

岩石海岸のカシワ林の植物社会学的研究

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Hiroki NAKANISHI* : Phytosociological Studies on *Quercus dentata* Scrubs of Rocky Coasts in Japan.

中西弘樹：岩石海岸のカシワ林の植物社会学的研究

Introduction

Coastal scrub vegetations are developed under the influence of salt spray brought by sea winds and occasionally show a wind-cut form in physiognomy. Stands of the scrub are usually in a deteriorated state occurring only on shallow soils on rocky slopes and sandy habitats. Along the coast in southern Japan, ever-green broad-leaved or sclerophyllous scrubs featuring *Pittosporum tobira* and *Quercus phillyraeoides* are widely distributed and have been phytosociologically studied by many authors (SUZUKI & HACHIYA 1951; YAMANAKA 1958; MIYAMOTO 1963, 1967; NAKANISHI & H. SUZUKI 1973; ITOW et al. 1974). On the other hand, deciduous scrubs dominated by *Quercus dentata* and *Q. mongolica* are found in northern Japan, especially on sand dunes in Hokkaido. But these scrubs have been destroyed by grazing, mowing and cutting, and many of these stands have been replaced by secondary herbaceous communities. The scrubs on sandy coasts in northern Japan were studied by TATEWAKI (1961), TUJII & YAMORI (1965) and OHBA, MIYAWAKI & TÜXEN (1973). The last authors established two associations for this scrub vegetation: the *Angelico anomalae-Quercetum dentatae* and the *Angelico anomalae-Quercetum mongolicae*. Specific studies for the *Quercus* scrub along the rocky coasts were undertaken by only a few authors (ISHIZUKA 1951; OKADA 1969). Plant geographical and syntaxonomical studies have never been made.

The aims of the present studies are to classify the *Quercus dentata* scrub vegetation of rocky coasts in Japan on a phytosociological basis using the method of the ZM school, and to describe the vegetation units with particular reference to the geographical factor.

I wish to express my sincere thanks to Prof. Emer. H. SUZUKI of Hiroshima University, under whose guidance the present studies were carried

out.

Area investigated and Methods

In the present study, I concentrated on sampling stands from the whole range of the *Quercus dentata* scrub as is occurred on rocky coasts in Japan. The 23 localities chosen for field investigation are shown in Fig. 1. The locality numbers coincide with NAKANISHI (1980) (see the Table 1 in NAKANISHI 1980). The additional localities shown the number with letter "N" are only listed in Table 1.

The study was carried out on the *Quercus dentata* scrub vegetation as it has developed on cliffs, slopes and outcrops along coastal areas.

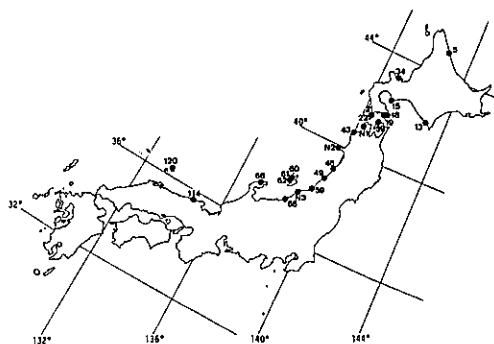


Fig. 1. Map showing the localities investigated. Numerals on the map refer to the number of the localities shown in Table 1 of NAKANISHI (1980).

Table 1. Additional localities investigated

No.	Locality	Date of investigation
N1	Motowaki, Shiura-mura, Kitatsugaru-gun, Aomori Pref.	July 22. 1980
N2	Shiohama, Oga City, Akita Pref.	July 23. 1980
N3	Maze, Iwamuro-mura, Nishikanbara-gun, Niigata Pref.	July 25. 1980

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The description and classification of the communities were made according to the ZM school of phytosociology (BRAUN-BLANQUET 1964; MUELLER-DOMBOIS & ELLENBERG 1974).

Classification

From 107 phytosociological records of the *Quercus dentata* scrub on rocky coasts, the following one alliance, two suballiances and five associations are classified.

All. Quercion dentatae all. nov. (Table 2)

Character species: *Quercus dentata*, *Quercus mongolica*, *Lonicera morrowii*.

Type association: Angelico anomalae-Quercetum dentatae.

Distribution: San-in, Hokuriku, Tohoku and Hokkaido.

The natural *Quercus dentata* scrub vegetation is restricted to deteriorated stands where the natural climatic forests can not developed. These stands are found widely along coastal areas in northern Japan. The sandy coast *Quercus* scrub

vegetation is distributed from northern Tohoku to Hokkaido, but that along the rocky coast is distributed from the San-in District through Tohoku to the north. OHBA, MIYAWAKI & TÜXEN (1973) phytosociologically studied the scrub on the sandy coast in Hokkaido and suggested that the *Quercus* scrubs might be incorporated in an alliance. In the same district, the species composition of the rocky coast scrub is very similar to the one on sandy coast. The *Quercus dentata* scrubs along rocky coasts are incorporated into an alliance including the ones along sandy coasts.

The scrub of this rocky coast alliance is usually developed along the south-facing slopes which are exposed and sunny in the northern area. In the southern area, however, the scrub found on west-facing slopes are severely exposed to winter winds. The canopy of the scrub is occupied only by *Quercus dentata* and is occasionally associated with *Acer mono*, *Quercus mongolica* and *Viburnum dilatatum*. The herb layer is usually composed of many species.

Table 2. Quercion dentatae

A. Suball. Coccole orbiculati-Quercion: 1. Albizio julibrissin-Quercetum, 2. Carici cuneatae-Quercetum
 B. Suball. Celastrio papilloso-Quercion: 3. Angelico edulis-Quercetum, 4. Angelico ursinae-Quercetum, 5. Angelico anomalae-Quercetum

Suballiance Association Subassociation Number of records	A						B					
	1			2			3		4		5	
	a	b	c	a	b	c	a	b	a	b	a	b
	5	4	3	7	27	6	16	4	16	6	6	6
Ch. & diff. spp. of association												
Albizia julibrissin	IV	4	1	.	.	.	.	.	.	.	.	Nemunoki
Celtis sinensis var. japonica	I	3	3	.	II	.	.	.	.	.	.	Enoki
Pittosporum tobira	IV	1	.	.	.	.	.	.	.	.	.	Tobera
Carex stenostachys var. cuneata	.	.	.	V	V	V	.	.	.	.	.	Michinokuhonmonjisuge
Potentilla togasii	.	.	.	.	II	I	.	.	.	.	.	Echigokijimushiro
Saussurea nipponica var. muramatsui	.	.	.	.	III	.	.	.	.	.	.	Togahigotai
Prunus apetala var. pilosa	.	.	.	.	II	.	.	.	.	.	.	Okuchojizakura
Angelica ursina	.	.	.	.	.	.	.	V	V	.	.	Ezonyu
Chloranthus serratus	.	.	.	.	I	.	.	III	III	.	I	Futarishizuka
Artemisia keiskeana	I	4	.	I	II	.	.	II	IV	.	.	Inuyomogi
Angelica anomala	.	.	.	.	.	.	.	.	.	V	V	Ezonoyoroigusa
Moehringia lateriflora	.	.	.	.	.	.	.	.	.	IV	III	Ooyamafusuma
Convallaria keiskei	.	.	.	.	.	.	.	I	.	IV	II	Suzuran
Maianthemum dilatatum	.	.	.	.	.	.	.	.	.	II	V	Maizuruso
Diff. spp. of subassociation												
Festuca ovina	IV	.	.	.	.	.	4	.	.	.	.	Ushinokegusa
Plectranthus inflexus	III	.	.	II	.	.	.	III	.	.	I	Yamahakka
Artemisia japonica	III	.	.	.	.	.	.	.	III	.	.	Otokoyomogi
Carex breviculmis var. fibrillosa	IV	.	.	.	.	.	.	.	.	.	.	Hamaosuge
Asparagus schoberioides	IV	.	.	.	.	.	.	.	.	.	.	Kijikakushi
Lysimachia mauritiana	III	.	.	.	.	.	.	.	.	.	.	Hamabossu
Aster scaber	.	3	.	II	I	.	.	III	V	.	V	Shirayamagiku
Prunus jamasakura	.	4	.	.	.	.	.	.	.	.	.	Yamazakura
Epimedium sempervirens	.	4	.	.	.	.	.	.	.	.	.	Tokiwakariso
Zanthoxylum piperitum	.	4	.	I	I	.	.	.	.	.	.	Sansho
Parthenocissus tricuspidata	.	4	.	I	I	.	.	.	.	.	.	Natsuzuta
Rubus palmatus	.	3	.	.	.	.	.	.	.	.	.	Nagabamomijiichigo
Hosta montana	.	3	.	.	.	.	.	.	.	.	.	Oobagiboshi
Philadelphus satsumi	.	3	.	.	.	.	.	.	.	.	.	Baikautsugi
Synurus palmatopinnatifidus	.	3	.	.	.	.	.	.	.	.	.	Yamabokuchi
Rubus parvifolius	.	3	.	I	.	.	.	I	.	.	.	Nawashiroichigo
Festuca rubra	.	3	V	I	II	I	2	I	I	I	.	Ooushinokegusa
Euonymus japonicus	.	3	.	.	.	.	.	.	.	.	.	Masaki

In Hokkaido, the scrub floor is usually covered with *Sasa senanensis* over which tall herbs grow, such as *Angelica* spp., *Cirsium kamtschaticum* and *Petasites japonicus* var. *giganteus*. Under the *Sasa* layer, small herbs are sparsely found due to the low light intensity. Common species in the herb layer are *Adenophora triphylla* var. *japonica*, *Artemisia montana*, *Solidago virga-aurea* var. *asiatica*, *Carex blepharicarpa*, *Miscanthus sinensis* and *Thalictrum minus* var. *hypoleucum*. Most of these plants are component species of the herb communities in the class Miscanthetea. This may be due to the fact that the scrub floor has a comparatively low light intensity and the stands have only shallow soils.

Suball. **Cocculo orbiculati-Quercenion dentatae** suball. nov. (Table 2)

Differential species: *Cocculus orbiculatus*, *Smilax china*, *Ampelopsis brevipedunculata*, *Clematis terniflora*, *Paederia scandens* var. *mairei*, *Pueraria lobata*.

Type association: Carici cuneatae-Quercetum.

Distribution: San-in, Hokuriku and western side of Tohoku

The *Quercus dentata* associations are distributed in the southern part of the Quercion region and are clearly different from those of northern part by the floristic composition and the physiognomy of the scrub floor. The southern type is differentiated by many liana plants. The herb layer is composed chiefly of cliff herbaceous vegetation elements, but not by *Sasa*. This type of scrub is assigned to a new suballiance; Cocculo orbiculati-Quercenion.

The scrub which has developed in more southern region often has several species of the Camellietea element, which is especially characteristic of the Pittosporion and includes *Cyrtomium falcatum*, *Pittosporum tobira* and *Euonymus japonicus*.

The suballiance includes the following two associations.

1. Ass. **Albizio julibrissin-Quercetum dentatae** ass. nov. (Table 3; Fig. 2)

Character & differential species: *Albizia julibrissin*, *Celtis sinensis* var. *japonica*, *Pittosporum tobira*.

Type record: Table 3, column no. 5.

Distribution: San-in and Hokuriku.

Synonym: *Quercus dentata-Viburnum carlesii* var. *bitchense* comm. (H. SUZUKI & NAKANISHI 1972), *Quercus dentata-Albizia julibrissin* comm. (NAKANISHI 1981).

This *Quercus dentata* scrub vegetation is not clearly characterized by any species. The floristic compositions of all stands are more or less different from each other due to somewhat unstable stands and geography. It is restricted to the southern part of the *Quercus dentata* scrub region and is often associated with some ever-green plants of the alliance Pittosporion. This scrub is differentiated from the other *Quercus dentata* scrubs by the presence of *Albizia julibrissin*, *Celtis sinensis* var. *japonica* and *Pittosporum tobira*. The former two species are deciduous tree species. On the floor of this scrub, *Bracypodium sylvaticum* and *Dianthus superbus* var. *longicalycinus* are more frequently found than in the other scrub vegetation. *Miscanthus sinensis* constantly occurs here.

The distribution of the association is in the area of the Japan Sea side of central Japan (Fig. 2), from the Sado Island of Niigata Prefecture, through the Hokuriku District, to the Oki Islands of Shimane Prefecture in the San-in District. Some fragments of this association seem to extend to northern Kyushu. Although in the Sanin District the Pittosporion scrubs are also found, this deciduous *Quercus* scrub is restricted to the slopes which are severely influenced by the

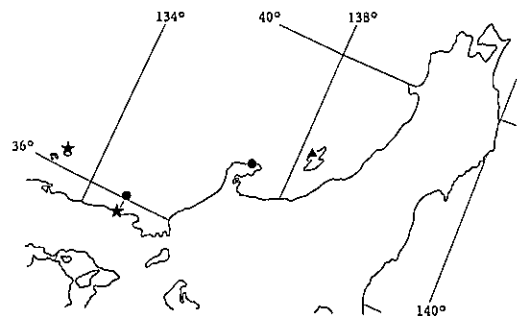


Fig. 2. Distribution of Albizio julibrissin-Quercetum dentatae. Subass. festucetosum ovinae (●), Subass. epimeditosum sempervirens (★), Subass. euonymetosum japonici (▲).

Table 3. *Albizia julibrissin*-*Quercetum dentatae*1-a. Subass. *festucetosum ovinae*, 1-b. Subass. *epimeditetosum sempervirens*
1-c. Subass. *euonymetosum japonici*

Subassociation	1-a				1-b				1-c				
	1	2	3	4	5	6	7	8	9	10	11	12	
Column number	120	120	120	114	114	68	68	68	114	61	61	61	
Locality number	10	20	50	30	30	100	100	50	60	50	50	30	
Altitude (m)	10	10	150	20	20	100	100	100	-	50	50	70	
Distance from shoreline (m)	SW	NW	NW	E	E	NW	NW	NW	SE	SE	SE	S	
Slope aspect (°)	60	30	80			70	70	55	45	10	10		
Slope degree (°)	40	25	15	20	20	30	30	3	30	70	75	35	
Height of shrub layer (m)	1	1.2	25	18	18	3	4	3	7	2	2	25	
Coverage of shrub layer (%)	60	95	85	70	65	90	95	95	75	98	98	95	
Height of herb layer (cm)	50	50	80	80	80	80	80	70	60	70	70	60	
Coverage of herb layer (%)	60	15	40	70	70	90	65	65	50	10	5	15	
Size of plot area (m ²)	25	25	25	36	36	36	36	36	49	36	36	36	
Number of species	19	20	22	20	18	33	39	34	38	16	16	15	
Ch. & diff. spp. of association													
<i>Albizia julibrissin</i>	.	+	+2	+	12	22	11	12	+	.	11	.	Nemunuki
<i>Celtis sinensis</i> var. <i>japonica</i>	.	.	+2	.	.	+	12	.	+	+	11	12	Enoki
<i>Pittosporum tobira</i>	22	+	.	+	+	.	.	.	+	.	.	.	Tobera
Diff. spp. of subassociation													
<i>Festuca ovina</i>	12	+2	.	(+)	(+)	.	.	.	.	.	.	.	Ushinokegusa
<i>Asparagus schoberioides</i>	+	+	.	+	+	.	.	.	.	.	.	.	Kijikakushi
<i>Carex breviculmis</i> var. <i>fibrillosa</i>	+	.	+2	+	+	.	.	.	.	.	.	.	Hamaaosuge
<i>Plectranthus inflexus</i>	+	+2	+2	.	.	.	.	.	.	.	.	.	Yamahakka
<i>Lysimachia mauritiana</i>	+	.	.	+	+	.	.	.	.	.	.	.	Hamabossu
<i>Clematis terniflora</i>	+	.	.	+	+	.	.	.	.	.	.	.	Senninso
<i>Artemisia japonica</i>	.	.	+2	+	+	.	.	.	.	.	.	.	Otokoyomogi
<i>Prunus jamasakura</i>	.	.	.	.	.	+	22	+2	+	.	.	.	Yamazakura
<i>Epimedium sempervirens</i>	.	.	.	.	.	+2	+2	+	12	.	.	.	Tokiwaikariso
<i>Zanthoxylum piperitum</i>	.	.	.	.	.	+2	+	12	11	.	.	.	Sansho
<i>Parthenocissus tricuspidata</i>	.	.	.	.	.	+	+2	+2	+	.	.	.	Natsuzuta
<i>Artemisia keiskeana</i>	.	12	.	.	.	+2	23	22	+	.	.	.	Inuyomogi
<i>Melica nutans</i>	.	+	.	.	.	12	12	33	+	.	.	.	Komegaya
<i>Sasa senanensis</i>	.	.	.	.	.	22	12	22	.	.	.	.	Kumaizasa
<i>Rubus palmatus</i>	.	.	.	.	.	12	+	+	.	.	.	.	Nagabamomijiichigo
<i>Hosta montana</i>	.	.	.	.	.	+	+	+	.	.	.	.	Obagiboushi
<i>Philadelphus satsumi</i>	.	.	.	.	.	+	+	+	.	.	.	.	Baikautsugi
<i>Aster scaber</i>	.	.	.	.	.	+	.	+	+	.	.	.	Shirayamagiku
<i>Synurus palmatopinnatifidus</i>	.	.	.	.	.	.	+	+	+	.	.	.	Yamabokuchi
<i>Rubus parvifolius</i>	.	.	.	.	.	.	+	+	+	.	.	.	Nawashiroichigo
<i>Euonymus japonicus</i>	.	.	.	.	.	.	.	.	.	33	33	33	Masaki
<i>Cyrtomium falcatum</i>	.	.	.	.	.	.	.	.	.	+2	+2	+	Oniyabusotetsu
<i>Festuca rubra</i>	.	.	.	.	.	.	.	.	.	+	+	+2	Ooushinokegusa
<i>Euonymus sieboldianus</i>	.	.	.	.	.	.	.	.	.	+	+	+	Mayumi
Ch. & diff. spp. of suballiance													
<i>Paederia scandens</i> var. <i>mairei</i>	+	.	+2	+	.	+	+2	+2	+	.	.	.	Hekusokazura
<i>Smilax china</i>	.	.	+2	+	+	+	+	.	.	.	+	.	Sarutoriibara
<i>Cocculus orbiculatus</i>	+	.	.	.	.	+	+	.	.	.	.	+	Aotsuzurafuji
<i>Ampelopsis brevipedunculata</i>	.	.	+	.	.	+	+	.	.	.	+	.	Nobudo
<i>Pueraria lobata</i>	.	.	.	.	.	.	.	.	.	+	.	.	Kuzu
Ch. spp. of allinace													
<i>Quercus dentata</i>	33	33	55	44	44	55	44	44	44	55	55	55	Kashiwa
<i>Lonicera morrowii</i>	12	+	+	.	.	.	.	.	.	+	+	.	Hyotanboku
Ch. spp. of order & class													
<i>Viburnum dilatatum</i>	.	.	.	.	.	12	+2	12	12	+	+	+	Gamazumi
<i>Polygonatum lasianthum</i>	.	+2	.	.	.	.	.	.	.	.	+	+	Miyamanarukoyuri
<i>Rhus ambigua</i>	.	.	.	.	.	+2	.	.	.	.	.	.	Tsutaursushi
<i>Acer mono</i>	.	.	.	.	.	.	12	.	.	.	.	.	Itayakaede
Companions													
<i>Brachypodium sylvaticum</i>	+2	.	.	44	44	+2	12	22	22	+	+	12	Yamakamojigusa
<i>Miscanthus sinensis</i>	+2	+2	12	11	12	+2	+2	12	.	+	+	.	Susuki
<i>Adenophora triphylla</i> var. <i>japonica</i>	+	+	.	.	.	+	+2	+	+	+	+	+	Tsuriganeninjin
<i>Solidagovirga-aurea</i> var. <i>asiatica</i>	.	+	.	.	.	+	+	+	+	+	+	+2	Akinokirinso
<i>Lysimachia clethroides</i>	.	+	.	+	.	12	+2	12	+	.	.	.	Okatorano
<i>Dianthus superbus</i> var. <i>longicalycinus</i>	+	.	.	+	+	+	+	.	+	.	.	.	Kawaranadeshiko
<i>Thalictrum minus</i> var. <i>hypoleucum</i>	.	.	.	+	+	.	.	.	.	+	+	+	Akikaramatsu
<i>Ligustrum obtusifolium</i>	.	.	+	+	11	.	+	.	.	.	.	.	Ibotanoki
<i>Akebia trifoliata</i>	.	.	+	.	.	+	+	.	+	.	.	.	Mitsubaakebi
<i>Carex blepharicarpa</i>	.	.	.	.	.	22	44	44	.	.	.	+2	Shojyosuge
<i>Viola grypoceras</i>	.	+	.	.	.	+	+	.	.	.	.	.	Tachitsubosumire
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	.	.	+2	.	+	.	.	+2	.	.	.	.	Warabi
<i>Rosa multiflora</i>	.	.	+	.	.	.	+2	.	.	.	.	.	Noibara
<i>Chrysanthemum makinoi</i> var. <i>wakasaense</i>	.	.	.	+	11	.	.	.	+	.	.	.	Wakasahamagiku
<i>Dystaenia ibukiensis</i>	.	.	.	+	+	.	.	.	+	.	.	.	Serimodoki
<i>Spodiopogon sibiricus</i>	+	+	.	.	.	.	.	.	.	.	.	.	Ooaburasusuki
<i>Hypericum erectum</i>	+	+	.	.	.	.	.	.	.	.	.	.	Otogiriso
<i>Chrysanthemum okiense</i>	+	.	12	.	.	.	.	.	.	.	.	.	Okinoaburagiku
<i>Pinus thunbergii</i>	.	+	.	.	.	.	.	12	.	.	.	.	Kuromatsu

Elaeagnus umbellata	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	Akigumi
Lespedeza bicolor	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	Yamahagi
Ophiopogon japonicus	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	Jyano-hige
Angelica pubescens	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	Shishiudo
Mallostus japonicus	.	.	.	.	.	.	.	.	.	12	+	.	.	.	.	Akamegashiwa

Other companions: in column no. 1. *Cynanchum wilfordii* (Koikema) +, in 2. *Viburnum carlesii* var. *bitchunense* (Chojigamazumi) 22, *Inula salicina* var. *asiatica* (Kasense) +2, in 3. *Aster ageratoides* var. *ovatus* (Nokongiku) 33, *Lonicera japonica* (Suikazura) 12, *Oxalis corniculata* (Katabami) +, *Vitis ficifolia* var. *lobata* (Ebizuru) +, in 6. *Sedum kamtschaticum* (Kirinso) +2, *Zelkova serrata* (Keyaki) 12, in 7. *Akebia quinata* (Akebi) +, *Oplismenus undulatifolius* var. *japonicus* (Chijimizasa) +, *Ophiopogon planiscapus* (Obajjyano-hige) +, *Trachelospermum asiaticum* (Teikakazura) +, *Carex humilis* var. *nana* (Hosobahikagesuge) 12, in 8. *Artemisia montana* (Ooyomogi) +, *Patrinia villosa* (Otokoeshi) +, *Campanula punctata* (Hotarubukuro) +, *Dioscorea japonica* (Yamanoimo) +, *Codonopsis lanceolata* (Tsuruminjin) +, *Eupatorium chinense* var. *simplicifolium* (Hiyodoribana) +, *Cerastium fischerianum* +, in 9. *Rhododendron kaempferi* (Yamatsutsuji) 22, *Ilex crenata* (Inutsuge) 12, *Carex lanceolata* (Hikagesuge) 12, *Struthiopteris niponica* (Shishigashira) +2, *Osmanda japonica* (Zenmai) +, *Gentiana scabra* var. *buergeri* (Rindo) +, *Elaeagnus macrophylla* (Oobagumi) +, *Ardisia japonica* (Yabukoji) +, *Eurya japonica* (Hisakaki) 11, *Cinnamomum japonicum* (Yabunikkei) +, *Hydrangea luteo-venosa* (Kogakuutsugi) +, *Spiraea obtusa* (Tangoiwagasa) +, in 10. *Rubia jesoensis* (Ooakane) +, in 12. *Hemerocallis middendorffii* (Ezozenteika) +.

northwesterly wind in winter.

By the difference of floristic composition and edaphic conditions, this association is distinguished into three subassociations.

1-a. Subass. *festucetosum ovinae*

Differential species: *Festuca ovina*, *Asparagus schoberioides*, *Carex breviculmis* var. *fibrillosa*, *Plectranthus inflexus*, *Lysimachia mauritiana*, *Clematis terniflora*, *Artemisia japonica*.

Distribution: Shimane and Hyogo Prefectures.

This subassociation is the southernmost type of this association. The stands are on rocky slopes with shallow soils. The canopy of the scrub is never closed by *Quercus dentata* and the height is 1 to 2.5 m. Consequently, the herbaceous community elements of the rocky coasts, such as *Festuca ovina*, *Artemisia japonica* and *Lysimachia mauritiana*, are often found on the floor.

1-b. Subass. *epimeditosum sempervirens*

Differential species: *Prunus jamasakura*, *Epimedium sempervirens*, *Zanthoxylum piperitum*, *Parthenocissus tricuspidata*, *Artemisia keiskeana*, *Melica nutans*, *Sasa senanensis*, *Rubus palmatus*, *Hosta montana*, *Philadelphus satsumi*, *Aster scaber*, *Rubus parvifolius*, *Synurus palmatopinnatifidus*.

Distribution: Hyogo and Ishikawa Prefectures.

This subassociation is developed on the upper parts of cliffs at altitude of 50 to 100 m. Consequently, the scrub is scarcely influenced by salt spray in spite of receiving heavy winds. The occurrences of *Rubus parvifolius*, *R. palmatus* and *Zanthoxylum piperitum* may, however, indicate unstable conditions of these stands. Habitats of

these scrub are provided with moist deeper soils, so that many herbaceous species are found. The frequent occurrence of ever-green herbs, such as *Carex* spp., ferns, *Epimedium sempervirens* and *Ophiopogon japonicus* are especially conspicuous. The number of component species is very great, 36.0 on the average. The record (column no. 9) from Hyogo Prefecture is somewhat different from the others, but is obviously included in this subassociation.

1-c. Subass. *euonymetosum japonici*

Differential species: *Euonymus japonicus*, *Cyrtomium falcatum*, *Festuca rubra*, *Euonymus sieboldianus*.

Distribution: Niigata Prefecture (Sado Is.)

The present subassociation which is the northernmost type of the association is developed on the south-facing slope. *Euonymus japonicus* and *Cyrtomium falcatum*, which are differential species of this subassociation, are also character species of the alliance *Pittosporion tobirae*. The first species is the only ever-green shrub in this deciduous scrub vegetation. Due to the steep slopes of 35 to 75 degrees, the undergrowth coverage is poor, 5 to 15%. The number of component species is 15.7 on the average.

2. Ass. *Carici cuneatae-Quercetum dentatae* ass. nov. (Table 4; Figs. 3 and 4)

Character & differential species: *Carex stenostachys* var. *cuneata*, *Potentilla togashii*, *Prunus apetala* var. *pilosa*, *Saussurea nipponica* var. *muramatsui*.

Type record: Table 4, column no. 19.

Distribution: Hokuriku and western side of Tohoku.

Synonym: *Quercus dentata*-*Acer mono* thicket (YOSHIOKA 1964), *Quercus dentata*-*Tilia japonica* comm. (OKADA 1969).

This *Quercus dentata* scrub, especially in Sado Island, has been studied by several authors (YOSHIOKA 1957, 1964; OKADA 1969; HONMA 1972), but has not been treated phytosociologically based on the method of the ZM school.

The present association is characteristically associated with the many endemic species which are restricted to the Japan Sea side of northern Honshu. The floor is usually densely covered with graminoides species (*Carex blepharicarpa*, *C. stenostachys* var. *cuneata* and *Festuca rubra*). In the shrub layer, *Quercus dentata* is a dominant species. *Viburnum dilatatum* and *Acer mono* also commonly occur. *Euonymus sieboldianus* and *Prunus apetala* var. *pilosa* are often found. These shrubby species are not abundant, except for *Quercus dentata*. The scrub is constantly associated with many liana plants such as *Cocculus orbiculatus*, *Clematis terniflora*, *Pueraria lobata* and *Paederia scandens* var. *mairei*, but they are not abundant. In natural conditions this *Quercus dentata* scrub is closely related to the *Acer mono*- or the *Zelkova serrata*-forests. These communities floristically resemble each other, but are physiognomically and ecologically different. The latter two forests developed on the more favored stands, that is less exposed and with deeper soils. This association is divided into the following three subassociations.

2-a. Subass. *festucetosum rubrae*

Differential species: *Festuca rubra*, *Seseli libanotis* var. *japonica*, *Dianthus superbus* var. *longicalycinus*, *Spodiopogon depauperatus*, *Sedum kamschaticum*, *Luzula capitata*, *Inula salicina* var. *asiatica*, *Cirsium japonicum*, *Rhododendron japonicum*, *Lespedeza cuneata*, *Pinus densiflora*.

Distribution: Niigata Prefecture (Sado Is.).

This subassociation is commonly found on west-facing coastal slopes on Sado Island. The stands are usually on gravelly outcrops. Such stands permit the occurrence of the plant of the order Sedo-Festucetalia in the herb layer whose coverage is 30 to 85 %, average 65 %. *Festuca rubra* is usually dominant and some other species

are constantly found, but not abundant. The scrub is occasionally developed close to the *Pinus densiflora* secondary forests, so that *Pinus densiflora* and *Rhododendron japonicum* have invaded there.

2-b. Subass. *akebietosum trifoliatae*

Differential species: *Akebia trifoliata*, *Dystaenia ibukiensis*, *Rosa multiflora*, *Wisteria floribunda*, *Euonymus sieboldianus*, *Calamagrostis arundinacea* var. *brachytricha*.

Distribution: Niigata, Yamagata, Akita and Aomori Prefectures.

This subassociation is the commonest and widest spread type of the association Carici-Quercetum. The stands are exposed by wind, but not salt spray. The height of this scrub is taller; some are 6 to 7 m in height and the number of component species is more than the other subassociations. Some stands of the subassociation are facing south and in sunny conditions so that

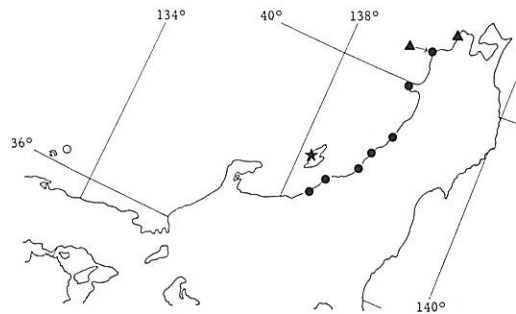


Fig. 3. Distribution of Carici cuneatae-Quercetum dentatae. Subass. festucetosum rubrae (●), Subass. akebietosum trifoliatae (★), Subass. euonymetosum planipes (▲).



Fig. 4. Carici cuneatae-Quercetum dentatae at the Oga Peninsula in Akita Prefecture, Tohoku.

Table 4. *Carici cuneatae*-*Quercetum dentatae*

2-a. Subass. *festucetosum rubrae*, 2-b. Subass. *akebietosum trifoliat*

Subassociation	2-a																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Column number	60	60	60	60	60	60	60	59	59	59	46	46	46	62	62	66	66
Locality number	40	30	25	25	30	10	30	50	30	30	15	17	17	10	10	75	75
Altitude (m)	20	15	30	30	50	10	20	60	100	150	50	60	60	30	30	10	10
Distance from shoreline (m)	NW	NW	W	W	SW	NW	NW	SE	S	SE	SE	SE	SE	SE	S	SW	SW
Slope aspect (°)	80	55			80	80	55	40		20	10	10	10	20	20		65
Slope degree (°)	25	30	15	15	10	15	20	25	15	10	15	10	15	25	25	40	40
Height of shrub layer (m)	2	4	1	1.2	2	1.2	1.8	6	6	5	4	4	4	6	6	5	6
Coverage of shrub layer (%)	100	85	95	100	98	100	90	80	80	95	98	98	98	95	95	95	90
Height of herb layer (cm)	60	80	30	40	50	50	50	70	70	50	50	50	60	90	80	80	80
Coverage of herb layer (%)	80	65	75	85	30	80	45	80	80	98	90	90	90	80	80	80	95
Size of plot area (m ²)	49	49	4	9	25	9	9	49	49	49	25	25	36	36	36	30	30
Number of species	20	25	16	20	21	18	24	29	31	25	34	32	33	25	23	22	29
Ch. & diff. spp. of association																	
<i>Carex stenostachys</i> var. <i>cuneata</i>	12	11	11	22	+2	22	12	12	22	33	22	22	22	33	33	33	33
<i>Potentilla togasii</i>	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
<i>Saussurea nipponica</i> var. <i>muramatsui</i>	.	.	.	.	.	.	.	.	.	.	+2	+	.	.	.	.	.
<i>Prunus apetala</i> var. <i>pilosa</i>	.	.	.	.	.	.	.	12	+	12	+	.	+	.	.	+	+
Diff. spp. of subassociation																	
<i>Festuca rubra</i>	23	33	44	33	33	12	12	.	.	.	.	.	.	.	.	.	.
<i>Seseli libanotis</i> var. <i>japonica</i>	+2	12	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.
<i>Dianthus superbus</i> var. <i>longicalycinus</i>	+	+2	+	+	+2	+	.	.	.	.	.	.	.	.	.	.	.
<i>Spodiopogon depauperatus</i>	(+)	+2	+2	+2	.	+2	22	.	.	.	.	.	.	.	.	.	.
<i>Sedum kamschatcicum</i>	+2	.	+	+	+	+	.	.	+	.	.	.	.	.	.	.	.
<i>Luzula capitata</i>	.	+	.	+	+	+	+	.	+	.	.	.	.	.	.	.	.
<i>Inula salicina</i> var. <i>asiatica</i>	.	.	+	+	+	+	+2	.	.	.	.	.	.	.	.	.	.
<i>Cirsium japonicum</i>	.	.	+	+	+	+	+	+	+2	.	.	+	.	.	.	.	.
<i>Rhododendron japonicum</i>	.	.	.	(+)	11	33	12	.	.	.	.	.	.	.	.	.	.
<i>Lespedeza cuneata</i>	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Pinus densiflora</i>	.	.	.	.	11	+	+	.	.	.	.	.	.	.	.	.	.
<i>Akebia trifoliata</i>	.	.	.	.	.	.	.	+	+	+	+2	12	22	12	+	.	+2
<i>Dystaenia ibukiensis</i>	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+2	+
<i>Rosa multiflora</i>	.	.	.	.	.	.	.	.	.	.	+2	+2	+	+	+	+	+
<i>Wisteria floribunda</i>	.	.	.	.	.	.	.	11	+2	.	+2	+	+	12	12	.	.
<i>Euonymus sieboldianus</i>	.	.	.	.	.	.	.	12	.	+	.	.	.	+	+2	.	+
<i>Calamagrostis arundinacea</i> var. <i>brachytricha</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
<i>Euonymus planipes</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cirsium kamschatcicum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sasa palmata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Buglossoides zollingeri</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Morus bombycis</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
<i>Angelica edulis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Picris hieracioides</i> var. <i>glabrescens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch. & diff. spp. of suballiance																	
<i>Cocculus orbiculatus</i>	.	+2	.	.	+	.	.	.	+	.	+	+	+	.	.	.	.
<i>Paederia scandens</i> var. <i>mairei</i>	.	.	.	+	+	+	+	+	.	+	+	+2	+	+2	+	.	+
<i>Pueraria lobata</i>	(+)	.	+	.	(+)	.	.	.	.	.	+	12	.	.	.	+	+
<i>Clematis terniflora</i>	.	.	.	.	+	.	.	.	+	.	.	+	+	+2	+	.	.
<i>Ampelopsis brevipedunculata</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.
Ch. spp. of alliance																	
<i>Quercus dentata</i>	55	55	55	55	55	55	55	44	55	55	55	55	55	55	55	55	44
<i>Lonicera morrowii</i>	(+)	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
<i>Quercus mongolica</i>	.	.	.	.	.	.	.	.	.	.	.	11	11	.	.	.	.
Ch. spp. of order & class																	
<i>Viburnum dilatatum</i>	.	+	+	(+)	.	.	+	12	+	12	+	.	+	+	11	11	12
<i>Acer mono</i>	.	+	.	.	.	.	11	11	+	.	.	11	.	.	.	12	12
<i>Polygonatum lasianthum</i>	+	.	.	.	.	.	.	.	+2	+	+2	+	+	.	+	.	.
<i>Rhus ambigua</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	22
<i>Tilia japonica</i>	.	.	.	.	.	.	.	.	.	.	+	.	11	.	.	.	.
<i>Euonymus oxyhyllus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Companions																	
<i>Miscanthus sinensis</i>	+	+	+2	+2	+	+2	+	22	12	12	+	+	+	12	.	+2	+2
<i>Adenophora triphylla</i> var. <i>japonica</i>	+2	12	12	12	+2	+2	+	12	+2	+2	22	22	22	+	+	.	.
<i>Thalictrum minus</i> var. <i>hypoleucum</i>	+2	+	+	.	+	.	.	12	+2	12	+	+	+	+2	22	+	+
<i>Carex blepharicarpa</i>	+2	+2	+2	22	+2	22	12	12	22	22	22	22	22	12	33	33	33
<i>Artemisia montana</i>	+	.	.	.	+	.	.	12	+	+2	12	+	+	+2	.	+	+
<i>Smilax china</i>	.	.	+	.	.	+	.	.	+	+	+	.	+	+	+	.	+
<i>Solidago virga-aurea</i> var. <i>asiatica</i>	.	+	.	.	.	.	11	11	+	.	.	11	.	.	.	12	12
<i>Lysimachia clethroides</i>	.	.	.	+	.	.	+	+	+2	+	.	+	.	.	.	.	+
<i>Celastrus orbiculatus</i> var. <i>papillosus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+
<i>Melica nutans</i>	12	+2	.	.	+	+	.	+	.	.	.	.	+	+2	+	.	.
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
<i>Vitis ficifolia</i> var. <i>lobata</i>	.	.	.	.	.	.	.	+	.	.	+	+	+	.	.	.	+
<i>Brachypodium sylvaticum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+2	+2	.
<i>Aster scaber</i>	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.
<i>Artemisia keiskeana</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

scrub overlaps the area of the *Angelica ursinae*-*Quercetum*, but the scrub can not be assigned to the association. From these distinctive feature of the species composition and the ecology, this scrub can be regarded as an association; *Angelico edulis*-*Quercetum*.

This association is subdivided into two sub-associations.

3-a. Subass. **hemerocallietosum middendorffii**

Differential species: *Hemerocallis middendorffii*, *Melica nutans*, *Artemisia montana*, *Vitis coignetiae*, *Sasa senanensis*.

Distribution: western central Hokkaido.

Constantly present undergrowth species include *Adenophora triphylla* var. *japonica*, *Carex blepharicarpa*, *Melica nutans* and *Hemerocallis middendorffii*. Many of these plants may be tolerant of the aridity. This subassociation grows luxuriantly at the environs of Otaru, western central Hokkaido. This scrub is divided into the following two parts due to the difference in the floor vegetation type. But between these parts, the difference of distribution and floristic condition, except the occurrence or the absence of *Sasa senanensis*, is not found.

3-b. Subass. **festucetosum ovinae**

Differential species: *Festuca ovina*, *Quercus mongolica*, *Chrysanthemum yezoense*, *Luzula capitata*, *Sedum kamtschaticum*.

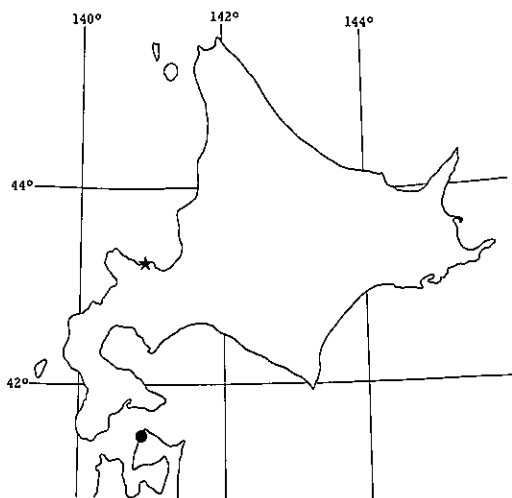


Fig. 5. Distribution of *Angelico edulis*-*Quercetum dentatae*. Subass. *hemerocallietosum middendorffii* (●), Subass. *festucetosum ovinae* (★).

Distribution: Aomori Prefecture.

This subassociation is developed at the top of cliffs. The stands are on rocky places covered with shallow soils. This scrub is constantly associated with only *Quercus dentata* and *Q. mongolica* in the shrub layer, whose height is 0.9 to 1.6 m. In the herb layer, *Festuca ovina* is dominant. *Miscanthus sinensis* and *Rhus ambigua* are common.

4. Ass. **Angelico ursinae-Quercetum dentatae** ass. nov. (Table 6, Figs. 6 and 7)

Character & differential species: *Angelica ursina*, *Chloranthus serratus*, *Artemisia keiskeana*.

Type record: Table 6, column no. 20.

Distribution: Southern Hokkaido.

Synonym: *Quercus dentata*-*Morus bombycis* comm. (ISHIZUKA 1951).

Like the next association, *Angelico anomarae*-*Quercetum*, this association is dominated by *Sasa senanensis* on the floor. *Angelica ursina* which is a character species of this association is ecologically vicarious with *A. anomala* which is the one of the next association. Therefore, these two association physiognomically resemble each other, but their floristic composition and geographical range are clearly different.

The shrub floor is divided into two layers, one is 80 to 100 cm in height and is covered with *Sasa senanensis*. Furthermore, *Adenophora triphylla* var. *japonica*, *Artemisia montana* and *Cirsium kamtschaticum* are frequently found there. The other layer is below 30 cm and is occasionally dominated by *Carex blepharicarpa*. The common occurrence of *Chloranthus* spp. is remarkable. This association is classified into two subassociations.

4-a. Subass. **hemerocallietosum middendorffii**

Differential species: *Hemerocallis middendorffii*, *Chloranthus japonicus*, *Smilax china*, *Petasites japonicus* var. *giganteus*, *Plectranthus inflexus*, *Lonicera morrowii*, *Veratrum maackii* var. *japonicum*, *Sanguisorba tenuifolia* var. *alba*.

Distribution: Matsumae Peninsula.

This subassociation is distributed in southernmost Hokkaido. The height of the scrub varies with the habitat condition. The scrub remained on the terrace scarp along the coast of the Kameda Peninsula is 6.5 to 7 m in height. The scrub

Table 6. *Angelico ursinae-Quercetum dentatae*

Subassociation	4-a. Subass. <i>hemerocallietosum middendorffii</i> ,										4-b. Subass. <i>achill</i>				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Locality number	22	22	22	22	21	21	21	18	18	18	18	18	19	19	19
Altitude (m)	8	8	8	8	30	30	25	10	10	10	10	10	50	50	30
Distance from shoreline (m)	30	30	30	30	50	50	100	50	50	50	50	50	100	100	100
Slope aspect (°)	S	SE	S	-	SE	SE	SE	SW	SW	SW	SW	SW	SW	SW	SE
		20			50	45	30	45	45	55	55	50	20	20	30
Slope degree (°)	1	5	5	0	25	20	30	20	20	25	25	25	10	10	30
Height of shrub layer (m)	4.5	4	3	3	5	6	7	7	7	6.5	6.5	7	2	2	2.5
Coverage of shrub layer (%)	95	95	95	90	85	95	90	98	98	98	98	98	95	95	95
Height of herb layer (cm)	80	70	80	80	90	90	70	80	70	80	80	80	40	40	50
Coverage of herb layer (%)	95	95	95	95	100	100	100	100	100	100	100	100	100	100	100
Size of plot area (m ²)	18	28	36	36	36	49	49	49	64	64	64	56	25	25	25
Number of species	19	17	16	15	24	21	23	21	30	25	30	26	18	20	24
Ch. & diff. spp. of association															
<i>Angelica ursina</i>	22	12	+	+	12	+2	+2	12	12	12	12	+2	+	+2	+2
<i>Chloranthus serratus</i>	+	.	.	.	+	+	.	.	+	+2	+	+	.	.	.
<i>Artemisia keiskeana</i>	.	.	.	.	.	.	12	.	12	.	.	.	+2	+2	22
Diff. spp. of subassociation															
<i>Hemerocallis middendorffii</i>	.	+2	12	12	12	23	12	12	+2	12	12	22	22	12	.
<i>Chloranthus japonicus</i>	12	12	+2	+	+2	.	+2	.	+2	+	+2	.	.	.	.
<i>Smilax china</i>	+	.	.	+	+2	+	+2	+	+	.	+	.	.	+	+2
<i>Petasites japonicus</i> var. <i>giganteus</i>	23	.	12	12	+2	12	11	.	+2	.	12	.	.	.	.
<i>Plectranthus inflexus</i>	+	.	.	.	+	+	.	.	+	+2	+	+	.	.	.
<i>Lonicera morrowii</i>	12	.	(+)	.	+2	+	+	+	.	.	+	.	.	.	.
<i>Veratrum maackii</i> var. <i>japonicum</i>	.	.	.	.	.	.	.	.	12	12	+2	12	+2	+	+2
<i>Sanguisorba tenuifolia</i> var. <i>alba</i>	.	.	.	.	.	.	.	.	+	.	+	+	+2	12	+2
<i>Achillea sibirica</i> var. <i>angustifolia</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Aralia cordata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Solidago virga-aurea</i> var. <i>gigantea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lespedeza bicolor</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
<i>Miscanthus sinensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Artemisia japonica</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sedum kamschaticum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Ch. & diff. spp. of suballiance															
<i>Sasa senanensis</i>	33	44	44	44	12	55	23	55	55	55	55	55	.	.	.
<i>Celastrus orbiculatus</i> var. <i>papillosus</i>	12	12	+2	+2	.	.	+	+2	+2	.	+	+2	.	.	+2
<i>Cirsium kamschaticum</i>	.	.	+	+	+	+	.	.	+	+	.	+	+	.	.
<i>Angelica edulis</i>	.	.	.	.	.	.	.	.	+	+	+	.	.	.	+
<i>Vitis coignetiae</i>	.	+	.	+	+	.	.	+	.	+	.	+	.	.	.
<i>Morus bombycis</i>	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Ch. spp. of alliance															
<i>Quercus dentata</i>	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
<i>Quercus mongolica</i>	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.
Ch. spp. of order & class															
<i>Viburnum dilatatum</i>	.	.	(+)	.	+2	11	.	.	+2	.	+	.	.	11	11
<i>Rhus ambigua</i>	.	+2	+	12	22	.	.	.	.	.	.	.	.	.	.
<i>Euonymus sieboldianus</i>	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.
<i>Polygonatum lasianthum</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Quercus mongolica</i> var. <i>grosseserrata</i>	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.
<i>Hydrangea petiolaris</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
<i>Tilia japonica</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Companions															
<i>Artemisia montana</i>	12	+2	+2	+2	+2	+	+2	12	+	+2	12	+2	.	+2	+2
<i>Carex blepharicarpa</i>	12	12	+2	22	33	33	44	.	.	.	.	.	33	33	22
<i>Adenophora triphylla</i> var. <i>japonica</i>	+	+	.	.	.	(+)	+2	+	12	.	+2	+	+2	+2	+2
<i>Thalictrum minus</i> var. <i>hypoleucum</i>	+	.	.	.	+	.	.	+	+2	+	+2	+2	.	.	+2
<i>Solidago verga-aurea</i> var. <i>asiatica</i>	(+)	+	.	.	+2	(+)	+	.	.	.	.	+	+2	+	+
<i>Aster scaber</i>	.	.	.	.	+	(+)	.	.	.	.	+	.	+2	+2	+2
<i>Brachypodium sylvaticum</i>	.	.	+	.	.	.	.	.	+	.	+	+2	+2	.	+2
<i>Lysimachia clethroides</i>	.	+	+2	+2	+	(+)	.	.	+	.	.	.	.	.	.
<i>Pleurospermum camtschaticum</i>	.	.	.	.	.	.	.	+	+2	+2	+	+	.	.	+2
<i>Anthriscus sylvestris</i>	.	.	.	.	.	.	.	+	.	+	+	+	.	.	.
<i>Polygonum sachalinense</i>	.	.	.	.	12	+2	.	.	.	+2	.	+2	.	.	+
<i>Maianthemum dilatatum</i>	.	.	.	.	.	.	.	+2	+2	+2	+2	12	.	.	.
<i>Carex caryophylla</i> var. <i>microtricha</i>	.	.	.	.	.	.	.	+2	+2	+	+2	+	.	.	.
<i>Smilax riparia</i> var. <i>ussuriensis</i>	.	.	.	.	.	.	.	+	+	+	+	+2	.	.	.
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.
<i>Galium verum</i> var. <i>asiaticum</i>	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.

etosum angustifoliae

4-b						
16	17	18	19	20	21	22
19	15	15	15	15	15	15
35	25	25	25	25	25	10
100	45	40	45	45	50	45
SE	SW	SW	SW	SW	S	S
30	10	10	10	10		
30	25	25	25	25	20	30
2	4	35	5	4	5	4
95	100	95	95	98	100	100
50	80	80	70	70	80	60
100	100	100	95	95	100	35
25	25	25	36	36	36	36
18	17	17	21	19	18	20

12	12	+	+	12	+2	12	Ezonyu
.	+	.	+	.	.	.	Futarishizuka
+2	.	+	+	+	.	23	Inuyomogi
23	.	.	.	.	.	.	Ezozenteika
.	.	.	.	.	.	.	Hitorishizuka
.	.	.	.	.	.	.	Sarutoriibara
.	.	.	.	.	.	.	Akitabuki
.	.	.	.	.	.	.	Yamahakka
.	.	.	.	.	.	.	Hyotanboku
.	.	.	.	.	.	.	Syuroso
+2	.	.	.	.	.	.	Nagabonowaremoko
.	+	+	+	.	.	+	Kitanokogiriso
.	+	+	+2	+	.	.	Udo
.	+	.	.	+	+	12	Ooakinokirinso
.	.	+	+	.	+	+	Yamahagi
.	+	.	.	.	.	+	Susuki
.	.	.	+	+	.	+	Otokoyomogi
.	.	.	+	+	.	12	Kirinso
.	55	55	44	55	55	12	Kumaizasa
12	+2	+	+2	+	+2	12	Onitsuruumemodoki
+	+	.	.	+	.	.	Chishimaazami
.	+	+	+	+	+	+	Amanyu
.	.	.	.	.	.	+	Yamabudo
.	.	+	.	.	+	.	Yamaguwa
55	55	55	55	55	55	55	Kashiwa
.	.	.	.	.	.	.	Mongorinara
+	11	+	+	.	11	.	Gamazumi
.	.	.	.	.	.	.	Tsutaerushi
.	.	.	.	.	.	.	Mayumi
+	.	.	.	.	.	.	Miyamanarukoyuri
.	.	.	.	.	.	.	Mizunara
.	.	.	.	.	.	.	Gotozuru
.	.	.	.	.	.	.	Shinanoki
+2	+2	12	+2	12	+2	12	Ooyomogi
33	12	+2	23	12	+	22	Shojoyosuge
+2	12	12	+2	.	12	+	Tsuriganeninjin
.	+	+2	+2	12	+	+	Akikaramatsu
.	.	.	.	+	.	.	Akinokirinso
+2	.	+	+	+	.	+	Shirayamagiku
+2	.	.	.	.	+	.	Yamakamojigusa
.	.	.	.	.	.	.	Okatoranoo
.	.	.	.	.	.	.	Ookasamochi
.	.	.	.	.	.	.	Shaku
.	.	.	.	.	.	.	Ooitadori
.	.	.	.	.	.	.	Maizuruso
.	.	.	.	.	.	.	Cyashibasuge
.	.	.	.	.	.	.	Shiode
.	.	.	.	.	.	+	Warabi
.	.	+	.	.	.	+	Kawarayomogi

developed on exposed rocky slopes is low, only 2 to 2.5 m in height. The latter scrub type lacks *Sasa senanensis* is the herb layer, but *Carex blepharicarpa* and *Hemerocallis middendorffii* are co-dominant.

4-b. Subass. **achilletosum angustifoliae**

Differential species: *Achillea sibirica* var. *angustifolia*, *Aralia cordata*, *Solidago virga-aurea* var. *gigantea*, *Lespedeza bicolor*, *Miscanthus sinensis*, *Artemisia japonica*, *Sedum kamtschaticum*.

Distribution: Muroran.

This *Quercus dentata* scrub occurs on the south-facing steep slopes 20 to 30 degrees. The shrub layer is composed of *Quercus dentata*, *Viburnum dilatatum*, *Celastrus orbiculatus* var.

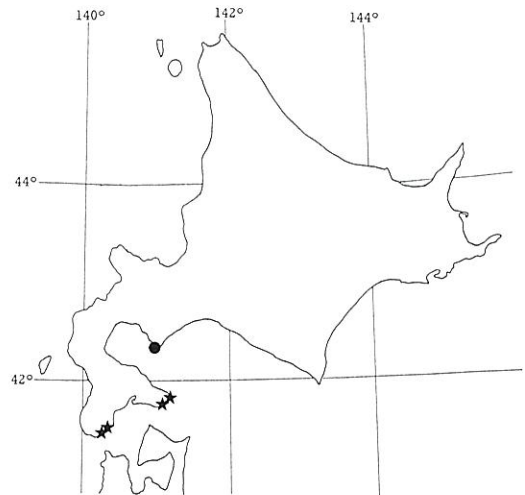


Fig. 6. Distribution of Angelico ursinae-Quercetum dentatae. Subass. hemerocallietosum middendorffii (●), Subass. achilletosum angustifoliae (★).



Fig. 7. Angelico ursinae-Quercetum dentatae at the Chikyu-misaki Cape in Muroran, Hokkaido.

.	.	.	.	.	.	.	Mizuhiki
.	.	.	.	.	.	.	Suiba
.	.	.	.	.	.	.	Chigoyuri
+2	.	.	.	.	.	.	Yamatsutsuji
+	.	.	.	.	.	.	Metakarako
.	.	.	.	.	.	.	Fuji
.	.	.	.	.	.	.	Nawashiroichigo
.	.	.	.	.	.	.	Yamabukishoma
+	.	.	.	.	.	.	Kamatsuka
.	.	.	.	.	.	.	Kitakobushi
.	.	.	.	.	.	.	Yobusumaso
.	.	.	.	.	.	.	Oodaikonso
.	.	.	+	.	.	.	Ooushinokegusa
+	.	.	.	.	.	.	Himekansuge
.	+	.	.	.	+	.	Zenmai

se (Sugina) +2, in 9. *Synurus palmatopi-*
(Ootachitsubosumire) +, in 13. *Convallaria*
(Ibotanoki) +, *Calamagrostis arundinacea*.
themum yezoense (Kohamagiku) +, in 21.

senanensis.

5-b. Subass. *caricetosum siderostictae*

Differential species: *Carex siderosticta*, *Rhus ambigua*, *Sanguisorba tenuifolia* var. *alba*, *Viburnum dilatatum*, *Acer mono*, *Angelica edulis*, *Aster scaber*, *Lespedeza bicolor*, *Lysimachia clethroides*, *Sedum kamtschaticum*, *Lastrea totta*, *Disporum smilacinum*, *Actinidia arguta*, *Smilacina japonica*, *Calamagrostis arundinacea* var. *brachytricha*, *Aruncus dioicus* var. *kamtschaticus*.

Distribution: Samani.

The present subassociation is developed on wet stands located at 20 to 30 m above the sea level on the slope of the coastal terrace. Since the scrub is scarcely influenced by salt spray, the area is rich

in species (29.2 spp. per quadrat on an average) and inland species have often invaded the floor. The height of the scrub is greater, 5 to 8 m than the previous subassociation. In the shrub layer, *Viburnum dilatatum*, *Acer mono* and *Lespedeza bicolor* are common but with low dominance. The *Quercus dentata*-*Sasa nipponica* community described by TAKAHASHI & OKABE (1968) in the Enrum Cape, Hidaka may be incorporated in this subassociation due to floristic and geographical similarity.

Discussion

The coastal scrub vegetation of the Japanese mainland can be divided into two types. One is the southern type: ever-green broad-leaved scrubs, the alliance *Pittosporion tobirae*, which is usually composed by some characteristic shrubs. This scrub occurs luxuriantly on the coastal areas of the Camellietea region. The other is the northern type: deciduous scrubs, the alliance *Quercion dentatae*, which is constantly associated with only one shrub; *Quercus dentata*. The *Quercion* scrubs are distributed from the San-in District through Hokuriku and Tohoku to Hokkaido. In the Sanin and Hokuriku Districts where the coastal scrubs of the southern type are also developed, the *Quercion* scrubs are restricted to limited stands. These stands are rocky slopes which are severely influenced by the northwesterly wind in winter. Consequently, scrubs of the southern type can not developed there.

The *Quercion* scrubs is lacking along the Sanriku Coast, that is the eastern side of Tohoku. This may be due to the submerged shoreline, namely the ria coast, which is scarcely influenced by salt spray. In place of it, some inland shrubby species such as *Taxus cuspidata*, *Thujaopsis dolabrata* and *Juniperus chinensis* var. *sargentii* are occasionally developed on the coastal rocky slopes.

The range of the *Quercion* scrubs extends more southward on rocky coasts than on sandy coasts (Fig. 9). Scrubs which have developed on sand dunes are found from the northern Tohoku to Hokkaido. The reason is not clear, but it may be due to the mesophytic character of *Quercus dentata*. The sand dunes may be to dry to prevent high evaporation from large leaves of this species.

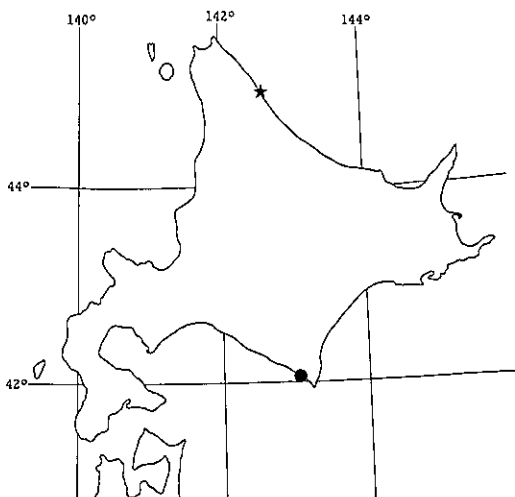


Fig. 8. Distribution of *Angelico anomalae-Quercetum dentatae*. Subass. *quercetosum mongolicae* (●), Subass. *caricetosum siderostictae* (★).

Table 7. *Angelico anomalae-Quercetum dentatae*

5-a. Subass. quercetosum mongolicae, 5-b. Subass. caricetosum siderostictae														
Subassociation	5-a						5-b							
Column number	1	2	3	4	5	6	7	8	9	10	11	12		
Locality number	5	5	5	5	5	5	13	13	13	13	13	13		
Altitude (m)	7	7	7	8	10	10	20	20	30	30	20	20		
Distance from shoreline (m)	30	30	30	40	45	-	-	-	-	-	50	50		
Slope aspect (°)	SW	SW	SW	SW	NW	NW	NW	NW	SW	SW	SW	SW		
	75	75	35	35	40	40	40	40	60	60	70	70		
Slope degree (°)	20	20	20	20	10	10	30	30	25	25	25	25		
Height of shrub layer (m)	1.4	1.3	1.7	1.7	1.2	1.2	6	6	8	8	5	5		
Coverage of shrub layer (%)	100	100	100	90	85	80	90	98	100	100	95	95		
Height of herb layer (cm)	60	60	60	60	60	60	60	60	70	70	80	80		
Coverage of herb layer (%)	20	20	25	15	95	95	80	60	98	100	90	90		
Size of plot area (m ²)	16	16	16	16	16	16	49	49	49	49	36	36		
Number of species	19	20	21	18	21	20	35	24	33	25	31	27		
Ch. & diff. spp. of association														
<i>Angelica anomala</i>	+2	12	+2	+2	+2	+2	+2	+2	+2	+	22	12	Ezonoyoroigusa	
<i>Moehringia lateriflora</i>	+2	.	.	.	+2	+2	.	.	.	+	.	.	Ooyamafusuma	
<i>Convallaria keiskei</i>	+2	+2	+2	12	.	.	.	.	.	+2	.	.	Suzuran
<i>Maianthemum dilatatum</i>	.	.	.	.	12	12	+2	+2	+2	+	23	12	Maizuruso
Diff. spp. of subassociation														
<i>Quercus mongolica</i>	+	22	12	55	22	12	.	.	.	.	.	.	Mongorinara
<i>Hemerocallis middendorffii</i>	+2	12	+2	12	12	12	.	.	.	.	.	.	Ezozenteika
<i>Stellaria radianus</i>	+	12	+	+	12	+2	.	.	.	.	.	.	Ezoooyamahakobe
<i>Galium kamschaticum</i> var. <i>acutifolium</i>	+	+	+	.	12	+2	.	.	.	.	.	.	Oobayotsubamugura
<i>Vaccinium smallii</i>	12	.	+	+	+	+2	.	.	.	.	.	.	Oobasunoki
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	.	+	+	+	22	12	.	.	.	.	.	.	Warabi
<i>Asarum heterotropoides</i>	+2	+	+	12	.	.	.	.	.	.	.	.	Okuezosaishin
<i>Calamagrostis pseudo-phragmites</i>	.	+	.	.	+2	+2	.	.	.	.	.	.	Hossugaya
<i>Carex pilosa</i>	.	+2	12	+2	.	.	.	.	.	.	.	.	Carex pilosa
<i>Euonymus oxyphyllus</i>	.	.	.	.	.	+2	.	.	.	.	.	.	Tsuribana
<i>Carex siderosticta</i>	.	.	.	.	.	.	+2	+2	.	+	+2	12	Taganeso
<i>Rhus ambigua</i>	.	.	.	.	.	.	23	12	12	12	12	12	Tsutaurushi
<i>Sanguisorba tenuifolia</i> var. <i>alba</i>	.	.	.	.	+	.	+2	+2	+	+	22	12	Nagabonoshirowaremo
<i>Viburnum dilatatum</i>	.	.	.	.	.	.	.	+2	+	+2	+2	+	Gamazumi
<i>Acer mono</i>	.	.	.	.	.	.	11	12	+	+	+	11	Itayakaede
<i>Angelica edulis</i>	.	.	.	.	.	.	.	+	+	12	+	+2	Amanyu
<i>Aster scaber</i>	.	.	.	.	.	.	.	.	+2	+	+	+	Shirayamagiku
<i>Lespedeza bicolor</i>	.	.	.	.	.	.	.	.	+	11	+	+	Yamahagi
<i>Lysimachia clethroides</i>	.	.	.	.	.	.	.	.	+	+	+2	.	Okatoranoo
<i>Sedum kamschaticum</i>	.	.	.	.	.	.	.	+2	+	+	+	+	Kirinso
<i>Lastrea totta</i>	.	.	.	.	.	.	+2	+	.	.	.	+	Mizoshida
<i>Disporum smilacinum</i>	.	.	.	.	.	.	.	.	+	.	.	+	Chigoyuri
<i>Actinidia arguta</i>	.	.	.	.	.	.	12	.	.	.	.	+	Sarunashi
<i>Smilacina japonica</i>	.	.	.	.	.	.	.	.	+	+	+	.	Yukizasa
<i>Calamagrostis arundinacea</i> var. <i>brachytricha</i>	.	.	.	.	.	.	.	.	.	+2	.	.	Nogariyasu
<i>Aruncus dioicus</i> var. <i>kamschaticus</i>	.	.	.	.	.	.	.	.	.	+	+2	+2	Yamabukishoma
Ch. & diff. spp. of suballiance														
<i>Sasa senanensis</i>	22	12	33	44	33	22	22	23	55	55	33	33	Kumaizasa	
<i>Celastrus orbiculatus</i> var. <i>papillosus</i>	12	+2	.	12	12	.	.	+	+2	+	+2	12	Onitsuruumemodoki	
<i>Cirsium kamschaticum</i>	.	+	+	.	.	+	.	.	.	.	.	.	Chishimaazami
<i>Petasites japonicus</i> var. <i>giganteus</i>	.	+	+	.	.	.	.	.	+	.	.	.	Akitabuki
<i>Vitis coignetiae</i>	.	.	.	.	.	.	12	+2	.	.	.	.	Yamabudo
<i>Morus bombycis</i>	.	.	.	.	.	.	.	.	.	.	.	+	Yamaguwa
Ch. spp. of alliance														
<i>Quercus dentata</i>	55	55	55	22	33	44	55	55	55	55	55	55	Kashiwa	
Ch. spp. of order & class														
<i>Hydrangea petiolaris</i>	.	.	.	.	.	12	.	.	.	.	.	+	Gotozuru
<i>Tilia japonica</i>	.	.	.	.	.	.	.	.	.	.	.	+	Shinanoki
Companions														
<i>Thalictrum minus</i> var. <i>hypoleucum</i>	+	+	+2	+	+2	+2	12	12	+2	+	+2	12	Akikaramatsu	
<i>Adenophora triphylla</i> var. <i>japonica</i>	+2	+2	+	+2	12	.	.	+	+2	.	.	+	Tsuriganeninjin	
<i>Melica nutans</i>	.	.	.	.	+2	+2	.	+2	+	.	.	+	Komegaya
<i>Artemisia montana</i>	+	.	+	+	.	.	.	.	.	.	+2	.	Ooyomogi
<i>Carex blepharicarpa</i>	.	+	+2	.	12	12	.	.	+2	.	.	.	Shojoyosuge	
<i>Miscanthus sinensis</i>	+	.	.	+2	+2	.	.	.	.	.	.	+2	Susuki
<i>Polygonum sachalinense</i>	.	.	+	.	.	.	.	.	.	.	.	+	Ooitadori
<i>Brachypodium sylvaticum</i>	.	+	.	.	.	.	.	.	.	.	.	.	Yamakamogigusa
<i>Leucothoe grayana</i> var. <i>oblongifolia</i>	.	.	.	.	+	+	.	.	.	.	.	.	Hanahirinoki
<i>Equisetum arvense</i>	.	.	.	.	.	.	.	+	+	.	.	.	Sugina
<i>Anthriscus sylvestris</i>	.	.	.	.	.	.	.	+	+	.	.	.	Shaku
<i>Athyrium pycnosorum</i>	.	.	.	.	.	.	.	+	+	.	.	.	Miyamashikeshida
<i>Onoclea sensibilis</i>	.	.	.	.	.	.	.	+2	+	.	.	.	Koyawarabi
<i>Cardamine leucantha</i>	.	.	.	.	.	.	.	+2	+	.	.	.	Konronso
<i>Viburnum opulus</i> var. <i>calvescens</i>	.	.	.	.	.	.	.	12	+	.	.	.	Kanboku
<i>Primula jesoana</i> var. <i>pubescens</i>	.	.	.	.	.	.	.	+2	12	.	.	.	Ezoosakuraso
<i>Solidago virga-aurea</i> var. <i>gigantea</i>	.	.	.	.	.	.	.	.	.	.	.	+	Ooakinokirinso
<i>Cacalia auriculata</i> var. <i>kamschatica</i>	.	.	.	.	.	.	.	.	.	.	+2	.	Mimikomori
<i>Veratrum maackii</i> var. <i>japonicum</i>	.	.	.	.	.	.	.	.	.	.	.	+	Shuroso
<i>Cacalia hastata</i> var. <i>orientalis</i>	.	.	.	.	.	.	.	.	.	.	+	.	Yobusumaso
<i>Phryma leptostachya</i> var. <i>asiatica</i>	.	.	.	.	.	.	.	.	.	.	+	.	Haedokuso
<i>Maackia amurensis</i> var. <i>buergeri</i>	.	.	.	.	.	.	.	.	.	.	+	.	Inuenjyu
<i>Betula maximowicziana</i>	.	.	.	.	.	.	.	.	.	.	.	+	Udaikanba
Other companions: in column no. 1. <i>Solidago virga-aurea</i> var. <i>asiatica</i> (Akinokirinso) +2, <i>Festuca rubra</i> (Oo-ushinokegusa) +, <i>Vicia kusanoana</i> (Kusafuji) +, in 6. <i>Anaphalis margaritacea</i> var. <i>angustior</i> (Yamahakko) +, in 7. <i>Trillium kamschaticum</i> (Oobananoenreiso) +, in 9. <i>Smilax riparia</i> var. <i>ussuriensis</i> (Shiode) +, <i>Agrimonia pilosa</i> (Kinmizuhiki) +, <i>Calamagrostis epigeios</i> (Yamaawa) +, <i>Viola kusanoana</i> (Ootachitsubosumori) +, in 11. <i>Lysimachia vulgaris</i> var. <i>davurica</i> (Kusaredama) +2, <i>Fraxinus lanuginosa</i> (Kobanotoneriko) +, <i>Achillea sibirica</i> var. <i>angustifolia</i> (Kitanokogiriso) +, <i>Galium verum</i> var. <i>asiaticum</i> (Kawaramatsuba) +, in 12. <i>Chloranthus serratus</i> (Futarishizuka) +, <i>Plectranthus inflexus</i> (Yamahakka) +.														

The *Quercus dentata* scrubs extend from the Asian Continent and Korea to Japan with other deciduous *Quercus* forests. The Korean Peninsula was connected to western Japan during recent geological time. The frequent occurrence of the continental elements in these *Quercus* woods attests to it. Although western Japan is located near Korea, the *Quercus dentata* scrub is not developed there. The scrub is not successful in competition with the Pittosporion scrub in western and southern Japan.

From the floristic composition and distribution point of view, the alliance Quercion dentatae belongs to the order Quercetalia serrato-grosseserratae and to the class Fagetea crenatae.

Summary

1. The present study was undertaken to classify and describe the *Quercus dentata* scrub of rocky coasts in Japan on the basis of the vegetation concept and method of the ZM school.
2. The investigations were carried out in 23 localities. From the 107 phytosociological records obtained, the following syntaxonomical system was accomplished.

All. Quercion dentatae.

I. Subass. Cocculo orbiculati-Quercenion dentatae.

1. Ass. Albizio julibrissin-Quercetum dentatae.

1-a. Subass. festucetosum ovinae.

1-b. Subass. epimeditosum sempervirens.

1-c. Subass. euonymetosum japonici.

2. Ass. Carici cuneatae-Quercetum

dentatae.

2-a. Subass. festucetosum rubrae.

2-b. Subass. akebietosum trifoliatae.

2-c. Subass. euonymetosum planipes.

II. Suball. Celastrio papilloso-Quercenion dentatae.

3. Ass. Angelico edulis-Quercetum dentatae

3-a. Subass. hemerocallietosum middendorffii

3-b. Subass. festucetosum ovinae.

4. Ass. Angelico ursinae-Quercetum dentatae.

4-a. Subass. hemerocallietosum middendorffii.

4-b. Subass. achilletosum angustifoliae.

5. Ass. Angelico anomalae-Quercetum dentatae TATEWAKI ex OHBA, MIYAWAKI et TÜXEN 1973.

5-a. Subass. quercetosum mongolicae.

5-b. Subass. caricetosum siderostictae.

3. The distribution of the *Quercus dentata* scrub was discussed.

4. The Quercion dentatae which is newly described, includes *Quercus dentata* scrub developed on sand dunes, and belongs to the order Quercetalia serrato-grosseserratae and to the class Fagetea crenatae.

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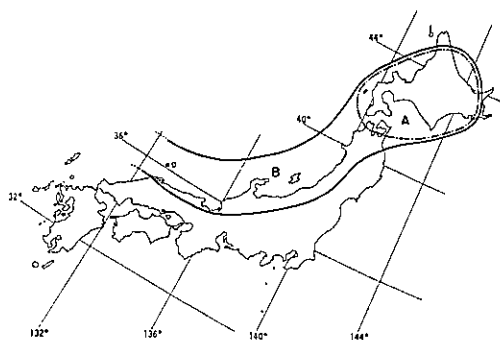


Fig. 9. Distribution range of the *Quercus dentatae* scrub on sand dunes (A) and on rocky coasts (B).

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摘 要

1. 海岸の崖地、傾斜地、露岩地などの岩石海岸に発達するカシワ林について植物社会学的な研究を行った。得られた107の植生調査資料から次に示した1群団, 2亜群団, 5群集, 12亜群集を区分し, 記載した。

カシワ群団 (新)

I. カシワアオツヅラフジ亜群団 (新)

1. カシカーネムノキ群集 (新) (a. ウシノケグサ亜群集, b. トキワイカリソウ亜群集, c. マサキ亜群集)

2. カシワミチノクホンモンジスゲ群集 (新) (a. オオウシノケグサ亜群集, b. ミツバアケビ亜群集, c. オオツリバナ亜群集)

II. カシワオニツルウメモドキ亜群団 (新)

3. カシワアマニュウ群集 (新) (a. エゾゼンテイカ亜群集, b. ウシノケグサ亜群集)

4. カシワエゾニュウ群集 (新) (a. エゾゼンテイカ亜群集, b. キタノコギリソウ亜群集)

5. カシワエゾノヨロイグサ群集 (a. モンゴリナラ亜群集, b. タガネソウ亜群集)

2. 岩石海岸のカシワ林は、山陰の一部から北陸、東北、北海道に分布するが、砂丘のカシワ林は東北北部と北海道に限られる。これは東北以南の砂丘が、カシワ林の成立にとって乾燥しすぎるためだと思われる。

3. カシワ林は朝鮮半島から日本列島へ分布を拡大してきたものと考えられる。朝鮮半島に近い西日本にカシワ林があまり発達していないのは、トベラ群団に属する常緑の海岸林が旺盛なためである。

4. 新たに設定されたカシワ群団は、東北北部から北海道の砂丘に発達するカシワ林の群集も含み、上級単位はミズナラーコナラオーダー、ブナクラスに属する。

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○ 西宮市教育委員会 日野神社社叢の保全に関する調査報告書 昭和58年3月31日発行。B5版, 236頁。非売品。

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