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Assessment of the current condition and ontogenetic structure of the populations of *Leontice incerta* (Berberidaceae) in the Kyzyl-Kum Desert, Uzbekistan

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Abstract. *Bobokandov N, Nomozova Z, Tashpulatov Y, Isomov E, Akhmedov A. 2024. Assessment of the current condition and ontogenetic structure of the populations of* Leontice incerta *(Berberidaceae) in the Kyzyl-Kum Desert, Uzbekistan. Biodiversitas 25: 2757-2764.* The desert ecosystems of central Asia, including Uzbekistan, have a rich biodiversity and unique plant communities. High human pressure and long drought periods due to climate change have caused habitat destruction in these areas and a parallel crisis in vegetation cover. This study aimed to estimate the current population of *Leontice incerta* Pall., primarily distributed in the Kyzyl-Kum Desert, Uzbekistan. This focal species grew under climatic changes and human pressure in the Kyzyl-Kum Desert. The study identified five populations of *L. incerta* in the Kyzyl-Kum Desert. All 5 populations were estimated and measured by delta-omega and the population spectrum was determined. In the plant community, there are mostly dominated by Asteraceae (6 species), followed by Fabaceae (5 species), Amaranthaceae (4 species), Lamiaceae (4 species), Apiaceae (3 species), and other families. The plant communities consist of 49 species, including 1 species of tree, 6 species of shrubs, 6 species of semi-shrubs, 26 species of perennial herbs, and 10 species of annual herbs. The ontogenetic structure was incomplete, that is, it did not include all age groups due to biological features and harsh conditions. At all sites, the population density was low with most populations classified as young ontogenetic structures. The results will make it possible to understand estimating the current state of *L. incerta*. It indicated this species might, soon, become rare in the wild, therefore conservation and protection areas for this focal species are necessary.

Keywords: Climate change, *Leontice incerta*, ontogenetic structure, plant community, population structure, Uzbekistan

INTRODUCTION

Under a climate change scenario, a temperature increases of up to 3.5°C could turn this semi-arid region into an arid one, leading to desertification (Marengo et al. 2009). The climate forecast for Uzbekistan predicts a 5% to 10% reduction in annual rainfall and a 3.5°C temperature rise by the end of the century (Mitchell et al. 2017). Impacts of climate change pose an extremely high risk to central Asia, including Uzbekistan and this site is highly exposed to climatic change (Vakulchuk et al. 2022).

Due to increasing human and climate impact on the ecosystem, it is necessary to conduct studies to identify and preserve biological diversity. In global practice, significant progress has been made in identifying the factors contributing to the decline in plant populations, evaluating their dynamics, and developing conservation measures (Akhmedov et al. 2021). As a result, hundreds of species, plant communities, and their habitats need protection (Abduraimov et al. 2022; Khalimov et al. 2023; Rakhimova et al. 2023). The problem of protecting biological diversity is becoming more urgent in the context of increasing anthropogenic impact on natural ecosystems. The ontogenetic structure is one of the important parameters of the population. The ontogenetic structural organization provides the ability of a population system to support itself and determines its tolerance. An estimate of the ontogenetic structure of plants provides knowledge of the further state of species populations (Zaugolnova 1994; Osmanova and Zhivotovsky 2020; Akhmedov et al. 2022). The population ontogenetic method is widely used in botany and ecology. This method takes into account various parameters that characterize plant development in a plant community, rather than relying solely on visual evaluations. The ontogenetic spectrum, which refers to the distribution of individuals by ontogenetic conditions, is an essential feature of each population and the population-ontogenetic approach makes it possible to estimate the natural population state in different ecologic-phytocoenotic conditions and to predict development in response to biotic and abiotic factors (Astashenkov et al. 2019; Barsukova and Leonova 2019).

The family Berberidaceae Juss. consists of shrubs and perennial herbs. It is a small family of early-flowering tuberous herbs. The fruits are characterized by exposed seeds when the membranous pericarp splits. It has attracted the interest of botanists for more than a century (Chupov 2018; Sun et al. 2018). Most species of Berberidaceae are rich in alkaloids with important medicinal values (Peng et al. 2006; Akramov et al. 2021; Nurullayeva et al. 2021). According to POWO (2024), Berberidaceae consists of 13 accepted genera, including *Nandina* Thunb. (1 spp.), *Caulophyllum* Michx. (3 spp.), *Leontice* L. (4 spp.), and *Gymnospermium* Spach (11 spp.). The genus *Leontice* consists of 4 species, namely *L. armeniaca* Boivin, *L. ewersmannii* Bunge, *L. leontopetalum* L., and *L. incerta* Pall. The genus has some economic value, such as *L. leontopetalum* has antioxidant, antidiabetic, convulsive and anti-convulsive, cytotoxic, anticholinesterase, cardiovascular, and smooth muscle contractile effects (Al-Snafi 2019).

Here, we focus on *L. incerta* that is the first time studying this species at the population level. This study aimed to assess the current condition and ontogenetic structure of *L. incerta* populations in the Kyzul-Kum desert, growing at an altitude of 283-515 m asl. This study is oriented at estimating the current ontogenetic structure statuses of populations of *L. incerta*, preserving them in different conditions of the Kyzyl-Kum desert, Uzbekistan.

MATERIALS AND METHODS

Study site

The research was conducted in the Kyzyl-Kum Desert, Uzbekistan. Field surveys were conducted during the growing seasons of 2022- 2023. Kyzyl-Kum is a sandy desert between the Amu-Darya and Syr-Darya rivers. It is limited in the north-west by the Aral Sea, in the north-east by the Syr-Darya, in the east by the spurs of the Tien Shan and Pamir-Alai, in the south-west by the Amu Darya. The area is about 300,000 km². The peculiar soil and climatic conditions determine the difference in the originality of the floristic composition of the remnant mountains.

In the Kyzyl-Kum, more than 20 remnant mountains of different sizes are noted and most of them are included in several separate remnant mountain systems. At the same time, in terms of location and territory coverage, a special place is occupied by Kukchatau, Kuljuktau, Auminzatau, Muruntau, Tamdytau, Aktau, Bukantau, and Sultanuvastau (Shomurodov 2018). In this study, we focus on five populations of *L. incerta* growing in the Kyzyl-Kum Desert (Figure 1).

Long-term meteorological data is unavailable in Uzbekistan. Consequently, mean monthly precipitation and temperature data were obtained from the Climatic Research Unit (CRU) TS3.10 datasets (Harris et al. 2014) for each site. The mean annual temperature is 15.3°C, and the mean annual rainfall exceeds 125 mm. Soil types are grey-brown and rocky-stony (Shomurodov 2018) (Table 1).

Procedures

Plant population evaluation

The geobotany is engaged in scientific and applied activities in the field of studying plant communities (phytocenoses). It is at the intersection of ecology, geography, and often statistical science. The main practical task of geobotany is to control plant reserves and study the human impact on the population of certain plants, and the diversity of phytocenoses in the area.

Convention of geobotanical (Plant ecology) methods were utilized to describe the plant communities present within the populations of *L. incerta*. At each site, we described the plant community and inventoried all plant species occurring in one randomly selected 25×25 m plot. Unidentified plant species were collected for identification (Abdulayeva 1987). Total vegetation cover was estimated in each plot using the method developed by Braun-Blanquet (1965), where each species cover was assessed based on cover classes, i.e., 0 5%, 5-25%, 25-50%, 50-75%, and 95-100%.

The life forms of plants, which include trees, shrubs, semi-shrubs, and herbs (perennial, biennial, and annual), were described according to POWO (2024) datasets. Environmental variables such as aspect, slope, distance to water, annual precipitation, and anthropogenic factors were estimated for each site. The aspect was measured using the Global Positioning System (GPS) (Garmin 62; Garmin Ltd., Olathe, KA, USA) and the slope was visually estimated.

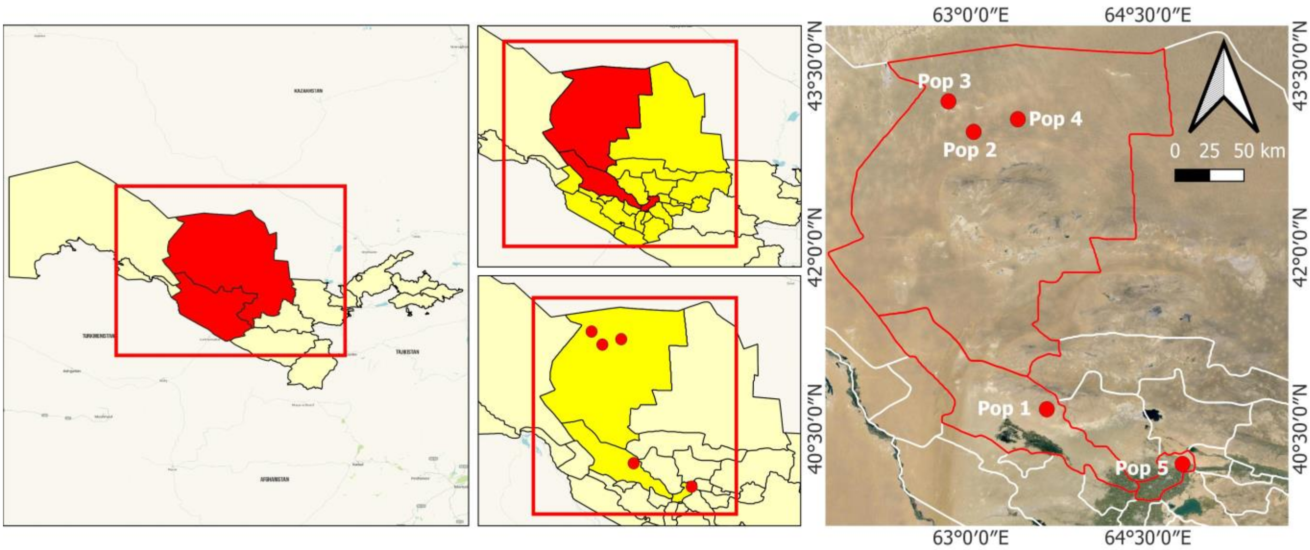

Figure 1. Study site in the Kyzyl-Kum Desert, Uzbekistan (Map created by QGIS 3.16)

Table 1. Site characteristics of *Leontice incerta*

Region	Pop	MAP (mm yr^{-1})	MAT (°C)	Soil	Landscape	Latitude/N	Longitude/E	Elevation (m asl.)
Kuldjuktau	1	110	14.5	Grey-brown	Desert	40°753′730″	63°760`793″	480
Uchkuduk (Bedor ota)	2	151	13.1	Grey-brown	Desert	42°194′709″	63°584′373″	310
Bukantau	3	140	12.1	Grey-brown	Desert	42°546′475″	63°357′357″	515
Uchkuduk (Khoshkhar ota)	4	150	13.2	Grey-brown	Desert	42°192′537″	63°541′832″	283
Kukchatau	5	175	13.5	Rocky and stony	Desert	40°129′811″	65°101′431″	370

Note: MAP: Mean Annual Precipitation; MAT: Mean Annual Temperature

Table 2. Types of ontogenetic spectrum

Ontogenetic spectrum	Ontogenetic stages	Dominated by
Left-sided	j, im, v and g1	Regenerative and generative stages
Bimodal	j, im with g2 or g3	Regenerative, generative or post-generative
Centered	g2	Generative
Right-sided	g3, ss and s	Generative and post-generative

Population structure measurements

The methodology described by Zaugolnova (1994) to evaluate the population structure. Three transects were established at each site and all starting from a random common point. One transect was set to the north, one to the south, and one to the east, and each was 1 m wide and 10 m long. Each transect was divided into 10 squares of 1 m^2 and counted the number of individuals in each ontogenetic stage (s: seedlings, j: juvenile, im: immature, v: virginile, g1: young generative, g2: mature generative, g3: old generative, ss: sub-senile, s: senile) (Osmanova and Zhivotovsky 2017). Finally, the ontogenetic spectrum of the population was determined by using the standard method developed by Uranov and Smirnova (1969).

Four distinct types of ontogenetic spectra can be identified based on the proportion of individuals in different growth states. These states include pre-generative states (s, j, im, v), generative states (g1, g2, g3), and post-generative states (ss, s). According to Zaugolnova (1994), the four population structure scenarios are as follows: (i) Left-sided spectrum: This type of spectrum is characterized by a prevalence of individuals in the pre-generative or generative states. It is a very dynamic spectrum and the individuals within specific populations are quite diverse, (ii) Centered spectrum: This spectrum is dominated by individuals in the average age generative ontogenetic state, (iii) Bimodal spectrum: Two maximums are characteristic for this type of spectrum, one in the regenerative stage and the other in older generative plants (less often mature), (iv) Right-sided spectrum: In this spectrum, old individuals are dominant and there is a lack of young individuals in the ontogenetic stages (Table 2).

Data analysis

Descriptive statistics were conducted in Excel and Origin Pro for Windows version 3.4.1 was used for graphics. Maps were created by QGIS 3.16. A WGS84 geographic coordinate system was used as a reference. Population type was classified with the "delta-omega" (Δ-ω) method (Zhivotovsky 2001). Delta (Δ) is an index of population age, which assesses the age level of populations at any moment (equation x), and whereas omega (ω) is the effectiveness of the plant ontogenetic stages, the value of "load" on the energetic resources of the environment, expressed as a fraction load produced by middle-aged generative condition plants of this population. According to the delta-omega classification, the population can be classified as young, maturing, transition, senescent, and old. Population structures were analyzed by OriginPro8.6 (data analyzing and software). The average density of individuals per m^2 was measured as the average number of individuals in each of the 10 m^2 quadrants within a population.

RESULTS AND DISCUSSION

Description of *Leontice incerta* and its communities

Leontice incerta is a perennial herb, tuber spherical, 1.5-2.5 cm wide. Stems are erect, unbranched, cylindrical, 10-15 cm high. Leaves up to 7 cm long, stem leaves usually 2, long-petiolate, 2.5-4 cm long, trifoliate or twice trifoliate; lobes elliptical or ovoid, 1.3-3.2 cm long, 6-20 mm wide, entire, somewhat fleshy, lateral parts sometimes dissected. Peduncles (without a raceme), not exceeding the leaves or slightly exceeding them, 2-3.5 cm long. Brushes are sparse, about 5-10 colors. At the base of each flower, there is a rounded bract. Pedicels are thin, directed obliquely upward, 8-12 mm long. Sepals elliptical or ovate, 5-7 mm long, 4-5 times larger than the petals. The petals are kidney-shaped, vaguely toothed at the apex, and immediately narrowed at the base into a thin nail, twice as short as the limb. Pistil with a very short style and an almost sessile stigma. Capsule almost spherical, 15-40 mm wide, vesicular swollen, indestructible seeds, 2-6, dark brown (Rosati et al. 2019). Blooms and bears fruit in April-May (Figure 2).

Figure 2. Habitus of *Leontice incerta* (March 2023, Photo: N. Bobokandov)

Among *Leontice* species, *L. incerta* has closely related to *L. ewersmannii*. It is a perennial and native species in Uzbekistan. Botanical description of *L. ewersmannii* is as follows: tuber large and deep; the stem and leaves are waxy, and hairless, emerging from different spots on the ground; leaves are pinnate; inflorescence is much-branched, with many yellow flowers; flower with 6 sepals, 6 petals (6 nectaries are hidden under 6 scales at the bases of the petals), and 6 anthers; the fruit is an inflated, egg-shaped structure. After drying, the plant detaches from the ground, tumbles, and disperses its seeds (Al-Snafi 2019).

Five populations of *L. incerta* growing in the Kyzyl-Kum desert were described. The first population (Pop 1) of *L. incerta* was in Kuljiktau of the southwest Kyzyl-Kum Desert. The vegetation was wastage and the total vegetation cover was 20-25%. The total cover of *L. incerta* was less than 1%. Species richness showed 21 species of vascular plants in the community, of which 2 species of shrubs, 3 species of semi-shrubs, 12 of perennial herbs, and 4 annual herbs (Table 3). The second population (Pop 2) of *L. incerta* was in Uchkuduk (Bedor ota) of the southwest Kyzyl-Kum desert. The vegetation was wastage and the total vegetation cover was 25-30%. The total cover of *L. incerta* was less than 1%. Species richness showed 22 species of vascular plants in the community (Table 3), of which 1 species of tree, 2 species of shrubs, 3 species of semi-shrubs, 11 species of perennial herbs, and 5 species of annual herbs. The third population (Pop 3) of *L. incerta* was in Bukantau (Erler ota) of the southwest Kyzyl-Kum Desert. The vegetation was wastage and the total vegetation cover was 15-20%. The total cover of *L. incerta* was less than 1%. Species richness showed 10 species of vascular plants in the community (Table 3), of which 2 species of shrubs, 1 species of semi-shrub, and 7 species of perennial herbs. The fourth population (Pop 4) of *L. incerta* was in Uchkuduk (Khoshkhar ota) of the southwest Kyzyl-Kum Desert. The vegetation was wastage and the total vegetation cover was 30-35%. The total cover of *L. incerta* was less than 1%. Species richness showed 16 species of vascular plants in the community (Table 3), of which 1 species of tree, 2 species of shrubs, 2 species of semi-shrubs, 8 species of perennial herbs, and 3 species of annual herbs. The fifth population (Pop 5) of *L. incerta* was in Kukchatau of the central Kyzyl-Kum Desert. The vegetation was wastage and the total vegetation cover was 20-25%. The total cover of *L. incerta* was less than 1%. Species richness showed 17 species of vascular plants in the community (Table 3), of which 4 species of semi-shrubs, 9 species of perennial herbs, and 4 species of annual herbs.

In terms of dominant species, the following species were found in almost all populations of *L. incerta*, namely *Haloxylon ammodendron* (tree), *Tamarix laxa* (shrub), *Artemisia diffusa* (semi-shrub), *Artemisia turanica* (semi-shrub), and *Peganum harmala* (perennial herb). This vegetation cover changes due to global warming and anthropogenic pressure. Natural environment loss caused by human activities is a major cause of biodiversity loss worldwide (Cardinale et al. 2012). As a result of this loss and fragmentation, significant changes occur in the landscape, which can have an impact on the diversity of plants and their response to global changes in the future (Zambrano et al. 2019). The increasing pressure from human activities, coupled with global warming, has a negative impact on the populations of plants in natural ecosystems.

Ontogenetic stages of *Leontice incerta*

Ontogenesis is described in Ephemeral plants-Artemisia communities' properties in the central Kyzyl-Kum (Figure 1). The study of ontogeny was carried out widely using plant populations in the Kyzyl-Kum Desert (Akhmedov et al. 2015). In natural habitats, *L. incerta* reproduces only by seeds. Seeds germinate in February. Germination does not exceed 30% in natural conditions (Mamut et al. 2020). Ontogeny studying of species and the concept of a discrete description of ontogenesis proposed by Rabotnov (1950). The description of the structure of adult individuals of the species was perennial and the study of ontogeny was carried out using generally accepted methods and approaches according to Zaugolnova (1994).

Leontice incerta has several ontogenetic stages (Figure 3). In juvenile stage (j), the leaf is three-lobed, fleshy, green, 2.5-3.0 cm in length and 2.0-2.5 cm in width. Immature stage (im), the leaves are divided into 4-5 parts, the length is 4.5-5.0 cm, and the width is 3.0-3.5 cm. Virginile stage (v), there are 2 leaves and it is divided into three parts twice. Young generative stage (g1), the leaves are arranged in a row on the stem. the ball-shaped bulbous, the initial flowering stage is characterized by a smaller number of flowers and a mature generative stage (g2), it is the most mature generative stage, and there are many flowers in a complex flower-shaped inflorescence. Thus, in the conditions of the Kyzyl-Kum, the ontogeny of *L. incerta* individuals lasts at least 15 years.

Population structure of *Leontice incerta*

The impacts of climate change pose a very high risk to central Asia, which is highly vulnerable to climatic change (Vakulchuk et al. 2022). In the Kyzyl-Kym Desert area, 110-175 mm of rain falls during recent years (Table 1). This condition is one of the characteristic features of the

Turonian province of central Asia. In this area, the growth of desert vegetation is under pressure by both temperature and aridity. This condition has also been reported by Akhmedov et al. (2021).

The current study describes the climate sensitivity and populations of *L. incerta* in the Kyzyl-Kum Desert. Analysis of the ontogenetic structure enables the diagnosis of the current population state and assessment of the future state (Abduraimov et al. 2023). The indicators of the populations allow long-term monitoring work in these areas and sustainable use of plant natural resources.

Table 3. Characteristics of plant communities of *Leontice incerta*

Species	Family	Populations and total vegetation cover					Life form
		1	2	3	4	5	
		20-25%	25-30%	15-20%	30-35%	20-25%	
Acanthophyllum sp.	Caryophyllaceae			3			Perennial
Alhagi pseudalhagi subsp. *kirghisorum* (Schrenk) Yakovl.	Fabaceae		+		+		Perennial
Artemisia diffusa Krasch. ex Poljakov	Asteraceae	5	5		7	5	Semi-shrub
Artemisia scoparia Waldst. & Kit.	Asteraceae	2					Annual
Artemisia turanica Krasch.	Asteraceae		3		5	5	Semi-shrub
Astragalus centralis E.Sheld.	Fabaceae			+			Perennial
Astragalus schrenkianus Fisch. & C.A.Mey.	Fabaceae			+			Perennial
Astragalus kuldzhuktauense F.O.Khass., Shomur. & Esankulov	Fabaceae	+					Perennial
Bromus scoparius L.	Poaceae		1		1		Annual
Carex physodes M.Bieb.	Cyperaceae		2		3		Perennial
Ceratocarpus arenarius L.	Amaranthaceae		1			2	Annual
Ranunculus testiculatus Crantz	Ranunculaceae		+		+	+	Annual
Convolvulus hamadae (Vved.) Petrov	Convolvulaceae		1			3	Semi-shrub
Cousinia hamadae Juz.	Asteraceae	+				+	Perennial
Cousinia resinosa Juz.	Asteraceae					+	Perennial
Dianthus crinitus subsp. *tetralepis* (Nevski) Rech.f.	Caryophyllaceae	+					Perennial
Ephedra intermedia Schrenk & C.A. Mey.	Ephedraceae		3		4		Shrub
Eremopyrum bonaepartis (Spreng.) Nevski	Poaceae	+					Annual
Ferula foetida (Bunge) Regel	Apiaceae				+		Perennial
Ferula kyzylkumica Korovin	Apiaceae	+		1			Perennial
Ferula lehmannii Boiss.	Apiaceae		+				Perennial
Galium spurium L.	Rubiaceae		+				Annual
Caragana halodendron (Pall.) Dum.Cours.	Fabaceae			3			Shrub
Haloxylon ammodendron (C.A.Mey.) Bunge ex Fenzl	Amaranthaceae		4	4	5		Tree
Heliotropium dasycarpum Ledeb.	Boraginaceae		+			+	Perennial
Iris songarica Schrenk ex Fisch. & C.A.Mey.	Iridaceae			1			Perennial
Lachnoloma lehmannii Bunge	Brassicaceae					+	Annual
Lagochilus gypsaceus Vved.	Lamiaceae					+	Semi-shrub
Lagochilus vvedenskyi Kamelin & Tzuker.	Lamiaceae	+		+			Semi-shrub
Leontice incerta Pall.	Berberidaceae	1	1	+	2	+	Perennial
Lepidium subcordatum Botsch. & Vved.	Brassicaceae	+					Perennial
Lycium ruthenicum Murray	Solanaceae	+					Shrub
Meniocus linifolius (Stephan ex Willd.) DC.	Brassicaceae	+					Annual
Roemeria pavonina (Schrenk) Banfi, Bartolucci, J.-M.Tison & Galasso	Papaveraceae		+		+	+	Annual
Peganum harmala L.	Nitrariaceae		+	+	1	2	Perennial
Phlomoides eriocalyx (Regel) Adylov, Kamelin & Makhm.	Lamiaceae		+			+	Perennial
Poa bulbosa L.	Poaceae	+	+		+	+	Perennial
Polygonum polycnemoides Jaub. & Spach	Polygonaceae		+			+	Perennial
Pulicaria sp.	Asteraceae	+					Perennial
Rhamnus erythroxyloides subsp. *sintenisii* (Rech.f.) Mabb.	Rhamnaceae			+			Shrub
Rheum turkestanicum Janisch.	Polygonaceae		+		+		Perennial
Xylosalsola arbuscula (Pall.) Tzvelev	Amaranthaceae	3					Shrub
Caroxylon scleranthum (C.A.Mey.) Akhani & Roalson	Amaranthaceae	2					Perennial
Lactuca orientalis (Boiss.) Boiss.	Asteraceae	1					Semi-shrub
Stipa aktauensis Roshev.	Poaceae	+					Perennial
Stipa hohenackeriana Trin. & Rupr.	Poaceae	+					Perennial
Tamarix laxa Willd.	Tamaricaceae		2		3		Shrub
Tulipa biflora Pall.	Liliaceae	+					Perennial
Ziziphora tenuior L.	Lamiaceae	+					Annual

Notes: 1,2,3,4, and 5 are percentages of plants, plus (+) is an occurrence of species in the plant community

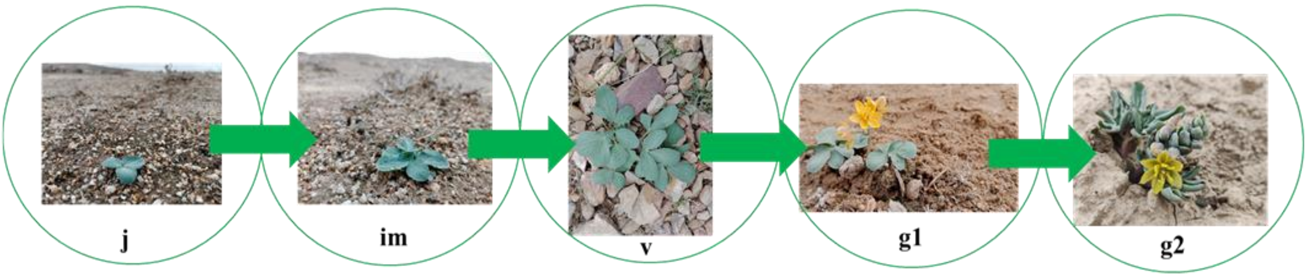

Figure 3. Ontogenetic stages of *Leontice incerta* (pre-generative and generative periods). j: Juvenile; im: Immature; v: Virginile; g1: Young generative; g2: Mature generative

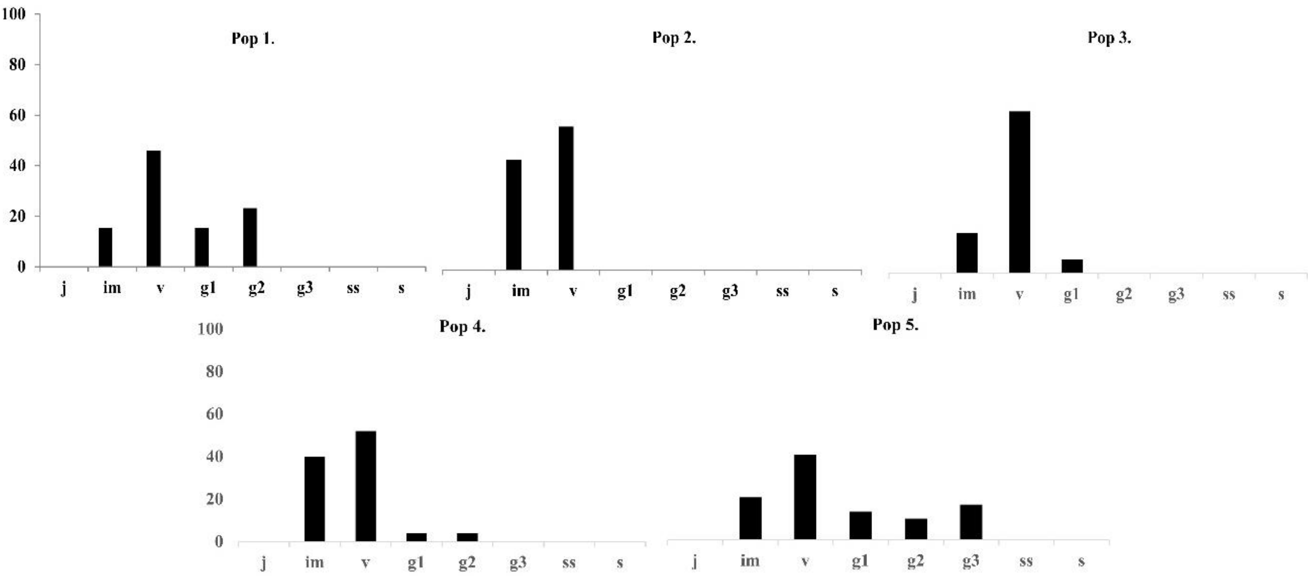

Figure 4. Ontogenetic spectra of *Leontice incerta* populations. Notes: X: Developmental stage; Y: Distribution of individuals by developmental stages (%)

The ontogenetic structure of populations of representatives of the genus *Leontice* and in particular, *L. incerta* has not been previously studied by anyone. *L. incerta* was normal, but incomplete in ontogenetic structure, here, it did not all stages of individuals. In all populations, we found no individuals of juvenile, sub-senile, and senile states (pop 1-5) and explained by the biology of the species (apparently, the ontogeny of the species ends in the old generative state). There was the left-sided type of ontogenetic spectra of the population *L. incerta* (Figure 4).

The spectrum maximum was noted for the group of virginal individuals (46-75%). This variant of the spectrum is formed with abundant fruiting and rapid development of young individuals. The high proportion of young generative individuals in all populations is associated with the intensive rates of development of individuals in pre-generative age states. Pop 3 has a high proportion of virginile individuals (75%) as a result of the rapid pace of development of young individuals and a long stay in the virginile state. All populations of *L. incerta* have generative individuals besides (pop 2) and this is due to a gradual increase in the life expectancy of individuals in the generative period. Only, pop 5 has old generative due to tolerance features and long life of ontogenesis.

According to Uranov (1975), evaluated the ontogenetic structure and introduced the age index called "delta" (Δ). This index measures the amount of energy metabolized by the plant at the beginning of the next ontogenetic phase. Meanwhile, the "weight" represents the share of each ontogenetic phase. As claimed by Zhivotovsky (2001) and added "omega" (ω) to this evaluation. Omega can be considered as the mean energy effectiveness or energy pressure on the environment imposed by an "ordinary" plant. By comparing these two indexes, the delta-omega classification was developed, which allows populations to be divided into young, adult, and old based on a two-dimensional approach. Evaluation of the age (Δ: delta) and efficiency (ω: omega) of populations revealed that the studied populations were young (populations 1,2,3, 4,5) (Figure 5).

The current study describes the climate sensitivity and population dynamics of *L. incerta* in the Kyzyl-Kum Desert. Result presented here confirm the hypothesis populations of *L. incerta* is under increasing risk and decrease in all generations with lower precipitation amounts in recent years.

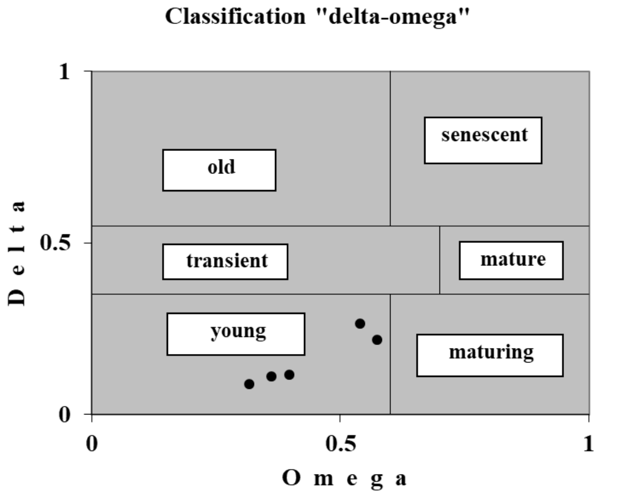

Figure 5. Types of populations of *Leontice incerta* according to the “Delta-Omega” classification. Notes: delta (Δ) is an index of population age, omega (ω) is the effectiveness of the plant ontogenetic stages

In conclusion, in the five populations of *L. incerta* revealed that the population's status is unsatisfactory and identified 50 vascular species in the Kyzyl-Kum Desert. The research showed that the climate is highly sensitive to change, affecting the current population status of *L. incerta* in the Kyzyl-Kum Desert. The investigation indicated that the populations were all young due to the biological features and ecological conditions of this focal species. Results presented here confirm the hypothesis that the populations of *L. incerta* are at increasing risk due to lower precipitation, resulting in fewer individuals. The study indicated differences in successional conditions of populations of *L. incerta*. The studied populations of *L. incerta* are incomplete due to global warming, drought cases, and human pressure negatively affecting the populations of this focal species.

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