IRSTI 34.29.25 https://doi.org/10.26577/eb.2021.v87.i2.06

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# PRIMARY INTRODUCTION RESULTS OF THE GENUS *DACTYLORHIZA* NECKER EX NEVSKI IN THE ALTAI BOTANICAL GARDEN

The article presents the results of the primary introduction of species of the genus Dactylorhiza Necker ex Nevski in the Altai Botanical Garden. The primary introduction resulted in a stable collection of 4 species of the genus Dactylorhiza: D. fuchsii (Druce) Soo, D. incarnata (L.) Soo, D. maculata (L.) Soo, D. umbrosa (Kar. & Kir.) Nevski. Individuals of D. incarnata showed plasticity and good adaptability to conditions of culture. Their morphometric indicators of the length of the inflorescence increased by 14%, and the number of flowers in the inflorescence by 52%, indicators of the length and width of the basal leaves by 108% and 23% respectively. In the case of D. umbrosa almost all morphometric parameters were reduced. There is an increase of the number of flowers per inflorescence – 73%. The rest of the indicators were reduced by an average of 29%. D. fuchsii showed a 57% increase in flowers per inflorescence; the indices of the length of the basal leaves and the length of the stem leaves remained almost unchanged, and the width of the stem leaves increased by 23%. Indicators of D. maculata decreased very significantly. The height of the plant decreased by 43%, the length of the inflorescence by 41%, the length of the basal leaves by 27% and the length of the stem leaves by 30%. The main limiting factors for the introduction were identified: strong solar insolation, dry air, poverty and soil acidity. The results of the study have of great importance for the development of introduction agricultural technology of rare and endangered plants in the mountain taiga zone of East Kazakhstan, contribute to the preservation of biodiversity. Due to the short-term observation, more detailed analyzes of the results will be obtained with the further continuation of the introduction experiment.

**Key words:** Dactylorhiza Necker ex Nevski, introduction, collection, conservation, rare species.

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## Алтай ботаникалық бағына *Dactylorhiza* Necker ex Nevski тұқымдасының түрлерін алғашқы енгізу нәтижелері

Мақалада Алтай ботаникалық бағында Dactylorhiza Necker ex Nevski тұқымдасының түрлерін алғашқы енгізу нәтижелері көрсетілген. Бастапқы енгізудің нәтижесінде Dactylorhiza тұқымдасының 4 түрінің тұрақты коллекциясы қалыптасты: D. fuchsii (Druce) Soo, D. incarnata (L.) Soo, D. maculata (L.) Soo, D. umbrosa (Kar. & Kir.) Nevski. Жағдайларға икемділік пен жақсы бейімділікті D. incarnata түрі көрсетті. Олардың гүл шоғырының ұзындығының морфометриялық көрсеткіштері 14%-ға, ал гүлшоғырындағы гүлдер саны 52%-ға, базальды жапырақтардың ұзындығы мен енінің көрсеткіштері сәйкесінше 108% және 23%-ға өсті. D. umbrosa-де морфометриялық көрсеткіштердің барлығы дерлік төмендеді. 73%-ға өсу тек бір гүлшоғырдағы гүлдер санында байқалды. Қалған индикаторлар орта есеппен 29% төмендеді. D. fuchsii бір гүл шоғырына гүлдердің 57% өсуін көрсетті; базальды жапырақтардың ұзындығы мен сабақ жапырақтарының ұзындығының көрсеткіштері өзгеріссіз қалды, ал сабақ жапырақтарының ені 23% өсті. D. maculata кейбір индикаторлары айтарлықтай төмендеді. Өсімдіктің биіктігі – 43%, гүлшоғырының ұзындығы – 41%, базальды жапырақтардың ұзындығы – 27% және сабақ жапырақтарының ұзындығы 30% төмендеді. Енгізудің негізгі шектеуші факторлары анықталды: күшті күн инсоляциясы, құрғақ ауа, кедейлік және топырақтың қышқылдығы. Алынған нәтижелер Шығыс Қазақстанның таулы тайга зонасында сирек кездесетін және құрып кету қаупі бар өсімдіктердің ауылшаруашылық технологиясын енгізу және зерттеу үшін үлкен маңызға ие, биоәртүрлілікті сақтауға ықпал

 

етеді. Қысқа мерзімді бақылаудың арқасында енгізу тәжірибесін одан әрі жалғастыра отырып, нәтижелерді толығырақ талдау жасалады.

**Түйін сөздер**: Dactylorhiza Necker ex Nevski, енгізу, жинау, сақтау, сирек кездесетін түрлер.

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**Итоги первичной интродукции видов рода *Dactylorhiza* Necker ex Nevski в Алтайском ботаническом саду**

В статье представлены результаты первичной интродукции видов рода Dactylorhiza Necker ex Nevski в Алтайском ботаническом саду. В результате первичной интродукции была получена устойчивая коллекция из 4 видов рода Dactylorhiza: D. fuchsii (Druce) Soo, D. incarnata (L.) Soo, D. maculata (L.) Soo, D. umbrosa (Kar. & Kir.) Nevski. Пластичность и хорошую приспосабливаемость к условиям культуры показали особи D. incarnata. Их морфометрические показатели длины соцветия выросли на 14%, а количество цветков в соцветии – на 52%, показатели длины и ширины прикорневых листьев – на 108% и 23% соответственно. У D. umbrosa почти все морфометрические показатели были снижены. Увеличение на 73% было замечено только в количестве цветков в одном соцветии. Остальные показатели были снижены в среднем на 29%. D. fuchsii показал увеличение цветков, находящихся на одном соцветии на 57%; показатели длины прикорневых листьев и длины стеблевых листьев почти не изменились, а ширина стеблевых листьев увеличилась на 23%. Некоторые показатели D. maculata снизились очень значительно. Высота растения снизилась на 43%, длина соцветия – на 41%, длина прикорневых листьев – на 27% и длина стеблевых листьев – на 30%. Выявлены основные лимитирующие факторы при интродукции: сильная солнечная инсоляция, сухой воздух, бедность и кислотность почвы. Полученные результаты имеют высокое значение для изучения и разработки интродукционной агротехники редких и исчезающих растений в горно-таежной зоне Восточного Казахстана, способствуют сохранению биоразнообразия. В связи с краткосрочностью наблюдений, более подробные анализы результатов будут получены при дальнейшем продолжении интродукционного эксперимента.

**Ключевые слова**: Dactylorhiza Necker ex Nevski, интродукция, коллекция, сохранение, редкий вид.

## Introduction

The most universal method in the study, conservation of rare and endangered plant species in botanical gardens is the introduction [1]. The use of the introduction method for reconstruction (restoration) of natural populations is one of the most effective ways to maintain the reproduction of populations and a reliable tool for the biodiversity conservation [2].

The basis for the cultivation and conservation of rare orchid species is the development of effective methods for their reproduction. This is relevant for species that have a wide disjunctive range and reproduce well by seeds or vegetative way [3, 4, 5]. Reconstruction by the method of reintroduction by seedlings or translocation by adult plants in such species may give better results than sowing with seeds [6]. Germination of terrestrial species have requirements that are more specific and they are little researched [7, 8, 9, 10].

Terrestrial orchids may be more dependent on mycorrhizal fungi than on epiphytic species [11]. As for *Dactylorhiza*, the rate of vegetative reproduction is very slow, and seed germination in nature is very low – from 0.2 to 0.3% [12]. One capsule contains millions of seeds without a metabolic mechanism and endosperm. Despite the very large number of produced seeds, only a few seeds germinate in nature [13]. Introduction of *Dactylorhiza* matters for many botanical gardens in many countries interested in the manufacture of salep [14, 15].

The rarity of *Dactylorhiza*, like all orchids, is due to habitat loss and climate change, but many orchids are also threatened by unsustainable (often illegal) collection of ornamental, food and medicinal species. In addition, it is difficult to compete with invasive species of grasses [16, 17]. Whereas during the introduction, conditions are created to correspond ecological requirements of the species. Moreover, the method of sod transplantation is chosen as the most successful way of transportation species into new growing conditions. The method is described in numerous literary sources [18, 19] and has proven

itself in creating artificial cenoses with the highest degree of adaptation.

According to the results of the introduction of the Komarov Botanical Institute of the Russian Academy of Sciences (BIN RAS), it was confirmed that *D. fuchsii* grows well in culture (in partial shade and in open areas), without requiring special substrates. This species is easily grown *in vitro* culture from mature seeds. The seedlings develop well. Individuals easily adapt after disembarking in non-sterile conditions. They bloom 5-6 years after sowing [20].

There are 8 species of *Dactylorhiza* in Kazakhstan, among which 4 were selected for primary introduction, including *D. fuchsii* listed in the Red Book of Kazakhstan. All species are economically valuable, representatives of the biodiversity of the flora of Kazakhstan.

The beneficial properties and potential of many *Dactylorhiza* species are still being actively studied [21, 22, 23].

The purpose of this work is to analyze the results of the primary introduction of species of the genus *Dactylorhiza* to identify the most promising species and forms.

## Materials and methods

The objects of the study were representatives of the genus *Dactylorhiza* (Fig 1): *D. fuchsii* (Druce) Soo, *D. incarnata* (L.) Soo, *D. maculata* (L.) Soo, *D. umbrosa* (Kar. & Kir.) Nevski during introduction in conditions of mountain forest zone – Ridder «Altai Botanical Garden".

Primary introduction tests were carried out in 2018 – 2020.


**Figure 1 –** Species of the genera *Dactylorhiza* in the primary introduction:
A – *D. fuchsii*; B – *D. incarnata*; C – *D. maculata*; D – *D. umbrosa*

The collection of material was carried out during 3 expedition trips by the route-reconnaissance method. Studies of natural habitats were carried out in the Kurchum and Katon-Karagai administrative regions. The routes of the expeditions through the territory of South Altai passed through flat, low-mountain and mid-mountain territories, covering the ranges: South Altai, South Altai Tarbagatai, Azutau, Kurchum, Narym; Bukhtarma mountains, Chundogatui mountains; depressions: Bobrovskaya, Karakabinskaya, Katon-Karagayskaya and Markakolskaya. The valleys of the next rivers were studied: Bukhtarma, Akkaba, Kurchum, Sogornaya, Sarymsakty, Kaldzhir, Narym, Karakaba, Basterekty, Tau-Tekeli. The total length of the expeditionary routes was 4925 km.

The material was transplanted into the culture from natural habitats by living plants. Places for attraction to culture are indicated on the map-scheme (Fig. 2).

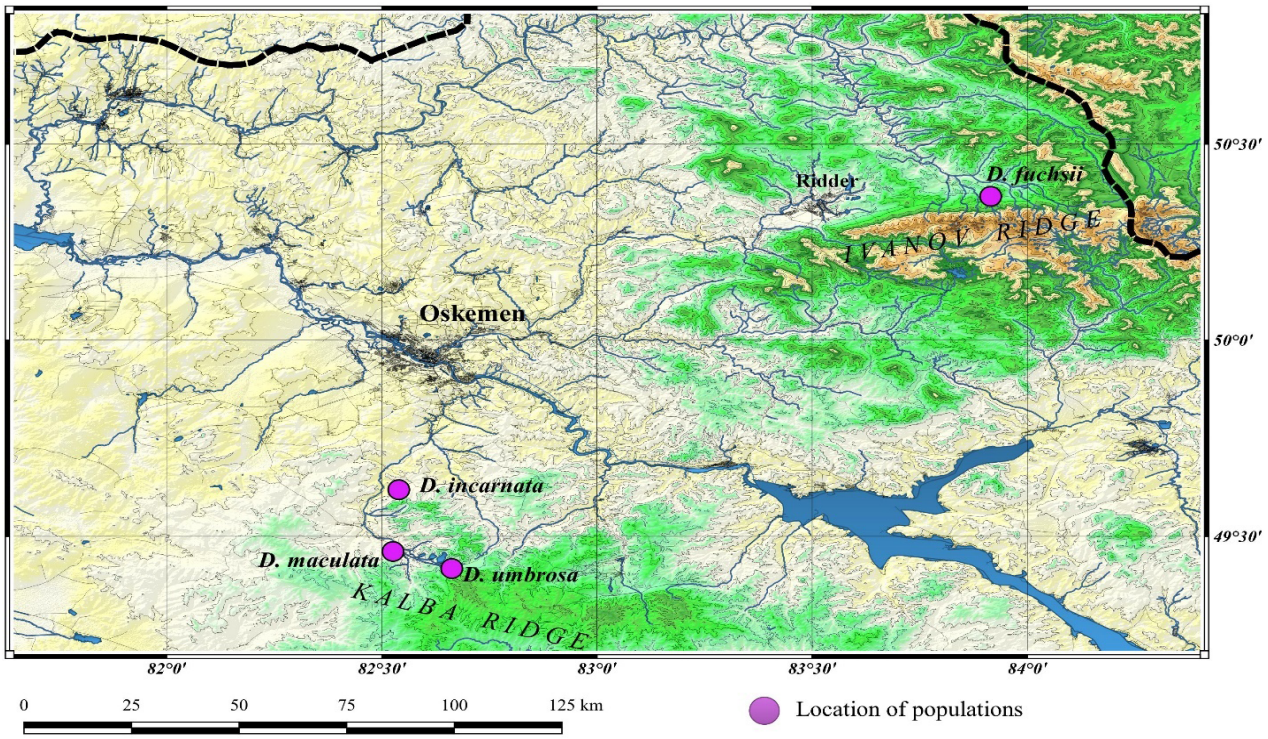


**Figure 2** – Schematic map of the habitats of the species involved in the introduction.

The selection of material, principles and methods of introduction research were studied according to the method of K.A. Sobolevskaya [24] and based on the existing methods of cultivating rare plants in botanical gardens [25-30].

Individuals transported by a block of sod for better preservation of the planting material and were planted in the ground with a lump of earth to preserve mycorrhiza.

On the experimental territory of the laboratory of natural flora in the Altai botanical garden were created conditions close to natural for each plant species. The plants were planted in open areas since in nature these species grow in overly humid meadows, in moderately humid meadows with full illumination throughout the day. During planting to the planting pits was added soil from the sample collection point to enrich them with microflora, including mycorrhizal fungi, which are necessary for the growth and development of orchids.

Severity of the climate in the region affects to the plants collection safety. That is why agrotechnical and maintenance measures carried out from early spring to the establishment of snow cover very important. Orchids are not able to compete with the powerful weed. Therefore, during the growing season, weeding with shallow loosening was carried out on the collection of orchids. During the summer period, there were often periods without precipitation for more than 10 days. There-

fore, the collection site has an artificial irrigation system. For the winter at the end of October, the site was covered with 3-5 cm thick linden and birch leaves to protect it from freezing and replenish the soil with organic matter.

Well-developed individuals of medium size, without signs of diseases and pests were selected for measurements. According to method of Vakhrameeva M.G. [30] for each coenopopulation, the following were determined: the number of generative and vegetative individuals, the height of the generative shoots, the number of leaves on the generative shoots, the length of the peduncle, leaf sizes, the size of the inflorescence, and the number of flowers. These indicators were determined in 20 replicates.

Due to the short duration of the study and the rather long period of ontogenesis of the studied species, such introduction parameters as: the passage of seasonal phenophases, seed productivity and seed viability were not included in the objectives of this study. The study of these parameters is foreseen at the next stage of the introduction tests.

**Research results and discussion**

Republican state enterprise "Altai Botanical Garden" is located in the Leninogorsk intermountain basin of the Ubinsky (1967 m) and Ivanovsky (2776 m) ridges. The erosion-tectonic trough of the Leninogorsk depression is a consequence of the alpine orogenesis. Its structure involves rocks of the Upper Paleozoic age – clay and siliceous shales, sandstones, tuffs, limestones, granites, etc. The territory of the basin is composed of deluvial-proluvial deposits and is a slightly hilly surface [31].

The soil of the garden belongs to mountain chernozems. The humus content ranges from 6 to 8 (10%) with a high percentage of nitrogen and potassium. In the upper horizons, the soil reaction is neutral or slightly acidic; in the lower layers, it acquires an alkaline reaction. Parent rocks are the loess-like loams of various genesis [32, 33].

The climate is sharply continental, characterized by long cold winters and hot short summers.

The limiting factors for the introduction of plants in the Altai Botanical Garden are the sharp changes in temperature and humidity during the year, season and day, and a short growing season. The air temperature during the day fluctuates sharply, in winter the drop can reach 25 ºC, and in summer up to 20 ºC. The growing season begins with the establishment of a stable transition of air temperature through +5 ºC, and ends with the manifestation of the first autumn frosts – in the first decade of September.

The beginning of the growing season in our zone is considered to be April. Unusually warm weather in the 1st decade of April: up to +9, caused complete snow melting, and early release of the soil from snow. The average monthly air temperature was positive +5.8º C. The snow completely melted on 13 April. A stable transition of the average daily temperature through 0º C occurred on April 16, 2 weeks earlier than the long-term average date. The amount of precipitation for the month is above the norm – 71.7 mm.

Warm weather was observed in the first ten days of May. In the afternoon, the air temperature reached +24.5º C. The soil thawed violently, which completely ended at the end of the decade. There was a sharp drop in day and night temperatures.

In June, the weather was rainy. Abundant precipitation was observed: 149.2 mm, 3 times higher than the norm. The air temperature remained moderately warm: 16.8º C. The air humidity was high: 72-74%. There were no frosts in June.

In the first half of July, the weather was hot and sunny. In the first and second decades, there was practically no precipitation, and the air temperature reached +28.8º C. The top layers of the soil were dry. It rained in the third decade of the month. But they practically did not replenish the moisture reserves in the soil, and therefore the plants experienced a lack of moisture.

The weather remained hot in the first half of August. The air temperature was kept within +29.2º C. Little precipitation was noted. In the third decade of the month, the first slight frosts were observed up to –1º C on the soil surface.

Observations of the seasonal rhythm of development showed that all *Dactylorhiza* species emerge under the snow without signs of sub-snow growth. All species go through a full cycle of seasonal development and complete the growing season naturally in the first or second decades of September. The percentage of boll formation is low – 10-17.6%, due to the dry growing season.

Information about the life of these plants, the bioecological characteristics of species, the peculiarities of their relationship with the conditions of the edaphic environment reveals more fully study of the morphological structure of underground organs of *Dactylorhiza*.

*Dactylorhiza* species are tuberoid orchids. The root part of the tuberoid has finger-split tu-

bers, consisting of thickened accrete root bases, while their bases remain thin and reach up to 5-8 cm. In addition to root tubers, there are non-thickened adventitious roots of the first and second order. The seasonal development of the stem-root tuberoid is accompanied by the annual replacement of the old tuber, which is functioned in the current year, with a young one, bearing a renewal bud, from which next year will develop an underground shoot. During the growing season, the old tuber, which functioned in the last year, shrivels, turns brown. Therefore, despite the perennial life cycle, the plant is renewed annually.

During the introduction to the site of the Altai Botanical Garden from 2015 to 2019 were involved 7 species of *Dactylorhiza.* For 2020, the collection is represented by 4 species (Table 1).

**Table 1 –** Attraction of *Dactylorhiza* for introduction

| Registration number | Species name | Year of attraction | Places of attract settlements |
|---|---|---|---|
| 13-19 | *D. fuchsi*i | 2017 | Southwestern Altai, Ivanovsky ridge, Gray meadow tract, Bolshaya Poperechka river valley, southwestern foothills, fir-birch edge, moistened meadow covered with moss. 50°20’38»N, 83°53’34» E, 1212 m above sea level. |
| 26-18 | *D. incarnata* | 2018 | Kalbinsky Altai, Kalbinsky ridge, Koktau mountains, Shat tract, Toganas environs, wet meadow; 49°35’45»N, 82°31’07» E, 634 m above sea level. |
| 15-18 | *D. maculata* | 2018 | Kalbinskiy Altai, eastern part of the Kalbinsky ridge, southwestern periphery of the Koktau mountains, the vicinity of the village Algabas. 49°26′21»N, 82°33′42»E, 696 m above sea level. |
| 19-17 | *D. umbrosa* | 2017 | Kalbinsky Altai, Kalbinsky ridge, in the region of Sibinsky lakes, before reaching the third upper lake, intermountain valley; the coastal zone of the Sibinka river. 49°22′55»N, 82°38′41» E, 705 m above sea level. |

The first results of the primary introduction of the genera already make it possible to identify the most promising species for introduction (Table 2).

The species *D. fuchsii* showed a 1.6-fold increase in flowers per inflorescence; increase in the length of the basal leaves by 1.01 times; an increase in the length and width of stem leaves by 1.2 and 1.3 times, respectively (Fig. 3).

During introduction *D. incarnata* species showed an increase in inflorescence length by 1.14 times; increase in flowers in the inflorescence by 1.5 times; an increase in the length and width of basal leaves by 2 and 1.2 times, respectively (Fig. 4).

*D. maculata* and *D. umbrosa* performed slightly less well. The species *D. maculata* showed an increase in flowers in one inflorescence by 1.8 times and an increase in the width of basal leaves by 1.08 times (Fig. 5).

Individuals of *D. umbrosa* showed 1.7-fold increase in flowers in one inflorescence (Fig. 6).

All *Dactylorhiza* species that were introduced in the Altai Botanical Garden showed a decrease in plant height by an average of 1.52 times and a decrease in inflorescence width by 1.1 times. The species *D. fuchsii*, *D. maculata*, and *D. umbrosa* showed a decrease in inflorescence length by an average of 1.7 times. The species *D. maculata* and *D. umbrosa* showed a decrease in the length of basal leaves by an average of 1.4 times. In the case of species *D. umbrosa* and *D. fuchsii*, we noted a decrease in the width of basal leaves by an average of 1.9 times. In almost all species except *D. fuchsii*, was noted a decrease in the length and width of stem leaves by 1.2 and 1.5 times, respectively (Figure 7).

**Table 2** – Measurements of plants of *Dactylorhiza* species

| name of the trait | *D. fuchsii* | | *D. incarnata* | | *D. maculata* | | *D. umbrosa* | |
|---|---|---|---|---|---|---|---|---|
| | In nature, cm | In culture, cm | In nature, cm | In culture, cm | In nature, cm | In culture, cm | In nature, cm | In culture, cm |
| Plant height | 35-63 $\overline{X}$=50,1±3,4 | 30-47 $\overline{X} = 36_{\pm 1,9}$ | 42-60 $\overline{X} = 53,7_{\pm 3,51}$ | 25-41 $\overline{X} = 36 \pm 3,6$ | 40-48 $\overline{X}$=42,5±2,2 | 28-36 $\overline{X} = 32_{\pm 2,1}$ | 55-64 $\overline{X} = 60 \pm 2$ | 30-47 $\overline{X} = 39,6 \pm 3,2$ |
| Inflorescence length | 6-13 $\overline{X} = 9,53_{\pm 0,99}$ | 5,5-9 $\overline{X} = 6,8 \pm 0,8$ | 4-8 $\overline{X} = 6,15_{\pm 0,44}$ | 6,5-7,5 $\overline{X} = 7_{\pm 1,65}$ | 6-10 $\overline{X} = 7,2 \pm 1,48$ | 4-4,5 $\overline{X} = 4,25 \pm 0,1$ | 13-16 $\overline{X} = 14,5 \pm 1,3$ | 6-9 $\overline{X} = 7,2_{\pm 1,4}$ |
| Inflorescence width | 2-3 $\overline{X} = 2,8_{\pm 0,2}$ | 2-3,5 $\overline{X} = 2,66_{\pm 0,4}$ | 2,5-3,5 $\overline{X} = 2,94 \pm 0,23$ | 2,5-3 $\overline{X} = 2,8 \pm 0,48$ | 2,5-3 $\overline{X} = 2,83 \pm 0,25$ | 2,5-3 $\overline{X} = 2,74 \pm 0,8$ | 4-5 $\overline{X} = 4,5 \pm 0,22$ | 3,5-4 $\overline{X} = 3,83_{\pm 0,17}$ |
| Flowers on one inflorescence | 14-30 $\overline{X} = 29,2_{\pm 0,5}$ | 30-46 $\overline{X} = 36_{\pm 2}$ | 12-49 $\overline{X} = 24,3 \pm 8,6$ | 36-42 $\overline{X} = 37 \pm 4$ | 14-22 $\overline{X} = 18,3 \pm 2,86$ | 30-36 $\overline{X} = 33 \pm 2,1$ | 26-36 $\overline{X} = 31 \pm 3,4$ | 46-64 $\overline{X} = 52_{\pm 3,6}$ |
| Basal leaf length | 7-12 $\overline{X} = 8,75_{\pm 1,83}$ | 7,5-11 $\overline{X} = 8,87_{\pm 1,39}$ | 5-9 $\overline{X} = 6,3_{\pm 1,4}$ | 11-15 $\overline{X} = 13,1_{\pm 2,54}$ | 9-11 $\overline{X} = 9,87 \pm 1,18$ | 6,5-8 $\overline{X} = 7,25 \pm 0,6$ | 13-18 $\overline{X} = 15 \pm 1,5$ | 8-15 $\overline{X} = 11_{\pm 1,9}$ |
| Basal leaf width | 2-4 $\overline{X} = 3_{\pm 0,63}$ | 1,2-1,5 $\overline{X} = 1,42_{\pm 0,07}$ | 2-2,5 $\overline{X} = 2,2_{\pm 0,25}$ | 2-3 $\overline{X} = 2,7_{\pm 0,34}$ | 2-2,5 $\overline{X} = 2,12_{\pm 0,3}$ | 2-3 $\overline{X} = 2,3_{\pm 0,12}$ | 4,6-7 $\overline{X} = 5 \pm 0,3$ | 3-3,5 $\overline{X} = 3,2_{\pm 0,15}$ |
| Length of stem leaves | 6-10 $\overline{X} = 9,2_{\pm 0,8}$ | 8-10 $\overline{X} = 9,2_{\pm 1,58}$ | 7-11 $\overline{X} = 9,75_{\pm 2,63}$ | 6-10 $\overline{X} = 8,5_{\pm 1,86}$ | 11-16 $\overline{X} = 13,3_{\pm 1,86}$ | 8-10 $\overline{X} = 9,3_{\pm 0,2}$ | 19-20 $\overline{X} = 19,5 \pm 0,18$ | 11-25 $\overline{X} = 16,2 \pm 2,4$ |
| Stem leaf width | 1-1,5 $\overline{X} = 1,3 \pm 0,18$ | 1-2 $\overline{X} = 1,6_{\pm 0,17}$ | 2-2,5 $\overline{X} = 2,2_{\pm 0,14}$ | 1-1,5 $\overline{X} = 1,33_{\pm 0,21}$ | 1,5-2,5 $\overline{X} = 1,83_{\pm 0,41}$ | 0,7-2 $\overline{X} = 1,24 \pm 0,08$ | 0,78-2,56 $\overline{X} = 1,3 \pm 0,34$ | 1-2 $\overline{X} = 1,6_{\pm 0,14}$ |
| In the numerator min-max – the minimum and maximum value of the indicator; the denominator is the average value of the indicator | | | | | | | | |

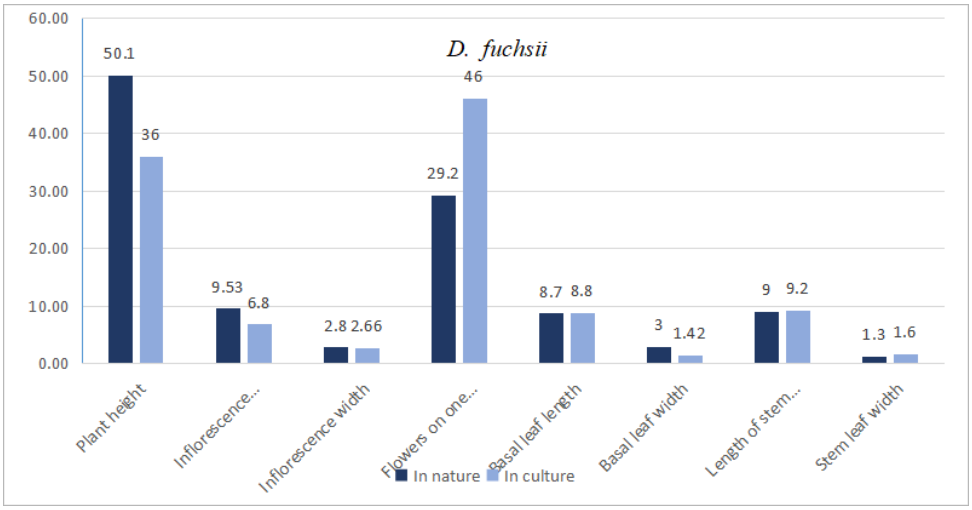


**Figure 3** – Indicators of *D. fuchsii* in nature and during introduction

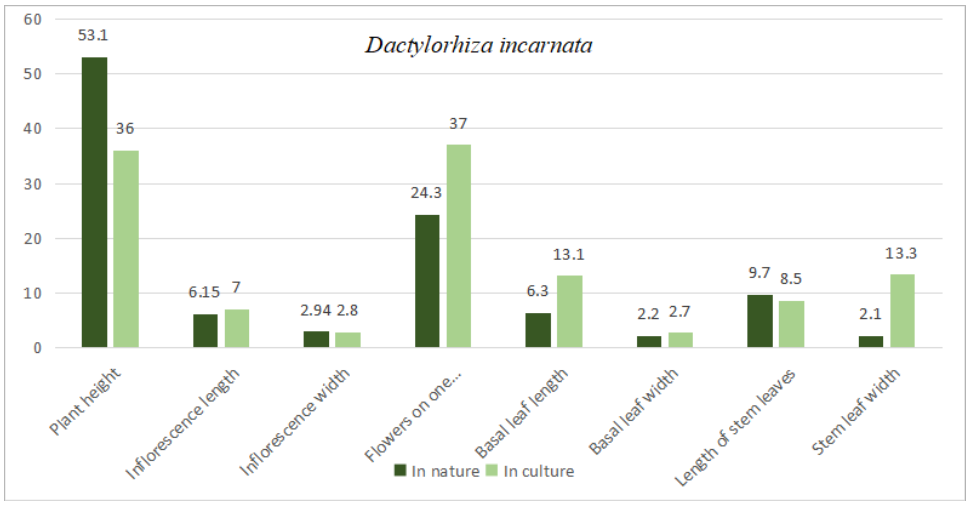


**Figure 4** – Indicators of *Dactylorhiza incarnata* in nature and during introduction.

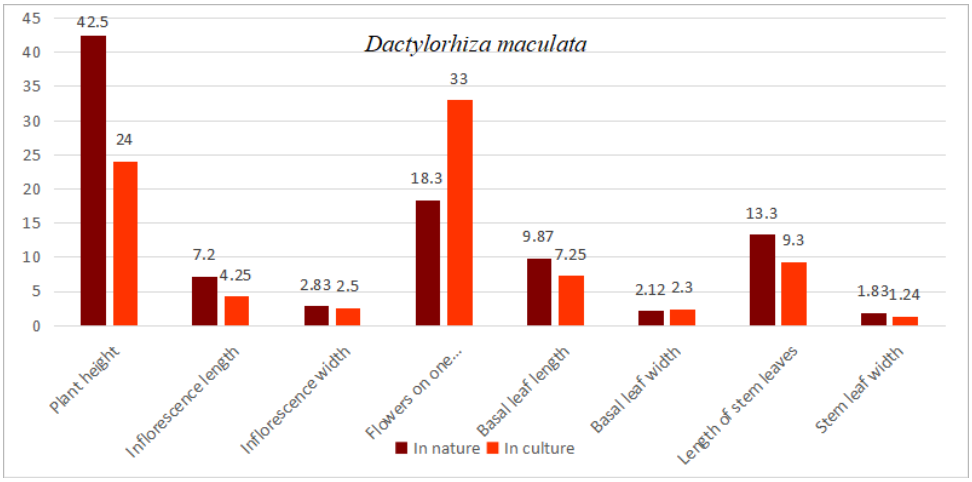


**Figure 5** – Indicators of *Dactylorhiza maculata* in nature and during introduction.

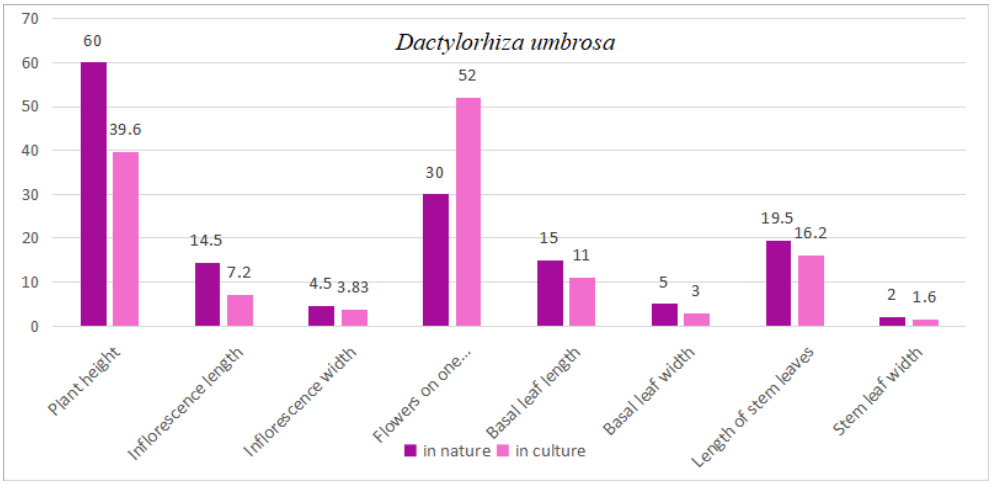


**Figure 6** – Indicators of *Dactylorhiza umbrosa* in nature and during introduction

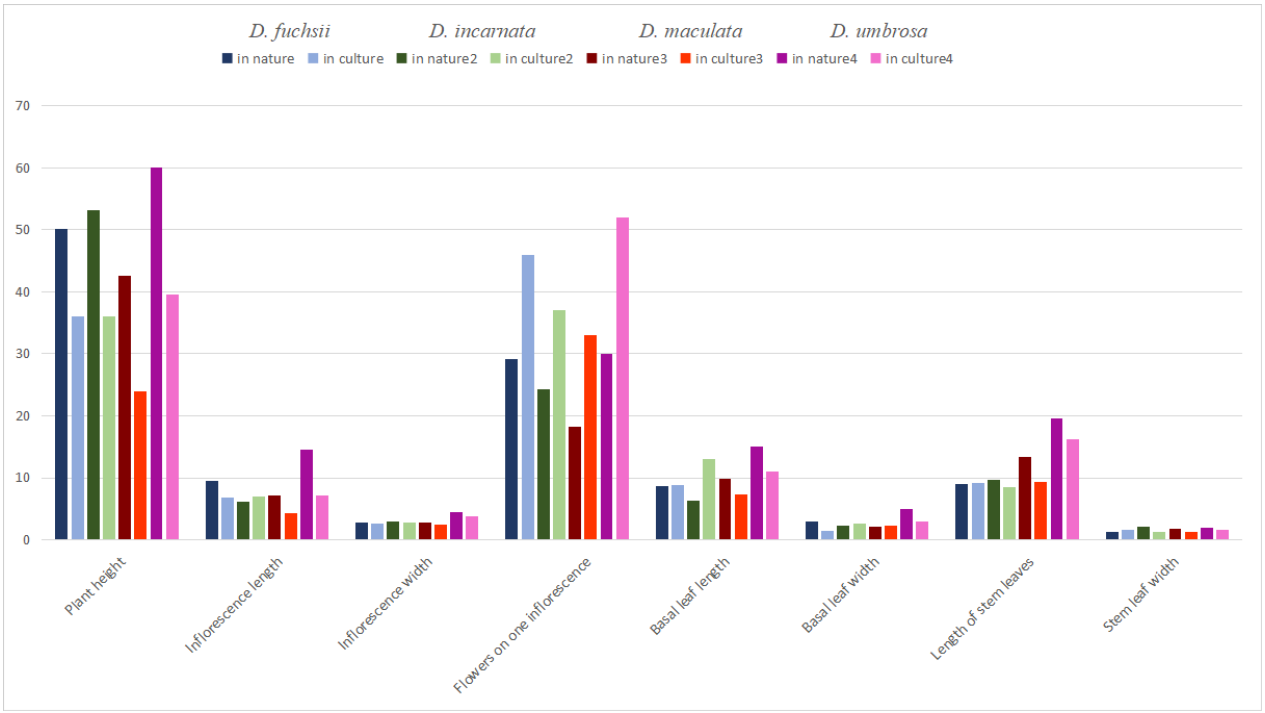


**Figure 7** – Comparison of indicators of all *Dactylorhiza* species

The main limiting factors for the dispersal of the species in natural habitats are high competition in phytocenoses, anthropogenic load, and strict ecological confinement. During introduction, the limiting factors are strong insolation, dry air, soil poverty and insufficient acidity.

For *D. fuchsii* and *D. maculata* species, direct sunlight and dry air is destructive. In nature, these species grow in thickets where the air is humid and direct sunlight does not enter. Due to the periodic weeding of the area *Dactylorhiza* species will decrease in height due to the abundance of sunlight. In nature, all soils are poor in nutrients. During introduction, the plants were planted in soils enriched with nutrients and minerals. This gave an impetus to increase the number of flowers per inflorescence, fruiting and productivity. The overall indicators are also decreasing due to dry air and insufficient irrigation. In the future, watering of this area will be intensified. A decrease of indicators *D. maculata*, *D. umbrosa*, and *D. incarnata* were noted due to insufficiently acidic soil. It is important to take into account the species plasticity. The species *D. incarnata* adapts well to the cultivation conditions.

Based on the obtained data, can be drawn the following conclusions:

1. Individuals of the species *D. incarnata* are plastic and adapt well to the culture conditions; they showed the best results in terms of introduction. Inflorescence length indicators increased by 14%, and the number of flowers per inflorescence by 52%. The length and width of basal leaves increased by 108% and 23%, respectively.

2. Individuals *D. umbrosa* showed poor results. Almost all morphometric parameters were reduced. An increase of 73% was only seen in the number of flowers per inflorescence. The rest of the indicators were reduced by an average of 29%.

3. The species *D. fuchsii* showed an increase in flowers per inflorescence by 57%; indicators of the length of basal leaves and the length of stem leaves remained almost unchanged, and the width of stem leaves increased by 23%.

4. Some indicators of *D. maculata* species have decreased significantly. The height of the plant decreased by 43%, the length of the inflorescence by 41%, the length of the basal leaves by 27% and the length of the stem leaves by 30%. And the number of flowers per inflorescence has increased by 80%. The width of the basal leaves increased slightly by 8%.

## Conclusion

Primary introduction of species of the genera *Dactylorhiza* in the Altai Botanical Garden resulted as stable collection of 4 species of the genera *Dactylorhiza*: *D. fuchsii*, *D. incarnata*, *D. maculata* and *D. umbrosa*. The species *D. incarnata* proved to be more plastic and adaptable to the cultivation conditions, the indicators of the length of the inflorescence, the number of flowers per inflorescence, the length and width of the basal leaves increased significantly. *D. umbrosa* reduced all parameters except the number of flowers per inflorescence. Due to the high nutritional content of the soil, the number of flowers per inflorescence increased in all 4 species. In addition, the indicator of plant height, due to the receipt of more sunlight decreased in all species.

The results of the study have of great importance for the development of introduction agricultural technology of rare and endangered plants in the mountain-taiga zone of East Kazakhstan, contribute to the preservation of biodiversity.

Due to the short-term observation, more detailed analyzes of the results will be obtained with the further continuation of the introduction experiment.

## Conflict of interests

All authors have read and are familiar with the content of the article and have no conflicts of interest.

## Source of financing

The article was prepared with the financial support of Science Technical Program “Development of scientific and practical foundations and innovative approaches to plant introduction in natural zones of Western and Eastern Kazakhstan for rational and effective use” of the Ministry of Education and Science of the Republic of Kazakhstan for 2021-2022.

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