南九州産サタツツジの形態と花色素分布

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Morphology and Flower Pigments of Wild Evergreen Azaleas (*Rhododendron sataense* Nakai) in Southern Kyushu

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Summary

The origin of flower color variation in *Rhododendron sataense* Nakai, one of the most colorful wild azaleas in southern Kyusyu, was investigated.

The range of flower color variations and two other morphological characteristics, flower size and petal blotch, of *R. sataense* were almost the same as those of *R. obtusum* Planch. The latter whose natural habitat is in the Kirishima Mountains, and is thought to be an interspecific hybrid between *R. kiusianum* Makino and *R. kaempferi* Planch. Constitutions of flavonols in the petals, however, were quite different between the two species; *R. sataense* does not contain methylated flavonols, whereas the *R. obtusum* in a high percentage of the population.

We conclude, therefore, that the origin of flower color variations in *R. sataense* on Takakuma Mountains is not the result of the natural hybridization between *R. kiusianum* and *R. kaempferi,* although natural hybrids have been found on the Kirishima Mountains.

Introduction

Rhododendron sataense Nakai, one of the most colorful, wild azaleas in southern Kyushu, found at the low altitude (300-700 m) mountains or plateaus surrounding Kagoshima Bay has a wide range of flower color variations. Based on the similarities in the morphological and pigmental characteristics of this species to ornamental Kurume azalea, *R. sataense* has been regarded as one of the parents of Kurume azaleas (Kobayashi, 1980; Kunishige, 1978).

The wild, evergreen azaleas which also have a wide flower color variations are endemic to the Kirishima Mountains (Abe and Uematsu, 1969: Kunishige and Tamura, 1961). In the previous report on the variations of morphological and pigmental characteristics of azaleas on this mountain range by Sakata et al. (1993). Those on the intermediate slope were thought to be hybrids between *R. kaempferi* Planch. at the foot and *R. kiusianum* Makino at the summits of the mountains. Yokogawa and Hotta (1995) also reported that many morphological characteristics of these individuals are intermediate between *R. kaempferi* and *R. kiusianum* and that these populations are derivatives from natural hybridization of the two species. From these results, they advocate that members of these populations should be classified as *R. obtusum* Planch.

On the Takakuma Mountains, *R. kaempferi* is commonly found at the base, whereas *R. kiusianum* is found at the summits. The variations of flower colors in *R. sataense* on the slopes of the mountain mass were similar to *R. obtusum* (Kunishige and Tamura, 1961). Abe (1969) pointed out the similarities of these two species. The origin of the flower color variations of *R. sataense,* however, have not yet been clearly established.

Flower color and size, the petal blotch expression, and the constitution of flavonols of these wild azalea species were examined to trace the possible origin of the flower color variations in *R. sataense.*

Materials and Methods

The localities where the flowers of evergreen azaleas were collected on the Takakuma Moun-

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Studies on the variations of characteristics in the evergreen azaleas. IV

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tains were mapped (Fig. 1), but those on Kirishima Mountains were shown in the previous paper (Sakata et al., 1993).

About 700 individuals in Kirishima Mountains and 224 individuals in Takakuma Mountains were examined for flower color, flower size, and petal blotch expression, whereas 167 and 163 individuals in the respective mountains were examined for petal pigmentation (Table 1).

Fully expanded petals were collected, measured for flower color, size, and petal blotch expression and lyophilized at −20 °C, and stored in a desiccator until analyzed. The colors of the flowers were identified according to the Royal Horticultural Society Colour Chart (RHSCC). The flowers were classified according to the intensity of petal blotching as prominent, slight, or none.

The procedures used for pigment extraction and the analytical conditions of a high performance liquid chromatography (HPLC) used for the identification of flavonols were previously described (Sakata et al., 1991).

Results and Discussion

Rhododendron kaempferi flowers have vermilion petals, whereas *R. kiusianum* flowers have purplish petals (Fig. 2). Flower color variations, however, were extremely narrow in both species.

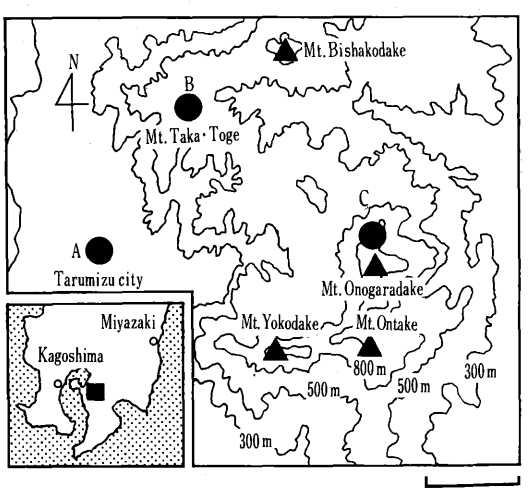

Fig. 1. Collection sites (●) on the Takakuma Mountains in this paper. A, Tarumizu city (alt. 150 m); B, Mt. Taka-Toge (alt. 550 m); C, Mt. Onogaradake (alt. 1,237 m).

Table 1. Collection sites and number of individuals for population samples of wild evergreen azaleas on the Kirishima and Takakuma Mountains.

Site	Species	Number of individuals examined for: Flower color, diameter, and petal blotch expression	Number of individuals examined for: Petal pigmentation
Kirishima Mountains			
Mt. Karakunidake	*R. kiusianum*	236	28
Shinyu and Yunono	*R. obtusum*	330	118
Kirishima town	*R. kaempferi*	134	21
Takakuma Mountains			
Mt. Onogaradake	*R. kiusianum*	61	61
Mt. Taka-Toge	*R. sataense*	138	138
Tarumizu city	*R. kaempferi*	25	25

On the slopes of Shinyu and Yunono, Mt. Taka-Toge, the flower colors ranged from vermilion through red to pink and purple.

The range of flower size and blotch on the petals were also similar to those in the two species on both mountain ranges (Fig. 3).

R. sataense has been regarded as a local variety of *R. kaempferi* because of its similarity in petal size, blotch expression, and the growth habit of branches (Kunishige and Tamura, 1961). The morphological characteristics of flowers of *R. sataense* were similar to those of *R. kaempferi* except for flower color variations.

Kunishige and Kobayashi (1980) reported that the wild azalea populations which range in flower color from vermilion through red, pink to purple are usually progenies of natural crossings between the species having the anthocyanins of delphinidin series (purple flower) and those of cyanidin series (red flower).

The anthocyanins and flavonols are one kind of flavonoid found in the petals of azaleas (De Loose, 1969, 1970a, 1970b, 1978). The anthocyanins are the most important and widespread group of coloring matters in plants and these pigments are responsible for pink, scarlet, red, mauve, violet, and blue colors in the petals. But the flavonols make a significant contribution either as yellow pigments or as co-pigments to anthocyanins on

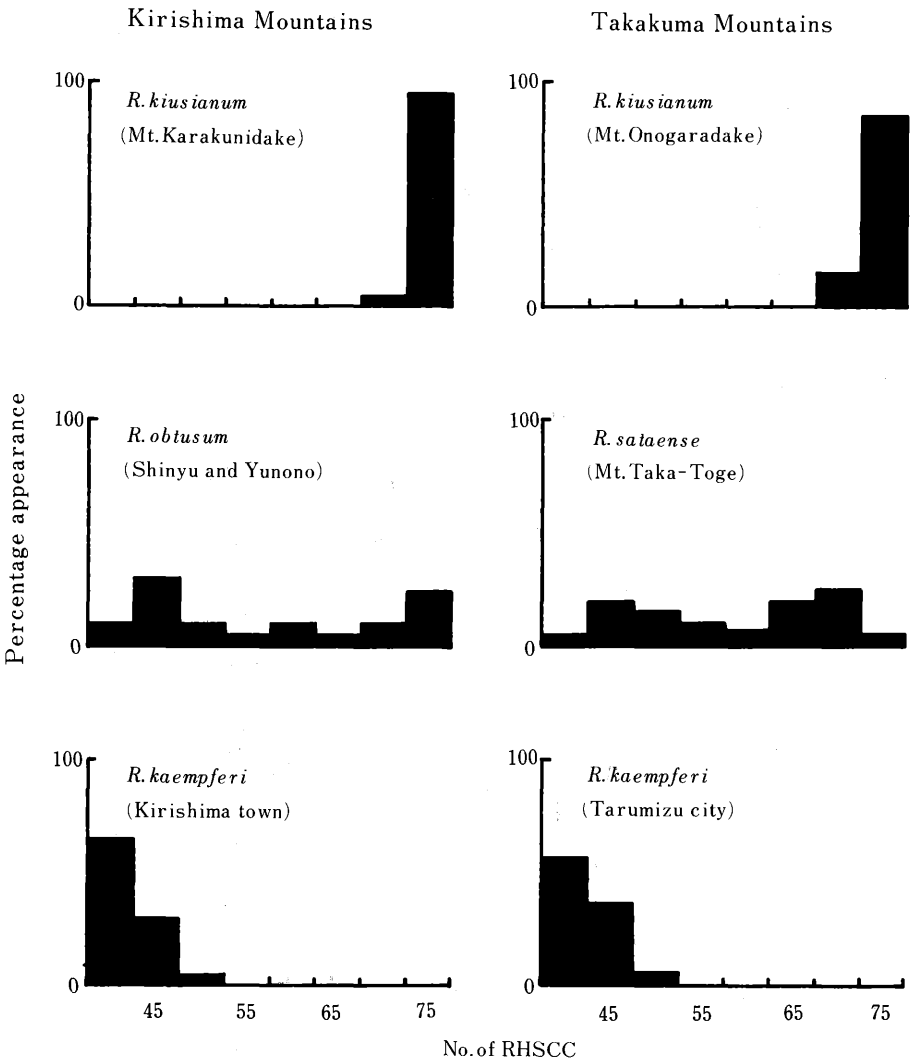

Fig. 2. Frequency of individuals based on the flower color of wild evergreen azaleas on the Kirishima and Takakuma Mountains.

which they have a bluing effect (Harborne, 1967).

Heursel and Horn (1977) reported that the progenies obtained from the artificial crossing between purple flower cultivars (based on malvidin glycoside) and red flower cultivars (based on cyanidin glycosides) have complicated anthocyanin constitutions in their petals. Umeki and Inazu (1989) reported that petal color ranging from red to purple in azaleas were from anthocyanins.

Therefore, the extremely wide variation of flower colors in *R. sataense* suggests that it is an interspecific hybrid between *R. kaempferi* and *R. kiusianum* similar to the natural hybrid azaleas in the Kirishima and Unzen Mountains (Miyajima et al., 1995).

Almost all individuals of *R. kiusianum* at the summits of Mt. Karakunidake and Mt. Onogaradake and those of *R. obtusum* (RHSCC No. 65 <) found on the Kirishima Mountains contained a high ratio of methylated flavonols in their petals (Fig. 4). Only three individuals out of 138 analyzed in the populations of *R. sataense,* however,

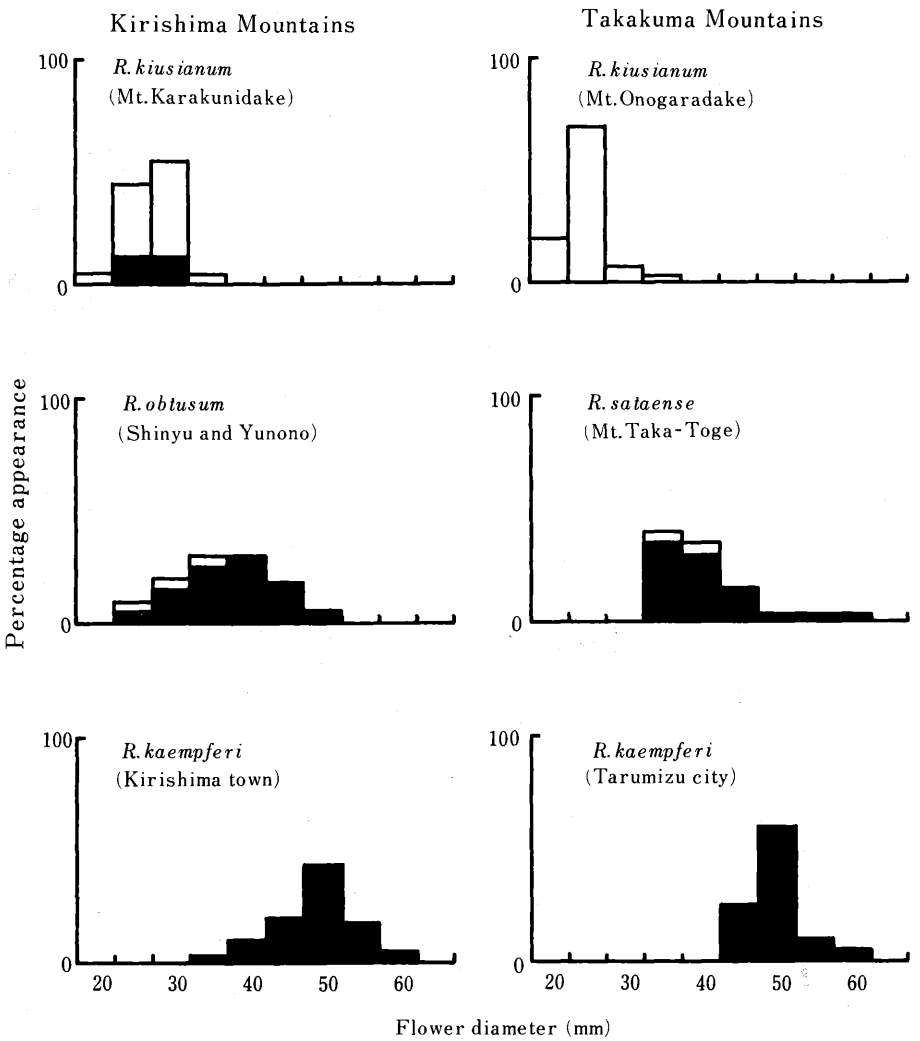

Fig. 3. Frequency of individuals based on the flower size and petal blotch expression of wild evergreen azaleas on the Kirishima and Takakuma Mountains. Open column, flowers with slight blotch or without blotch; solid column, flowers with prominent blotch.

contained them.

Heursel (1975) pointed out that in a cross between garden azaleas with and without methylated flavonols, the production of the former flavonols were genetically dominant over that of the latter.

Yamaguchi et al. (1985) reported the high cross compatibility between *R. kiusianum* and *R. kaempferi*, whereas Yokogawa and Hotta (1995) observed common pollinators for both species in Kirishima Mountains. Therefore, if *R. sataense* were the natural hybrids between *R. kiusianum* and *R. kaempferi*, high ratio of methylated flavonols should be detected in the petals as in *R. obtusum*. The three individuals among *R. sataense* population that contained methylated flavonols are presumed to be the progenies between *R. kiusianum* and *R. kaempferi*. Based on the inheritance pattern of flavonol pigments in *R. sataense* it seems that the variation of flower color in this species is not derived from the natural crossing between *R. kiusianum* and *R. kaempferi*.

R. eriocarpum Nakai, *R. tosaense* Makino and

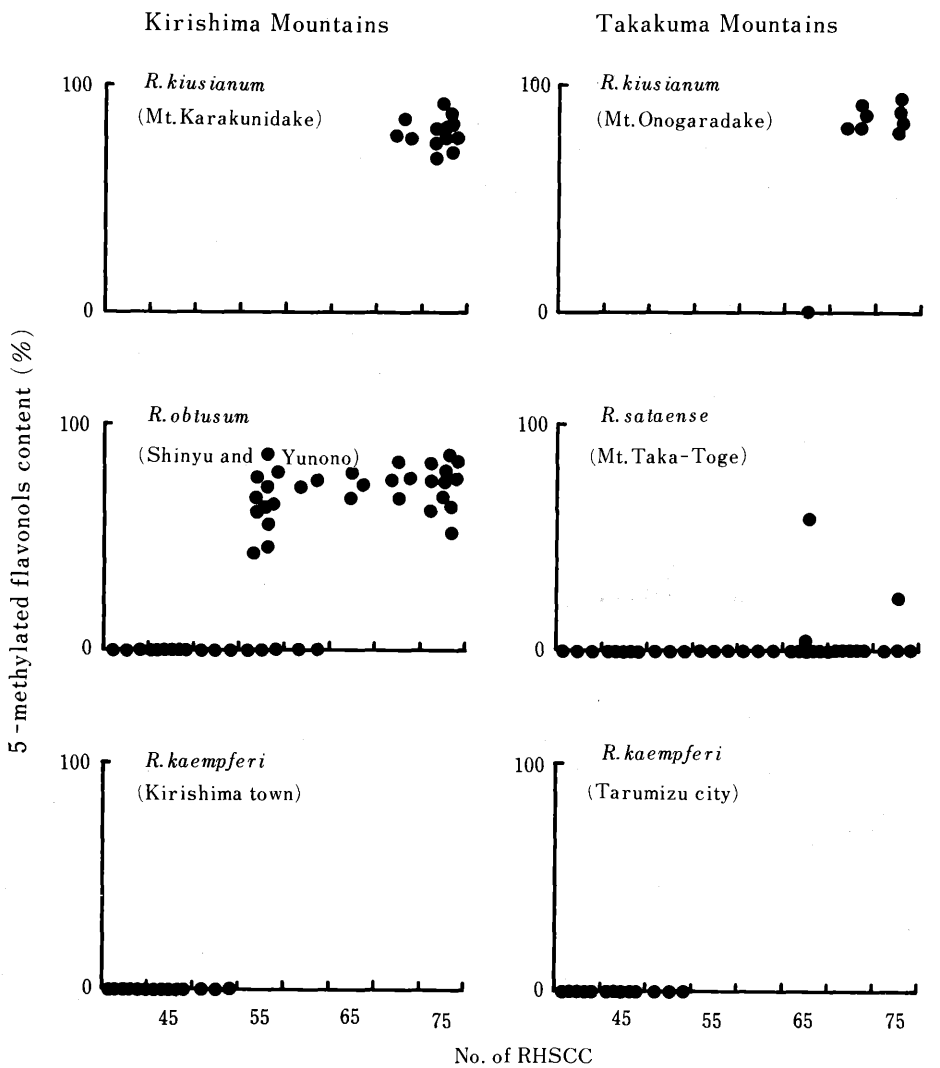

Fig. 4. Distribution of individuals based on the occurrence of methylated flavonols in the petals of wild evergreen azaleas on the Kirishima and Takakuma Mountains.

some *R. sataense* have purple flowers and are endemic to southeastern Kyushu. Furthermore, *R. sataense*, and *R. eriocarpum* have a similar leaf shape (Hatsushima, 1958), whereas *R. tosaense* and *R. sataense* have a similar flower shape and growth environment. Thus, a possibility exists that *R. eriocarpum* and *R. tosaense* may have contributed to the pigmentation of *R. sataense*.

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南九州産サタツツジの形態と花色素分布

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摘　要

野生ツツジ類のなかで最も花色が豊富な南九州産サタツツジ（*Rhododendron sataense* Nakai）の花色変異の要因について検討した．

サタツツジの花色，花径および花弁のブロッチの変異は，ミヤマキリシマとヤマツツジとの種間交雑と考えられている霧島山系のキリシマツツジのそれとほぼ同程度であった．しかしながら，サタツツジとキリシマツツジとの花弁内フラボノール構成は全く異なっていた．すなわち，前者の花弁にはメチルフラボノールが含まれていないのに対し，後者の花弁には高い割合でメチルフラボノールが含まれていた．

従って，高隈山系のサタツツジにみられる多彩な花色変異は，ミヤマキリシマとヤマツツジとの自然交雑の結果ではないものと思われた．

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