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Ecological Characteristics of *Imperata cylindrica* var. *koenigii* in Kuju-Aso Area, Kyushu

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In order to know the factors and condition which make ***Imperata*** *cylindrica* var.*koenigii* dominant in vegetation, the ecological characteristics of *Imperata* in Kuju-Aso area, Kyushu Island were investigated in relation to typical types of seminatural grassland, *Miscanthus* ***sinensis*** and *Pleioblastus chino* var.*viridis*. Eleven sites with rather high coverage of ***Imperata*** were selected and examined the floristic composition and ***Imperata*** growth. From the floristic composition, the studied stands basically belonged to *Miscanthus* = *Pleioblastus* type of vegetation grouped by Suzuki and Abe (1959) in Kuju-Aso area.

Similarity of stands and ordination of the stands revealed that ***Imperata*** dominant vegetation located in transient phase from ***Miscanthus*** grassland in mowed habitats to ***Pleioblastus*** grassland in continuously grazed habitat and vice *versa*. This suggests that ***Imperata*** dominant vegetation might be formed and maintained under more than once a year of cutting and lighter grazing condition.

INTRODUCTION

Imperata cylindrica is a component of native pastures over wide ares of tropics and subtropics. Although mostly distributed in those areas, since early of this century, it has been spreading to much temperate regions of the world (Patterson et ***al., 1980).***

Imperata is a rhizomatous perennial grass with wide ecological amplitude. It spreads mainly by shifting cultivation and generally invades abandoned cultivated land and deforested areas (Sandanan and Jayasinghe, 1977). Davies and Skidmore (1966) observed that when forest is destroyed and further replaced by grassland, the pasture constituents are seldom the native grass of forest, but constituents are the invading grasses such as ***Imperata.***

Imperata *cylindrica* var.koenigii is widely spread in Japan, especially in such places as the banks of river, road and railway (Ito, 1982; Ito ***et al.,*** 1982). ***Imperata*** is reported as one of the important species in the perennial herb stage in the secondary succession in Kanto District (Numata et ***al., 1964).*** Although Osako (1973) has described the seral stage of ***Imperata*** in the succession of seminatural grasslands in Japan, it is not considered nowadays to be a valid stage of succession in Kyushu Island and northward. However, among the typical types of grassland, *Miscanthus* ***sinensis*** grassland in

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mowed and burned habitats and *Zoysia* ***japonica*** grassland or *Pleioblastus* ***chino*** var. ***viridis*** grassland in grazed habitats, there are various types of grassland including ***Imperata*** dominated grassland.

The seminatural grassland in Kuju-Aso area in Kyushu Island has been studied intensively (Suzuki and Abe, 1959; Abe and Suzuki, 1961; Kayama ***et al.,*** 1969). Although it is not considered as the major flora in the sense of phytosociology (Suzuki and Abe, 1959), some vegetations of *Imperata* with relatively high dominance have been reported in this area (Takayanagi ***et al.,*** 1975). Nevertheless, what kind of factors which may relate to the formation of *Imperata* dominated vegetation is not yet fully understood.

In the present research, the ecological characteristics of grassland containing ***Imperata*** were investigated in relation to the major types of seminatural grassland in Kuju-Aso area and discussed the condition and factors which make ***Imperata*** dominant in vegetation.

METHODS

In Kuju-Aso area, 11 sites shown in Fig.1 were investigated on June 23, 24 and 25, 1987. At each site, a stand with relatively high coverage of *Imperata* was selected as a sampling point and placed a 1 × 1 m quadrat. The plant height and the number of tillers of ***Imperata*** present in the quadrat were measured. Floristic composition was recorded and the plants were cut at 5 cm above the ground level. The cut samples were classified into species and dried for 48 hours to weigh dry matter yields. At the same

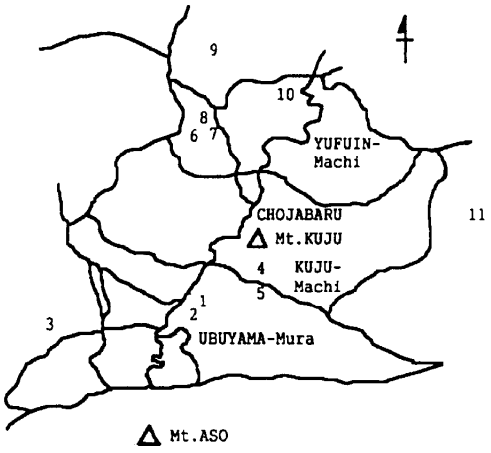

Fig. 1. The locations of stands studied.

1: Ubuyama
2: Yamaga
3: Aso-kitagairin
4: Akagawa
5: Toubu
6: Machida 1
7: Machida 2
8: Machida 3
9: Komatsudai
10: Ajibaru
11: Notsuharu

time, the soil from surface to 5 cm depth was sampled and put under pH determination and available and total phosphate contents analyses (Bray and Kurtz, 1945). Indices of similarity among the stands were calculated by Gleason's quantitative modification of Jaccard's Coefficients of community (Gleason cited by Itow, 1977), and their interstand distances were calculated by Bray and Curtis (1957).

RESULTS AND DISCUSSION

The surveyed sites are located in elevation from 400 m to 900 m. The annual mean temperature of this highland area is 12-13°C and annual precipitation is 2000-3000 mm. These sites are situated on the volcanic ash soil originated from Mt.Kuju and Mt.Aso. The soil contains much amount of humus and has large absorbing power of phosphorus. The stands have been mowed at least once a year, though the obtained information on managemental practice was not sufficient.

Floristic composition

Dry weight proportion of species in each stand was shown in Table 1. The species commonly appeared in the stands (appeared in more than 6 stands) were ***Imperata*** *cylindrica* ***var.koenigii, Miscanthus sinensis,*** *Pleioblastus* ***chino*** var. *viridis, Arundinella hirta,* ***Lotus*** *corniculatus, Cirsium japonicum, Ixeris dentata, Erigeron* ***annuus,*** *Potentilla* ***freyniana,*** *Artemisia princeps,* ***Viola*** spp. and *Carex* spp.. These species are characteristic species which consist of Japanese ***Miscanthus*** grassland (Suzuki and Abe, 1959; Suganuma, 1966).

Dry matter yield, plant height and the number of tillers of ***Imperata*** were presented in Table 2. The highest dry matter yield of more than 300 g/m^2 was obtained in No. 11 stand where the number of tillers also showed the highest value of 729 $/m^2$.

The soil pH and available and total phosphate contents were shown in Table 2. The succession from ***Miscanthus*** to *Sasa* type grassland was suggested to relate with the progress of soil pH (Abe and Suzuki, 1961). Omura (1961) and Abe and Suzuki (1961) reported the lower pH and fertility in ***Imperata*** increased vegetation soil than ***Miscanthus*** dominant vegetation soil. But in this study, any significant relationships between the composition of species or the dominance of ***Imperata*** and soil pH or phosphate content were not found.

The seminatural grassland in Kuju-Aso area have been grouped into 5 types by Suzuki and Abe (1959). These are 1.*Miscanthus* type, 2.*Pleioblastus* = ***Miscanthus*** type, 3.*Pleioblastus* type, 4.*Pleioblastus* = *Pteridium* type and 5.*Pteridium* type. The presence of ***Imperata*** was reported in the 2, 3 and 4 type, however, *Imperata* dominated stands were not reported. From the floristic composition, the stands in this study could be classified in their *Pleioblastus* = ***Miscanthus*** type basically, though there might be a possibility to classify ***Imperata*** dominant vegetation as another type of vegetational group in this area. More sampling stands and further phytosociological study are needed.

Stands ordination

The stands were arranged on a three-dimensional presentation in Fig. 2 to determine the distances among the floristic composition of the stands. The stands of

Table 1. Floristic composition of the stands(dry weight percentage in a 1m × 1m quadrat).

Stand No.	1	2	3	4	5	6	7	8	9	10	11
Location	Ubuyama	Yamaga	Kitagairin	Akagawa	Toubu	Machidal	Machida2	Machida3	Komatsudai	Ajibaru	Notsuharu
Altitude(m)	700	730	670	920	800	780	800	760	600	600	400
Number of species	10	20	17	11	15	31	21	16	19	14	17
Imperata cylindrica	84.2	10.2	90.9	92.7	60.7	53.0	36.6	49.8	40.9	73.4	97.3
Miscanthus sinensis	14.6		0.1			31.0	45.3	10.7	20.7		0.1
Pleioblastus chino v.*viridis*		80.6	8.7	6.8	13.1	8.2	0.9	10.5	3.0	25.7	
Arundinella hirta		3.9	0.1		6.4	6.6	16.3		5.4		
Pteridium aquilinum					18.5	0.1	0.1		11.6	0.1	
Erigeron annuus	+	+	+	+	+		+	+		+	4.6
Carex spp.	+	+		+		+	+	+	+	+	+
Ixeris dentata	+	+	+		+	+		+	+	+	
Viola spp.	+	+	+		+		+	+	+		+
Artemisia princeps	+			+		+	+	+	+	+	+
Cirsium japonicum		+	+		+	+	+		+	+	
Potentilla freyniana		+	+			+	+	+		+	+
Lotus corniculatus v.*japonicus*	+	+			+	+	+		10.2		
Cassia nomame		+			+	+	+				
Indigofera psued-tinctoria			+	+	1.9				1.4		
Achillea sibirica v.*brevidens*		+			+				+		+
Ranunculus japonicus						+	+			+	+
Geranium thunbergii	+			+			+				+
Agrostis clavata		+		+		+				+	
Sanguisorba officinalis			+			+			+		

* The weight percentage below 0.1% is shown as +.

Table 2. Plant height, the number of tillers and dry matter yield of ***Imperata*** *cylindrica* in lm × lm quadrat and pH, available and total phosphate contents of the soil.

Stand No.	Plant height	Tiller number	Dry matter yield	Soil pH (KCl)	Available soil P_2O_5	Total soil P_2O_5
	(cm)	(/m²)	(g/m²)		(mg/g soil)	(mg/g soil)
1	68	138	54.9	4.51	0.30	2.11
2	52	99	23.8	3.93	0.49	3.21
3	69	729	305.7	4.50	0.01	6.69
4	80	484	142.7	3.86	0.14	1.69
5	72	272	132.0	3.85	0.54	3.66
6	64	298	93.7	4.48	0.20	6.78
7	79	187	71.0	4.71	0.19	2.29
8	73	185	65.2	4.04	0.46	6.46
9	44	208	38.2	3.82	0.69	6.28
10	75	223	93.0	nd	nd	nd
11	86	598	222.3	3.89	0.39	2.98

nd; not determined

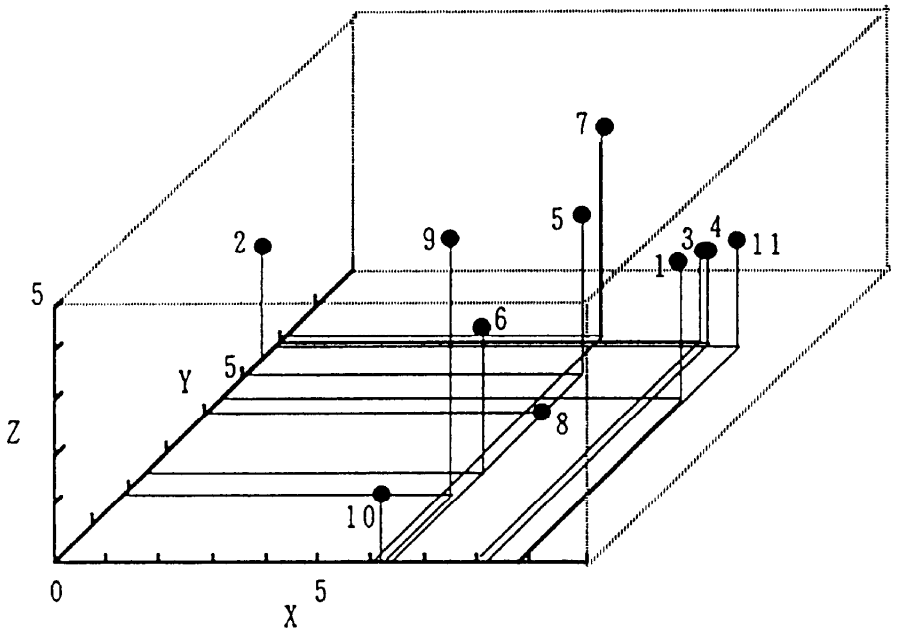

Fig. 2. The stands location in three dimensions.

No. 3, 4 and 11 had relatively near distances between each other, and from these stands No. 2 and 10 stand situated in the farthest positions. No.5, 6, 7, 8, 9 and 10 stand were on the similar locations on the X axis but they clearly separated on the Y and Z axis.

In order to estimate the contribution to the different ordinations, the behaviours of four important species within the stands (*Imperata, Miscanthus, Pleioblastus* and

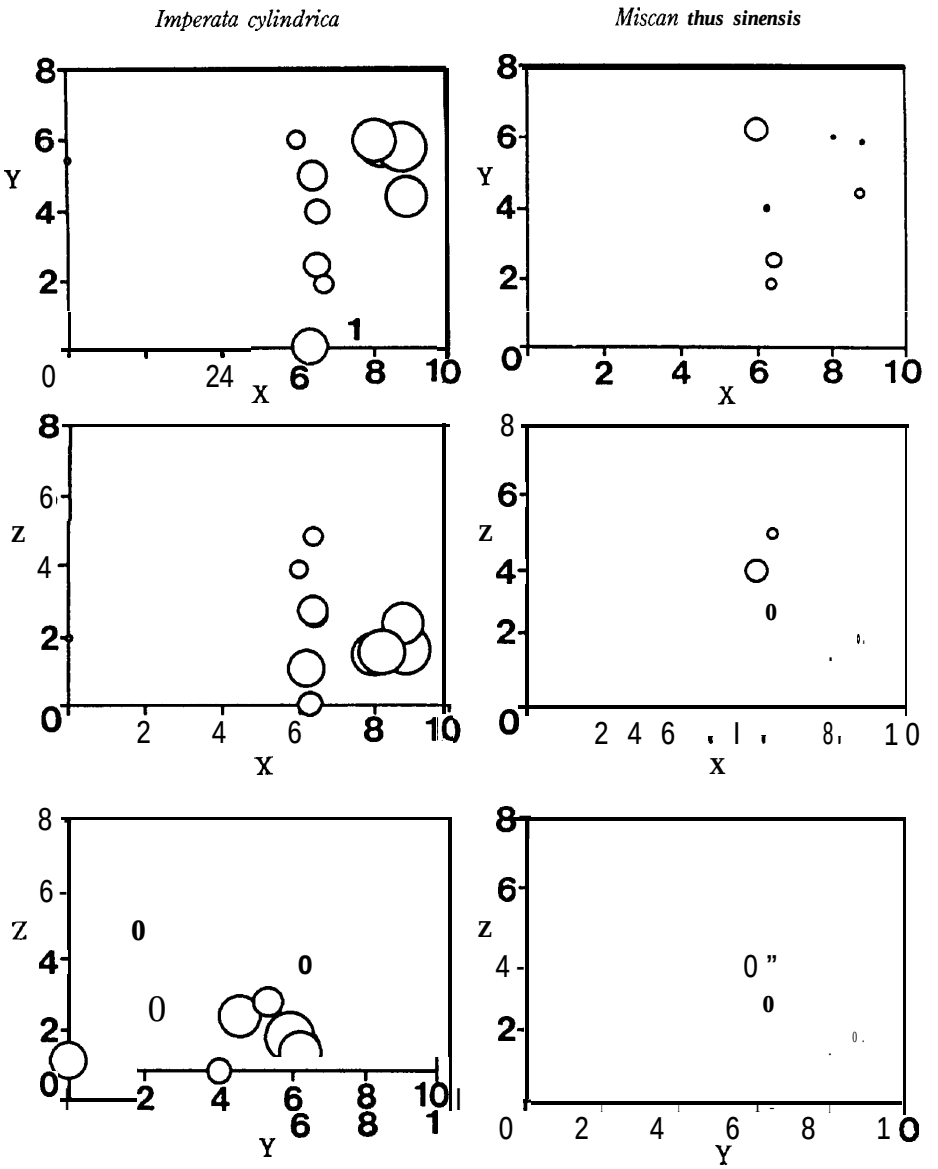

Fig. 3-(a). Dominance behaviour of *Imperata cylindrica* and *Miscanthus* ***sinensis*** within each of the 3 views of the ordination. Size of circle corresponds to the weight proportion in the stand.

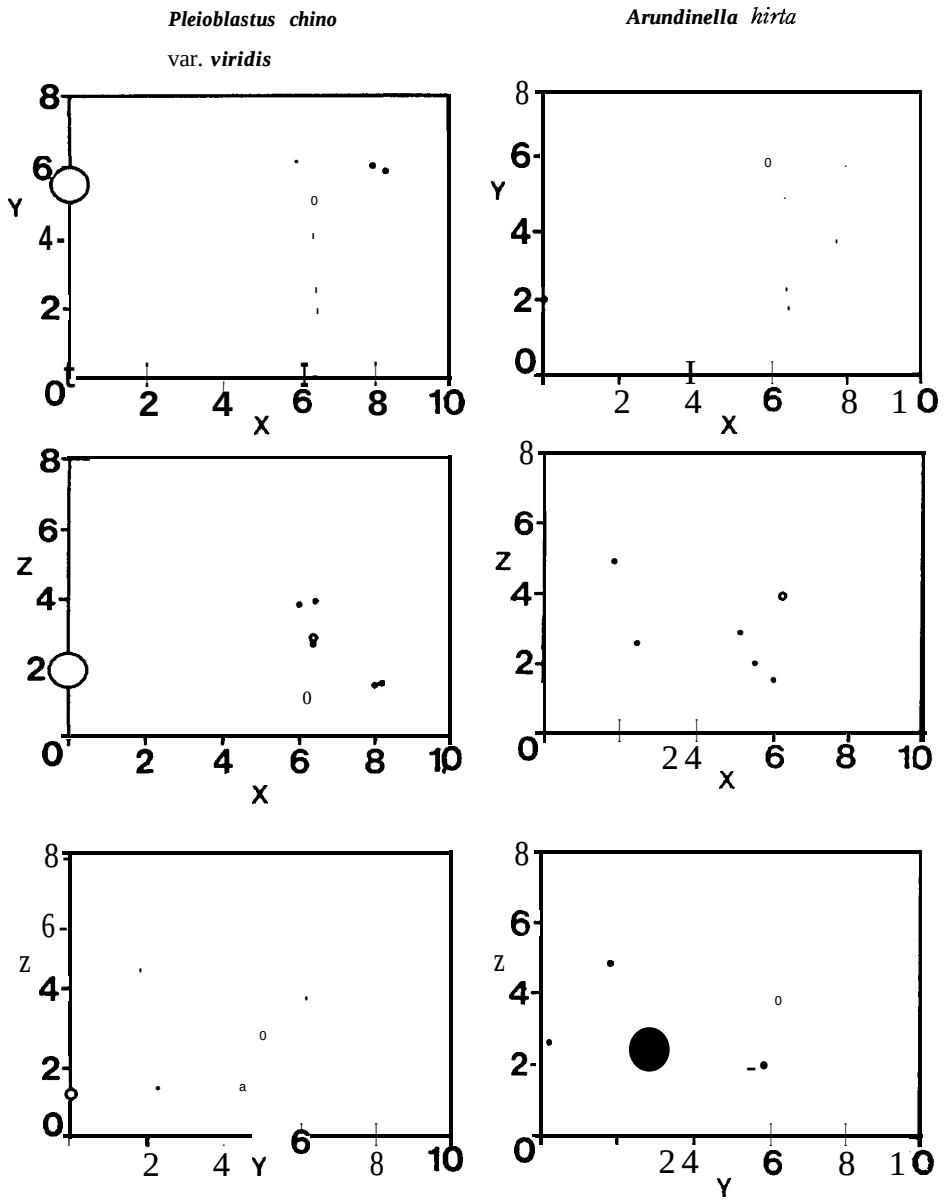

Fig. 3-(b). Dominance behaviour of *Pleioblastus* **chino** var. *viridis* and *Arundinella hirta* within each of the 3 views of the ordination. Size of circle corresponds to the weight proportion in the stand.

Arundinella) were examined. The weight proportions of the four species were plotted on the X and Y axis, X and Z axis and Y and Z axis, which can be thought as three views (front, top and side) of a three-dimensional cube (Fig. 3). Although it might be insufficient to determine with only 11 stands studied, locations of species midpoints are calculated on the ordination axes which represent the points at which species reach their optimum importance. The midpoint of *Imperata* might occupy around 8, 6, and 1.5 unit on the X, Y and Z axis, respectively. While ***Miscanthus*** might locate at the similar position on the Y axis but lower on the X axis and higher on the Z axis. For *Pleioblastus,* it was not possible to find the midpoint on the three axes in this study, though the position on the ordination axes was markedly differed from ***Imperata*** and ***Miscan thus.***

Ecological position of *Imperata*

From Table 1, Fig. 2 and Fig. 3, it is apparent that the distances among the stands in the ordination were mainly related with the proportion of ***Imperata, Miscanthus*** and *Pleioblastus*. The distances of each stand from the stand in which ***Imperata*** was most dominant, i.e. No. 11 as the reference stand, were calculated. Then the stands containing *Pleioblastus* arrayed to the left of the reference stand in accordance with the distances, and the stands containing ***Miscanthus*** arrayed in similar way on the right hand on the X axis. Also the weight proportion of the three species and *Arundinella* ***hirta*** which is a deferential species of ***Miscanthus*** grassland were plotted on the Y axis. This was shown in Fig. 4.

The proportion of Imperata increased with the decrease in the proportion of ***Miscanthus*** and similarly with decreasing of ***Pleioblastus.*** It may be concluded that ***Imperata*** dominant vegetation locates between ***Miscanthus*** dominant vegetation and

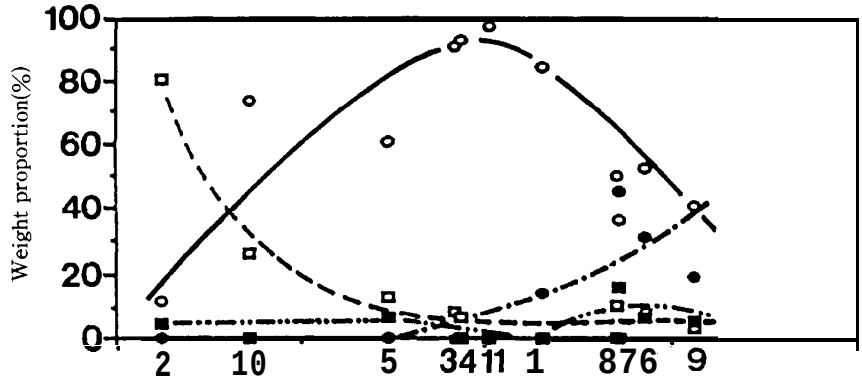

Fig. 4. The ecological position of ***Imperata*** vegetation.

Imperata *cylindrica*
Miscan ***thus sinensis***
Pleioblastus chino v. *viridis*
Arundinella ***hirta***

Pleioblastus dominant vegetation. Rather small amount of *Arundinella* was present with *Miscanthus* and *Pleioblastus* but almost replaced by ***Imperata.*** The stands departed from the curves were invaded by relative amount of *Pteridium aquilinum, Dunbaria villosa* or ***Lotus comiculatus.***

It is well known that the main types of grassland in Kuju-Aso area in warm-temperate climatic zone are *Miscanthus* ***sinensis*** grassland in mowed habitats and *Pleioblastus* ***chino*** var. *viridis* grassland in grazed habitats. The former would be retrogressively succeeded by the latter under frequent cutting or continuous grazing, and the latter would be succeeded by the former when the disturbance is light (once a year cutting at most) for a long period (Itow, 1974). Figure 4 suggests that *Imperata* dominant vegetation might appear in transient phase from *Miscanthus* to *Pleioblastus* and ***vice*** *versa*. This means that *Imperata* might maintain its dominance under circumstances in which more than once a year cutting and lighter grazing is practiced. Nevertheless, the authors could not always find ***Imperata*** dominant vegetation in grasslands where such strength of disturbance had been retained. It must be necessary to study other factors which relate with the invasion and domination of ***Imperata*** and also to examine the strength of disturbance that maintains dominance of ***Imperata*** in this area.

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