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Correlations between the Moss Floras of Japan and New Zealand

Masanobu Higuchi[1] and Allan J. Fife[2]

[1] Department of Botany, National Science Museum, 4–1–1 Amakubo, Tsukuba, Ibaraki 305–0005 Japan
(e-mail: higuchi@kahaku.go.jp)
[2] Landcare Research, PO Box 69, Lincoln 8152, New Zealand
(e-mail: fifea@landcareresearch.co.nz)

Abstract The moss floras of Japan and New Zealand are reviewed based on the literature. The two countries have comparatively rich and unique moss floras for their land areas, which might be due to climatic diversity, locally high precipitation, complicated topography, as well as geological history. Japan and New Zealand also have in common many tectonically active hotspots with frequent volcanic activity and earthquakes. The moss floras of these two widely-separated areas have a total of over 1,500 species. A comparison of the mosses recorded from Japan and New Zealand reveals that the Japanese moss flora is richer than that of New Zealand, but that the endemism rate at the species level in New Zealand is higher than that of Japan. Although their moss floras are different in their species composition, nearly 90 species are common to both areas. Of the species with disjunctive ranges, several might be considered more or less cosmopolitan with little geographical significance. Others are extremely interesting, and require further studies and explanations.

Key words: mosses, flora, Japan, New Zealand, phytogeography

Introduction

Japan and New Zealand consist of the main islands and many smaller islands, and are situated in the western region of the Pacific Ocean. The Japanese archipelago has a northeast/southwest orientation and consists of four main islands and many smaller islands, and stretches 3,000 km between 24°N and 45°N latitude. The highest peak is Mt. Fuji on Honshu Island at 3,776 m. The total land mass is approximately 373,000 km^2. On the other hand, New Zealand consists of three main islands and several smaller islands, and extends 3,000 km between 30°S and 53°S latitude. The highest peak of 3,764 m is Mt. Cook on the South Island. The total land mass is approximately 270,000 km^2. Japan and New Zealand have basically temperate and oceanic climates, but their mountainous topographies contribute to their widely varying climate. Additionally they also have in common many tectonically active hotspots with frequent volcanic activity and earthquakes.

Japan and New Zealand have rich and unique moss floras for their land areas. The moss flora of Japan has been compiled by Iishiba (1929), Sakurai (1954), Noguchi (1959, 1974), Iwatsuki & Noguchi (1973), Noguchi (1987, 1988, 1989, 1991, 1994) and Iwatsuki (1991, 2004), and that of New Zealand is described in detail in other article in this proceedings by Fife (2006).

This article aims to compare the moss flora of Japan with that of New Zealand based on updated data, and to discuss their relationship.

Materials and Methods

The comparison was mainly based on the checklists of Japan (Iwatsuki, 2004) and New Zealand (Fife, 1995). Recent taxonomic treatments and new records on the moss floras were also adopted. The data of distribution were from Noguchi (1987, 1988, 1989, 1991, 1994), Wijk *et al*. (1959, 1962, 1964, 1967, 1969) and recent floral and revisional studies.

Results and Discussion

Comparison between the moss floras of Japan and New Zealand

Iwatsuki (2004) and Fife (1995) listed 1,135 species of mosses from Japan and 523 from New Zealand respectively (Table 1). The two countries have comparatively rich moss floras for their land areas, which might to due to climatic diversity, locally high precipitation, complicated topography, as well as geological history. In New Zealand, however, the rich moss flora might be attributed to climatic and topographic diversity rather than geological age.

In the number of species, Japanese moss flora is richer than that of New Zealand, which might be due to close relationship with Asian continent. On the other hand, the number of endemic species in Japanese and New Zealand moss floras is 101 (9%) and 108 (21%) respectively. The endemism rate at the species level in New Zealand is distinctly higher than that of Japan. The reason why the endemism rate is so high in New Zealand is not clear, but it should be noted that New Zealand is more isolated from a continental land mass than Japan.

Twelve families are present in Japan but absent from New Zealand, such as Bryoxiphiaceae (*Bryoxiphium norvegicum* subsp. *japonicum*), Disceliaceae (*Discelium nudum*), Fontinalaceae (*Fontinalis antipyretica* and *F. hypnoides*), Leucodontaceae (*Dozya japonica*, *Felipponea esquirolii* and *Leucodon* spp.), Pleuroziopsidaceae (*Pleuroziopsis ruthenica*), Prionodontaceae (*Taiwanobryum speciosum*), Rhachitheciaceae (*Rhachithecium*), Schistostegaceae (*Schistostega pennata*), Symphyodontaceae (*Symphyodon perrottetii*), Takakiaceae (*Takakia lepidozioides*, Fig. 1) and Trachypodaceae (*Duthiella* spp., *Pseudospiridentopsis horrida*, *Trachypus bicolor* and *T. humilis*). The families absent from Japan but present in New Zealand are twelve mainly differentiated in the Southern Hemisphere, such as Calomniaceae (*Calomnion complanatum* and *C. brownseyi*), Cyrtopodaceae (*Cyrtopus setosus*), Daltoniaceae (*Catharomnion ciliatum*, *Crosbya nervosa*, *C. straminea* and *Daltonia splachnoides*), Dicnemonaceae (*Dicnemon* spp. and *Mesotus celatus*), Echinodiaceae (*Echinodium* spp.), Ephemeropsaceae (*Ephemeropsis trentepohlioides*), Gigaspermaceae (*Gigaspermum repens*), Lepyrodontaceae (*Lepyrodon australis* and *L. lagurus*), Mittenicaceae (*Mittenia plumula*), Phyllogonicaceae (*Catagonium nitens* and *Orthorrhynchium elegans*), Pleurophascaceae (*Pleurophascum grandiglobum* var. *decurrens*) and Ptychomniaceae (*Cladomnion ericoides*, *Dichelodontium nitidum*, *Glyphothecium sciuroides*, *Hampeella* spp., *Ptychomnion aciculare* (Fig. 2), *P. densifolium* and *Tetraphidopsis pusilla*).

Table 1. Comparisons of moss floras of Japan and New Zealand.

	Japan	New Zealand	Common	Total
Families	60	61	48	73
Genera	301	211	130	413
Species	1135	523	94	1564
Taxa	1272	549	96	1725

Fig. 1. Habit of *Takakia lepidozioides*.

Fig. 2. Habit of *Ptychomnion aciculare*.

Analysis of the species common to Japan and New Zealand

Among a total of 1,564 species recognized from Japan and New Zealand, 93 species are common to both regions. This is 8% of the Japanese and 18% of New Zealand moss floras.

Species Common to Japan and New Zealand

Amblystegium serpens (N)
Amblystegium varium (N)
Aulacomnium palustre (N)
Barbula convoluta (C)
Barbula unguiculata (C)
Brachymenium exile (PAL)
Brachythecium campestre (N)
Brachythecium plumosum (N)
Brachythecium rutabulum (C)
Brachythecium salebrosum (N)
Brachythecium velutinum (N)
Bryoerythrophyllum recurvirostrum (C)
Bryum algovicum (N)
Bryum argenteum (C)
Bryum caespiticium (N)
Bryum coronatum (PAN)
Bryum dichotomum (O)
Bryum pachytheca (O)
Bryum pallescens (C)
Bryum pseudotriquetrum (C)
Bryum radiculosum (O)
Bryum rubens (N)
Buxbaumia aphylla (N)
Campyliadelphus stellatus (N)
Campylopodium medium (PAL)
Campylopus introflexus (C)
Ceratodon purpureus (C)
Climacium dendroides (N)
Cratoneuron filicinum (C)
Dicranella heteromalla (N)
Dicranum scoparium (N)
Distichium capillaceum (C)
Drepanocladus aduncus (C)
Eccremidium minutum (O)
Encalypta rhaptocarpa (N)
Encalypta vulgaris (N)
Ephemerum serratum (N)
Fissidens adianthoides (N)
Fissidens curvatus (O)
Fissidens dubius (N)
Fissidens oblongifolius (PAN)
Fissidens taxifolius (C)
Funaria hygrometrica (C)
Gymnostomum calcareum (C)
Haplohymenium pseudotriste (PAL)
Hedwigia ciliata (C)
Hennediella heimii (O)
Hylocomium splendens (N)
Hypnum cupressiforme (C)
Isopterygiopsis pulchella (N)
Isopterygium albescens (PAL)
Isopterygium minutirameum (PAL)
Kindbergia praelonga (C)
Leptobryum pyriforme (C)
Leptodictyum riparium (C)
Limprichtia revolvens (N)
Micromitrium tenerum (O)
Neckera pennata (C)
Plagiopus oederiana (N)
Pohlia camptotrachela (N)
Pohlia cruda (C)
Pohlia elongata (N)
Pohlia nutans (C)
Pohlia wahlenbergii (C)
Polytrichastrum formosum (C)
Polytrichum commune (C)
Polytrichum juniperinum (C)
Pseudephemerum nitidum (O)
Racomitrium lanuginosum (C)
Rhytidiadelphus squarrosus (N)
Rosulabryum billardieri (PAN)
Rosulabryum capillare (C)
Saelania glaucescens (C)
Sanionia uncinata (N)
Sarmenthypnum sarmentosum (O)
Schistidium apocarpum (C)
Schistidium rivulare (O)
Sphagnum compactum (C)
Sphagnum squarrosum (N)
Sphagnum subnitens (O)

Sphagnum teres (N)
Straminergon stramineum (N)
Tetrodontium brownianum (N)
Thuidium cymbifolium (PAL)
Timmia norvegica (O)
Tortella fragilis (N)
Tortula mucronifolia (N)
Tortula muralis (C)
Trichostomum brachydontium (N)
Warnstorfia exannulata (N)
Warnstorfia fluitans (C)
Weissia controversa (C)

The species common to Japan and New Zealand include several elements of distribution. They are classified roughly into the following floristic groups: circumboreal-like species (N; 37 spp., 40%), cosmopolitan (C; 35 spp., 38%), palaeotropical species (PAL; 6 spp., 7%), pantropical species (PAN; 3 spp., 3%), or others (O; 12 spp., 13%).

The circumboreal-like species, widely occurring in the Northern Hemisphere and New Zealand, are represented by *Aulacomnium palustre* and *Climacium dendroides* (Fig. 3). The cosmopolitan species, occurring widely without relation to any continent or vegetation types, includes *Bryum argenteum*, etc. The palaeotropical species, occurring in tropical regions except America, are represented by *Isopterygium albescens*. Japan and New Zealand are often the northern and the southern limit of distribution for palaeotropical species. The pantropical species, occurring on all continents in tropical regions, are represented by *Campylopodium medium* (Fig. 4). Tropical storms which blow from the equator region to north and south might contribute to their range extensions. *Eccremidium minutum*, an example of the others, has been known from through Australia and the North Island of New Zealand. Subsequently this species was recorded from Japan by Iwatsuki & Takaki (1979), who considered that this was introduced and long-distance dispersal by wind is not possible because of large spores.

The bipolar distribution is considered to be one of the most interesting disjunctive patterns in plants. According to Du Rietz (1940), the taxa with bipolar distribution are defined as taxa "distributed both in the boreal and austral zone but absent from the tropical lowlands, with or without intermediate populations in tropical mountain areas." Schofield (1974) discussed the bipolar disjunctive mosses mainly occurring in New Zealand. He pointed out that fourteen species have

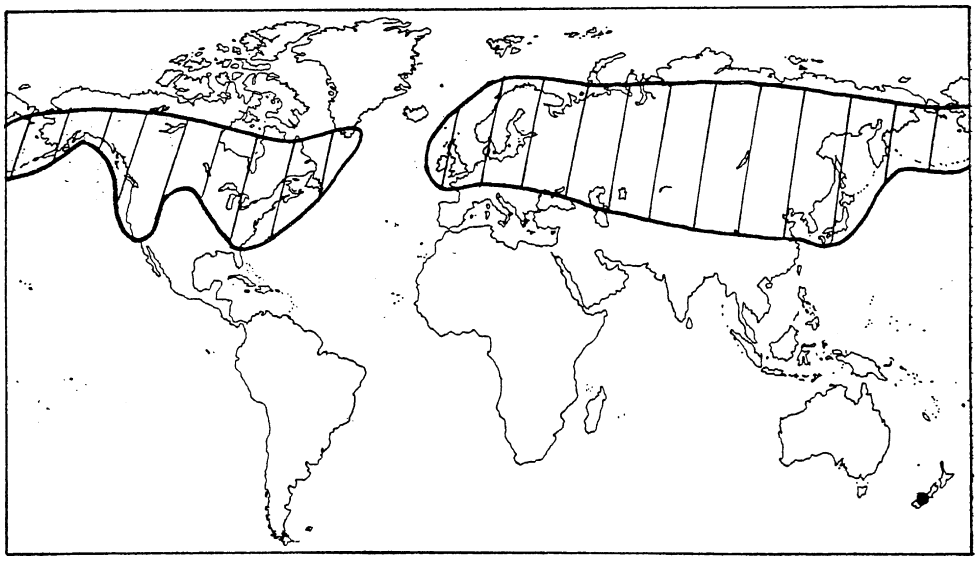

Fig. 3. Distribution of *Climacium dendroides* (after Schofield 1974).

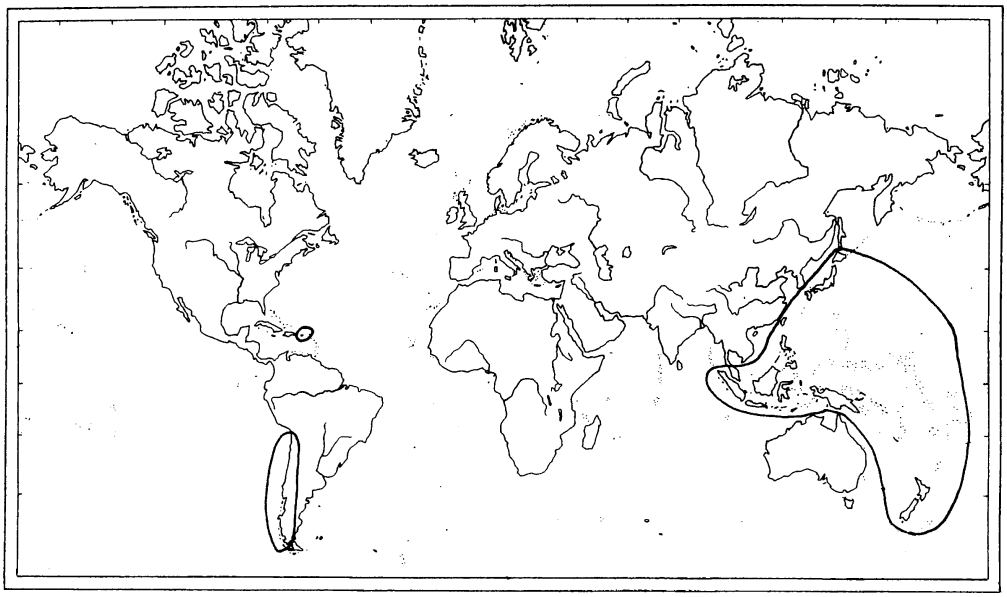

Fig. 4. Distribution of *Campylopodium medium* (after Giese & Frahm 1985).

been introduced into New Zealand since the colonization of these islands by Europeans. Among them the species common to Japan are as follows: *Barbula convoluta*, *B. unguiculata*, *Bryum rubens*, *Campylopus introflexus* and *Psudephemerum nitidum*. Although long-distance dispersal is one possible reason for the remarkable disjuncts, there has no direct evidence to support it. The origin of the distribution in these "bipolar" species could be investigated using molecular techniques.

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