LEAF PHENOTYPIC VARIATION IN NATURAL POPULATIONS

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Abstract: Along with the diversity of the flower, the phenotypic diversity of the leaf is particularly beautiful and attractive. The synthesis and functionality of chlorophyll, crucial for photosynthesis, largely dictate leaf coloration, with varying concentrations imparting different shades of green. Complex gene interactions regulate chlorophyll synthesis,and disruptions in these pathways can result in abnormal chlorophyll production, thereby affecting leaf pigmentation.

The paper presents the results of a study conducted on the Black Sea coast of Adjara, describing Japanese camellia varieties that are distinguished by their diverse leaf coloration. Any transformation of its shape, size and structure is adaptive in nature, it is caused by changes in ecological factors or age-related changes in the organism. Phenotypic variation of a leaf depends on a combination of internal and external factors, plant age, branch location, exposure and crown part, leaf age, environmental conditions, genetic and other factors.

Keywords: Camellia, variability, pigments, mutation.

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Introduction: Camellia (Camellia L.) is one of the most important and commercially valuable genera of the family Theaceae from an ornamental perspective. The primary basis for classification within the genus is flower structure; however, the anatomical and morphological characteristics of the leaf also play a significant role in species identification and taxonomic differentiation. Based on these features, approximately 93 Camellia species have been identified by various researchers. Using the same traits, genetic diversity among cultivars has also been established (Sealy, 1958; Mugnai et al., 2008; Wu et al., 2013).

Researchers pay particular attention to the study of the leaf blade of Japanese camellia (Camellia japonica L.), as it represents an important source of information for analyzing patterns of variability (Lu et al., 2008). Changes in leaf shape, size, and anatomical structure are generally adaptive in nature and are caused by variation in ecological factors as well as age-related transformations within the plant. Leaf morphological variability depends on the combined influence of internal and external factors, including plant age, branch position, exposure, and the specific part of the crown. Leaf size and coloration vary according to leaf age and environmental conditions. Leaf venation is also of particular importance, as it is a characteristic trait of a cultivar, although a certain degree of variation may also occur within the same cultivar (Zhongchen et al., 2012).

In Japanese camellia, flower diversity—especially in terms of coloration—is clearly of particular importance; however, as an evergreen ornamental plant, it also deserves attention for leaf pigmentation. In this respect, the cultivar *Elegans* is especially noteworthy. Along with floral diversity, variation in leaf pigmentation is particularly beautiful and attractive. There is no available information on the artificial induction of variegated leaves in Japanese camellia; however, inducing such changes through the use of ionizing radiation (especially gamma rays) or chemical mutagens does not present a major difficulty. A wide diversity of plastid chimeras has been obtained in tea plants under the influence of chemical and physical mutagens (Baratashvili 2009).

It has been shown that if the maternal plant has green leaves and the paternal plant is variegated, the F1 generation produces plants with green leaves. In reciprocal crosses, when the maternal plant is variegated and the paternal plant has green leaves, the F1 generation includes green-leaved, variegated, and white-leaved plants. This indicates that the trait is inherited exclusively through the maternal line. It has been demonstrated that a variegated leaf consists of three types of cells: cells with green plastids, cells with both green and white plastids, and cells with white plastids (the latter lacking the ability to synthesize chlorophyll).

After mitotic division, the appearance of a particular cell type depends on how the cell plate (division wall) is formed. The inability of plastids to carry out chlorophyll synthesis is caused by defects (mutations) in their DNA. In some cases, a homozygous state of a nuclear gene may act as a mutagenic factor. For example, in maize, such a factor is the homozygous condition of the *ij* gene (genotype *ijij*). According to various data, the frequency of spontaneous mutations in plastids ranges from 0.02% to 0.5%.

Method: The research object comprised cultivars of Japanese camellia, in which individuals from different habitats were studied, differing in altitude above sea level, light conditions, and soil–climatic characteristics. From each variety, 5–10 fully developed, healthy leaves from the same phenological phase (active period of vegetation) were taken to reduce ontogenic variation (Sultan et al. 2000; Valladares et al. 2007; Poorter et al. 2009). The identification of Japanese camellia cultivars was carried out according to the International Camellia Nomenclature (Trujillo et al. 2002; Baratashvili et al. 2019).

At each study location, altitude above sea level, light intensity, air temperature, relative humidity, and soil moisture were recorded. These parameters were used to assess the effects of environmental gradients on leaf phenotypic traits (Körner, C., 2007; Grime, J. P., 2001).

Discussion: Plastidial changes in leaf coloration are relatively rare in Japanese camellia cultivars. Exceptions to this are the cultivars *Pelaqia* (Fig. 1) and *Elegans* (Fig. 2). In these cultivars, leaves frequently develop with different plastid combinations. As shown in the figures, leaf pigmentation is highly variable, and the combination of white, yellow, and other color types, together with flower coloration, creates an appealing mosaic pattern.

Fig. 1. Different types of leaf pigmentation changes in the Japanese camellia cultivar *Pelaqia*.

Fig. 2. Different types of leaf pigmentation changes in the Japanese camellia cultivar *Elegans*.

According to the international classification, chlorophyll deficiency in camellia leaves can be grouped as follows:

Group I – Single-color shoots:

1. **Albina** – white-colored shoots.
2. **Xantha** – yellow-colored shoots.
3. **Viridis** – shoots exhibiting a pale green coloration, with the leaf transitioning from yellow to green.

Group II – Multi-colored shoots:

1. **Maculata** – shoots showing chlorophyll deficiency in the center or at the edges of the leaf.
2. **Costata** – shoots showing chlorophyll deficiency between the leaf veins.
3. **Mixochimera** – shoots with an irregular chlorophyll deficiency across the entire leaf blade.

Group III – Shoots with gradually changing leaf coloration:

1. **Albescens** – shoots in which the leaf color gradually transitions from green to white and yellow.
2. **Liutescens** – shoots in which the leaf color gradually shifts from green to yellow-green.
3. **Viriscens** – shoots with pale leaves that gradually acquire a normal green coloration.

Neither chlorophyll-based nor other types of chimeric traits are transmitted to the next generational offspring. Of particular interest is the study of plastid inheritance in vegetative generations of Japanese camellia.

Table 1

Inheritance of plastid changes in V1 and V2 generations of Japanese Camellia

Breed name	**Vegetative generation**	**Number of developed plants**		**Preserved changes %**					
				Total		**Among them**			
		Number	**%**	**Number**	**%**	**Number**	**One type**	**Number**	**Two or more types**
Pelaqia	V_1	171	85,5±2,5	24	14,0±2,6	15	8,8±2,2	9	5,3±1,7
Pelaqia	V_2	164	82,0±2,7	17	10,4±2,4	10	6,1±1,9	7	4,3±1,9
Eleqans	V_1	183	91,5±2,0	45	24,6±3,2	22	12±2,4	23	12,6±2,5
Eleqans	V_2	178	89±2,3	34	19,1±3,1	20	11,2±2,4	14	7,9±2,0

Note: Each option contains 200-200 pens.

The occurrence of leaf pigmentation variability-including white, yellow, and other color patterns-is relatively rare among Japanese camellia cultivars found in the Batumi Botanical Garden and along the coastal zone of Adjara. In our study, this phenomenon was observed in two Japanese camellia cultivars: *Pelaqia* and *Elegans*. In the first case, leaf pigmentation is less diverse, and the percentage of its retention in the V1 and V2 generations is relatively low. For example, in *Pelaqia*, during vegetative propagation of plants exhibiting different types of chlorophyllin changes, 14.2 ± 2.6% of plants in the V1 generation retained the changes, while in the V2 generation this percentage decreased to 10.4 ± 2.4%. In the *Elegans* cultivar, these types of changes were retained in 24.6 ± 3.2% of plants in V1 and 19.1 ± 3.1% in V2 (Table 1).

As the results of the study show, the induction of chlorophyll changes under natural conditions is a genotypic feature of Japanese camellia and is strongly expressed in the Eleqans variety.

Conclusion: Chlorophyll chimeras are a rare occurrence in Japanese camellias and are clearly expressed only in two varieties - Pelaqia and Eleqans. In the case of the first variety, 14.2±2.6% of plastid changes are inherited in the V1 generation, and 10.4±2.4% in the V2 generation, in the case of the second variety, the indicated rate is higher and amounts to 24.6±3.2% and 19.1±3.1%, respectively.

In natural populations of Adjara, Camellia japonica varieties exhibit a sharp variation in leaf phenotypic traits, which is associated with the heterogeneity of environmental conditions. The results obtained confirm the high adaptive potential of the species and emphasize the importance of conserving the diverse habitats of Colchian forests. Leaf phenotypic traits can be used as effective indicators in monitoring the ecological status of populations and their response to climate change.

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