A Castanopsis Type Association of the Setouchi District in Southwestern Japan

by

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Introduction

The areas surrounding the Seto Inland Sea have been usually known as the Setouchi district. Most of the warm temperate zone within the district is covered with the substitute vegetation dominated by *Pinus densiflora* and *Quercus serrata*. Judging from the natural vegetation survived around shrines and temples, however, it is concluded that Castanopsis type forests are the most typical climatic climax in the district.

Up to now, the Castanopsis type forests in the Setouchi district have been investigated by many authors and identified to some associations; for example Symploco-Shiietum cuspidatae (Suzuki-Tok. & Mori 1957; Yamanaka 1957, 1962; Suganuma 1972), Cleyero-Castanopsietum cuspidatae (Miyawaki & Fujiwara 1974; Kobayashi *et al*. 1976-a) and Bladhio-Shiietum sieboldii (Suzuki-Tok. & Mori 1957; Yano *et al*. 1972). Thus, it seems that there are some confusions in the phytosociological treatment of the Castanopsis type forests in the district.

Recently, as the results of their phytosociological studies of the natural forests in the district, Nakanishi, Takeda & Hattori (1977) reported that the Castanopsis type forests were classified into two associations. One of them is Photinio-Castanopsietum cuspidatae which is distributed in the eastern part of the district and the other is Symploco lucidae-Castanopsietum cuspidatae in the western part.

One of the aims of this study is to throw light on the floristic composition and the geographical range of Photinio-Castanopsietum cuspidatae by comparison with the related associations. Another aim is to clarify the ecological characteristics of the association in question by means of the comparison in respect to the distribution patterns of the main component species and their distribution responses to the thermal and the humidity-aridity gradients.

Through such study, we intend to complete the syntaxonomical system of the warm temperate forests in the southwestern Japan.

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I. Environmental background of the area investigated

In view of the aims of this study, the Castanopsis type forests in the Setouchi district were taken as the immediate subject of the present study. Moreover, consideration was given to the forests in the neighbouring areas, too, in order to clarify the compositional differentiation and the geographical range of the Photinio-Castanopsietum cuspidatae. The areas treated in this study are shown in Fig. 1.

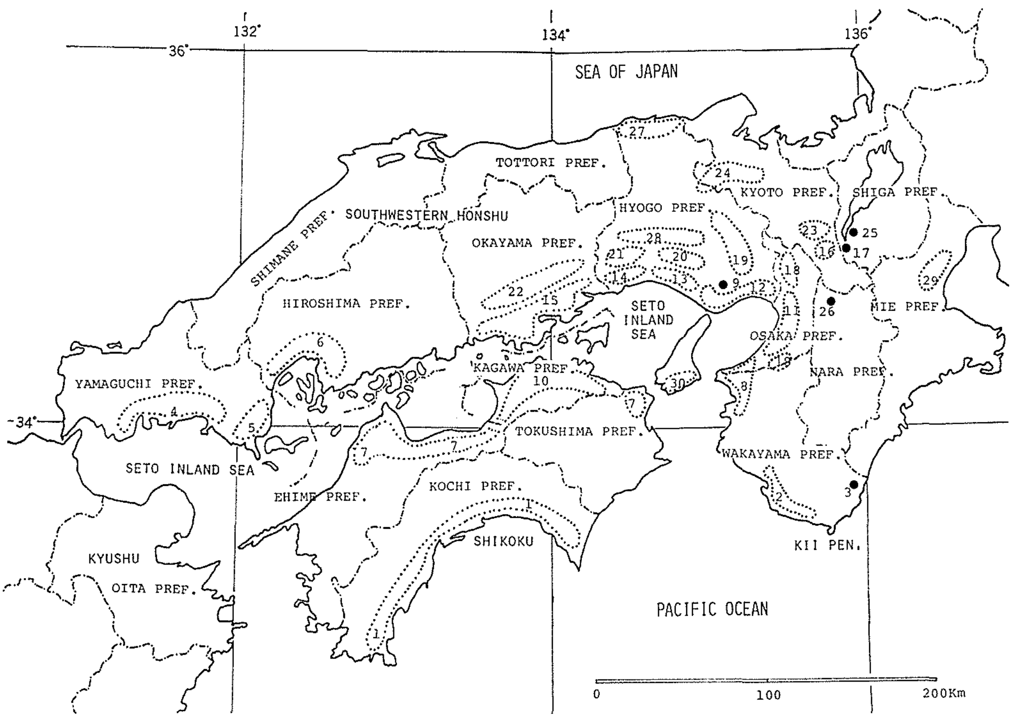

Fig. 1. Map showing the location of the study areas which are shown by the dotted line or the black dot. The numerals in the map correspond to the locality number in Tables 5 and 6.

1. History of human disturbance to vegetation

According to the the results of pollen analysis in the coastal area of Osaka Bay, it is definitely deduced that the original form of the present evergreen broad leaf forest was established about six thousand years ago (Maeda 1976). It is also concluded from the palynological investigations that the exteneive destruction of the natural vegetation by human activities happened in the Yayoi period (2300~1700 BP) with the advance and spread of rice crop agriculture (Tsukada 1974). Such human disturbance as deforestation, mowing and firing forest has continued throughout history until recently. In this way, in the lowland and hills of the Setouchi district, the natural vegetation has been replaced mostly by such cultivated vegetation as rice field and the secondary forest dominated by *Pinus densiflora* and partly by the grass land of *Miscanthus sinensis*.

Today, the natural vegetation ramains mainly in the sanctuaries around shrines and temples to keep a sacred atmosphere (see Figs. 11, 12 and 13). So, most of the field investigations were carried out in the sanctuaries of shrines and temples. Among them, the shrines and temples with an excellent natural

Table 1. The thermal climate at some stations in the Setouchi district and the neighbouring area

Station \ Month	1	2	3	4	5	6	7	8	9	10	11	12	ANN	W I	Alt. (m)
SHINGU	**6.6**	7.4	10.2	14.9	19.1	22.3	26.8	27.3	24.7	19.4	14.3	9.2	16.9	142.0	8
KOCHI	**5.7**	6.5	9.6	14.5	18.6	21.9	25.9	26.8	24.0	18.4	13.2	8.3	16.1	133.4	1
HIROSHIMA	**4.1**	4.6	7.4	12.5	17.4	21.4	26.1	27.3	23.2	17.1	11.5	6.8	15.0	120.7	29
TOKUYAMA	**4.6**	5.1	8.4	13.3	17.8	21.7	26.5	27.5	23.7	17.8	12.2	7.4	15.7	126.4	20
KAMINOGO	**4.8**	5.0	8.0	13.7	18.5	22.6	27.1	27.7	24.0	17.8	12.4	7.6	15.8	129.4	34
TOKUSHIMA	**5.1**	5.3	8.1	13.4	18.1	21.9	26.3	27.2	23.8	17.9	12.7	7.8	15.6	127.6	1
MATSUYAMA	**4.9**	5.1	8.1	13.2	17.7	21.8	26.5	27.3	23.6	17.5	12.3	7.6	15.5	125.7	31
AKO	**4.0**	4.4	7.2	12.5	17.3	21.5	26.1	27.3	23.7	17.4	11.8	6.7	15.0	121.5	2
OKAYAMA	**3.6**	4.0	7.1	12.6	17.7	21.9	26.6	27.6	23.4	16.7	11.1	6.2	14.9	120.9	8
SAKAIDE	**5.3**	5.4	8.1	13.5	18.2	22.4	27.2	28.3	24.6	18.2	12.9	7.8	16.0	131.9	3
KYOTO	**3.5**	3.9	7.0	12.6	17.7	21.9	26.7	27.6	23.4	16.9	11.1	6.1	14.9	121.0	42
FUKUCHIYAMA	**2.7**	3.3	6.8	21.6	17.5	21.9	26.8	27.5	23.1	16.6	10.6	5.7	14.6	119.1	18
KAMEYAMA	**3.7**	3.8	6.8	12.1	17.2	21.4	25.8	26.4	22.8	16.7	11.4	6.2	14.5	116.8	69
IKUNO	**1.6**	2.0	5.0	11.1	15.9	20.2	24.8	25.6	21.4	14.9	9.4	4.5	13.0	103.3	302
HAMASAKA	3.8	**3.4**	6.5	11.9	16.8	20.9	25.6	26.6	22.3	16.5	11.6	7.1	14.4	115.8	8

ANN: Annual mean temperature (°C). W I: Kira's warmth index (°C month).
The figures printed in black letter show the mean temperature in the coldest month (MTCM).

Table 2. The precipitation in mm and Kira's humidity/aridity index (K H/A I) at some stations in the Setouchi district and the neighbouring area

Station \ Month	1	2	3	4	5	6	7	8	9	10	11	12	Annual	K H/A I
SHINGU	111	130	234	290	309	609	322	367	466	334	200	113	3285	23.3
KOCHI	56	93	174	221	273	320	360	325	353	195	109	77	2556	18.7
HIROSHIMA	40	68	105	138	144	249	230	107	213	113	66	54	1527	11.7
TOKUYAMA	49	75	124	184	195	311	236	122	211	96	76	55	1734	13.0
KAMINOGO	42	62	90	117	115	177	137	101	179	134	87	56	1297	9.6
TOKUSHIMA	36	62	87	115	126	195	190	157	260	194	97	50	1569	12.3
MATSUYAMA	45	63	90	114	118	198	187	97	175	108	75	62	1332	10.0
AKO	30	48	79	91	114	163	139	90	167	109	61	35	1126	8.6
OKAYAMA	29	50	75	87	107	163	145	88	152	98	59	40	1093	8.4
SAKAIDE	30	49	70	79	94	158	129	82	157	105	61	43	1057	7.8
KYOTO	46	63	100	133	141	229	190	128	189	127	87	55	1488	11.4
FUKUCHIYAMA	98	108	120	116	119	181	181	132	226	159	88	92	1616	12.5
KAMEYAMA	50	71	113	160	155	287	214	262	266	206	102	58	1944	15.1
IKUNO	90	108	130	152	141	205	220	170	252	159	88	92	1616	12.5
HAMASAKA	272	198	137	119	102	147	133	146	266	184	189	284	2177	17.0

forest will be listed as the representative localities of each vegetation unit.

2. Climate

The meteorological data on temperature and precipitation at some stations are shown in Table 1 and 2 respectively. As a whole, the study area seems to be in warm temperate climate zone where it is hot in summer and not so cold in winter, the annual mean temperature being 14.5～16.0°C.

On the other hand, the annual precipitation varies from 1050 mm to 1600 mm. These values indicate that this area has the least rain throughout Japan; the national average of rainfall is about 1600 mm. Especially, little rain in the summer season (August) is so noticeable that the climate of the district is called the Setouchi climate.

In order to make the state of humidity-aridity climate clear, Kira's Humidity/Aridity Index (KH/AI) is calculated according to the following formula (Imanishi & Kira 1953).

$$KH/AI = P/(WI+20) \quad \text{if } WI \leqq 100$$
$$P/(WI+140) \quad \text{if } WI \geqq 100$$

where P is the annual precipitation, W I is the value of warmth index. It may be noted that this index (K) is correlative to Thornthwaite's Moisture Index (Im) (Thornthwaite 1948) and that the regression of K on Im is almost linear, nearly $K=0.0594\ Im+6.366$ (Yim & Kira 1976).

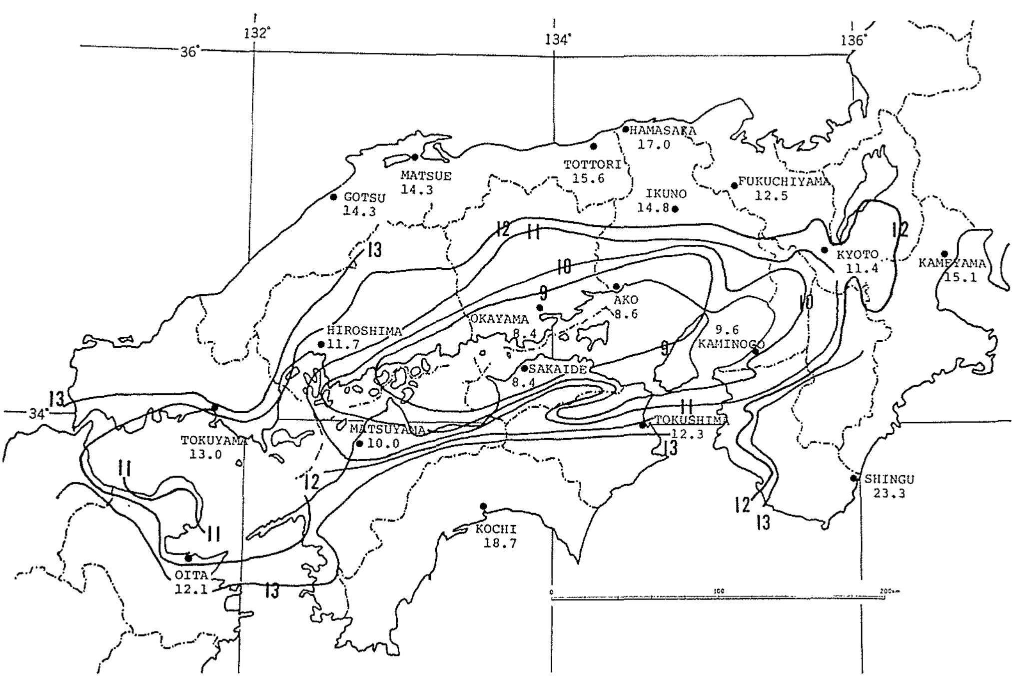

Fig. 2. Distribution of isoline of Kira's humidity/aridity index in the Setouchi district.

As shown in Fig. 2, the value of Kira's Humidity/Aridity Index varies from 8 to 12 in the study area. The eastern part of the Setouchi district seems to be under a relatively arid climate showing the values less than 10.

3. Geology

The areas in question are mostly located in the inner zone of the median tectonic line which divides the geology of southwestern Japan into two zones. Geology of this area consists of granite, rhyolite, andesite, conglomerate, sandstone, mudstone, tuff, diorite, slate, quartz and others. Among them, the granite and rhyolite cover this area broadly. They show a tendency to form a sandy soil which is liable to dry.

As a whole, the natural environmental background of the district studied is more arid than other areas not only in the climatic but also in the edaphic aspect.

II. Historical review on the phytosociological treatment of Castanopsis type forests in the Setouchi district

Suzuki-Tok. & Mori (1957), Yamanaka (1957, 1962) and Suganuma (1972) regarded the forests dominated by *Castanopsis cuspidata* as the Simploco-Shiietum cuspidatae which had been described by Nomoto (1953) in the southwestern Shikoku, On the other hand, Miyawaki & Fujiwara (1974) and Kobayashi *et al.* (1976-a) treated the forests as the Cleyero-Castanopsietum cuspidatae which had been described by Yato (1955) in Ise of Kii Peninsula. Suzuki-Tok. & Mori (1975), and Yano *et al.* (1972) identified the forests dominated by *Castanopsis cuspidata* var. *sieboldii* as the Bladhio-Shiietum sieboldii which had been described by Suzuki-Tok. (1952) in Izu Peninsula. In addition to these three associations, the Castanopsis type forests were reported as other associations, for example, as the Liriopo-Shiietum cuspidatae (Suganuma 1972), or as the Osmantho-Cyclobalanopsietum (Miyawaki & Fujiwara 1970; Kameyama, Noda & Maenaka 1973). Moreover, the Castanopsis type forests have been also reported under the various community names.

We have investigated the Castanopsis type forests at various places in the district and examined their floristic composition in comparision with the original documentation of each association previously reported. Through the field investigations, it has become clear that *Castanopsis cuspidata* and the variety *sieboldii* often grow together in the Setouchi district and that they are not distinguishable from each other by the morphological characters of their leaves and bark fissure as pointed out by Yamanaka (1966). These facts seem to suggest that they may be treated as one species in the phytosociological classification of the Castanopsis type forests. In this way, it has become clear that the Castanopsis type forests of the Setouchi district can not correspond to any of the associations previously described.

Thus Nakanishi (1973-a) concluded that it was more reasonable to treat the Castanopsis type forests in Kobe as a new association "Photinio-Castanopsietum cuspidatae" because it had a unique floristic composition influenced by the arid environmental condition of the Setouchi district. Later, the occurrence of this association in the coastal regions of Osaka Bay was confirmed by Hattori (1975). Then Nakanishi, Hattori & Takeda (1976) reported that the Photinio-Castanopsietum was also distributed in the southern part of Okayama Prefecture, and that it was replaced by the Symploco lucidae-Castanopsietum cuspidatae in the western part of the Setouchi district. On the basis of these knowledge, this association was finally authorized by Nakanishi, Takeda & Hattori (1977).

In the study on the Castanopsis type forests in the northern part of Shikoku, Kishimoto *et al.* (1978) recently reported that the Photinio-Castanopsietum was also distributed in the regions facing the Seto Inland Sea and the Symploco glaucae-Castanopsietum sieboldii was developed in the southern part of Shikoku.

Through the related studies, it has been definitely shown that the Photinio-Castanopsietum is distributed in the eastern part of the Setouchi district, and the Symploco lucidae-Castanopsietum is distributed in the western part. And it has become clear the Symploco glaucae-Castanopsietum is originally developed in the maritime climate region facing the Pacific Ocean, including the southern parts of Kii Peninsula and Shikoku.

III. Revisional description of Photinio-Castanopsietum cuspidatae

The vegetation records used here was obtained by our field investigations during the nine years from 1970 to 1978. The methodology of ZM school (Ellenberg 1956; Braun-Blanquet 1964; Mueller-Dombois & Ellenberg 1974) was adopted for the analysis of vegetation. In addition to the vegetation data investigated by ourselves, the further information was obtained from the papers of Yamanaka (1970), Koshimizu & Suganuma (1971) and Yano *et al.* (1977).

In order to make the compositional characteristic distinct, the vegetation records of the Photinio-Castanopsietum were summarized at every representative area with those of the related associations in Table 6.

1. Association Photinio-Castanopsietum cuspidatae Nakanishi, Takeda et Hattori 1977.

Literature: Vegetation in the western part of Harima Province, Hyogo Prefecture. Soil, flora and vegetation of the western part of Harima Province, Hyogo Prefecture, 70～144 (1977).

Type relevé: Relevé No. 24 in Attached table 2, relevés 1～49, excl. 16, 32. Nakanishi *et al.* (1977).

Reference: Nakanishi 1973-a; Hattori 1975; Nakanishi, Hattori & Takeda 1976; Kishimoto *et al.* 1978.

Character and differential species: *Photinia glabra, Ilex chinensis, Ilex latifolia, Prunus spinulosa* and *Vaccinium bracteatum.*

Range: Eastern part of the Setouchi district and the neighbouring areas.

Synonyms: Symploceto-Shiietum cuspidatae, Suzuki-Tok. & Mori 1957 p. p. maj.; *Shiia cuspidata-Symplocos prunifolia* Ass., Yamanaka 1957 p. p.; Symploceto-Shiietum, Yamanaka 1962 p. p.; Symploco-Castanopsidetum cuspidatae, Koshimizu & Suganuma 1971 p. p. maj.; Kameyama, Noda & Maenaka 1973 p. p.; Symploco-Shiietum cuspidatae, Suganuma 1972 p. p.——Bladhieto-Shiietum sieboldii, Suzuki-Tok. & Mori 1957 p. p.; Bladhio-Shiietum sieboldii, Yano *et al.* 1972 p. p. ——Acero-Zerkovetum, Miyawaki & Fujiwara 1970 p. p. ——Osmantho-Cyclobalanopsietum, Miyawaki & Fujiwara 1970 p. p.; Kameyama, Noda & Maenaka 1973 p. p.; Osmantho-Cyclobalanopsidetum stenophyllae, Koshimizu & Suganuma 1971 p. p.; *Osmanthus illicifolius-Quercus salicina* Ass., Noda *et al.* 1972 p. p.——Rapanaeo-

Shiietum sieboldii, Yano *et al.* 1972 p. p.; Rapanaeto-Shiietum sieboldii, Nakanishi 1973-b p. p. ——Liriopo-Shiietum cuspidatae, Suganuma 1972 p. p. ——Rumohro-Castanopsietum sieboldii, Nakanishi 1973-b p. p. ——Cleyero-Castanopsietum cuspidatae, Miyawaki & Fujiwara 1974 p. p.; Cleyereto-Castanopsietum cuspidatae, Kobayashi *et al.* 1976-a p. p. ——Symploco glauca-Castanopsietum sieboldii, Hattori 1975 p. p. ——*Castanopsis cuspidata* Comm., Nakanishi *et al.* 1970 p. p. maj. ——*Gardenia grandiflora-Castanopsis cuspidata* var. *sieboldii* Gesellschaft, Miyawaki *el al.* 1971 p. p. ——*Photinia glabra-Castanopsis cuspidata* Comm., Yano & Okawa 1976 p. p. maj. ——*Cleyera japonica-Castanopsis cuspidata* Comm., Tabata 1974 p. p.——*Myrsine seguinii-Castanopsis cuspidata* var. *sieboldii* Comm., Yano *et al.* 1977 p. p.

As known from the Table 5, this association has no character species in the strict sense of the word. It can be said, however, that the compositional characteristics of the present association are in the lack of many character and differential species of the related associations and in the preferential occurrence of *Photinia glabra*, *Ilex latifolia*, *Prunus spinulosa* and *Vaccinium bracteatum*. It is also a remarkable characteristic that the present association hardly contains *Machilus thunbergii* which is one of the most common members of the evergreen broad leaf forest of Japan.

This association is integrated into the alliance Ardisio-Castanopsion together with the Symploco glaucae-Castanopsietum, the Symploco lucidae-Castanopsietum and the Osmantho-Cyclobalanopsietum. This alliance belongs to the order Camellietalia japonicae which is integrated to the class Camellietea japonicae.

Generally speaking, the tree layer, about 20 m high, of this association is characterized by the dominant tree of *Castanopsis cuspidata* (incl. var. *sieboldii*) and the subdominant trees of *Quercus glauca*, *Myrica rubra*, in the inland region of *Quercus salicina* and Q. *myrsinaefolia*. The sub-tree and shrub layers more than 4 m are occupied mostly by the evergreen broad leaf trees and shrubs of *Cleyera japonica*, *Dendropanax trifidus*, *Ilex chinensis*, *Cinnamomum japonicum*, *Prunus spinulosa* and *Ilex pedunculosa*. These trees and tall shrubs usually make up the cumuluslike forest canopy (cf. Fig. 14).

The small shrub layer from 1 m to 3 m is mainly composed of the evergreen broad leaf shrubs of *Eurya japonica*, *Ligustrum japonicum*, *Photinia glabra*, *Vaccinium bracteatum* and *Ardisia crenata*, in the inland area, of *Illicium religiosum*, *Pieris japonica* and *Skimmia japonica*. The herb layer is characterized by the abundant occurrence of an evergreen liana, *Trachelospermum asiaticum*, a sempre-virescent fern, *Dryopteris erythrosora*, and an evergreen caespitose liliaceous herb, *Ophiopogon ohwii*. In addition to these plants, *Ardisia japonica*, *Cymbidium goeringii*, *Liriope platyphylla* and *Ficus nipponica* occur frequently. It seems to be a remarkable characteristic in the physiognomy that the most members of this association are the evergreen broad leaved plants.

The present association is developed well on rather arid habitats which are covered poorly with the sandy soil derived from igneous rocks. This association extends from the coastal land to the inland country of the eastern part of the

Seto Inland Sea as shown in Fig. 1.

The actual habitats of the present association are in the range from 1000 mm to 1600 mm of the mean of annual precipitation and from 7 to 12 of Kira's Humidity/Aridity Index. Regarding the thermal environment, the present association is found in the range from 100°C to 130°C of the Warmth Index and from 1.5°C to 5.5°C of the mean temperature of the coldest month. On the whole, the geographical range of this association corresponds to the Setouchi climate which is relatively arid in Japan (cf. Fig. 2).

In the southernmost part of the geographical range, this association borders the Symploco glaucae-Castanopsietum which extends in warm and humid climate regions. The boundaries are located in the vicinity of Wakayama in Kii Peninsula and around Tokushima and Matsuyama in Shikoku. The present association is interchanged with the Symploco lucidae-Castanopsietum which occupies the areas surrounding the western part of the Seto Inland Sea. The boundary is situated in and around Takehara in Hiroshima Prefecture. The Castanopsis type forests in north of the middle part of Mie Prefecture seem to be similar to the Photinio-Castanopsietum because they contain *Photinia glabra* and *Vaccinium bracteatum*. However, it seems that they are somewhat different from the association in question by the frequent occurrence of *Machilus thunbergii* and the absence or rare occurrence of *Prunus spinulosa* and *Ilex chinensis*. In this paper, this community is provisionally treated as the *Castanopsis cuspidata-Cleyera japonica* Community. The further investigation on the community is left to be carried on in the future. In the northernmost part of the range, the association is usually replaced by the Osmantho-Cyclobalanopsietum which mainly occurs in the higher land of about 350～400 m above sea level. If a lowland along a river is thoroughly extended to northernmost part of the range, this association adjoins to the *Castanopsis cuspidata-Epimedium grandiflorum* ssp. *sempervirens* Community which is a peculiar Castanopsis type forest in the Japan Sea area. Such phenomenon is observed in the vicinity of Fukuchiyama Basin on the Japan Sea side which is connected with the Setouchi district through the lowlands along the Kako river and the Yura river.

2. Subdivision of Photinio-Castanopsietum cuspidatae

The Photinio-Castanopsietum is subdivided into two subassociations. One of them is the dendropanacetosum which is distributed on lowlands and hills in the coastal region. The other is the quercetosum myrsinaefoliae which is found in the country area of the inland region. The floristic composition of these community types is summarized in the Table 6.

1) Subassociation dendropanacetosum

This subassociation is differentiated by the presence of *Polystichopsis aristata, Symplocos prunifolia, Podocarpus macrophyllus, Daphniphyllum teijsmannii, Dendropanax trifidus, Myrica rubra, Ilex rotunda, Damnacanthus major, D. indicus, Ternstroemia gymnanthera, Gardenia jasminoides* f. *grandiflora* and *Maesa japonica*.

This is subdivided into the variant of *Myrsine seguinii* and the variant of typicum. The former usually occurs in the southernmost area of the association range where the present association transits to the Symploco glaucae-Castanopsietum. The variant of typicum is found in more arid and cooler localities than the former variant.

(1) Variant of *Myrsine seguinii*

Type relevé: Relevé No. 43, in Attached tab. 1, Kishimoto *et al.* 1978.

Synonyms: Symploceto-Shiietum cuspidatae, Suzuki-Tok. & Mori 1975, Tab. 3 (No. 3); Symploco-Castanopsidetum cuspidatae *Symplocos glauca* subordinate Comm., Kameyama, Noda & Maenaka 1973, Tab. 14 (Nos. 25, 26, 40～45).—— Rapanaeo-Shiietum sieboldii, Yano *et al.* 1972, Tab. 1 (Nos. 1～3, 25, 28, 37～40, 42, 43, 51, 59, 61, 68); Rapanaeto-Shiietum sieboldii, Nakanishi 1973–b, Tab. 5 (Nos. 22, 24, 26, 28, 30～32, 36, 39, 40, 46, 47, 50～54, 56, 57).—— Rumohro-Castanopsietum sieboldii, Nakanishi 1973–b, Tab. 4 (Nos. 20, 21, 24, 25, 37, 38, 41～44, 59). —— Photinio-Castanopsietum cuspidatae *Symplocos prunifolia* subass., Nakanishi 1973, Tab. 1 (Nos. 1～7); subassociation of *Myrsine seguinii*, Nakanishi, Takeda & Hattori 1977, Attached tab. 7 (Locality no. 6); *Myrsine seguinii* Community type, Kishimoto *et al.* 1978, Attached tab. 1 (Nos. 1～3, 11～14, 38～41,43, 44, 217～220, 222, 235, 236, 255～258). —— Symploco glauca-Castanopsietum sieboldii, Hattori 1975, Attached tab. 2 (Nos. 2–2, 2–5, 2–6, 2–7, 14–6, 15–1, 15–8, 16–7, 16–8, 19–2, 19–5, 12–7–1, 12–7–2). —— *Gardenia grandiflora-Castanopsis cuspidata* var. *sieboldii* Gesellschaft, Miyawaki *et al.* 1971, Tab. 2 (Nos. 14～17, 27, 28).—— *Myrsine seguinii-Castanopsis cuspidata* var. *sieboldii* Comm., Yano *et al.* 1977, Tab. 1 (Nos. 8～12, 16～29, 35～38, 98).

This variant is differentiated from the variant of typicum by the occurrence of *Myrsine seguinii*, *Symplocos glauca*, *Elaeocarpus sylvestris* var. *ellipticus*, *Michelia compressa*, *Anodendron affine*, *Chroranthus glaber* and *Distylium racemosum*.

As a whole, this variant is similar to the Symploco glaucae-Castanopsietum with respect to the floristic composition. However, this variant is distinguishable from that association by the dominant occurrence of *Photinia glabra*, *Ilex chinensis* and *Vaccinium bracteatum*, moreover, by the absence of *Machilus thunbergii*.

The localities of this variant are distributed in the southern coastal regions of the eastern part of the Setouchi district where the climate is in the range from 1300 mm to 1600 mm of the annual precipitation, from 10 to 12 of Kira's Humidity/Aridity Index and from 4°C to 7°C of the monthly temperature of the coldest month. The representative localities are as follows.

Representative localities: OSAKA PREF. Ogami-jinja (意賀美神社), Habudaki, Kishiwada; Shindachi-jinja (信達神社), Kinyuji Sennan; Kosen-ji (高仙寺), Kamikyoshi, Misaki. HYOGO PREF. Taisan-ji (太山寺), Ikawadani, Kobe; Shirakami-jinja (白髪神社), Kaminada, Nandan; Yahata-jinja (八幡神社), Korikawa, Nandan; Junnin Imperial Mausoleum (淳仁天皇陵), Nandan. WAKAYAMA PREF. Hachiman-jinja (八幡神社), Okawa, Wakayama. Tosho-gu (東照宮), Wakanoura, Wakayama; Kinomotohachiman-gu (木本八幡宮), Kishi, Wakayama.

TOKUSHIMA PREF. Katsuragi-jinja (葛城神社), Kitanada, Naruto; Umachihachiman-jinja (馬地八幡神社), Umachi, Kamiyama. EHIME PREF. Mt. Shiroyama (城山), Matsuyama; Taki-jinja (滝神社), Takinomiya, Niihama; Kyaku-jinja (客神社), Kikuma, Hojo.

(2) Variant of typicum

Type relevé: Relevé No. 24 in Attached tab. 2. Nakanishi *et al.* 1977.

Synonyms: *Shiia cuspidata-Symplocos prunifolia* Ass., Yamanaka 1957, p. 4; Symploceto-Shiietum, Yamanaka 1962, Tab. 5 (No.6); Symploco-Shiietum cuspidatae, Suganuma 1972, Tab. (Nos. 31, 32); Symploco-Castanopsidetum cuspidatae Typical subordinate Comm., Kameyama, Noda & Maenaka 1973, Tab. 14 (Nos. 5, 6, 23, 24, 28～34). ——Acero-Zerkovetum, Miyawaki & Fujiwara 1970, Tab. 2 (No. 19). ——Osmantho-Cyclobalanopsietum, Miyawaki & Fujiwara 1970, Tab. 2 (Nos. 12, 13, 17). ——Bladhio-Shiietum sieboldii, Yano *et al.* 1972, Tab. 2 (Nos. 32, 54). ——Photinio-Castanopsietum cuspidatae, Nakanishi 1973–a, Tab. 1 (Nos. 18～20); Subass. of *Dendropanax trifidus*, Hattori 1975, Attached tab. 2 (Nos. 2–3, 4–1, 4–2, 4–5, 13–1, 13–3, 24–1, 25–6, 32–3, 63–1, 64–1, 64–2); Nakanishi, Takeda & Hattori 1977, Tab. 2 (Nos. 1～31); Typical community type, Kishimoto *et al.* 1978, Attached tab. 1 (Nos. 25～29, 56, 57, 87～93, 95, 99～107, 129, 132, 133, 135, 138～140). ——Cleyero-Castanopsietum cuspidatae, Miyawaki & Fujiwara 1974, Tab. 9 (Nos. 7～13); Subass. of *Pieris japonica*, Kobayashi *et al.* 1976–a, Tab. 1 (No. p-14); Subass. of *Pieris japonica-Ampelopsis brevipedunculata*, Kobayashi *et el.* 1976–a, Tab. 1 (No. p-5).——*Cleyera japonica-Castanopsis cuspidata* Comm., Tabata 1974, p. 27～29.

This variant has no differential species. This is distributed in the eastern part of the Setouchi district. In highlands, it is replaced by the quercetosum myrsinaefoliae around 100 to 200 m above sea level. The climate of the distribution area is more arid and cooler than that of the former variant being 1000mm to 1300mm of the annual precipitation, 7 to 10 of Kira's Humidity/Aridity Index and 3°C to 5°C of the monthly temperature of the coldest month. The representative localities are as follows.

Representative localities: SHIGA PREF. Ishiyama-dera (石山寺), Terabe, Otsu. KYOTO PREF. Kiyomizu-dera (清水寺), Kiyomizu, Kyoto; Fushimi-inari (伏見稲荷), Fushimi, Kyoto; Matsuo-taisha (松尾大社), Matsuo, Kyoto; Iwashimizuhachiman-gu (石清水八幡宮), Otokoyama, Yahata; Otoshi-jnja (大歳神社), Haikata, Nagaokakyo. OSAKA PREF. Amanokongo-ji (天野金剛寺), Amano, Kawachinagano; Ryoan-ji (滝安寺), Mino; Hoshidamyoken-gu (星田妙見), Hoshida, Katano; Eboshigata-jinja (烏帽子形神社), Kita, Kawachinagano; Wakayama-jinja (若山神社), Shimamoto. HYOGO PREF. Nihyakuyosha-jinja (二百余社神社), Goji Yumesaki; Hitsukura-jinja (櫃蔵神社), Miyaoki, Yumesaki; Hiyoshi-jinja (日吉神社), Hie, Okochi; Temporin-ji (転法輪寺), Myodani, Kobe; Is. Ikushima (生島), Sakoshi, Ako; Kurai-jinja (鞍居神社), Kanaji, Kamigori; Mt. Keirosan (鶏籠山), Tatsuno. OKAYAMA PREF. Saikou-jinja (西幸神社), Saikou, Chuo; Ishidate-jinja (石立神社), Mukai, Bizen; Usahachiman-gu (宇佐八幡宮), Yonezawa, Saeki; Yuka-jinja (由加神社), Kojimayuka, Kurashiki. KAGAWA PREF. Mt. Zozusan (象頭山), Kotohira; Sugo-jinja (菅生神社), Tsuji, Yamamoto; Fujio-jinja (藤尾神社), Nishiueda-cho, Takamatsu; Ominakami-jinja (大水上神社), Ukata, Takase.

2) Subassociation quercetosum myrsinaefoliae

Type relevé: Relevé No. 46 in Attached tab. 2, Nakanishi *et al.* 1977.

Synonyms: Bladhieto-Shiietum sieboldii, Suzuki-Tok. & Mori 1957, Tab. 3 (No. 2). ——Symploco-Castanopsidetum cuspidatae, Koshimizu & Suganuma 1971, Tab. 2–13 (Nos. 64, 66～68, 70, 72～74, 76, 78). ——Osmantho-Cyclobalanopsietum, Kameyama, Noda & Maenaka 1973, Tab. 16 (No. 27); *Osmanthus illicifolius-Quercus salicina* Ass. *Castanopsis cuspidata* var. *sieboldii* Subass., Noda *et al.* 1972, Tab. 1 (Nos. 18, 20, 21, 23～30). ——Liriopo-Shiietum cuspidatae, Suganuma 1972, Tab. (No. 15). ——Photinio-Castanopsietum cuspidatae Subass. of *Quercus acuta*, Hattori 1975, Attached tab. 2 (Nos. 3, 4–4, 4–7, 19–1～19–3, 24–5, 24–6, 25–1～25–3, 30–1, 50–1～50–3, 52–1, 129–1, 130–1). ——Cleyereto-Castanopsietum cuspidatae Subass. of typicum, Kobayashi *et al.* 1976–a, Tab. 1 (Nos. p-4, p-11). ——*Castanopsis cuspidata* Comm., Nakanishi *el at.* 1970, Tab. 5 (23～29). ——*Gardenia grandiflora-Castanopsis cuspidata* var. *sieboldii* Gesell., Miyawaki *et al.* 1971, Tab. 2 (Nos. 18, 19). ——*Photinia glabra-Castanopsis cuspidata* Comm., Yano & Okawa 1976, Tab. 3 (Nos. 54, 56, 58, 61, 62, 64～67); Yano & Okawa 1976, Attached tab. (No. 76).

This subassociation is distinguishable from the dendropanacetosum by the frequent occurrence of *Abies firma*, *Tsuga sieboldii*, *Illicium religiosum*, *Skimmia japonica*, *Daphniphyllum macropodum*, *Cephalotaxus harringtonia*, *Torreya nucifera*, *Quercus acuta*, *Q. sessilifolia* and *Q. myrsinaefolia*. Many of these species are also the component species of the Osmantho-Cyclobalanopsietum. So, the composition of this subassociation exhibits transitional aspect between the Photinio-Castanopsietum and the Osmantho-Cyclobalanopsietum.

This subassociation exhibits the physiognomy of *Castanopsis-Quercus* mixture forest, in which the trees of *Quercus* (*Q. acuta*, *Q. myrsinaefolia*, *Q. salicina*, *Q. sessilifolia*) usually form the tree layer with *Castanopsis cuspidata.*

This is mainly found in the flat and the skirts of a mountain in somewhat inland country region, especially in the basins of Hyogo and Kyoto Prefectures, where the climatic conditions are from 1200mm to 1600 mm of the annual precipitation, 10 to 12 of Kira's Humidity/Aridity Index and 1°C to 3°C of the monthly temperature of the coldest month. It borders the Osmantho-Cyclobalanopsietum in the uppermost zone of the range which is about 300m to 400 m above sea level. The representative localities are as follows.

Representative localities: SHIGA PREF. Kasuga-jinja (春日神社), Tomikawa, Otsu. KYOTO PREF. Hasehachiman-jinja (長谷八幡神社),

Iwakura, Kyoto; Residence forest (屋敷林), Teramachi, Ayabe; Residence forest (屋敷林), Iwasaki,Fukuchiyama; Kasahara-jinja (笠原神社), Mikata, Ayabe. OSAKA PREF. Susanoo-jinja (素戔嗚神社), Kiyosaka, Ibaraki; Yokawa-jinja (吉川神社), Yokawa, Nose; Kanshin-ji (観心寺), Teramoto, Kawachinagano; Fuhomi-jinja (不本見神社), Higashizaka, Chihayaakasaka; Yahata-jinja (八幡神社), Amami, Kawachinagano; Ten-jinja (天神社), Takihata, Kawachinagano. WAKAYAMA PREF. Tennou-jinja (天王神社), Yagurawaki, Hashimoto. HYOGO PREF. Goryo-jinja (御霊神社), Iwakuragami, Kami; Hodara-ji (補陀落寺), Bunden, Yumesaki; Enkyo-ji (円教寺), Mt. Shoshazan, Himeji; Saimyo-ji (最明寺), Teramae, Okochi; Komausahachiman-jinja (駒宇佐八幡神社), Kamihonjo, Sanda; Shakubu-ji (石峯寺), Ogo, Kobe; Susanoo-jinja (素戔嗚神社), Ozo, Kobe; Yasaka-jinja (八坂神社), Kizukami, Inagawa; Kochi-jinja (公智神社), Shimoyamaguchi, Nishinomiya; Arima-jinja (有馬神社), Arino, Kobe; Banshoin (万勝院), Todoma, Kamigori; Ohara-jinja (大原神社), Tokuo, Ichijima. OKAYAMA PREF. Tokuzou-jinja (徳蔵神社), Kawachi, Mitsu; Genju-ji (幻住寺), Asahi; Kagamiishi-jinja (鏡石神社), Shizutani, Bizen; Taisei-ji (大聖寺), Sakuto; Takitani-jinja (滝谷神社), Takitani, Yoshinaga.

IV. Discussion

In order to clarify the peculiality of Photinio-Castanopsietum cuspidatae, the comparative examinations with the related association are made on two properties. One is in regard to the composition of distribution elements in every association. The other is the distribution response of the main component species to the climatic gradients from coldness to warmth as well as from aridity to humidity.

1. *Composition of distribution element in every association*

Hotta (1974) pointed out that the warm temperate plants could be classified into six distribution groups. However, this grouping is so general that it is not enough for the component species of warm temperate forests in the southwestern Japan, because it is indifferent to the distribution aspect in the Setouchi district. So, with reference to the distribution maps illustrated by Horikawa (1972, 1976), Nakanishi *et al.* (1976, 1977) classified the main component species into fourteen distribution groups after due consideration not only of the latitudinal distribution but also of the altitudinal distribution. Among them the following eleven groups have some relations to the associations treated in the present paper.

1) *Camellia japonica* group

The species of this group are widely distributed through the warm temperate zones of Ryukyu, Kyushu, Shikoku and Honshu. The representative species are *Camellia japonica* and *Eurya japonica* (cf. 1 in Fig. 3).

2) *Ardisia japonica* group

The species of this group grow through the warm temperate zones of Kyushu, Shikoku and Honshu, but not in Ryukyu. The representative species are *Ardisia japonica* and *Dryopteris erythrosora* (cf. 2 in Fig. 3).

3) *Castanopsis cuspidata* group

This group is akin to the *Camellia japonica* group in the latitudinal distribution. However, the species of this group do not occur in the mountain and highland of inland region but in the flat land and hill of coastal region. The typical species are *Castanopsis cuspidata* and *Ilex integra* (cf. 3 in Fig. 3).

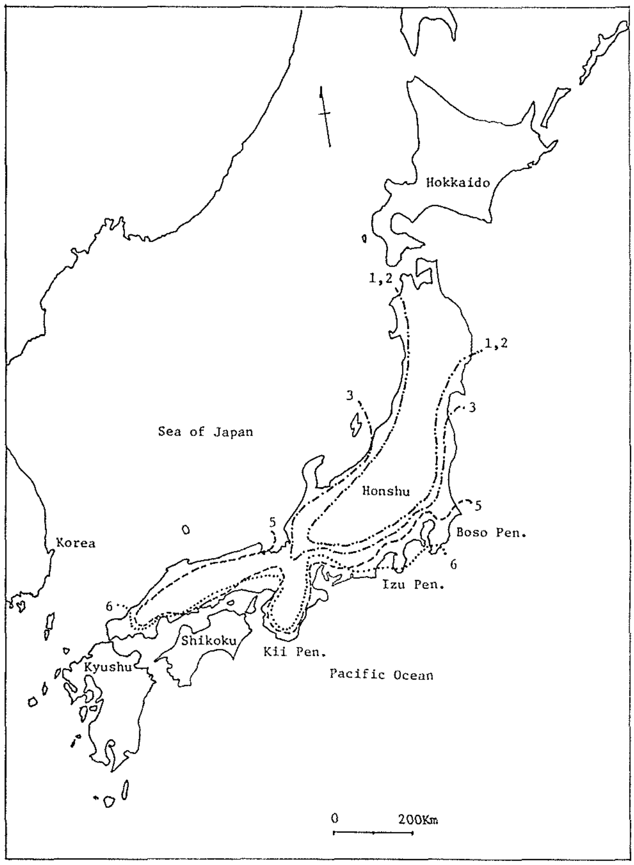

Fig. 3. Map showing the approximate distribution limits of the distribution groups 1, 2, 3, 5 and 6.

4) *Quercus acuta* group

This group is inconspicuous or absent in Ryukyu but common in the submontane region of Kyushu, Shikoku and Honshu. This group is distributed latitudinally south of the Kanto district on the Pacific side, and south of the Hokuriku district on the Japan Sea side. The present element is found more frequently in the hill or high land of the inland region than in the low land of the coastal region. The typical species are *Quercus acuta* and *Daphniphyllum macropodum*.

5) *Dendropanax trifidus* group

This group is distributed along the coastal areas from Ryukyu to Honshu, and the northernmost of distributional range is around the Kanto district on the Pacific side and Wakasa Bay on the Japan Sea side. The species of this group are relatively small in number. Among them, *Dendropanax trifidus* and *Daphni-*

phyllum teijsmannii are the typical species (cf. 5 in Fig. 3).

6) *Symplocos prunifolia* group

This group is very similar to the preceding group, excepting that the northernmost locality on the Japan Sea side is around the Iwami Province. The representative species of this group are *Symplocos prunifolia* and *Maesa japonica* (cf. 6 in Fig. 3).

7) *Elaeocarpus sylvestris* var. *ellipticus* group

This group is distributed from Ryukyu to Honshu, like the *Symplocos prunifolia* group. But this group scarcely extend in the Setouchi district. The representative species are *Elaeocarpus sylvestris* var. *ellipticus* and *Myrsine seguinii* (cf. 7 in Fig. 4).

8) *Meliosma rigida* group

This group is close to the *Elaeocarpus sylvestris* var. *ellipticus* group, but the northern limit of the distribution range is around the Tokai district or Kii Peninsula. It hardly occurs on the Japan Sea side. The representative species are *Meliosma rigida* and *Helicia cochinchinensis* (cf. 8 in Fig. 4).

9) *Simplocos lucida* group

The range of this group spreads from Ryukyu to Honshu. But it occurs abundantly in the western side of Kyushu and the Sanin district and poorly in Shikoku and Kii Peninsula along the Pacific Ocean. The species of this group are few. *Symplocos lucida* and *Ilex buergeri* are the typical species (cf. 9 in Fig. 4).

10) *Photinia glabra* group

The range of this group is restricted to the southwestern Japan excepting the Japan Sea side area and Kyushu. Especially it occurs abundantly in the areas surrounding the Seto Inland Sea. The typical species are *Photinia glabra* and *Ilex chinensis* (cf. 10 in Fig. 4).

11) *Epimedium grandiflorum* ssp. *sempervirens* group

This group seems to be the plants that grow originally in the lower part of the cool temperate zone. It occurs only in the Japan Sea side regions north of Shimane Peninsula. *Epimedium grandiflorum* ssp. *sempervirens* and *Aucuba japonica* var. *borealis* are the typical species.

As pointed out by Yamasaki (1959), Yoshioka (1963), Kira (1974) and Hotta (1974), it can be said that the geographical distribution of the warm temperate forests are primarily determined by the temperature factor. However, the distribution of *Epimedium grandflorum* ssp. *sempervirens* group seems to be subject to the influence of snow deposit in the winter season, not of temperature factor. Moreover, the *Symplocos lucida* group and *Photinia glabra* group do not seem to be correlative to temperature factor or other climatic factors. They might be related to the geohistorical factors.

Table 3 shows summarily what kinds of the distribution groups take part in composing each of the Castanopsis type associations and the allied ones. The Symploco glaucae-Castanopsietum is characterized by the abundant occurrence of many of the distribution groups. This fact would suggest that this is the typical association in the warm temperate evergreen broad leaf forest zone of Japan.

Comparing with the Symploco glaucae-Castanopsietum, the Symploco lucidae-

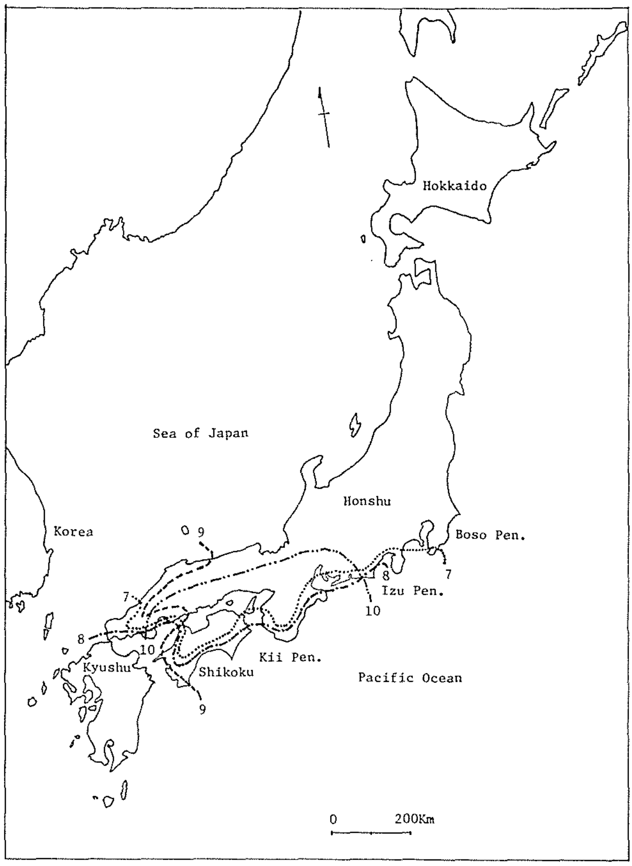

Fig. 4. Map showing the approximate distribution limits of the distribution groups 7, 8, 9 and 10.

Table 3. The composition of the distribution group in each of the Castanopsis type associations and the related one in the Setouchi district

Association \ Distribution Group	1	2	3	4	5	6	7	8	9	10	11
Symploco glaucae-Castanopsietum sieboldii	+++	+++	+++	+++	++	+	+++	+++			
Symploco lucidae-Castanopsietum cuspidatae	+++	+++	+++	+++	++	++	+	+	+++		
Photinio-Castanopsietum cuspidatae	+++	+++	+++	++	++	+++	+				+
Castanopsis cuspidata-Epimedium grandiflorum subsp. *sempervirens* Comm.	+++	+++	+++	+						+++	++
Osmantho-Cyclobalanopsietum	+++	+++									+++

1. *Camellia japonica* G. 2. *Ardisia japonica* G. 3. *Castanopsis cuspidata* G.
4. *Dendropanax trifidus* G. 5. *Symplocos prunifolia* G. 6. *Photinia glabra* G.
7. *Elaeocarpus sylvestris* var. *ellipticus* G. 8. *Meliosma rigida* G.
9. *Symplocos lucida* G. 10. *Epimedium grandiflorum* subsp. *sempervirens* G.
11. *Quercus acuta* G.

Castanopsietum seems to be poor in the composition of distribution element. That is characterized by the peculiar occurrence of *Symplocos lucida* group as well as by the absence of *Elaeocarpus sylvestris* var. *ellipticus* group and *Meliosma rigida* group which are distributed along the coastal regions of Kyushu, Shikoku, and Kii Peninsula through the Island of Ryukyu from more southern regions.

The floristic composition of the Photinio-Castanopsietum is characterized by the absence not only of the groups of *Elaeocarpus sylvestris* var. *ellipticus*, *Meliosma rigida* and *Symplocos lucida* but also by no occurrence of the peculiar distribution group. It can be said in another expression that there is the peculiarity of this association in the survival of *Photinia glabra* group which occurs with a high dominance. The lack of these distribution groups would be caused by a relatively arid environment in the eastern part of the Setouchi district.

Castanopsis-Epimedium grandiflorum ssp. *sempervirens* Community and Osmantho-Cyclobalanopsietum lack many species of the warm temperate species because they are developed under colder climate of highlands or northern regions. However, they have the peculiar distribution group respectively.

As a whole, it seems that the less suitable the environment of habitats for the warm temperate forests is, the poorer the diversity of distribution group in the forest association developed there.

2. Distribution response of the main components along the thermal and humidity-aridity gradients

Generally speaking, the floristic composition and distribution of the warm temperate forest associations are primarily influenced by the temperature factor and secondarily by the water factor. Accordingly, it is very significant for the definition of the ecological peculiarity of each association to know the occurrence responses of the main members to the thermal gradient from coldness to warmth as well as to the gradient from aridity to humidity.

The distribution limits of the warm temperate species usually depend on the coldness of winter. In this study, the mean temperature of the coldest month (MTCM) was singled out as the index of thermal gradient. It may be said in this connection that this index (MTCM) shows a high correlation with Kira's Coldness Index. On the other hand Kira's Humidity/Aridity Index (K H/A I) was selected as the index indicating the state of the water environment.

Then, about three hundred sample forests were picked out from the warm temperate forests investigated in the Setouchi district and its neighbouring areas. The sample forests are regarded as the natural or almost natural vegetation. Two climatic indices in every sample forest were calculated from the meteorological data in the nearest station. In this computation, the temperature lapse rate of 0.6°C per 100 m was used.

The sample forests with similar value in each of two climatic indices were grouped at an interval of 0.5°C of MTCM, in the same way of 1 of K H/A I. The occurrence frequency of the main component species was calculated in every sample group classified by the procedure as mentioned above. Thus, the occurrence aspects of every component species were able to express in the form of the curves showing the change of the frequency along the thermal gradient from coldness to warmth as well as the climatic gradient form arid to humid. According to the patterns of their curves and the positions of their distribution limits, the main component species were assorted into the following nine types.

1) Type A (Fig. 5)

The species of this type occur more frequently with the increase of MTCM having their distribution limit at 3~4°C of MTCM. They also become more abundant along the climatic gradient from arid to humid having their distribution limit at 8~10 of K H/A I. Their optimum ranges seem to be in warmer and

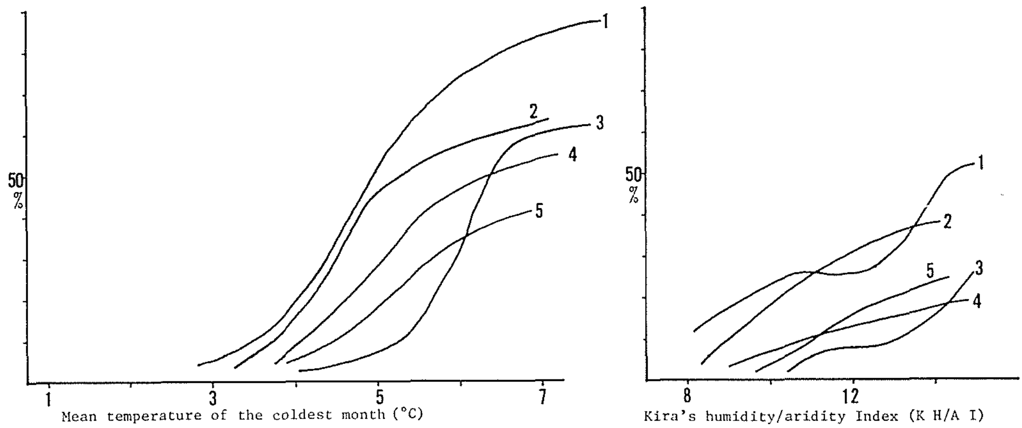

Fig. 5. Occurrence aspects of the species grouped in Type A along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Myrsine seguinii* 2. *Symplocos glauca* 3. *Anodendron affine* 4. *Meliosma rigida* 5. *Ardisia pusilla*

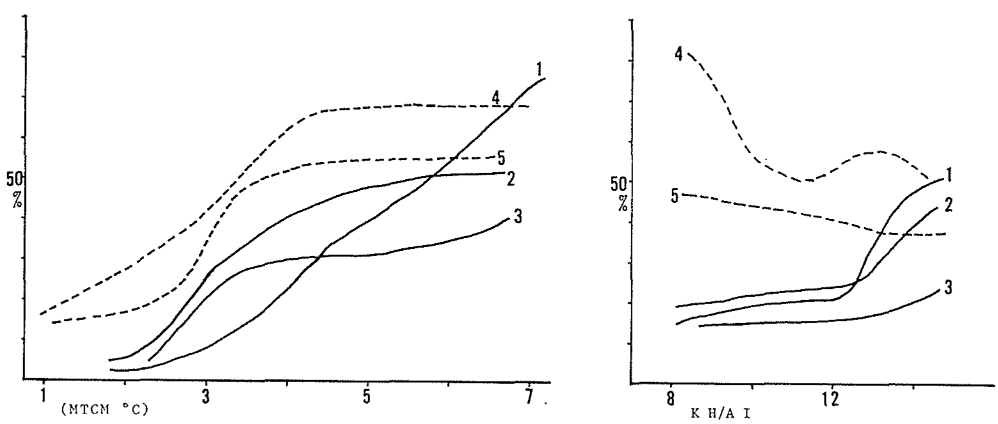

Fig. 6. Occurrence aspects of the species assorted in Type B (1, 2, and 3) and Type C (4 and 5) along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Daphniphyllum teijsmannii* 2. *Maesa japonica* 3. *Damnacanthus indicus* 4. *Dendropanax trifidus* 5. *Ternstroemia gymnanthera*

more humid habitats.

2) Type B (Fig. 6)

The occurrence aspect of this type is fundamentally not different from Type A. However, the species of this type have their distribution limit at 2~3°C of MTCM.

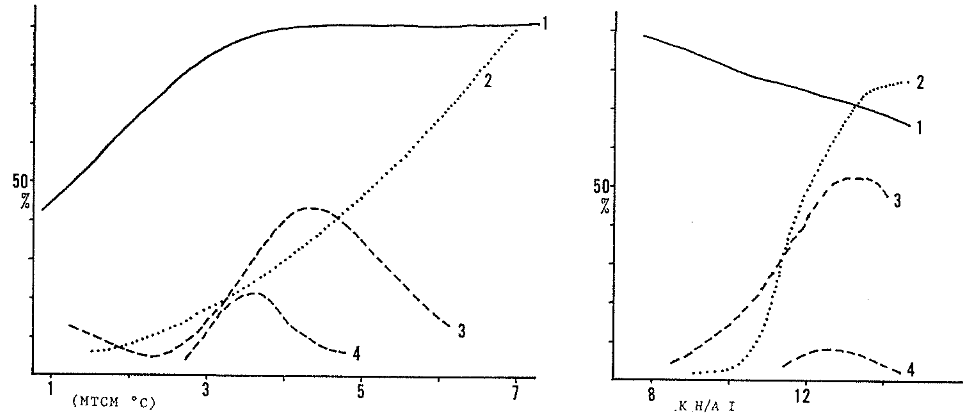

Fig. 7. Occurrence aspects of the species grouped in Type D (1), Type E (2) and Type G (3, 4) along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Castanopsis cuspidata* (incl. var. *sieboldii*) 2. *Machilus thunbergii* 3. *Symplocos lucida* 4. *Ilex buergeri*

3) Type C (Fig. 6)

The occurrence aspect of this type along the thermal gradient is akin to Types A and B. But the distribution limit is at about 1 °C of MTCM. Moreover, this type shows a tendency to become less abundant with the increase of K H/A I value.

4) Type D (Fig. 7)

This type is very similar to the foregoing Type C. However, the species of this type are able to grow in colder climate than the species of Type C, having its distribution limit at around 0°C of MTCM.

5) Type E (Fig. 7)

This type is akin to Types B and C in their occurrence aspect to the thermal gradient. But this type exhibits a remarkable reaction to the humidity-aridity gradient having the distribution limit at 10 of K H/A I.

6) Type F (Fig. 8)

This type is so unique that there is no analogous type. It shows the mountain-shaped curve to the thermal gradient, while the decline curve to the humidity-aridity gradient. The species of this type have their optimum growth at around 3～4°C of MTCM. Moreover, they seem to be tolerant to an arid environment.

7) Type G (Fig. 7)

This type appears to show the mountain-shaped curve to the thermal gradient having its optimum at 3～5°C of MTCM. Moreover, the occurrence aspect along the humidity-aridity gradient seems to be diverse because its geographical distribution is likely to be correlated with geohistorical factors.

8) Type H (Fig. 9)

This type shows the descending curve to the thermal gradient from coldness to warmth. This fact means that, compared with other warm temperate species, the species of this type prefer colder climate. On the other hand, they indicate

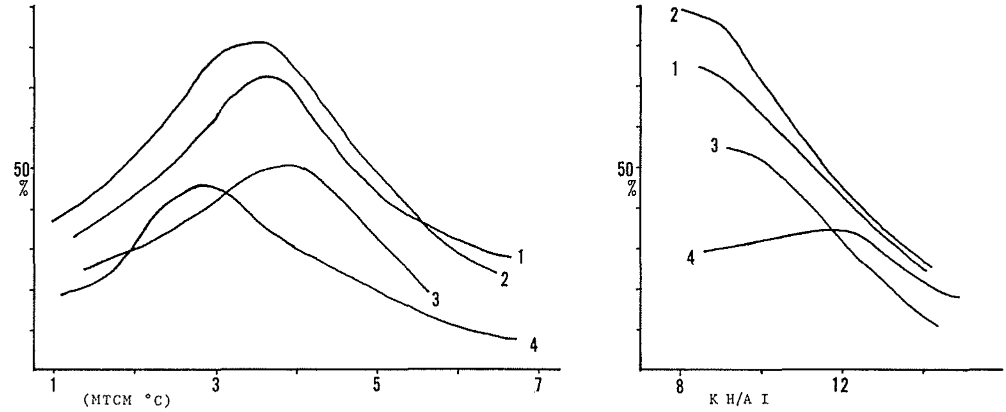

Fig. 8. Occurrence aspects of species grouped in Type F along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Vaccinium bracteatum* 2. *Photinia glabra* 3. *Ilex chinensis* 4. *Prunus spinulosa*

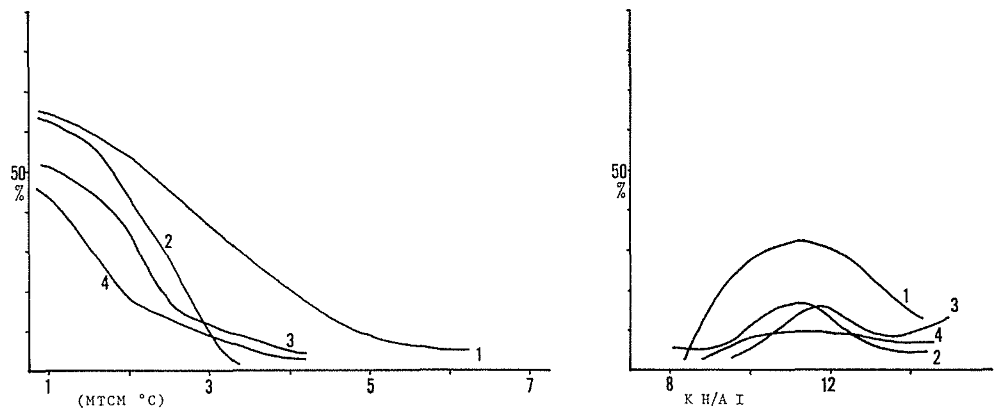

Fig. 9. Occurrence aspects of the species grouped in Type H along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Illicium religiosum* 2. *Skimmia japonica* 3. *Quercus acuta* 4. *Torreya nucifera*

the mountain-shaped curve to the water gradient showing the optimum at 11～12 of K H/A I.

9) Type I (Fig. 10)

So far as the sample forests used in this study are concerned, the species of this type occur with almost similar frequency along the thermal and humidity-aridity gradients. This fact suggests that they are most eurythermal as well as most euryhydric among the temperate plants.

Table 4 summarily indicates the type of the distribution response that the main members of each vegetation unit exhibit. As a whole, it can be said that the geographical distribution patterns of the warm temperate plants discussed in the preceding section correspond closely to their responses to the thermal and humidity-aridity gradients, except the cases of *Machilus thunbergii* and a few other species.

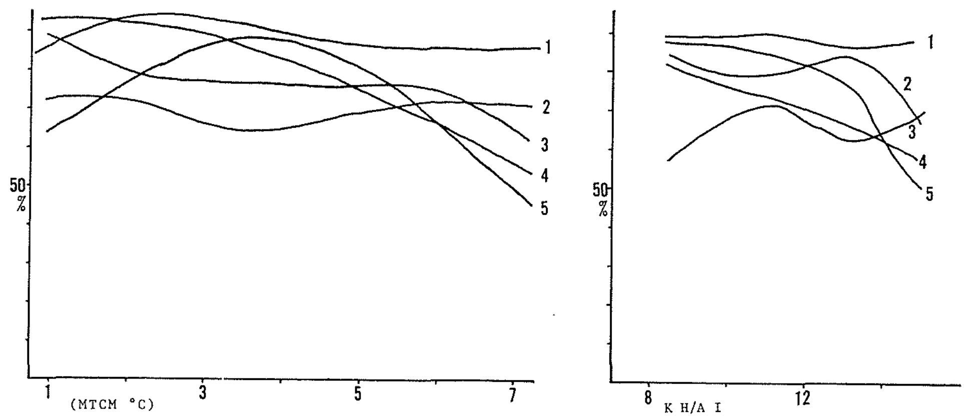

Fig. 10. Occurrence aspects of the species grouped in Type I along the thermal gradient (left) and the humidity aridity gradient (right).
1. *Camellia japonica* 2. *Cinnamomum japonicum* 3. *Trachelospermum asiaticum*
4. *Eurya japonica* 5. *Dryopteris erythrosora*

Table 4. The composition of the group of response type to climatic gradiants in each of the Castanopsis type associations and the related one in the Setouchi district

Association \ Group*	I	B	C	D	F	E	A	G	H
Symploco glaucae-Castanopsietum sieboldii	+++	+++	+++	+++	+	+++	+++		
Symploco lucidae-Castanopsietum cuspidatae	+++	+++	+++	+++	++	+++	+	+++	
Photinio-Castanopsietum cuspidatae	+++	++	+++	+++	+++		+		+
Osmantho-Cyclobalanopsietum	+++								+++

* The grouping is based on the occurrence pattern along the climatic gradients. See the text for the details.

The Symploco glaucae-Castanopsietum is characterized by the peculiar presence of the Types A and B which have their optimum growth in warm and humid climate. The Symploco lucidae-Castanopsietum is characterized by the Type G which seems to be stenothermal as well as stenohydric. At the same time, it can be distinguished from the allied associations by disappearance of the Types A and F.

The characteristic of Photinio-Castanopsietum is in the relatively dominant occurrence of the Type F. Moreover, this association is also distinguishable by the absence or rarity of the Types A, B, E and G. It is definitely concluded from these facts that the Photinio-Castanopsietum is a Castanopsis type association which has been differentiated by an arid climate of the Setouchi district.

Summary

The Setouchi district surrounding the Seto Inland Sea in the southwestern Japan is characterized by a relatively arid climate, especially little rain in the summer season (August), though Japan as a whole has much rain. Up to now, the natural forests of the Setouchi district have been investigated by many authors. However, it seems that there are some confusions in the syntaxonomical treat-

ment of the Castanopsis type forests in the district.

As the results of our phytosociological examination, it has become clear that it is more reasonable to treat the Castanopsis type forests of the eastern part of the Setouchi district as a new association Photinio-Castanopsietum cuspidatae. It is the main aim of this study to re-examine this association through the replenishment of the additional information on the floristic composition and the geographical distribution, and through the discussion about the relationship between the present association and the allied ones.

As the results of the re-examination, it is concluded that this association is divided into two subassociations, one is the dendropanacetosum which is subdivided into the variant of *Myrsine seguinii* and the variant of typicum, the other is the quercetosum myrsinaefoliae. The floristic composition and the habitat condition of each vegetation unit were deseribed.

The comparative considerations with the related associations are made on two properties in order to clarify the peculiarity of the Photinio-Castanopsietum. One is with regard to the composition of the distribution elements, the other is the distribution responses of the main component species to both thermal and humidity-aridity gradients.

In respect to the composition of the distribution element, it can be said that the Photinio-Castanopsietum is characterized not only by the absence of some distribution groups which have their distribution center in the coastal regions of Kyushu, Shikoku and Kii Peninsula but also the relatively dominant occurrence of *Photinia glabra* group which is distributed concentratedly in the Setouchi district. The species of *Photinia glabra* group exhibit a decline in response along the climatic gradient from arid to humid. These facts definitely show that the Photinio-Castanopsietum is the Castanopsis type association which has adapted to the arid climate of the eastern part of the Setouchi district.

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Fig. 11. The Junnin Imperial Mausoleum in the rice field zone of the southern part of Awaji-Shima. The Mausoleum is covered with the natural forest (Photinio-Castanopsietum) for it has been preserved as the sacred place for one thousand years or more.

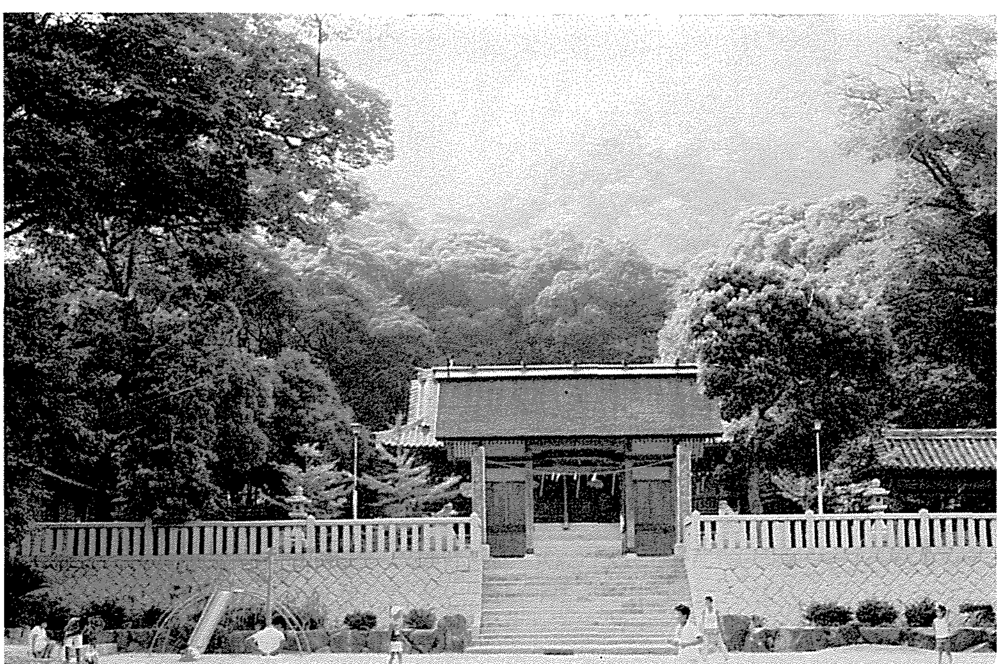

Fig. 12. The front view of a shrine. The shrine and oratory are sometimes surrounded by the forest which has been kept natural.

Fig. 13. The distant view of the Taisan-ji temple in Kobe. The natural forest (Photinio-Castanopsietum) of the mountain in the background plays a role to engender a religious atmosphere.

Fig. 14. The cumulus-like forest canopy of the Photinio-Castanopsietum.

Fig. 15. *Photinia glabra* with the fruits, the most representative character species of the Photinio-Castanopsietum.

Fig. 16. A young plant of *Ilex latifolia*, a character species of the Photinio-Castanopsietum.

Fig. 17. *Damnacanthus indicus*, dominating the small shrub layer of the dendropanacetosum.

Fig. 18. *Dryopteris erythrosora*, the most common fern grown abundantly in the herb layer of the Photinio-Castanopsietum.