

*Studies on the Expression of Color Tone
in Rose Petals. I
Characteristic Structure of the Epidermis of
Petals in Velvety Dark Red Roses.*

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We have a group of horticultural roses known as "Black Rose". It is how the varieties had this name that the petals of these varieties are dark red rather than red.

Many varieties of this group have petals with velvet-like surface changing in color tone depending on the strength and direction of light. Sometimes they look red while another times they are typical blackish red. Rarely they even seem deep black. Such color tone will be better called "velvety dark red".

In the preliminary experiment the author (unpublished) could proved that the quantity and quality of pigment estimated in the petals can not show any actual difference among these rose varieties.

In this paper, the surface structures of petals of the group beeing velvety dark red were compared morphologically with those of other red group. And the author observed that a certain structural difference between the two groups was a main cause for the different expression of color tone.

Materials and Methods

The materials used in this investigation were 3 varieties of velvety dark red rose and 7 varieties of red one, which were shown on the first column in Table 1 and 2. The peripheral petals of 80 % opened flowers (the stage was just before the pistils and stamens appeared) of these varieties were used.

5 mm squares were cut off from the central portion of each petal, and fixed in FAA, ¹⁾dehydrated with butylalcohol method ²⁾and cut into 15 μ paraffin sections. In each group, longitudinal and cross sections were made. In this paper "longitudinal section" means being cut by the plane parallel to vein, and "cross section" means cut by the plane perpendicular to it. DELAFIELD's hematoxylin solution was employed as stains.

The surface view was observed by lighting the petal surface at an angle of

30°. In certain case observation of surface view was made by lighting the same surface at angle of 30° in oposit side separately.

In the case of velvety dark red rose, one petal consists of two areas, one being velvety dark red and the other red. Both areas were treated and observed separately.

Observation

The figures of each preparation was not essentially different from the general pattern of the petal structur on the whole.⁽⁵⁾⁽⁴⁾ That is, the upper epidermal cells were of variously shaped nipple form, and palisade parenchyma was usually composed of one layer of cells. The spongy parenchyma was loose and had vascular bundles in it. The lower epidermal cells were not of nipple form and were packed tightly. The red pigment was mainly contained in both upper and lower epidermal cells and palisade parenchyma cells. In certain varieties it was also contained in some of the spongy parenchyma cells.

In the section of the petals of any varieties, so far as the surface structure is concerned, only the shape of upper epidermal cells was noticed to be different. Thus the observation was limited to upper epidermal system.

I) *The shape of epidermal cells of the petals in velvety dark red rose.*

(a) **The area which is velvety dark red :**

The shape of epidermal cells belonging to this area of variety BONNE NUI is shown in Fig. 1, 2 and Illustration 1 a and b. JOSEPHINE BRUCE and CHARLES MALLERIN were closely resembled to BONNE NUI in this respect, so their figures were omitted. The length (length perpendicular to the surface) and the width (at cell

Table 1. Length, width and $\frac{\text{length}}{\text{width}}$ ratio of the epidermal cells in petals of velvety dark red roses.

	Epidermal cells					
	Longitudinal section			Cross section		
	Length (μ)	Width (μ)	Length Width ratio	Length (μ)	Width (μ)	Length Width ratio
The area which is velvety dark red.						
BONNE NUI	45.4	16.2	2.80	45.4	18.3	2.48
JOSEPHINE BRUCE	43.2	19.4	2.20	43.2	20.8	2.08
CHARLES MALLERIN	42.1	19.4	2.17	42.1	16.2	2.60
The area which is not velvety dark red.						
BONNE NUI	35.6	24.8	1.43	35.6	22.7	1.57
JOSEPHINE BRUCE	36.7	38.9	0.95	36.7	32.4	1.14
CHARLES MALLERIN	38.9	29.2	1.33	38.9	25.1	1.56

base contacting with the palisade parenchyma) of the epidermal cells in the petals of each variety are shown in Table 1.

It could be decided through Fig. 1. 2. and Table 1 that the cells in this area gave nipple form, $42\sim 44\ \mu$ in height, and $16\sim 20\ \mu$ in diameter of the basal portion (this diameter slightly shortened as it went upward). The cells were arranged with certain spaces without touching each other by the side wall.

It is shown in Illustration 1 a and b how the epidermal cells cast the shadows on the surface when a light was projected aslant. If on the same surface a slanting light was projected from left or right separately, then it was noticed that the position and the shape of shadows were evidently different.

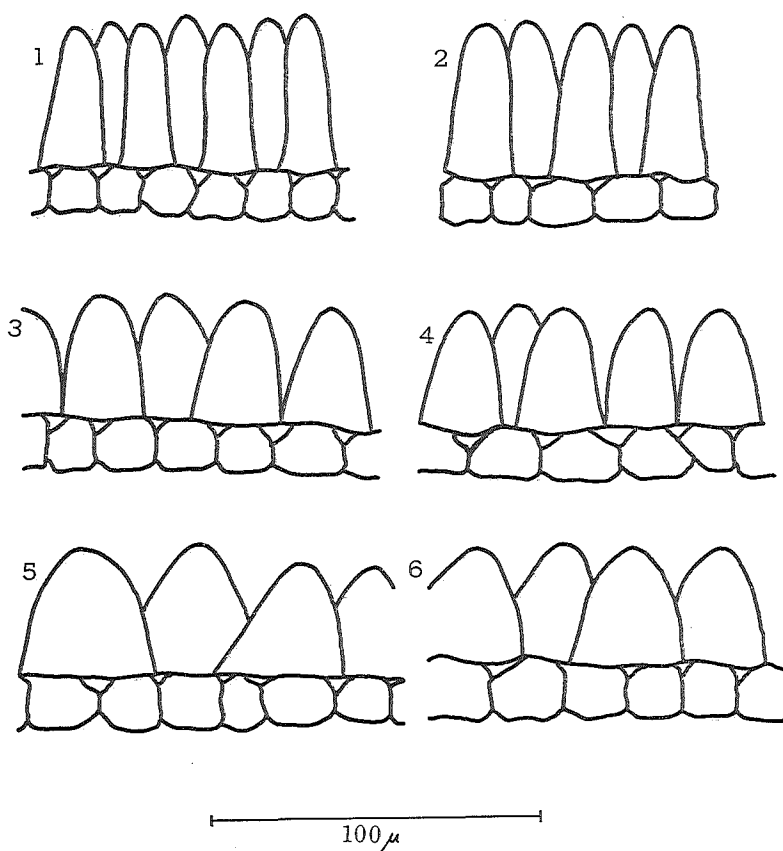


Fig. 1~4 Sections of the petal of BONNE NUI.

1 : a longitudinal section of the area which is velvety dark red.

2 : a cross section of the same area.

3 : a longitudinal section of the area which is not velvety dark red.

4 : a cross section of the same area.

Fig. 5~6 Sections of the petal of RADAL.

5 : a longitudinal section.

6 : a cross section.

(b) The area not velvety dark red :

As a specimen of the epidermal cells of this area, those of BONNE NUI are again represented in Fig. 3, 4 and Illustration 2. The shape of the cells in this area was also of nipple form like that of (a) and different from it in following points: (1) it was shorter (35~40 μ) but wider (24~39 μ) than that of (a), and the ratio of length/width was below 1.6 (short-nipple shaped), which was also less than (a) (above 2.0, long-nipple shaped) (Table 1); (2) the shadow of cells cast by light was less conspicuous than the case of (a) (Illustration 2); (3) though above condition was the same with (a) in that the epidermal cells were not closely touching each other, there were not always certain spaces among them, in times contacting at the base.

Other varieties of velvety dark, JOSEPHINE BRUCE and CHARLES MALLERIN were closely resembled to BONNE NUI⁽⁵⁾⁽⁶⁾ in appearance.

II) The shape of epidermal cells of the petals in red rose.

Epidermal cells of petals of variety RADAL are shown in Fig. 5, 6 and Illustration 3. Other 6 varieties were not fundamentally different from RADAL in this respect. A slight variation was seen in the length and width of the cells (Table 2), and the ratio of length/width was 0.85~1.33 in vertical sections and 1.40~1.94 in cross sections, not exceeding 2.0 which never the case of the area showing velvety dark red.

Table 2. Length, width and $\frac{\text{length}}{\text{width}}$ ratio of the epidermal cells in petals of red roses.

	Epidermal cells					
	Longitudinal section			Cross section		
	Length (μ)	Width (μ)	$\frac{\text{Length}}{\text{Width}}$ ratio	Length (μ)	Width (μ)	$\frac{\text{Length}}{\text{Width}}$ ratio
KARL HERBST	36.7	43.2	0.85	36.5	21.6	1.69
HAPPINESS	37.8	36.7	1.03	37.8	19.4	1.94
RADAL	35.6	32.4	1.13	35.6	22.7	1.64
INDEPENDENCE	37.8	32.1	1.18	37.8	27.0	1.40
FIRE KING	39.4	30.9	1.28	39.4	29.4	1.34
ENA HARKNESS	38.9	30.2	1.28	38.9	23.8	1.63
CI-CRIMSON GLORY	34.6	25.9	1.33	34.5	20.5	1.68

Furthermore, the shadow of the epidermal cells was not especially conspicuous (Illustration 3).

Discussion

It was made clear through the observations that in the petals of velvety dark red roses, the epidermal cells of the area showing apparently velvety dark red were comparatively longer vertically to the surface of petal, than those of

area not showing velvety dark red in the same petals and those of petals of red roses.

Generally speaking, a condition in which short nipple shaped cells are arranged on the surface leaving certain space should probably make the surface of petal look rough. This is the case of the petals of red rose and of the area not showing the velvety dark red in the petals of velvety dark red rose. When a slanting light was projected on this surface the shadow of the nipple-like epidermal cells might not be so conspicuous, as are shown in Illustration 2 and 3.

But when the nipple-like epidermal cell is comparatively long on vertical direction to the surface, it should give a velvety appearance. The surface of the area of velvety dark red is just the case. When a light was projected from upper angle on such a surface, the shadow of the nipple-like epidermal cells will be conspicuous as shown in Illustration 1 a and b. When a shadow is thrown onto a red ground, mass of shadow spots appear to be black or blackish.

On the other hand, as shown in Illustration 1 a and b, the fact that the position and shape of the shadow made by lighting the same nipple-like epidermal cells differ according to the difference of the beam direction, suggests that the expression of the black tone depends mainly upon the shape of the epidermal cells and that the quantity and quality of the pigment cannot be the main factor.

HARA⁽⁷⁾ investigated the development of variegation in leaves and pointed out that in certain species of plants this variegation was not resulted from chlorophyll deficiency, but depended upon the inner structure of the leaf. In this report, it was proved that the development of the black tone in the petals of so called "black rose" depended upon the surface structure of the petal. The author would propose a term "morphological color tone" for the histological structure affecting the development of color tone.

Summary

BONNE NUI, CHARLES MALLERIN and JOSEPHINE BRUCE are the most typical varieties among so called "black rose", the petals of which are velvety dark red with black tone.

The author made a comparative morphological study on the epidermal structure of petal between a group of 3 varieties of the velvety dark red rose and another group of 7 red varieties. The study made it clear that the epidermal cells of the velvety dark red area in the petals were longer vertically to the petal surface than those of other varieties, and that each epidermal cell was separate without contacting each other, having more spaces among the epider-

mal cells than in those of other varieties of the roses.

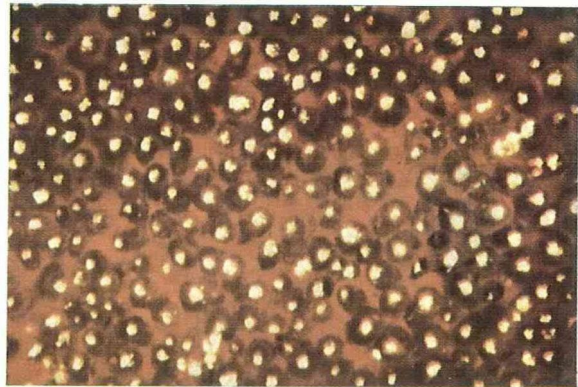
These characteristics of the epidermal structure of the petals were thought to be responsible for casting the shadow of epidermal cells on the petal surface. It was concluded that the conditions above mentioned were a main cause of expression of black tone in the petals of the velvety dark red roses.

A term "morphological color tone" was proposed by the author to the histological structure affecting development of color tone.

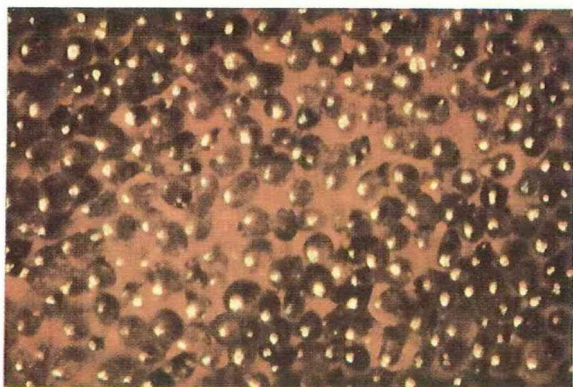
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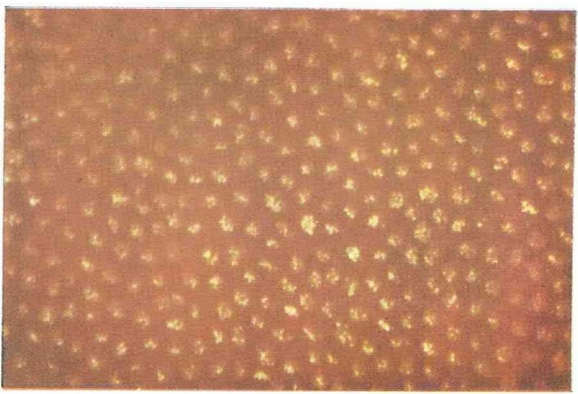
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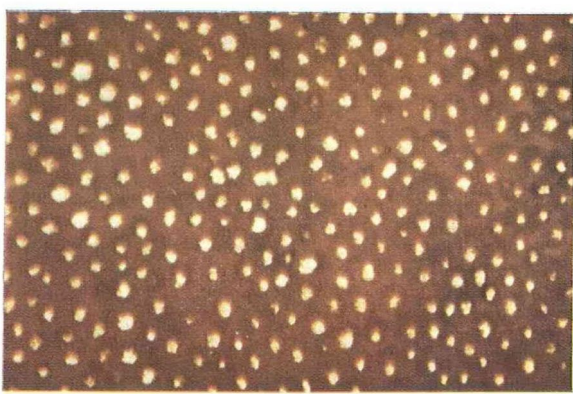
1a ←



1b →



2



3

Illustration 1-2 ($\times 250$) : surface views of the petal of BON SE NUI.

1 a-b : views of the area which is velvety dark red. (In the a and b a slanting light was projected from the direction of the arrow on the same area.)

2 : a view of the area which is not velvety dark red.

Illustration 3 ($\times 250$) : a surface view of the petal of RADAL.