

Zeitschrift: Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübel, in Zürich
Herausgeber: Geobotanisches Institut, Stiftung Rübel (Zürich)
Band: 98 (1988)

Artikel: An outline of the flora of Japan = Ein Überblick über die Flora Japans
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DOI: <https://doi.org/10.5169/seals-308898>

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An outline of the flora of Japan

Ein Überblick über die Flora Japans

by

Tatemi SHIMIZU

1. INTRODUCTION

The Japanese Islands, the continental islands located at the eastern edge of Eurasia, consist of four main islands, Hokkaido, Honshu, Shikoku, and Kyushu. They range from $26^{\circ}59'10''\text{N}$ to $45^{\circ}31'16''\text{N}$ in latitude. The whole area is 369662 km^2 . The highest peak, the top of Mt. Fuji in central Honshu, is 3776 m a.s.l. Honshu is divided into five districts, Tohoku, Kanto, Chubu, Kinki, and Chugoku (Fig. 1).

Owing to the geohistorical characteristics, the wide range of the climatic conditions, and the great ecological complexity, the flora as well as the vegetation are rich and of high diversity in the Japanese Islands. The number of taxa of indigenous seed plants, calculated on the basis of OHWI (1983) with a little modification, is 174, 999, and 3834

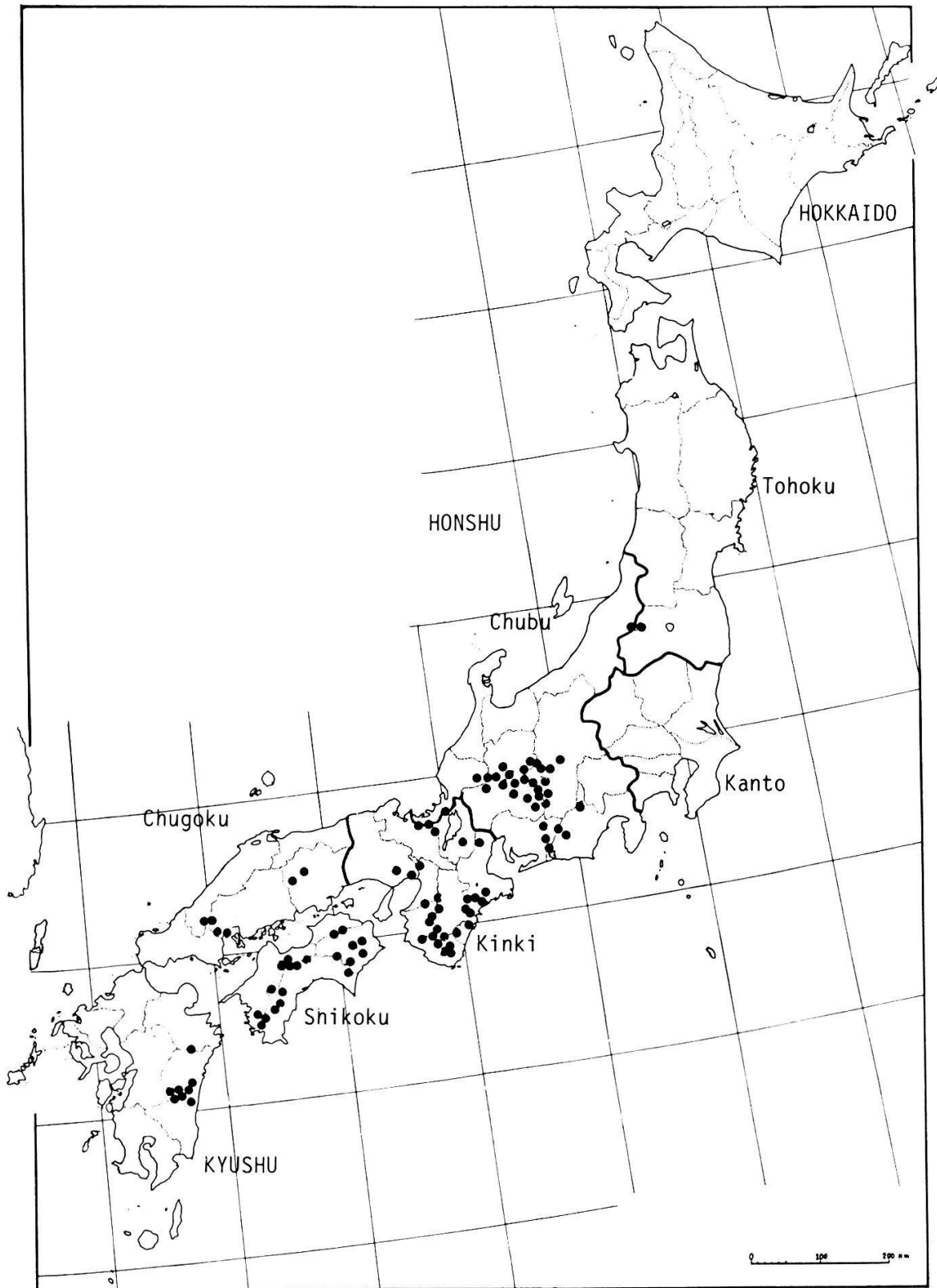


Fig. 1. Eight districts of the Japanese Islands with the distribution area of *Sciadopitys verticillata* (after KURATA and HAMAYA 1971, slightly modified)

Abb. 1. Acht Distrikte der Japanischen Inseln mit dem Verbreitungsareal von *Sciadopitys verticillata* (nach KURATA and HAMAYA 1971, leicht abgeändert)

as to family, genus, and species, respectively (Table 1). The species density, i.e. the average number of species per square kilometre, is 0.01037. These numbers are comparable with those of other countries. In case of the British Isles, the continental islands at the western edge of Eurasia, for example, the number of family, genus, and species of seed plants is 109, 543, and 1457, respectively (Table 2). These numbers were calculated on the basis of CLAPHAM et al. (1962) with adjusting of

Table 1. Number of taxa of seed plants in the Japanese Islands and endemism (in parentheses)

Tab. 1. Anzahl von Spermatophyten-Taxa auf den Japanischen Inseln und Endemismus (in Klammern)

Taxa	Family	Genus	Species	Species endemism %
Gymnospermae	8 (1)	17 (2)	38 (20)	52.6
Angiospermae	166 (1)	982 (20)	3796 (1397)	36.8
Dicotyledoneae	139 (1)	714 (16)	2603 (1024)	39.4
Monocotyledoneae	27 (0)	268 (4)	1193 (373)	31.3
Total	174 (2)	999 (22)	3834 (1449)	37.8

Table 2. Number of taxa of seed plants in the British Isles and endemism (in parentheses)

Tab. 2. Anzahl von Spermatophyten-Taxa auf den Britischen Inseln und Endemismus (in Klammern)

Taxa	Family	Genus	Species	Species endemism %
Gymnospermae	3 (0)	3 (0)	3 (0)	0.0
Angiospermae	106 (0)	540 (0)	1454 (57)	3.9
Dicotyledoneae	83 (0)	397 (0)	1006 (54)	5.4
Monocotyledoneae	23 (0)	143 (0)	448 (3)	0.7
Total	109 (0)	543 (0)	1457 (57)	3.9

the range of corresponding taxa to that of OHWI (1983). The species density is $0.00595/\text{km}^2$, about half of that of the Japanese Islands.

In addition, we have about 1500 species of seed plants in Ryukyu Islands, about 90 of which are endemic. In the case of the Bonin Islands, the seed plants amount to about 180 species including 107 endemic ones.

2. ENDEMIC TAXA OF SEED PLANTS

The number of endemic taxa in each category is shown in parentheses in Tables 1 and 2. In the Japanese Islands, we have endemic taxa of two families, 22 genera, and 1449 species. Therefore the species endemism of 37.8% is expected. In the British Isles, on the other hand, there occur neither endemic families nor endemic genera. The endemic species are 57 in number, showing species endemism of merely 3.9%. This is a great floristic difference between these two countries.

The endemic families in the Japanese Islands are Sciadopityaceae (Gymnospermae) and Glaucidiaceae (Angiospermae). Each of them is represented by only one species, viz. Sciadopitys verticillata and Glaucidium palmatum. The genus Sciadopitys is known to have been widely distributed in the Northern Hemisphere, above all, in Europe since the late Jurassic and extinguished by the beginning of the Pleistocene except in Japan (FLORIN 1959). At present, it is found on the Pacific side of western Honshu, Shikoku, and Kyushu with a few disjunctive spots in northeastern Honshu (Fig. 1). The habitat is in the warm temperate and in the cool temperate zone, ranging from 300 m to 1500 m a.s.l.

In contrast, neither fossils nor remains of Glaucidium have been reported. Its present distribution area is southwestern Hokkaido and northeastern Honshu (Fig. 2). The habitat is in the cool temperate zone and in the lower part of the subalpine zone, ranging from 800 m to 2000 m a.s.l. It is noteworthy that it is confined to the Japan Sea side where in the winter season we have thick snow-cover over the mean annual maximum depth of 50 cm. Generally speaking, the Japan Sea side shows a distinct floristic contrast with the Pacific side on the reflection of such climatic condition.

Besides these two families or genera, there are 20 endemic genera in the Japanese Islands, as noted above. They appear indifferently to phyletic lines in various families of Gymnospermae, Dicotyledoneae, and Monocoty-

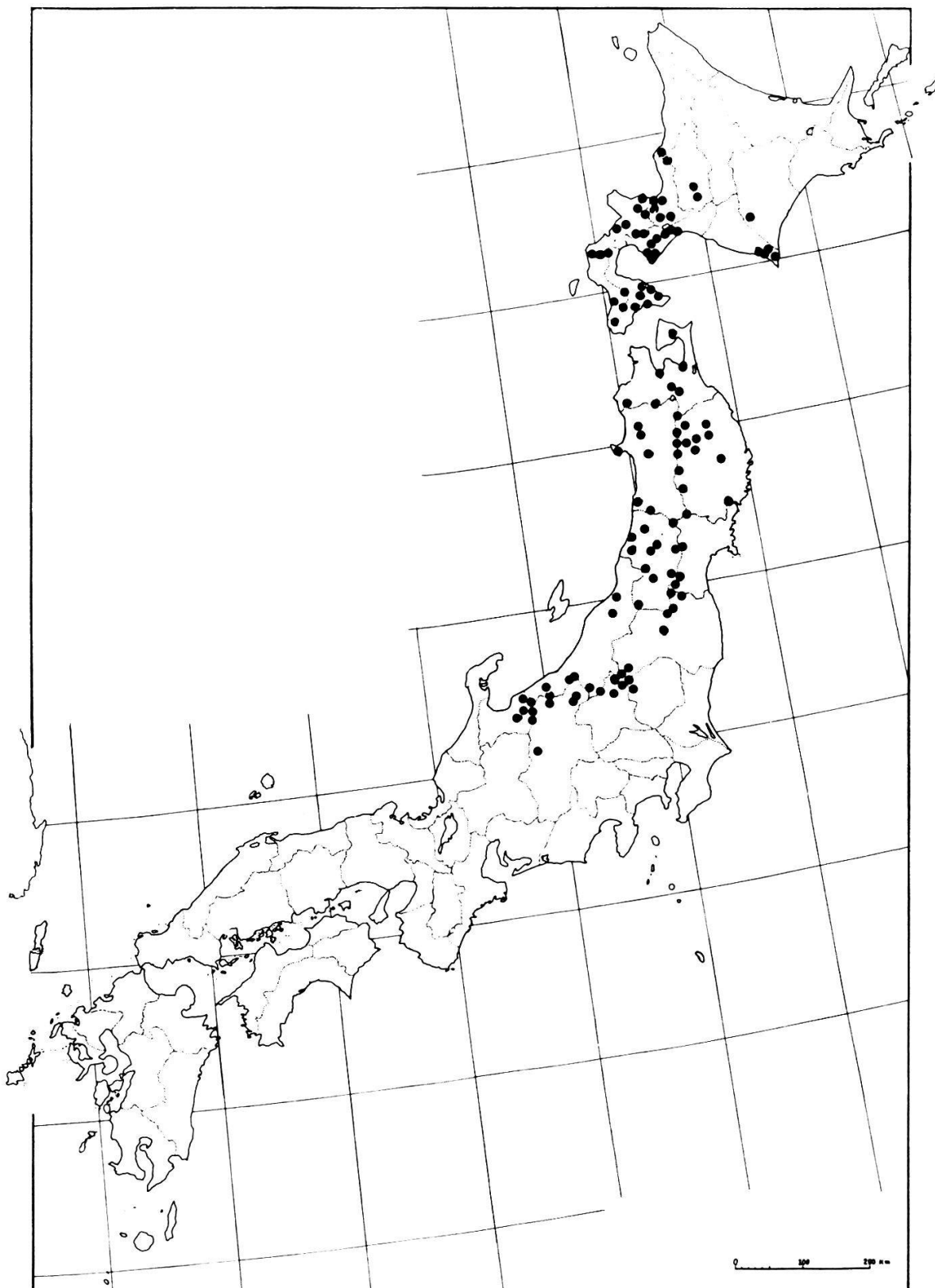


Fig. 2. Distribution area of Glaucidium palmatum
(after HARA and KANAI 1959, slightly modified)

Abb. 2. Verbreitungsareal von Glaucidium palmatum
(nach HARA and KANAI 1959, leicht abgeändert)

ledoneae, and indifferently to the ecological conditions. They could be classified into three groups from the viewpoint of distribution pattern. The first comprises the members which are distributed on the Pacific side west of Kanto District. They are Thujopsis (Cupressaceae), Anemonopsis (Ranunculaceae), Peltoboykinia (2 species, Saxifragaceae), Apodiocarpum (Umbelliferae), Ancistrocarya (Boraginaceae), Perillula (Labiatae), Pseudopyxis (2 species, Rubiaceae), Diaspananthus, Miricacalia (Compositae), Alectorurus (Liliaceae), and Hakonechloa (Gramineae). Their main habitat is almost always in the warm temperate zone. The second consists of the members of northern Japan or of the Japan Sea side, distributed from Hokkaido to Chubu District. They are Ranzania (Berberidaceae), Pteridophyllum (Papaveraceae), Parapyrola (Ericaceae), Japonolirion (Liliaceae), and Eleorchis (Orchidaceae). Their main habitat is the cool temperate zone and the subalpine zone. Some of them are restricted to the Japan Sea side likewise in Ranzania and Parapyrola. The rest are the members covering almost all parts of the Japanese Islands or occupying a small restricted area. The former are exemplified by Chamaele (Umbelliferae) and Tripetaleia (2 species, Ericaceae), and Dactylostalix (Orchidaceae), while the latter are represented by Tsusio-phyllum (Ericaceae) inhabiting rocky ridges in the border area between Kanto and Chubu District.

3. FLORISTICS IN THE ALPINE ZONE

The forest line in the Japanese Islands is situated at about 2500 m a.s.l. in central Honshu and at about 1400 m a.s.l. in central Hokkaido. Usually the alpine zone is regarded as that above the forest line. As noted above, it is characterized by no endemic genera. All the endemic genera in Japan are found in the subalpine zone or temperate zone. This means that the alpine flora is not as old as their floras. However, the endemic species there are richer than in the other zones. The species endemism is estimated to be 51.5% (Table 3), higher than that of the whole Japanese Islands, 37.8% (Table 2). This is one of the most important characteristics of the alpine flora of Japan.

In my previous works (SHIMIZU 1983, 1984), I tried to classify the Japanese alpine plants into floristic elements as follows.

- A. **Cosmopolitan.** Occurring both in the Northern and Southern Hemisphere. Represented by Deschampsia flexuosa and seven other species.
- B. **Northern Circumpolar.** The species concerned, or their allies, widely occurring in the northern part of the Northern Hemisphere.
- B-1. Eurasian - Northern American. The species concerned, or their allies, occurring in Eurasia and North America. Represented by Antennaria dioica and 85 other species.
- B-2. Eurasian. The species concerned, or their allies, occurring in Eurasia only. Represented by Swertia perennis and 15 other species.
- B-3. Asian - North American. The species concerned, or their allies, occurring in Asia and North America. Represented by Lomatogonium carinthiacum and 13 other species.
- C. **Asian.** The species concerned, or their allies, occurring in Asia only.
- C-1. Northeastern Asiatic. The species concerned, or their allies, occurring in Kamchatka, eastern Siberia, the Kuriles, and Sakhalin. Represented by Campanula chamissonis and 69 other species.
- C-2. Eastern Asiatic. The species concerned, or their allies, occurring in Korea, eastern and northeastern China and its vicinity. Represented by Hedysarum ussuriense and 62 other species.
- C-3. Northern Asiatic. The species concerned, or their allies, occurring in Siberia, Mongolia, and northern China. Represented by Rhododendron aureum and 13 other species.
- C-4. Central Asiatic. The species concerned, or their allies, occurring in western China and Central Asia. Represented by Leontopodium hayachinense and 7 other species.
- C-5. Southern Chinese and Himalayan. The species concerned, or their allies, occurring in southern China and the Himalayas. Represented by Nepeta subsessilis and 11 other species.
- C-6. Southeastern Asiatic. The species concerned, or their allies, occurring in Southeast Asian countries with relation to the bipolar elements. Represented by Euphrasia insignis, and two other species.
- C-7. Asiatic. The species concerned, or their allies, occurring widely in the Asiatic Continent. Represented by Ptilagrostis mongholica and other species.
- D. **Pacific.** The species concerned, or their allies, occurring in the northern Pacific areas.

D-1. Northern Pacific. The species concerned, or their allies, continuously occurring in the northern Pacific areas. Represented by Arnica unalaschkensis and 58 other species.

D-2. Amphi-Pacific. The species concerned, or their allies, discontinuously occurring on the eastern and western side of the Pacific. Represented by Rubus pedatus and 11 other species.

E. **Montane.** The species concerned, or their allies, occurring also in the lower montane zone. Represented by Aruncus dioicus and 50 other species.

F. **Really endemic.** Endemic species without particular allies. Represented by Primula kitadakensis and 43 other species.

The floristics of the alpine flora of Japan are summarized in Table 3; it should be pointed out that endemic alpine species were also classified to each floristic element on the basis of the distribution pattern of the related species.

Table 3. Floristics of the alpine species in Japan

Tab. 3. Floristische Beziehungen der alpinen Arten in Japan

Elements		Non-endemic	Endemic	Total	Sum	Ratio %
Cosmopolitan		6	2	8	8	1.7
N Circumpolar	Eurasian-N American	64	22	86	116	25.1
	Eurasian	8	8	16		
	Eurasian-N American	8	6	14		
Asian	NE Asiatic	50	20	70	172	37.2
	E Asiatic	33	30	63		
	N Asiatic	6	8	14		
	C Asiatic	1	7	8		
	S Chinese-Himalayan	1	11	12		
	SE Asiatic		3	3		
	Asiatic	2		2		
Pacific	N Pacific	38	21	59	71	15.4
	Amphi-Pacific	3	9	12		
Montane		4	47	51	51	11.0
Really endemic			44	44	44	9.6
Total		224	238	462	462	51.5

4. FLORISTIC DISTRICTS

From the viewpoint of floristic plant geography, the whole of the Japanese Islands are grouped into the Sino-Japanese region (GOOD 1974) or into the Eastern Asiatic Region (TAKHTAJAN 1986). Various phytogeographical subdivisions of Japan have been proposed by several authors (MAEKAWA 1949, KITAMURA 1957, YAMAZAKI 1959, etc.). In the present paper, four floristic districts are simply recognized on the basis of distribution of endemic taxa and dominant species (Fig. 3).

4.1. HOKKAIDO FLORISTIC DISTRICT

Since a cool climate prevails throughout Hokkaido, the coniferous forests represented by Picea glehnii, P. jesoensis, Abies sachalinensis, and A. mayriana are dominant. Many endemic species and rare plants occur in the central mountains. For example, Salix paludicola, Stellaria pterosperma, Aconitum yamazakii, Draba nakaiana, etc. are endemic to Mts. Daisetsu. Betula apoiensis, Aconitum apoiense, Callianthemum miyabeianum, Saxifraga nishidae, Rhamnus ishidae, Viola yubariana, Crepis gymnopus, Saussurea chionophylla and Eriocaulon perplexum are restricted to the serpentine areas in Mt. Yubari and/or Mt. Apoi or its vicinity.

Some common plants in Hokkaido, Picea glehnii and Bryanthus gmelinii, occur in Tohoku District only at the upper elevation of Mt. Hayachine. Arenaria katoana and Draba japonica are the serpentine plants appearing both in central Hokkaido and on Mt. Hayachine. These facts might suggest a close phytogeographical relationship between these two districts.

4.2. JAPAN SEA FLORISTIC DISTRICT

Much snowfall is a remarkable characteristic of this district, as pointed out above. The beech forests with Sasa species belonging to Sect. Macrochlamys or Sect. Sasa are well developed in the temperate zone. There grow such decumbent small trees as Torreya nucifera var. radicans, Cephalotaxus harringtonia var. nana, Daphniphyllum macropodum ssp. humile, Camellia japonica var. decumbens, and Aucuba japonica var. borealis. The monotypic genera, Ranzania and Glaucidium, have been long preserved in the beech forest here.



Fig. 3. The four floristic districts of the Japanese Islands
Abb. 3. Die vier floristischen Distrikte der Japanischen Inseln

4.3. CENTRAL MOUNTAIN FLORISTIC DISTRICT

The climate is somewhat dry in the central part of Honshu. Instead of the beech forest, the mixed forests including Abies homolepis as the dominant tree are developed in the temperate zone. The conifers such as Abies veitchii, Larix kaempferi, and Picea koyamae are the important members of the subalpine zone. It is a striking characteristic in this district that many plants of continental origin grow here. In the temperate zone, Viola thibaudieri and Triosteum sinuatum (Manchuria-Korea elements), and Chosenia arbutifolia, Draba sachalinensis, Rosa davurica, and Crataegus chlorosarca (Sakhalin-Amur elements) are found. For the subalpine zone, Pinus koraiensis, Larix kaempferi (endemic), Trifolium lupinaster, and Gentiana contorta should be mentioned. Some alpine plants such as Ranunculus kitadakeanus and R. yatsugatakensis have closely related forms in the Himalayas, while the species such as Gentiana aquatica and Artemisia glomerata are the subarctic or arctic elements.

4.4. PACIFIC FLORISTIC DISTRICT

This is well contrasted with the Japan Sea district in respect to snowfall. The temperate zone is characterized by the beech forests having Sasamorphia. In this zone, there occur many endemic species called 'Sohayaki elements', which are exemplified by Pseudotsuga japonica, Deinandra bifida, Kirengeshoma palmata, Peltoboykinia watanabei, Praty crater arguta, Tanakaea radicans, Diaspananthus palmatus, Miricacalia makineana, Alectorurus yedoensis, etc. All these species have close relatives in southern Korea, or in central and/or southern China, characterizing the western half of the present district. In its northeastern half, few positive characteristics are recognized.

SUMMARY

The floristics of the Japanese Islands, Hokkaido, Shikoku and Kyushu, have been summarized as follows:

1. The number of taxa of seed plants is estimated to be 174, 999, and 3824 as to family, genus, and species, respectively (Table 1).
2. The endemic taxa of seed plants are estimated to be 2, 22, and 1449 in number as to family, genus, and species, respectively (37.8%; Table 1).

3. The alpine floristics are also discussed. It shows higher species endemism (51.5%). There are recognized 6 major and 12 minor elements (Table 3).
4. Four floristic districts are recognized in the Japanese Islands, viz. Hokkaido, Japan Sea, Central Mountain, and Pacific (Fig. 3).

ZUSAMMENFASSUNG

Die Flora der Japanischen Inseln (Hokkaido, Honshu, Shikoku und Kyushu) kann wie folgt zusammengefasst werden:

1. Spermatophyten: 174 Familien, 999 Gattungen und 3834 Arten (Tab. 1).
2. Endemische Spermatophyten: 2 Familien, 22 Gattungen und 1449 Arten (37.8%; Tab. 1).
3. Die alpine Flora weist einen höheren Anteil endemischer Pflanzen auf (51.5%). Sechs Haupt- und 12 Nebenelemente wurden unterschieden (Tab. 3).
4. Die Flora wurde in vier Distrikte eingeteilt: Hokkaido, Japan-Meer, Zentral-Gebirge und Pazifik (Abb. 3).

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