

Highland Macrolichen Flora of Northwestern Yunnan, China

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Fifty-six species in 36 genera of macrolichens are reported from the Zhongdian area, northwest Yunnan, China during the lichenological expedition for highland macrolichen survey in June, 2004. More than 60% of these species have not been reported in South Korea. All of the 182 collected specimens are deposited in the Korean Lichen Research Institute (KoLRI) at Sunchon National University in Korea, and some of them are duplicated in the lichen herbarium, Crytogamic Herbarium, Kunming Institute of Botany, Academia Sinica (KUN-L) in China. This is the first report on the macrolichen flora in the visited areas.

Key words: China, flora, KoLRI, macrolichen, Yunnan

Yunnan in southern China, located between 22-28°N and 97-106°E, has attracted many botanists and collectors since the end of the 19th century. For lichens, Hue (1887, 1889) studied the collection made by Abbé Delavay, and Zahlbruckner (1930) enumerated many species, mainly based on the collection made by Handel-Mazzetti. Chinese lichenologists have conducted floristic and taxonomic studies on lichens in this area for the last decade (Wei and Jiang, 1991; Wu and Wang, 1992; Chen *et al.*, 1994; Wang and Chen, 1994), but many genera and places still remain incompletely investigated.

In June 2004, we had a lichenological expedition for the floristic survey of highland macrolichens in northwestern Yunnan, China as a part of the Bioresource Conservation Projects supported by the Korean Ministry of Sciences and Technology. During this expedition, 56 species in 36 genera were identified among the 182 specimens collected. More than 60% of the species have not been reported in South Korea (Hur *et al.*, 2004). Here, we reported our highland macrolichen floristic survey on northwest Yunnan lichens.

Materials and Methods

Study area

The study area is located in the regions of northwest Yunnan, southwest Sichuan, and southeast Tibet (E-Xizang), forming the eastern end of the Great "Sino-Himalayan" mountain chain between 25°05' to 35°10'N and 85°10' to

103°35'E. This area is known worldwide for its rich flora of lichen species. The average elevation in the area is over 3800 m. The area is very broken country, characterized by steeply sloping river gorges and high mountain peaks. Within the area, the Yunnan Plateau type of climate prevails. Although the area is outside of the direct effect of the summer monsoon, the high mountains get significant rain in the summer season, when warm air masses meet the colder air from Siberia. This explains the well-developed bryophyte vegetation in the oroboreal forests of the area. In winter, when high pressure develops in Western China and Mongolia and the relative pressure over the Pacific is lower, cold and dry air flows from the interior to the sea, often dropping temperatures below -20°C.

Most of the collecting localities were either cool, temperate forests at 2500 - 3200 m or oroboreal forests and shrubs at approximately 3200 - 4600 m. In the temperate zone, there are woods composed mainly of pines, such as *Pinus yunnanensis*, *P. armandii*, and *P. densata*, on dry sites. On mesic sites, there are woods of *Acer*, *Tilia*, *Ulmus*, and other deciduous trees. In oroboreal zones, the forest is a mixture of *Betula*, *Picea*, *Larix*, *Abies*, *Quercus*, and *Rhododendron*. The uppermost part of the upper oroboreal zone is evidently low shrub vegetation formed by *Berberis*, *Juniperus*, and *Rhododendron* and, in the wetter sites, *Salix*. In these regions, alpine tundra is usually developed from 4200 to 4600 m elevation. In these areas, the richest lichen vegetation occurs at elevations between 3000 to 4500 m. The oroboreal vegetation in this area is similar to the vegetation in some other high mountains in China, such as Mt. Chang-bai (Koponen *et al.*,

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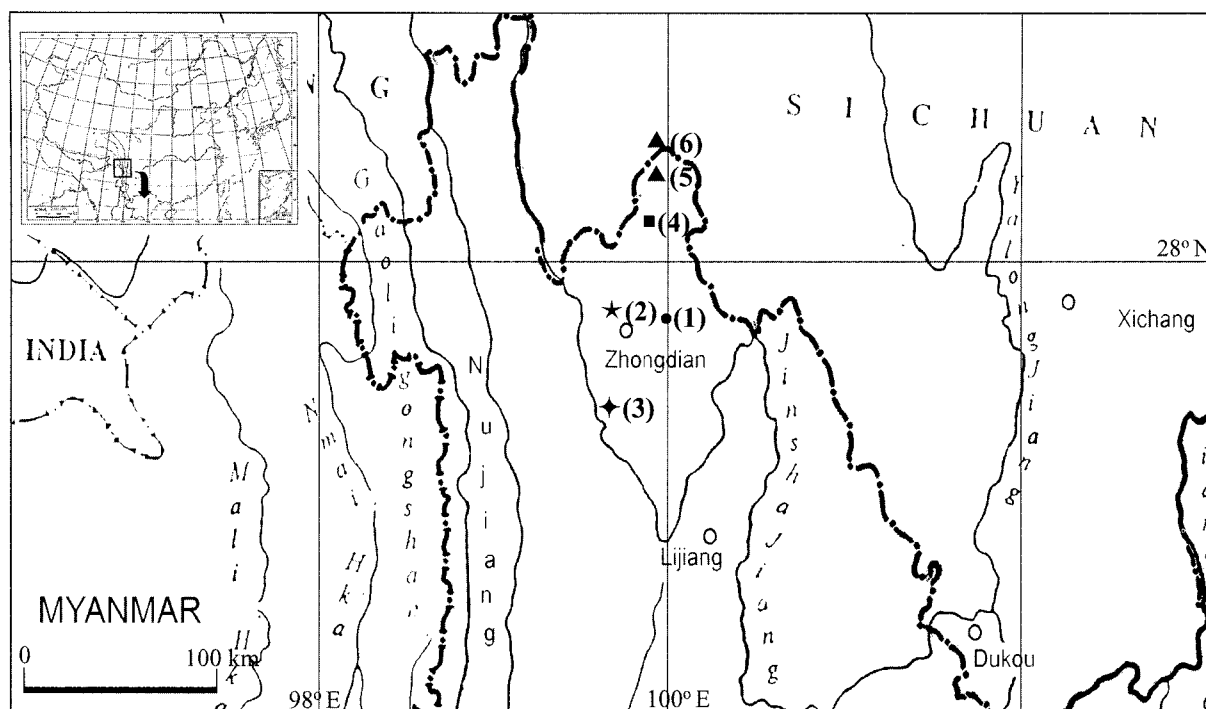


Fig. 1. The study areas and collecting localities (1 - 6) around Zhongdian county, northwest Yunnan, China. A description of each locality is presented in the text.

1983). This is evidently due to the high precipitation and humidity of these high elevation forests.

This work is based on collections made around the Zhongdian area (Fig. 1). Collecting localities are given below (see also Figs. 1 and 2).

1. Da Bao Su : 20 km E of Zhongdian. Forest of *Picea*, *Pinus*, *Rhododendron*, and *Quercus*; alt. 3250 - 3300 m, 27°45'N, 99°46'E.
2. Napahai : 10 km NW of Zhongdian. Forest of *Picea*, *Salix*, and *Rhododendron*; alt. 3550 - 3700 m, 27°55'N, 99°35'N.
3. Tian Chi Hu (Fig. 2 A): 40 km S of Zhongdian. Forest of *Abies*, *Betula*, *Picea*, *Quercus*, *Pinus*, *Sorbus*, and *Larix*; alt. 3200 - 3750 m, 27°37' - 38'N, 99°38'E.
4. Birang Gorge : 85 km N of Zhongdian. Forest of *Quercus*, *Pinus*, *Populus*, and *Rhododendron*; alt. 3050 m, 28°24'N, 99°46'E.
5. Mt. Da Xue, Yunnan side, valley (Fig. 2 B, C): 100 km N of Zhongdian. Forest of *Pinus*, *Juniperus*, and *Quercus*; alt. 3700 - 4050 m, 28°32'N, 99°56'E.
6. Mt. Da Xue, Sichuan side (Fig. 2 D): 120 km N of Zhongdian. Forest of *Berberis*, *Juniperus*, *Rhododendron*, and *Salix*; alt. 4050 - 4450 m, 28°35'N, 99°50'E.

Lichen collection and identification

One-hundred eighty-two specimens were collected by Hur and Wang in the middle of June, 2004. This lichen collection expedition was officially permitted by the Yunnan

Forest Administration through the Kunming Institute of Botany. These collections are deposited in the Korean Lichen Research Institute (KoLRI) at Sunchon National University in Korea; some of the collection is duplicated in the lichen herbarium, Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica (KUN-L) in China.

For this study, identification was mainly performed by Mr. Wang at KUN. For confirmation of the identification, some types of specimens in the herbarium of KUN were used. Where appropriate, the nomenclature follows Index-Fungorum. Recent generic treatments were adopted for this study.

Thin-layer chromatography (TLC) was also performed to identify lichen chemical compounds. Most often, half-plates (10 cm high) were used. The usual methods of three developing solvent systems were used (Culberson, 1972; Culberson, 1974). In general, illustrations of some species are found in the following books: Yoshimura (1974), Wu (1987), and Lai (2000).

For molecular identification, analysis of the ribosomal DNA sequence of the ITS region was also attempted in some lichen species. Total DNA was extracted from fresh material using a Cetyl-trimethyl ammonium bromide (CTAB)-based protocol (Cubero *et al.*, 1999). Dilutions (10^{-1}) of the total DNA were used for PCR amplification of the nuclear rDNA ITS and 5.8S genes. Primers for amplification were: ITS4 (5'-TCCTCCGCTTATTGATATGC-3'; White *et al.*, 1990) and ITS5 (5'-GGAAGTAAAAGTC-GRAACAAGG-3'; White *et al.*, 1990). Conditions for PCR amplification and cycle



Fig. 2. Scenery and vegetations of the collecting localities. **A:** Tian Chi Hu Forest of *Abies*, *Betula*, *Picea*, *Quercus*, *Pinus*, *Sorbus*, and *Larix*, alt. 3750 m. **B** (Summit), **C** (Valley): Mt. Da Xue, Yunnan side, Forest of *Pinus*, *Juniperus*, and *Quercus*, alt. 3700 -4050 m. **D:** Mt. Da Xue, Sichuan side Forest of *Berberis*, *Juniperus*, *Rhododendron*, and *Salix*, alt. 4050 - 4450 m.

sequencing have been described previously (Arup, 2002). Resulting sequences were compared with other ITS sequences for lichen-forming fungi available from NCBI.

Results and Discussion

Lichen flora

The following are the lichen species identified in this study; bold letters represent the lichen species reported in South Korea. Illustrations of some lichen species are presented in Fig. 3.

Allocetraria madreporiformis (Ach.) Kärnefelt & A. Thell (Fig. 3)

Mt. Da Xue, on moss (soil), 4250 m (28°35' N, 99°50'E), CH-04-149; Det. Wang, 2004.

Allocetraria stracheyi (Bab.) Kurok. & M.J.Lai
Mt. Da Xue, on moss (soil), 4300 m (28°35'N, 99°50' E), CH-04-160; Det. Wang, 2004.

Anzia hypoleucoides Müll. Arg. (Fig. 3)
Mt. Da Xue, valley, on trunk of *Pinus armandii*, 4000 m (28°24'N, 99°46'E), CH-04-112; Det. Wang, 2004.

Baeomyces placophyllus Ach. (Fig. 3)

Tian Chi Hu, on soil, 3700 m (27°37'N, 99°38' E), CH-04-037; Det. Wang, 2004.

Bryoria confusa (D.D.Awasthi) Brodo & D.Hawksw. (Fig. 3)

Tian Chi Hu, on trunk of *Quercus*, 3700 m (27°38'N, 99°38'E), CH-04-050; Det. Wang, 2004.

Bunodophoron melanocarpum (Sw.) Wedin (Fig. 3)

Mt. Da Xue, valley, on trunk of *Juniperus saltuaria*, 4050 m (28°32'N, 99°56'E), CH-04-092; Det. Wang, 2004.

Cetraria islandica (L.) Ach. (Fig. 3)

Mt. Da Xue, on moss (soil), 4200 m (28°35'N, 99°50' E), CH-04-137; Det. Hur, 2004.

Cetrelia monachorum (Zahlbr.) W.L.Culb. & C.F.Culb.
Tian Chi Hu, on trunk of *Abies*, 3750 m (27°38'N, 99°38'E), CH-04-049; Det. Wang, 2004.

Cladonia amaurocraea (Flörke) Schaer.

Mt. Da Xue, on moss (soil), 4350 m (28°35'N, 99°50' E), CH-04-172; Det. Wang, 2004.

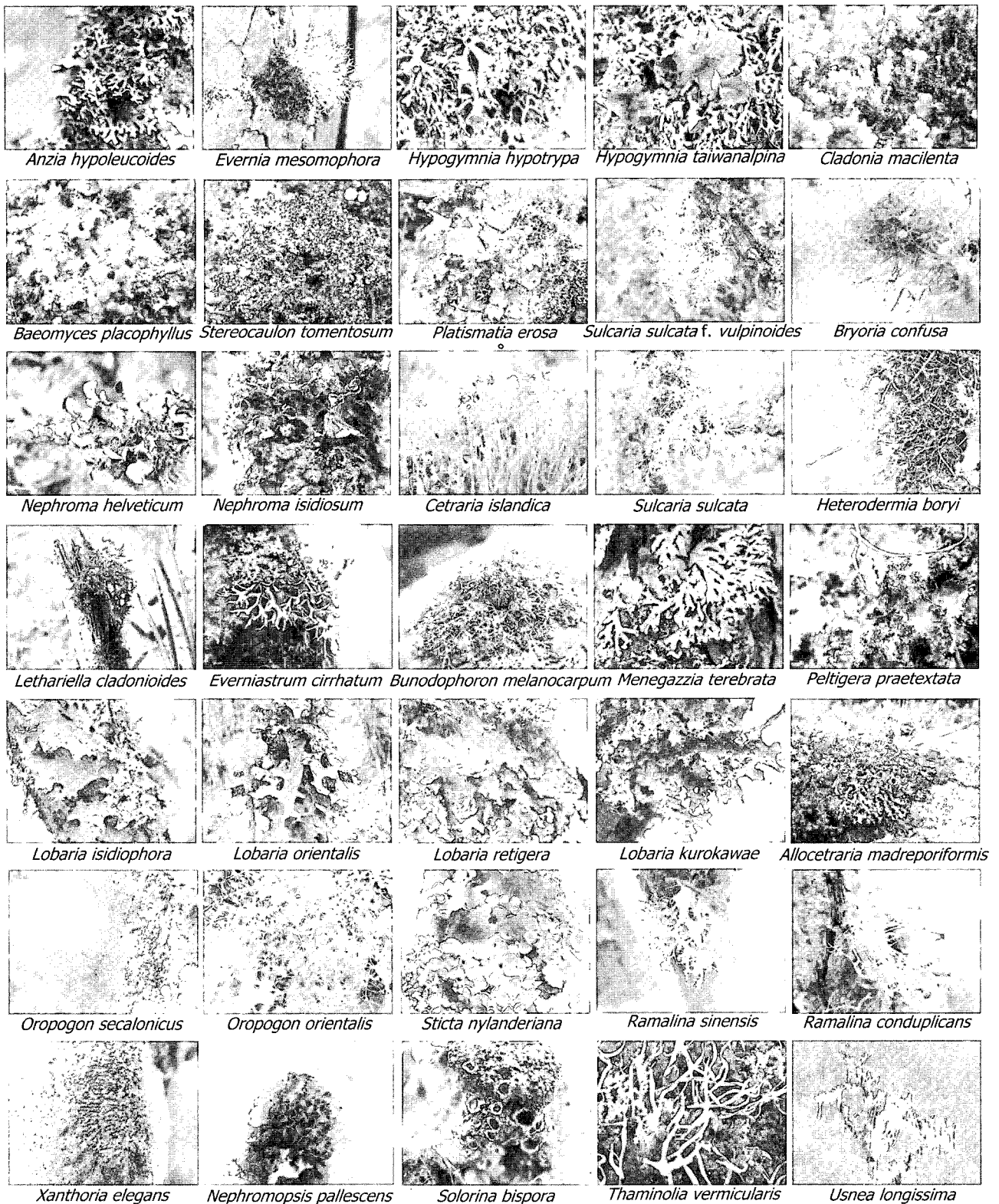


Fig. 3. Illustration of some of the highland macrolichen species reported in this study.

***Cladonia macilenta* Hoffm. (Fig. 3)**

Tian Chi Hu, on rotten wood, 3700 m (27°37'N, 99°38' E), CH-04-029; Det. Wang, 2004.

***Cladonia rangiferina* (L.) Webber ex F.H. Wigg.**

Mt. Da Xue, on moss (soil), 4250 m (28°35'N, 99°50' E), CH-04-153; Det. Wang, 2004.

Cladonia squamosa (Scop.) Hoffm.

Mt. Da Xue, on soil, 4100 m (28°35'N, 99°50'E), CH-04-148; Det. Wang, 2004.

Coccocarpia erythroxyli (Spreng.) Swinscow & Krog
Birang Gorge, on trunk of *Quercus*, 3050 m (28°24'N, 99°46'E), CH-04-122; Det. Hur, 2004.

Collema subnigrescens Degel.

Tian Chi Hu, on trunk of *Betula*, 3200 m (27°38'N, 99°38'E), CH-04-055; Det. Wang, 2004.

Dendriscoaulon intricatum (Nyl.) Henssen

Mt. Da Xue, on trunk of *Salix*, 4100 m (28°35'N, 99°50'E), CH-04-141; Det. Wang, 2004.

Evernia mesomorpha Nyl. (Fig. 3)

Da Bao temple, on trunk of *Picea*, 3300 m (27°45'N, 99°46'E), CH-04-002; Det. Wang, 2004.

Everniastrum cirrhatum (Fr.) Hale ex Sipman (Fig. 3)

Mt. Da Xue, valley, on trunk of *Pinus armandii*, 3800 m (28°32'N, 99°56'E), CH-04-105; Det. Wang, 2004.

Heterodermia boryi Hale (Fig. 3)

Birang Gorge, on trunk of *Pinus densata*, 3050 m

(28°24'N, 99°46'E), CH-04-121; Det. Hur, 2004.

Heterodermia propagulifera (Vain.) J.P.Dey

Mt. Da Xue, valley, on trunk of *Quercus*, 3750 m (28°32'N, 99°56'E), CH-04-107; Det. Wang, 2004.

Hypogymnia diffractaica McCune

Tian Chi Hu, on trunk of *Abies*, 3700 m (27°37'N, 99°38'E), CH-04-033; Det. Wang, 2004.

Hypogymnia hypotrya (Nyl.) Rasm. (Fig. 3)

Tian Chi Hu, on trunk of *Picea*, 3700 m (27°37'N, 99°38'E), CH-04-031; Det. Wang, 2004.

Hypogymnia taiwanalpina M.J.Lai (Fig. 3)

Tian Chi Hu, on trunk of *Picea*, 3700 m (27°37'N, 99°38'E), CH-04-045; Det. Wang, 2004.

Leptogium trichophoroides P.M.Jørg. & A.K.Wallace

Tian Chi Hu, on trunk of *Quercus*, 3200 m (27°37'N, 99°38'E), CH-04-052; Det. Wang, 2004

Lethariella cladonioides (Nyl.) Krog (Fig. 3)

Mt. Da Xue, valley, on trunk of *Juniperus saltuaria*, 4050 m (28°32'N, 99°56'E), CH-04-085; Det. Wang, 2004.



Fig. 4. Habits of *Lichenomphalia hudsoniana* (A), *Umbilicaria hypococcinea* (B), *Lethariella zahlbruckneri* (C), and *Allocetraria stracheyi* (D).

- Lethariilla zahlbruckneri* (Du Rietz) Krog
Mt. Da Xue, valley, on trunk of *Juniperus saltuaria*, 4050 m (28°32'N, 99°56'E), CH-04-088; Det. Wang, 2004.
- Lichenomphalia hudsoniana* (H.S.Jenn.) Redhead *et al.*
Tian Chi Hu, on soil, 3700 m (27°37'N, 99°38'E), CH-04-038; Det. Wang, 2004.
- Lobaria isidiophora* Yoshim. (Fig. 3)
Da Bao temple, on trunk of *Salix*, 3350 m (27°45'N, 99°46'E), CH-04-006; Det. Wang, 2004.
- Lobaria kurokawae* Yoshim. (Fig. 3)
Mt. Da Xue, on trunk of *Rhododendron*, 4100 m (28°35'N, 99°50'E), CH-04-135; Det. Wang, 2004.
- Lobaria orientalis* (Asahina) Yoshim. (Fig. 3)
Mt. Da Xue, on trunk of *Salix*, 4100 m (28°35'N, 99°50'E), CH-04-139; Det. Wang, 2004.
- Lobaria retigera* (Bory) Trevis. (Fig. 3)
Tian Chi Hu, on moss, 3700 m (27°37'N, 99°38'E), CH-04-034; Det. Hur, 2004.
- Menegazzia terebrata* (Hoffm.) A.Massal. (Fig. 3)
Tian Chi Hu, on trunk of *Pinus armandii*, 3700 m (27°37'N, 99°38'E), CH-04-028; Det. Hur, 2004.
- Nephroma helveticum* Ach. (Fig. 3)
Da Bao temple, on trunk of *Pinus*, 3350 m (27°45'N, 99°46'E), CH-04-003; Det. Hur, 2004.
- Nephroma isidiosum* (Nyl.) Gyeln. (Fig. 3)
Mt. Da Xue, on trunk of *Quercus*, 4100 m (28°35'N, 99°50'E), CH-04-136; Det. Wang, 2004.
- Nephromopsis pallescens* (Schaer.) Y.S.Park (Fig. 3)
Napahai, on trunk of *Quercus*, 3550 m (27°55'N, 99°35'E), CH-04-015; Det. Hur, 2004.
- Oropogon orientalis* (Gyeln.) Essl. (Fig. 3)
Birang Gorge, on trunk of *Populus*, 3050 m (28°24'N, 99°46'E), CH-04-130; Det. Wang, 2004.
- Oropogon secalonicus* Essl. (Fig. 3)
Mt. Da Xue, valley, on trunk of *Quercus*, 3700 m (28°32'N, 99°56'E), CH-04-113; Det. Wang, 2004.
- Parmelia masonii* Essl. & Poelt
Da Bao temple, on trunk of *Quercus*, 3350 m (27°45'N, 99°46'E), CH-04-010; Det. Wang, 2004.
- Peltigera canina* (L.) Willd.
Da Bao temple, on soil, 3350 m (27°45'N, 99°46'E), CH-04-004; Det. Wang, 2004.
- Peltigera polydactylon* (Neck.) Hoffm.
Da Bao temple, on soil, 3350 m (27°45'N, 99°46'E), CH-04-013; Det. Wang, 2004.
- Peltigera praetextata* (Flörke ex Sommerf.) Vain. (Fig. 3)
Mt. Da Xue, valley, on moss (soil), 3900 m (28°32'N, 99°56'E), CH-04-101; Det. Wang, 2004.
- Platismatia erosa* W.L.Culb. & C.F.Culb. (Fig. 3)
Tian Chi Hu, on trunk of *Betula*, 3750 m (27°37'N, 99°38'E), CH-04-030; Det. Wang, 2004.
- Ramalina conduplicans* Vain. (Fig. 3)
Birang Gorge, on trunk of *Rhododendron*, 3050 m (28°24'N, 99°46'E), CH-04-116; Det. Hur, 2004.
- Ramalina farinacea* (L.) Ach.
Tian Chi Hu, on trunk of *Sorbus*, 3700 m (27°37'N, 99°38'E), CH-04-059; Det. Wang, 2004.
- Ramalina sinensis* Jatta (Fig. 3)
Napahai, on trunk of *Pinus armandii*, 3550 m (27°55'N, 99°35'E), CH-04-020; Det. Hur, 2004.
- Solorina bispora* Nyl.
Mt. Da Xue, on soil, 4450 m (28°35'N, 99°50'E), CH-04-171; Det. Wang, 2004.
- Stereocaulon tomentosum* Th. Fr. (Fig. 3)
Tian Chi Hu, on rock, 3750 m (27°37'N, 99°38'E), CH-04-035; Det. Wang, 2004.
- Sticta nylanderiana* Zahlbr. (Fig. 3)
Mt. Da Xue, on trunk of *Salix*, 4060 m (28°35'N, 99°50'E), CH-04-133; Det. Wang, 2004.
- Sulcaria sulcata* (Lév.) Bystrek ex Brodo & Hawksw. (Fig. 3)
Tian Chi Hu, on trunk of *Pinus armandii*, 3200 m (27°37'N, 99°38'E), CH-04-064; Det. Wang, 2004.
- Sulcaria sulcata* f. *vulpinoides* (Zahlb.) Hawksw. (Fig. 3)
Tian Chi Hu, on trunk of *Pinus densata*, 3200 m (27°37'N, 99°38'E), CH-04-056; Det. Wang, 2004.
- Thaminolia vermicularis* Schaer. (Fig. 3)
Mt. Da Xue, on moss (soil), 4400 m (28°35'N, 99°50'E), CH-04-157; Det. Wang, 2004.
- Tuckneraria laureri* (Kremp.) Randle & A.Thell
Tian Chi Hu, on trunk of *Larix*, 3750 m (27°38'N, 99°38'E), CH-04-039; Det. Wang, 2004.
- Tuckneraria laxa* (Zahlbr.) Randle & A.Thell
Tian Chi Hu, on trunk of *Larix*, 3700 m (27°37'N,

99°38'E), CH-04-027; Det. Wang, 2004.

Umbilicaria hypococcinea (Jatta) Llano

Mt. Da Xue, valley, on rock, 4050 m (28°32'N, 99°56'E), CH-04-078; Det. Wang, 2004.

Umbilicaria proboscidea (L.) Schrad.

Mt. Da Xue, valley, on rock, 4050 m (28°32'N, 99°56'E), CH-04-077; Det. Wang, 2004.

Usnea longissima Ach. (Fig. 3)

Da Bao temple, on trunk of *Pinus*, 3300 m (27°45'N, 99°46'E), CH-04-001; Det. Wang, 2004.

Xanthoria elegans (Link) Th. Fr. (Fig. 3)

Mt. Da Xue, on rock, 4350 m (28°35'N, 99°50'E), CH-04-182; Det. Hur, 2004.

ITS sequences analysis

ITS and 5.8S rDNA sequences of thirty-four lichen species were analyzed. Among them, the sequences of 17 lichen species were newly reported (Italic accession number in Table 1). The sequences of some lichen sequences, such as *Cetraria islandica* and *Usnea longissima*, showed more than 99% homology with those registered in NCBI. Most of the sequences showed high homology of 95 to 98% with those registered in NCBI. However, the

sequence of *Cladonia macroceras* was poorly matched with NCBI sequences (91% homology), but more closely matched with *C. amaurocreae* (96% homology). The species was excluded in this lichen flora for further identification. As previously reported on Korean crustose lichen (Kahng *et al.*, 2004), the sequence analysis demonstrated that molecular confirmation could be a very useful tool for lichen identification in rarely investigated areas.

Some interesting lichen species

Some interesting lichen species were collected in our expedition. For example, *Lichenomphalia hudsoniana* (H.S. Jenn.) Redhead *et al.*, basidiolichen, was found on moss in humid *Abies* forests in alpine areas (Fig. 4A). The lichen is characterized by its small, pale buff, yellow, or orange fruit bodies with waxy gills and smooth stems, without a veil or basal cup. The vegetative thallus of the coriscium-type consists of squamules, 2 - 10 mm diameter, green to dark-green, concave to plane or slightly convex, and rounded to lobulate, with whitish revolute margins. Photobiont unicellular, *Coccomyxa* had pileus of 4 - 11 mm diameter, convex to shallowly depressed, a slightly undulate margin, striate, hygrophanous, pale orange to orange-yellow, surface glabrous. Pileipellis decurrent was close to subdistant, orange-yellow, fading to pale orange, and pallid at maturity. The stipe was 6 - 18 mm long, 1 - 2 mm thick, more or less equal, straight, hol-

Table 1. ITS and 5.8S r-DNA sequences with current classification and Genebank accession number

Species	Family	Collection number	Accession number ^a
<i>Alloctetraria madreporiformis</i>	Parmeliaceae	CH-04-149	DQ001271
<i>Alloctetraria stracheyi</i>	Parmeliaceae	CH-04-160	DQ001272
<i>Baeomyces placophyllus</i>	Baeomycetaceae	CH-04-037	<i>DQ001274</i>
<i>Cetraria islandica</i>	Parmeliaceae	CH-04-137	DQ001275
<i>Cetrelia monachorum</i>	Parmeliaceae	CH-04-049	<i>DQ001276</i>
<i>Cladonia macroceras</i>	Cladoniaceae	CH-04-156	DQ001277
<i>Dendriscoaulon intricatulum</i>	Lobariaceae	CH-04-141	<i>DQ001281</i>
<i>Evernia mesomorpha</i>	Parmeliaceae	CH-04-002	<i>DQ001282</i>
<i>Heterodermia propagulifera</i>	Physciaceae	CH-04-107	<i>DQ001283</i>
<i>Hypogymnia hypotrypella</i>	Parmeliaceae	CH-04-031	<i>DQ001284</i>
<i>Lethariella cladonioides</i>	Parmeliaceae	CH-04-085	<i>DQ001286</i>
<i>Lethariella zahlbruckneri</i>	Parmeliaceae	CH-04-085	<i>DQ001287</i>
<i>Lobaria isidiophora</i>	Lobariaceae	CH-04-006	<i>DQ001288</i>
<i>Lobaria kurokawae</i>	Lobariaceae	CH-04-135	<i>DQ001289</i>
<i>Nephroma isidiosum</i>	Nephromaceae	CH-04-136	<i>DQ001293</i>
<i>Oropogon secalonicus</i>	Parmeliaceae	CH-04-113	<i>DQ001294</i>
<i>Parmelia masonii</i>	Parmeliaceae	CH-04-010	<i>DQ001295</i>
<i>Ramalina conduplicans</i>	Ramalinaceae	CH-04-116	<i>DQ001297</i>
<i>Stereocaulon tomentosum</i>	Stereocaulaceae	CH-04-035	<i>DQ001301</i>
<i>Sulcaria sulcata</i> f. <i>vulpinoides</i>	Parmeliaceae	CH-04-056	<i>DQ001303</i>
<i>Usnea longissima</i>	Parmeliaceae	CH-04-001	<i>DQ001304</i>

^aItalics indicate the newly reported sequences in this study.

low in age; yellowish, paler than pileus; pubescent over the entire length, with a white mycelial patch at the base in contact with the vegetative thallus. Lamellae distant was ventricose, shallowly decurrent, concolorous with pileus.

Umbilicaria hypococcinea (Jatta) Llano is a unique lichen with an orange-colored lower cortex (Fig. 4B). Thallus monophyllous was membranous, 1.5 - 7 cm diameter, subrounded to irregular, with a dark brown upper surface, with a thin layer of white pruina; smooth lower surface, sometimes slightly verrucose or areolate without rhizines or only with a few and scattered rhizines, occasionally with rich rhizines in all tints of coccineous around umbo. Apothecia was characterized by gyrose discs, numerous and scattered on the upper surface of the thallus, 0.5 - 2.5 mm diameter, adnate to stipitate; spores ellipsoid, hyaline, $8.4 - 9 \times 7 - 7.8 \mu\text{m}$. Lecanoric and gyrophoric acids were present. It is distributed in the Xizang, Shanxi, Shaanxi, and Yunnan provinces.

Lethariella zahlbruckneri (Du Rietz) Krog is characteristic lichen with long, slender thalli and endemic species of the Sino-Himalayan area (Fig. 4C). Thallus fruticose is pendent, usually 10 - 20 cm long, soft, with cylindrical branches, even in diameter, orange to yellowish-brown, dull, anisotomic-dichotomously branched in the basal part, becoming isotomic-dichotomously branched towards the apices; cortex $40 \mu\text{m}$ thick, yellowish, medulla $118 - 173 \mu\text{m}$ thick; soralia and isidia were absent. The apothecia are unknown. Atranorin is present. It is distributed in the Sichuan, Shanxi, and Yunnan provinces.

Allocetraria stracheyi (Bab.) Kurok. & M.J.Lai is one of the alpine lichen species (Fig. 4D). Thallus foliose to fruticose are erect, 3 - 5 cm tall, 1 - 2 mm diameter, rigid, greenish-yellow, dull; branches are filled with a dense, white medulla; rhizines are sparse, along the margins; apothecia are rare, subterminal, red brown. Usnic and secalonic acids are present. It is distributed in the Himalayas and in Taiwan.

This is the first report on macrolichen flora in the visited areas. Fifty-six species of 36 genera were reported in this study. Among them, 20 lichen species (marked with bold) have been reported in South Korea. These lichen species are the following; *Cladonia rangiferina*, *C. amaurocraea*, *C. macilenta*, *C. squamosa*, *Coccocarpia erythroxy*, *Everniastrium cirrhatum*, *Heterodermia boryi*, *H. propagulifera*, *Lobaria orientalis*, *L. retigera*, *Menegazzia terebrata*, *Nephroma helveticum*, *Nephromopsis pallescens*, *Peltigera canina*, *P. polydactylon*, *P. praetextata*, *Ramalina conduplicans*, *R. sinensis*, *Sulcaria sulcata*, and *Xanthoria elegans*.

The lichen specimens will be used for comparative study on lichen distribution in East Asia. Isolation of lichen-forming fungi from the ascospore or thalli of these lichen specimens is now being conducted to obtain and preserve the potential bioresources of biologically active substances.

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