STUDIES ON GANPI*

IV. Relation of Climatic Factors to the Distribution of Ganpi Plants in the Chugoku-Shikoku Region

Michihiko TAKAHASHI and Michiyo KITA**

I. Introduction

There are still many plants found in the world in a truly wild state, not yet having been effected by humans. Ganpi is such plants. In the past, however, many people tried to cultivate it, because of the excellent paper making quality of the bark. Nevertheless, its cultivation was so difficult that nobody could succed in it(2). Thus the distribution is still in quite natural and is directly influenced by the atmosphere.

What relation is there between the factors of the atmosphere and the distribution of Ganpi, then? Are there any laws governing them? The authors carried out this investigation in order to solve these questions by gathering basic ecological and distributional data on Ganpi in the Chugoku-Shikoku region.

II. Matters for investigation

The species studied were: *D. sikokiana*, *D. ganpi*, *D. trichotoma*(12), *Daisen*, *Ido*(13) from Kagawa prefecture and *Tatsu*, *Haru*, and *Kazu* from Yanahara-cho in Okayama prefecture, where practical field observations were done. The localities and these eight Ganpi plants were observed together with the mean annual temperatures and rainfall over a period of seventeen years (1954–1971).

III. Results and Consideration

1. Influence of rainfall upon the distribution of Ganpi

(1) The mean annual rainfall and distribution in Kagawa prefecture.

As shown in Fig. 1, Kagawa prefecture can be divided into three parts by the isohyets of the mean annual rainfall. They are the mountain area with a mean annual rainfall about 1400 mm, the plain area, about 1200 mm, and the coasted area about 1100 mm. In these three areas *D. sikokiana*, *D. ganpi*, *D. trichotoma*, *Daisen*, and *Ido* were distributed, as follows: *D. sikokiana* and *D. ganpi* were widely distributed being found in the rainy mountains and on Shodoshima island which has the least rain in all Japan; *D. trichotoma* and *Daisen* grew only at Miai village, at the foot of Mt. Daisen (1049 m); and *Ido* inhabited only the Ido area of Nagao-cho (1432 mm mean annual rainfall)(6).

Even so these four species displayed noticable horizontal and vertical distribution differences. These distributions are given in Fig. 2 and 3. The relation between rainfall and the distribu-

* *Diplomorpha sikokiana*; *Wikstroemia sikokiana*—Ganpi (Japanese name), *Diplomorpha ganpi*; *Wikstroemia ganpi*—Kusa-Ganpi, *Diplomorpha trichotoma*; *Wikstromia trichotoma*—Ki-Ganpi

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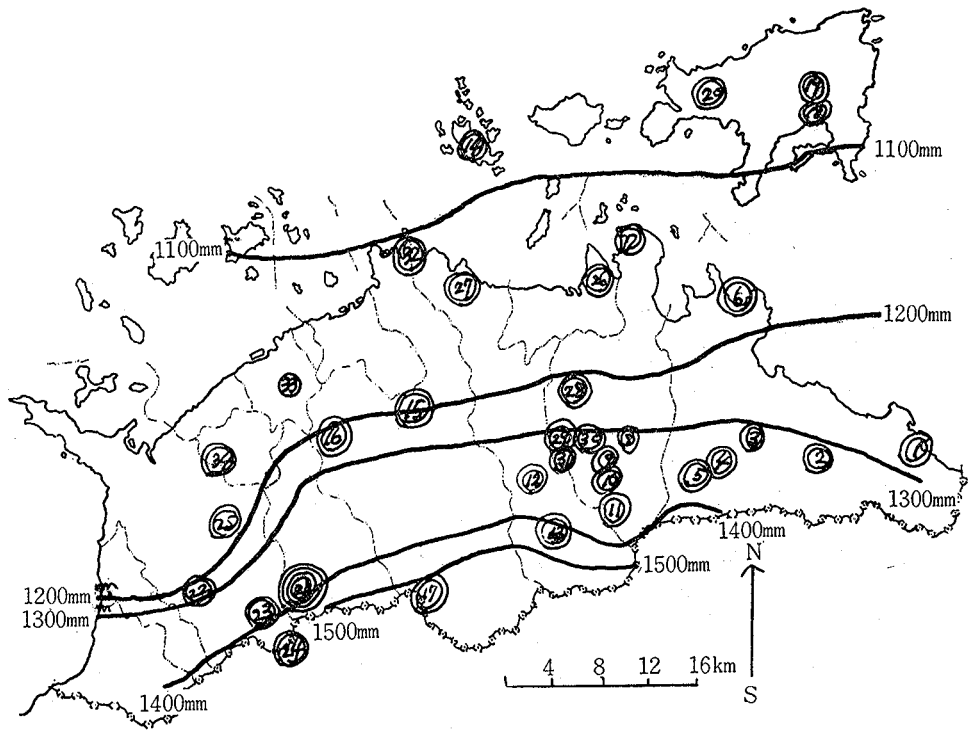

Fig. 1. The isohyets of the mean annual rainfall and distributions of Ganpi plants in Kagawa prefecture

Notes: ○ *D. ganpi* exists.
◎ *D. sikokiana*, and *D. ganpi* exist.
◎ *D. trichotoma*, *D. sikokiana*, *D. ganpi*, and *Daisen* exist.

Place names:

1. Hiketa,
2. Toramaruyama,
3. Kasagamine,
4. Danshiyama,
5. Nyotaizan,
6. Odawan,
7. Aji,
8. Tanaka,
9. Asakura,
10. Ashidauchi,
11. Komino,
12. Yasuhara,
13. Shionoe,
14. Naoshima,
15. Ryohnan,
16. Okada,
17. Miai,
18. Uchinomi,
19. Kankakei,
20. Umakoshi,
21. Chunan,
22. Yamamoto,
23. Saita,
24. Inohanatohge,
25. Takase,
26. Yoshima,
27. Shimokasai,
28. Kawashima,
29. Higashi-Ueta,
30. Nishi-Ueta,
31. Jinnai,
32. Ohgoshi,
33. Hill,
34. Hill,

tion of *D. sikokiana*, *D. ganpi*, *D. trichotoma*, and *Daisen* was clearly demonstrated at Miai village[3].

(2) The mean annual rainfall and distribution at Yanahara-cho.

The mean annual rainfall of Yanahara-cho, as small locality with an area of 78km², is generally about 1500mm[10]. Three varieties: Tatsu, Haru, and Kazu were found here. Fig. 4 illustrates this information.

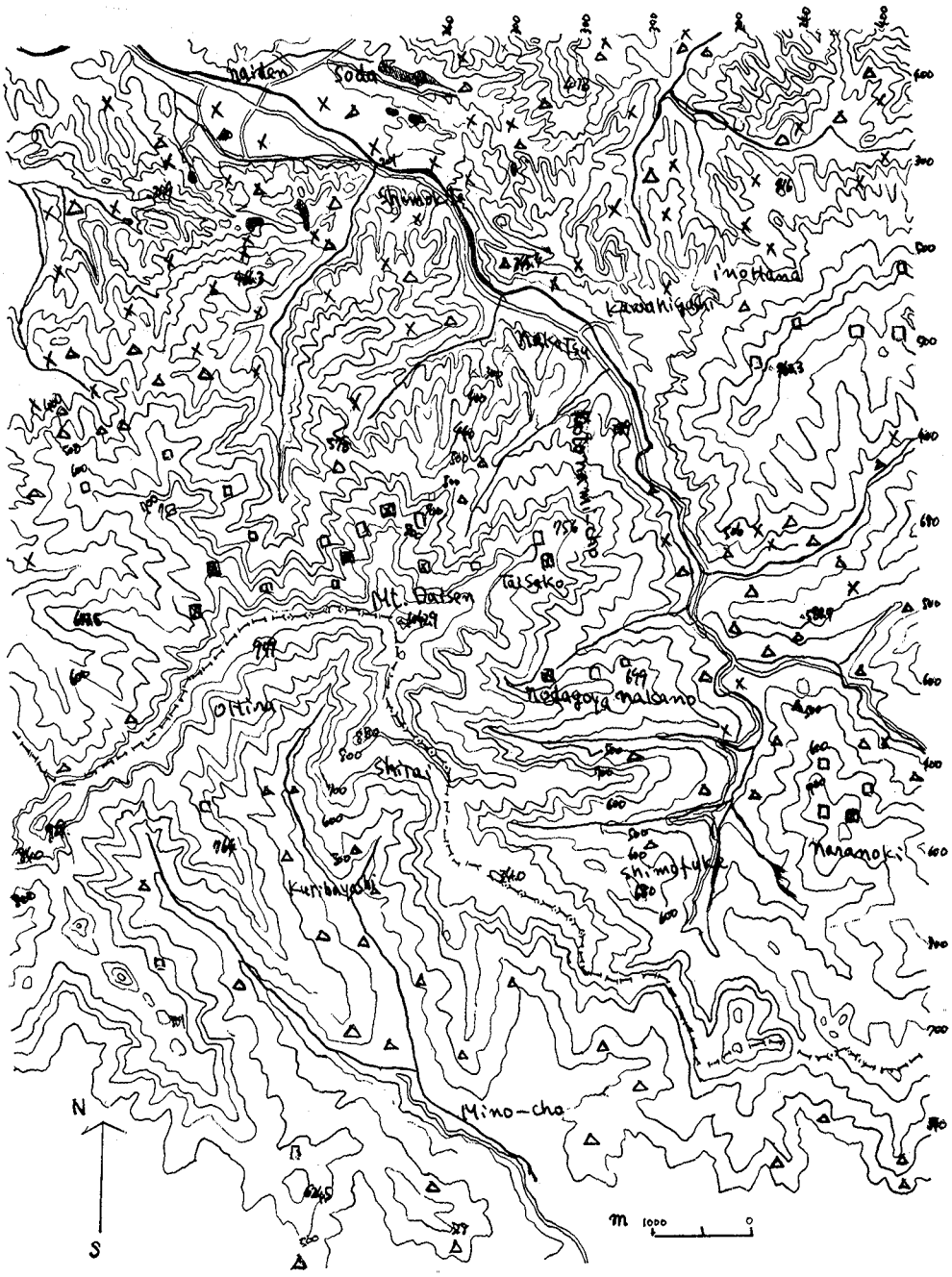

Fig. 2. The distribution and variety of Ganpi plants at the foot of Mt. Daisen in Kagawa prefecture

Notes: × *D. Ganpi*
△ *D. Sikokiana*
□ *D. Trichotoma*
⊠ *Daisen*

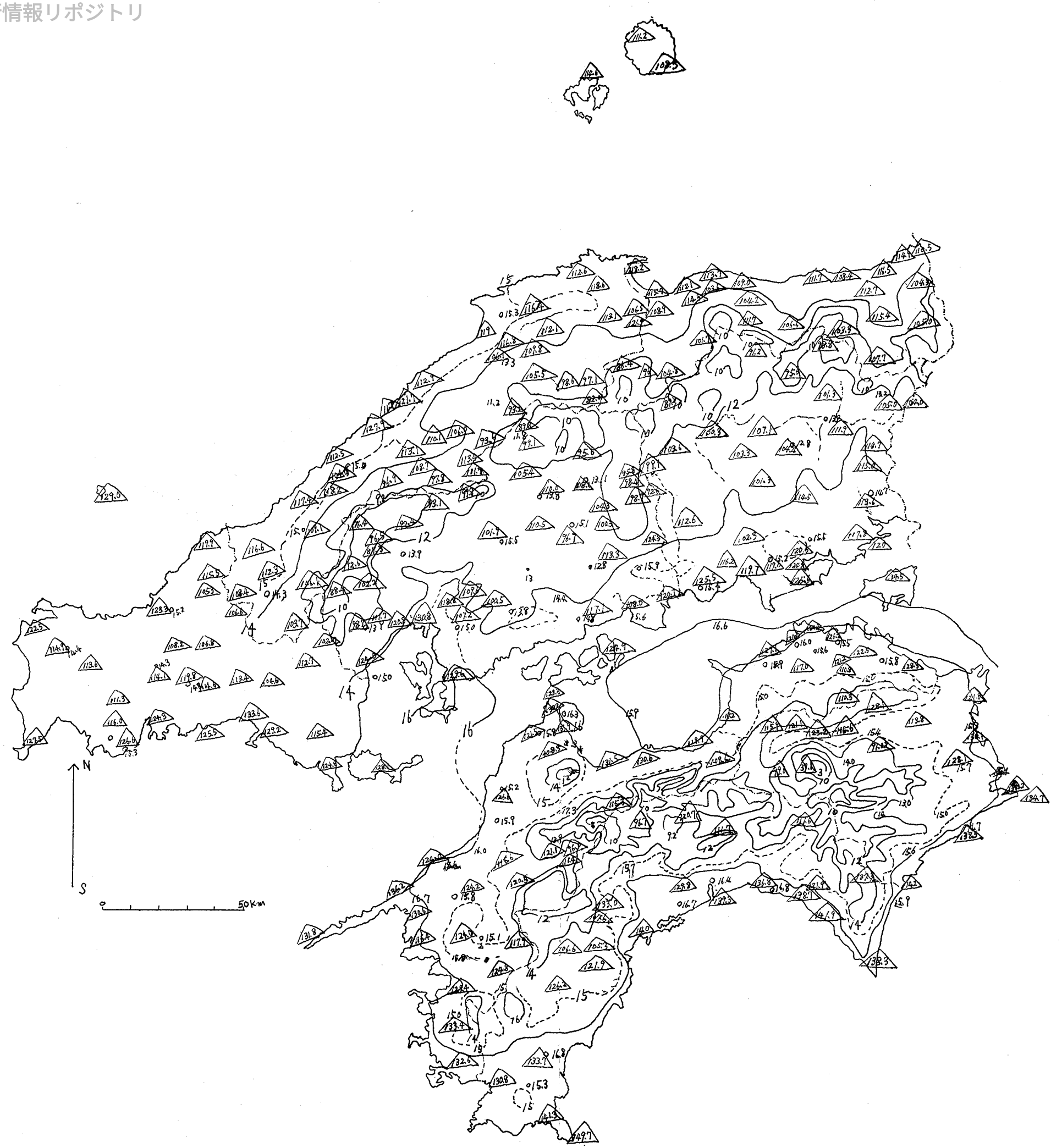

Fig. 6. The isotherms of the mean annual temperature and warmth indexes in the Chugoku-Shikoku region

Note: △ Warmth indexes

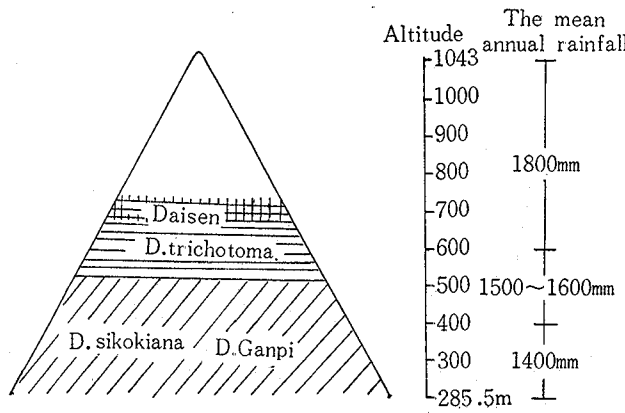

Fig. 3. The vertical distribution of Ganpi plants and rainfall at Mt. Daisen in Kagawa prefecture

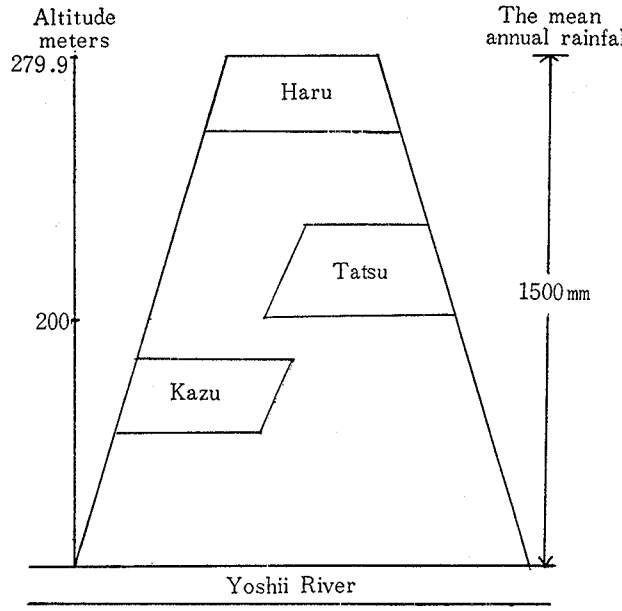

Fig. 4. The horizontal distribution of Ganpi plants and rainfall at Yanahara-cho Mt. Shiroyama in Okayama prefecture

Putting all the above facts together, it was considered that such differences of rainfall had no great influence in determining the distribution of Ganpi plants in the two districts. But *D. trichotoma* and *Daisen* grew in comparatively rainy areas.

2. Influence of temperature upon the distribution of Ganpi.

(1) The mean annual temperature and distribution in Kagawa prefecture.

As shown in Fig. 5, the distributional range of *D. sikokiana* and of *D. ganpi* was from 14°C and 17°C, and of *Ido*, from 14°C to 15°C. *D. tricotoma* and *Daisen* seems to exist at 14°C in the chart[6], but they grew at near 11°C in their particular locality.

The observational results at Miai village were as follows: *D. sikokiana* and *D. ganpi* were found

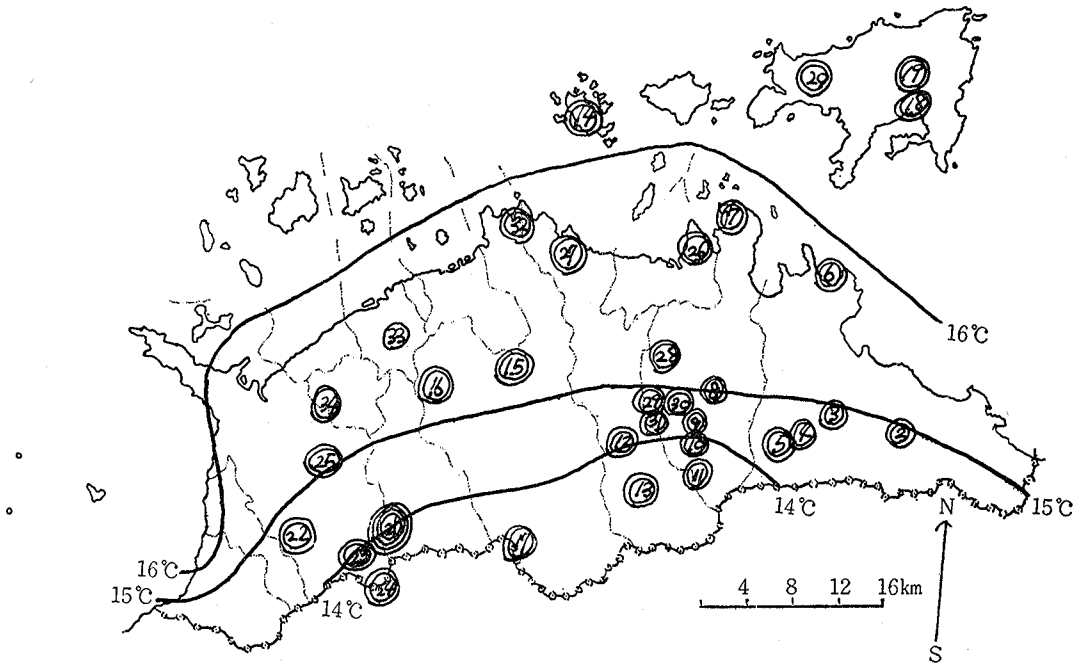

Fig. 5. The isotherm of the mean annual temperature and distribution of Ganpi plants in Kagawa prefecture

Note: See the notes in Fig. 1.

Table 1. Altitudes and mean monthly-mean temperatures (Mt. Daisen).

Month / Altitude meters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly mean
	℃	℃	℃	℃	℃	℃	℃	℃	℃	℃	℃	℃	℃
1043	−0.5	−0.5	2.5	7.5	12.5	16.1	20.0	21.1	17.5	11.1	5.8	1.3	9.4
1000	−0.3	−0.3	2.8	7.8	12.8	16.4	20.3	21.4	17.8	11.4	6.11	1.6	9.7
900	−0.2	−0.2	3.4	8.4	13.4	17.0	20.9	22.0	18.4	12.0	6.7	2.2	10.3
800	0.3	0.3	4.0	9.0	14.0	17.6	21.5	22.6	19.0	12.6	7.3	2.8	10.9
700	0.9	0.9	4.6	9.6	14.6	18.2	22.1	23.2	19.6	13.2	7.9	3.4	11.5
600	1.5	1.5	5.2	10.2	15.2	18.8	22.7	23.8	20.2	13.8	8.5	4.0	12.1
500	2.1	2.1	5.8	10.8	15.8	19.4	23.3	24.4	20.8	14.4	9.1	4.6	12.7
400	2.7	2.7	6.4	11.4	16.4	20.0	23.9	25.0	21.4	15.0	9.7	5.2	13.3
300	3.3	3.3	7.0	12.0	17.0	20.6	24.5	25.6	22.0	15.6	10.3	5.8	13.9
285.5	3.4	3.4	7.1	12.1	17.1	20.7	24.6	25.7	22.1	15.7	10.4	5.9	14.0

from 12°C to 14°C of mean annual temperature; *D. trichotoma*, from 11°C to 12°C, and *Daisen*, about 11°C. These figures are given in Table 1.

(2) The mean annual temperature and distribution in Yanahara-cho.

Table 2 presents the mean annual temperatures at the individual places described. Because of a small area, there were little differences of temperature among them, the lower limit was 12.9°C and the upper limit 13.6°C. The numerical values were similar to those of *D. sikokiana* and *D. ganpi* in Kagawa prefecture.

Table 2. Altitudes and mean monthly-mean annual temperatures (Shiroyama).

Month / Altitude	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly mean
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
279.9 m	0.6	2.9	3.3	11.1	16.7	19.5	25.0	26.0	23.0	15.1	8.3	3.0	12.9
145 m	1.5	3.8	4.2	12.0	17.6	20.3	25.9	26.9	23.9	16.0	9.2	3.9	13.6

Putting all the above facts together, it was considered that temperature plays an important role in the distribution of Ganpi varieties in the two districts.

IV. Discussion

Previously it was considered that the distribution of Ganpi plants in Kagawa prefecture and at Yanahara-cho depended on temperature rather than rainfall. Stated below there is a consideration of whether the relation between temperature and distribution in the two districts is also relevant for the whole of the Chugoku-Shikoku region.

A concept of the warmth index[1] was newly included to clarify this point. It is very useful to explain the distribution of vegetation in Japan, and is expressed by $\Sigma(-5)$ month-degrees, provided that the mean monthly temperatures is above 5°C, and also assuming the mean physiological zero point to be 5°C. The warmth indexes of the Ganpi varieties in the two districts were: *D. sikokiana*, 98.9 to 104.5; *D. ganpi*, 98.9 to 104.5; *D. trichotoma* 88.5 to 93.5; *Daisen*, 88.5; *Ido*, 118.5; and *Tatsu*, *Haru*, and *Kazu*, 105.4 to 107.1.

Fig. 6 is a chart showing the localities, varieties, and warmth indexes of Ganpi plants found in the Chugoku-Shikoku region, together with isotherms of the mean annual temperature[4,5,6,7,8,9,10,11]. Hence it appears that for *D. sikokiana* and *D. ganpi* the distribution and warmth indexes of the whole Chugoku-Shikoku region coincide with the cases in Kagawa prefecture. That is, *D. sikokiana* and *D. ganpi* were distributed at the mean annual temperature from 12°C to 17.5°C and the warmth index from 18.9 to 149.7. As the others were not found anywhere except at specifically identified places in the Chugoku-Shikoku region, the relations of the mean annual temperature and warmth index to the distribution in the two districts could not be generalized extensively in relation to the whole Chugoku-Shikoku region.

V. Summary

The above considerations are summarized briefly, as follows:

Such differences of rainfall as found in Kagawa prefecture and at Yanahara-cho in Okayama prefecture had little effect on the distribution of Ganpi. But *trichotoma* and *Daisen* grew in comparatively rainy areas.

Rather temperature was found to be an important element influencing the distribution of Ganpi in the Chugoku-Shikoku region.

The following mean annual temperatures and warmth indexes apply respectively the varieties listed below: *D. sikokiana* and *D. ganpi* 12°C to 17°C (mean annual temperature) and 98.9 to 149.7 (warmth index); *D. trichotoma*, 11°C to 12°C and 88.5 to 93.5; *Daisen*, 11°C and 88.5; Ido, 14.7°C and 1118.1; and *Tatsu Haru*, and *Kazu*, 12.9°C to 13.6°C and 105.1 to 107.1.

As *D. trichotoma*, *Daisen*, *Tatsu*, *Haru*, *Kazu*, and *Ido* are not found anywhere except at the

certain specifically identified localities distributional conditions could not be generalized with relation to the whole Chugoku-Shikoku region.

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Literature Cited

(1) ASHIDA, K. (Ed.): Living things and Environment, 232-244, Tokyo, Kyōritsu, (1961).

(2) TAKAHASHI, M.: Essential Condition on the Cultivation of Ganpi. *Abstract in Shikoku Region Crop Society*, (4), 29(1967).

(3) TAKAHASHI, M.: Studies on Some Ganpi Plants with Ecology, Charactor, and Chromosome Number. *Abstract in Breeding Society*, **20** (2), 140 (1970).

(4) THE KOCHI LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Kochi Prefecture*, 16-24 (1971).

(5) THE TOKUSHIMA LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Tokushima Prefecture*, 10-15 (1970).

(6) THE TAKAMATSU LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Kagawa Prefecture*, 1-18 (1970).

(7) THE MATSUYAMA LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Ehime Prefecture*, 1-23 (1970).

(8) THE TOTTORI LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Tottori Prefecture*, 9-12 (1970).

(9) THE OKAYAMA LOCAL METEOROLOGICAL OBSERVATORY: *Annual Weather Report in Okayama Prefecture*, 1-19 (1970).

(10) THE MATSUE LOCAL METEOROLOGICAL OBSERVATORY: *Annual Agriculture Weather Report in Shimane Prefecture*, 16-30 (1970).

(11) THE HIROSHIMA LOCAL METEOROLOGICAL OBSERVATORY: *Hydrometeorology Weather*, **19** (13), 23-25 (1970).

(12) TAKAHASHI, M., KITA, M.: Studies on Ganpi I Glassification of Ganpi Plants. *Technical Bulletin of Faculty of Agriculture, Kagawa University*, **23** (11), 17-26 (1971).

(13) TAKAHASHI, M.: Studies on Ganpi II Characteristics and Chromosome Number of Ganpi Plants from the Chugoku-Shikoku Region. *Technical Bulletin of Faculty of Agriculture, Kagawa University*, **22** (11), 17-26 (1971).

ガンピに関する研究

VI 中，四国地方における気象要因のガンピ自生分布への影響

高橋道彦・喜田美千代*

要旨

中，四国地方に自生するガンピ8種類について，雨量及び温度が，これらの種類の自生分布に，どの様に影響しているかを調査した．その結果 *D. sikokiana*, *D. ganpi* は，中，四国全域に自生し，雨量との関係を細かく考察することは出来なかった．ただ *D. trichotoma*, *Daisen* は年降水量 1800 mm の割合に多雨地帯に自生地を有していることが認められた．温度と自生分布についてみると，*D. sikokiana* と *D. ganpi* は年平均気温 12°C～17°C 温量指数149.7～98.9の温度帯に自生分布していた．*D. trichotoma* は香川県大川山の観測値から年平均気温 11°C 附近，温量指数 93.5～88.5 の温度帯に自生分布することが判明した．*Daisen*, *Tatsu*, *Haru*, *Kazu*, *Ido* は現在のところ，特定の地域以外は発見されておらず，従って，これらの自生分布条件を確定することは出来なかったが，*Daisen* は年平均気温 11°C，温量指数 88.5 に Ido, 14.7°C，118.1 に，*Tatsu*, *Haru*, *Kazu* は年平均気温 12.9～13.6°C，温量指数 105.1～107.1 の範囲に自生分布していることが明らかとなつた．この様に，ガンピは種類ごとに，ある範囲の温量指数の地点に自生分布していることから，中，四国地方以外の地域についても，温量指数を求めることによって，自生の有無について，種類別に，ある程度の推論を試みることが可能となった．

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