and neighbouring areas is presented. Typical characters, chemical constituents and distribution data are reported for all 26 species from seven genera (*Allocetraria*, *Cetraria*, *Cetrellopsis*, *Flavocetraria*, *Nephromopsis*, *Tuckneraria* and *Vulpicida*). Complete descriptions are provided for several taxa which have not been included in recent reviews of the cetrarioid genera. Two identification keys for taxa – both at generic and species level – have been compiled. Worldwide distribution maps are presented for the first time for some *Allocetraria*, *Cetraria*, *Cetrellopsis* and *Tuckneraria* species.

INTRODUCTION

The family Parmeliaceae consists of nearly 90 genera and more than 2000 species (Hawksworth *et al.* 1995; Tehler 1996). The largest parmelioid genus, *Xanthoparmelia*, is primarily distributed in the southern hemisphere, and several other species rich parmelioid genera are considered to have their centers of speciation or distribution in either South America, Australia or southern Africa – including *Bulbothrix*, *Hypotrachyna*, *Flavoparmelia*, *Paraparmelia*, *Punctelia*, *Rimelia* etc. (Elix 1993). Many cetrarioid genera, on the contrary, are mainly (e. g. *Platismatia*, *Tuckermannopsis*) or only (e.g. *Ahtiana*, *Allocetraria*, *Asahinea*, *Vulpicida*) distributed in the northern hemisphere. Such cetrarioid taxa as *Cetrelia*, *Cetrellopsis*, *Nephromopsis*, *Tuckneraria* evidently have their centers of speciation in eastern or

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\* Lichenological results of the Sino-German Joint Expedition to south-eastern and eastern Tibet 1994. VI.

southeastern Asia. The Tibetan area is one of the regions where the cetrarioid lichen flora is extremely prolific.

The aim of the present paper is to survey one of the most distinctive morphological groups of Parmeliaceae – the yellow cetrarioid species – in the Tibetan area. Although most lichenologists can readily distinguish parmelioid and cetrarioid lichens as well as identify the presence of usnic acid in the thallus, the precise identification of the yellow cetrarioid lichens is not as simple. For example, 10 such species were reported from the province Xizang, China relatively recently (Wei & Jiang 1986; Wei 1991), but today 20 yellow cetrarioid species from various genera are known from this region. Six\* further species (*Allocetraria endochrysea*, '*Cetraria*' *leucostigma*, *Nephromopsis komarovii*, *N. ornata*, *N. stracheyi*, *Vulpicida juniperina*) can now be added to this list as they have been collected from neighbouring territories. To promote the knowledge of these rare and beautiful lichens, two keys (for the identification of taxa both at generic and at species level) have been compiled. They include 26 taxa containing usnic acid from seven cetrarioid genera (*Allocetraria*, *Cetraria*, *Cetreliopsis*, *Flavocetraria*, *Nephromopsis*, *Tuckneraria* and *Vulpicida*). The numerous keys which have been published previously enable one to identify taxa at the species level, whereas determining the correct genus has often been a problem. The keys presented in this paper should avoid this deficiency. Complete descriptions have been provided for several taxa which have not been included in recent reviews of cetrarioid genera (Kärnefelt & Thell 1996; Kärnefelt *et al.* 1994; Mattsson 1993; Randle & Saag 1998; Randle *et al.* 1994, 1995; Thell *et al.* 1995). For other species literature descriptions are referenced while chemical and distributional data are reported in full, usually with some additions to the published data. Worldwide distribution maps are presented for the first time for some *Allocetraria*, *Cetraria*, *Cetreliopsis* and *Tuckneraria* species.

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\* One more species probably belonging to the group of yellow cetrarioid lichens – *Nephromopsis hengduanensis* L. H. Chen – has been described just recently from China, Yunnan province (Chen & Gao 2001). We are not sure about the generic position of this new species as the original description of the taxon reveals the state of some essential characters as very unusual for the indicated genus (ascospores extremely large, pycnoconidia bifusiform till filiform, pseudocyphellae present both on the upper and lower surfaces, thallus occasionally ciliate). We decided not to include *N. hengduanensis* in the present survey before the type material of this taxon is available for further studies.

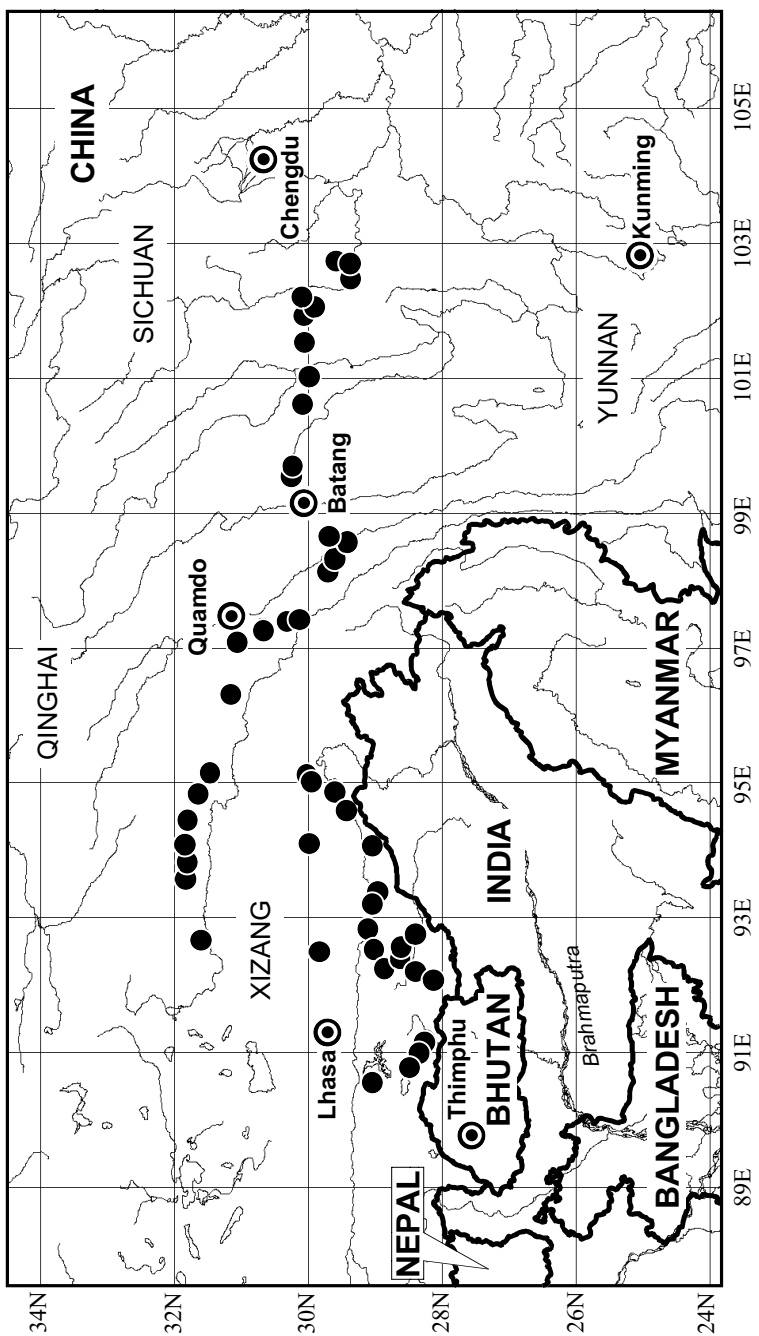


Fig. 1. Location of collection sites of the Sino-German Joint Expedition to Tibet 1994.

## MATERIAL AND METHODS

The basic material for the present work comprised approximately 90 specimens which were collected by the third author and his colleagues Georg and Sabine Miehe, Ubbo Wündisch, Achim Bräuning and Bernhard Dickoré during the Sino-German Joint Expedition to south-eastern and eastern Tibet in 1994 (Fig. 1). Additionally, several other collections from the Tibetan area and its surrounding mountain-systems, which are housed in B, BM, COLO, FH, GZU, H, LD, S, STU, TU, UPS and US, have been included. Historically an extensive mountainous area in southern Asia (which at present is divided between China, India, Nepal, Bhutan, Myanmar) is called Tibet. According to the official administrative arrangement, Tibet is defined as Xizang province of China (Wei 1991). To present the list of Tibetan yellow cetrarioid lichens, we have included all the species that had been reported from Xizang, and added the taxa known from neighbouring areas (including Qinghai, Sichuan, Xinjiang and Yunnan provinces of China; Nepal, Bhutan and north-eastern areas of India).

Microscopic studies were conducted with light microscopes Carl Zeiss Technival 2 and Olympus CH40. Chemical analyses were carried out according to the standardized TLC methods (Culberson & Kristinsson 1970; Culberson 1972; Culberson *et al.* 1981). The acetone extracts were run in solvent systems C and G.

Distribution maps were compiled using the computer program DMAP; both literature data and localities of herbarium specimens examined were included.

The following abbreviations for collectors have been used in the location lists:

A.B. = Achim Bräuning; B.D. = Bernhard Dickoré; U.K. = U. Kirschbaum; V.K. = Vera Komarkova; G. & S.M. = Georg & Sabine Miehe; W.O. = Walter Obermayer; J.P. = Josef Poelt; U.W. = Ubbo Wündisch.

## RESULTS

### Key to the genera of yellow cetrarioid lichens from the Tibetan area and adjacent regions

1. Medulla bright yellow (pinastric and vulpinic acids).....*Vulpicida*
  - Medulla white, pale yellow or orange (various medullary substances may be present but pinastric and vulpinic acids are absent)..... 2
2. Cross sections of the thallus branches more or less radially symmetric .....*Allocetraria* (p.p.)

- Thallus distinctly dorsiventral (although the lobes may be canaliculate or subtubular)..... 3
- 3. Lobes rather narrow, 2–8 (10) mm wide, and/or elongate. Pycnoconidia either filiform (10–19 x 0.5–2 µm) or bifusiform (5–6 x 1 µm). Mainly growing on soil, a few species corticolous ..... 4
  - Lobes usually wider, 8–15 (30) mm, not elongate. Pycnoconidia always bifusiform (4–5 x 1–2 µm). Mainly corticolous, one species epilithic ..... 7
- 4. Pycnoconidia filiform (10–19 x 0.5–2 µm). Apothecia (if present) contain globose (7–10 µm in diam) to subglobose (6–9 x 5–7 µm) ascospores.....*Allocetraria* (p.p.)
  - Pycnoconidia bifusiform (5–6 x 1 µm). Apothecia usually absent, if present – containing ellipsoid ascospores ..... 5
- 5. Thallus sorediate, attached to the substrate. Medulla Pd + orange ..... '*Cetraria*' (p.p.)
  - Thallus not sorediate, erect or suberect. Medulla Pd – ..... 6
- 6. Distinct pseudocyphellae present on the lower surface or on both surfaces ..... '*Cetraria*' (p.p.)
  - Pseudocyphellae on the lower surface very indistinct, or totally absent.....*Flavocetraria*
- 7. Pseudocyphellae present on both surfaces, medulla Pd + red (protocetraric and fumarprotocetraric acids).....*Cetreliaopsis*
  - Pseudocyphellae present on lower surface only, medulla Pd – ..... 8
- 8. Ascospores globose (7–10 µm in diam) to subglobose (6–9 x 5–7 µm) or thallus sorediate ..... *Tuckneraria*
  - Ascospores ellipsoid (6–12 x 3–7 µm). Soredia not present ..... *Nephromopsis*

**Key to the species of yellow cetrarioid lichens from the Tibetan area and adjacent regions**

- 1. Corticolous or lignicolous..... 2
  - Terricolous or epilithic..... 18
- 2. Thallus sorediate ..... 3
  - Thallus not sorediate ..... 6
- 3. Soredia and medulla bright yellow ..... *Vulpicida pinastri*
  - Medulla white, soredia white or very pale yellow ..... 4
- 4. Lower surface with small pseudocyphellae ..... *Tuckneraria laureri*
  - Lower surface without pseudocyphellae ..... 5
- 5. Medulla Pd – ..... *Allocetraria oakesiana*
  - Medulla Pd + orange ..... *Cetraria xizangensis*

6. Thallus isidiate ..... *Allocetraria isidiigera*  
 – Thallus not isidiate ..... 7
7. Medulla bright yellow (pinastric and vulpinic acids) .....  
 ..... *Vulpicida juniperina*  
 – Medulla white, pale yellow or orange (various medullary substances  
 may be present but pinastric and vulpinic acids absent)..... 8
8. Lobes rather narrow, 2–8 (10) mm wide. Ascospores globose (7–10  $\mu\text{m}$   
 in diam) or subglobose (6–9 x 5–7  $\mu\text{m}$ ) ..... 9  
 – Lobes usually wider, 8–15 (30) mm. Ascospores ellipsoid (6–12 x  
 3–7  $\mu\text{m}$ )..... 12
9. Marginal cilia may be present. Pycnoconidia bifusiform (5x1–15 $\mu\text{m}$ ).....  
 ..... *Tuckneraria ahtii*  
 – Marginal cilia always absent. Pycnoconidia filiform (10–19x0.5–2 $\mu\text{m}$ )... 10
10. Lower surface pale yellow ..... *Allocetraria ambigua*  
 – Lower surface pale brown, brown or black..... 11
11. Thallus usually fertile. Medulla Pd – ..... *Allocetraria globulans*  
 – Thallus usually sterile. Medulla Pd + red (fumarprotosestric acid).....  
 ..... *Allocetraria flavonigrescens*
12. Pseudocyphellae on both surfaces. Medulla Pd+ orange  
 (protocetraric and fumarprotocetraric acids)..... *Cetrellopsis asahinae*  
 – Pseudocyphellae on lower surface only. Medulla Pd – ..... 13
13. Medulla pale yellow, K + deep yellow (secalonic acids) .....  
 ..... *Nephromopsis ornata*  
 – Medulla white, K–..... 14
14. Apothecia small and numerous, mainly laminal.....  
 ..... *Nephromopsis pallescens* var. *pallescens*  
 – Apothecia of various size and number, mainly marginal ..... 15
15. Lower surface black, only margins brown to pale brown .....  
 ..... *Nephromopsis morrisonicola*  
 – Lower surface brown to whitish throughout ..... 16
16. Medulla C + red (olivatoric or anziaic acid) ..... *Nephromopsis stracheyi*  
 – Medulla C – ..... 17
17. Lower surface remarkably rugose, pseudocyphellae on ridges and  
 plug-like outgrowths. Pycnidia numerous, on emergent projections  
 ..... *Nephromopsis yunnanensis*  
 – Lower surface smooth or moderately rugose, pseudocyphellae either  
 on the surface or on ridges but not on special outgrowths. Pycnidia  
 absent or marginal and immersed ..... 18
18. Thallus moderately rugose, often with secondary marginal lobules.  
 Pseudocyphellae small and flat, mainly developed on ridges .....  
 ..... *Nephromopsis laii*  
 – Thallus smooth or slightly wrinkled, without secondary marginal  
 lobes. Pseudocyphellae medium to large, flat or concave,  
 developed on the surface..... *Nephromopsis nephromoides*

19. Epilithic ..... *Nephromopsis komarovii*  
 – Terricolous..... 20
20. Cross sections of the thallus branches more or less radially symmetric ..... 21  
 – Thallus distinctly dorsiventral (although the lobes may be canaliculate or subtubular)..... 23
21. Thallus branches always radially symmetric, slightly inflated, becoming arachnoid or even partly hollow to the center..... 22  
 – Thallus irregular, may be radially symmetric or dorsiventral in the same specimen, medulla compact..... *Allocetraria stracheyi*
22. Medulla yellow to orange (hybocarpace). Pycnidia emergent..... *Allocetraria endochrysea*  
 – Medulla white. Pycnidia immersed or very slightly emergent..... *Allocetraria madreporiformis*
23. Lobes strongly canaliculate or subtubular; yellow on both surfaces, with reddish basal parts..... *Flavocetraria cucullata*  
 – Lobes plane, slightly convex or concave but not strongly canaliculate or subtubular; upper surface yellow to brown, lower surface yellow to black, basal parts not reddish..... 24
24. Thallus pale yellow on both surfaces, with dark yellow basal parts. Lobes foveolate and strongly wrinkled (especially on the upper side)..... *Flavocetraria nivalis*  
 – Thallus yellow to brown (may be black on the lower surface), basal parts not differently coloured. Lobes rather smooth..... 25
25. Medulla Pd + red (fumarprotocetraric acid)..... *Allocetraria flavonigrescens*  
 – Medulla Pd – ..... 26
26. Lower surface uniformly brown, with pseudocyphellae forming a continuous white line along the margins on the lower side ..... *Allocetraria sinensis*  
 – Lower surface either yellow or brown. Pseudocyphellae (if present) different..... 27
27. Lobes rather narrow (1–4 mm wide). Pseudocyphellae absent or present marginally in the form of small indistinct white dots ..... 28  
 – Lobes wider (up to 8 mm). Pseudocyphellae always present (on the lower side only or on both surfaces), distinct, laminal, in the form of oval or rounded wide spots..... 29
28. Lobes more or less convex on the upper side. Medulla white or coloured ..... *Allocetraria stracheyi*  
 – Lobes distinctly concave on the upper side – especially terminally. Medulla white..... *Allocetraria ambigua*

29. Upper surface yellow, lower surface brown. Pseudocyphellae white and very distinct; present on the lower side of the thallus.....  
 ..... ‘*Cetraria*’ *leucostigma*
- Upper surface yellow, lower surface yellow or brown. Pseudocyphellae grey, surrounded by a distinct dark line; always present on the lower side but may also occur on the upper side .....  
 ..... ‘*Cetraria*’ *melaloma*

### The species

#### *Allocetraria ambigua* (Bab.) Kurok. & M. J. Lai

Bull. Natl. Sci. Mus. Tokyo, Ser. B, 17: 62, 1991. – *Cetraria ambigua* Bab., Hooker’s J. Bot. Kew Gard. Misc. 4: 244, 1852. – Type: [India] Bompras, Garhwal, on wood and mosses, alt. 16 000 ft., R. *Strachey* & E. *Winterbottom*, Himalayan Herb., no. 6 (BM! – lectotype).

*Description* – see Thell *et al.* (1995).

*Typical characters.* Thallus dorsiventral, pale yellow on both surfaces. Lobes elongate, rather narrow (up to 4 mm wide) and distinctly concave on the upper side. Medulla white.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic-protolichesterinic type fatty acids in the medulla. Secalonic acids A and/or C have been detected in several specimens (Thell *et al.* 1995).

*Notes.* The species might be confused with *Flavocetraria nivalis*, or more often with *Allocetraria stracheyi*, as all three taxa may grow together. *A. ambigua* is distinguished morphologically by the thin pale yellow thallus with elongated lobes which are usually clearly concave, especially near the apices of lobes. Unlike *F. nivalis* the upper surface of the thallus is rather smooth and not foveolate. If still in doubt, the shape of the pycnoconidia should be checked (filiform in *Allocetraria* and bifusiform in *Flavocetraria*). For the differences between this species and *A. stracheyi* see under the latter.

*Distribution and habitat.* Occurs mainly in the Himalayas, including China (Qinghai, Shaanxi, Sichuan and Xizang provinces), India (Awasthi 1983) and Nepal (Kurokawa 1993) (Fig. 2). Grows on soil (rarely at the base of small shrubs) in alpine meadows at altitudes of 2800–5600 m.

*Selected specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. QINGHAI.** Mountains SE of village He Ka, 100 km S of Koko Nur (Qinghai Lake), 35°49’N 99°50’E (nos 277–289), 4000 m alt., lower to middle alpine belt, 26./27.VIII.1985, V.K. 285 (GZU). – On the SE slope of Mt. Kan She Ka, Leng Long Ling, 37°36’N 102°15’E, Nan Shan, Kun Lun Shan, NE of the Haibei Research Station (nos 27–36, 223–252), 4000–4500 m alt., upper alpine belt, 19./20.VII.1985, V.K. 30; 32–34; 225-1; 225-2; 228; 229; 233-2; 234; 235-2; 247; 249 (GZU). – **PROV. SICHUAN.** Shalui Shan Mts., 40 km NNE of Batang, SE of Yidun, 30°14’N 99°34’E, 4700–4850 m alt., alpine meadows with *Kobresia* and *Rhododendron* shrubs, on soil, 28.VI.1994, W.O. 03518; 03519-1 (GZU). – Shalui Shan Mts., 35 km NNE of Batang, SE of Yidun, 30°16’N 99°28’E, 4200–4300 m alt., pasture with schist outcrops and single



*Juniperus* trees, on soil, 27.VI.1994, W.O. 03494 (GZU). – **PROV. XIZANG.** Taniantaweng Shan Mts., 60 km W of Markam (=Gartok), pass 15 km NE of Zogang (=Wangda), 29°43'N 98°00'E, 4950–5010 m alt., on soil, 4.VII.1994, W.O. 03812a (GZU). – Tanggula Shan, way from Quamdo (=Changtu) to Nagqu (=Nakchu), 31°40'N 94°40'E, 4850 m alt., on soil, 9.VII.1994, W.O. 04137 (GZU). – Himalaya Range, 170 km SE of Lhasa, 80 km SE of Tsetang (Nedong), 2<sup>nd</sup> pass on way from Tsetang to Lhünze, 28°38'N 92°14'E, 5000 m alt., alpine meadows and debris cones, on ground, 25.VII.1994, W.O. 04941 (GZU). – Himalaya Range, 190 km SSE of Lhasa, 125 km S of Tsetang (Nedong), 20 km S of Nera Tso (=Ni la Hu), on way to Cona (=Tsona), 28°07'N 91°55'E, 4650–4800 m alt., alpine meadows, on ground and *Rhododendron*, 30.VII.1994, W.O. 05061b (GZU). – Himalaya Range, mountain directly southwest above Nyalam, 28°09'N 85°58'E (nos 362–384), 4000–4770 m alt., lower to upper alpine belt, on soil, 5./6.VII.1986, V.K. 369; 370-3; 371 (GZU). – **NEPAL.** Annapurna, rocks in the middle of North-Annapurna glacier, 5335 m alt., 6.IX.1979, V. Komarkova (COLO).

***Allocetraria endochrysea* (Lynge) Kärnefelt & A. Thell**

Nova Hedwigia 62: 507, 1996. – *Dactylina endochrysea* Lynge, Skr. Svalbard Ishavet (Oslo) 59, Suppl. 5: 62, 1933. – Type: China, Yunnan, Mt. Li Kiang, alt. 4 000 m, 1886, R. P. Delavay (H-NYL 35806 – holotype, O – isotype).

*Description* – see Kärnefelt & Thell (1996).

*Typical characters.* Thallus radial symmetric, slightly inflated, becoming arachnoid in the center. Medulla coloured (deep yellow to orange). Pycnidia emergent.

*Chemical constituents.* Contains usnic acid in the cortex and hybocarpone and secalonic acid B in the medulla. Literature data about medullary compounds are various – Follmann *et al.* (1968) mention dufourin and endochrysin; Kärnefelt & Thell (1996) add lichesterinic and protolichesterinic acids. The latest HPLC analysis by Elix established that in addition to usnic acid, hybocarpone (major) and secalonic acid B (minor) were present in our Tibetan specimen. Hybocarpone is a novel cytotoxic naphthazarin derivative which was recently described from *Lecanora hybocarpa* (Tuck.) Brodo (Ernst-Russell *et al.* 1999). Endochrysin is probably an older name for the complex of secalonic acids. Chemical structure and position of dufourin is uncertain (Culberson 1970).

*Notes.* The taxon was originally described by Lynge (1933) as a *Dactylina* because of its morphological similarity to *D. madreporeiformis*. Both species were transferred to *Allocetraria* by Kärnefelt & Thell (1996), mainly on the basis of a very distinctive type of filiform pycnoconidia and the medullary chemistry. Apothecia have not previously been observed. Our single specimen was fertile; apothecia terminal, c. 2–5 mm in diameter, with a brown disc and rather thick thalline margin; mature asci not found. The species can be separated from *A. madreporeiformis* by the coloured medulla.

*Distribution and habitat.* Endemic to the Himalayas; has been found in China in Sichuan and Yunnan provinces (Follmann *et al.* 1968; Wei 1991;

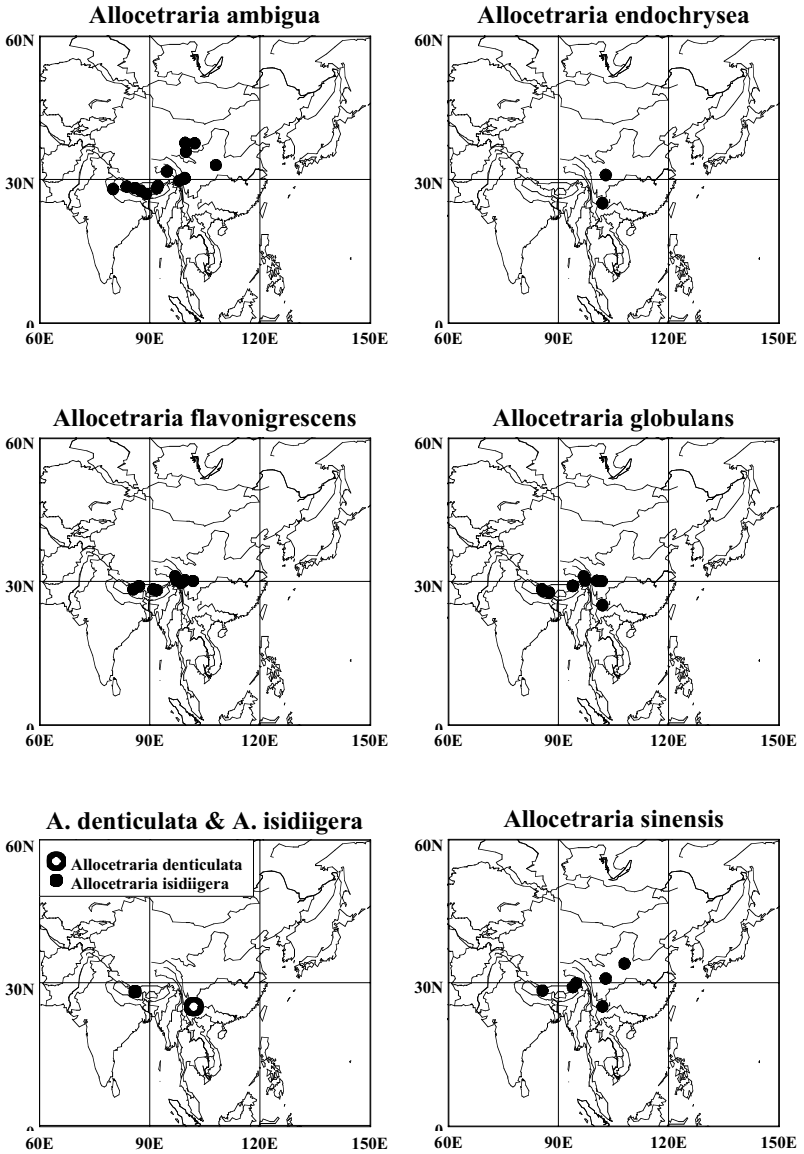


Fig. 2. World distribution of *Allocetraria* species (I).

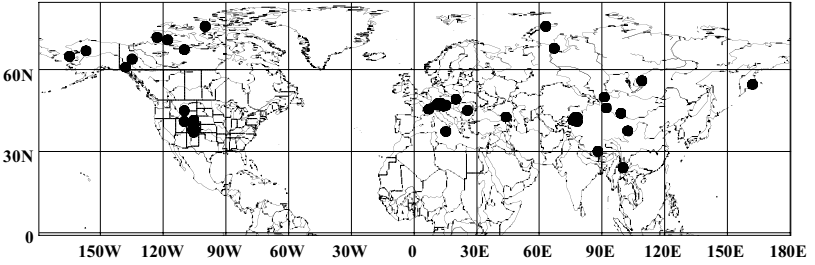
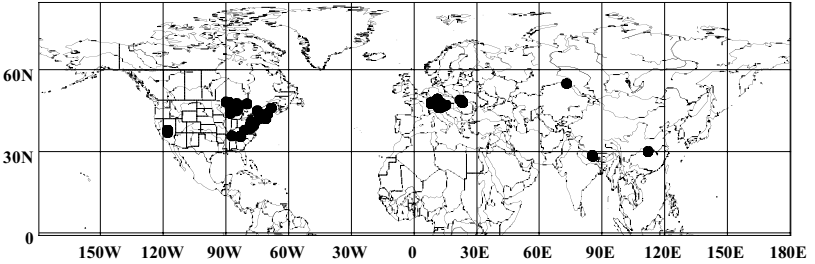
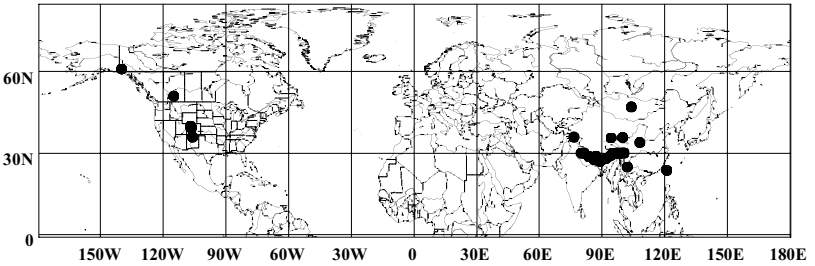
***Allocetraria madreporiformis******Allocetraria oakesiana******Allocetraria stracheyi***

Fig. 3. World distribution of *Allocetraria* species (II).

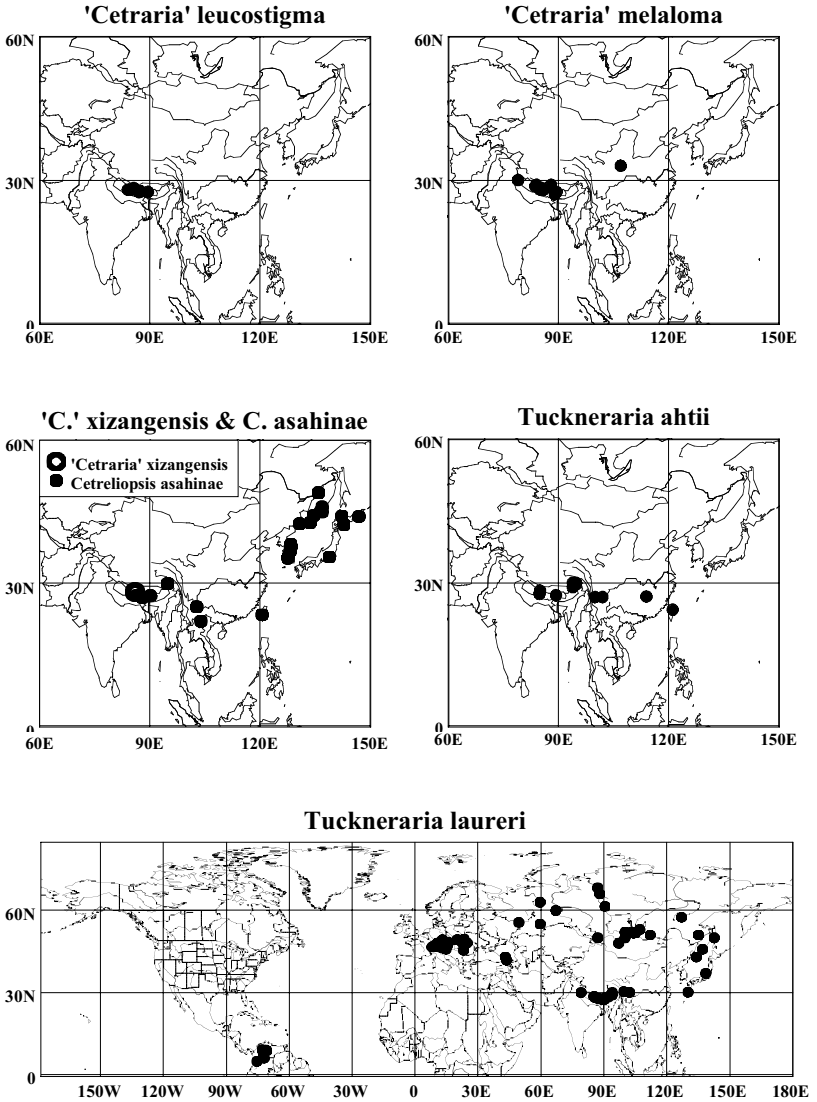


Fig. 4. World distribution of some *Cetraria*, *Cetreliopsis* and *Tuckneraria* species.

Kärnefeldt & Thell 1996) (Fig. 2). Not recorded from Tibet but most probably occurs there. Grows on soil at altitudes of 4000–4700 m.

*Specimens examined from Tibet and/or neighbouring areas.* CHINA. PROV. SICHUAN. Southern Qionglai Shan, E of Chengdu, pass W of Wolong, 30°55'N 102°56'E, 4450 m alt., alpine mats with frost heaves, on ground, 9.X.1994, G. & S.M. and U.W. 94-546-32A2 (GZU).

***Allocetraria flavonigrescens* A. Thell & Randlane**

in Daniels *et al.* (eds), Flechten Follmann: 359, 1995. – Type: Nepal, Langtang, Pemdang Karpo, SW exposed rocks, on *Juniperus*, 29.09.1986, G.M. & S. Miehe 13 056 (GZU! – holotype).

When this taxon was described some years ago (Thell *et al.* 1995) only sterile material (two specimens) was available and neither pycnoconidia nor ascospores had been observed. It was placed in *Allocetraria* on the basis of general morphology and the anatomy of the cortices. Now a number of additional specimens have been identified and the original description can be complemented with the details of the fruiting bodies.

*Descripton.* Thallus dorsiventral, subfruticose to foliose, suberect to prostrate, up to 6 cm wide, irregularly branched; lobes narrow to medium size, mainly convex, 1–5 mm wide; upper surface usually pale yellow, sometimes greenish or brownish yellow; lower surface dark brown to black, occasionally pale brown at the apices of lobes; rhizines absent or sparse, situated marginally or laminally on the lower surface; pseudocyphellae absent. Apothecia rare, marginal to submarginal, with a brown disc up to 15 mm wide; thalline margin rather thick and crenulate, pale yellow; asci subcylindrical or narrowly clavate, 30–42 x 9–12 µm; ascospores globose, 4–5 µm in diameter. Pycnidia marginal to laminal, black, immersed or more often on short projections, sometimes in clusters; pycnoconidia filiform, 13–17 x 1–1.5 µm.

*Typical characters.* Thallus dorsiventral, upper surface yellow, lower surface dark brown to black. Pseudocyphellae absent. Contains fumarprotocetraric acid in the medulla, Pd + red.

*Chemical constituents.* Contains usnic acid in the cortex; fumarprotocetraric acid (major), protocetraric acid (minor) and an unknown fatty acid (neither lichesterinic-protolichesterinic type nor caperatic acid) in the medulla. An unidentified violet pigment is also occasionally detected.

*Notes.* This recently described species is not rare in Tibet – we have examined *ca.* 20 specimens. *A. flavonigrescens* is characterized by the positive Pd reaction and until recently was considered the only species in the genus *Allocetraria* which contained fumarprotocetraric acid. Investigation of the type material of *A. isidiigera* has now showed that this species also contains fumarprotocetraric acid in the medulla. However, the latter taxon is readily distinguished from *A. flavonigrescens* by the presence of sparse isidia. In our opinion, the isidia and isidia-like structures in *A. isidiigera* are

ill-defined and not a definitive character and suggest that *A. isidiigera* and *A. flavonigrescens* are very closely allied taxa. Their possible conspecific status probably cannot be verified by morphological-chemical studies alone but molecular methods should solve this problem.

*Distribution and habitat.* Endemic to the Himalayas: in Nepal (Thell *et al.* 1995) and in China (Sichuan and Xizang provinces) (Fig. 2). Grows on soil at altitudes of 4200–5300 m, occasionally also on twigs of *Juniperus* and *Rhododendron*.

*Specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. SICHUAN.** Shalui Shan Mts., 40 km NNE of Batang, SE of Yidun, 30°14'N 99°34'E, 4700–4850 m alt., alpine meadows with *Kobresia* and *Rhododendron* shrubs, on soil, 28.VI.1994, W.O. 03517; 03519-3; 03521 (GZU). – *ibid.*, first pass between Kangding (Dardo) and Litang, 30°05'N 101°48'E, 4300 m alt., alpine meadows with *Kobresia pygmaea*, 23.VI.1994, W.O. 03106 (GZU). – **PROV. XIZANG.** Karo La Pass E of Gyantse, on the road towards Lhasa, in the mountains of Ninjin Kanshan (nos 303–354), 5000–5600 m alt., middle to upper alpine belt, 28.VI.–1.VII.1986, V.K. 311 (GZU). – Himalaya Range, 170 km S of Lhasa, between Lhozhang and Lhakhang Dzong, W-facing slopes of Dhalari mountain, 28°20'N 90°58'E, 4300 m alt., NNW-exposed, underhang, on mosses on rock, 20.VII.1994, W.O. 04501 (GZU). – Himalaya Range, 190 km SSE of Lhasa, 125 km S of Tsetang (Nedong), 20 km S of Nera Tso (=Ni la Hu), on way to Cona (=Tsona), 28°07'N 91°55'E, 4650–4800 m alt., alpine meadows, on ground, 30.VII.1994, W.O. 05107 (GZU). – Tibetan Himalaya, Everest E, head Kangchung Gl., 13 km E of Everest top (Camp Ev8), 28°59'N 87°02'E, 5280 m alt., upper alpine *Kobresia pygmaea-Festuca* turf, on cushions, open moraine sand, among gneiss boulders, 16.X.1989, B.D. K-63-8a; K-63-8c (GZU). – *ibid.*, ascent Karpo La S, 29°00'N 87°02'E, 5740 m alt., subniv., highest scree plants on ridge, gneiss boulders, on ground, 17.X.1989, B.D. K-65-1 (GZU). – Tanggula Shan, way from Quamdo (=Changtu) to Nagqu (=Nakchu), 31°05'N 96°56'E, 4800 m alt., pass-area, on soil, 8.VII.1994, W.O. 04054; 04069 (GZU). – 120 km SSW of Quamdo (=Changtu), 10 km S of Bamda, 30°09'N 97°17'E, 4500–4700 m alt., on ground, 6.VII.1994, W.O. 03965 (GZU). – *ibid.*, *Rhododendron* shrubs, on soil and *Rhododendron*, 5.VII.1994, W.O. 03869 (GZU). – Ningjing Shan Mts., 9 km W of Markam (=Gartog), 29°40'N 98°32'E, 4200–4400 m alt., *Rhododendron* shrubs with *Picea*, on *Juniperus* (base), 1.VII.1994, W.O. 03631 (GZU).

### *Allocetraria globulans* (Nyl.) A. Thell & Randle

in Daniels *et al.* (eds), Flechten Follmann: 360, 1995. – *Platysma globulans* Nyl., Flora 70: 134, 1887. – Type: China, Yunnan, 1885, *R. P. Delavay 1570* (H-NYL 36 135! – holotype). – *Cetraria globulans* (Nyl.) Zahlbr., Trudy Troitskos.-Kyakhtinsk. Otd. Priamursk. Otd. Imp. Russk. Geogr. Obshch. 12: 89, 1911. – *Nephromopsis globulans* (Nyl.) M. J. Lai, Quart. J. Taiwan Mus. 33: 222, 1981.

*Description* – see Thell *et al.* (1995).

*Typical characters.* Thallus dorsiventral, upper surface yellow to brown, lower surface brown. Lobes rather narrow, 2–8 mm wide. Apothecia marginal to submarginal; ascospores globose to subglobose. Pycnidia marginal, on emergent projections; pycnoconidia filiform.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic, protolichesterinic, caperatic (±) acids in the medulla; scalonic acids A and C (±) may also occasionally occur.

*Notes.* Most of the epiphytic cetrarioid lichens containing usnic acid have rather large dorsiventral thalli; this taxon is one of the smallest, with narrow lobes, and is usually fertile. The shape of both ascospores and pycnospores should be checked, if the identification is doubtful.

*Distribution and habitat.* Endemic to the Himalayas: has been found in Nepal (Thell *et al.* 1995) and in China (Sichuan, Xizang and Yunnan provinces) (Fig. 2). Grows on twigs of *Potentilla fruticosa* (Thell *et al.* 1995), *Abies*, *Juniperus* and *Rhododendron*, occasionally also on soil at altitudes of 3200–4900 m.

*Specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. SICHUAN.** Between Kangding (Dardo) and Litang, 30°03'N 101°49'E, 3800–3900 m alt., *Rhododendron-Salix-Juniperus*-shrub, on *Rhododendron*, 23.VI.1994, W.O. 03049 (GZU). – *ibid.*, on *Salix*, 23.VI.1994, W.O. 03080 (GZU). – E of Litang, 30°07'N 100°30'E, 4200–4400 m alt., alpine meadows with *Kobresia pygmaea*, on *Rhododendron*, 24.VI.1994, W.O. 03165b (GZU). – Second pass between Kangding (Dardo) and Litang, 30°04'N 101°24'E, 4200–4300 m alt., *Rhododendron* shrub (2–4 m stem height) and alpine meadows, on *Rhododendron*, 23.VI.1994, W.O. 03132 (GZU). – Second pass between Kangding (Dardo) and Litang, 30°04'N 101°24'E, 4200–4300 m alt., *Rhododendron* shrub (2–4 m stem height) and alpine meadows, on *Salix*, 23.VI.1994, W.O. 03136 (GZU). – **PROV. XIZANG.** 120 km SSW of Quamdo (=Changtu), 10 km S of Bamda, 30°09'N 97°17'E, 4500–4600 m alt., *Rhododendron* shrubs, on soil and *Rhododendron*, 5.VII.1994, W.O. 03870b (GZU). – 120 km SSW of Quamdo (=Changtu), 10 km S of Bamda, 30°09'N 97°17'E, 4600–4800 m alt., alpine meadows with *Kobresia*, on *Rhododendron*, 5.VII.1994, W.O. 03907 (GZU). – Way from Quamdo (=Changtu) to Nagqu (=Nakchu), 31°05'N 96°56'E, 4800 m alt., pass-area, on *Juniperus*, 8.VII.1994, W.O. 04048 (GZU). – Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, 29°03'N 93°56'E, 3900–4100 m alt., *Juniperus-Abies* forest, on *Rhododendron*, 13.VIII.1994, W.O. 06145 (GZU). – Himalaya Range, 280 km ESE of Lhasa, 45 km SW of Mainling, way down from a mountain pasture hut to the valley of a tributary of the Tsangpo, 29°02–03'N 93°54–56'E, 3400–3800 m alt., *Abies* forest, on *Abies*, 14.VIII.1994, W.O. 06232 (GZU).

### *Allocetraria isidiigera* Kurok. & M. J. Lai

Bull. Natl. Sci. Mus. (Tokyo) B, 17: 62, 1991. – Type: China, Xizang, Nyalam, 28°09'N 85°58'E, on *Rhododendron* stem, alt. 3910 m, *J. C. Wei & J. B. Chen 1857* (HMAS – holotype, TNS – isotype!).

*Description.* Thallus foliose, dorsiventral, slightly attached to the substrate, yellow on the upper surface. Lobes dichotomously branched, elongate, rather narrow, 1–3 mm wide, with scattered cylindrical isidia. Lower surface brown to black, distinctly rugulose, with sparse rhizinae of 0.3 mm long. Marginal pseudocyphellae reported in the original description (Kurokawa & Lai 1991) were not detected in the isotype material. Upper cortex palisade plectenchymatous, *ca.* 10 µm, algal layer 10–15 µm, medulla 100–150 µm, lower cortex 5–9 µm. Medulla white to pale yellow to yellow-ochre. Apothecia rare, laminal, *ca.* 4 mm in diameter; ascospores not seen. Pycnidia numerous, both immersed and elevated on black projections, also at the top of isidia-like structures; pycnoconidia filiform, 11–13 x 0.8 µm.

*Typical characters.* Tallus dorsiventral, yellow on the upper and brown to black on the lower surface. Lobes elongate, rather narrow (up to 3 mm), isidiate. Contains fumarprotocetraric acid in the medulla, Pd + red.

*Chemical constituents.* Contains usnic acid in the cortex; fumarprotocetraric, protcetraric and secalononic acid together with related pigments in the medulla; an unknown fatty acid has also been detected using TLC (fumarprotocetraric acid, protcetraric acid and fatty acid were not reported by the authors of the taxon who used microcrystallization methods only).

*Notes.* This species is poorly known. The present description was compiled from the original Latin description and observations made on the isotype specimen. The original authors of this taxon (Kurokawa & Lai 1991) state that *A. isidiigera* is closer to *A. stracheyi* than to *A. ambigua*, while the main characteristic for separating *A. isidiigera* is the presence of sparse isidia. We do not consider the presence of sparse isidia-like structures a reliable character and suggest that this taxon is very closely related to *A. flavonigrescens* – see the description of the latter species for their distinguishing characters. Another poorly known Chinese taxon is *A. denticulata* (Hue) A. Thell & Randlane which has been recorded only once (Hue 1899) – from the type locality in Yunnan province (Fig. 2). This species is also distinguished by a rather brief description (Thell *et al.* 1995) and might be closely allied (if not conspecific) to these taxa. The status of *A. denticulata* cannot be reliably determined until the type material is available for study.

*Distribution and habitat.* Known only from the type locality in Xizang province, China (Fig. 2).

### ***Allocetraria madreporiformis* (Ach.) Kärnefelt & A. Thell**

Nova Hedwigia 62: 508, 1996. – *Dufourea madreporiformis* Ach., Lich. Univ.: 525, 1810. – Type: Helvetia [Switzerland], *Acharius* (H-ACH 1507! – lectotype, selected here). – *Dactylina madreporiformis* (Ach.) Tuck., Proc. Amer. Acad. Arts Sci. 5: 398, 1862. – *Cetraria madreporiformis* (Ach.) Müll. Arg., Flora 53: 325, 1870. – *Dufourea madreporiformis* var. *irregularis* Vain., Bot. Tidsskr. 26: 241, 1904. – Type: [Kirghisia] Western Tjanschan, Talas Alatau, Tjuss Aschu, alt. 13 500 feet, 1898–99, *B. Fedtschenko*, Herb. Vainio No. 01151 (TUR!). – *Dactylina madreporiformis* f. *irregularis* (Vain.) Lyngé, Skr. Svalbard Ishavet (Oslo) 59: 39, 1933.

*Description* – see Kärnefelt & Thell (1996).

*Typical characters.* Thallus yellow to brown, radially symmetric, slightly inflated, becoming arachnoid in the center. Medulla white. Pycnidia immersed or slightly emergent.

*Chemical constituents.* Contains usnic acid in the cortex and a lichesterinic-protolichesterinic type fatty acid in the medulla.



*Notes.* In the typical form this taxon is easily recognized by the radially symmetric thallus and white medulla. The variety *Dactylina madreporiformis* var. *irregularis* (Vain.) Lyngbe has been referred to as having a distinctly dorsiventral thallus (Thomson & Bird 1978). However, the original description of this taxon (... *vulgo leviter compressis aut plus minusve irregulariter subcylindricis* ...) (Vainio 1904) as well as the type material demonstrate that this is not correct – the thallus of var. *irregularis* is inflated, obviously radially symmetric and occasionally slightly compressed. Therefore the collections with distinctly flat lobes from Colorado in North America reported by Weber & Shushan (1955) and Imshaug (1957) are, in our opinion, *A. stracheyi* rather than *A. madreporiformis*.

*Distribution and habitat.* This is the most widely distributed *Allocetraria* species which occurs in the arctic and alpine areas of North America and Asia, and in the mountains of central Europe (Fig. 3). In Asia it is known from China (Qinghai, Xinjiang, Xizang and Yunnan provinces), Kirghizia, Mongolia, and Russia (Wei, 1991; Kärnefelt & Thell 1996). Grows on soil, preferably calcareous soils.

*Specimens examined from Tibet and/or neighbouring areas.* CHINA. PROV. QINGHAI. On the SE slope of Mt. Kan She Ka, Leng Long Ling, 37°36'N 102°15'E, Nan Shan, Kun Lun Shan, NE of the Haibei Research Station (nos 27–36), 4000–4500 m alt., upper alpine belt. 19.20.VII.1985, V.K. 27;31;233-1;235-1 (GZU).

### ***Allocetraria oakesiana* (Tuck.) Randle & A. Thell**

in Daniels *et al.* (eds), Flechten Follmann: 363, 1995. – *Cetraria oakesiana* Tuck., Boston J. Nat. Hist. 3: 445, 1841. – Type: White Mountains, alpine regions, on small branches of dwarf firs, 25.06.1839, *Oakes* (FH! – lectotype). – *Platysma oakesianum* (Tuck.) Nyl., Mém. Soc. Sci. Nat. Cherbourg 3: 172, 1855. – *Tuckermannopsis oakesiana* (Tuck.) Hale, Bryologist 90: 164, 1987. – *Cetraria oakesiana* var. *spinulosa* G. Merr., Bryologist 13: 25, 1910. – *Cetraria bavarica* Kremp., Flora 34: 273, 1851. – Type: Germany, Oberbayern, 06.1851, *Krempelhuber* (UPS! – isolectotype).

*Description* – see Thell *et al.* (1995).

*Typical characters.* Thallus dorsiventral, yellow on the upper surface and brown to dark yellow or light tan on the lower surface. Marginal soredia and medulla white to very pale yellow. Pseudocyphellae absent on both surfaces. Medulla Pd –.

*Chemical constituents.* Contains usnic acid in the cortex and fatty acids (caperatic, lichesterinic and protolichesterinic acids) in the medulla; secalonic acids also occur (±) in the lower parts of the medulla (Thell *et al.* 1995).

*Notes.* The species might be confused with *Tuckneraria laureri*; for differences therefrom – see the description of the latter species.

Another sorediate cetrarioid lichen, '*Cetraria*' *xizangensis* is morphologically very similar to *A. oakesiana* but differs from it in medullary chemistry and is easily identified by the positive Pd reaction on the medulla.

The former species is extremely rare, being known only from the type locality in Nyalam (China, Xizang province) only.

*Distribution and habitat.* Another widely distributed *Allocetraria* species which grows in the montane forests of Central Europe (Austria, Germany, Italy, Slovakia, Ukraine), in North America (Canada, USA) and Asia (China, Nepal, Russia) (Fig. 3). In China this taxon has only been found occasionally – in central China in Hubei (Wei 1991), and now from Xizang province. This species is corticolous on coniferous and deciduous trees.

*Specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. XIZANG.** Central Himalayas, Upper Trisuli gorge, W of Mt. Xixabangma, 28°33'N 85°18'E, 4440 m alt., *Rhododendron anthopogon* dwarf-scrub, on *Rhododendron*, 22.VIII.1993, G. & S.M. 9544/11-1 (GZU). – **NEPAL.** Central Nepal, Langtang valley, Kyangjin, 28°13'N 85°34'E, 3910–4210 m alt., 06–21.VIII.1995, U.W. 16-1, 25, 31, 58 (GZU).

### *Allocetraria sinensis* X. Q. Gao

in Daniels *et al.* (eds), Flechten Follmann: 365, 1995. – Type: China, Shaanxi, Mt. Taibai, alt. 3400 m, on ground, X. Q. Gao 3052 (HMAS – holotype, LD!, UPS! – isotypes).

*Description* – see Thell *et al.* (1995).

*Typical characters.* Thallus dorsiventral, yellow on the upper surface and brown on the lower surface. Lobes elongate. Marginal pseudocyphellae present on the lower side in the form of a white continuous line. Medulla Pd–.

*Chemical constituents.* Contains usnic acid (±) in the cortex; lichesterinic, protolichesterinic and an unknown fatty acid in the medulla; secalononic acid A and other related pigments (±) may also occur occasionally.

*Notes.* The taxon can readily be separated from all the other *Allocetraria* species by elongate lobes with a yellow shiny upper surface and a lower surface which is brown, also shiny and has marginal pseudocyphellae. Morphologically it is somewhat similar to *A. flavonigrescens*, but this species has a dark lower surface which lacks pseudocyphellae and has a positive medullary Pd reaction (containing fumarprotocetraric acid).

*Distribution and habitat.* A rare species, distributed in Nepal and China, in Shaanxi (Thell *et al.* 1995) and now also in Sichuan, Xizang and Yunnan provinces (Fig. 2). Grows on soil at altitudes of 3400–5100 m, and has also been found on debris at the front of a glacier.

*Specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. SICHUAN.** Wenchaun County, pass SW of Wolong, E of Densheng, 30°53'N 102°54'E, 4450 m alt., 8.X.1994, A.B. (GZU). – **PROV. XIZANG.** 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 10 km S of Tongjug village, W-side of the glacier, steep E-facing slopes and ridge area, 29°54'N 94°51'–52'E, 4500–4700 m alt., steep E-facing slopes and ridge area, on soil, 19.VIII.1994, W.O. 06518 (GZU). – Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, way from a mountain pasture hut to the glacier, 29°03'N 93°56'E, 5000–5100 m alt., area on immediate front of a glacier, on soil, 11.VIII.1994, W.O. 05981, 05987 (GZU). – **PROV. YUNNAN.** Reg. bor., 4000–4300 m alt., 21.VII.1922, H. Smith (COLO). – **NEPAL.** Langtang area, above Yala, alt. 4830 m, G. & S.M., 05.VII.1986 (GZU).

***Allocetraria stracheyi* (Bab.) Kurok. & M. J. Lai**

Bull. Natl. Sci. Mus. (Tokyo) Ser. B, 17: 62–63, 1991. – *Evernia stracheyi* Bab., Hooker's J. Bot. Kew Gard. Misc. 4: 244, 1852. – Type: [India] Kumaon, Gori river, among mosses and dead leaves, alt. 4700 ft (?), *R. Strachey* & *J. E. Winterbottom* (H-NYL 36 055! – lectotype, BM! – isolectotype). – *Platysma everniellum* Nyl., Mém. Soc. Sci. Nat. Cherbourg 5: 100, 1858 (based on *Evernia stracheyi* Bab.). – *Cetraria everniella* (Nyl.) Kremp., Verh. Zool.-Bot. Ges. Wien 18: 315, 1868. – *Cetraria potaninii* Oxner, Zhurn. Bio-Bot. Tsyklu Vseukraïns'k. Akad. Nauk 7–8: 169, 1933. – Type: China, Tibet, Mts Kamenses, inter stat-s Tasso et Penczamu, Tassaschanj, 31.05.1893, *Potanin* (KW! – holotype). – *Allocetraria potaninii* (Oxner) Randlane & Saag, Mycotaxon 44: 492, 1992.

*Description* – see Thell *et al.* (1995).

*Typical characters.* Thallus dorsiventral, yellow on the upper surface and yellow to pale brown on the lower surface; occasionally almost radially symmetric. Lobes elongate, rather narrow (up to 4 mm) and distinctly convex on the upper side. Medulla white or pale yellow to orange.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic fatty acids in the medulla; secalonic acids (A or C) together with other pigments (endocrocin) may occur occasionally also in the medulla. A recently described lichen substance, hybocarpone (Ernst-Russell *et al.* 1999), known only from *Lecanora hybocarpa* and *Allocetraria endochrysea* has also been detected. Three other pigments, eumitrin T, eumitrin W, and secalonic acid Z2, have been identified by Elix & Wardlaw (in sched.) in several specimens of *Allocetraria stracheyi*. These pigments belong to the group of secalonic acid (ergochrome) and eumitrin derivatives of which several related but structurally unidentified substances have recently been detected (Elix & Tønsberg 1999). The presence of the cited pigments is responsible for the colour of the medulla which may vary from white to yellow or orange in different specimens.

*Notes.* The taxon is morphologically rather variable – the thallus may be either dorsiventral or sometimes more or less radially symmetric. In the latter case it is easily recognized as most other *Allocetraria* species do not have radially symmetric thalli. The thalli of *A. endochrysea* and *A. madreporiformis* are also subterete but these are rather different – cylindrical, slightly inflated, becoming arachnoid in the center, and only sparsely branched. When the thallus of *A. stracheyi* is distinctly dorsiventral, it may be confused with *A. ambigua*. In such cases it is useful to consider the cross section of lobes. The dorsiventral lobes of *A. stracheyi* are more or less convex on the upper side whereas the lobes of *A. ambigua* are clearly concave. In a few cases (three from more than 80 specimens examined by us) sorediate thalli have been observed.

*Distribution and habitat.* This taxon has generally been considered a typical Himalayan species, occurring in China, India and Nepal (Kurokawa & Lai 1991). In China it has been found in Shaanxi, Taiwan, Xizang, Yunnan (Wei 1991) and now also in Qinghai, Sichuan and Xinjiang provinces. Some years ago *Allocetraria potaninii* was synonymized with *A. stracheyi* (Thell *et al.* 1995) and its distribution proved much wider than expected – extending to the eastern territories of Mongolia (Golubkova 1981). We now report it also for Colorado, western North America, (see discussion under *A. madreporiformis*) (Fig. 3). Even so, *A. stracheyi* is not the most widely distributed species in the genus since both *A. madreporiformis* and the sorediate *Allocetraria oakesiana* are known from Europe, Asia and North America (Thell *et al.* 1995; Kärnefelt & Thell 1996). In Asia *A. stracheyi* usually grows on soil in alpine meadows at the altitudes of 4200–5800 m. Occasionally it is epiphytic on *Rhododendron*. In North America it has been found on soil among mosses at somewhat lower altitudes (3800–4500 m).

*Selected specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. QINGHAI.** Kunlun Shan, Northern declivity, E of Kunlun Shankou, SW of Golmud, 35°41'N 94°14'E, 4610 m alt., upper slope with *Kobresia pygmaea* turfs colonized by Dicots, on ground, 1.VIII.1993, G. & S.M. 9378/16-1 (GZU). – **PROV. SICHUAN.** Shalui Shan Mts., 40 km NNE of Batang, 30°14'N 99°34'E, 4700–4850 m alt., alpine meadows with *Kobresia* and *Rhododendron* shrubs, on soil, 28.VI.1994, W.O. 03519-2 (GZU). – E of Litang, 30°07'N 100°30'E, 4200–4400 m alt., alpine meadows with *Kobresia pygmaea*, on soil, 24.VI.1994, W.O. 03145(GZU). – **PROV. XINJIANG.** Karakorum, 35°58'N 76°28'E, 5000 m alt., alpine meadows with *Carex*, *Kobresia*, on ground, 23.IX.1986, B.D. F22-1, F22-2 (GZU). – **PROV. XIZANG.** West Himalaya, Upper Karnali, Burang, 30°08'N 81°20'E, 4640 m alt., 25–26° N-exp. surface of rock glacier with snow-beds, on ground, 31.VIII.1993, G. & S.M. 9620/19-1 (GZU). – Himalaya Range, 190 km SSE of Lhasa, 28°07'N 91°55'E, 4650–4800 m alt., alpine meadows, on ground and *Rhododendron*, 30.VII.1994, W.O. 05061a (GZU). – Mountain directly SW above Nyalam, 28°09'N 85°58'E, 4000–4770 m alt., lower to upper alpine belt, on soil, 5.-6.VII.1986, V.K. 362-1, 362-2 etc. (GZU). – Nyainqentanglha Shan, 340 km E of Lhasa, pass between Nyingchi and Dongjug, 29°37'N 94°39'E, 4500 m alt., alpine meadows with boulders, on ground, 16.VIII.1994, W.O. 06330 (GZU). – **NEPAL.** Kali-Gandaki-Gebiet, NW of Tukuche, (28°43'N 83°40'E), 4200 m alt., alpine meadow with *Rhododendron*, 12.IV.1979, U.K. 3–5 (GZU). – NNW Manangbhot, E Muktinath, 5300 m alt., on rocks, 28.IX.1979, U.K. (GZU). – East-Nepal, Khumbu, Ngozumpa glacier, Cho Oyu base camp, 5380 m alt., on soil, 2.X.1982, G.M. (GZU). – Langtang Area, way from Kyangjin to Nubama Dhang, 3750–3900 m alt., rocks; riveraine scrub; pasture, on ground, 11.IX.1986, J.P. N86-L140-2 (GZU).

*American specimens examined.* **USA. COLORADO.** Clear Creek Co., Mt. Evans, tundra above Lincoln Lake, 3830 m alt., 25. VIII.1954, W.A. Weber L-3761 (COLO, TU). – Rocky shore of Summit Lake, NE slope of Mt. Evans, 4230 m alt., 22.VII.1955, W.A. Weber L-5619. – Rocky Mt. Front Range, 4500 m alt., moss tundra, on soil, 15.VII.1998, W.A. Weber, J. Corbridge & R. Wittmann L-93,142 (COLO, TU). – Grand Co., head of Current Creek, Berthoud Pass, 3800–4170 m alt., 6.VII.1960, W.A. Weber L-24776a (COLO, TU). – Larimer Co., Rocky Mt. Nat. Park, Trail Ridge Road, 4000 m alt., tundra, VII.1957, Shushan & Thomson L-9054 (COLO, TU). – Park Co., Summit Co., east end of Hoosier Ridge, 11 miles N of Fairplay, 4330 m alt., 8.VII.1956, Shushan & Imshaug L-8218 (COLO, TU).

**'Cetraria' leucostigma Lév.**

in Jacquemont, Voyage dans l'Inde Bot.: 180, 1841–1844. – Type: India orientalis, dédit J. H. Lévillé (H-NYL 36 083! – neotype, proposed by Awasthi 1983). – *Platysma leucostigmeum* (Lév.) Nyl., Mém. Soc. Sci. Nat. Cherbourg 5: 100. 1858. – *Cetraria sikkimensis* Räsänen, Arch. Soc. Zool. Bot. Fenn. Vanamo 5: 25, 1950. – Type: [India] Sikkim, Chhangu, alt. ca. 3900 m, on branches of *Rhododendron* shrub, 05.1947, D. D. Awasthi 355 (H – holotype, Herb. Awasthi – isotype).

*Description.* Thallus dorsiventral, suberect to erect, 3–5(8) cm high, irregularly branched; lobes plane or involute, of medium size, 5–7(10) mm broad, with undulate margins; upper surface yellow to pale brown, lower surface shiny, brown with occasional yellowish patches. Pseudocyphellae laminal, round or oval, ca. 0.3 mm in diameter, white, plain or concave, present on the lower surface only; rhizines, isidia and soredia absent. Medulla white. Apothecia rare, marginal, round to oblong, 16 x 6 mm; ascospores ellipsoid, 8–9 x 6 µm (according to Awasthi 1983; ascomata not seen in present work). Pycnidia black, on emergent marginal projections; pycnoconidia not seen.

*Typical characters.* Thallus dorsiventral, yellow on the upper surface and brown on the lower surface. Lobes rather wide (up to 7 mm). Pseudocyphellae distinct on the lower side – laminal, round or oval, white.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla.

*Notes.* For differences from '*C. melaloma*' see under that species.

*Distribution and habitat.* A rare lichen, known only from Bhutan, India and Nepal (Awasthi 1983, 1988) (Fig. 4). Not recorded from Tibet but most probably occurs there. Grows on soil or on twigs of shrubs (*Rhododendron*) in alpine areas at altitudes of 3500–4500 m.

*Specimens examined.* **BHUTAN. THIMPHU DISTR.** Between Sim Kotaa lakes and Gigma Latsho, 27°32'N 89°31'E, 3900–4100 m alt., alpine meadow with *Rhododendron*, on soil, 4.V.1998, U. Søchting 9151 (TU). – **INDIA.** India orientalis, ad *Quercum truncos* (location unknown), dédit J. H. Lévillé (H-NYL 36 083 – neotype). – **NEPAL.** Langtang area, Chisedang Lekh, N-exposed very humid slopes S above Palpa (Papal) towards Palphu, 3500–4000 m alt., 7.IX.1986, J.P. 86-L605 (GZU). – Ganja La (N), 4160 m alt., *Rhododendron anthopogon* scrub, N-exp., on ground, 17.VII.1986, G. & S.M. 5715 (GZU). – Keldang, Dupku Danda, 4490 m alt., N-facing *Potentilla coriandrifolia* assoc., 27.VII.1986, G. & S.M. 6771a (GZU). – Pangsang Lekh, 4000 m alt., N-facing slope with *Rhododendron anthopogon*, on mosses, 29.V.1986, G. & S.M. 2520 (GZU). – East Nepal, Topkegola, ridge between Rupapokhari and Sajupokhari, 4500 m alt., on ground and twigs of a small *Rhododendron*, 30.V.1953, D.D. Awasthi 2409 (COLO) – Lamjung Himal, Rambrong, in moss and grass among boulders, 10.VII.1954, Staiton, Sykes & Williams 6255 (BM).

**'Cetraria' melaloma (Nyl.) Kremp.**

Verh. Zool.-Bot. Ges. Wien 18: 315, 1868. – *Platysma melalomum* Nyl., Syn. Lich. 1: 303, 1860. – Type: [India] Sikkim, Jongri, regione alpina, supra

mare alt. 13 000 ft, inter *Cladonias* et muscos, *J. D. Hooker 2665* (BM! – lectotype, H-NYL 36 072! – isolectotype). – *Cetraria pallida* D. D. Awasthi, Proc. Indian Acad. Sci. 45: 130, 1957. – Type: Nepal, Topkegola, Thaglabhanjyang, alt. 4200 m, 29.05.1953, *D. D. Awasthi 2347* (Herb. Awasthi – holotype).

*Description.* Thallus dorsiventral, suberect to erect, 2–3.5 cm high, irregularly branched; lobes plane or involute, of medium size, 2–6 mm broad, with undulate margins; both surfaces pale yellow up to brownish yellow, often with brown margins and always with black marginal projections; pseudocyphellae laminal, round or oval, ca. 0.5 mm in diameter, grey in colour, surrounded by a black or brown rim, may be present on both surfaces but more usual on the lower surface only; rhizines, isidia and soredia absent. Medulla white. Apothecia unknown. Pycnidia black, on short marginal projections; pycnoconidia not seen.

*Typical characters.* Thallus dorsiventral, pale yellow to brownish yellow on both surfaces. Lobes rather wide (up to 6 mm). Pseudocyphellae – laminal, round or oval, grey, surrounded by a dark rim – may be present on both surfaces but are more common on the lower surface.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla. According to Awasthi (1983), stictic acid has also been detected occasionally.

*Notes.* The species is morphologically rather similar to another rare Asian *Cetraria* – '*C.*' *leucostigma* Lév. However, the latter is darker in colour (usually yellow on the upper and brown on the lower surface), with white pseudocyphellae only on the lower surface. Apothecia have not been observed in '*C.*' *melaloma*, and have only been reported once in '*C.*' *leucostigma* (Awasthi 1983) but have not been thoroughly studied. Pycnidia have been observed in both species but pycnoconidia have not been detected in either taxon. We agree with Thell (1996) that '*C.*' *leucostigma* and '*C.*' *melaloma* do not belong to the genus *Cetraria* s. strict. According to the revised definition of the genus (Kärnefelt *et al.* 1993), all the cetrarioid lichens containing usnic acid have been excluded from *Cetraria* s. strict. Presence of one-layered palisade plectenchymatous cortex with anticlinally arranged hyphae in '*C.*' *leucostigma* and '*C.*' *melaloma* (Thell 1996) is not characteristic of *Cetraria* s. strict. either. The systematic position (generic location) of these two species has yet to be determined (Randlane *et al.* 1997), and will be dependent upon a detailed investigation of ascomata or upon molecular analysis.

*Distribution and habitat.* A rare species, known from India (Awasthi 1983, 1988), Nepal (Awasthi 1983) and China – Shaanxi and Xizang provinces (Wei 1991); and now also from Bhutan (Fig. 4). Grows on soil among mosses or on rocks in alpine meadows at altitudes of 3500–4800 m.

*Specimens examined.* **BHUTAN. THIMPHU DISTR.** Between Gigme Lang tsho and Jaley la Dzong, 27°30'N 89°30'E, 3980 m alt., alpine meadow, on soil, 05.V.1998, U. Søchting 9181 (TU). **INDIA. SIKKIM.** Jongri, alpine reg., alt. 13 000 ft, between Cladonias and mosses, J.D. Hooker 2665 (BM – lectotype, H-NYL 36 072 – isolectotype). – **UTTAR PRADESH.** Almora distr., Phurkia to near Pindari glacier, near Mirtoli, alt. 3450 m, on ground under *Rhododendron* bushes, 11.VI.1970, D. Awasthi 7695 (COLO). – **NEPAL.** Kali-Gandaki area, NW Tukuche, between Tukuche [28°43'N 83°40'E] and Dhampuspass, S-exposed slope with *Rhododendron* in alpine meadow, 4200 m alt., 12.IV.1979, U.K s.n. 6 (GZU). – Langtang area, Central Himalaya, Upper Langtang, near Kyangjing, 3900 m alt., on boulders, 25.VI.1986, G. & S.M. 4016b (GZU). – Ganja La, 4140 m alt., *Rhododendron* dwarf scrub, NW-exp., on ground, 17.VII.1986, G. & S.M. 5675 (GZU). – Langshisa Glacier, E lateral moraine, 4610 m alt., *Rhododendron-Potentilla fruticosa* scrub, W-exp., on ground, 16.IX.1986, G. & S.M. 12059 (GZU). – Pemdang Karpo, terminal moraine, 4660 m alt., *Potentilla fruticosa-Cyperaceae* pasture, ESE-exp., 7.X.1986, G. & S.M. 13590 (GZU). – *ibid.*, *Rhododendron* dwarf-scrub, NW-facing slope, on ground, 7.X.1986, G. & S.M. 13602e (GZU). – Rocks, riverain scrub, pasture on way from Kyangjin to Nubama Dhang, 3750–3900 m alt., 11.IX.1986, J.P. N86-L140-1 (GZU). – Schiabru N-flank, 4440 m alt., *Rhododendron anthopogon* dwarf scrub on N-facing slope, on ground, 24.X.1986, G. & S.M. 14752f (GZU). – Slopes N above Nubama Dhang, 4300–4500 m alt., pasture, moraines, rocks, 13.IX.1986, J.P. N86-L737 (GZU).

### '*Cetraria*' *xizangensis* J. C. Wei & Y. M. Jiang

Acta Phytotax. Sin. 18: 288, 1980. – Type: [China] Xizang, Nyalam, silvicola, ad corticem *Betula*, alt. 3900 m, 22.06.1966, J. C. Wei & J. B. Chen 1899 (HMAS – holotype, isotype!).

*Description.* Thallus foliose, dorsiventral, suborbicular to irregular, *ca.* 1–3 cm in diameter, yellow. Lobes rounded, partly crenulate and undulate and sparsely pruinose in lobe apices, with marginal white to pale yellow granular soredia; the sorediate zone 0.5–2 mm wide. Lower surface yellow to brown, with brown rhizinae. Thallus *ca.* (95) 139–177 (196)  $\mu\text{m}$  thick; upper cortex *ca.* 21–27  $\mu\text{m}$ , algal layer *ca.* 21–50  $\mu\text{m}$ , medulla *ca.* 21–98  $\mu\text{m}$ , lower cortex *ca.* 17–21  $\mu\text{m}$ . Algal photobiont green, cells *ca.* 11–17  $\mu\text{m}$  in diameter. Medullary hyphae 3–4  $\mu\text{m}$ ; medulla white. Pycnidia and apothecia unknown.

*Typical characters.* Thallus dorsiventral, yellow on the upper surface and yellow to brown on the lower surface, with marginal white granular soredia. Medulla white, Pd + orange.

*Chemical constituents.* Contains usnic acid in the cortex; fumarprotocetraric (major), protocetraric (minor), lichesterinic and protolichesterinic acids in the medulla.

*Notes.* The species is not well known. The present characterization is compiled from the original Latin description (Wei & Jiang 1980) and the study of isotype material. The taxon is said to be similar to *Vulpicida pinastri* but the medulla and soredia are white and the medullary colour tests with K and Pd are positive (Wei & Jiang 1980). In our opinion '*C.*' *xizangensis* is morphologically very similar to *Alloctetraria oakesiana* but the chemistry of the two taxa is quite different. The Pd reaction on the medulla should be used to distinguish these lichens (positive in '*C.*' *xizangensis* and negative in *A.*

*oakesiana*). The true generic position of '*C.*' *xizangensis* has yet to be determined as no ascospores nor pycnidiospores have been detected. Still, it is evident that this taxon does not belong to *Cetraria* s. strict.

*Distribution and habitat.* Known only from the type locality in Xizang province, China (Fig. 4). Grows on trees (*Betula*) at rather high altitude (3900 m).

***Cetrellopsis asahinae* (M. Satô) Randalne & A. Thell**

Cryptog. Bryol. Lichénol. 16: 46, 1995. – *Cetraria asahinae* M. Satô, Res. Bull. Saito Ho-On Kai Mus. 11: 12, 1936. – Type: [Russia] Kuril Islands, Kunashiri, Tomarimura, 16.08.1923, *Yasuda* (DUKE – isotype).

*Description* – see Randalne *et al.* 1995.

*Typical characters.* Thallus dorsiventral, upper surface yellow, lower surface black. Lobes rather wide (8–15 mm). Pseudocyphellae on the upper surface surrounded with a black rim and bearing black emergent projections; on the lower surface they appear as small white spots. Medulla Pd + red.

*Chemical constituents.* Contains usnic acid in the cortex (rarely absent); protocetraric (major compound), fumarprotocetraric and physodalic ( $\pm$ ) acids in the medulla.

*Notes.* The taxon is readily distinguished by the apparent pseudocyphellae on the upper surface, an unusual feature for this group. The pseudocyphellae on the lower side are less conspicuous. The medullary chemistry – that is the presence of protocetraric and fumarprotocetraric acids – and the occurrence of pseudocyphellae on both surfaces is typical for this genus.

*Distribution and habitat.* Distributed in Bhutan; in China – in Taiwan, Xizang (Wei 1991) and Yunnan provinces; in India and Nepal (*Cetraria rhytidocarpa sensu* Awasthi in Awasthi 1983), Japan (Yoshimura 1979), Russian Far East – in Habarovsk and Primorye regions and the Kuril Islands (Randalne *et al.* 1995, Skirina 1998); in South Korea (Park 1990) and Vietnam (Randalne *et al.* 1995) (Fig. 4). Grows in mixed and deciduous forests, epiphytic on living and fallen trees (e.g. *Abies*, *Picea*, *Quercus*, *Rhododendron*, *Tilia*) at lower and medium altitudes (up to 3500 m).

*Specimens examined from Tibet and/or neighbouring areas.* **BHUTAN.** WANGDI DISTR. Phobji valley, Khebeythang, 27°30'N 90°11'E, 2620 m alt., mixed forest, 14.IV.1998, U. Sochting 8060 (TU). – **CHINA.** PROV. XIZANG. Nyainqêntanglha Shan, 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 29°54–55'N 94°52–53'E, 3500 m alt., *Rhododendron-Abies* forest, on *Rhododendron*, 18.VIII.1994, W.O. 06646 (GZU). – **PROV. YUNNAN.** Schilungba prope Yünnan-fu, 1950 m alt., 19.II.1914, H. Handel-Mazzetti 45 (WU).

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

Acta Bot. Fenn. 150: 81, 1994. – *Lichen cucullatus* Bellardi, Osservaz. Bot.: 54, 1788. – Type: TO. – *Platysma cucullatum* (Bellardi) Hoffm., Descr. Adumbr. Plant. Lich. 3: 17, 1801. – *Cetraria cucullata* (Bellardi) Ach., Meth. Lich.: 293, 1803. – *Parmelia cucullata* Spreng., Syst. Veget. 4(1): 281, 1827.



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

*Description* – see Kärnefelt *et al.* 1994.

*Typical characters.* Thallus erect, dorsiventral, yellow on both surfaces with reddish basal parts. Lobes strongly canaliculate or subtubular.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla. Several anthraquinone pigments are present in the basal parts of the thallus, in both the cortex and medulla.

*Notes.* Two well-known yellow species – *F. cucullata* and *F. nivalis* – were recently transferred from *Cetraria* to a newly described genus *Flavocetraria* on the grounds of anatomical characters (shape of pycnoconidia, structure of upper cortex) and cortical chemistry (Kärnefelt *et al.* 1994). *F. cucullata* is usually easily recognized by its typical canaliculate or subtubular lobes.

*Distribution and habitat.* Widely distributed in arctic and boreal regions of the northern hemisphere; also occurs in cold temperate areas of southernmost South America (Kärnefelt *et al.* 1994). In Asia it is known from China [Neimongol, Xizang and Yunnan provinces (Wei 1991)], India (Awasthi 1983), Japan (Yoshimura 1979; Kurokawa 1991), Mongolia (Golubkova 1981), Nepal (Kurokawa 1993) and Russia (Rassadina 1950). We have not examined any herbarium specimens of *A. cucullata* from Tibet but its occurrence there has been recorded in literature (Wei 1991). Grows on ground among mosses and other lichens in tundra or alpine vegetation.

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

Acta Bot. Fenn. 150: 84, 1994. – *Lichen nivalis* L., Spec. Plant.: 1149, 1753. – Type: LINN 1273.101 (lectotype). – *Cetraria nivalis* (L.) Ach., Meth. Lich.: 293, 1803. – *Platysma nivale* (L.) Frege, Deutsch. Bot. Tachenbuch 2: 161, 1812. – *Parmelia nivalis* (L.) Spreng., Syst. Veget. 3: 525, 1831. – *Allocetraria nivalis* (L.) Randle & Saag, Mycotaxon 44: 492, 1992.

*Description* – see Kärnefelt *et al.* 1994.

*Typical characters.* Thallus erect, dorsiventral, yellow on both surfaces with basal parts dark yellow. Lobes foveolate and strongly wrinkled, especially on the upper side.

*Chemical constituents.* Contains usnic acid in the cortex. No medullary compounds detected.

*Notes.* *F. nivalis* is a well-known lichen normally readily distinguished by its yellow thallus and strongly wrinkled lobes. In the Himalayas it may be confused with *Allocetraria ambigua*. For differences from the latter see under *Allocetraria ambigua*.

*Distribution and habitat.* Widely distributed in arctic and boreal regions of the northern hemisphere; occurs also in cold temperate areas of southernmost South America (Kärnefelt *et al.* 1994). In Asia this species is

more restricted than *C. cucullata*, recorded from China [Neimongol, Xinjiang and Xizang provinces (Wei 1991)], Japan (Yoshimura 1979; Kurokawa 1991), Mongolia (Golubkova 1981) and Russia (Rassadina 1950). A related but separate taxon, *F. nivalis* ssp. *montana* Kärnefelt & A. Thell, is known from New Guinea (Kärnefelt *et al.* 1994). This species is included in the present study on the basis of the literature (Wei 1991). Grows on ground among mosses and other lichens in tundra or alpine vegetation.

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

Enumer. Lich. China: 158, 1991. – *Cetraria komarovii* Elenkin, Izv. Imp. S.-Peterburgsk. Bot. Sada 3: 51, 1903. – Type: Russia, Irkutsk region, in vicinibus Nilova Pustyn, ad terram montis Chongoldoi montium Sajanensium, 1902, *A. Elenkin* 155 (LE – holotype, FH!, W! – isotypes). – *Cetraria perstraminea* Zahlbr., Trudy Troitskos.-Kyakhtinsk. Otd. Priamursk. Otd. Imp. Russk. Geogr. Obshch. 12: 88, 1911. – Type: Russia, Transbaikalia, Chilgindin, 10.10.1908, *P. S. Mikhno* (W! – holotype).

*Description* – see Randle & Saag (1998).

*Typical characters.* Thallus foliose, characteristically rugose (in a somewhat concentric pattern), intense green to lemon yellow on the upper surface and brown on lower surface. Marginal but juvenile apothecia often present.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla; fumarprotocetraric acid (Huneck *et al.* 1984), stictic and constictic acids (personal communication from T. Ahti) have also been detected in some specimens.

*Distribution and habitat.* Distributed in China [Hebei, Jilin (Wei 1991), Shaanxi and Sichuan provinces], Mongolia and Russia (see Fig. 2 in Randle & Saag 1998). Not recorded from Tibet but highly probable there. The only epilithic representative in this group of yellow cetrarioid lichens. Grows over the rocks and boulders in shaded localities in montane forests at lower and medium altitudes (up to 3000 m).

*Specimens examined from Tibet and/or neighbouring areas.* CHINA. PROV. SICHUAN. Distr. monasteri Muli, ad rupes in pinetis prope vic. Hosö, ca 2950 m alt., 8.VIII.1915, H. Handel-Mazzetti 1364 (WU).

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

Bryologist 100: 111, 1997. – *Cetrariopsis laii* A. Thell & Randle, Cryptog. Bryol. Lichénol. 16: 46, 1995. – Type: Russia, Primorye region, Kedrovaya Padj Nature Reserve, 17.09.1961, *S. Pärn* (TU! – holotype, LD! – isotype).

*Description* – see Randle *et al.* (1995).

*Typical characters.* Thallus dorsiventral, moderately rugose, upper surface greenish yellow, lower surface pale brown to brown. Lobes rather wide (8–15 mm), often with secondary marginal lobules. Pseudocyphellae

small and flat, mainly developed on the ridges of the lower side. Apothecia marginal, numerous, often juvenile only.

*Chemical constituents.* Contains usnic acid in the cortex; alectoronic and/or lichesterinic, protolichesterinic-type fatty acids in the medulla.

*Notes.* This species can be confused with *Nephromopsis pallescens* var. *pallescens* or *N. nephromoides*. *N. pallescens* is usually readily distinguished by numerous, small, laminal apothecia with clearly rounded discs while the apothecia of *N. laii* are mainly marginal or submarginal and the disc is often reniform. Nevertheless, the apothecia of *N. laii* can be quite similar to those of *N. nephromoides* and then the lower side of the thallus should be examined. Pseudocyphellae are small and flat and situated mainly on the brown coloured ridges of the generally paler lower surface in *N. laii*, while the pseudocyphellae of *N. nephromoides* are medium to large, flat or concave and developed directly on the surface. Secondary lobules forming a fringe along the margins of lobes are characteristic for *N. laii*.

*Distribution and habitat.* Distributed in China, India, Japan, Russia, Vietnam (see Fig. 3 in Randlane & Saag 1998). In China it has been found in Taiwan, Yunnan, now also in Xizang provinces. Corticolous on coniferous (*Abies*, *Pinus*) and deciduous (*Betula*, *Sorbus*, *Quercus*) trees in mountain forests at the altitude 600–3300 m.

*Specimens examined from Tibet and/or neighbouring areas.* CHINA. PROV. XIZANG. Himalaya Range, 275 km ESE of Lhasa, 60 km SW of Mainling, 29°02'N 93°53'–54'E, 3150–3250 m alt., forest area close to a river, on *Sorbus*, 9.VIII.1994, W.O. 05817(GZU).

### *Nephromopsis morrisonicola* M. J. Lai

Quart. J. Taiwan Mus. 33: 223, 1981. – Type: [China], Taiwan, Nanton Co., Mt. Morrison, alt. 3500–3900 m, 1978, *M. J. Lai* 10 438 (TAIM! – holotype).

*Description* see Randlane *et al.* (1995).

*Typical characters.* Thallus dorsiventral, upper surface yellow, lower surface black (only the margins may be brown to pale brown). Lobes rather wide (8–15 mm). Medulla white. Pseudocyphellae on the lower surface only.

*Chemical constituents.* Contains usnic acid ( $\pm$ ) in the cortex; lichesterinic, protolichesterinic and caperatic ( $\pm$ ) acids in the medulla.

*Notes.* The most conspicuous characters for separating *N. morrisonicola* from other *Nephromopsis* species is black underside **and** white medulla. *N. ornata*, another taxon with black lower surface, has pale yellow medulla. Some *Cetrellopsis* species which may also appear similar to *N. morrisonicola* (e.g. *C. asahinae*) are readily separated by the presence of pseudocyphellae also on the upper surface and the positive Pd reaction of the medulla.

*Distribution and habitat.* Distributed in China, Indonesia, Nepal, Papua New Guinea and the Philippines (see Fig. 4 in Randlane & Saag 1998). In China it has been found in Taiwan, Yunnan, now also in Xizang provinces.

Corticolous on coniferous (*Abies*) and deciduous (*Betula*) trees or shrubs (*Vaccinium*) in mountainous forests at rather high altitude (2400–4000 m).

*Specimens examined from Tibet and/or neighbouring areas.* CHINA. PROV. XIZANG. 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 10 km S of Tongjug village, 29°54'N 94°52'E, 3800–3900 m alt., steep E-facing slopes and ridge area, on *Abies*, 19.VIII.1994, W.O. 06778, 06779, 06785 (GZU).

***Nephromopsis nephromoides* (Nyl.) Ahti & Randle**

Cryptog. Bryol. Lichénol. 19: 183, 1998. – *Platysma nephromoides* Nyl., Flora 52: 442, 443, 1869. – Type: India, West Bengal, Darjeeling distr., Tonglo, alt. 10 000 ft., *Hooker fil. & T. Thomson 2080* (H-NYL 36 068! – lectotype, B!, PC!, UPS! – isolectotypes). – *Nephromopsis stracheyi* var. *nephromoides* (Nyl.) Räsänen, Kuopion Luonnon Ystäväin Yhdistyksen Julkaisuja, B, 2, 6: 48, 1952. – *Cetraria nephromoides* (Nyl.) D. D. Awasthi, Bull. Bot. Surv. India 24: 11, 1982. – *Nephromopsis stracheyi* f. *ectocarpisma* Hue, Nouv. Arch. Mus. Hist. Nat., Sér. 4, 1: 218, 1899. – Types: Japan, insula Yeso [Hokkaido], in sylvis Mombetsu, 1891, *U. J. Faurie 3521* (PC! – lectotype); Japan, Onikobe prope Sendai, 1897, *U. J. Faurie 284* (BM! – paratype). – *Nephromopsis ectocarpisma* (Hue) Gyeln., Ann. Cryptog. Exot. 4: 173, 1931.

*Description* see Randle & Saag. (1998).

*Typical characters.* Thallus dorsiventral, smooth or slightly wrinkled, upper surface greenish yellow, lower surface pale brown. Lobes rather wide (8–15 mm). Pseudocyphellae medium to large, flat or concave, developed directly on the lower surface. Apothecia marginal, numerous, rather small (up to 8 mm in diameter).

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic, protolichesterinic and additionally some other fatty acids, e.g. caperic acid (±) in the medulla.

*Notes.* This species may be confused with *Nephromopsis laii*. For distinguishing characters see discussion under that species. *N. nephromoides* has previously been treated as an infraspecific taxon of *N. stracheyi*. Although the general habit of the thallus and the character of pseudocyphellae on the lower surface of these two species are rather similar, the differences are still distinct – the apothecia of *N. stracheyi* are usually much larger (up to 20 mm in diameter), and the medulla is C + red.

*Distribution and habitat.* Distributed in Bhutan, China, India, Japan, Nepal and Vietnam (see Fig. 5 in Randle & Saag 1998). In China it has been found in Hebei, Heilongjiang, Shaanxi, Sichuan, Taiwan, Xizang and Yunnan provinces (Wei 1991). Corticolous on living and fallen trees at the altitude 2400–3600 m.

*Specimens examined from Tibet and/or neighbouring areas.* BHUTAN. PARO DISTR. Drugey Dzong. 27°30'N 89°20'E, 2600 m alt., pine forest, on *Pinus wallichiana*, 21.IV.1998, U. Sochting 8214 (TU). – THIMPHU DISTR. Dochu la pass, SW of Thimphu, 27°30'N 89°45'E, 3150 m alt., mixed *Tsuga-Rhododendron* forest, 30.IV.1998, U. Sochting 8465 (TU).

***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. – Type: Japan, Mt. Ontake, No. 109. – *Nephromopsis delavayi* Hue, Nouv. Arch. Mus. Hist. Nat., Sér. 4, 1: 219, 1899. – Type: China, Yunnan. Lopinchan, Lanhong, alt. 3200 m, 31.07.1888, *R. P. Delavay* (DUKE). – *Cetraria delavayi* (Hue) M. Satô in Nakai & Honda, Nov. Fl. Jap. 5: 48, 1939. – *Nephromopsis endoxantha* Hue, Nouv. Arch. Mus. Hist. Nat., Sér. 4, 1: 220, 1899. – Type: Japan, Togakushi, 17.09.1898, *U. J. Faurie* 776 (KY – lectotype, DUKE – isolectotype). – *Tuckermannopsis endoxantha* (Hue) Gyeln., Acta Fauna Fl. Universali, Ser. 2, Bot. 1, 5/6: 6, 1933. – *Cetraria endoxantha* (Hue) D. D. Awasthi, Bull. Bot. Surv. India 24: 9, 1983.

*Description* – see Randle & Saag (1998).

*Typical characters.* Thallus dorsiventral, upper surface greenish yellow, lower surface brown to almost black. Lobes rather wide (8–15 mm). Medulla pale yellow, K + deep yellow.

*Chemical constituents.* Contains usnic acid in the cortex; secalonidic acids A or C in the medulla, occasionally several fatty acids and traces of endocrocin and fumarprotocetraric acid are also present.

*Notes.* A beautiful and easily recognized lichen characterized by the brown or black underside **and** yellow medulla. If fertile, the nephromoid apothecia often very large (to 20 mm in diameter) and attractive.

*Distribution and habitat.* Distributed in China, Japan, Russia and South Korea (see Fig. 6 in Randle & Saag 1998). In China it has been found in Jilin, Sichuan, Taiwan, and Yunnan provinces (Wei 1991); probably also occurs in Tibet although not yet recorded. Corticolous on coniferous and deciduous trees in forests at lower and medium altitudes (up to 3200 m).

***Nephromopsis pallescens* (Shaer.) Y. S. Park var. *pallescens***

Bryologist 93: 122, 1990. – *Cetraria pallescens* Schaer., in Moritzi, Syst. Verzeichn.: 129, 1845–1846. Type: [Indonesia] Java, Mt. Pangerango, *H. Zollinger* 449 (G! – holotype). – *Platysma pallescens* (Schaer.) Nyl., Mém. Soc. Sci. Nat. Cherbourg 5: 100, 1858. – *Cetrariopsis pallescens* (Schaer.) Randle & A. Thell, Cryptog. Bryol. Lichénol. 16: 42, 1995. – *Sticta wallichiana* Taylor, London J. Bot. 6: 177, 1847. – Type: Nepal, *N. Wallich* (FH – holotype, G 2003/1!, G 2003/2!, PC! – isotypes). – *Parmelia wallichiana* (Taylor) Nyl., Mém. Soc. Sci. Nat. Cherbourg 5: 105, 1858. – *Platysma leucostigmeum* var. *wallichianum* (Taylor) Nyl., Syn. Meth. Lich. I: 306, 1860. – *Platysma wallichianum* (Taylor) Nyl., Flora 52: 443, 1869. – *Cetraria wallichiana* (Taylor) Müll. Arg., Flora 71: 139, 1888. – *Cetrariopsis wallichiana* (Taylor) Kurok., Mem. Natl. Sci. Mus. Tokyo 13: 140, 1980. – *Ahtia wallichiana* (Taylor) M. J. Lai, Quart. J. Taiwan Mus. 33: 220, 1981 (*nom. illeg.*). – *Cetraria sulphurea* Mont. & Bosch, in Montagne, Syll. Gen.

Sp. Crypt.: 322, 1856 (not validly published). – Orig. coll.: [Indonesia] Java, *F. W. Junghuhn*. – *Cetraria teijsmannii* (“*Teysmannii*”) Mont. & Bosch, in *Montagne, Syll. Gen. Sp. Crypt.*: 474, 1856. – Type: [Indonesia] Java, *J. E. Teijsmann*. – *Platysma teijsmannii* (“*Teysmannii*”) (Mont. & Bosch) Nyl., *Mém. Soc. Sci. Nat. Cherbourg* 5: 100, 1858.

*Description* – see Randle et al. (1995).

*Typical characters*. Thallus dorsiventral, upper surface greenish yellow, lower surface white to yellow. Lobes rather wide (8–15 mm). Pseudocyphellae on the lower surface on special plug-like outgrowths. Apothecia small and numerous, mainly laminal.

*Chemical constituents*. Contains usnic acid in the cortex; alectoronic and/or lichesterinic, protolichesterinic acids in the medulla.

*Notes*. The species which is well-known and easily recognized in its typical form by the laminal apothecia which is unusual for cetrarioid lichens. Even so, some specimens have ascoma developed mainly along the margins of the upper surface with only a few laminal apothecia. In such specimens the lower surface should be checked for the presence of pseudocyphellae on special outgrowths – especially in the central part of the thallus.

*Distribution and habitat*. Distributed in China, India, Indonesia, Japan, Nepal, Papua New Guinea, Russia, South Korea and Thailand (see Fig. 7 in Randle & Saag 1998). In China it has been found in Sichuan, Taiwan, Xizang and Yunnan provinces (Wei 1991). Corticolous on coniferous (*Larix*, *Pinus*) and deciduous (*Carpinus*, *Populus*, *Salix*, *Sorbus*, *Quercus*) trees or shrubs (*Berberis*, *Rhododendron*, *Spirea*) in mountainous forests at medium and high altitudes (1200–4300 m).

*Selected specimens examined from Tibet and/or neighbouring areas*. **CHINA. PROV. SICHUAN**. Shalui Shan Mts., 35 km NNE of Batang, 30°16'N 99°28'E, 4200–4300 m alt., pasture with schist outcrops and single *Juniperus* trees, on *Spirea*, 27.VI.1994, W.O. 03443 (GZU). – **PROV. XIZANG**. Himalaya Range, 275 km ESE of Lhasa, 60 km SW of Mainling, 29°02'N 93°53–54'E, 3150–3250 m alt., forest area close to a river, on *Sorbus*, 9.VIII.1994, W.O. 05811, 05812, 05818, 05821, 05823, 05842 (GZU). – Nyainqêntanglha Shan, 360 km E of Lhasa, near the bend of the river Tsangpo, 5 km S of Tongjug village, 29°58'N 94°54'E, 2700 m alt., on *Berberis*, 18.VIII.1994, W.O. 06608 (GZU). – Ibid., on *Populus*, 21.VIII.1994, W.O. 06890 (GZU). – 370 km E of Lhasa, near the bend of the river Tsangpo, between the villages Tongjug and Tangmai, 30°01'N 94°58'E, 2300–2400 m alt., deciduous trees along the river, on dead *Populus*, 23.VIII.1994, W.O. 07065 (GZU).

### *Nephromopsis stracheyi* (Bab.) Müll. Arg.

*Flora* 74: 374, 1891. – *Cetraria stracheyi* Bab., *Hooker's J. Bot. Kew Gard. Misc.* 4: 245, 1852. – [India], Himalaya, Kathi, 7200 ft, *R. Stracheyi* & *E. Winterbottom* (BM – holotype, H-NYL 36 138! – isotype). – *Platysma stracheyi* (Bab.) Nyl., *Flora* 52: 443, 1869.

*Description* – see Randle & Saag (1998).

*Typical characters*. Thallus dorsiventral, often very large (to 20 cm in diameter), upper surface yellowish grey, lower surface brown. Lobes wide

(up to 30 mm). Pseudocyphellae medium to large, flat or concave, forming directly on the lower surface. Medulla white, C + red. Apothecia marginal, often very large (to 20 mm in diameter).

*Chemical constituents.* Contains usnic acid in the cortex; olivetoric or anziaic acid in the medulla.

*Notes.* For differences from *N. nephromoides* see under that species.

*Distribution and habitat.* Distributed in Bhutan, China, India, Nepal (see Fig. 9 in Randle & Saag 1998). In China it has been found in Hubei, Taiwan and Yunnan provinces (Wei 1991); probably also occurs in Tibet although not yet recorded. Grows on trees at low and medium altitudes (up to ca. 3000 m).

*Specimens examined from Tibet and/or neighbouring areas.* **BHUTAN.** WANGDI DISTR. Phobji valley, Khebeythang, 27°23'N 90°11'E, 2620 m alt., mixed coniferous forest, on *Rhododendron*, 15.IV.1998, U. Søchting 8095, 8105 (TU). **NEPAL.** Yamphoshin, 27°27'N 81°57'E, 9000 ft. alt., on tree trunk, 25.VI.1969, L. Williams 954 (BM).

### *Nephromopsis yunnanensis* (Nyl.) Randle & Saag

Mycotaxon 44: 488, 1992. – *Platysma yunnanense* (“yunnense”) Nyl., Lich. Nov. Zeland.: 150, 1888. – Type: China, Yunnan, alt. 1800 m, *R. P. Delavay 1602* (H-NYL 36 134! – lectotype). – *Cetraria yunnanensis* (Nyl.) Zahlbr., Trudy Troitskos.-Kyakhtinsk. Otd. Priamursk. Otd. Imp. Russk. Geogr. Obshch. 12: 89, 1911.

*Description* – see Randle *et al.* (1995).

*Typical characters.* Thallus dorsiventral, upper surface yellow, lower surface white to pale brown and extremely rugose. Lobes rather wide (8–15 mm). Pseudocyphellae on the lower surface on ridges and plug-like outgrowths. Pycnidia numerous, both laminal and marginal, on pale emergent projections.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla.

*Notes.* A rare lichen, endemic to southern China. *N. yunnanensis* is not easily confused with any other species and can be recognized by the numerous pycnidia on pale emergent projections which develop both marginally and laminally on the upper and sometimes even on the lower surface.

*Distribution and habitat.* Distributed in China: previously known from Yunnan province (see Fig. 10 in Randle & Saag 1998) and now also from Xizang. Corticolous on coniferous (*Picea*) and deciduous (*Quercus*, *Sorbus*) trees in mountain forests at the altitude 1800–3200 m.

*Specimens examined from Tibet and/or neighbouring areas.* **CHINA. PROV. XIZANG.** Himalaya Range, 275 km ESE of Lhasa, 60 km SW of Mainling, 29°02'N 93°53'–54'E, 3150–3250 m alt., forest area close to a river, on *Sorbus*. – 9.VIII.1994, W.O. 05828, 05829, 05842 (GZU).

***Tuckneraria ahtii* Randle & Saag**

Acta Bot. Fenn. 150: 147, 1994. – Type: China, Prov. Yunnan, Lijiang County, Mt. Yulongshan, lower central E slope, Ganheba, 3200–3300 m, 27°06'N 100°14'E, on *Abies*, 23.04.1987, T. Ahti, J. B. Chen & L. S. Wang 46 649 (H! – holotype, TU! – isotype).

*Description* – see Randle *et al.* (1994).

*Typical characters.* Thallus dorsiventral, upper surface yellowish grey, lower surface pale to dark brown. Lobes rather narrow (4–10 mm wide). Marginal cilia may be present. Pycnoconidia bifusiform (5 x 1–1,5 µm). Ascospores subglobose (5–7 x 4–5 µm).

*Chemical constituents.* Contains usnic acid (±) in the cortex; lichesterinic, protolichesterinic, caperatic (±) and occasionally other unidentified fatty acids in the medulla.

*Notes.* A taxon which is not easily distinguished by morphology alone, but by the shape of both ascospores and pycnospores.

*Distribution and habitat.* Distributed in Bhutan, China – in Sichuan, Taiwan, Xizang and Yunnan provinces – and Nepal (Randle *et al.* 1994) (Fig. 4). Corticolous on coniferous (*Abies*, *Juniperus*, *Picea*) and deciduous (*Hippophae*, *Salix*) trees or shrubs (*Rhododendron*) in mountain forests at the altitude 3200–4500 m.

*Selected specimens examined from Tibet and/or neighbouring areas.* **BHUTAN.** PARO **DISTR.** Chele la pass, 27°22'N 89°29'E, 3900 m alt., subalpine zone, on and among dwarf *Rhododendron*, 1.V.1998, U. Søchting 8489 (TU). **CHINA.** PROV. XIZANG. Nyainqentanglha Shan, 350 km E of Lhasa, 20 km E of Nyingchi, 29°36'N 94°44'E, 3800 m alt., *Picea-Abies* forest, on *Abies*, 27.VIII.1994, W.O. 07140 (GZU). – 275 km E of Lhasa, 70 km E of Gongbo Gyamda, 30°00'N 93°56–57'E, 3500–3600 m alt., mixed forest, on *Hippophae*, 29.VIII.1994, W.O. 07138 (GZU). – 350 km E of Lhasa, 29°36'N 94°44'E, 3650–3750 m alt., flood plain area along a small rivulett, on *Abies*, *Picea*, *Salix*, 24.–25.VIII.1994, W.O. 07142, 07143, 07144, 07146 (GZU). – 360 km E of Lhasa, near the bend of the river Tsangpo, 29°56–58'N 94°53–54'E, 3000 m alt., on *Abies*, 21.VIII.1994, W.O. 06936 (GZU). – Himalaya Range, 280 km ESE of Lhasa, 45 km SW of Mainling, 29°02–03'N 93°54–56'E, 4000–4100 m alt., *Abies* forest, on *Abies*, 10.VIII.1994, W.O. 05915 (GZU). – **PROV. YUNNAN.** Mt. Yulong-shan near Lijiang, 3450–3500 m alt., H. Handel-Mazzetti 3563 (FH, US). – Lijiang Co., Yangtze watershed, eastern slopes of Lijiang Snow Range, Rock 11 773 (UPS). – **NEPAL.** Langtang area, Pamdang Karpo, 4620 m alt., 1986, G. & S.M. 13 056f (GZU). – Langtang area, terminal moraine of Langtang Glacier, 4480 m alt., 1986, G. & S.M. 12 424.

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

Acta Bot. Fenn. 150: 149, 1994. – *Cetraria laureri* Kremp., Flora 34: 673, 1851. – *Nephromopsis laureri* (Kremp.) Kurok., J. Jap. Bot. 66: 156, 1991. – *Cetraria complicata* Laurer, in Fries, Lichenogr. Eur. Ref. 459, 1831 (*nom. nud.*). – *Platysma complicatum* (Laurer) Nyl., Syn. Lich. 1: 303. 1860 (*nom. inval.*). – *Cetraria straminea* Kremp. ex Schwend. in Nägeli, Beitr. Wiss. Bot. (Leipzig) 2: 154, 1860.

*Description* – see Randle *et al.* (1994).



*Typical characters.* Thallus dorsiventral, pale yellow on the upper surface and white to pale brown on the lower surface, with marginal whitish soredia and scattered cilia. Lower surface with small pseudocyphellae. Medulla white, Pd –.

*Chemical constituents.* Contains usnic acid in the cortex; lichesterinic and protolichesterinic acids in the medulla.

*Notes.* A taxon which had earlier been confused with another sorediate cetrarioid lichen *Allocetraria oakesiana*. These two species are morphologically somewhat similar as both have rather small yellow dorsiventral thalli and the marginal soralia. However, these taxa are distinct both anatomically (filiform pycnoconidia in *A. oakesiana*, bifusiform pycnoconidia in *T. laureri*) and chemically (occurrence of caperatic acid and occasionally also secalonic acid in *A. oakesiana*). The careful investigation of the lower surface reveals small pseudocyphellae in *T. laureri* but never in *A. oakesiana*. *A. oakesiana* is widely distributed in North America and Europe but occurs just occasionally in Asia (China, Nepal, Russia).

*Distribution and habitat.* A very extensively distributed taxon in different parts of the world: in montane forests of many countries in Central Europe – Austria, Germany, Italy, Poland, Romania, Slovakia, Switzerland, Ukraine; in Asia – Bhutan, China, India, Japan, Mongolia, Nepal, Russia; in South-America – Colombia, Venezuela (Fig. 4). In China it is known from Sichuan and Xizang provinces. Corticolous on coniferous (*Abies*, *Juniperus*, *Picea*, *Pinus*) and deciduous (*Betula*, *Hippophae*, *Lonicera*, *Quercus*, *Prunus*, *Rhododendron*, *Salix*, *Sorbus*) trees or lignicolous at altitudes 2400–5100 m.

*Selected specimens examined from Tibet and/or neighbouring areas.* **BHUTAN. PARO** **DISTR.** Chele la pass, 27°22'N 89°20'E, 3900 m alt., subalpine zone, on dwarf *Rhododendron*, 1.V.1998, U. Søchting 9066 (TU). – **THIMPHU** **DISTR.**, Thimphu valley below Tango Gonpa, 27°36'N 89°38'E, 2700 m alt., temperate oak forest with *Rhododendron*, on dead wood, 28.IV.1998, U. Søchting 8403 (TU). – **WANGDI** **DISTR.**, Phobji valley, Khebeythang, 27°30'N 90°11'E, 2620 m alt., mixed forest, on rotten *Tsuga* stump, 15.IV.1998, U. Søchting 8124 (TU). – **CHINA. PROV. SICHUAN.** Shalui Shan Mts., 30 km NNE of Batang, SSE of Yidun, 30°16'N 99°25'E, 4100–4150 m alt., S-facing slope with *Quercus*, *Juniperus* and *Picea*, on *Quercus*, 26.VI.1994, W.O. 03341 (GZU). – E of Litang, 30°07'N 100°30'E, 4200–4400 m alt., alpine meadows with *Kobresia pygmaea*, on *Rhododendron*, 24.VI.1994, W.O. 03161, 03165a (GZU). – **PROV. XIZANG.** Himalaya Range, 170–175 km S of Lhasa, between Lhozhag and Lhaxhang Dzong, 28°18'N 90°57'E, 4250 m alt., *Betula-Rhododendron* forest, on *Betula utilis*, 22.VII.1994, W.O. 04818, 04840, 04859 (GZU). – Himalaya Range, 180 km SE of Lhasa, 100 km SSE of Tsetang (Nedong), 28°35'N 92°28'E, 4200–4300 m alt., canyon with *Betula - Rhododendron* forest, on *Rhododendron*, 27.VII.1994, W.O. 04610 (GZU). – Everest E, Kama Chu, W of Sakyatang (Camp Ev3–4), 27°58'N 87°13'E, 4320 m alt., subalpine *Abies-Juniperus-Rhododendron* forest, on *Abies*, *Juniperus*, *Rhododendron*, 24.X.1989, B.D. K-87-1 (GZU). – Central Himalayas, Upper Trisuli gorge, W of Mt. Xixabangma, 28°32'N 85°16'E, 4310 m alt., subalpine thickets, on *Rhododendron*, *Sorbus*, 23.VIII.1993, G. & S.M. 9549/13-1, 9549/13-2 (GZU). – Nyainqêntanglha Shan, 275 km E of Lhasa, 70 km E of Gongbo Gyamda, 30°00'N 93°56'–57'E, 3500 m alt., on wood, 30.VIII.1994, W.O. 07156, 07628 (GZU). – **NEPAL.** Central Nepal, Langtang valley, Kyangjin, 28°13'N 85°34'E, 3790–4420 m alt., 02–21.VIII.1995, U.W. 09, 39, 41-1, 46, 47, 56, 57, 60, 64 (GZU).

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

Mycotaxon 49: 427, 1993. – *Lichen juniperinus* L., Species Plantarum: 1147, 1753. – Type: LINN 132 (lectotype). – *Cetraria juniperina* (L.) Ach., Meth. Lich.: 298, 1803. – *Tuckermannopsis juniperina* (L.) Hale, Bryologist 90: 164, 1987.

*Description* – see Mattsson (1993).

*Typical characters.* Thallus dorsiventral, greenish yellow on both surfaces, with bright yellow medulla; soredia absent but apothecia and pycnidia common.

*Chemical constituents.* Contains usnic acid in the cortex; pinastric and vulpinic acids in the medulla; some other substances – zeorin and other triterpens – have also been detected by TLC (Mattsson 1993) but they have no taxonomic importance.

*Notes.* The species is distinguished by the bright yellow medulla due to the presence of pinastric and vulpinic acids; the absence of soredia is the diagnostic character which separates this taxon from *Vulpicida pinastris*.

*Distribution and habitat.* Distributed in boreal and mountainous regions of northern Europe and north-eastern Asia (see Figs 18–20 in Mattsson 1993). In Asia this species is much rarer than *V. pinastris*; known from China (Jilin and Xinjiang provinces) (Wei 1991; Abbas & Wu 1998), Japan (Yoshimura 1979; Kurokawa 1991), Mongolia (Biazrov *et al.* 1989), and Russia (Rassadina 1950). We have not examined any specimens of *V. juniperina* from Tibet, but its occurrence in neighbouring areas (Xinjiang province) has been recorded in literature (Abbas & Wu 1998). It is an epiphyte that is mainly restricted to *Juniperus communis* in Europe and to *Pinus pumila* in Asia. Occasionally grows also on *Betula* or on calcareous soil.

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

Mycotaxon 49: 428, 1993. – *Lichen pinastris* Scop., Flora Carniolica 2: 382, 1772. – Type: Italy, Friuli, Prov. Udine, Carnic Alps, road between Sauris and Casera Razzo, ca 3 km before the latter, subalpine *Larix*-woodland, on *Larix*, 1750 m, 24.03.1993, *P. L. Nimis* (LD! – neotype, TSB – isoneotype). – *Cetraria juniperina* var. *pinastris* Ach., Meth. Lich.: 298, 1803. – *Cetraria pinastris* (Scop.) S. F. Gray, Natural Arrang. Brit. Plants 1: 432, 1821. – *Tuckermannopsis pinastris* (Scop.) Hale, Bryologist 90: 164, 1987.

*Description* – see Mattsson (1993).

*Typical characters.* Thallus dorsiventral, greenish yellow on both surfaces, with bright yellow marginal soredia and medulla of the same colour.

*Chemical constituents.* Contains usnic acid in the cortex; pinastric and vulpinic acids in the medulla; several other substances – zeorin and other

triterpens – have also been detected by TLC (Mattsson 1993) but they have no taxonomic importance.

*Notes.* The species is distinguished by the bright yellow marginal soredia and medulla, caused by the presence of pinastric and vulpinic acids.

*Distribution and habitat.* Widely distributed in arctic, boreal and mountainous regions of the northern hemisphere (see Figs 23 & 24 in Mattsson 1993). In Asia known from China (Neimongol, Jilin, Heilongjiang and Xizang provinces) (Wei 1991), Japan (Yoshimura 1979; Kurokawa 1991), Kazakhstan, Mongolia (Golubkova 1981) and Russia (Rassadina 1950). We have not seen any herbarium specimens of *V. pinastris* from Tibet but its occurrence there has been recorded in literature (Wei 1991). Grows preferably on coniferous (*Juniperus*, *Larix*, *Picea*, *Pinus*) but also on deciduous trees with poor bark (*Betula*), occasionally on lignum, rocks and soil.

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