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Study of ontogenesis of *Scabiosa ochroleuca* L. in the conditions of the Central Kazakhstan

The article presents the results of the *Scabiosa ochroleuca* ontogenesis study under the conditions of the nature of the Central Kazakhstan. The study of this species is due to the need to use it as a source of biologically active substances and to determine the potential of introduction. 4 periods (latent, virginal, generative and senile) and 7 age states (resting seeds, seedlings, juvenile, immature, adult vegetative, generative and senile) are revealed. Morphological features of each period and state, degree of development of above-ground and underground organs, alternation of vegetation phases are determined. The duration of the ontogenesis cycle of *Scabiosa ochroleuca* in nature was 2 years, of which in the 1st year the plants took place in 150–176 days with coverage of the conditions of seedlings, juvenile and immature plants. For the 2nd year, the life cycle covered 137–151 days, during which periods of adult vegetative, generative and senile plants pass. Potential of introduction of *Scabiosa ochroleuca* in Karaganda region is determined.

Keywords: *Scabiosa ochroleuca*, ontogenesis, age period, age state, duration, introduction.

Introduction

One way to manage and conserve the natural resources of rare, endangered and endemic plant species is to introduce them into the culture. The introduction of species of natural flora provides extensive material for scientific research, primarily in the field of rhythms of ontogenesis. In *ex situ* conditions the researcher gets the opportunity to observe the dynamics of the development of individuals in their entirety, fixing the change in age states, which is very difficult when conducting such studies in natural conditions. Ontogenesis study makes it possible to assess plant development in different age phases, to determine vegetation duration, to assess climate effects on development of above-ground and underground organs in process [1, 2].

The genus *Scabiosa* L. is a genus of herbaceous, or semi-shrub plants of *Dipsacacese* family [3]. Representatives of this family are characterized by the presence of wrapper leaves, the cup is reduced to bristles.

There is practical interest for an introduction of *Scabiosa ochroleuca* L. Currently, the plant is used in folk medicine. Wound healing agents are made from it is used, in diseases such as hemorrhoids, skin rashes, warts, and female diseases [4]. There is potential application of herb of this species as anti-inflammatory, wound healing and antimicrobial agent [5–9].

Based on the above, the aim of the study was to investigate the stages of ontogenesis of *Scabiosa ochroleuca* in the conditions of the Central Kazakhstan.

Object and methodology

The object of the study was the seed material and *Scabiosa* plants from the natural populations.

Scabiosa ochroleuca is a biennial, less often perennial, herbaceous plants up to 50–75 cm tall, in culture they can reach a height of up to 130 cm. The rhizome is woolly, branchy, thickened in the neck. The stems are simple or branched at the top, pubescent with curly hairs in the upper and lower parts. Leaves of barren shoots on long petioles, whole, toothed, lyre-notched, lyre-pinnate-dissected. It blooms in July-October. It is frost-resistant, moderately drought-resistant [10].

The initial stages of the study were carried out at the research center of biotechnology and ecomonitoring of the Faculty of Biology and Geography of Karagandy University of the name of academician E.A. Buketov in 2019–2021. The remaining phases of ontogenesis were established on natural populations in Korneev forests (Bukhar-Zhyrau district of Karaganda region).

The seed material was divided into batches by size and weight (small, medium and large), measured with a ruler and germinated. Seed material was attracted from natural habitats: 1) Buiratau State National Natural Park, Karagash tract (Karaganda region); 2) vicinity of Karagaily village (Karkaraly district of Karaganda region); Karkaraly Mountains (Karkaraly District, Karaganda Region).

Periods of ontogenesis and determination of age states were carried out according to the methodological guidelines available in the literature [11–13]. Germination of seeds was determined according to the generally accepted method [14]. Experiments were laid in 4 times repetition, the germination energy was determined on the 6th day, germination — on the 30th day. Morphology of seeds and seedlings was examined on a binocular microscope MBS-1 in laboratory conditions with an increase of 40–80 times. The following parameters were measured: total height of plants, length of the epicotyls, length and width of the first leaf, length of the root system.

Results and discussion

In ontogenesis of *Scabiosa ochroleuca* is separated into 4 age periods and 7 age state (Table 1):

i) Latent, represented by resting seeds;

ii) Virgin, or pre-generative, period, in which the conditions of seedlings, juvenile, immature and adult vegetative plants are separated;

iii) Generative period, represented by state of generative plants;

iv) Senile period, represented by state of senile plants.

Latent period. *Scabiosa ochroleuca* seed with a pale yellow conical shape with a blunt nose and 6–8 clearly visible ribs (Fig. 1), 2.2–3.6 mm length and 1.5–2.1 mm wide; weight of 1000 seeds is 0.15–0.34 grams. On top, the seed is covered with a film coating forming a wavy crown with rigid bristles, the surface along the ribs is lowered by simple white trichomes.

The largest seeds are marked for the Karkaraly Mountains, the smallest — from the Buiratau National Park [15].

Figure 1. Internal view of *Scabiosa ochroleuca* seeds

This aspect can be explained by the fact that in the Karkaraly Mountains more mesophytic conditions are observed (more precipitation), which leads to a good development of plant morphology. In the Buiratau Mountains, the conditions are more xerophytic, so the size of the seeds is lower.

The germination rate of freshly harvested seeds ranged from 50.1 to 64.5 %, however, during storage, a gradual decrease was observed (Fig. 2). So, after 6 months of storage, there was a decrease in germination by 15 %, after 1 year — by 23 %, after 2 years — by 2.2 times. Total loss of germination is noted for seeds after 4 years of storage (Figure 2).

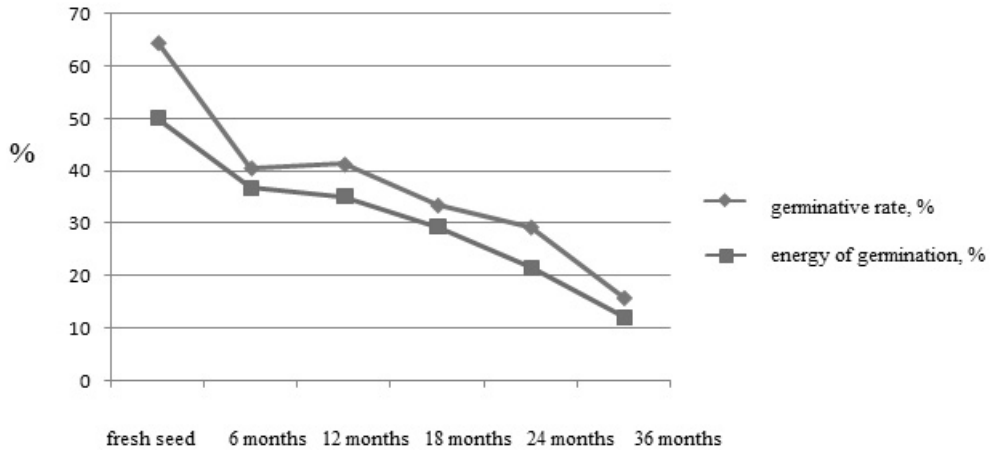

Figure 2. Germinative rate and energy of germination of *Scabiosa ochroleuca* seeds in process of storage

Table 1

Duration of major phases of *Scabiosa ochroleuca* ontogenesis in the Central Kazakhstan

№	Period	State	Duration of period / state
1	Latent	Resting seeds	From 6 months till 3.5 years
2	Virgin	Seedlings	30–35 days
3		Juvenile	35–40 days
4		Immature	85–92 days
5		Adult vegetative plants	42–46 days
6	Generative	Generative plants	75–80 days
7	Senile	Senile plants	20–25 days

Virgin period. *State of seedlings*. Seed germination begins on day 4–5 after planting on Petri dishes. When sowing in open ground, underground conditions, seedlings appear in the 1st — 2nd decades of May. The germ root appears first of the seed, 6–8 mm long and up to 0.5 mm in diameter. After one day, a hypocotyl appears, which makes a knee bend and carries out the cotyledons folded together. Cotyledon leaves open after 1–2 days. The prophet currently has a height of 1.5–1.8 cm, the root length is 2.5–4 cm; cotyledon leaves 1.4–1.8 cm long and up to 0.5–0.6 cm wide, narrowly elliptic in shape with a rounded base and a notched apex. After 14–20 days, the first pair of real leaves appears, obovate in shape, with a serrated edge.

Duration of state is 30–35 days.

Juvenile state. Plants pass into this age state after drying and dying of cotyledon leaves. As a result, a small rosette with 4–6 real leaves is formed (Fig. 3). The plant has a height of 2.5–3 cm, the length of the root system is 5.7 cm. Real leaves are sessile, up to 2.5 cm long and 1.5–1.8 cm wide.

Duration of state is 35–40 days.

Immature state. In immature plants, *Scabiosa ochroleuca* show the appearance in the rosette of leaves of lyre-cut leaves. The socket reaches a height of up to 4–5 cm, a diameter of 8–12 cm, a root system of the rod type, deepens by 14–18 cm, lateral roots of the 1st order appear. Leaf leaves up to 5–7 cm long and 2.5–3 cm wide, petiole 1.5–2 cm. In this phase, plants go under winter rest.

The duration of the state is 85–92 days.

Adult vegetative plants. Plant growth for the next year of vegetation begins in the 3rd decade of April — early May, depending on weather conditions. *Scabiosa* plants transition to an adult vegetative state. It is characterized by the formation of a basal rosette of leaves, consisting only of lyre-separate leaves, as well as the formation of a vertical shoot branching in the upper part. Leaves on the stem are lyre-dissected, opposite sessile, with thin linear lobes. The height of plants reaches 30–40 cm, diameter 8–15 cm, the number of real leaves exceeds 8–15. The root system is 23–30 cm deep, rod type; lateral roots of the 2nd order appear.

The duration of the age period is 42–46 days.

Figure 2. Internal view of seedlings of *Scabiosa ochroleuca*

Generative period. *Generative state*. In mid-June, the beginnings of head inflorescences begin to form on the tops of shoots, which marks the transition of the plant to the generative period. Simultaneously with the appearance of generative organs, further growth in heights and the formation of lateral shoots are observed (Fig. 3).

A B

Figure 3. Internal view of *Scabiosa ochroleuca* in generative period: A — phase of flowering, B — phase of fruiting

The blossoming phase falls on the 2nd decade of June — the beginning of July, single flowering — at the end of June, mass — 2–3 decades of July. Individuals can bloom until the end of August, which depends on habitat conditions and weather factors. In August, individual inflorescences pass to the fruiting stage, the mass phase of which falls on the end of August — beginning of September. With the beginning of fruiting in individuals, yellowing and wilting of leaves in the basal rosette are observed; plant growth is completely stopped. The height of plants by the end of the period reaches 50–75 cm, the number of inflorescences per 1st individual from 1 to 5 (7) pieces. The length of the root reaches 30–35 cm, the roots of 1–2 orders are marked.

The phase duration is 75–80 days.

Senile perios. *Senile plants*. After ripening and scattering, the seeds of *Scabiosa ochroleuca* plant pass into the senile period. There is a browning of above-ground organs, twisting of stem leaves. Vertical shoots with remnants of underdeveloped seeds remain. Dying plants in this form go away in the winter.

The duration of the condition is 20–25 days.

Thus, *Scabiosa ochroleuca* plants in the Central Kazakhstan undergo a full cycle of ontogenesis in two years, with the duration of ontogenesis phases for the 1st year of vegetation being 150–167 days, for the 2nd year — 137–151 days, which fully corresponds to the duration of the growing period of the Karaganda region.

Conclusion

Based on the results of observations, the main periods and states of ontogenesis of *Scabiosa ochroleuca* in the conditions of the Central Kazakhstan are determined. There are 4 periods (latent, virginal, generative and senile) and 7 age states (resting seeds, seedlings, juvenile, immature, adult vegetative, generative and senile) that take place in the 2-year period. In the first year of vegetation, the initial phases of ontogenesis take place in 150–167 days, in the 2nd year for a period of 137–151 days. Observation of the phases of ontogenesis shows the prospect of introducing the studied species of plant into the introduction experiment.

Reference

1 Павлова М.А. Особенности онтогенеза *Carex divulsa* Stokes в условиях культуры на юго-востоке Украины / М.А. Павлова // Промышленная ботаника. — 2014. — Вып. 14. — С. 174–180.

2 Ткаченко К.Г. Взаимодополняющие методы изучения и сохранения редких и полезных растений в условиях *ex situ* и *in situ* / К.Г. Ткаченко // Научные ведомости. Сер. Естественные науки. — 2010. — № 9 (80). — Вып. 11. — С. 25–32.

3 3 Бобров Е. Г. Род 1416. Скабиоза — *Scabiosa* L. / Е.Г. Бобров // Флора СССР. — М.–Л.: Изд-во АН СССР, 1957. — Т. 24. — С. 56–91.

4 Растительные ресурсы России: дикорастущие цветковые растения, их компонентный состав и биологическая активность. Т. 5. Семейство *Asteraceae* (*Compositae*). — СПб. – М.: Товарищество научных изданий МКМ, 2013. — 312 с.

5 Крупенникова В.Г. Фенолкарбоновые кислоты скабиозы венечной и скабиозы бледно-желтой / В.Г. Крупенникова, Г.М. Федосеева // Сиб. мед. журн. — 2007. — № 4. — С. 90–92.

6 Жунусова М.А. Фармацевтическая разработка лекарственных средств из растительного сырья *Scabiosa ochroleuca* L. и *Scabiosa isetensis* L.: дис. ... д-ра PhD / М.А. Жунусова. — Караганда, 2019. — 173 с.

7 Zhunusova M.A. Constituent composition and biological activity of CO_2-extracts of *Scabiosa isetensis* and *S.ochroleuca* / M.A. Zhunusova, E.M. Suleimen, Z.B. Iskakova, M. Yu. Ishmuratova, R.M. Abdullabekova // Chemistry of Natural compounds. - 2017. — Vol. 53, № 2. — P. 775–777. doi: 10.1007/s10600–017–2118–9

8 Kowalczyk A. Preliminary antifungal activity of some *Dipsacaceae* family plants / A. Kowalczyk, J. Krzyzanowska // Herba Polonica. — 1999. — № 45 (2). — P. 101–107.

9 Pinto D.C.G.A. *Scabiosa* genus: A rich source of Bioactive Metabolites / D.C.G.A. Pinto, N. Rahmouni, N. Beghidja, A.M. Silva // Medicines. — 2018. — Vol. 5. — Issue 4. — P. 110–120.

10 Флора Казахстана. — Т. 8. — Алма-Ата: Наука, 1965. — С. 271, 272.

11 Рекомендации по изучению онтогенеза интродуцированных растений в Ботанических садах СССР. — Киев, 1990. — 184 с.

12 Уранов А.А. Онтогенез и возрастной состав популяции / А.А. Уранов // Онтогенез и возрастной состав популяций цветковых растений. — М., 1967. — С. 3–8.

13 Кирик А.И. Онтоморфология растений. Курс лекций / А.И. Кирик, Е.С. Гегучадзе. — Воронеж, 2001. — 32 с.

14 Зорина М.С. Определение семенной продуктивности и качества семян интродуцентов / М.С. Зорина, С.П. Кабанов // Методики интродукционных исследований в Казахстане. — Алма-Ата: Наука, 1986. — С. 75–85.

15 Ishmuratova M. Yu. Study of peculiarities of morphology and germination of seeds of *Scabiosa ochroleuca* from the Central Kazakhstan / M. Yu. Ishmuratova, S.S. Tyrzhanova // Bulletin of the Karaganda University, series biology, medicine, geography. — 2020. — № 3 (99). — P. 75–82 doi: 10.31489/2020BMG3/75–82

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Орталық Қазақстан жағдайында *Scabiosa ochroleuca* L. онтогенезін зерттеу

Мақалада Орталық Қазақстанның табиғаты жағдайында (*Scabiosa ochroleuca)* скабиозының онтогенезін зерттеу нәтижелері келтірілген. Бұл түрді зерттеу оны биологиялық белсенді заттардың көзі ретінде қолдану және енгізу әлеуетін анықтау қажеттілігімен байланысты. 4 кезең (жасырын, виргинильді, генеративті және сенильді) және 7 жас жағдайы (демалатын тұқымдар, көшеттер, ювенальды, имматуральды, ересек вегетативті, генеративті және сенильді) анықталды. Әр кезең мен жағдайдың морфологиялық ерекшеліктері, жерүсті және жерасты мүшелерінің даму дәрежесі, вегетация кезеңдерінің ауысуы анықталды. Табиғатта онтогенез циклінің ұзақтығы Scabiosa ochroleuca 2 жыл болды, оның ішінде 1-ші жылы өсімдіктер 150–176 күн ішінде өскіндер, балауса және имматуралық өсімдіктер жағдайларын қамтыды. 2-ші жылы өмірлік цикл 137–151 күнді қамтиды, онда ересек вегетативті, генеративті және сенильді өсімдіктер кезеңдері өтеді. Қарағанды облысы жағдайында *Scabiosa ochroleuca*-ны жерсіндіруге енгізу әлеуеті анықталды.

Кілт сөздер: Scabiosa ochroleuca, онтогенез, жас кезеңі, жас жағдайы, ұзақтығы, интродукция.

С.С. Тыржанова, М.М. Силантьева

Изучение онтогенеза *Scabiosa ochroleuca* L. в условиях Центрального Казахстана

В статье представлены результаты исследования онтогенеза скабиозы *(Scabiosa ochroleuca)* в условиях природы Центрального Казахстана. Изучение данного вида обусловлено необходимостью его применения в качестве источника биологически активных веществ и определения потенциала интродукции. Выявлены 4 периода (латентный, виргинильный, генеративный и сенильный) и 7 возрастных состояний (покоящиеся семена, проростки, ювенильное, имматурное, взрослое вегетативное, генеративное и сенильное). Определены морфологические особенности каждого периода и состояния, степень развития надземных и подземных органов, чередование фаз вегетации. Продолжительность цикла онтогенеза в природе *Scabiosa ochroleuca* составила 2 года, из которых в 1-й год растения проходили за 150–176 дней с охватом состояний проростков, ювенильных и имматурных растений. На 2-й год жизненный цикл охватывает 137–151 суток, в которые проходят периоды взрослого вегетативного, генеративного и сенильного растения. Определен потенциал введения *Scabiosa ochroleuca* в интродукцию в условиях Карагандинской области.

Ключевые слова: *Scabiosa ochroleuca*, онтогенез, возрастной период, возрастное состояние, продолжительность, интродукция.

Reference

1 Pavlova, M.A. (2014). Osobennosti ontogeneza Carex divulsa Stokes v usloviiakh kultury na yugo-vostoke Ukrainy [Peculiarities of ontogenesis of *Carex divulsa* Stokes in the conditions of culture on south-east of Ukraine]. *Promyshlennaia botanika — Industrial Botany, 14*; 174–180 [in Russian].

2 Tkachenko, K.G. (2010). Vzaimodopolniaiushchie metody izucheniia i sokhraneniia redkikh i poleznykh rastenii v usloviiakh *ex situ* i *in situ* [Complementary methods of studying and preserving rare and useful plants in *ex situ* and *in situ* conditions]. *Nauchnye vedomosti. Seriia Estestvennye nauki — Scientific Statement, series natural science, 9 (80), 11*; 25–32 [in Russian].

3 Bobrov, E.G. (1957). Rod 1416. Skabioza — *Scabiosa* L. [Genus 1416. *Scabiosa* L.]. *Flora SSSR — Flora of USSR. Moscow – Leningrad: Izdatelstvo AN SSRS, 24*; 56–91 [in Russian].

4 (2013). *Rastitelnye resursy Rossii: dikorastushchie tsvetkovye rasteniia, ikh komponentnyi sostav i biologicheskaia aktivnost. T. 5. Semeistvo Asteraceae (Compositae) [Plant resources of Russian: wild flowering plants, their component compositions and biological activity. Vol. 5. Family Asteraceae (Compositae)*]. Saint Petersburg–Moscow: KMK [in Russian].

5 Krupennikova, V.G. & Fedoseeva, G.M. (2007). Fenolkarbonovye kisloty skabiozy venechnoii i skabiozy bledno-zheltoi [Phenolcarbonic acids of *Scabiosa comosa* and *Scabiosa ochroleuca*]. *Sibirskii meditsinskii zhurnal — Siberian Medicinal Journal,* 4; 90–92 [in Russian].

6 Zhunusova, M. A. (2019). Farmatsevticheskaia razrabotka lekarstvennykh sredstv iz rastitelnogo syria *Scabiosa ochroleuca* L. i *Scabiosa isetensis* L. [Pharmaceutical development of herbal drugs *Scabiosa ochroleuca* L. and *Scabiosa isetensis* L.]. *Thesis PhD*. Karaganda [in Russian].

7 Zhunusova, M. A., Suleimen, E. M., Iskakova, Z. B., Ishmuratova, M. Yu. & Abdullabekova, R.M. (2017). Constituent composition and biological activity of CO_2-extracts of *Scabiosa isetensis* and *S.ochroleuca*. *Chemistry of Natural compounds, 53, 2*; 775–777. doi: 10.1007/s10600–017–2118–9

8 Kowalczyk, A. & Krzyzanowska, J. (1999). Preliminary antifungal activity of some *Dipsacaceae* family plants. *Herba Polonica, 45 (2*); 101–107.

9 Pinto, D.C.G.A., Rahmouni, N., Beghidja, N. & Silva, A. M. (2018). *Scabiosa* genus: A rich source of Bioactive Metabolites. Medicines, 5 (4); 110–120.

10 (1965). *Flora Kazakhstana [Flora of Kazakhstan]*. Vol. 8. Alma-Ata [in Russian].

11 (1990). *Rekomendatsii po izucheniiu ontogeneza introdutsirovannykh rastenii v botanicheskikh sadakh SSSR [Recommendation for study of ontogenesis of introduced plants in botanical gardens of USSR]*. Kiev [in Russian].

12 Uranov, A.A. (1967). Ontogenez i vozrastnoi sostav populiatsii [Ontogenesis and age composition of populations]. *Ontogenez i vozrastnoi sostav populiatsii tsvetkovykh rastenii — Ontogenesis and age composition of populations of flower plants*, Moscow [in Russian].

13 Kirik, A.I. & Geguchadze, E.S. (2001). *Ontomorfologiia rastenii. Kurs lektsii [The Plant Ontovorphology. Cources of lectures]*. Voronezh [in Russian].

14 Zorina, M.S. & Kabanov, S.P. (1986). Opredelenie semennoi produktivnosti i kachestva semian introdutsentov [Determination of seed productivity and quality of seeds of introduced plants]. *Metodiki introduktsionnykh issledovanii v Kazakhstane — Methodology of introduction research in Kazakhstan*. Alma-Ata: Nauka [in Russian].

15 Ishmuratova, M. Yu. & Tyrzhanova, S. S. (2020). Study of peculiarities of morphology and germination of seeds of *Scabiosa ochroleuca* from the Central Kazakhstan. *Bulletin of the Karaganda University, series biology, medicine, geography, 3 (99)*; 75–82 doi: 10.31489/2020BMG3/75–82