Morphobiological features of *Dracocephalum krylovii* Lipsky in ex situ conditions in the Kuzbass Botanical Garden

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Abstract. One of the methods of preserving the natural gene pool is its ex situ cultivation. For the first time he results of evaluation of morphobiological features of Dracocephalum krylovii at introduction were obtained in the Kuzbass Botanical Garden. The period of flowering and the sum of positive temperatures above 0 °C, effective temperatures above +5 °C, active temperatures above +10 °C, necessary for such phenophases as regrowth, budding, flowering, fruiting were determined as well as the initial stages of Dracocephalum krylovii's development were studied. During the first year of growth of bions, latent and regenerative periods are distinguished. Under culture conditions an orthotropic elongated sprout is formed in the first year of life, the basal part of which is retracted into the soil and takes part in the construction of the underground perennial shoot structure

1 Introduction

Dracocephalum krylovii Lipsky is a perennial herbaceous long-rooted tap-shaped caudex plant of the *Lamiaceae* family [1].

A narrowly local endemic of Mountain Shoria area. This plant is common in Tashtagol city municipal district middle stream of the Mrasu River and some settlements like Sredny Chilei, Ust'-Anzas, Verkhny Anzas, Kolkhozny Karchit. It is considered to be a rare species and is listed in the Red Data Book (endangered-species list) of Kuzbass region and and Russia (Fig.1) [2].

The target of this work is to analyze morphobiological features and study the initial stages of ontogenesis of Dracocephalum krylovii in ex situ conditions in the Kuzbass Botanical Garden (KuzBG).

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Fig. 1. The spread of *Dracocephalum krylovii* Lipsky

2 Materials and Methods

The work had been carried out during 2009–2023 years on the territory of the Kuzbass Botanical Garden (Kemerovo) located in the northern part of the forest-steppe zone of Western Siberia. The climate of the research area is sharply continental with the average annual air temperature 0,9 °C. The highest air temperature is in summer (35...38 °C) and the lowest during the winter months (-57 °C). The first spring frosts generally occur from May 28 to June 11, the first autumn frosts fall on the periond from August 26 to September 14. Average annual precipitation is 450...500 mm. The height of snow cover – from 47 to 72 cm.

The rick collection funds of the KuzBG have served as the material for this study. Phenological observations of *Dracocephalum krylovii* had been carried out from 2009 to 2023 while the study of ontogenesis stages in KuzBG conditions began in 2022 and was conducted for the first time.

When studying the stages of Dracocephalum krylovii ontogenesis under the conditions of introduction, the concept of discrete description of ontogenesis was adopted [3]. Life form and shoot type at the initial stages of ontogenesis were determined according to Ivan Serebryakov [4], ornamental quality was assessed according to the methodology of testing in State breeding centres [5]. Phenological observations were carried out according to the methodology of phenological observations in botanical gardens [6]. The sum of positive temperatures above 0 °C, effective temperatures above +5 °C, and active temperatures above +10 °C was determined using methodological approaches [7]. Seed productivity of the species was evaluated using generally accepted methods [8, 9]. When evaluating the primary introduction a 100-point scale was used rating winter hardiness, resistance to diseases and pests, general condition of plants, methods of reproduction in culture, and plant development during the growing season. Low-promising species of less than 90 points, promising species of over 90 points and very promising species with 100 points [10], the character of phenorhythmotype was determined in accordance with the classification developed by I. Borisova [11].

3 Results and Discussion

During the study of growth and development phenorhythms it was found that the earliest spring regrowth of *Dracocephalum krylovii* occurred in 2012 and 2020, in the second part of April. During the regrowth period, the sum of positive temperatures is 342.5 ° C, effective – 328 ° C and active – 231.4 ° C.

The beginning of flowering occurs 42–51 days after regrowth. The earliest beginning of flowering was observed in 2020 with the sum of active temperatures equaling to 904.3°C (Table 1).

Duration of flowering is from 47 to 56 days depending on hydrothermal conditions, in warm and arid periods it is short, in humid periods it is longer (Table 2).

Fruit ripening lasts from 45 to 54 days. The earliest fruit ripening was observed in 2012 and 2020, in the second part of July. The sum of active temperatures made up 768.7°C.

The vegetation period ranges from 130 to 150 days. By the type of phenorhythmotype Dracocephalum krylovii belongs to the group of long-vegetative spring-summer-autumn-green plants with a period of winter dormancy.

Table 1. Average phenodata of Dracocephalum krylovii from 2009 to 2020

Beginning of regrowth	29.04±6
Beginning of flowering	05.06±5
End of flowering	26.07±1
Beginning of fruiting	23.06±5
End of fruiting	08.08±3
Beginning to die off	30.07±3
Die off	26.09±5

Table 2. Agroclimatic indicators of vegetation periods from 2009 to 2023

Year	Total precipitation, mm	Sum of temperatures above 10˚C	HTC	Characteristics of heat and moisture supply
2009	79,4	436,4	1,82	moist
2010	89,1	376,1	2,37	moist
2011	103,5	868	1,19	slightly arid
2012	99,2	1015,9	0,98	arid
2013	62,7	238,3	2,63	moist
2014	119,9	710	1,69	moist
2015	103,5	868	1,19	slightly arid
2016	63,6	812,3	0,78	arid
2017	145,7	938,1	1,55	moist
2018	58,7	658,9	0,89	arid
2019	86,8	854,2	1,02	slightly arid
2020	77,4	1028,0	0,75	arid
2021	119,9	710	1,69	moist
2022	60,4	771,3	0,78	arid
2023	93,8	750,2	1,25	slightly arid

HTC – Hydrothermal coefficient

Morphometric parameters of vegetative organs showed that the species in culture exceeds natural parameters: shoot length equals to 25-30 cm. The coefficient of variation of shoot height for 15 years was 7.4 %.

The maximum number of flowers in the inflorescence is 45–50 pcs with the maximum number of flowers in the inflorescence is 45–50 pcs. Duration of flowering of Dracocephalum krylovii is closely related to the number of flowers in the inflorescence and does not depend on plant height and flower diameter.

The indicator of flower productivity varies by years with the low flower productivity observed in warm arid growing season 2012, 2020, high was in slightly arid years of 2011, 2015, 2019, 2023 (Table 2). No flowering was observed in 2017.

According to the complex of ornamental traits it was found to be 96 points (Table 3).

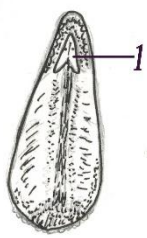
Table 3. Assessment of ornamental traits of *Dracocephalum krylovii* from 2009 to 2023.

Decorative features	K	Rating of ornamental traits on a 5/100 point scale
Flower coloration and its stability	3	5/15
Flower size	2	5/10
Flower shape	2	5/10
Aroma	2	4/4
Flower spike (length and strength)	1	4/4
Inflorescence (size, shape, number of flowers)	2	5/10
Abundance of blooms	2	5/10
Simultaneity of flowering (number of flowers opening simultaneously)	1	5/10
Plant habitus	1	4/4
Originality	3	5/15
Plant condition	1	4/4
Overall evaluation of the variety on a 100-point scale		96

K – significance coefficient

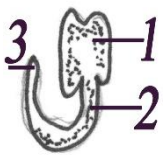
During the first year of development of individuals latent and pregenerative periods are distinguished. Stages of ontogenesis are shown in Figure 3.

Latent period. Seeds are black, black-brown, triangular, oblong, 3–3.5 mm long with a narrow wing-like outgrowth at the top (Fig. 2).



1 – elastosome

Fig. 2. Seed of *Dracocephalum krylovii:*



1 – cotyledons; 2 – hypocotyl; 3 – embryonic spine

Fig. 3. The embryo of the seed *Dracocephalum krylovii*:

The skin of the seed is rough covered with mucus when swollen. Under the skin there is a dark yellow endosperm with a dark brown furrow in the center. The embryo of the seed is represented by two cotyledons, hypocotyl, embryonic spine (Fig.3).

Sprouts. Seeds were sown in early May 2023. Sprouting is aboveground, sprouts are observed on the 5-7 days after sowing. Sprouts have two cotyledon leaves of oval shape, smooth-edged, with notched apex and kidney-shaped base, 4.5–5.0 mm long, 3.5–4.0 mm wide, on a petiole up to 10 mm long, pubescent. About 10-15 days after sowing, 2 round-ovoid green leaves develop on an elongated shoot, 1.5 mm long, 1.0 mm wide, pubescent with hairs, and arranged oppositely. Hypocotyl doesn't exceed 1.0 cm in length, glabrous. The zone of transition of hypocotyl to main root is well expressed. The main root is up to 2 cm long, 0.1 cm in diameter, branching up to 1 order. The duration of ontogenetic state is 10–15 days. By this time, the height of the aboveground part of plants reaches 2.5–3 cm.

Juvenile plant. In this state, up to 2–3 nodes with oppositely located petiolate leaves are formed on the main monopodial shoot. Leaf blade is eliptic with a crenate edges, increasing in size to 0.3 cm long and 0.2 cm wide, pubescent with hairs, petiole is 0.3 cm long. The lower leaves gradually die off. Buds set in the axils of the cotyledons and green leaves. The height of the shoot is 6 cm.

The root system elongates up to 7 cm. The main root pulls the hypocotyl into the soil due to contractile activity. The duration of the juvenile state averages to 15–20 days.

Immature plant. The main shoot ranges from 7 to 10 cm in length and the shoot develops up to 8–10 pairs of leaves. The leaf blade is wide-ovoid with visibly prominent veins. The leaf plate is 0.2 to 0.3 cm wide and 0.7 cm long. The main shoot branches to the 2nd order. After vegetation, the above-ground part of the shoot dies off. The preserved basal part of the shoot, the residue, is involved in the construction of the underground perennial shoot structure. The main root is spindle-shaped thickened, branching along its entire length up to the second order.

The vegetation of the first year of life plants end in the immature state (Fig.4).

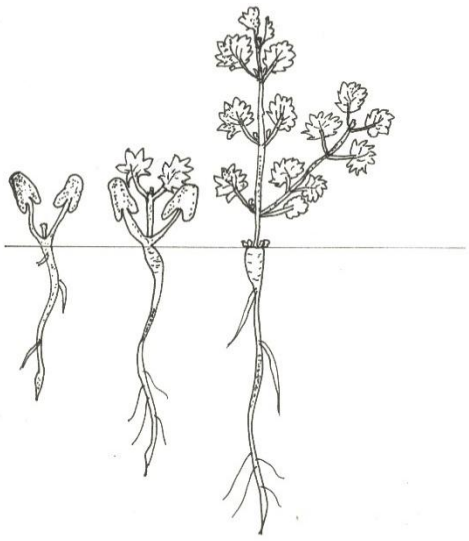


Fig. 4. Initial stages of ontogenesis of *Dracocephalum krylovii.*

4 Conclusion

Dracocephalum krylovii is a long-vegetating spring-summer-autumn-green plant with a period of winter dormancy. Under Kuzbass regional conditions it undergoes a full cycle of seasonal development. During the first year of development of individuals, latent and pregenerative periods are distinguished. Under the conditions of culture in the first year of life an orthotropic elongated shoot is formed, the basal part of which is retracted into the soil and takes part in the construction of underground perennial shoot structure. High ornamental qualities and stability in culture make it necessary to preserve and propagate it in *ex situ* conditions as a donor for use in reintroduction, breeding and landscaping of localities in Kuzbass region.

5 Gratitude

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