Replenishing the biodiversity of cultivated plants with new varieties of *Paeonia hybrida*

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Abstract. The article presents the results of breeding studies with representatives of the generic complex *Paeonia* L. at the South-Ural Botanical Garden-Institute of Ufa Federal Research Centre of Russian Academy of Sciences. The goal of the work is to create local highly decorative varieties of *P. hybrida* hort. for the climatic zone of the Republic of Bashkortostan with good resistance to diseases and pests, high winter hardiness and heat resistance. Beginning in the 1950s of the 20th century, a collection fund of the complex of *Paeonia* family was formed in the botanical garden of the city of Ufa. This made it possible to select parental forms with specified decorative characteristics for hybridization. In 1999–2000, garden employees carried out crossbreeding combinations between certain varieties of *Paeonia*, and also collected seeds from free pollination. As a result, by sowing the resulting seeds in open ground, about 200 seedlings were grown from forced pollination and 22 from free pollination. When the hybrids reached the generative phase of development, they were carefully selected according to the main decorative characteristics (color, doubleness, flower size) and samples were selected that were superior to the parent varieties or were especially noticeable in one of them. The selected hybrids, upon reaching the period of full and mass flowering, were evaluated according to the method of the State Variety Test of the Russian Federation. Already from them, 11 especially interesting hybrid seedlings, distinguished by their decorative characteristics, were selected for transfer to the state variety plot for breeding testing. Descriptions of new varieties of *P. hybrida* hort. are given ('Bashkirskaya Zhemchuzhinka', 'Bashkirskiy Suvenir', 'Geliya', 'Kruzhevo Sada', 'Minzifa', 'Pamyati A.S. Sakharovoy', 'Ural'skaya Fantaziya', 'Ufimskiy Val’s', 'Ufimskiy Rassvet', 'Yubileynyy YuUBSI', 'Yantarnoye Ozherel’ye'), included in the State Register. All cultivars bred in the botanical garden are resistant to adverse weather conditions, pests and diseases, winter-hardy and drought-resistant. They are recommended for inclusion in the range of cultivated plants used for landscaping in populated areas of the Republic of Bashkortostan and in central Russia in general.

1 Introduction

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It is known that breeding work requires great perseverance, knowledge of the basics of plant breeding and love for the work. New ornamental flower plants can be obtained by selecting young hybrid seedlings obtained from mass sowing of seeds from free pollination of plants, and their targeted cultivation on a high agricultural background. But this method gives insignificant results, since it depends on various accidents of free pollination of parental pairs [1, 2].

Most often, intervarietal and interspecific hybridization (crossing) of individual varieties or forms is used. Greater success is achieved when hybridization is carried out in a targeted manner and the selection of parental pairs for crossing occurs consciously [3, 4]. Also I. V. Michurin noted that new hybrid offspring always contain a variety of seedlings, and even in the same family it is never possible to find two plants identical in characteristics and properties [5, 6].

The goal of the work is to create local highly decorative varieties of Paeonia hybrida hort. for the climatic zone of the Republic of Bashkortostan with good resistance to diseases and pests, high winter hardiness and heat resistance.

2 Materials and research methods

Selection of Paeonia, i.e. the breeding of new and improvement of existing varieties has been carried out at the South-Ural Botanical Garden - Institute of UFSC RAS (hereinafter referred to as SUBG I UFRC RAS) since 1955. To develop domestic varieties of Paeonia, two methods were used: open pollination and artificial hybridization with subsequent selection of the best forms. To carry out this work, an impressive collection of varieties and species of Paeonia, differing in decorative characteristics, such as bush habit, shape, size and color of the flower, was collected as source material for many years [7].

Of the entire variety of the taxa of Paeonia growing in the collection of the SUBG I UFRC RAS, the most decorative varieties were used when selecting parental pairs for hybridization. They differed from each other in three main pairs of alternative characters: flower shape - from non-double to double; according to the color of the flower - white, pink and red; by flower size - from small to very large [8, 9]. For this purpose, the most promising donors for crossing were selected from the collection fund based on the following economically valuable traits:

- with early flowering - ‘Francis Ortega’;
- late flowering - ‘Mary Woodbury Shaylor’;
- with long flowering - ‘Felix Crousse’;
- with abundant flowering - ‘Yubiley Revolyutsii’;
- with large, strongly double flowers - ‘Mary Woodbury Shaylor’;
- with a beautiful bush shape (globular, densely leafy) - ‘Jeanne d’Arc’, etc.

When selecting varieties that act as parent individuals, we took into account not only decorative characteristics, but also their resistance to diseases and pests, winter hardiness and heat resistance, reproduction rate, as well as other indicators.

The second stage of work on the hybridization of Paeonia was started by the staff of the SUBG I UFRC RAS L.N. Mironova and L.A. Tukhvatullina in 1999–2000. Combinations of crosses between varieties of Paeonia were carried out and seeds from open pollination were collected. As a result, by sowing the resulting seeds in open ground, about 200 seedlings were grown from forced pollination and 22 from free pollination [10].

3 Results and its discussion
When seedlings of *Paeonia* reached the generative phase of development, they were carefully mass-selected based on the main decorative characteristics (color, doubleness, flower size) and hybrids were selected that were superior to the parent varieties or were especially noticeable in one of them [11, 12]. As can be seen from the data in Table 1, of the 220 hybrids studied, 26% developed new, unusual decorative features, such as a different flower color, unlike the parent varieties (15%), a different flower shape (5%), inappropriate size (in 9%).

### Table 1.

The data characterizing the inheritance of the main characteristics of parental varieties of *Paeonia* in the first generation (color, shape and size of the flower)

| Name of variety | Number of grown hybrid seedlings, pcs. | Among those blooming it turned out: | | | |
|-----------------|----------------------------------------|-----------------------------------|-------------------|-------------------|
|                 |                                        | maternal                           | paternal           | total             |
|                 |                                        | blooming                          | worse than parent varieties | similar to the mother plant in: | similar to the father plant in: | superior to parent varieties in: |
|                 |                                        | coloring                          | form               | size              | coloring            | form               | size              |
| Jeanne d' Arc   | 113                                    | 97                                | 38                 | 80                | 2                 | 72                 | 10                | 10                | 72                | 7                 | 1                 | 18                |
|                 |                                        | %                                  | 100                | 86                | 39                | 82                | 2                 | 74                | 10                | 10                | 74                | 7                 | 1                 | 19                |
| Mary Woodbury   | 85                                     | 80                                | 18                 | 43                | 7                 | 6                  | 26                | 7                 | 71                | 11                | 8                 |                   |
|                 |                                        | %                                  | 100                | 94                | 23                | 54                | 9                 | 7                 | 88                | 14                | 10                |                   |
| Yubiley Revolyutsii | 22                                | 20                                | 7                  | 8                  | 6                 | 1                  |                   |                   |                   |                   |                   | 12                | 1                 |                   |
|                 |                                        | %                                  | 100                | 91                | 32                | 36                | 36                | 54                | 5                 | 5                 |                   |                   | 54                | 5                 |                   |

In the offspring of hybrids, the degree of inheritance from the parental varieties of precisely these basic characteristics was studied: color, shape and size of the flower. The results of a long-term study of the degree of inheritance in the offspring of the first generation of hybrids are shown in Table 2. As an example, let us consider the analysis of...
several families (a family is hybrid seedlings grown from seeds obtained from crossing one parental pair).

Table 2. Analysis of families of varietal Paeonies

<table>
<thead>
<tr>
<th>Flower shape</th>
<th>Flower color</th>
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<tbody>
<tr>
<td>ND</td>
<td>white</td>
<td>small</td>
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<tr>
<td>SD</td>
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<td>A</td>
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First family. Mother plant – variety ‘Mary Woodbury Shaylor’: flower bisexual, pink, large, double pink; paternal plant – variety ‘Francis Ortega’: bisexual, red, medium, double pink flower. 85 hybrid seedlings were grown, 80 of which bloomed. The offspring of these varieties are 41% represented by plants with semi-double flowers, 21% with anemone flowers, 19% with double flowers and 19% with non-double flowers. Moreover, among the double forms there were only 9% of rose-shaped flowers (similar to the mother and father plants). The color of the flowers of the seedlings is varied: 54% of plants were pink in various shades (like the mother plant), 32% were red (like the father plant), and 14% of the plants were white. In terms of flower size, 89% of plants had medium flowers (12−15 cm, like the father plant), 7% had large flowers (more than 15 cm, like the mother plant), and 4% had small flowers (less than 12 cm). Of the entire family, 7 hybrids were identified as promising. They are distinguished by their special originality: pure and bright color of the flower, abundant flowering.

Thus, the analysis of the inheritance of such a trait as flower shape is of an intermediate nature. When analyzing the color of flowers of seedlings, it was revealed that the maternal shade dominates. In terms of flower size, most hybrids inherited average parameters from their father.

Second family. Mother plant – ‘Jeanne d’Arc’: unisexual, feminized, pink, medium, double hemispherical flower; father plant – ‘Felix Crousse’ – bisexual, red, medium, double bomb-shaped flower. 113 hybrid seedlings were grown, of which 97 bloomed. The majority of hybrids (38%) had a semi-double flower shape, 32% of hybrids had a non-double flower shape, and 17% had an anemone-shaped flower. Only 13% of seedlings had a double flower form, incl. in 2% it is hemispherical (like the mother plant) and in 1% it is double bomb-shaped (like the father). In terms of flower color, almost all seedlings (83%) are similar to the mother variety – pink and lilac. 10% of the hybrids acquired a red color (like the father’s) and 7% acquired a white color. In terms of flower size, 74% of hybrids had a medium-sized flower (12–15 cm, like the father and mother), 19% had large flowers, and 7% had small flowers. Of the entire family, 3 hybrids were particularly original. Thus, most seedlings inherited the color of the flower from the mother plant. In terms of flower size, 74% of hybrids inherited average parameters from their mother and father. In terms of flower shape, most hybrids acquired a semi-double form, while the parents had a double form.
Consequently, there is inheritance of an intermediate nature. Most hybrids have pink, medium-sized and semi-double flowers. Hybrids of *Paeonia* from open pollination also have many valuable traits. Among them there is a high percentage of plants with semi-double and double flowers. Many of them have an original flower structure and color.

The selected hybrids, upon reaching the period of full and mass flowering, were assessed for 57 characteristics, according to the testing methodology for distinctiveness, uniformity and stability, developed by the State Commission of the Russian Federation for Testing and Protection of Breeding Achievements [13, 14]. Already from them, 11 especially interesting hybrid seedlings, distinguished by their decorative characteristics, were selected for transfer to the state variety plot for breeding testing. Subsequently, copyright certificates and patents were obtained for them.

Below is a description of the decorative qualities of new varieties of *Paeonia hybrida* hort. selected by the South-Ural Botanical Garden-Institute of UFRC RAS.

‘Bashkirskaya Zhemchuzhinka’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 11618). Developed by hybridizing the varieties ‘Jeanne d’Arc’ and ‘Felix Crousse’. The bush is semi-spreading, with strong foliage, and the stem is of medium strength. The leaves are moderate yellowish-green, the shape of the segment is pointed-elliptical, the petiole is red-brown. The flower is of the Japanese type, single-row, light purple in color (Fig. 1). The outer petals are obovate, with a notched edge. Staminodes are ribbon-shaped, wide, yellow. A flower with a pleasant aroma, low fading. The start of flowering is mid-late.

‘Bashkiy Suvenir’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 12322). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is semi-spreading, medium foliage, the stem is strong. The leaves are moderate olive-green, the shape of the segment is pointed-elliptical, the petiole is red-brown. The flower is semi-double, purple-pink in color (Fig. 1). The outer petals are obovate, with a notched edge; internal-indeterminate, with a dissected edge. A flower with a pleasant aroma, highly fading. The start of flowering time is average.

‘Geliya’ (authors: Reut A.A., Shigapov Z.Kh.; patent No. 13016). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is semi-spreading, with strong foliage, and the stem is of medium strength. The leaves are moderate yellowish-green, the shape of the segment is elliptical, the petiole is brown-green. The flower is single with two rows of petals, yellowish-white in color with pink dots (Fig. 1). The outer petals are spatulate, with a dissected edge. A flower with a specific aroma, slightly fading. The start of flowering is mid-early.

‘Kruzhevo Sada’ (authors: Reut A.A., Shigapov Z.Kh.; patent No. 13015). The variety ‘Yubiley Revolyutsii’ was bred by open pollination. The bush is semi-spreading, of medium foliage, the stem is of medium strength. The leaves are green, the shape of the segment is pointed-ovate, the petiole is red-brown. The flower is semi-double, red-purple in color (Fig. 1). The outer petals are obovate, with a notched edge; internal–indeterminate, with a separate edge. A flower with a pleasant aroma, low fading. The start of flowering time is average.

‘Minzifa’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 11619). Developed by hybridizing the varieties ‘Jeanne d’Arc’ and ‘Felix Crousse’. The bush is compact, has strong foliage, and the stem is strong. The leaves are moderate yellowish-green, the shape of the segment is pointed-elliptical, the petiole is red-brown. The flower is semi-double, bright reddish-purple in color (Fig. 1). The outer petals are elliptical, with a notched edge; internal-lanceolate, with a separate edge. A flower with a pleasant aroma, low fading. The start of flowering time is average.
‘Pamyati A.S. Sakharovoy’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 11621). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is compact, of medium foliage, the stem is strong. The leaves are moderate olive-green, the shape of the segment is pointed-elliptical, the petiole is red-brown. The flower is anemone-shaped, rich reddish-purple in color (Fig. 1). The outer petals are rounded, with a solid edge; internal-lanceolate, with a separate edge. A flower with a pleasant aroma that does not fade. The start of flowering is early.

‘Ural’skaya Fantaziya’ (authors: Reut A.A., Shigapov Z.Kh.; patent No. 13009). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is compact, has strong foliage, and the stem is strong. The leaves are green, the shape of the segment is pointed-ovate, the petiole is green. The flower is of the Japanese type, two-row, red-purple in color (Fig. 1). The outer petals are obovate, with a whole edge; internal ones are oblong-linear, with a separate edge. Staminodes are ribbon-shaped, medium wide, white. A flower with a pleasant aroma, low fading. The start of flowering time is average.

‘Ufimskiy Val’ (authors: Reut A.A., Shigapov Z.Kh.; patent No. 13017). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is compact, of medium foliage, the stem is of medium strength. The leaves are moderate olive-green, the shape of the segment is pointed-elliptical, the petiole is green. The flower is double, hemispherical, greenish-white in color (Fig. 1). The outer petals are obovate, with a dissected edge; internal-lanceolate, with a separate edge. A flower with a pleasant aroma, low fading. The start of flowering is mid-early.

‘Ufimskiy Rassvet’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 11620). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is compact, of medium foliage, the stem is of medium strength. The leaves are rich yellowish-green, the shape of the segment is pointed-elliptical, the petiole is red-brown. The flower is double, spherical, pale purple-pink in color with pronounced dots. The outer petals are obovate, with a notched edge; internal–indefinite, with a separate edge. Flower with aroma, low fading. The start of flowering time is average.

‘Yubileynyy YUBSI’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 11622). Developed by hybridizing the varieties ‘Mary Woodbury Shaylor’ and ‘Francis Ortega’. The bush is compact, of medium foliage, the stem is strong. The leaves are grayish-olive-green, the shape of the segment is pointed-ovate, the petiole is red-brown. The flower is double, spherical, pale purple-pink in color (Fig. 1). The outer petals are rounded, with a notched edge; internal-lanceolate, with a separate edge. A flower with a strong aroma and low fading. The start of flowering time is average.

‘Yantarnoye Ozherel’ye’ (authors: Mironova L.N., Reut A.A., Shigapov Z.Kh.; patent No. 12321). Developed by hybridizing the varieties ‘Jeanne d’Arc’ and ‘Felix Crousse’. The bush is semi-spreading, of medium foliage, the stem is of medium strength. The leaves are moderate olive-green, the shape of the segment is lanceolate, the petiole is red-brown. The flower is semi-double, pale purple-pink in color (Fig. 1). The outer and inner petals are elliptical, with a separate edge. Flower with aroma, low fading. The start of flowering time is average.
4 Conclusions

As a result of a preliminary analysis of the inheritance of traits in the offspring of hybrids, it was revealed that the shape of the flower has an intermediate pattern of inheritance; flower color is often inherited from the mother plant; in addition, it was noticed that hybrids with medium flower sizes predominate in the offspring.

The result of many years of breeding research has become eleven new varieties of hybrid peony, included in the State Register of Varieties Approved for Use. All varieties are resistant to adverse weather conditions, pests and diseases, winter-hardy and drought-resistant. They are recommended for inclusion in the range of cultivated plants for landscaping settlements in the Republic of Bashkortostan, the Southern Ural and in central Russia in general.

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