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A Vegetation-Ecological View of the Japanese Archipelago*

日本列島の植生生態学的考察

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Synopsis

Four main vegetation regions can be recognized in the Japanese archipelago: a lowland region of evergreen broad-leaved forest (Camellietea japonicae region); a lowland-to-montane region of summergreen broad-leaved forest (Fagetea crenatae region); various regions of subalpine needle-leaved forests (Vaccinio-Piceetea region); and small regions of alpine heaths or "tundra" plus treeline krummholz.

The evergreen broad-leaved forests are generally dominated by *Castanopsis cuspidata* (incl. var. *sieboldii*), *Persea thunbergii*, and/or various evergreen *Quercus* species. The understorey contains the character species *Camellia japonica* as well as various other evergreen smaller trees, shrubs, and herbs. This evergreen forest vegetation has been almost completely destroyed by human settlement activities.

The summergreen broad-leaved forests are generally dominated by *Fagus crenata* and/or other holarctic deciduous trees (e.g. *Ulmus*, *Acer*) but may also contain conifers, evergreen broad-leaved understorey species, and a conspicuous ground cover of *Sasa* spp., a dwarf bamboo. Various wetlands are also well developed in this region, including raised bogs and various types of fens. The vegetation of this region has recently been clear-cut over large areas and converted to conifer plantations (*Larix*, *Cryptomeria*, *Chamaecyparis*).

The subalpine needle-leaved forests occur above the summergreen forests wherever the mountains rise high enough, generally within the belt 1600–2500 meters in central Honshu. The most important species are *Abies mariesii* and *A. veitchii*, *Tsuga diversifolia*, *Picea jezoensis*, and *Larix kaempferi*, with *Vaccinium* spp. as character species.

Above the subalpine forests (generally above 2500 m in central Honshu), and on unstable sites below, occur *Pinus pumila* krummholz and various alpine meadows and heaths. All of these subalpine and alpine areas are currently threatened by expanding tourism.

Potential natural vegetation represents the theoretical vegetation which would arise, under current conditions, if all disturbance were removed.

The map of the potential natural vegetation of Japan suggests four main vegetation regions: a lowland region of evergreen broad-leaved forest (Camellietea japonicae), a lowland-to montane region of summergreen broad-leaved forest (Fagetea crenatae), various regions of subalpine needle-leaved forests (Vaccinio-Piceetea), and small regions of alpine heaths or "tundra".

The Camellietea japonicae region covers roughly the southern half of Japan, extending up the coasts further to the north, including the original coastline of Tokyo Bay. The summergreen forest replaces the evergreen forest as winters become colder, both to the north and at higher elevations (about 700–1600 m in central Honshu). The subalpine needle-leaved forests occur mainly at higher elevations (above 1600 m in central Honshu) but can descend almost to sea level on Hokkaido.

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I. Natural Vegetation on the Japanese Islands

The Japanese Archipelago, from Hokkaido in the north to the Ryukyu Islands in the south, extends in a 3000 km-long arc along the east coast of Eurosiberia. Thanks to the diversity of climates, soils, and topographic situations, over 6000 species of higher plants grow on the islands. Because of close ties with almost all continents and countries of the earth, more and more new species become established in Japan, temporarily or for longer periods, some known but perhaps more unknown. As a result, despite the small surface area of only 372,391 km^2, a great many different plant communities have arisen on the Japanese Islands.

If one looks at general vegetation patterns, the vegetation regions of Japan can be grouped into the following three main natural vegetation zones.

1. The Evergreen Broad-Leaved Forest region (Camellietea japonicae region)

Along the coasts of the Camellietea japonicae region, *Castanopsis cuspidata* var. *sieboldii* and *Persea* (*Machilus*) *thunbergii* are the dominant forest canopy species; the dominant canopy species inland are *Quercus* species such as *Qu. myrsinaefolia*, *Qu. salicina*, *Qu. glauca*, *Qu. acuta*, *Qu. sessilifolia*, and *Qu. miyagii*.

In the lower tree layer and in the shrub layer of these evergreen forests, the following occur: *Camellia japonica*, *Neolitsea sericea*, *Aucuba japonica*, *Eurya japonica*, *Ligustrum japonicum*, *Ilex integra*, plus other evergreen trees and shrubs. In the ground layer one finds *Trachelospermum asiaticum* var. *intermedium*, *Ophiopogon japonicus*, *Cymbidium goeringii*, *Reineckea carnea*; ferns such as *Dryopteris erythrosora*, *Arachniodes pseudo-aristata*, *A. aristata*, *Dryopteris lacera*; and other plants, all of which are evergreen. Using these and other species as diagnostic and character species, the natural forest vegetation is characterized as the class Camellietea japonicae (Miyawaki and Ohba 1963).

The entire warm-temperate area of Japan, from the Ryukyu Islands, Kyushu, and Shikoku to the southwestern part of the Kanto Plain (central Japan) and along the coasts to Tohoku (northern Honshu), was covered by evergreen broad-leaved forests in its original, natural condition. These forests are named Camellietea japonicae, refering to the character species of these forests, *Camellia japonica*. This region, which still today could be covered with such evergreen broad-leaved forests if all human influences could be removed, is called the Camellietea japonicae region (Miyawaki 1967; 1977, p. 34). This forest region reaches an elevation of 750 m above sea level in the Kanto region (around Tokyo and Yokohama).

This evergreen-forest region is also the center of settlement of the Japanese population. The earliest settlements which have been found in Japan were mostly in Kyushu, Shikoku and Honshu. Rice cultivation (whether introduced from the Ryukyu Islands, Korea or China is still unclear and argued by the archeologists) and settlements in the vicinity of the Camellietea japonicae region about 2000 years ago have been verified. Rice (*Oryza sativa* L.) is, of course, a warm-climate tropical plant.

As a result of this, the Camellietea japonicae forests became the essential life-support base of the Japanese people, for their physical as well as spiritual development. Today there are 20 cities in Japan each with over 500,000 inhabitants. Except for Sapporo

Fig. 1. In the rice-paddy region of the lowlands some evergreen broad-leaved forests have persisted the Polysticho-Perseetum thunbergii. The paddy in the foreground is shown just prior to the planting of the rice crop in the spring (Katsuura, 10 m a.s.l. Pref. Chiba).

Fig. 2. The early fall aspect of the Aucubo-Fagetum crenatae with the abundant understorey of *Sasa kurilensis* (Oze, 1450 m a.s.l. Pref. Gunma).

Fig. 3. Abietetum veitchii-mariesii on the Jumonji Pass, 2000 m a.s.l. (Pref. Saitama).

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4. Polysticho-Perseetum thunbergii as a protected forest around a Shinto shrine near the Sea of Japan (Miyazu, 5 m a.s.l. Pref. Kyoto).

and Asahikawa on Hokkaido, where 100 years ago there were hardly 1000 inhabitants, all of these large cities lie in the Camellietea japonicae region (Fig. 3). As a result of several thousand years of settlement activities by the Japanese, the original natural vegetation of most of these Camellietea japonicae areas is today either greatly modified or completely gone. Through various human influences the natural vegetation was replaced by corresponding secondary communities, such as summergreen *Quercus* forests (Quercetum acutissimo-serratae), *Miscanthus sinensis* grassland, plantations of *Cryptomeria japonica*, *Chamaecyparis obtusa*, *Pinus densiflora*, *P. thunbergii*, or field or rice-paddy ruderal communities.

Natural or nearly natural *Castanopsis sieboldii-Persea thunbergii* forests and various evergreen *Quercus* forests have survived up to the present day or have been created anew on steep slopes, ridges, and around Shinto shrines, Buddhist temples, in native groves around houses, etc. Through such remnants of the natural and nearly natural vegetation, even in the largest cities (Tokyo, Yokohama, and others), we can still today determine the potential natural vegetation regions (Tüxen 1956, Miyawaki 1967, Miyawaki *et al.* 1976).

The Camellietea japonicae evergreen broad-leaved forests are characterized, according to community structure and physiognomy as well as site environmental relations, by the following features:

1) Canopy tree layer: *Castanopsis cuspidata* var. *sieboldii*, *Persea thunbergii*, evergreen *Quercus* species such as *Qu. myrsinaefolia*, *Qu. salicina*, *Qu. acuta*, and *Qu. miyagii* as main tree species. On steep slopes and on other extreme sites one also finds *Abies firma*, *Tsuga sieboldii*, *Torreya nucifera*, and other coniferous species mixed in.

2) Lower tree layer: *Camellia japonica*, *Ilex integra*, *Neolitsea sericea*, *Dendropanax trifidus*, and other evergreen broad-leaved tree species are widely distributed.

3) Shrub layer: *Aucuba japonica*, *Eurya japonica*, *Fatsia japonica*, and other shade-

tolerant evergreen shrubs grow over wide areas.

4) Herb layer: as a result of the low light levels in all four seasons the species composition of the herb layer remains rather monotonous, especially in the forests on dry summits and ridges. As important species of the herb layer we can mention *Cymbidium goeringii*, *Liriope platyphylla*, *Ophiopogon japonicus*, *Ardisia japonica*; the vines *Trachelospermum*

Fig. 5. The many-storeyed forest structure inside the evergreen laurel forest of Ardisio-Castanopsietum sieboldii (Kamakura, 20 m a.s.l. Pref. Kanagawa).

asiaticum var. *intermedium*, *Hedera rhombea*, and *Kadzura japonica*; and ferns *Dryopteris erythrosora*, *D. lacera*, *D. pacifica*, and *Arachniodes asiatica*.

The characterizing feature of these natural forests is the fact that, from the higher tree layer to the shrub layer and vines, the forest is composed entirely of evergreen species.

The natural forests of the Camellietea japonicae region can be subdivided most generally into two groups: *Castanopsis sieboldii-Persea thunbergii* forests dominate along the coastal areas, while evergreen *Quercus* forests grow inland. In places, *Abies firma* and *Tsuga sieboldii* dominate near the upper limit of the *Quercus* species. On deep soils and mesic sites near the coast, *Persea thunbergii* dominates in the upper tree layer with evergreen ferns like *Polystichum polyblepharum*, *Arachniodes aristata*, and *A. pseudo-aristata* in the ground layer. In inland valleys, summergreen *Zelkova serrata* forests grow along the valley bottoms. On the west-Japanese alluvial areas near Osaka and Hiroshima, summergreen tree species such as *Aphananthe aspera* and *Celtis sinensis* var. *japonica* occur on corresponding sites.

On the generally slightly drier ridges and upper slopes grow *Castanopsis cuspidata* var. *sieboldii* forests near the coast and evergreen *Quercus* forests inland, such as Quercetum myrsinaefoliae, Nandino-Quercetum glaucae, and Distylio-Quercetum salicinae (Miyawaki, Okuda and Mochizuki 1978, 1984, Fujiwara, K. 1981). These diverse Japanese evergreen broad-leaved forests, along with the corresponding East Asian forests, were called Laurilignosa or "laurel forests" by Rübel (1930), in comparison with the European evergreen broad-leaved forests or Durilignosa, the sclerophyll forests of the Mediterranean region.

The Japanese "laurel forests", based on our present-day phytosociological studies on almost all the Japanese islands, have been summarized into various associations or corresponding but as yet unranked groupings. The units from the Ogasawara Islands, the Ryukyu Islands, Kyushu, Shikoku, Honshu, and various small neighboring islands were united into six alliances and three orders, placed in the Camellietea japonicae (Miyawaki ed. 1980, 1981, 1982, 1983, 1984: Vegetation of Japan I–V, Miyawaki, K. Fujiwara u.a. 1971; Miya-

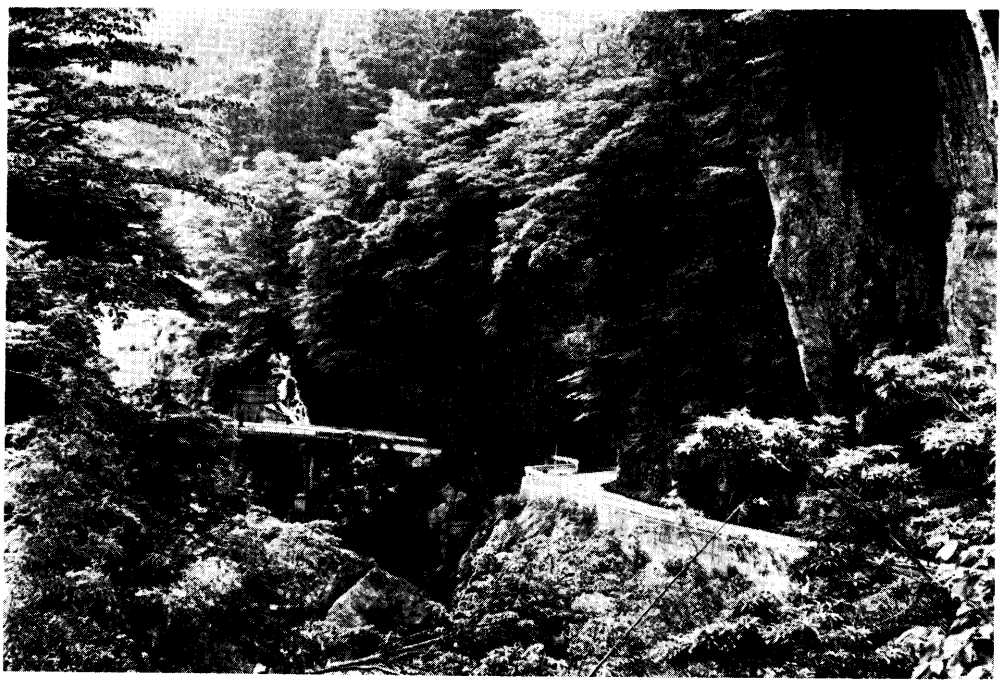

Fig. 6. The Aceri-Zelkovetum along a ravine (Sedogawa, 800 m a.s.l. Pref. Kochi, Shikoku).

Fig. 7. An old farm-house woodlot in the evergreen broad-leaved forest region. Tall *Quercus myrsinaefolia* trees on the homestead woodlot in the distance. Hedge trees like *Quercus glauca* and other species surrounding the houses. The Quercetum myrsinaefoliae forest indicates the potential natural vegetation (Tsukuba, 20 m a.s.l. Pref. Ibaraki).

waki, Okuda, Mochizuki 1978, 1984, Fujiwara, K. 1981).

In Japan as in other civilized countries, many substitute communities have arisen over long periods of time as a result of human activities in almost the entire Camellietea japonicae region, from the seacoasts to the upper limit in the lower montane belt. Corresponding to the type and intensity as well as the duration of the human influence, very different substitute communities have been formed from native and new species: summergreen secondary forests with Daphno pseudo-mezerei-Quercetum serratae, Quercetum acutissimo-serratae; secondary grasslands like Miscanthetea sinensis with Miscanthion sinensis, and Zoysion japonicae, Artemisietea principis, and Plantaginetalia asiaticae, as well as field and rice-paddy communities of the Commelinetalia communis (Chenopodietea) and Oryzetea sativae. Also, in the natural landscape, around ponds and lakes, there grow Alnetea japonicae and along rivers Salicetea sachalinensis with Salicion integrae, Salicion subfragilis, Phragmitetalia and other communities. Forest margins are bordered by various edge communities which are included in the class Rosetea multiflorae. Along the seacoast, before and on the dune systems, there grow Salsoletea komarovii, Glehnietea littoralis, Viticetea rotundifoliae, Euonymo-Pittosporetum tobira, and Pittosporo-Quercetum phillyraeoidis with *Pinus thunbergii* in the upper tree storey.

2. Summergreen Broad-Leaved Forest Region (Fagetea crenatae region)

Summergreen broad-leaved forests, i.e. Fagetea crenatae forests, are developed in central Japan in the elevational belt from 700 to 1600 meters. Their distribution dies out in the north, in the Tohoku region (northern Honshu), and on Hokkaido further to the north. In the south, the Fagetea crenatae area occurs higher and has its lower limit on

Fig. 8. A well-developed stand of the Sapio-Fagetum crenatae, subassoc. of Sasa tsuboiana with an undergrowth of *Sasa tsuboiana* (Mt. Omogo, 1500 m a.s.l. Pref. Tokushima, Shikoku).

Kirishima (1700 m) at around 1000 m. For the species composition, physiognomy, structure, and distribution of the Japanese beech forests, the Fagetea crenatae forests, both the general decrease in temperature towards the north and the snow depth, (dependent on the winter monsoon effect) play a deciding role. The monsoonal high-pressure cell which develops over Siberia in winter forces moist air masses across the Japanese Sea and against the mountainous backbone of the Japanese Islands. As a result, over 3 meters of snow fall in places along the western, windward slopes. Here the development of the *Fagus crenata* forests is luxurious, the germination potential of *Fagus crenata* is very high, and the size of the leaves is quite striking, compared with the leeward Pacific slopes.

The *Fagus* forests of the Japanese Sea side of Honshu contain various distinguishing species such as *Daphniphyllum macropodum* var. *humile*, *Cephalotaxus harringtonia* var. *nana*, *Aucuba japonica* var. *borealis*, *Sasa kurilensis*, *Ilex leucoclada*, and *Lindera umbellata* var. *membranacea* in the Saso kurilensae-Fagion crenatae, with Aucubo-Fagetum crenatae, Lindero umbellatae-Fagetum crenatae, Hamamelido-Fagetum crenatae, and other associations.

On the other hand, the *Fagus* forests of the Pacific side of the mountains can be grouped together with the Corno-Fagetum crenatae, Sapio japonici-Fagetum crenatae, Fagetum crenato-japonicae and other associations into the Sasamorpho-Fagion crenatae. Both Fagion alliances are grouped with the Carici-Tsugetum sieboldii, Disantho-Chamaecyparidietum obtusae, and other montane, conifer-dominated associations of mountain ridges, drier slopes, and other somewhat drier or seasonally dry, more or less extreme sites into the order Saso-Fagetalia crenatae.

To the Fagetea crenatae belong the Fraxino-Ulmetalia with the Pterocaryion rhoifoliae and its associations Polysticho-Pterocaryetum, Dryopteridi-Fraxinetum spaethianae, Isopyro-Fraxinetum spaethianae and the Ulmion davidianae

Fig. 9. The Abieti homolepidis-Fagetum crenatae stand with the typical overstorey and small openings caused by deer browse (Mt. Odaigahara, 1610 m a.s.l. Pref. Nara).

with the Ulmetum davidianae and the Syringo-Fraxinetum mandshuricae. Both alliances and their associations occur mostly on deeper, moister, more nutrient-rich soils. Important species of the Japanese Fraxino-Ulmetalia are the following: *Ulmus japonica* (*davidiana*), *Arachniodes standishii*, *Laportea macrostachya*, *Pterocarya rhoifolia*, *Laportea bulbifera*, *Aesculus turbinata*, *Dryopteris crassirhizoma*, *Ulmus laciniata*, *Polystichum tripteron*, *Acer carpinifolium*, *Asperula odorata*, *Hydrangea macrophylla* var. *acuminata*, *Fraxinus spaethiana*, *Cercidiphyllum japonicum*, *Phyllitis scolopendrium*, *Alangium platanifolium*, and others. In floodplains grow Salicetea sachalinensis with Toisuso-Populetum maximowiczii and Alno-Salicetalia serissaefoliae in various alliances and associations.

A special order of the Fagetea crenatae, the Quercetalia serrato-grosseserratae with Zelkovion serratae, Celtio-Aphananthion, Carpino-Quercion serratae and Pinion densiflorae, is distributed today more or less up to the Camellietea japonicae region. The Zelkovion, with the Torreyo radicantis-Zelkovetum serratae, Orixo-Zelkovetum serratae, and Hovenio dulcis-Zelkovetum serratae association, the Parabenzoino praecocis-Zelkovetum, and other associations occur on river banks and at the foot of slopes along the rivers. On sites in this region which are too moist or too unstable for the Camellietea japonicae communities there occur most of the associations of the Zelkovion serratae as well as some of the associations of the Alnetea japonicae. These associations grow on saturated, poorly aerated fringes of various water bodies.

Some striking associations such as Quercetum acutissimo-serratae, Daphno pseudo-mezerei-Quercetum serratae, and Castaneo-Quercetum serratae today extend far into the evergreen Camellietea japonicae region as typical secondary forests. They are maintained as permanent communities by the more or less regularly occuring clear-cutting every 15–25 years. These summergreen Carpino-Quercion serratae communities in the Kanto Plains near Tokyo and Yokohama and in other Camellietea japonicae regions

were almost all regarded earlier as natural forests. But through comparative field studies of natural vegetation and the substitute vegetation arisen through human influences, the syndynamic position of these summergreen forests as secondary forests has been ascertained (Miyawaki 1967, 1977, 1978; Miyawaki *et al.* 1972, 1977, etc.).

In comparison with the Camellietea japonicae region, the vegetation of the Fagetea crenatae region was at first not so drastically and fundamentally destroyed by human influences. These summergreen areas were used only in some places for pastures or as mowed grasslands. In the last 100 years, however, settlement on the northernmost island Hokkaido has been extended considerably. Especially since World War II, the montane Fagetea crenatae region in the mostly parts of Japan (Shikoku, Honshu and Hokkaido) has been greatly changed by extensive clear-cutting of natural forests, monotonous afforestation of coniferous species such as *Larix leptolepis*, *Cryptomeria japonica*, and *Chamaecyparis obtusa*, and through the construction of forest roads and new tourist facilities. The substitute communities of the Fagetea crenatae region, however, have not yet become stable, permanent communities, as in the Camellietea japonicae region or in the European Querco-Fagetea sylvaticae region. The most common substitute communities of the Fagetea crenatae region are the Castaneo-Quercetum crispulae, Rhododendro-Maletum, and Actinidio-Vition coignetiae, which are partly natural forests or typical edge communities.

Raised bogs with Oxycocco-Sphagnetea have also developed locally in the Fagetea crenatae and Vaccinio-Piceetea region. These include the Sphagnetalia fusci, the Eriophoro vaginati-Sphagnetalia papillosi, and the Sphagnetalia compacti, as well as the communities of the low, water-filled depressions (hollows), with various characteristic Japanese alliances and associations (Tüxen, R., A. Miyawaki u. K. Fujiwara 1970).

3. Belt of Subalpine Needle-Forests and Alpine Meadows and Heaths (Vaccinio-Piceetea and *Pinus pumila* scrub, plus alpine meadows and heaths)

Central Honshu, from 1600 to 2500 m, belongs to the Vaccinio-Piceetea region, with the important character species *Vaccinium vitis-idaea*, *V. ovalifolium*, *V. smallii*, *Listera cordata*, and *Coptis trifolia* etc., and with the Abieti-Piceetalia, with the important distinguishing species *Abies mariesii*, *A. veitchii*, *Larix leptolepis*, *Tsuga diversifolia*, and *Picea jezoensis* var. *hondoensis*. Above 2500 meters, and also on unstable sites, occur the Vaccinio-Pinetalia with the Vaccinio-Pinion pumilae alliance, where the krummholz forms of *Pinus pumila* dominate. The elevation of this belt decreases steadily towards the north.

The Abieti-Piceetalia contains the Abieti-Piceion along with the Abietetum mariesii and the Abietetum veitchii, which both occur on Honshu. The Abietetum veitchii also occurs on Shikoku, and the Dryopteridi-Abietetum mayrianae and Saso-Piceetum jezoensis occur on Hokkaido. On ridges, steep slopes, and other extreme sites in the Vaccinio-Piceetea region the Rhododendro-Thujion standishii occurs with Ilici-Thujetum standishii, Arachniodo muticae-Chamaecyparidetum obtusae, Patrino-Chamaecyparidetum obtusae, and others.

At elevations above 2500 m, with climatic conditions including deep snow and high winds, and with special chemical and physical characteristics such as ultra-basic parent materials, soil slumping, etc., There grow the corresponding alpine dwarf-shrub and natural meadow communities. These include Dicentro-Stellarietea nipponicae, Asplenietea rupestris, Carici rupestris-Kobresietea bellardii, Phyllodoco-Harrimanelletea, and other communities in numerous Japanese associations, which today are threatened with annihilation in many places by tourist facilities such as roads, hotels, and alpine shelters.

Fig. 10. The Abietetum veitchii-mariesii with a thick moss carpet (Mt. Norikura-dake, 2900 m a.s.l. Pref. Nagano).

Fig. 11. The Vaccinio-Pinetum pumilae "krummholz" association with the dense cover of *Pinus pumila*.

II. Potential Natural Vegetation of Japan

The potential natural vegetation (Tüxen 1956) represents the theoretical natural vegetation. The map of the potential natural vegetation of Japan is the integrated vegetation-ecological expression of the current site conditions, assuming all of man's influences on the vegetation in the cultural landscape could be excluded. The map of Japanese potential natural vegetation reflects four general vegetation regions.

1. Camellietea japonicae region (evergreen broad-leaved forest zone)

Central Honshu is covered, from the coasts to about 700 m above sea level, by evergreen

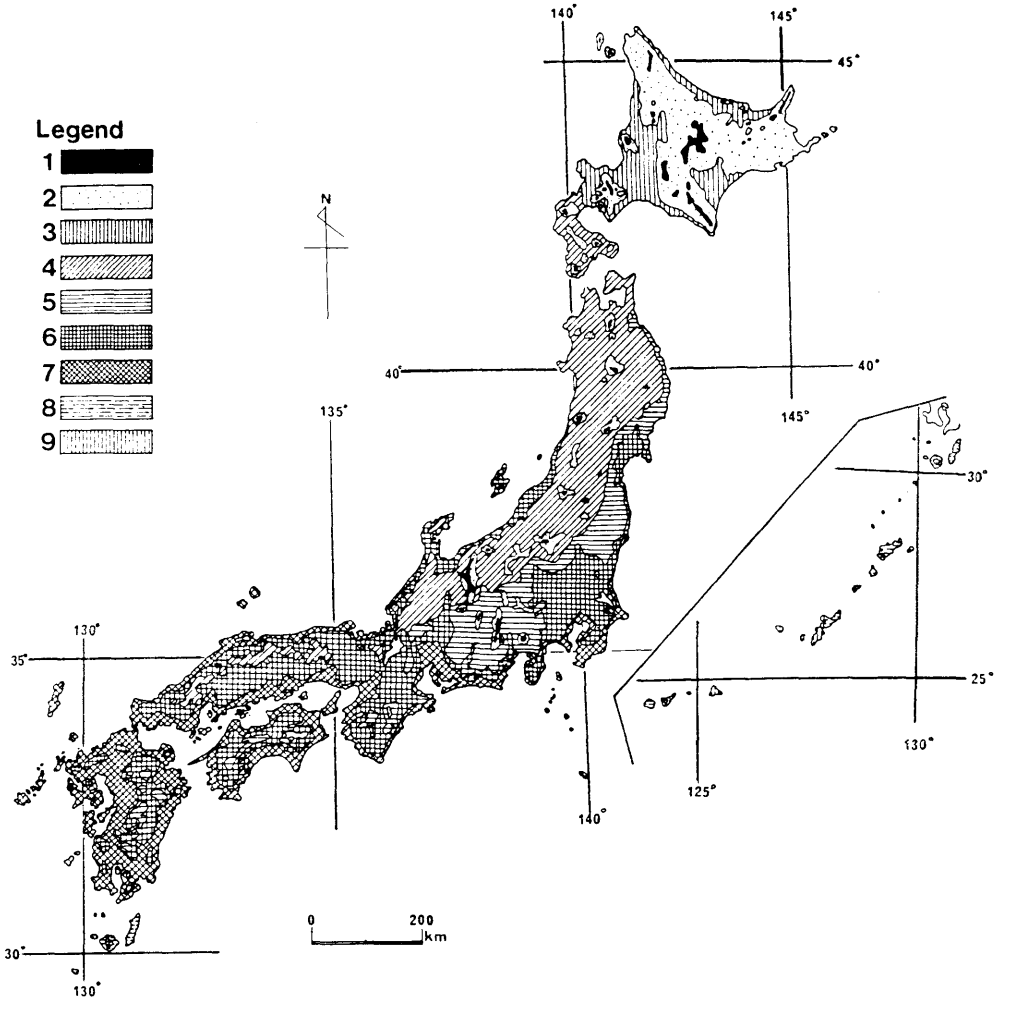

Fig. 12. The potential natural vegetation map of Japan.—Alpine vegetation region; 1) Vaccinio-Pinion pumilae, wind-exposed dwarf-shrub heath, grassland, etc.—Vaccinio-Piceetea japonicae region (subalpine conifer forest zone); 2) Abieti-Piceion—Fagetea crenatae region (deciduous broad-leaved forest zone); 3) Saso-Fagion crenatae in Hokkaido (*Quercus mongolica* var. *grosseserrata-Tilia maximowicziana*-forest); 4) Saso-Fagion crenatae in Honshu, Shikoku, and Kyushu (*Fagus crenata-Fagus japonica*-forest); 5) Sasamorpho-Fagion crenatae.—Camellietea japonicae region (evergreen broad-leaved forest zone); 6) Quercion acuto-myrsinaefoliae; 7) Maeso japonicae-Castanopsion sieboldii; 8) Psychotrio-Castanopsion sieboldii; 9) Psychotrio manillensis-Acerion oblongi (partly changed from Miyawaki, A., K. Suzuki & K. Fujiwara (1977)).

broad-leaved forests. On ridges and other somewhat drier sites near the coast (to 10–15 km inland), especially on thin soils, there grow Ardisio-Castanopsietum sieboldii and Symploco glaucae-Castanopsietum sieboldii grow, including the Psychotrio-Castanopsietum sieboldii with several *Castanopsis sieboldii* associations on the Ryukyu Islands. At the base of alluvial slopes and on other more mesic sites, usually with deeper soils, the Polysticho-Perseetum thunbergii, Arisaemato ringentis-Perseetum thunbergii, and other *Persea thunbergii* forests occur as the potential natural vegetation.

Evergreen *Quercus* (*Cyclobalanopsis*) forests cover extensive inland areas in the Camellietea japonicae region, including the Quercetum myrsinaefoliae in the Kanto Plains near Tokyo and Yokohama, and the Quercetum gilvae, Photinio-Castanopsietum cuspidatae, Distylio-Cyclobalanopsietum, Nandino-Quercetum glaucae, and Aucubo-Quercetum salicinae in western Honshu, Shikoku, and Kyushu.

On ridgecrests, steep slopes, and other, similarly extreme sites near the upper limit of the Camellietea japonicae region, where pure broad-leaved forests can no longer dominate, conifer-dominated forests occur in some places. These include Illicio-Abietetum firmae, Ilici-Tsugetum sieboldii, and Lindero-Cryptomerietum.

A schematic representation of the vertical distribution of the most important alliances and classes of the actual and potential natural vegetation in central Honshu is shown by Miyawaki (1979, Figs. 13, 14).

2. Fagetea crenatae region (summergreen broad-leaved forest zone)

The Fagetea crenatae region in central Honshu reaches from about 700 to about 1600 m above sea level. The horizontal width of this belt increases steadily to the north, toward northern Honshu and Hokkaido. To the south, in western Honshu and Kyushu,

Fig. 13. The early spring aspect of the Quercetum acutissimo-serratae coppice forest which will be harvested every 15–20 years for firewood and charcoal (Aso, Kawasaki City, 60 m a.s.l. Pref. Kanagawa).

the potential Fagetea crenatae region climbs steadily to higher elevations.

An important summergreen forest grouping in the Fagetea crenatae region is the Saso-Fagetalia crenatae communities, the ground in which is almost always thickly covered by characteristic small *Sasa* species. Thanks to the climatic conditions, especially the abundant snow associated with the winter monsoon, Saso kurilensis-Fagion crenatae, with Aucubo-Fagetum crenatae, and other *Fagus* forests are widespread on the windward, Japanese Sea side of Honshu. On the Pacific side, with less snow, grow Sasamorpho-Fagion crenatae communities, with Corno-Fagetum crenatae, Sapio japonicae-Fagetum crenatae, Fagetum crenato-japonicae, and other associations.

In the Fagetea crenatae region north of Kuromatsunai in southern Hokkaido, where *Fagus* species can no longer occur. There appear in place of the Fagetea crenatae such forests as *Quercus mongolica* var. *grosseserrata-Quercus dentata* forests and the *Tilia maximowicziana-Quercus mongolica* var. *grosseserrata* community. In wet places along streams or mires (Moor), Fraxino-Ulmetalia with Pterocaryon rhoifoliae and Ulmion davidianae are widespread.

3. Vaccinio-Piceetea region (Subalpine and Subarctic conifer-forest zone)

In Honshu, the upper summergreen broad-leaved forest belt borders directly on the subalpine conifer-forest belt. On Honshu, Shikoku and Hokkaido this is the Abieti-Piceion. In central Honshu (Japanese Alps) the Abietetum mariesii and Abietetum veitchii occur above 1600 m. On Shikoku the Abietetum sikokianae takes over this position above 1800 m on the mountains Ishizuchi (1981 m) and Tsurugisan (1893 m).

On Hokkaido the Dryopterido-Abietetum mayrianae, Saso-Piceetum jezoensis, and other boreal or subarctic needle-forests grow on the mountain Daisetsu (2290 m, in central Hokkaido) and on other mountains. In northern and eastern Hokkaido,

Fig. 14. An artificial plantation of *Cryptomeria japonica* with a rich understorey of its potential natural vegetation of the Sapio-Fagetum crenatae (Honkawa-son, 1350 m a.s.l. Pref. Kochi, Shikoku).

however, the conifer stands sometimes descend almost to the seacoast or to the nearby mires.

The character of the subalpine and boreal conifer forests is rather monotonous physiognomically, due to the small number of dominant conifer species plus the only occasional admixture of *Betula ermanii*.

The natural vegetation of the Japanese subalpine and boreal conifer belt has been greatly altered recently through clear-cutting, road construction, and other human influences. This conifer vegetation is generally in better condition, though, for the most part, than the vegetation of the Camellietea japonicae and the Fagetea crenatae regions. Thus, the potential natural vegetation in this region is also easier to ascertain in the field than in the other, lower-lying regions.

4. Alpine Vegetation belt

The central Japanese mountain ranges on Honshu are called the "Japanese Alps" and include more than 10 peaks above 3000 meters. On this highest of Japanese montane belts, above 2500 m, and on the 1500 m-high mountains of Hokkaido, grow various alpine heath and meadow communities mixed in among the shrub-like Pinion pumilae krummholz communities, which belong still to the subalpine Vaccinio-Piceetea.

Strictly speaking, the areas of alpine vegetation in Japan simply are not large enough to be represented on the map. Instead, on the map of the potential natural vegetation of the Japanese Islands, the areas of the Pinion pumilae communities and the micro-mosaic of alpine meadow and heath communities are combined as "alpine vegetation".

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