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Distribution Patterns of Japanese Lecideoid Lichens Occurring in Subalpine or Alpine Regions, with Special Reference to the Taxa Being Distributed in Both Japan and Svalbard

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Abstract

The distribution patterns of Japanese lecideoid lichens occurring in subalpine or alpine regions are previewed. The species which are distributed in both Japan and Svalbard are enumerated. It is evident that many lecidoid lichens occupy the major taxa of subalpine or alpine lichen flora in Japan. The distribution patterns are divided into 11 categories. More than a half representatives of Japanese lecideoid lichens are a member of the circumpolar or bipolar elements and comprise many same species as those in Svalbard.

Key words: lecideoid lichens, distribution pattern, arctic-alpine, bipolar, Japan, Svalbard

Introduction

The lecideoid lichens are distinguished from other lichens by its crustose to effigurate or squamulose thallus containing protococcoid algae, lecideine or biatorine sessile apothecia and mostly colorless simple spores which are small- to medium-sized. Most of the lichen forming fungi including the plant taxa, which are occurring in subalpine or alpine regions of Japan, are regarded as a member of boreal or arctic-alpine elements. The Japanese lecideoid lichens, in particular, such as *Amygdalaria, Calvitimela, Carbonea, Immersaria, Lecidea, Lecidoma, Tremolecia*, etc. are known to occur mainly in higher elevations in central and / or northern Japan (Inoue, 1994).

The lecideoid lichen flora of many parts of the world is still poorly known. But in recent years the important series of papers, notably by Alstrup et al. (2000), Andreev (2004), Castello & Nimis (1995), Elvebakk & Hertel (1997), Hertel (1977, 1981, 1987, 1991, 2001, etc.), Inoue (1991), Inoue et al. (2007), Øvstedal & Smith (2001), Rambold (1989), Thomson (1997), and Upreti (1996) have reported them from arctic-alpine or antarctic regions. The lecideoid lichen flora of the regions are not so vague.

From 14th to 19th of August in 2000, we carried out a lichenological survey in Ny-Ålesund (78°54'N; 11°52'E; the highest elevation where we reached was the summit of Mt. Zeppelinfjelle (560 meters above sea level) of Spitzbergen, Svalbard Isls., and we collected many lecideoid lichens including the same species as those in Japan.

Our objective is to present the geography of lecideoid lichens occurring in subalpine or alpine regions of Japan, especially the taxa being distributed in both Japan and Svalbard, and to consider the taxonomic implications.

There are three main bioclimatic zones in the Japanese archipelago, extending for nearly 3400 km in a south-west to north-east direction and lying between lat. 20°25'N and 45°33'N; warm temperate-subtropical, temperate, and boreal or subarctic (subalpine or alpine) zones. The Japanese archipelago, which is said to be separated from the continent about 15 millions years ago, has a complicated geographical history. In this respect, it is noteworthy that there are numerous volcanoes as well as non volcanic mountains which are considered as folded ones and / or made up of calcareous rocks or serpentines.

From the altitudinal viewpoints, higher mountains, which reach 3000 m above sea level or over, are concentrated in central Japan. The top elevation is Mt. Fuji (3776 m a.s.l.). On the contrary the top elevation 2290 m a.s.l. is the highest one in the Hokkaido district, 2346 m a.s.l. in the Tohoku district, and 1981 m a.s.l. in south-western Japan.

Materials and methods

Japanese specimens used in this study have been collected mainly by the senior author throughout Japan since 1972 (Fig. 1). Beside the present collections from Ny-Ålesund, the list reported by Elvebakk & Hertel (1997) are adopted. Except the monographic works, the

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following representative papers are employed for obtaining the informations concerning the world distribution of each lichens; Andreev et al. (1996), Brodo (1995), Degelius (1982), Filson (1996), Gowan & Brodo (1988), Hansen (2002), Llimona & Hladun (2001), Nimis & Poelt (1987), Purvis et al. (1992), Santesson (1993), Vězda & Liska (1999), Wong & Brodo (1992) and Thurbenko et al. (2006).

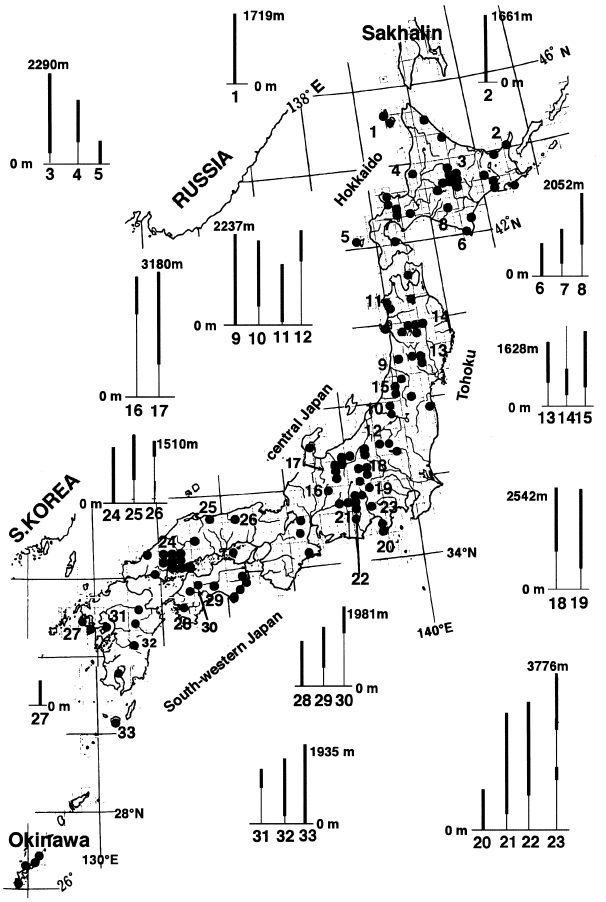

Fig.1. Map showing the major localities (1-33) investigated. Vertical lines indicate altitude of each locality, and the actual investigated dimension in each locality is shown as a wider line. After Inoue (1994) with slight modification.

1, Rishiri- & Rebun Isl.; 2, Shiretoko Pen.; 3, Mts. Daisetsu; 4, Mt. Shokanbetsu; 5, Okujiri Isl.; 6, Mt. Apoi (Mts. Hidaka); 7, aroud Sapporo; 8, Mt. Poroshiri (Mts. Hidaka); 9, Mt. Chokai; 10, Mt. Iide; 11, Mts. Shirakami; 12, Mt. Hiuchi & Mt. Shibutsu; 13, Mts. Kurikoma; 14, Mt. Iwate; 15, Mts. Asahi; 16, Mt. Ontake; 17, Mts. Hida; 18, Mts. Asama; 19, Mts. Kanto; 20, Idzu Pen.; 21, Mts. Kiso; 22, Mts. Akaishi; 23, Mt. Fuji; 24, around Hiroshima; 25, Mt. Daisen; 26, Mt. Hyonosen; 27, around Nagasaki; 28, Mt. Onigajou; 29, Mt. Shiraga; 30, Mts. Ishizuchi; 31, Mt. Unzen; 32, Mt. Ichifusa; 33, Yakushima Isl.

The Japanese specimens are preserved in the herbarium of Akita University and in the National Science Museum, Tokyo (**TNS**), and those from Spitzbergen are preserved in the herbarium of the National Institute for Polar Research (**NIPR**).

Results and Discussion

1. Lecideoid lichens occurring in subalpine or alpine regions of Japan including those in Svalbard.

Lecideoid lichens hitherto known from subalpine or alpine regions of Japan including those occurring in both Svalbard and Japan are shown in Table 1. And the lecideoid genera with the number of species occuring in subalpine or alpine regions of Japan and Svalbard are summarized in Table 2.

Table1. List of taxa present in subalpine or alpine regions of Japan. Taxa occurring in both Japan and Svalbard are represent by boldface, and those not known from Svalbard by lightface

1 . ***Adelolecia pilati*** **(Hepp) Hertel & Hafellner**
2 . *Ainoa mooreana* (Carrol) Lumbsch & I. Schimitt
3 . *Amygdalaria aeolotera* (Vain.) Brodo & Hertel, ***A. consentiens*** **(Nyl.) Hertel, Brodo & Mas.Inoue var.** ***consentiens****, A. consentiens* var. *japonica* Mas.Inoue, *A. elegantior* (H.Magn.) Brodo & Hertel, ***A. panaeola*** **(Ach.) Brodo & Hertel**, *A. pelobotryon* (Wahlenb. in Ach.) Norman, *A. subdissentiens* (Nyl.) Mas.Inoue & Brodo
4 . ***Arthrorhaphis citrinella*** **(Ach.) Poelt**
5 . Biatora *helvola* Körb. ex Hellb., *B. vernalis* (L.) Fr.
6 . ***Bilimbia lobulata*** **(Sommerf.) Hafellner & Coppins**
7 . ***Bryonora castanea*** **(Hepp) Poelt**
8 . ***Calvitimela aglaea*** **(Sommerf.) Hafellner,** ***C. armeniaca*** **(DC.) Hertel & Rambold**
9 . ***Carbonea atronivea*** **(Arnold) Hertel,** ***C. vorticosa*** **(Flörke) Hertel**
10. ***Cecidonia umbonella*** **(Nyl.) Triebel & Rambold**
11. *Clauzadeana macula* (Tayl.) Coppins & Rambold
12. ***Farnoldia jurana*** **(Schaer.) Hertel**
13. *Fuscidea austera* (Nyl.) P. James, *F. circumflexa* (Nyl.) V.Wirth & Vězda, *F. intercincta* (Nyl.) Poelt, *F. lygaea* (Ach.) V.Wirth & Vězda, *F. mollis* (Wahlenb.) V.Wirth & Vězda, *F. submollis* Mas.Inoue, *F. verruciformis* Mas.Inoue
14. *Helocarpon crassipes* Th. Fr.
15. *Hypocenomyce friesii* (Ach.) P.James & G.Schneider
16. *Immersaria athroocarpa* (Ach.) Rambold & Pietschmann
17. ***Japewia tørnoensis*** **(Nyl.) Tønsberg**
18. *Lecidea advena* Nyl., ***L. atrobrunnea*** **(Ram. ex Lam. & DC.) Schaerer,** ***L. auriculata*** **Th.Fr**., *L. brachyspora* (Th.Fr.) Nyl, *L. diducens* Nyl., ***L. lactea*** **Floerke ex Schaerer,** ***L. lapicida*** **(Ach.) Ach**., *L. lithophila* (Ach.) Ach., *L.* ***plana*** **(Lahm) Nyl**., *L.subleucothallina* Mas.Inoue, *L. subpaupercula* Mas.Inoue, ***L. syncarpa*** **Zahlbr**., ***L. tesselata*** **var.** ***caesia*** **(Anzi) Arnold**
19. *Lecidea* (s. lato) *albofuscescens* Nyl., ***L. limosa*** **Ach**., *L. marginata* Schaerer, *L. ocelliformis* Nyl., *L. phaeops* Nyl.
20. *Lecidella asema* (Nyl.) Knoph & Hertel, ***L. bullata*** **Körber**, *L. carpathica* Körber, ***L. euphorea*** **(Flörke) Hertel**
21. ***Lecidoma demissum*** **(Rutstr.) G.Schneider**
22. ***Miriquidica complanata*** **(Körber) Hertel & Rambold**
23. ***Mycobilimbia berengeriana*** **(Massal.) Hafellner & V.Wirth,** ***M. hypnorum*** **(Lib.) Kalb & Hafellner**

24. ***Orphniospora moriopsis* (A.Massal.) D.Hawksw.**
25. ***Placynthiella icmalea* (Ach.) Copppins & P.James, *P. uliginosa* (Schrad.) Coppins & P.James**
26. ***Porpidia cinereoatra* (Ach.) Hertel & Leuckert, *P. crustulata* (Ach.) Hertel & Knoph, *P. flavocaerulescens* (Hornem.) Hertel & A.J.Schwab., *P. macrocarpa* (DC.) Hertel & A.J.Schwab**, *P. musiva* (Körber) Hertel & Knoph, *P. nigrocruenta* (Anzi) ad int., *P. percontigua* (Nyl.) ad int., ***P. speirea* (Ach.) Krempelh**., ***P. tuberculosa* (Sm.) Hertel & Knoph**
27. ***Psora rubiformis* (Ach.) Hooker**, *P. testacea* Hoffm.
28. *Pyrrhospora elabens* (Fr.) Hafellner
29. *Ropalospora lugubris* (Sommerf.) Poelt
30. *Trapelia coarctata* (Sm. & Sow.) Choisy,
31. *Trapeliopsis granulosa* (Hoffm.) Lumbsch
32. ***Tremolecia atrata* (Ach.) Hertel**

Table2. Japanese lecideoid genera occurring in subalpine or alpine regions, and the number of species distributing in both Svalbard and Japan. Figures in parentheses show the number of species which are known to occur in Japan with the representative literature.

1. ***Adelolecia* Hertel & Hafellner**: 1 sp (1 sp.; Kashiwadani et al. 2002).
2. ***Ainoa* Lumbsch & I. Schmitt**: deficient. (1 sp.; under *Trapelia*, Inoue 1997a, Kashiwadani et al.2002)
3. ***Amygdalaria* Norman**: 2 spp. (6 spp. & 1 var.; Inoue 1984, Brodo & Hertel 1987, Shimizu et al. 2004, Inoue et al. 2007)
4. ***Arthrorhaphis* Th.Fr.:** 1 sp. (1 sp.: Inoue 1997, Kashiwadani et al. 2002, Inoue et al. 2007)
5. ***Biatora* Fr. s.str**.: deficient. (2 spp.; Inoue & Moon 1995, Inoue et al 2007)
6. ***Bilimbia* De Not**.: 1 sp. (1 sp.; Inoue et al. 2007)
7. ***Bryonora* Poelt**: 1 sp. (1 sp.; Inoue et al 2007)
8. ***Calvitimela* Hafellner**: 2 spp. (2 spp.; Inoue 1988a, Shimizu et al. 2004, Kashiwadani et al. 2002, Inoue et al. 2007).
9. ***Carbonea* (Hertel) Hertel**: 2 sp. (2 sp.; Inoue & Moon 1995, Kashiwadani et al. 2002, Inoue et al. 2007).
10. ***Cecidonia* Triebel & Rambold**: 1 sp. (1 sp.; Inoue 1997a)
11. ***Clauzadeana* Hafellner & Bellem**. : deficient (1 sp.; Inoue 1982 as *Lecidea instratula*, Inoue et al. 2007).
12. ***Farnoldia* Hertel** : 1 sp. (1 sp.; Kashiwadani et al. 2002, Inoue et al. 2007).
13. ***Fuscidea* Wirth & Vězda**: deficient (7 spp.; Inoue 1981, Inoue & Moon1998, Kashiwadani et al. 2002, Shimizu et al. 2004, Inoue et al. 2007).
14. ***Helocarpon* Th.Fr**.: deficient (1 sp.; Inoue 1988a, Inoue et al. 2007)
15. ***Hypocenomyce* Choisy**: deficient (1 sp.; Inoue 1988)
16. ***Immersaria* Rambold & Pietschmann**: deficient (1 sp.; Inoue 1982, under *Lecidea*)
17. ***Japewia Tonsberg***: 1 sp. (1 sp.; Nyl. 1890)
18. ***Lecidea* Ach**.: 7 spp. (13 spp.; Inoue 1982, Inoue et al. 2007)
19. ***Lecidea* (s. lato)**: 1 sp. (5 spp.; Inoue 1988, Inoue et al. 2007)
20. ***Lecidella* Körb**.: 2 spp. (4 spp.; Inoue 1997b & 2000, Kashiwadani et al. 2002)
21. ***Lecidoma* G.Schneider**: 1 sp. (1sp.; Inoue 1988, Inoue et al. 2007)
22. ***Miriquidica* Hertel & Rambold**: 1 sp. (1 sp.; Shimizu et al. 2004)
23. ***Mycobilimbia* Rehm**: 2 spp. (2 spp; Inoue & Moon 1998, Inoue et al. 2007)
24. ***Orphniospora* Körb**.: 1 sp. (1 sp.; Kashiwadani et al. 2002, Shimizu et al. 2004, Inoue et al. 2007).
25. ***Placynthiella* Elenkin**: 2 spp. (2 spp.; Inoue & Moon 1995, Kashiwadani et al. 2000 & 2002)
26. ***Porpidia* Körb**.: 6 spp. (9 spp.; Inoue 1983 & 1988, under *Huilia*; Inoue et al. 2007)
27. ***Psora* Hoffm**.: 1 sp. (2 sp.; Inoue 1988a & 1994, under *Chrysopsora*)
28. ***Pyrrhospora* Körb**.: deficient (1sp.; Inoue 1982, under *Lecidea*)
29. ***Ropalospora* A.Massal**.: deficient (1 sp.; Inoue et al. 2007)
30. ***Trapelia* Choisy**: deficient (1 sp.; Kashiwadani et al. 2002)
31. ***Trapeliopsis* Hertel & G.Schneider**: deficient (1 sp.; Inoue et al. 2007)
32. ***Tremolecia* Choisy**: 1 sp. (1 sp.; Inoue1997a, Kashiwadani et al. 2002, Inoue et al. 2007)

The Japanese lecideoid taxa known to occur are 77 species in 31 genera. Thirty-seven species in 20 genera are distributed in both Svalbard and Japan, in which *Amygdalaria consentiens, A. panaeola, Lecidea auriculata, L. lactea, L. lapicida, L. plana, Lecidella bullata, Lecidoma demissum, Porpidia crustulata, P. flavocaerulescens, P. macrocarpa, Calvitimela aglaea, C. armeniaca,* and *Tremolecia atrata* are common lichens in subalpine or alpine regions of Japan.

The genera *Lecidea* and *Porpidia* comprise dominant species which occur in both Japan and Svalbard. It is evident that many lecideoid lichens occupy the major taxa of subalpine or alpine lichen flora in Japan. On the contrary, it is noteworthy that non of the species belonging to *Fuscidea* are not known in Svalbard. Indeed Thomson (1997) enumerated 4 species under *Fuscidea* from American arctic regions including Greenland and Iceland; *F. cyathoides, F. lowensis, F. mollis,* and *F. recensa*. But non of the Japanese subalpine or alpine species of the genus do not occur in Svalbard. Similarly *Immersaria athroocarpa* is hitherto not known from Svalbard and Greenland in spite of being rather common in boreal or arctic regions including subalpine or alpine regions of Japan, especially in central Japan (Fig. 2). We do not have any idea why the reason, however, this may have important taxonomic or geographical implications. Actually Hertel (2001) reported *I. athroocarpa* from several localities in North America, but this species might be rather rare in North America judging from being not enumerated by Thomson (1997) in his remarkable conspectus work dealing American Arctic lichens.

Among the species, which occur in both Japan and Svalbard, *Bilimbia lobulata, Cecidonia umbonella,*

Lecidea atrobrunnea, L. tessellata var. *caesia, Mycobilimbia hypnorum, Porpidia speirea* and *Psora rubiformis* are known from only one or two localities in Japan. In addition, it is interesting that 6 of the seven species are known from summit areas of Akaishi Mts. in central Japan; *Bilimbia lobulata & Mycobilimbia hypnorum* (Tekariiwa Rock of Mt. Tekari, 2550 m a.s.l., over soil or humus associated with limestone), *Cecidonia umbonella* (Mt. Ainotake, 3150 m a.s.l., on the thallus of *Lecidea lactea* on non-calcareous rocks), *Lecidea atrobrunnea* (Mt. Kitadake, 3180 m a.s.l. & Mt. Hijiri, 3010 m a.s.l, on non-calcareous rocks), *Lecidea tessellata* var. *caesia* (Mt. Kitadake, 3040 m a.s.l., on calcareous rocks), and *Porpidia speirea* (Mt. Ainotake, 3080m a.s.l., on non-calcareous rocks). And it is noteworthy that they are growing on so-called folded mountains in central Japan, which are geologically rather rare in Japan as pointed out by Inoue (1994). *Psora rubiformis* is known from Mt. Tengu (1000 m a.s.l.; 1120 m a.s.l., on sandy soil) near Sapporo in Hokkaido. From a phytogeographical viewpoint, it should be noted that each of these lichens is extremely rare in Japan, but are rather common in boreal or arctic regions as mentioned bellow. These species seems to be growing in Japan from older ages, and the range might have been contracted by the climatic or geohistoric changes..

2. Distribution patterns within Japan and in the world

Distribution patterns of lecideoid lichens growing in subalpine or alpine regions of Japan are grouped as follows. Taxa occurring in both Japan and Svalbard are represented by boldface and those not known from Svalbard or endemic species of Japan are by lightface as in Table 1.

A. Circumpolar arctic-alpine species (Thomson, 1997)

Adelolecia pilati, Amygdalaria consentiens* var. *consentiens, *A. elegantior,* ***A. panaeola***, *A. pelobotryon,* ***Arthrorhaphis citrinella,*** *Biatora vernalis,* ***Calvitimela aglaea***, ***Carbonea atronivea, Cecidonia umbonella***, ***Farnoldia jurana***, *Fuscidea mollis, Helocarpon crassipes,* ***Japewia tørnoensis***, *Lecidea brachyspora,* ***L. limosa***, *L. lithophila,* ***L. syncarpa, L. tesselata* var. *caesia*, *Lecidoma demissum, Orphniospora moriopsis, Psora rubiformis***

B. Circumpolar low arctic and boreal species (Thomson, 1997)

Biatora helvola, Hypocenomyce friesii, ***Mycobilimbia berengeriana***, ***Lecidella bullata, L. euphorea***, ***Porpidia tuberculosa***

C. Circumpolar, extend to Australia and New Zealand species

Ainoa mooreana, ***Calvitimela armeniaca*** *Clauzadeana macula,* ***Lecidea lactea, L. plana***, ***Miriquidica complanata, Placynthiella icmalea, P. uliginosa, Porpidia flavocaerulescens, P. macrocarpa, P. speirea,*** *Ropalospora lugubris*

D. Bipolar, arctic-alpine species

Bilimbia lobulata, Bryonora castanea, Carbonea vorticosa, *Immersaria athroocarpa,* ***Lecidea atrobrunnea, L. auriculata,*** *L. diducens,* ***L. lapicida***, *Lecidea (s. lato) marginata, Lecidella carpathica,* ***Mycobilimbia hypnorum, Porpidia cinereoatra, P. crustulata***, *Trapeliopsis granulosa,* ***Tremolecia atrata***

E. Species which are primarily temperate but which reach into the Arctic and subantarctic regions (cosmopolitan?)

Trapelia coarctata

F. Disjunct eastern Asia (incl. Japan), North America and Europe species

(Occurrences in other areas might be not yet well known.) *Fuscidea intercincta, Lecidea (s. lato) albofuscescens, Lecidea (s. lato) phaeops, Lecidella asema, Pyrrhospora elabens*

G. Disjunct Japan (or incl. eastern Asia) and Europe species

(Occurrences in other areas might be not yet well known, and those in eastern Asia are highly expected). *Fuscidea austera, F. lygaea, Lecidea (s. lato) ocelliformis, Porpidia musiva, P. nigrocruenta, P. percontigua, Psora testacea*

H. Amphi-Beringian species

(Occurrences in other areas might be not yet well known.) *Amygdalaria subdissentiens, Fuscidea circumflexa*

I. Species which occur in eastern Asia

Lecidea advena

J. Species which occur in alpine region of east - south-east Asia and in Papua New Guinea

Amygdalaria aeolotera

K. Species which hitherto known to occur only in Japan

Amygdalaria consentiens var. japonica, Fuscidea submollis, F. verruciformis, Lecidea subleucothallina, L. subpaupercula

The distribution of each species within Japan and those in the world, which are grouped above, are shown in Table 3.

Twenty-eight species (36%) belong to the circumpolar arctic-alpine / or low arctic and boreal element. Twelve species (16%) are circumpolar, but extend to Australia and New Zealand. More than a half representatives of Japanese lecideoid lichens which are distributed in subalpine or alpine regions are a member of the circumpolar element. And 15 species (19 %) are of

Table3. Distribution of taxa present in subalpine or alpine regions of Japan. H: Hokkaido district, T: Tohoku district, C: Central Japan, S: Southwestern Japan including Kinki-, Chugoku-, Shikoku-, and Kyushu district. (◎: known from 5 localities or more, ○: known from less than 5 localities)

Species	District				Distribution pattern*
	H	T	C	S	
Calvitimella aglaea	◎	○	◎	○	A
Porpidia flavocaerulescens	◎	◎	◎	○	C
Porpidia macrocarpa	◎	◎	◎	○	C
Placynthiella uliginosa	○	○	○	○	C
Trapelia coarctata	◎	◎	◎	◎	E
Lecidella asema	○	○	○	○	F
Porpidia nigrocruenta	◎	◎	◎	○	G
(Lecidea) ocelliformis	◎	◎	○	◎	G
Amygdalaria consentiens var. *japonica*	○	◎	◎	○	K
Amygdalaria consentiens var. *consentiens*	◎	○	○	·	A
Lecidea lithophila	◎	◎	◎	·	A
Lecidea brachyspora	○	◎	◎	·	A
Fuscidea mollis	○	○	◎	·	A
Helocarpon crassipes	○	○	◎	·	A
Lecidella bullata	◎	○	◎	·	B
Lecidella euphorea	○	○	○	·	B
Lecidea plana	◎	○	◎	·	C
Lecidea lactea	○	○	◎	·	C
Lecidea auriculata	◎	○	◎	·	D
Porpidia crustulata	◎	○	◎	·	D
Carbonea vorticosa	○	○	◎	·	D
Immersaria athroocarpa	◎	○	◎	·	D
(Lecidea) albofuscescens	◎	○	◎	·	F
(Lecidea) phaeops	○	○	○	·	F
Fuscidea austera	○	○	○	·	G
Porpidia musiva	○	○	○	·	G
Porpidia percontigua	○	○	○	·	G
Fuscidea circumflexa	○	○	◎	·	H
Lecidea advena	◎	○	◎	·	I
Amygdalaria aeolotera	○	◎	◎	·	J
Fuscidea submollis	◎	○	◎	·	K
Amygdalaria panaeola	○	·	◎	·	A
Amygdalaria elegantior	○	·	◎	·	A
Amygdalaria pelobotryon	○	·	◎	·	A
Lecidella carpathica	○	·	◎	·	D
Clauzaeanadeana macula	○	·	◎	·	C
Lecidea lapicida	○	·	◎	·	D
Tremolecia atrata	○	·	◎	·	D
(Lecidea) marginata	○	·	◎	·	D
Lecidea subleucothallina	◎	·	◎	·	K
Lecidoma demissum	◎	·	◎	·	A
Orphniospora moriopsis	◎	·	◎	·	A
Psora rubiformis	○	·	·	·	A
Miriquidica complanata	○	·	·	·	C
Fuscidea verruciformis	·	◎	◎	·	K
Ainoa mooreana	·	◎	◎	·	C
Arthrorhaphis citrinella	·	◎	○	·	A
Amygdalaria subdissentiens	·	○	◎	·	H
Porpidia tuberculosa	·	○	○	·	B
Fuscidea intercincta	·	○	○	·	F
Hypocenomyce friesii	·	○	·	·	B
Psora testacea	·	○	·	·	G
Adelolecia pilati	·	·	○	·	A
Bilimbia lobulata	·	·	○	·	D
Bryonora castanea	·	·	○	·	D
Farnoldia jurana	·	·	○	·	A
Fuscidea lygaea	·	·	○	·	G
Lecidea syncarpa	·	·	○	·	A
Lecidea limosa	·	·	○	·	A
Mycobilimbia hypnorum	·	·	○	·	D
Carbonea atronivea	·	·	○	·	A
Cecidonia umbonella	·	·	○	·	A
Lecidea tesselata var. *caesia*	·	·	○	·	A
Lecidea diducens	·	·	◎	·	D
Calvitimela armeniaca	·	·	◎	·	C
Lecidea atrobrunnea	·	·	○	·	D
Porpidia speirea	·	·	○	·	C
Porpidia cinereoatra	·	·	○	·	D
Ropalospora lugubris	·	·	○	·	C
Trapeliopsis granulosa	·	·	○	·	D
Pyrrhospora elabens	·	○	◎	○	F
Lecidea subpaupercula	·	·	◎	○	K

* A-K: distribution patterns which are coincident with the text

The range of the following species is not yet well known: *Biatora helvola*, *B. vernalis, Japewia tørnoensis, Mycobilimbia berengeriana, Placynthiella icmalea*.

bipolar, arctic-alpine element.

It is noteworthy that thirteen species (59 %) of 22 ones, which are distributed in Hokkaido, Tohoku and central Japan (Fig. 3), are the member of circumpolar or bipolar elements. Similarly ten species (91 %) of 11 ones, which are distributed in Hokkaido and central Japan (Fig. 4), are of the same element. Seventeen species (94 %) of 18 ones, which are known only from central Japan (Fig. 5), are also of the same element. As is shown in Table 3 seven of eight species which are distributed only in Tohoku district or both in Tohoku district and central Japan (Fig. 6) comprise the species occurring in both Japan and Svalbard. The reason why the ratio of circumpolar or bipolar lecideoid lichens in central Japan and in Hokkaido is higher than those in other districts seems to be the consentration of the mountains, which are geologically older and higher elevations reaching 3000 m above sea level or over, or to be situated on northern Japan.

Four species (36 %) of 11 ones, of which distribu-

tion are extended to south-western Japan (Fig. 7, 8), are the circumpolar element, and it is interesting that these three species are also distributed in Svalbard, and that other four are disjunctive, two are the endemic to Japan, and the rest one appears to be a cosmopolitan (Table 3). These species including above mentioned four species, which occur in both Japan and Svalbard, are rather common in Japan (Fig. 9), accordingly they may have a wider ecological amplitude.

Seventeen species (94 %) of 18 ones, which are known only from central Japan, are the peculiar species which show circumpolar or bipolar as well as extending to Australia and New Zealand distribution. I do not have any idea why the distribution of this kind of widely distributed species is restricted to central Japan, but this may have important geographical implications.

Six species and one variety of *Amygdalaria* are known to occur in subalpine or alpine regions of Japan. It is interesting that the genus comprises 4 taxa of circumpolar arctic-alpine element and 3 miscellaneous ones, which are *A. subdissentiens* (Fig. 6; Amphi-Behringian element), *A. aeolotera* (east-southeast Asia and in Papua New Guinea distribution) and *A. consentiens* var. *japonica* (endemic to Japan). The latter three taxa appears to be derived from a species of circumpolar arctic-alpine elements.

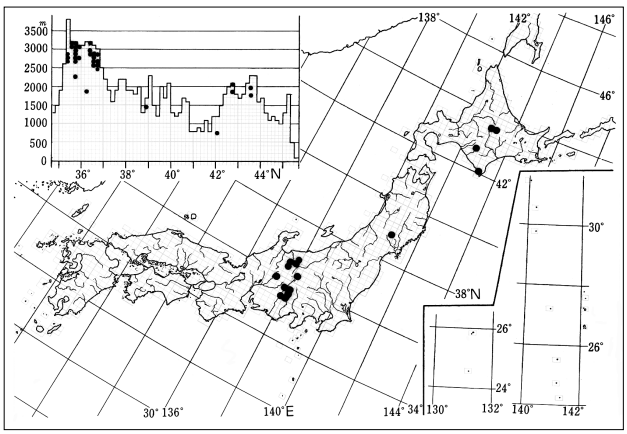

Fig.2. Distribution of *Immersaria athroocarpa* in Japan (Inoue 1982)

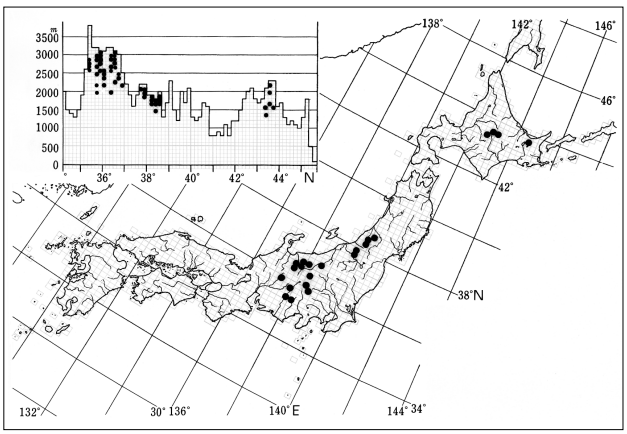

Fig.3. Distribution of *Lecidea lithophila* in Japan

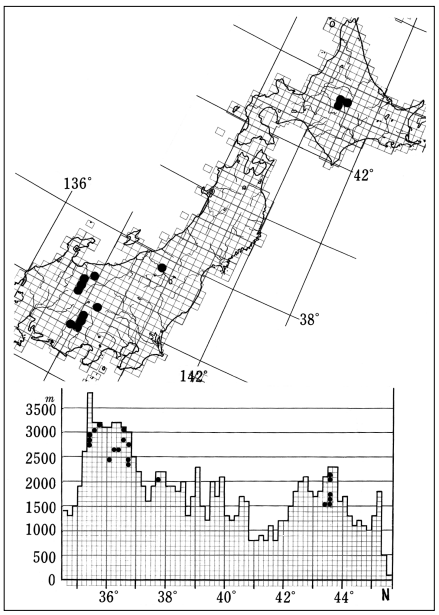

Fig.4. Distribution of *Lecidoma demissum* in Japan

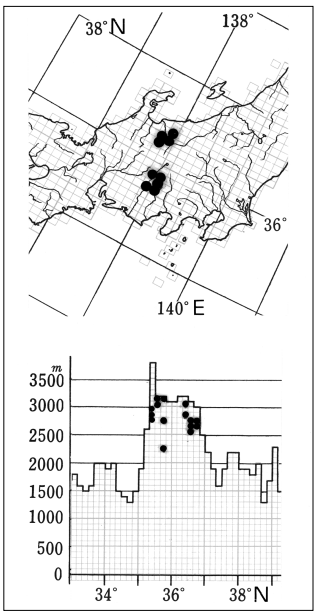

Fig.5. Distribution of *Calvitimela armeniaca* in Japan

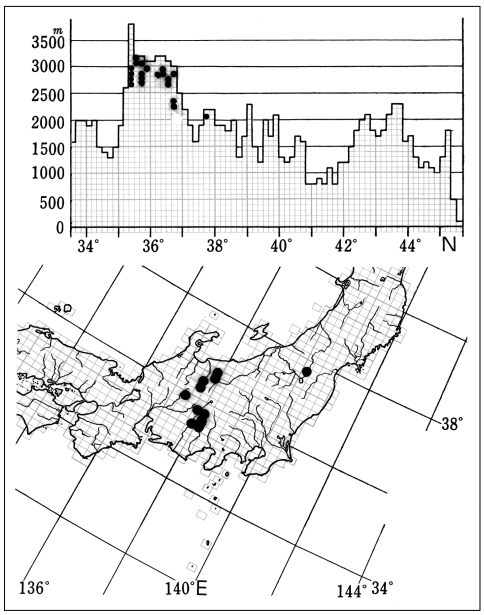

Fig.6. Distribution of *Amygdalaria subdissentiens* in Japan

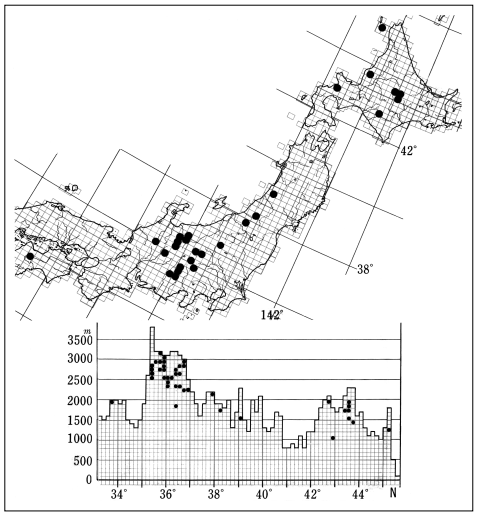

Fig.7. Distribution of *Calvitimela aglaea* in Japan

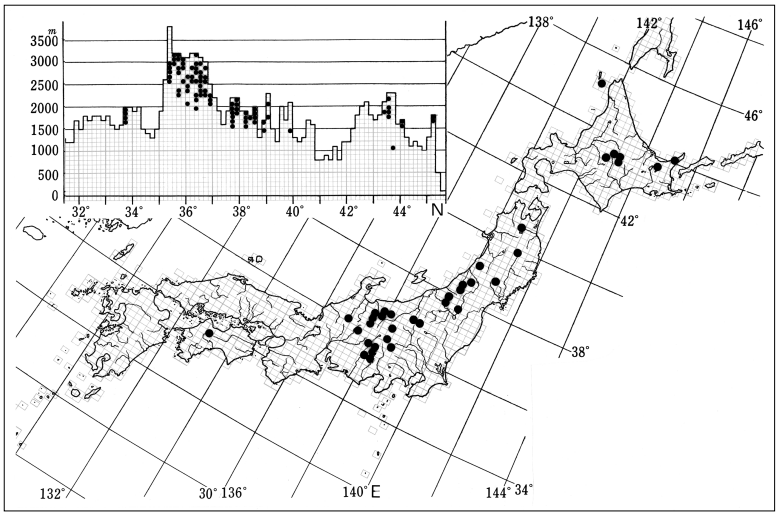

Fig.8. Distribution of *Porpidia flavocaerulescens* in Japan

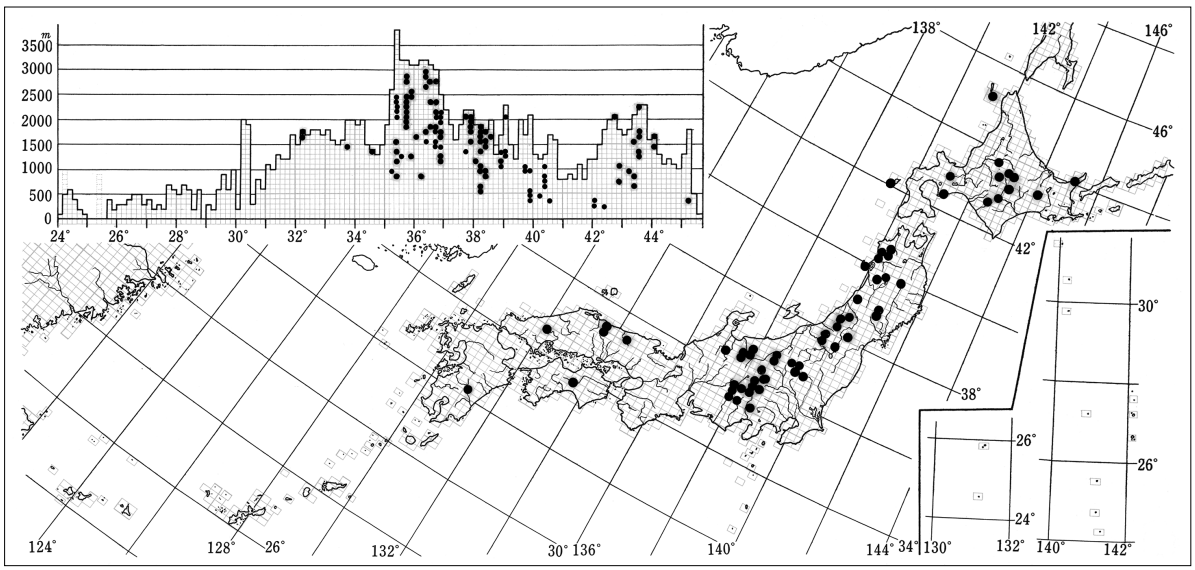

Fig.9. Distribution of *Porpidia macrocarpa* in Japan

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References

Alstrup, V.E., S. Hansen & F.J.A. Daniels, 2000. Lichenized, lichenicolous and other fungi from North and North East Greenland. Folia Cryptogamica Estonica **37**. 1-20.

Andreev, M. P., Yu. V. Kotlov & I. I. Makarova, 1996. Checklist of lichens and lichenicolous fungi of the Russian Arctic. Bryologist **99**: 137-169.

Andreev, M.P., 2004. Notes on the lichen genus *Miriquidica* (Lecanorales, Lecanoraceae) in Russia. Bibl. Lich. **88**: 15-42.

Brodo, I. M., 1995, Lichens and lichenicolous fungi of the Queen Charlotte Islands, British Columbia, Canada. 1. Introduction and new records for B. C., Canada and North America. Mycotaxon **56**:135-173.

Brodo, I. M. & H. Hertel, 1987. The lichen genus *Amygdalaria* (Porpidiaceae) in North America. HERZOGIA **7**: 493-521.

Castello, M. & P. Nimis, 1995. A critical revision of Antarctic lichens described by C. W. Dodge. Bibl. Lichenol. **57**: 71-92.

Degelius, G. , 1982. The Lichen Flora of the Island of Vega in Nordland, Northern Norway. Acta Reg. Got. **2**: 1-127.

Elvebakk, A. & H. Hertel, 1997. A catalogue of Svalbard lichens. In Elvebakk & Prestrud (eds.): A catalogue of Svalbard plants, fungi, algae, and cyanobacteria. Norsk Polarinstitutt Skrifter **198**: 271-359.

Filson, R. B., 1996. Checklist of Australian lichens and allied fungi. Flora of Australia supplementary series Number **7**, pp. 204.

Gowan, S.P. & I.M. Brodo, 1988. The lichens of Fundy National Park, New Brunnswick, Canada. Bryologist **91**: 255 - 325.

Hansen, E.S., 2002. Lichens from Inglefield Land. NW Green-

land. Willdenowia **32**: 105-125.
Hertel, H., 1977. *Lecidea* in der arktis I. Mitt. bot. staatssamml. München **13**: 337-352.
Hertel, H., 1981. *Lecidea* in der arktis II. Mitt. bot. staatssamml. München **17**: 171-184.
Hertel, H.,1984): Über saxicole, lecideoide Flechten der Subantarktis. Beiheft **79** zur Nova Hedwigia pp. 399-499.
Hertel, H., 1987. Bemerkenswerte Funde südhemispharischer, saxicoler Arten der Sammelgattung *Lecidea*. Mitt. Bot. Staatssamml. München. **23**: 321-340.
Hertel, H., 1991. *Lecidea* in der Arktis III (Lecideoide Flechten; Lecanorales). Mitt. Bot. Staatssamml. München **30**: 297-333.
Hertel, H., 2001. Floristic and taxonomic notes on saxicolous lecideoid lichens. Sendtnera **7**: 93-136.
Inoue, M., 1981. A taxonomic study on the Japanese species of *Fuscidea* (Lichens). Hikobia suppl. **1**: 161-176.
Inoue, M., 1982. The genera *Lecidea, Lecidella* and *Huilia* (Lichens) in Japan I. *Lecidea*. Journ. Sci. Hiroshima Univ., ser. B. Div. (Bot.), **18**: 1-55 .
Inoue, M., 1983. Japanese species of *Huilia* (Lichenes) (1) - (3). Journ. Jap. Bot. **58**: 113-128, 161-173, 225-236.
Inoue, M., 1988. Notes on eleven lecideoid lichens new to Japan. Hikobia **10**: 171-187.
Inoue, M., 1991. Lecideoid lichens of Prince Olav Coast and Soya Coast, Enderby Land, East Antarctica. Antarctic Record **35**, 271-284.
Inoue, M.. 1994. Phytogeography of Lecideoid lichens in Japan. J. Hattori Bot. Lab.**76**:183-195.
Inoue, M., 1997a. Little known crustose lichens bearing lecideine black apothecia from Japan. Bull. Natn. Sci. Mus., Tokyo, ser. B, **23**(2): 43-58.
Inoue, M., 1997b. Japanese species of *Lecidella* (Lichenes, Lecanoraceae) (1). Bull. Natn. Sci. Mus., Tokyo, ser. B, **23**(4): 127-136.
Inoue, M., 2000. Japanese species of *Lecidella* (Lichenes, Lecanoraceae) (2). Bull. Natn. Sci. Mus., Tokyo, ser. B, **26**(4): 139-153.
Inoue, M. & K.-H. Moon, 1998. Notes on some lecideoid lichens of Mts. Shirakami new to Japan. Hikobia **12**: 293-297.
Inoue, M., H. Kashiwadani & K.-H. Moon, 2007. Alpine lecideoid lichens from southern part of Mts. Akaishi, central Japan. Mem. Fac.& Ed. Hum. St., Akita Univ. No. **62**, 9-17.
Kashiwadani, H., M. Inoue, K.-H. Moon & K. Sasaki, 2002. Lichens of Ozegahara Moor and its adjacent areas, central Japan. Mem. Natn. Sci. Mus., Tokyo. **38**: 71-93.
Llimona, X. & N.L. Hladun, 2001. Checklist of the lichens and lichenicolous fungi of the iberian Peninsula and Balearic Islands. Bocconea **14**: 1-581.
Nimis, P. & J. Poelt, 1987. The lichens and lichenicolous fungi of Sardinia (Italy). Studia geobotanica **7** (Suppl.): 1-269.
Øvstedal, D.O. & R.I.L. Smith, 2001. Lichens of Antarctica and South Georgia. -- A guide to their identification and ecology. -- pp. 411, Cambridge University Press. Cambridge, UK
Purvis, O.W., B.J. Coppins, D.L. Hawksworth, P. James & D.M. Moore (ed.), 1992. The lichen flora of Great Britain and Ireland. pp. 710. Natural History Museum Publications, London, UK.
Rambold, G., 1989. A monograph of the saxicolous lecideoid lichens of Australia (excl. Tasmania) . Bibl. Lich. **34**: 1-345.
Santesson, R., 1993. The lichens and lichenicolous fungi of Sweden and Norway. pp. 240. Lund, Sweden.
Shimizu, A., M. Inoue & K.-H. Moon, 2004. Lichen flora of Mt. Tokachi, Hokkaido, Japan. Bull. Natn. Sci. Mus., Tokyo, ser. B, **30**(3): 89-102.
Thomson, J.W., 1997. American Arctic Lichens. 2. The Microlichens. The Universityof Wisconsin Press, pp. 675, Madison, Wisconsin.
Upreti, D.K., 1996. Lecideoid lichens from the Schirmacher Oasis, East Antarctica. Willdenowia **25**: 681 - 686.
Vězda, A. & Liska, J., 1999. A catalogue of lichens of the Czech Republic. pp.283, Institute of Botany Academy of Sciences of the Czech Republic. Pruhonice.
Wong, P. & Brodo, I. M., 1992. The lichens of Southern Ontario, Canada. Syllogeus **69**: 1-79.
Zhurbenko, M.P., N.V. Matveeva, C. Vonlanthen, D.A. Walker & M.K. Raynolds, 2006. Lichens from Ellef Ringnes Island, Canadian Artic Archipelago. EVANSIA **23**: 69-78.

井上正鉄*・神田啓史**：日本産亜高山・高山生ヘリトリゴケ地衣類，特に日本と北極圏に位置するスバールバル諸島に共通して分布する種類の分布型について

日本の亜高山・高山に分布する地衣類のヘリトリゴケ類 lecideoid lichens の分布地理を明らかにする目的で既報告種の分布型を調べるとともに，筆者らが調査研究をした北極圏に位置するスピッツベルゲン島と，この島が属するスバルバール諸島との共通種を挙げた。

亜高山・高山に分布する地衣類の内，ヘリトリゴケ類は最も優勢な分類群のひとつである事を示した。

日本産亜高山・高山生ヘリトリゴケ類の半数以上が周北極・高山要素あるいは，南極地域も含めた両極要素の種類であった。また，北海道と飛騨山脈・赤石山脈をはじめとする中部山岳地帯にのみ分布する種類の多くがこの分布型の要素であった。

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