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ADAPTIVE MECHANISMS OF CONSERVATION POPULATIONS OF RARE AND ENDEMIC SPECIES OF *KAMELINIA TIANSCHANICA* F.O. KHASS & I.I. MALZEV IN UZBEKISTAN

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Abstract

The current paper presents a data on the adaptation mechanisms of populations of an endemic species *Kamelinia tianschanica* F.O. Khass. & I.I. Malzev under conservation status. With this example we tried to highlight the adaptation mechanism in conservation populations of plant species in Uzbekistan, a country rich in endemic genera especially from Umbelliferae (Apiaceae Lindl.). The rare species *Kamelinia tianschanica* belongs to the respective endemic genus of Central Asia. We studied the features of morphogenesis and ontogenetic structure of populations, and the current state of *Kamelinia tianschanica* populations was estimated based on a set of factors. Ontogenetic stages are allocated. According to the results of our work, the ontogeny of the species can be divided into 3 periods and 7 age stages, characterized as shortened due to the elimination of a senile age stage and complicated by the presence of renewal shoots, allowing vegetative reproduction. The long duration of the middle-aged generative stage leads to rapid death and thus elimination of a senile period. Ramets lead to the shortening of the juvenile stage of development. The spectrum of populations with regard to the ontogenetic structure is left-sided, centered on virginal individuals, with the highest proportion of middle-aged generative individuals. In the studied populations, young plants (juvenile, immature) make up the smallest number, due to various factors of elimination, including irregular seed propagation. Adaptive conservation mechanisms include planting of some vegetative propagated individuals in the population to foster reproduction of *Kamelinia tianschanica*. Additionally, the location of a population's natural area is an important factor for the conservation of the species.

Key words: Ontogeny, Ontogenetic stages, Population, Ramets, Endemic, Western Tien Shan.

Introduction

For a broad comprehension of the adaptation strategy of species in various ecological groups of plants, it is necessary to study the issues of plant biology, where one of the leading aspects is the diversity of life forms (Dubrovnaya & Husnetdinova, 2015; Zhukova *et al*., 2015).

Data on the specifics of individual plant development contribute to a comprehensive understanding of plant morphological adaptations. The adaptation of species populations is largely affected by the morphological plasticity of the species, and the spatial position of the shoot system, and their growth and development depend on external conditions. Any adaptations of morphological adaptation are associated with the inclusion of many cellular and intracellular regulation systems, which allow morphological adaptations as a "product of physiological adaptation" (Polevoy, 1989).

Currently, in order to monitor changes in the environment, the study of rare and endangered plant species is particularly relevant (Cigala *et al*., 2018; Julien *et al*., 2022; Wu *et al*., 2022). A qualitative assessment of environmental features and the study of the biology of individual rare species at the population level are urgently needed. The development of a population's ontogenetic direction has shown that a research of population biodiversity is impossible without a detailed description of the complete ontogenesis of individuals or ramets for any plant species (Zhukova, 2001; Komarov *et al*., 2003; Osmanova *et al*., 2006; Zhukova, 2012; Rosseto *et al*., 2013; Gosney *et al*., 2014; Ochoa-López, *et al*., 2015; Zhukova *et al*., 2015; Evstigneev & Korotkov, 2016; Kirichok, 2016; Martínková & Klimešová, 2017; Sousa-Baena *et al*., 2018; Talovskaya, 2018; Belyakov & Lapirov, 2019). Population-based ontogenetic approaches identify the main patterns of structure and organization of populations, to understand the adaptation mechanisms and population dynamics of individual species, and to develop conservation and restoration efforts under increasing anthropogenic pressure (Ishbirdin & Ishmuratova, 2004; Ishbirdin & Ishmuratova, 2009).

Fardeeva (2016) developed a concept of species-specificity corresponding to the biological and ecological characteristics of a species based on the study of the spatial-ontogenetic structure of populations of tuberoid orchids. It was concluded that the ontogenetic structure of tuberoid orchids had broad diagnostic functions and could be used to analyze populations of plant species with a similar type of ontogenesis, life forms, strategies, distribution and mechanism of spatial growth of shoots. Their chemical structure also changes during the ontogeny of plants. According to other research, the foliar metabolome, the suite of small-molecule metabolites located in the leaves of tropical tree species, changes during leaf ontogeny under the influence of jasmonic acid as signaling molecule (Sedio *et al*., 2019).

Published data on the ontogeny and ontogenetic structure exist only for few Umbellifers from Northern latitudes, but most endemic relict species of Central Asia have so far been understudied (Vasilieva & Lashchinsky, 1987; Volkova, 2000; Volkova, 2001; Ermakova, 2000; Podgaevskaya, 2002; Pershina, 2006; Rakhimov, 2007; Astashenkov, 2008; Astashenkov, 2010; Petrova, 2016).

In Umbelliferae like *Heracleum sibiricum* L. (Ermakova, 2000) and *Bupleurum aureum* Fisch. ex Hoffm. (Podgayevskaya, 2002), belonging to different life forms, 10 - age stages were identified in ontogeny. Studying the ontogeny of *Bupleurum scorzonerifolium* Willd. and *B. sibiricum* Vest. in Eastern Transbaikalia, it was found that it included 4 periods and 8 ontogenetic stages (Pershina, 2006). According to Astashenkov (2010) the coenopopulations of *Bupleurum scorzonerifolium* in Transbaikalia were normal, mature with simple ontogeny, incomplete (no individuals of senile stage), and lasting not more than 12 years. The ontogeny of *Conioselinum tataricum* Hoffm. was found to be full or incomplete, with a long pre-generative period, without mechanisms for density stabilization and not adapted to the natural, cyclic dynamics of dark forests, forming coenopopulations of mainly the normal type, with various ages, and low density (Volkova, 2001, 2011). For some representatives of the semi-savanna flora of the Western Pamir-Alai, the ontogeny has also been studied, including some species from the family Umbelliferae. The ontogeny of *Ferula foetidissima* Regel & Schmalh. for example, shows absence of a post-generative period (Rakhimov, 2007).

The genus *Kamelinia* F. O. Khass. et I. I. Malzev was described by Khasanov and Malzev in 1992. *Kamelinia tianschanica* is a perennial polycarpic species, a national endemic to Uzbekistan, and a narrow-local endemic of the Western Tien Shan. It is included in the Red List with status 1, defined as rare, vulnerable, and in need of protection (Pimenov, 2009). Published data on the biomorphological features of *Kamelinia tianshanica* have so var not been available. Morphological and anatomical structure of underground organs of *Kamelinia tianshanica* and its closely related species *Korshinskya olgae* (Regel & Schmalh.) Lipsky were studied by Khamraeva (2019).

The purpose of our research was to study ontogenesis and ontogenetic structure of populations of *Kamelinia tianshanica* to identify the main adaptive mechanisms of the species.

Material and Methods

Kamelinia tianshanica grows on stony screes of the southern slope in the Tien-Shan, at altitudes of 1600–1700 m above sea level. It blooms from mid-May to mid- June, and fruits from late June to mid-July.

The studied populations of the species are located in the Ugam-Chatkal National Park of the State Forestry Committee of the Republic of Uzbekistan. Geobotanical descriptions are made in two populations, where the population structure of the species was studied. To study the age composition of populations, transects were laid in natural habitat, each with 5 transects, 10x1 m^2 in size, where systematic observations of different-aged individuals were taken in 2018–2019.

Research and collection of material were conducted in natural growth areas in 2014–2015 and 2018–2019. The development of individuals and the ontogenetic structure of populations of *Kamelinia tianschanica* was studied using Rabotnov (1950), Uranov (1975), Uranov & Serebryakova (1976). The ontogenetic structure of populations (P) was defined as the ratio of different ontogenetic groups in a population. The absolute maximum ontogenetic group classifications proposed by Uranov & Smirnova (1969) were used to characterize such populations. The evaluation of the ontogenetic structure was determined by Uranov (1975), according to which the age was indicated by the "delta" index (Δ) and supplemented with this rating by the "omega" (ω) index as the average energy efficiency or energy load on the medium exerted by the "average" plant (Zhivotovsky, 2001). We followed Odum (1986) for indicators of ecological density. The ontogeny scheme was analyzed using the method proposed by Zhukova (1983).

Qualitative and quantitative indicators in individuals were examined in ontogenesis at different age stages. The attribution of plants to a particular ontogenetic stage was made on the basis of a set of qualitative characteristics (Uranov, 1975). While identifying ontogenetic stages, it is particularly important to study the specific structure of the leaf: the presence or absence of a sheath and petiole, shape, size and degree of dissection of the leaf blade, and underground organs: branching, size, color, formation, development and death of the root system (Savinykh & Cheremushkina, 2015; Zhukova, *et al.* 2015). Five plants were chosen for biometric characterization of individuals at different ontogenetic stages.

Results

Ontogeny–Latent period: The mature fruit of *Kamelinia tianschanica* was 3–3.5 mm long, endosperm covers the most part of it. The embryo was straight, about 0.8–0.95 mm long, located in the upper part of the seed differentiated into a slightly elongated axial part and two cotyledons.

The pre-generative period seedlings: Under natural conditions, seedlings appear in early April (Fig. 1a; Fig. 2a, b). Germination was hypocotylar. Cotyledons were on a thin elongated petiole, 10–14 cm long, plate glabrous, lanceolate with blunt apex 3-4 mm long, 0.7–0.8 mm wide. The seedling had one sessile three-lobed leaf up to 0.8 mm long and 0.3–0.4 mm wide (Fig. 2a). The hypocotyl was thickened, 7–9 mm long, the main root 30–35 mm long, with numerous small lateral roots (Fig. 2b).

Juvenile plants: From the end of April, the juvenile phase of development started. Plants had a rosette shoot with one leaf on a thin, long stalk. In the initial phase the leaf blade was 1.2–1.3 mm long, 1.5–1.7 mm wide, in outline broadly triangular, 3-dissected, the lobes were deeply 3-divided, the sheath was narrow (Fig. 1b, c; Fig. 2c, d). The hypocotyl was radish-like-thickened, 0.9-1.0 cm in length, the main root was clearly visible among the thin first and subsequent orders of lateral roots (Fig. 2e). At the end of the first year of the juvenile phase of development, the hypocotyl also become radish-thickened, 1.0–1.2 cm long. The main and side roots were weakly branched and penetrated the soil shallowly, the main root was slightly thickened than the lateral roots. In this age stage, plants remain throughout the first growing season and retired at the end of June.

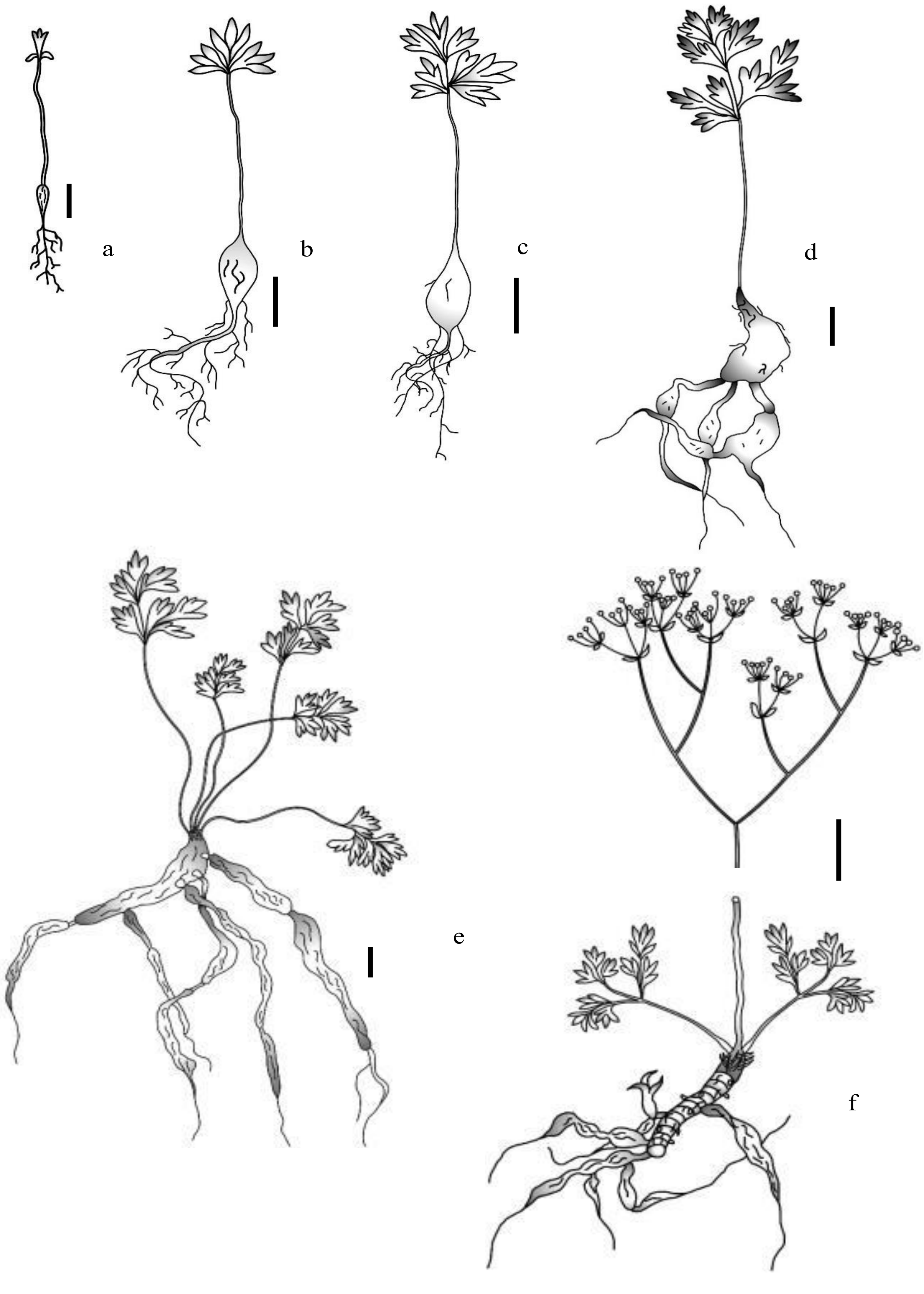

Fig. 1. Different-age individuals of *Kamelinia tianschanica*.
a – seedling, b – juvenile plant of the life's first year, c – juvenile plant of the life's second year, d - immature plant, e – virgin plant, f – generative plant.

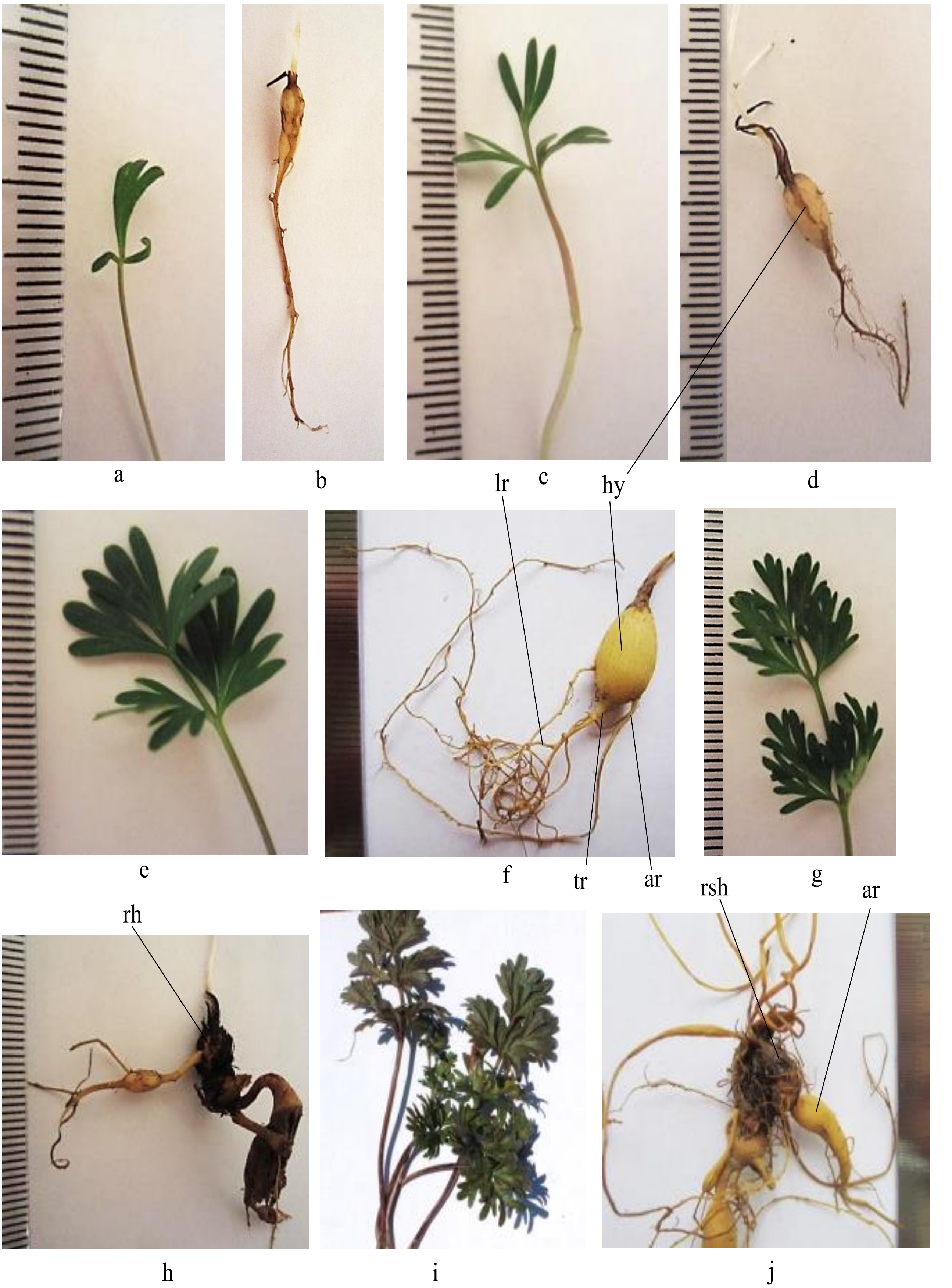

Fig. 2. The structure of *Kamelinia tianschanica* individuals of different ages.
a–b – general view of the aerial and underground parts of the seedling; c–d – a general view of the aboveground and underground parts of a juvenile plant of the life's first year; e–f – a general view of the aboveground and underground parts of a juvenile plant of the life's second year; g–h – a general view of the aboveground and underground parts of an immature plant; i–j – a general view of the aboveground and underground parts of a virgin plant.

In the second year of their development the juvenile plants developed a leaf blade of 1.9–2.1 cm long, up to 2.2 cm wide, rounded to round-oval in shape, twice ternary dissected, two-three-lobed, obtuse, with narrow sheath (Fig. 2e). The hypocotyl gradually increased in size, as it grew in early June, it became oval-thickened, 1.2–1.5 cm in length, with adventitious roots. The main root was not particularly distinguishable among lateral and hypocotyls adventitious roots (Fig. 2f). The tap root, lateral and adventitious roots were branched bearing some groups of thin short ephemeral roots (Fig. 2d, f).

Immature plants: Plants entered this phase of development from the second or third year of life, and the rosette shoot had monopodial growth. Leaves up to 4 formed in the rosette, long petiolate, with a narrow sheath, leaf blade ovate 2.5–3 cm long, up to 1.5 cm wide, , twice pinnate dissected, lobes two-three-lobed, obtuse (Fig. 1d; Fig. 2g, h).

In the immature phase of ontogeny in plants in the underground sphere, an orthotropic shortened wrinkled epigeogenic rhizome appeared, up to 1.5 cm long, which was formed due to the basal, recessed sections of the annual growths of the main shoot, covered with fibrous bases of last year's dead leaves (Fig. 2h).

In the axil of one of the first leaves, there appeared usually a renewal bud. The rhizome was cylindrically thickened, winding, the thickened adventitious roots, developed from it. At the end of the first year of the immature phase of development, the main root died. The immature stage lasted from 1 to 3 years.

Virginile plants: Plants retained a monopodial growing rosette shoot bearing up to 6 leaves (Fig. 1e; Fig. 2i, j). Petiole thin; 10–17.5 cm long, with narrow sheath. The leaf plate was twice-thrice pinnately dissected, ovate or broad-ovate in shape, 3–3.5 cm long.

The rhizome was light brown with pronounced annular protrusions corresponding to the nodes of last year's growths of the monocarpic shoot. On the rhizome, starting from the stage of the immature development of ontogeny, traces of the remains of the sheaths of last year's rosette leaves were visible in the form of annular scars, indicated the age of the plants. Rhizome unevenly cylindrically thickened, vertical or winding. In some individuals, as the plant developed, the distal part of the rhizome was deformed due to compression of stony rocks or damaged by various pests.

The adventitious roots on the rhizome did not have a strict character of regrowth and the branches could develop vertically and horizontally. They were few in number, had a narrowed, unevenly cylindrically thickened and elongated refined parts growing from the rhizome. The bark of the adventitious roots was fawn in color, thinner, easily peeling off. There were thin hairy roots in the form of brown wavy lines on the surface of the rhizome and adventitious roots. In addition, bunches of thin, hairy, short and short-lived ephemeral roots were also formed. At this period of plant development, renewal shoots up to 3 in number developed from the dormant buds of the rhizome. These rooted daughter individuals in case of death of the maternal plant reproduce vegetatively, there by preserving the existence of the species in nature (Fig. 2j). Individuals of vegetative reproduction did not have a juvenile stage of development of ontogeny, but began with an immature one, since their most thickened root system had enough nutrients in comparison with the plants developed from seeds. The virginal stage lasts from 2 to 5 years.

Generative period young generative plants: Plants started reproduction at the age of 8–10 years, sometimes even later. Only one generative shoot was the only one, half-rosette, up to 45 cm tall, branched up to 3 orders of panicle with closed double umbels; the 2–3 internodes were shortened, the rest were more elongated, with gradually decreasing leaves. Stem violet with 3–4th internodes. Basal leaves were 4–5 and The middle leaves were 3–4, petiolate, twice-thrice pinnate dissected, with an ovoid or wide ovate plate; the upper leaves were simple, sessile.

The roots consist of a vertical or tortuous, epigeogenic short rhizome, with dormant buds and renewal buds, as well as cylindrically thickened adventitious roots of the first order of branching, rarely of the second order, including 1 or 2.

Middle-aged generative plants: The plant was perennial polycarpic with polycyclic semi-rosette monocarpic shoots up to 30–65 cm tall, 3-4 times branches of the panicle type of closed double umbels (Fig. 1f, Fig. 3a, b). The stem is bent-curved, fine-ribbed, rounded at base, hollow, with 4–8 (10) internodes. Leaves twice-thrice pinnate dissected. Basal leaves 4–8, on long thin petioles, 10–18 cm long, the basal part of which was whitish-green and medium brown-crimson, with amplexicaul sheath and membranous edges pressed to the stem; leaf plate 6–6.5 cm long, ovate or broad ovate in outline; end segments 5–7 mm long, lanceolate-oval or obovate, sessile, obtuse or in the middle leaves sharp, undivided or two -, three-lobed. The cauline leaves were 3–4 in number, shortly petiolate or sessile, with a gradually simplified plate 2–2.5 cm long, up to 1 cm wide, with membranous edges and short sheaths. The upper leaves are sessile, up to 2 cm long, 3- lobed, and sheath was narrow with membranous edges. Covering leaves of lateral shoots of the higher orders were opposite.

In generative plants, underground organs consist of a vertical epigeogenic short rhizome and numerous adventitious roots forming a secondary homorizic root system. The rhizome was cylindrically thickened, sometimes winding, from 5 to 15 cm long; the bark was light brown in color. The adventitious roots branched up to 2 orders.

In the adventitious roots of the first order, the thickened part was 4–14 cm long, small roots of the second order were 2–5.5 cm in the thickened part. In the refined part, the adventitious roots grew to 10–20 cm in length, sometimes bifurcated. Bunches of thin, hairy, short and short-lived ephemeral roots develop on the adventitious roots. The process of decay was visible on some adventitious roots, or they were damaged by insect larvae. At this life cycle some individuals irregularly developed flowering shoots, temporarily non-blooming, probably due to the life strategy of the species and accumulation of storage substances in underground organs reserved for next flowering. Based on long term field observations, the duration of the regenerative and generative periods of life in plants was about 17–22 years.

Fig. 3. Middle-aged generative plant *Kamelinia tianschanica*.
a – general view of the aboveground part, b – general view of the underground part.

Ontogenetic structure: The first population (P-1) was recorded in the southern end of the Chiltenboa Range (a spur of the Chatkal Range), in the Chilten tract, at an altitude of 1600–1650 m above sea level (N 41.09.2987, E 70.05.1577). The slope steepness was 20^0–25^0, the soil was stony scree, with sufficient humidity. *Impatiens parviflora* DC and *Eremurus turkestanicus* Vved. predominated in the plant community. The herb cover amounted to 35–45%. The density of individuals of the studied species was 3-4%. The community was composed of 17 species of vascular plants belonging to different biomorphs. The degree of participation is indicated by the Drude 7-point system.

The second population (P-2) was found on the northeastern exposition, in the Kattasay tract (locus classicus), at an altitude of 1650–1700 m above sea level (N 41.14.833, E 70.12.585). The relief was steep rocky-gravelly slopes (40^0–45^0), the soil stony scree, which quickly dried due to the open slope. The dominant species of the community were *Eremurus regelii* Vved. and *Cerasus erythrocarpa* Nevski. The total cover of herbs did not exceed 40%, and the share of the studied species was again 3–4%. The community consisted of 22 species of vascular plants, most of which were herbaceous (Table 1).

The ontogenetic structure of the populations of *Kamelinia tianshanica* had not been studied previously. According to the classification of Uranov & Smirnova (1969), the populations of *Kamelinia tianshanica* is normal, incomplete.

In the first population, the ontogenetic structure was of the left-sided type, with an absolute maximum in individuals of the virginal age stage – 55.62 %. The second population was of the centered type, with an absolute maximum of individuals of the middle-aged generative stage – 40.29% (Fig. 4; Table 2).

Evaluation of the age (Δ – delta) and efficiency (ω – omega) of populations showed that one of the examined populations was young ($\Delta = 0.18$; $\omega = 0.5$), and the second population was maturing ($\Delta = 0.28$; $\omega = 0.66$) (Fig. 5). The density of individuals in the studied populations was low and fluctuated slightly, on average from 1.35 to 3.11 ind./m^2, ecological density from 1.8 to 3.88 ind./m^2 (Table 3).

Discussion

A result of our study on the ontogeny of *Kamelinia tianschanica,* we found that the species does not completely pass all the stages of ontogenesis, often skipping the post-generative period. The presence of a leaf in the seedling was noted, which was typical for other representatives of the Umbelliferae. According to published data, some members of Umbelliferae such as *Laserpitium latifolium* L., *Pimpinella saxifraga* L. (Petrova, 2016), as well as *Acronema commutatum* H. Wolff (Plunkett *et al.*, 2018), also had a single leaf in seedlings besides seed cotyledons.

Table 1. Characterization of plant communities with the participation of *Kamelinia tianschanica*.

Scientific name	Life form	Projective cover, %	
		P-1	P-2
Allium karataviense Regel	Perennial	sol	sol
Allium jodanthum Vved.	Perennial	-	sp^1
Alyssum stenostachyum Botsch. & Vved.	Annual	sol	sol
Bromus oxyodon Schrenk	Annual	sol	sol
Bromus tectorum L.	Annual	sp^1	sp^1
Centaurea squarrosa Willd.	Biennial	-	sp^1
Cerasus erythrocarpa Nevski	Shrub	-	sp^3
Convolvulus arvensis L.	Perennial	sp^3	-
Cousinia umbrosa Bunge	Perennial	sol	sol
Eremurus regelii Vved.	Perennial	-	cop^1
Eremurus turkestanicus Vved.	Perennial	cop^1	-
Ferula penninervis Regel & Schmalh.	Perennial	sp^2	sp^2
Ferula tenuisecta Korovin	Perennial	sp^1	sp^1
Filago arvensis L.	Annual	-	sol
Galium spurium L.	Annual	sp^1	-
Hordeum bulbosum L.	Perennial	sp^1	sp^1
Hyssopus serawschanicus (Dubj.) Pazij	Semi-shrub	sp^1	-
Impatiens parviflora DC.	Annual	cop^2	sp^1
Juniperus seravschanica Kom.	Tree	-	sol
Phleum phleoides (L.) H. Karst.	Perennial	-	sol
Poa bulbosa L.	Perennial	sol	sol
Poterium polygamum Waldst. & Kit.	Perennial	sol	sol
Silene brahuica Boiss.	Perennial	sol	sol
Thalictrum isopyroides C.A. Mey.	Perennial	-	sol
Torilis leptophylla (L.) Rchb. f.	Annual	-	sol
Tulipa vvedenskyi Botschantz.	Perennial	sp^1	sp^1

Note: sol – single, sp^1 – sporadic, sp^2 – rather rare, sp^3 – midding, cop^1 – often, cop^2 – very often

Table 2. Distribution of individuals by age groups, (%).

N/population	*j*	*im*	*v*	*g1*	*g2*	*s*
1	3.21	14.14	55.62	10.61	16.39	0
2	2.23	13.42	29.85	14.17	40.29	0

Table 3. Demographic characteristics of populations of *Kamelinia tianschanica*.

N/population	Total number	Average density individuals/m^2	Ecological density individuals/m^2	ω	Δ	Type of CP
1	311	3.11	3.88	0.5	0.18	Young
2	134	1.35	1.8	0.66	0.28	Maturing

Note: Δ – the age index, ω – the efficiency index

The populations of *Kamelinia tianshanica* had a low proportion of juvenile and immature plants. Perhaps the germination was low due to the presence of a large number of underdeveloped or germ-free fruits, irregular seed renewal, low germination rate, and the asynchrony in the rate of development of young individuals, which was typical for most Umbelliferous species (Volkova, 2000; Astashenkov, 2008). Sometimes some factors (collapse of rocks, washing away by strong torrents of rain) were the reasons for low number of seedlings. In *Kamelinia tianshanica*, the formation of renewal shoots (daughter individuals) from dormant buds on the rhizome serves to self-support populations by vegetative propagation. In vegetative individuals (ramet), there was an abbreviation of the juvenile ontogenetic stage. Due to a long stay in the middle-aged generative stage, individuals died off quickly, eventually leading to the fall of the senile ontogenetic stage.

Two types of ontogenetic spectra were recognized on the basis of the above biological features of *Kamelinia tianshanica*: left-sided, in the first population (P-1) and centered type in the second population (P-2).

In the first population the predominance of virginal individuals (P-1) was associated with an increased role of the vegetative method of reproduction a mechanism for compensating for low seed productivity, as well as the longest life span of plants in this age stage compared to other age groups of the pre-generative period in the left part of the spectrum. With sufficient soil moisture in P-1, the available proportion of juvenile individuals was more protected from anthropogenic load (lack of livestock grazing and paths laid by the local population) and wind erosion, but their minor elimination occurred with the flushing of plants of this fraction during mudflows and the root system was damaged by pests.

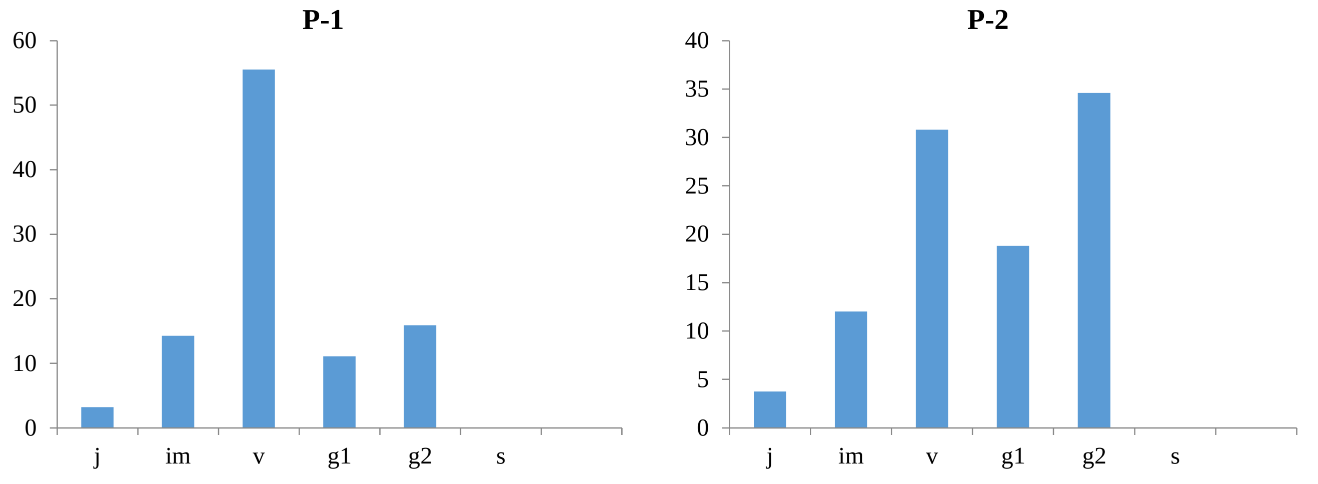

Fig. 4. Ontogenetic spectra of populations of *Kamelinia tianschanica*. Legend: X axis – ontogenetic stages; Y axis – percentage; P – population.

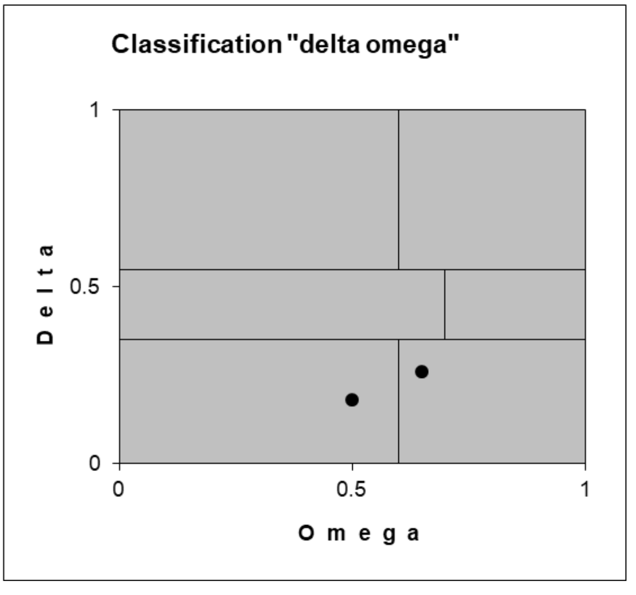

Fig. 5. Type of populations of *Kamelinia tianschanica*.
Symbols for figures: ar - adventitious root; hy – hypocotyl; lr - lateral root; rh – rhizome; rsh - renewal shoot; tr - tap root

In populations with a left-sided spectrum, individuals were mostly found in their early stages of ontogeny, usually called invasive, i.e. at the stage of implementation. According to Markov (2012), the arrival of primordia is often irregular, random, and the successful survival of seedlings is not mandatory (presence of individuals of all ontogenetic stages at the time of analysis).

The second variant (P-2) of the spectrum was formed by the middle-aged generative stage, due to the rapid rate of development and transition of young generative individuals to the middle-aged group. The accumulation of mature generative individuals in populations, was on one hand associated with slow rates of plant development in this ontogenetic stage, which reflected the biology of the species as a whole, secondly, with rhythmological polyvariance, expressed by omissions in flowering, which therefore increasing the residence time of individuals in the mature generative stage.

In P-2, individuals showed a longer life-span, a slightly greater loss of juvenile and immature stages due to anthropogenic impact (trampling), and constant rockfall due to the steepness of the slope (40^0–45^0). In addition, in this population, the root system of young individuals was damaged by pests.

The absolute maximum in the middle-aged generative group was generally associated with a longer life cycle of individuals at generative period and partial elimination of individuals of juvenile and immature conditions due to lack of moisture, a constant impact due to the passage of the local population along the access path, as well as the steepness of the slope and climatic variability factors, etc. Centered spectra, according to Zaugolnova (1994), were formed in caudex herbaceous plants with a long life-span of individuals in a middle-aged generative ontogenetic stage, their lowest elimination and the seeds showed a low germination rate.

Thus, in the ontogenesis of *Kamelinia tianshanica*, 3 ontogenetic periods (latent, regenerative, and generative) and 7 age-related stages were identified: seeds (mericarps), seedlings, juvenile, immature, virginile, young and middle-aged generative stages. At the initial stages of ontogeny, plants were represented by a tap rooted life form, starting with an immature-virginal stage - a short-rhizome adventitious rooted. Young vegetative (juvenile, immature) and middle-aged generative plants were differed well in the structure of the leaves and underground part. The root system of generative individuals consists of a vertical or tortuous short epigeogenic rhizome with numerous adventitious roots (up to 2 branching orders) and shoots of renewal.

The formation of daughter individuals started at virginal stage, but most active development occurred in the generative period. There was no senile period in ontogeny, and therefore it could be characterized as shortened, and complex due to the presence of renewal shoots that promote vegetative reproduction. Individuals of the middle-aged generative stage had the longest period of time of a large life cycle, which ultimately led to their fleeting death and the passage of the senile stage.

The studied populations of *Kamelinia tianshanica* under two ecological and phytocenotic conditions were normal and incomplete. The characteristic type of sp-cerum was left-handed for the first population, with a peak on virgin individuals, and centered in the second population, with a peak on middle-aged generative individuals. In the two studied communities with almost similar degree of grazing and closeness, a high proportion of pre-generative and generative fractions of plants was characteristic due to low germination and episodic seed renewal, vegetative method of reproduction. The longest life span of the virginal age state in comparison with other age groups of the pre-regenerative period, loss (abbreviation) of the juvenile stage of development in vegetatively originated individuals (ramets), partial elimination and asynchrony in the rates of development of young individuals, as well as the duration of life of the middle-aged generative stage.

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