

## Lichen Flora of Mt. Tokachi, Hokkaido, Japan

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**Abstract** As members of the lichen flora of Mt. Tokachi, an active volcano in Hokkaido, 159 lichen taxa belonging to 69 genera are recognized. Although most of them are common also in arctic-alpine and boreal zones of other areas of Japan, *Trapelia involuta* is reported for first time for Japan. The flora seems to be composed of lichens belonging to the arctic-alpine, circumboreal, Beringian, eastern Asia - North America disjunctive, pan-temperate, Far-Eastern groups.

**Key words:** lichens, flora, Mt. Tokachi, volcanic environment, Hokkaido.

Mt. Tokachi (2077 m; 43°25'N, 142°41'E) is an active volcano located in the Daisetsuzan National Park, Hokkaido, Japan (Fig. 1). The ground around Mt. Tokachi consists of volcanic ejecta and lava (mainly andesite) which were erupted during different periods from the Pleistocene to the present day (Katsui *et al.*, 1953). The last eruption in 1989 was of a small-scale but produced fumes and volcanic ashes. An active large fumarole is located approximately 1-km northwest of the summit at present. No lichens are found within a 0.4-km radius of the fumarole, after which different species appear at various distances away.

The study area is situated between 555 and 2060 m in elevation and the timberlines are observed at about 1300 m. According to Ito & Sato (1981), the vegetation around Mt. Tokachi varies mainly with elevations. Alpine flora with patches of *Pinus pumila* scrub covers the north-facing slope of Mt. Bieifuji (more than 1350 m in elevation, **12** in Fig. 1); subalpine forests dominated by *Picea glehnii* and *Betula ermanii* are found between 1350 and 1040 m (**14** in Fig. 1); *Abies sachalinensis* dominated in the mixed forest be-

tween 1040 and 700 m (**15** in Fig.1); deciduous forest dominated by *Fraxinus mandshurica* var. *japonica*, *Acer* sp., *Alnus hirsuta*, *Quercus crispula* var. *grosseserrata*, *Ulmus laciniata* etc. are developed in the riverside below 700 m (**16** in Fig. 1). Detailed vegetational features are given in the following description of sampling sites.

Mean annual precipitation as recorded by the nearest weather station is approximately 900 mm (Japan Meteorological Agency, 2000–2002), and the ground is covered with snow from the end of October to early May.

Lichen flora in Hokkaido was surveyed in the Hidaka Mountains (Kurokawa & Nakanishi, 1971), at Kushiro Marsh (Kashiwadani & Inoue, 1993) and in Mt. O-akan and its adjacent areas (Ohmura & Kashiwadani, 1997). Although lichens of the present area have been reported in taxonomic works of lichens in Japan (Inoue, 1982, 2001), lichens around the active fumarole have not been precisely studied before.

Field surveys for the lichens were carried out from 1997 until 2003 within an 8-km radius of the active fumarole of Mt. Tokachi. The lichens were collected mainly along mountain trails, on

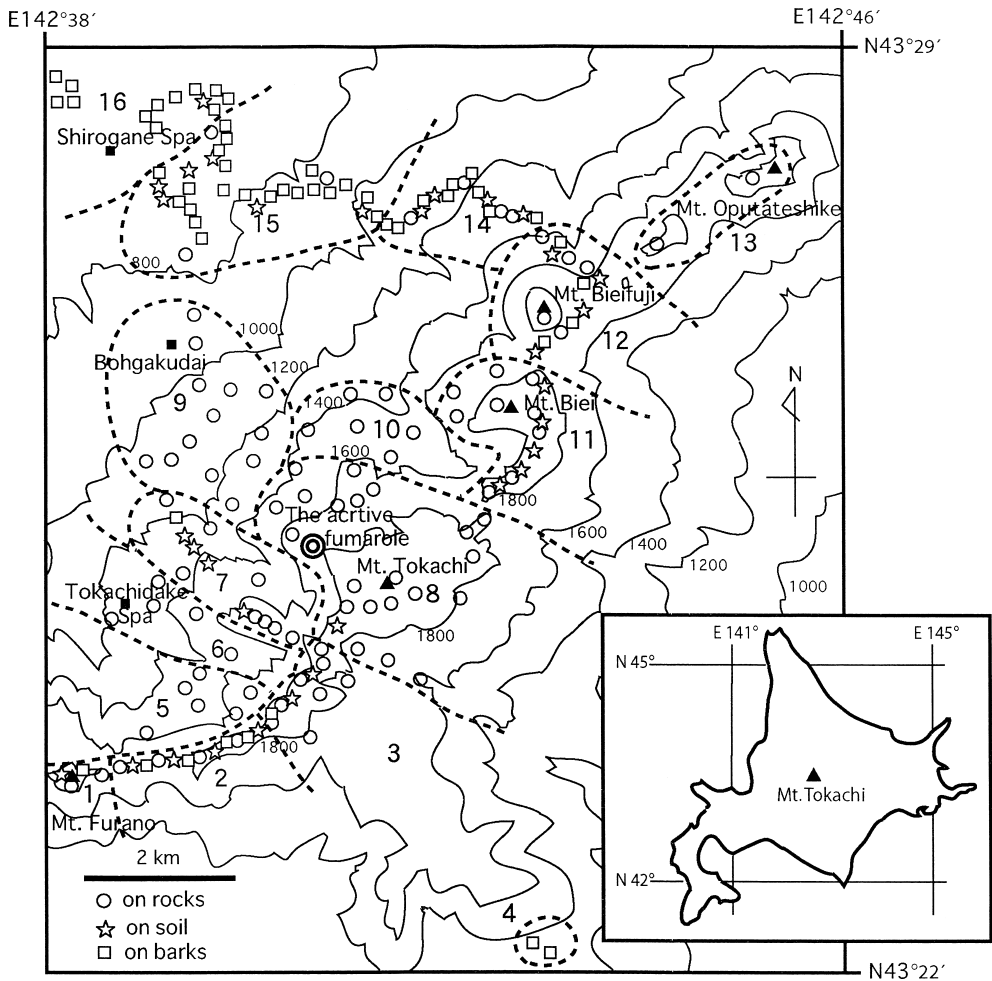


Fig. 1. Location of the study area including the sampling sites. The active fumarole of Mt. Tokachi ( $43^{\circ}25'N$ ,  $142^{\circ}41'E$ ) is shown by a double circle in the middle left of the topographical map. Major peaks are shown as black triangles and some noted points are shown as black squares. Sampling points are grouped in **1**~**16** and divided by thick broken lines (see the explanation of sampling sites in the text). Sampling points on rocks are shown by white circles, on soil by white stars and on barks by white squares.

volcanic fields and in forests. A total of 1325 specimens were collected from 378 sampling sites summarized in Fig. 1. Sections of apothecia and thalli were made using a hand-razor, and mounted in distilled water, GAW, Lugol's iodine solution (Purvis *et al.*, 1992) or lactophenol cotton-blue solution. Chemical tests including thin layer chromatography (Culberson & Johnson, 1982) using the solvent B system and micro crystal tests (MCT) were conducted if necessary. However, specimens of the genus *Bacidia*, *Buel-*

*lia*, *Lepraria*, and *Micarea* were excluded from this study, as further taxonomic studies are required for the Japanese species. All the specimens examined are preserved in the herbarium of the National Science Museum, Tokyo (TNS).

This study documents the lichen flora in the alpine to subalpine zones, which include volcanic fields, and presents taxonomic notes about several saxicolous species.

## Sampling Sites and Enumeration of Lichens

### Sampling sites

The following provides the abbreviations of sampling sites with location numbers in Fig. 1. All sites were located in Prov. Ishikari, Hokkaido.

- Ansei (6): Along Nukkakushifuranuigawa valley upper Tokachidake Spa, Kamifurano-cho. There are two solfataras in this area at Anseikakou (1440 m) and 0.8 km northeast of Tokachidake Spa. Fragile lava field partly covered with *Pinus pumila* scrub; elevation 1260–1500 m. September 16, 2000 and May 26, 2001.
- Bakemono (5): Along Sanpouzanzawa valley including the west ridge of Mt. Kamifurano, southwest of Bakemonoiwa, Kamifurano-cho. Dry riverbeds surrounded by *Pinus pumila* and *Sorbus commixta* scrubs; elevation 1500–1750 m. September 16, 2000 and June 9, 2001.
- Bieidake (11): Around Mt. Biei, Biei-cho. Rocky ridges and alpine flora with *Pinus pumila* scrubs; elevation 1680–2040 m. September 5, 1998, September 13, 1998, August 20, 2000 and August 27, 2000.
- Bieifuji (12): Around Mt. Bieifuji, extending from Biei-cho to Shintoku-cho. Rocky slope covered with *Pinus pumila* scrubs with *Sasa kurilensis* below 1520 m; elevation 1350–1865 m. September 13, 1998 and September 19, 1998.
- Bieigawa (16): Along Biei River behind the Shirogane Camp Ground and near Shirogane-Fudo Waterfall, Biei-cho. Riverside mixed forests with *Fraxinus mandshurica*, *Abies sachalinensis*, *Betula ermanii*, *Acer* sp., *Tilia japonica*, *Quercus crispula*, *Alnus hirsuta* and *Phellodendron amurense*; elevation 560–700 m. May 30, 1998, October 23, 1998, May 8, 1999, September 4, 1999 and April 6, 2003.
- Bohgakudai (9): Around Bohgakudai and between Bohgakudai and Tokachidake Mountain Refuge, extending from Kamifurano-cho to Biei-cho. Volcanic ejecta and lava fields with scattered *Pinus pumila* scrub, stunted *Betula ermanii* and grasses; elevation 880–1340 m. May 16, 1998, August 17, 2000, October 7, 2000, May 26, 2001 and June 17, 2001.
- Furanodake (1): Around Mt. Furano, extending from Kamifurano-cho to Furano-shi. Rocky slopes and alpine flora with patches of *Pinus pumila* scrubs; elevation 1750–1900 m. August 1, 1997 and August 15, 1998.
- Kamihoro (3): Around Mt. Kamifurano and Mt. Kamihorokamettoku, extending from Kamifurano-cho to Shintoku-cho. Rocky ridge and dry riverbeds with scattered *Pinus pumila* scrubs; elevation 1800–1905 m. August 1, 1997, August 23, 1998, September 9, 2000, June 3, 2001 and June 9, 2001.
- Karesawa (14): Along the trail on the north slopes of the Karesawa River, Biei-cho. Transitional area between alpine and subalpine zones with *Picea glehnii*, *Betula ermanii*, *Pinus pumila*, *Sorbus commixta* and *Sasa kurilensis*; elevation 1040–1350 m. May 4, 1998, September 19, 1998 and September 26, 1998.
- Kumonodaira (10): Around Kumonodaira including Ponpizawa valley, Biei-cho. Volcanic boulders and alpine flora with patches of *Pinus pumila* scrub; elevation 1315–1535 m. August 27, 2000, October 7, 2000 and June 17, 2001.
- Oputateshike (13): Along the trail between Mt. Oputateshike and Mt. Bebetu, extending from Biei-cho to Shintoku-cho. Rocky ridges; elevation 1825–1940 m. May 3, 1998.
- Sandanyama (7): Along the trail between Fukiage Spa and Taihouiwa via Mt. Sandan, Kamifurano-cho. Timberline is observed at approximately 1200 m; *Picea glehnii* and *Sasa kurilensis* dominate below it and *Pinus pumila* scrub dominate above it; elevation 1040–1865 m. May 21, 1998, August 2, 2000 and May 12, 2001.
- Sanpouzan (2): Along the trail from Mt. Furano to the southwest col of Mt. Kamifurano, extending from Kamifurano-cho to Shintoku-cho. Numerous boulders were found on the west slope of Mt. Sanpou. Rocky ridges with scattered scrubs of *Rhododendron aureum* and

*Pinus pumila*; elevation 1700–1866 m. August 1, 1997, August 22, 1998 and September 30, 2000.

Seinen (15): Along the woodland paths behind Seinen-no-ie around the Abaregawa and Iouzawa Rivers, Biei-cho. Mixed forest of *Abies sachalinensis*, *Betula ermanii* and *Acanthopanax sciadophylloides* with *Sasa kurilensis*; elevation 700–1040 m. May 16, 1998, May 30, 1998, September 26, 1998, October 3, 1998 and October 10, 1998.

Shimohoro (4): Northwest col of Mt. Shimohorokamettoku, Shintoku-cho. Highland marsh surrounded by forest of *Picea glehnii* and *Betula ermanii*; elevation about 1280 m. May 3, 2003.

Tokachidake (8): Around Mt. Tokachi near the active fumarole, extending from Kamifuranocho to Biei-cho, and Shintoku-cho. Volcanic ejecta and lava field; elevation 1430–2077 m. August 31, 1997, August 23, 1998, September 5, 1998, August 14, 2000, August 20, 2000, September 9, 2000, October 7, 2000, June 17, 2001 and June 30, 2001.

### Enumeration of lichens

The following species are found in the study area. Only representative specimens are cited and the numerals following by the abbreviations of collecting sites are specimen numbers of the authors.

- 1) *Acarospora fuscata* (Nyl.) Arnold Common on acid rocks and lava, distinctively colonizing in the depressions of rock surfaces. Characteristic features for this species are the reddish brown and flattened thalli with dispersed areoles, the immersed apothecia, the asci with numerous colorless spores and the presence of gyrophoric acid (thallus C+ red) as a chemical substance. Specimens from the present area are identical morphologically and chemically with *Kryptogamae Exsiccate Vind.* 2956 preserved in TNS. Tokachidake, 1155; Bohgakudai, 1161.
- 2) *A. smaragdula* (Wahlenb.) A.Massal.

Characteristic features for this species are, 1) the areolate or less peltate thalli with slightly swollen areoles to 1.5 mm wide, 2) the areoles with smooth or ridged surfaces, the black lower surface of areoles with black rhizines, 3) the asci with numerous colorless spores and 4) the absence of chemical substance. Specimens from the present area are identical with Rabenhorst: *Lich. Eur. Exs.* 872 preserved in TNS. This species resembles *A. asahinae*, an endemic species to Japan, from which it differs in having thicker thalli with rough surface with warty projections.

Even though this species has been reported only once from Japan by Vainio (1921) under the name of *A. fuscata* var. *smaragdula*, it is widely distributed in the world. It appears to be much more common in Japan, though this is the second report of the species there, since it is rather commonly found on acidic rocks in the present area. Tokachidake, 1272; Bohgakudai, 1312.

- 3) *Alectoria lata* (Taylor) Linds. Common on trunks and conifer branches. Karesawa, 567; Shimohoro, 1499.
- 4) *Amygdalaria pelobotryon* (Wahlenb.) Norman Occasionally found on dry rocks. This species is closely related to *A. subdis-sentiens*, but is distinguished by its smaller apothecia (less than 1 mm in diameter), thin subhymenium (15–32  $\mu\text{m}$  thick near the center) and the production of gyrophoric acid. This species has been reported from mountain areas of Hokkaido and central Honshu (Inoue, 1984). Karesawa, 530 and 534.
- 5) *Anaptychia isidiza* (Kurok.) Kurok. Common on barks of *Fraxinus* and *Ulmus*. Bieigawa, 699 and 716.
- 6) *Arctoparmelia incurva* (Pers.) Hale Occasionally found on rocks at elevations higher than 1300 m. Sanpouzan, 277; Bieifuji, 469.
- 7) *Asahinea chrysantha* (Tuck.) W.L.Culb. &

- C.F.Culb. Occasionally found on rocks and alpine dwarf shrubs at elevations higher than 1300 m. Sanpouzan, 278; Karesawa, 506.
- 8) *Aspicilia cinerea* (L.) Körb. Common on acid rocks. This species is characterized by chinky-areolate and ash-gray thalli, apothecia with thalloid margin and immersed black disk, colorless and ellipsoid spores  $10\text{--}22 \times 6\text{--}12 \mu\text{m}$  in size, and the presence of norstictic acid. The present species is easily distinguished from the related species by spores of moderate size and by the production of norstictic acid (Magnusson, 1939; Thomson, 1977), though it is rather variable in spore size and color of the thalli.
- Aspicilia cinerea* has been reported from Europe, Canada and Mongol and recorded from Honshu, Japan (Müll.Arg. 1892, Vainio 1921, Räsänen 1940). This is the first record of the species from Hokkaido, where it is apparently common on acidic rocks in open places.
- Biedake, 926; Tokachidake, 1289. Other specimens examined. Japan. Honshu. Prov. Kohzuke: Mt. Nabewari, A.Yasuda s.n. (TNS). Prov. Suruga: Subashiri, June 6, 1926, Y.Asahina s.n. (TNS). Exsiccata examined. Arnold: Lich. Exs. 1228-a (TNS) and Räsänen: Lichenes Fenniae Exsiccati 589 (TNS).
- 9) *Brigantiaea ferruginea* (Müll.Arg.) Kashiw. & Kurok. Occasional over mosses on trunk base of *Acer* and *Quercus*. Bieigawa, 744 and 749.
- 10) *Bryoria americana* (Motyka) Holien Common on barks of *Abies*. Seinen, 633 and 681.
- 11) *Calicium lenticulare* Ach. Occasional on rotten trunks of *Picea* in shaded conditions. Seinen, 686.
- 12) *Caloplaca flavovirescens* (Wulfen) Dalla Torre & Sarnth. Common on barks of *Fraxinus*, *Ulmus*, and *Quercus*. Bieigawa, 698 and 730.
- 13) *Calvitimela aglaea* (Sommerf.) Hafellner Occasional on rocks at elevations higher than 1800 m. This species has known to Japanese lichenologists as *Lecidea aglaea* or *Tephromela aglaea*. Hafellner (2001), however, transferred it to *Calvitimela*. In alpine regions of Japan, this species is easily distinguished from other species by the thick yellowish white bullate-areolate thalli, lecideoid apothecia that has no apothecial margins and black and convex discs, the colorless simple spores  $8\text{--}11 \times 6\text{--}8 \mu\text{m}$  in size and the presence of atranorin and usnic acid ( $\pm$ ). Four specimens collected in central Honshu are also identified with this species.
- Kamihoro, 1025. Other specimens examined. Japan. Honshu. Prov. Etchu: Mt. Etchusawa-dake, on rocks; elevation about 2400 m, H.Kashiwadani 13419 and 13457 (TNS). Prov. Shinano: Mt. You-dake, Yatsugatake Mts., May 30, 1926, Y.Asahina 90 (TNS); Jyogosa, Yatsugatake Mts., July 26, 1959 (TNS).
- 14) *Candelaria concolor* (Dicks.) Stein Occasional on tree barks. Bieigawa, 1489.
- 15) *Cetraria islandica* (L.) Ach. subsp. *orientalis* (Asahina) Kärnefelt Common among alpine fellfield plants. Furanodake, 235; Bieifuji, 461.
- 16) *C. laevigata* Rass. Common among alpine fellfield plants at elevations higher than 1655 m. Furanodake, 251; Bieifuji, 452.
- 17) *Cetrelia chicitae* (W.L.Culb.) W.L.Culb. & C.F.Culb. Occasional on trunks of *Acer* and *Abies*. Bieigawa, 741 and 789.
- 18) *Chaenotheca brunneola* (Ach.) Müll.Arg. Occasional on barks of *Picea glehnii*. Seinen, 613.
- 19) *C. chrysocephala* (Ach.) Th.Fr. Occasional on barks of *Picea glehnii*. Bieigawa, 683.
- 20) *Cladonia amaurocraea* (Flörke) Schaer. Common on soil and rocks. Furanodake, 249; Bieifuji, 472.

- 21) *C. arbuscula* subsp. *mitis* (Sandst.) Ruoss  
Rarely found near the Mt. Furano summit.  
Furanodake, 234.
- 22) *C. cornuta* subsp. *groenlandica* (E.Dahl)  
Ahti Common on soil and trunk base of  
*Pinus*, *Picea*, *Abies* and *Betula*. Bieifuji,  
490; Seinen, 654.
- 23) *C. crispata* (Ach.) Flot. Common on vol-  
canic ejecta and rocks. Bieidake, 397;  
Bieifuji, 487.
- 24) *C. glauca* Flörke Occasional on trunk base  
of *Betula* and *Picea*. Seinen, 653;  
Bieigawa, 687.
- 25) *C. gracilis* (L.) Willd. subsp. *turbinata*  
(Ach.) Ahti Common on soil, decayed  
woods and trunk base of *Abies*. Kare-  
sawa, 566; Seinen, 604.
- 26) *C. kanewskii* Oksner Occasional on soil  
surrounding alpine boulders. Sanpouzan,  
273; Bieifuji, 481.
- 27) *C. maxima* (Asahina) Ahti Rarely found  
on moist soil in the north-facing slope of  
Mt. Bieifuji. Karesawa, 545.
- 28) *C. metacorallifera* Asahina Common on  
soil, weathered rocks and trunk base of  
*Pinus* and *Betula*. Furanodake, 250;  
Karesawa, 526.
- 29) *C. nipponica* Asahina Rarely found at  
the east col of Mt. Furano. Sanpouzan,  
271.
- 30) *C. ochrochlora* Flörke Rarely found on  
rotten trunks of *Betula*. Seinen, 624.
- 31) *C. pleurota* (Flörke) Schaer. Occasional  
on soil and rocks. Seinen, 639.
- 32) *C. pyxidata* (L.) Hoffm. Rarely found  
near the summit of Mt. Furano. Furan-  
odake, 237.
- 33) *C. rangiferina* (L.) F.H.Wigg. subsp. *grisea*  
Ahti Locally abundant on soil at eleva-  
tions between 810 and 1340 m. Kare-  
sawa, 519 and 564.
- 34) *C. squamosa* Hoffm. Occasional on soil  
at elevations higher than 1440 m. Bieifu-  
ji, 483.
- 35) *C. submitis* A.Evans Common on soil  
and among alpine fellfield plants. San-  
pouzan, 267; Karesawa, 525.
- 36) *C. uncialis* (L.) F.H.Wigg. Occasional on  
soil among alpine boulders. Sanpouzan,  
275.
- 37) *C. vulcani* Savicz Common on volcanic  
ejecta and barks of *Picea glehnii* and *Betu-  
la*. As reported by Stenroos & Ahti (1994),  
this species has two chemo-types: 1) usnic  
and squamatic acids containing chemo-  
type and 2) usnic and thamnolic acid con-  
taining one. It is noteworthy that all speci-  
mens from the volcanic ejecta belonged to  
the former while those found on tree barks  
belonged to the latter. Kamihoro, 350;  
Karesawa, 562.
- 38) *Evernia mesomorpha* Nyl. Occasional on  
barks of *Betula*. Bieigawa, 1484.
- 39) *Flavoparmelia caperata* (L.) Hale Occa-  
sional on barks of *Betula* and *Abies*.  
Bieigawa, 1483.
- 40) *Fuscidea submollis* Mas.Inoue Common  
and abundant on rocks and volcanic lava.  
This species, one of the dominant species  
in the volcanic field, has been reported  
from mountain areas of Hokkaido and  
Honshu (Inoue, 1981). Sandanyama,  
814; Tokachidake, 1341.
- 41) *F. verruciformis* Mas.Inoue Occasional  
on barks of *Abies*. Seinen, 185.
- 42) *Glossodium japonicum* Zahlbr. Rarely  
found on decayed tree stumps. Bieigawa,  
745.
- 43) *Graphis aperiens* Müll.Arg. Occasional  
on tree barks such as *Acanthopanax*.  
Seinen, 182.
- 44) *G. scripta* (L.) Ach. Common on tree  
barks. Seinen, 593; Bieigawa, 771.
- 45) *G. tenella* Ach. Occasional on tree barks  
such as *Fraxinus*. Bieigawa, 777.
- 46) *Heterodermia hypoleuca* (Muhl.) Trevis.  
Occasional on tree barks. Bieigawa, 723.
- 47) *H. microphylla* (Kurok.) Skorepa Occa-  
sional on tree barks such as *Fraxinus*.  
Bieigawa, 715.
- 48) *Hypogymnia hokkaidensis* Kurok. Occa-  
sional on barks of *Abies sachalinensis*.

Bieigawa, 205.

- 49) *H. pseudophysodes* (Asahina) Rass. Common on conifer twigs and barks, often associated with *Parmelia squarrosa*. Karesawa, 540; Seinen, 637.
- 50) *H. pulverata* (Nyl.) Elix Occasional on barks of *Abies sachalinensis*. Seinen, 176.
- 51) *H. vittata* (Ach.) Parrique Occasional on barks of *Abies* and *Betula*. Seinen, 673; Bieigawa, 768.
- 52) *Icmadophila ericetorum* (L.) Zahlbr. Rarely found on shaded mosses. Seinen, 188.
- 53) *Imshaugia aleurites* (Ach.) S.L.F.Meyer Occasional on tree barks such as *Picea glehnii*. Karesawa, 569; Shimohoro, 1500.
- 54) *Ingvariella bispora* (Bagl.) Guderley & Lumbsch Occasional on rocks. Diagnostic characters for this species are the saxicolous habitat, the crustose thalli with areoles, the urceolate apothecia with pruinose discs, the brown ellipsoid spores with 3-septa (28–32×12–16 μm in size) and the presence of atranorin and lecanoric acid. These features coincide well with exsiccata specimens cited below.
- Although this species is widely distributed in the world, the report for Japan were made only by Lumbsch (1989) basing on a single collection from Nagasaki, Kyushu. This is the second report for this species in Japan. Collections from Prov. Izu, central Japan and one from Cheju Island, Korea are also identified as *I. bispora*.
- Sandanyama, 1179. Other specimens examined. Japan. Honshu. Prov. Izu: Matsuzaki, Kamo-gun, on rocks, elevation about 5 m, February 14, 1979, H.Kashiwadani 15015 & 15008 (TNS). Korea. Prov. Cheju: Songsan-lichubong, Sonsan-up, Namcheju-gun, Cheju Island, May 29, 2001, on rocks, elevation 80–120 m, K.H.Moon 5975 (TNS). Exsiccata examined. W.A.Weber: Lich. Exs. Colo 9 (TNS); V.Räsänen: Lich. Fenn. 986 (TNS).
- 55) *Japewia subaurifera* Muhr & Tonsberg Common on trunks of *Picea glehnii*. This species is widely distributed in the Northern Hemisphere, but it has been reported only once from Mt. Oakan, Hokkaido (Ohmura & Kashiwadani, 1997) in Japan. This is the second report of the species in Japan. Karesawa, 571 and 575.
- 56) *Lasallia pennsylvanica* (Hoffm.) Llano Occasional on rocks at elevations higher than 1610 m. Sanpouzan, 297; Bieifuji, 463.
- 57) *Lecanora andoi* H.Miyawaki Occasional on barks of *Pinus pumila*. Sanpouzan, 263.
- 58) *L. chionocarpa* Hue Occasional on tree barks such as *Fraxinus*. Bieigawa, 717 and 734.
- 59) *L. cinereofusca* H.Magn. Common on barks of deciduous trees. Seinen, 662; Bieigawa, 780.
- 60) *L. decorata* Vain. Rarely found on alpine boulders. Sanpouzan, 303.
- 61) *L. imshaugii* Brodo Occasional on barks of deciduous trees. Seinen, 647; Bieigawa, 703.
- 62) *L. intricata* (Ach.) Ach. Occasional on rocks often mixed with *Lecanora polytropa* from which it can be distinguished by the areolate thalli, pale greenish to olive-black apothecia and by the presence of zeorin. Specimens from the present area are identical with Pisut: Lich. Slov. Exs. 118 (TNS) and Lich. Polon. Merid. Exs. 67 (TNS). Bakemono, 1306.
- 63) *L. polytropa* (Hoffm.) Rabenh. Common on volcanic lava and exposed rocks near the fumarole. In the present area, this species is one of the most common crustose lichens especially in the volcanic highlands, where it is often associated with *Rhizocarpon badioatrum* and *Fuscidea submollis*. In Japan, this species has been reported from Mt. Fuji (Nylander, 1890). Specimens from the present area are iden-

- tical with Norrlin & Nylander: Herb. Lich. Fenn. 293 (TNS) and T.H.Nash: Lich. Exs., A. S. U. 317 (TNS). Tokachidake, 841; Kamihoro, 1264.
- 64) *L. yasudae* Zahlbr. Common on barks of deciduous trees. Bieigawa, 700 and 773.
- 65) *Lecidea auriculata* Th.Fr. Common on fully exposed alpine boulders. Kamihoro, 1020; Sanpouzan, 1099.
- 66) *L. brachyspora* (Th.Fr.) Nyl. Common on rocks. Bohgakudai, 1160 and 1171.
- 67) *L. lithophila* (Ach.) Ach. Occasional on alpine boulders. Sanpouzan, 1112.
- 68) *L. plana* (J.Lahm) Nyl. Common on rocks near mountain streams and snow bed. Ansei, 1247; Kumonodaira, 1326.
- 69) *L. subleucothallina* Mas.Inoue Occasional on rocks. Bakemono, 1056.
- 70) *Lecidella bullata* Korb. Occasional on rocks. This species is common in alpine zone in Hokkaido, being known from Rishiri Island, Mt Hakuun in Mts. Daisetsu and so on (Inoue, 1997). Kumonodaira, 1154; Bohgakudai, 1229.
- 71) *Leptogium azureum* (Sw.) Mont. Rarely found on barks of trees such as *Fraxinus*. Bieigawa, 721.
- 72) *L. burnetiae* C.W.Dodge Occasional on barks of trees such as *Fraxinus*. Bieigawa, 798.
- 73) *L. moluccanum* var. *myriophyllum* (Müll.Arg.) Asahina Occasional on barks of trees such as *Fraxinus*. Bieigawa, 706.
- 74) *Lichenomphalia hudsoniana* (Jennings) Redhead, Lutzoni, Moncalvo & Vilgalys Rare on soil being found at only one locality near the summit of Mt. Furano. Furano-dake, M. Inoue 7943.
- 75) *Lobaria discolor* (Bory) Hue Occasional on barks of trees such as *Salix*. Bieigawa, 794.
- 76) *L. fuscotomentosa* Yoshim. Occasional on barks of trees such as *Fraxinus*. Bieigawa, 708.
- 77) *L. isidiophora* Yoshim. Occasional on barks of trees such as *Salix*. Bieigawa, 207.
- 78) *L. japonica* f. *exsecta* (Nyl.) Yoshim. Rarely found on barks of *Fraxinus*. Bieigawa, 737.
- 79) *L. kurokawae* Yoshim. Occasional on barks of trees such as *Salix*. Bieigawa, 795.
- 80) *L. linita* (Ach.) Rabenh. Rarely found on barks of *Alnus*. Bieigawa, 763.
- 81) *L. sachalinensis* Asahina Occasional on rocks with mosses or on tree base. Bieigawa, 707 and 726.
- 82) *L. spathulata* (Inumaru) Yoshim. Occasional on barks of *Fraxinus* and *Abies*. Bieigawa, 772 and 787.
- 83) *Megalospora tuberculosa* (Fee) Sipman Rarely found on barks of *Acer*. Bieigawa, 210.
- 84) *Melanelia olivacea* (L.) Essl. Occasional on barks of *Betula*. Bieigawa, 1482.
- 85) *M. panniformis* (Nyl.) Essl. Occasional on rocks at elevations higher than 1730 m. Although this species shows circumpolar distribution in the northern hemisphere (Esslinger, 1977), it was reported only once from Mt. Mitsumine in Japan (Kashiwadani *et al.*, 1998). This is the second report for Japan and new to Hokkaido. Tokachidake, 991 and 992.
- 86) *M. stygia* (L.) Essl. Common on rocks at elevations higher than 1340 m. Sanpouzan, 315; Bieifuji, 466.
- 87) *Menegazzia terebrata* (Hoffm.) A. Massal. Common on barks of trees. According to Bjerke (2004), this species had been confused with *M. subsimilis* in Japan, but specimens from the present area are detected in this species. Bieigawa, 718 and 767.
- 88) *Miriquidica complanata* (Körb.) Hertel & Rambold Occasional on rocks. Sanpouzan, 1109.
- 89) *Mycoblastus sanguinarius* (L.) Norman Common and widely distributed on tree barks and rocks. Sanpouzan, 265; Kare-sawa, 514.



- 90) *Myelochroa entotheiochroa* (Hue) Elix & Hale Occasional on barks of *Tilia* and *Phellodendron*. Bieigawa, 1486.
- 91) *M. irrugans* (Nyl.) Elix & Hale Occasional on barks of *Fraxinus*. Bieigawa, 694 and 739.
- 92) *Nephroma resupinatum* (L.) Ach. Occasional on barks of *Fraxinus*. Bieigawa, 688 and 722.
- 93) *Nephromopsis endocrocea* Asahina Occasional on barks of *Abies*. Seinen, 675; Bieigawa, 766.
- 94) *N. ornata* (Müll.Arg.) Hue Rarely found on barks of *Alnus*. Bieigawa, 756.
- 95) *Ochrolechia parellula* (Müll.Arg.) Zahlbr. Common on rocks and alpine cushion plants at elevations higher than 1340 m. Kamihoro, 1040; Sanpouzan, 1138.
- 96) *O. tartarea* (L.) A.Massal. Rarely found on barks of *Abies*. Bieigawa, 788.
- 97) *O. trochophora* (Vain.) Oshio Common on barks of deciduous trees. Seinen, 605 and 618.
- 98) *Ophioparma lapponica* (Räsänen) Hafellner & R.W.Rogers Common on alpine boulders. Furanodake, 253; Bieidake, 393.
- 99) *Orphniospora moriopsis* (A.Massal.) D.Hawksw. Common on alpine boulders. Thallus areolate, distinctive by brownish black; apothecia black, often angular and immersed in juvenile stages; spores dark, simple or 1-septate, without halo, 12–18×8–10 μm. Norstictic acid were reported from North American arctic specimens (Thomson, 1997), while specimens from the present area contained class 7 unidentified substance. The specimens are identical with J. Poelt: *Plantae Graec.* 414 (TNS) including the lichen product mentioned above.
- In Japan, this species had firstly reported from Mt. Hiuchi summit (Kashiwadani *et al.*, 2002). This is the second report for the species in Japan. Sanpouzan, 1119; Sandanyama, 1215.
- 100) *Parmelia fertilis* Müll.Arg. Common on tree barks. Seinen, 587; Bieigawa, 742.
- 101) *P. laevior* Nyl. Rarely found on barks of *Fraxinus*. Bieigawa, 775.
- 102) *P. omphalodes* (L.) Ach. Occasional on rocks. Furanodake, 245.
- 103) *P. praesquarrosa* Kurok. Rarely found on barks of *Ulmus*. Bieigawa, 701.
- 104) *P. squarrosa* Hale Abundant on tree barks, often associated with *Hypogymnia pseudophysodes* and *Platismatia interrupta*. Karesawa, 537; Bieigawa, 736.
- 105) *Parmeliopsis hyperopta* (Ach.) Arnold Common and widely distributed on barks of *Pinus pumila*, *Picea glehnii*, *Sorbus* and *Betula*. Karesawa, 523 and 536.
- 106) *Peltigera dolichorrhiza* (Nyl.) Nyl. Rarely found on the ground covered mosses. Bieigawa, 685.
- 107) *P. horizontalis* (Huds.) Baumg. Occasional on soil. Bieigawa, 209.
- 108) *P. polydactylon* (Neck.) Hoffm. Rarely found on trunk base of *Quercus*. Bieigawa, 748.
- 109) *P. praetextata* (Sommerf.) Zopf Rarely found on trunk base of *Fraxinus*. Bieigawa, 720.
- 110) *Pertusaria commutata* Müll.Arg. Occasional on tree barks. Bieigawa, 747 and 791.
- 111) *P. composita* Zahlbr. Common on tree barks. Specimens from the present area contain protocetraric acid and succinprotocetraric acid. Seinen, 625; Bieigawa, 769.
- 112) *P. pertusa* (Weigel) Tuck. Rarely found on barks of *Fraxinus*. Specimens from the present area contain stictic acid and 4,5-dichlorolichexanthone. Bieigawa, 733.
- 113) *P. subcomposita* Oshio Occasional on barks of deciduous trees. Specimens from the present area contain fumarprotocetraric and protocetraric acids in addition to thamnolic acid. Seinen, 674.
- 114) *P. subfallens* Vain. Common on tree barks. All specimens from the present area

- contain fumarprotocetraric and protoce-traric acids as suggested by Kashiwadani *et al.* (2002). Bieigawa, 719 and 770.
- 115) *P. subobductans* Nyl. Rarely found on barks of *Fraxinus*. Specimens from the present area contain norstictic and perlatolic acids. Bieigawa, 783.
- 116) *P. violacea* Oshio Rarely found on barks of *Betula*. Specimens examined contain thamnolic acid. Seinen, 668.
- 117) *Phaeophyscia hispidula* (Ach.) Essl. Rarely found on barks of *Ulmus*. Bieigawa, 697.
- 118) *P. primaria* (Poelt) Trass Rarely found on barks of *Fraxinus*. Bieigawa, 738.
- 119) *P. pyrrophora* (Poelt) D.D.Awasthi & M.Joshi Rarely found on barks of *Fraxinus*. Bieigawa, 710.
- 120) *P. squarrosa* Kashiw. Rarely found on barks of *Fraxinus*. Bieigawa, 735.
- 121) *Physconia grumosa* Kashiw. & Poelt Occasional on tree barks such as *Fraxinus*. Bieigawa, 711 and 725.
- 122) *Pilophorus clavatus* Th.Fr. Occasional on shaded rocks. Bieifuji, 494; Karesawa, 560.
- 123) *Platismatia interrupta* W.L.Culb. & C.F.Culb. Abundant on tree barks, often associated with *Parmelia squarrosa*. Seinen, 641 and 648.
- 124) *Porpidia albocaerulescens* (Wulfen) Hertel & Knoph Rarely found on rocks located on forest floors. Bieigawa, 696.
- 125) *P. flavocaerulescens* (Hornem.) Hertel & A.J.Schwab Occasional on rocks near streams and snow bed. Bakemono, 1061 and 1302.
- 126) *P. musiva* (Körb.) Hertel & Knoph. Occasional on rocks. Sandanyama, 1178; Ansei, 1246.
- 127) *Protoparmelia badia* (Hoffm.) Hafellner Occasional on alpine boulders. This species has been reported from the mountain areas of Hokkaido and Honshu (Miyawaki, 1991). Bieidake, 927 and 951.
- 128) *Pseudephebe pubescens* (L.) M.Choisy Common on rocks at elevations higher than 1740 m. Bieidake, 370 and 432.
- 129) *Pseudopyrenula cinereoglaucescens* Vain. Occasional on barks of *Abies* and *Alnus*. Bieigawa, 754.
- 130) *Pyrenula japonica* Kurok. Occasionally found on barks of *Abies* and *Alnus*. Bieigawa, 753.
- 131) *Ramalina conduplicans* Vain. Occasionally found on barks of trees such as *Fraxinus*. Kashiwadani (1986) reported four chemical races for this species. All the specimens collected in the present area belonged to the divaricatic acid race. Bieigawa, 793.
- 132) *R. roesleri* (Schaer.) Nyl. Occasional on tree barks such as *Abies*. Specimens from the present area contain divaricatic acid. Bieigawa, 790.
- 133) *R. sinensis* Jatta Occasional on barks of trees such as *Acer*. Bieigawa, 1491.
- 134) *Rhizocarpon atrobrunnescens* (Nyl.) Zahlbr. Common on rocks. Ansei, 1088; Kumonodaira, 1322.
- 135) *R. badioatrum* (Spreng.) Th.Fr. Common and abundant on rocks and volcanic lava. This species is one of the most common species occurring in the volcanic field. Tokachidake, 1145; Sandanyama, 1186.
- 136) *R. eupetraeoides* (Nyl.) Blomb. & Forssell Common on rocks at elevations higher than 1380 m. Sanpouzan, 306; Kamihoro, 340.
- 137) *R. geographicum* (L.) DC. Common on rocks at elevations higher than 1210 m. Sanpouzan, 272; Karesawa, 532.
- 138) *R. hochstetteri* (Körb.) Vain. Occasional on rocks near mountain streams. Bakemono, 1069.
- 139) *R. lavatum* (Fr.) Hazsl. Occasional on rocks near mountain streams. Bakemono, 1068.
- 140) *R. obscuratum* (Ach.) A. Massal. Occasional on rocks near mountain streams. Bakemono, 1299.

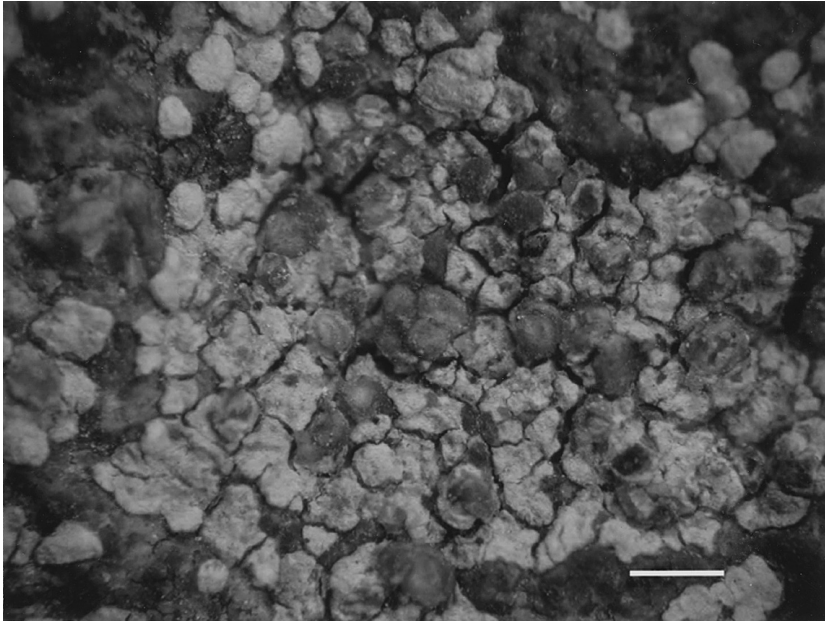


Fig. 2. *Trapelia involuta* (Taylor) Hertel, A. Shimizu 860, TNS. Scale=1 mm.

- 141) *R. vulcani* Mas.Inoue Occasional on rocks near small fumaroles. Distributed in Hokkaido to Kyushu and found near active fumaroles (Inoue, 2001). Ansei, 1198; Kumonodaira, 1329.
- 142) *Sphaerophorus fragilis* (L.) Pers. Occasional on alpine boulders. Sanpouzan, 257; Karesawa, 512.
- 143) *Stereocaulon apocalypticum* Nyl. Rarely found on alpine boulders. Sanpouzan, 294.
- 144) *S. curtatum* Nyl. Occasional on alpine boulders. Oputateshike, 164.
- 145) *S. intermedium* (Savicz) A.Magn. Occasional on rocks. Furanodake, 242.
- 146) *S. octomerellum* Müll.Arg. Occasional on wettish rocks. Karesawa, 531; Seinen, 596.
- 147) *S. pileatum* Ach. Occasional on fragmental ejecta. Tokachidake, 364.
- 148) *S. pseudodepreaultii* Asahina Occasional on exposed rocks at elevations higher than 1340 m. Sanpouzan, 302; Karesawa, 513.
- 149) *S. vesuvianum* Pers. Common on exposed rocks at elevations higher than 900 m. Sanpouzan, 270; Seinen, 597.
- 150) *Sticta nylanderiana* Zahlbr. Occasional on barks of *Fraxinus* and *Quercus*. Bieigawa, 727 and 746.
- 151) *Thamnolia subuliformis* (Ehrh.) W.L.Culb. Occasional among alpine fellfield plants. In Japan, this species occurs often mixed with *T. vermicularis* (Sato, 1963). However, no such coexistence was observed in the present area. Bieifuji, 435 and 453.
- 152) *Trapelia involuta* (Taylor) Hertel (Fig. 2) Rarely found on rocks near mountain streams. This species is widely distributed in boreal and pan-temperate zones, having been reported from British Island, Europe, North America, Indonesia and Auatralia (Allen *et al.*, 2001; Alstrup, 1993; Hertel, 1969; Purvis *et al.*, 1992). The range now includes Japan. The specimens from the present area have non-sorediate effigurate thalli which are often overlapping each other, red-brown apothecia with thick margins, colorless and simple ascospores, and produce gyrophoric acid as a chemical substance. This species resembles *T. coar-*

- tata*, but *T. coarctata* has smooth crustose thalli without overlapping areoles. Sandanyama, 860.
- 153) *Tuckermannopsis sepincola* (Ehrh.) Hale Occasional on barks of *Pinus pumila*, *Alnus* and *Sorbus*. Bieifuji, 440; Karesawa, 543.
- 154) *Umbilicaria caroliniana* Tuck. Locally abundant on exposed rocks at elevations higher than 1340 m. Sanpouzan, 300; Karesawa, 507.
- 155) *U. cylindrica* (L.) Delise ex Duby Common and widely distributed on rocks at elevations higher than 1610 m. Sanpouzan, 280; Bieidake, 428.
- 156) *U. exasperata* Hoffm. Occasional on exposed rocks at elevations higher than 1350 m. Sanpouzan, 313; Kamihoro, 330.
- 157) *U. torrefacta* (Lightf.) Schrad. Common on rocks at elevations higher than 1340 m. Bieidake, 369; Bieifuji, 495.
- 158) *Vulpicida juniperina* (L.) J.E.Mattsson & M.J.Lai Abundant and widely distributed on twigs and barks of *Pinus pumila*, often associated with *Parmeliopsis hyperopta*. Bieifuji, 475; Karesawa, 549.
- 159) *Vulpicida pinastri* (Scop.) J.E.Mattsson & M.J.Lai Rarely found on barks of *Pinus pumila*. Furanodake, 239.

### Ecological Notes

As members of the lichen flora of Mt. Tokachi and the adjacent areas, 159 lichen taxa belonging to 69 genera are recognized. Most of them are common in alpine and subalpine regions in Hokkaido and higher altitudes in northern and central Japan, *Trapelia involuta* is newly recorded from Japan. The occurrences of the following species in the present area are second records for them in Japan. They are *Acarospora smaragdula*, *Ingvariella bispora*, *Japewia subaurifera*, *Melanelia panniformis* and *Orphniospora moriopsis*.

Saxicolous macro-lichens such as *Arc-*

*toparmelia incurva*, *Asahinea chrysantha*, *Parmelia omphalodes*, *Sphaerophorus fragilis* etc. are found on alpine boulders as in other alpine areas in Japan. However, they are hardly distributed near the active fumarole of Mt. Tokachi. This should be due to the following: 1) on volcanic alpine grounds, soil erosion and soil-fluaction of volcanic ejecta prevent these saxicolous foliose or filamentose lichens from thriving on rocks, and/or 2) acidic environments affect the occurrence of these lichen species. It is also noteworthy that species of *Thamnolia* and *Ramalina* are rather rare, and *Anzia* and *Usnea* are thoroughly absent in this area. This seems to be caused by the fact that 1) deciduous forests are poorly developed in this area, and/or 2) they are particularly sensitive to volcanic gasses.

### Phytogeographical Notes

In regard to the phytogeography, several distribution patterns are recognized for the lichen taxa found in the present area. Consulting with Galloway (1996) and Moon (1999), the following phytogeographical groups can be recognized: 1) arctic-alpine group, 2) circumboreal group, 3) Beringian group, 4) eastern Asia - North America disjunctive group, 5) pan-temperate group and 6) Far-Eastern group.

1) Arctic-alpine group is developed in the arctic or alpine regions of the Northern Hemisphere including North America, Europe and Asia. Thirty-five lichen species (22% of the whole) in the present area are considered as belonging to this group. A great number of the saxicolous crustose species such as *Calvitimela aglaea*, *Lecidea brachyspora*, *L. lithophila*, *Lecidella bullata*, *Protoparmelia badia*, *Rhizocarpon badioatrum* and *R. eupetraeoides* belong to this group and seemed to be characteristic on acid rocks. Lichens such as *Cladonia arbuscula* subsp. *mitis*, *Lecidea auriculata*, *Peltigera horizontalis*, *Pseudephebe pubescens* and *Umbilicaria cylindrica* are known also from arctic alpine zones in the Southern Hemispheres and have been treated as bipolar taxa.

2) Lichens widely distributed in boreal regions in the Northern Hemisphere are treated as a circumboreal group. About a quarter of species (38 species, 24%) are considered as belonging to the group. They include *Amygdalaria pelobotryon*, *Aspicilia cinerea*, *Caloplaca flavovirescens*, *Chaenotheca chrysocephala*, *Cladonia cornuta*, *C. glauca*, *Imshaugia aleurites*, *Japewia subaurifera*, *Lecanora polytropa*, *Parmeliopsis hyperopta*, *Tuckermannopsis sepincola* and *Vulpicida juniperina*. Among them, *Chaenotheca chrysocephala*, *Cladonia cornuta*, *Imshaugia aleurites* and *Lecanora polytropa* are also distributed in boreal regions in the Southern Hemispheres.

3) Species of the Beringian group (6 species, 4%) are distributed around Beringian areas in the North Pacific. Species such as *Asahinea chrysantha*, *Cetraria laevigata*, *Stereocaulon apocalypticum* and *S. intermedium* belong here.

4) Eastern Asia-North America disjunctive group (8 species, 5%) is disjunctively distributed in both the areas. It includes *Cladonia submitis*, *Heterodermia hypoleuca*, *Lasallia pennsylvanica* and *Pilophorus clavatus*.

5) Species of the pan-temperate group (29 species, 18%) are widely distributed in temperate regions including mountain areas in the tropics. In the present area, *Candelaria concolor*, *Flavoparmelia caperata*, *Melanelia olivacea*, *Menegazzia terebrata* and *Stereocaulon octomerellum* are found.

6) Species of the Far-Eastern group (43 species, 27%) are endemic to the Far-Eastern areas spreading Taiwan, Korea, Sakhalin and China. They include *Anaptychia isidiza*, *Graphis aperiens*, *Hypogymnia pseudophysodes*, *Lobaria spathulata*, *Nephromopsis ornata*, *Ochrolechia parellura*, *O. trochophora*, *Parmelia laevior*, *P. praesquarrosa*, *Pertusaria commutata*, *P. composita*, *Platismatia interrupta*, *Pseudopyrenula cinereoglaucescens*, *Ramalina conduplicans*, *Stereocaulon curtatum*, *S. pseudodepreaultii* and *Sticta nylanderiana*.

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