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Study of population structure of *Ferula foetida* (Bunge) Regel in the conditions of Mangystau region

Results of a research of a condition of populations of *Ferula foetida* (*Apiaceae* family) in the territory of Mangystau region are given in the article. The composition, structure of populations, polymorphism, and condition of growth and peculiarities of the natural populations of *Ferula foetida* is studied. The general projective covering in community was from 35 to 80 %. Occurrence of samples of *Ferula foetida* was 0.1–0.8 pieces/sq.m. In natural populations all age states (from 1 year old to 7 years old individuals) are revealed; in a generative phase 5–6–7 years old individuals are noted. On the various populations 15–55 % of plants are observed in blossoming phase, other plants were in a phase of the radical leaf basket. The ratio of the main age groups of plants on each described population is defined, the phytocenotic structure and some morphological indicators of elevated bodies is conducted. The received results of phytocenotic descriptions testify to a possibility of practical using of natural population of *Ferula foetida*.

Keywords: *Ferula foetida*, Mangyshlak, abundance, spreading, floristic composition, community, morphology, age group.

Introduction

Plants of genus *Ferula* L. (family *Apiaceae* — *Umbelliferae*) are valuable aromatic, medical and food plants [1–6]. Among species of *Ferula* the wide range of medical activities has *Ferula foetida* (Bunge) Regel raw materials of which are applied for treatment of itch, asthma, syphilis, nervous diseases, dyspepsia, diarrhea, diabete, to healing of wounds, tumors, dermatitis, as antiparasitic and antiseptic remedy [7–12].

The wide range of medicinal properties of *Ferula foetida* leads to great demand as medicinal raw materials, especially in such countries as Iran, India, Afghanistan and China.

In Kazakhstan this species forms industrial and valuable communities on the Embinsky plateau, in the Western lowland, Aral region, desert Moiynkumy, Balkhash-Alakul, Kyzyl Kum, Turkestan, Chu-Ili mountains [13], in the western part of Kazakhstan this species has distribution on Karatau, the peninsula of Mangyshlak, in northern and southern Ustyurt [14]. If populations in the southern regions of Kazakhstan are studied rather well, then communities of *Ferula foetida* in the western part demand comprehensive observation and examination.

The purpose of the present research was to study floristic composition and structure of natural populations of *Ferula foetida* in the territory of Mangystau region.

Methodology

Field inspections carried out by reconnoitring and semiportable methods in 2018 in the following territories: Tuyesu sands, sandy and loamy massifs in the neighborhood of the plateau Tynymbay shoky, sandy massifs in the neighborhood of a wintering Karkol.

In field conditions carried out the description of the revealed populations with participation of *Ferula foetida*, determined full floristic structure [15, 16] abundance across Drudae [17], assessment of variability of above-ground parts, the analysis of age groups of plants, a ratio of age groups [18] and also sampling of plants for morphological analysis.

Specification of Latin names was conducted accordance of S.K. Czerepanov list [19]; determination of species was spent on Flora of Kazakhstan, vols. 1–9 [13] and to determinant of plants of Mangystau region [14].

Morphological indicators of the blossoming samples of *Ferula foetida* was estimated [19].

Statistical processing of materials of researches was carried out by G.F. Lakin [20] technique, with the use of a package of the statistical Excell 2010 programs.

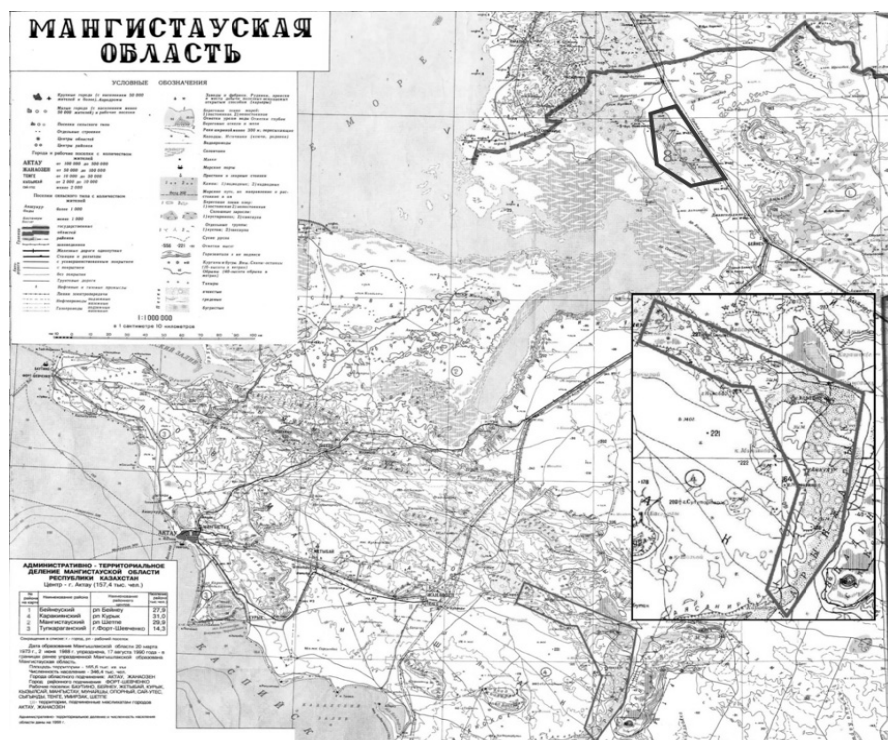
Results and their discussion

In natural flora of Mangyshlak 4 species of genus *Ferula* meet: *Ferula foetida* (Bunge) Regel, *F. dubjanskyi* Korovinex Pavlov (Dubjansky), *F. lehmannii* Boiss. (Lehman) and *F. nuda* Spreng. [17].

The ecological confinedness of *Ferula foetida* to the sandy area allows ranking this species as representatives of psammophytes [4]. The species is drought-resistant and capable to sprout in places with an arid hot climate. The periodic droughts characteristic of deserts and semi-desert territories, do not influence on development of *F. foetida* as this species possesses a powerful root system.

Density of growth of plants depends also from the edaphic conditions of the region. The species is various by the ecological nature and conditions of location, takes part in various vegetable communities.

On the basis of herbarium material and results of field inspections the point distribution map of populations of *Frula foetida* on Mangyshlak with coverage of sands Karynzhyryk, Tuyesu, Sam, Akkum, Kyzyl Kum, Bostankum, loamy hills in the neighborhood of plateau Tynymbay shoky, sandy massifs around a wintering Karkol (Fig.) is made.



1 — Tuyesu sand; 2 — western parts of plateau Tynymbay shoky; 3 — southern part of plateau Tynymbay shoky; 4 — natural boundary Karaadyr; 5 — natural boundary Kamysty; 6 — Mount Burma; 7 — Karynzhyryk sands, 8 — wintering Karkol

Figure. Map of spreading of location of *Ferula foetida*, suitable for industrial gathering (Mangystau region)

The description of the revealed vegetable communities with participation of *Ferula foetida* and their structural characteristic is given.

Tuyesu sands. They are located in a southwest part of Mangystau region on the outskirts of the settlement of Senek. Massifs are presented by the fixed and semi-fixed sands with small height difference; they are lasting from the southeast on the northeast on 30 km, from the north to the south on 12 km. In Tuyesu sands the following communities with participation of *Ferula foetida* are noted: saxaul-wormwood, wormwood-ferula-herba varia, saxaul-wormwood-herba varia.

In communities such species as *Haloxylon aphyllum* and *Haloxylon persicus*, *Artemisia arenaria*, *Artemisia terrae-albae*, *Iris tenuifolia*, *Tulipa sogdiana*, *Allium caspicum*, *Ceratocephala*, *Agropyron desertorum*, *Stipa*, *Astragalus ammodendron* and others are presented. The general projective covering in communities fluctuated from 20 to 60 %. The numerous traces of pasturable loading in the surveyed territory are noted.

Saxaul-wormwood communities (*Artemisia terrae-albae* — *Haloxylon aphyllum*) are noted on slopes with well-the fixed sandy hills. The general projective covering (further GPC) in community made 50–60 %. The dominant species was *Haloxylon aphyllum* with abundance cop 2 and vitality 4 points, a co-dominant was *Artemisia arenaria* with abundance cop 1 and vitality 3 points (Table 1).

Table 1

Floristic composition of saxaul-wormwood community with participation of *Ferula foetida*

Species	Consort	Abundance on Drudae	Vitality, point	Tier
<i>Haloxylon aphyllum</i>	Dominant	cop 2	4	1
<i>Artemisia arenaria</i>	Co-dominant	cop 1	3	2
<i>Artemisia terrae-albae</i>	Component	sp	3	3
<i>Astragalus ammodendron</i>	Component	sol	2–3	2
<i>Menicococcus linifolius</i>	Component	sol	3–4	3
<i>Descurainia sophia</i>	Component	sol	3–4	3
<i>Carex physoides</i>	Component	sol-sp	3	3
<i>Allium capsicum</i>	Component	sol	3–4	3
<i>Peganum harmala</i>	Component	sol	3	3
<i>Alyssum dasycarpum</i>	Component	sol	3	3
<i>Ferula foetida</i>	Component	sol	3–4	2
<i>Papaver pavonicum</i>	Component	sol-un	3	3
<i>Iris tenuifolia</i>	Component	sol	2–3	3
<i>Tulipa sogdiana</i>	Component	sol	4–5	3
<i>Ceratocephala testiculata</i>	Component	sol	2–3	3
<i>Atraphaxis replicata</i>	Component	un	2	2
<i>Agropyron desertorum</i>	Component	sol	2–3	3
<i>Calligonum leucladum</i>	Component	un	3	2

Other species in community are carried to components with abundance from sp to un, and vitality 2–4 points. Plants are distributed in 3 vertical tiers. The top, or wood tier (height of 150–200 cm), is presented by individuals of *Haloxylon aphyllum*; the second tier (height from 50 to 120 cm) consists of bushes and tall herbs as *Calligonum leucladum*, *Ferula foetida*, *Artemisia arenaria*, *Astragalus ammodendron*. The grassy tier (up to 40 cm high) is presented by other undersized annual and grassy perennial plants. In general the specific structure of community is not rich, about 17–19 species that is explained by droughty conditions and acute shortage of rainfall of the last 2 years in Tuyesu sands.

Examples of *Ferula foetida* are in satisfactory condition, blossoming about 20–25 % of individuals whereas the main part is in a vegetative state is noted.

Growth of individuals of *Ferula* of various age groups is noted: from shoots of the first year to 7-year individuals. A ratio of age groups was rather uniform: from 10 to 25 % (Table 2). Maximum amount was 2–4 year plants. In a blossoming phase in the current 2018 year there are about 10–12 % of individuals at the age of 5–7 years.

Table 2

Ratio of age groups of *Ferula foetida* in Tuyesu sands, in the neighborhood of a wintering Karkol and on the plateau Tynymbay shoky

Name of communities with participation of <i>Ferula foetida</i>	Share of age groups from 1 year old to 7 year old, %						
	1	2	3	4	5	6	7
Tuyesu sands							
Saxaul-wormwood	10	25	15	15	10	15	10
Wormwood-ferula-herba varia	10	10	10	15	20	20	15
Saxaul-wormwood-herba varia	15	10	10	20	20	15	10
Sands in the neighborhood of a wintering Karkol							
Cereal-wormwood-ferula	5	10	10	20	15	20	20
Eremopyron-wormwood-herba varia	15	15	25	20	25	–	–
Plateau Tynymbay shoky							
Wormwood-ferula-arthropytum	10	15	15	20	15	15	10

Wormwood-ferula-herba varia community (*Herba xerophytica* — *Ferula foetida* — *Artemisia arenaria*) is described on flat sites of Tyuesu sands with well-fixed soils. GPC is noted at the level of 40–45 %. *Artemisia arenaria* dominated in this community with abundance cop 2 and vitality 4 points; co-dominant was *Ferula foetida* with abundance sp and vitality 3 points (Table 3). Other species are carried to components with abundance of sp-sol-un and vitality 2–4 points.

Table 3

**Floristic composition of wormwood-ferula-herba varia communities
with participation of *Ferula foetida* in the Tyuesu sands**

Species	Consort	Abundance on Drudae	Vitality, point	Tier
<i>Artemisia arenaria</i>	Dominant	cop 2	4	2
<i>Ferula foetida</i>	Co-dominant	sp	3	2
<i>Atraphaxis replicata</i>	Component	sol	3	2
<i>Astragalus ammodendron</i>	Component	sol	3–4	2
<i>Artemisia terrae-albae</i>	Component	sol	3	3
<i>Agropyron desertorum</i>	Component	sp-sol	2–3	3
<i>Iris tenuifolia</i>	Component	sol	4	3
<i>Carex physoides</i>	Component	sol-sol	3–4	3
<i>Stipa lessingiana</i>	Component	sol	3	3
<i>Astragalus testiculatus</i>	Component	sol-un	3	3
<i>Tulipa sogdiana</i>	Component	sol	4	3
<i>Heliotropium arguzioides</i>	Component	sol	2–3	3
<i>Cousinia alata</i>	Component	un	3	2
<i>Euphorbia seguiriana</i>	Component	sol	3–4	3
<i>Anisantha tectorum</i>	Component	sol	2–3	3
<i>Calligonum leucocladum</i>	Component	un	3–4	1
<i>Meniocus linifolia</i>	Component	sol	3	3

The specific structure of community is also not rich — about 18 taxons which occupy 3 vegetable tiers: top (from 80 to 120 cm), average — a tier of high herbs (45–50 cm) and a tier of low herbs (up to 30–40 cm). The top tier is presented by single individuals of *Calligonum leucocladum* and *Atraphaxis replicata*, the average tier of *Cousinia alata*, *Ferula foetida*, *Artemisia arenaria*; the lower tier is made of *Meniocus linifolia*, *Euphorbia seguiriana*, *Anisantha tectorum*, *Artemisia terrae-albae* and others. This population differs in the high density of the plants blossoming *Ferula foetida* — to a half from all attendees of individuals.

The general ratio of age groups of *Ferula* shows prevalence of 4–7 years individuals (Table 2) and a low share of 1–3 years individuals that, apparently, is connected with a row of droughty years. It is possible to connect with this fact also a circumstance that vitality of species is lowered — from 2 to 3 points.

Saxaul-wormwood-herba varia community (*Herba xerophytica* — *Artemisia arenaria* — *Haloxyllon aphyllum*) is described near Besokty's wintering on the high sandy massifs with well developed micro and a mesorelief. In community *Haloxyllon aphyllum* dominated, co-dominant was *Artemisia arenaria* (Table 4), other species were members with small abundance.

Table 4

**Floristic composition of saxaul-wormwood-herba varia community
with participating of *Ferula foetida* in the Tyuesu sands**

Species	Consort	Abundance on Drudae	Vitality, point	Tier
1	2	3	4	5
<i>Haloxyllon aphyllum</i>	Dominant	cop 1, 2	4	1
<i>Artemisia arenaria</i>	Co-dominant	cop 1	3	2
<i>Ferula foetida</i>	Component	sp	3	2
<i>Consolida sp.</i>	Component	sol	4	3
<i>Anisantha tectorum</i>	Component	sol	3	3
<i>Eremopyrum orientale</i>	Component	sol	2–3	3
<i>Heiotrichon arguzioides</i>	Component	sol-sp	3	3

Continuation of Table 4

1	2	3	4	5
<i>Alhagi pseudoahagi</i>	Component	sol	3–4	3
<i>Descurainia Sophia</i>	Component	sol	2–3	3
<i>Agropyron desertorum</i>	Component	sol	4	3
<i>Salsola austrais</i>	Component	sol	3	3
<i>Lappula sinaica</i>	Component	sol	3–4	3
<i>Cousinia astracanica</i>	Component	un	4	2
<i>Alyssum turkestanicum</i>	Component	sol	2–3	3
<i>Centaurea adpressa</i>	Component	sol	2–3	3
<i>Ceratocaphala testiculata</i>	Component	sol	3	3
<i>Iris tenuifolia</i>	Component	sol	3–4	3
<i>Poa bulbosa</i>	Component	sol	3	3
<i>Carex physoides</i>	Component	sol-sp	3	3

GPC in community turned out low — about 25–30 % that it is connected with an active pasture of a livestock, soil destruction after cover and a long drought.

Dominant in community was *Haloxylon aphyllum* with abundance cop 1, 2 and vitality 4 points, codominant was *Artemisia arenaria* with abundance sor 1 and vitality 3 points. The general specific structure of community made 19 components with abundance of un-sol-sp and vitality from 2 to 4 points.

As well as in the previous described communities the vegetable cover is created in three tiers: top wood (height of 100–200 cm) consists of individuals of *Haloxylon aphyllum*; the average tier — tall herbs (height of 40–80 cm) is presented by *Artemisia arenaria*, *Ferula foetida*, *Cousinia astracanica*; the third grassy tier (up to 40 cm high) is composed by all other species of this community.

Occurrence of individuals of *Ferula foetida* was 0.3–0.4 pieces/sq.m. All age states are revealed; in a generative phase 5–6–7 years individuals are noted. Total number of the blossoming individuals did not exceed 15 %.

The analysis of a ratio of uneven-age plants of *Ferula foetida* showed that individuals of 4–7 years age prevail, whereas subgrowth (1–3 years plants) is presented in a considerable share less (Table 2). Possibly, it can be explained with droughty conditions of several last years that it led to smaller number of shoots in Tuyesu sands.

Sands in the neighborhood of wintering Karkol. This place is located in a northeast part of the Mangystau region, near border with the Atyrau region. Sands represent the extensive sandy massifs places, which are weak-fixed; certain sites are good-fixed. *Ferula* meets on sands sporadically, forming small sites of communities. The microrelief is well developed.

Traces of pasturable loading in the surveyed territory are noted. Occurrence of individuals of *Ferula foetida* was 0.3–0.8 pieces/sq.m. All age states are revealed; in a generative phase are noted 5–6–7 years individuals. About 20–25 % of individuals were blossoming; the main part was in a phase of the radical leaf basket. *Ferula* populations in the current year were in depression that connected with droughty conditions — high summer temperatures and lack of rainfall. On sands it is described cereal-wormwood-ferula and eremopyron-wormwood-herba varia communities.

Cereal-wormwood-ferula community (*Ferula foetida* — *Artemisia terrae-albae* — *Poa bulbosa*) is dated for flat sites with small height difference. Dominant in community was *Poa bulbosa* which performed with abundance cop 2 and vitality 4 points, co-dominants were *Artemisia terrae-albae* with abundance cop 1 and *Ferula foetida* with abundance cop-sp (Table 5).

Table 5

Floristic composition of cereal-wormwood-ferula communities with participation of *Ferula foetida*

Species	Consort	Abundance on Drudae	Vitality, point	Tier
1	2	3	4	5
<i>Poa bulbosa</i>	Dominant	cop 2	4	2
<i>Artemisia terrae-albae</i>	Co-dominant	cop 1	3–4	2
<i>Ferula foetida</i>	Co-dominant	cop-sp	4	1
<i>Ceratocephala testiculata</i>	Component	sol	2–3	2
<i>Alyssum desertorum</i>	Component	sol	3	2

Continuation of Table 5

1	2	3	4	5
<i>Ceratocarpus arenarius</i>	Component	sol	3	2
<i>Ferula nuda</i>	Component	sol	3–4	1
<i>Carex physoides</i>	Component	sp	3	2
<i>Eremopyrum orientale</i>	Component	sol	3	2
<i>Astragalus testiculatus</i>	Component	un	4	2
<i>Allium capsicum</i>	Component	sol	4	2
<i>Kochia prostrata</i>	Component	sol	3	2
<i>Arnebia decumbens</i>	Component	sol-un	3	2
<i>Trigonella arcuata</i>	Component	sol-un	3	2
<i>Agropyron desertorum</i>	Component	sol	3–4	2
<i>Papaver pavonicum</i>	Component	un	4	2
<i>Astragalus arbusculiformis</i>	Component	sol	3	1

The vegetable cover is put by two grassy tiers: top (height of 40–100 cm) which consists of *Ferula foetida*, *Ferula nuda* and *Astragalus arbusculiformis*; lower (up to 35 cm high) is formed by other grassy plants and semi-low shrubs.

The specific structure of community is estimated at 18–19 species with abundance from un to sp and vitality 2–4 points. GPC made about 50 %. Among the described individuals are noted plants aged from 1 up to 7 years. In generative state individuals are noted 5–7 years age plants that made up to 25 % of the total number of plants of *Ferula foetida*.

The ratio of age groups of plants showed prevalence of individuals of 4–7 years age whereas young plants (aged from 1 up to 3 years) occupied only 25 %.

Eremopyron-wormwood-herba varia community (*Herba xerophytica* — *Artemisia terrae-albae* — *Eremopyrum orientale*) is located in the western part of the sandy massif. GPC was 70–80 %. The sandy soils which are well fixed; the territory represented the plain with the developed microrelief.

To dominants in community was *Eremopyrum orientale* with abundance cop 2 and vitality 4 points; co-dominants were *Artemisia terrae-albae* with abundance cop 1 and vitality 3 points and *Ferula foetida* with abundance of sp-cop and vitality 4 points (Table 6).

Table 6

Floristic composition of eremopyron-worwood-ferula community

Species	Consort	Abundance on Drudae	Vitality, point	Tier
<i>Eremopyrum orientale</i>	Dominant	cop 2	4	2
<i>Artemisia terrae-albae</i>	Co-dominant	cop 1	3	2
<i>Ferula foetida</i>	Co-dominant	sp-cop	4	1
<i>Anabasis aphylla</i>	Component	sol	2–3	1
<i>Poa bulbosa</i>	Component	sol	4	2
<i>Alyssum desertorum</i>	Component	sol	3	2
<i>Peganum harmala</i>	Component	sol	3–4	2
<i>Carex physoides</i>	Component	sol-sp	4	2
<i>Ceratocarpus arenarius</i>	Component	sol	3–5	2
<i>Ceratocephala testiculata</i>	Component	sol	3	2
<i>Astragalus sp.</i>	Component	sol-un	4	2
<i>Agropyron desertorum</i>	Component	sp-sol	3	2
<i>Kochia prostrata</i>	Component	sol	3	2
<i>Senecio noneanus</i>	Component	sol	3	2
<i>Arabidopsis thaliana</i>	Component	sol	3	2
<i>Tragopogon ruber</i>	Component	sol	3–4	2
<i>Megacarpaea melanocarpa</i>	Component	sol	4	2
<i>Papaver pavonicum</i>	Component	un	4	2
<i>Artemisia arenaria</i>	Component	sol	3	2
<i>Ferula nuda</i>	Component	sol	3	2
<i>Alhagi pseudoalhagi</i>	Component	sol	4	2
<i>Gypsophila paniculata</i>	Component	sol	4	2

The floristic structure of this community is formed by 21–22 species with abundance of un-sol-sp and vitality 2–5 points. As well as in the previous community, species are placed in 2 vertical tiers. The top tier is formed by individuals of *Ferula foetida* and *Anabasis aphylla*; the second tier — undersized grassy plants and semi-low shrubs — *Tragopogon ruber*, *Kochia prostrata*, *Artemisia arenaria*, *Gypsophila paniculata*, *Senecio noneanus* and others.

GPC in community made 70–80 %, individuals of *Ferula* aged from 1 up to 5 years are presented. In a phase of blossoming there were 5-year plants.

Plateau Tynymbay shoky. On this point it is described wormwood-ferula-arthrophytum community (*Arthrophytum lehmannianum* — *Ferula foetida* — *Artemisia terrae-albae*). GPC was 60–65 %, specific structure included from 30 to 33 species (Table 7).

Table 7

**Floristic composition of wormwood-ferula-arthrophytum community
with participation of *Ferula foetida***

Species	Consort	Abundance on Drudae	Vitality, point	Tier
<i>Artemisia terrae-albae</i>	Dominant	cop 1, 2	4	1
<i>Ferula foetida</i>	Co-dominant	cop 1	4–5	1
<i>Arthrophytum lehmannianum</i>	Co-dominant	cop 1-sp	5	1
<i>Agropyron desertorum</i>	Component	sol	4	2
<i>Alhagi kirghisorum</i>	Component	sol	4	2
<i>Allium caspium</i>	Component	sol	4	2
<i>Allium sabulosum</i>	Component	sol	4	2
<i>Artemisia arenaria</i>	Component	sp	4–5	2
<i>Artemisia lercheana</i>	Component	sol	4	2
<i>Astragalus ammodendron</i>	Component	sol	3	2
<i>Astragalus erioceras</i>	Component	sol	4	2
<i>Calligonum dubjanskyi</i>	Component	sol	3–4	1
<i>Ceratocarpus arenarius</i>	Component	sol	4	2
<i>Climacoptera brachiata</i>	Component	sol	4	2
<i>Consolida divaricata</i>	Component	sol	4–5	2
<i>Cousinia alata</i>	Component	sol	4	2
<i>Echinops ritro</i>	Component	sol	4	2
<i>Eremopyrum buonapartis</i>	Component	sol	4	2
<i>Haplophyllum obtusifolium</i>	Component	sol	4–5	2
<i>Heliotropium arguzioides</i>	Component	sol	4	2
<i>Heliotropium dasycarpum</i>	Component	sol	4	2
<i>Heliotropium ellipticum</i>	Component	sol	4	2
<i>Iris tenuifolia</i>	Component	sol	4	2
<i>Kochia iranica</i>	Component	sol	4	2
<i>Kochia prostrata</i>	Component	sol	5	2
<i>Orobanche sp.</i>	Component	un	3	2
<i>Poa bulbosa</i>	Component	sol	4–5	2
<i>Rhinopetalum karelinii</i>	Component	un	4	2
<i>Salsola arbuscula</i>	Component	sol-sp	3–4	2
<i>Salsola dendroides</i>	Component	sol	3–4	1
<i>Scandix stellata</i>	Component	sol	4	2
<i>Stipa lessengiana</i>	Component	sp	5	2
<i>Zygophyllum turcomanicum</i>	Component	sol-un	4	2

Artemisia terrae-albae dominated in community with abundance cop 1, 2 and vitality 4 points, co-dominants are *Ferula foetida* with abundance cop 1 and vitality 4–5 points, and *Arthrophytum lehmannianum* with abundance of cop-sp and vitality 5 points. Other species in community are components having abundance of un-sol-sp and vitality from 3 to 5 points.

Vital forms in community are presented by bushes, low shrubs, semi-low shrubs and grassy forms. The ratio of age groups showed prevalence of 4 years individuals — 20 % (Table 2) whereas the share of other made groups 10–15 %.

Distribution of plants on vertical structure happens in 2 tiers. Two vertical tiers are allocated: a shrubby tier (height of 120–180 cm) and grassy with subtiers high (height of 40–55 cm) and low herbs (up to 25 cm high).

The top tier forms *Calligonum dubjanskyi* and *Astragalus ammodendron*; the top grassy subtier — *Agropyron desertorum*, *Alhagi kirghisorum*, *Stipa lessengiana*; the lower subtier is formed *Ceratocarpus arenarius*, *Zygophyllum turcomanicum*, *Allium caspium*, *Salsola paulsenii*, *Iris tenuifolia*, *Rhinopetalum karelinii*, *Consolida divaricata*, *Allium sabulosum*, *Artemisia terrae-albae*, *Heliotropium ellipticum* and others. *Ferula foetida* can borrow both the top and lower subtier, depending on a vegetation phase.

We carried out the assessment of some morphological indicators of above-ground parts of the blossoming individuals of *Ferula foetida* (Table 8).

Table 8

Morphometric indicators of elevated bodies of the blossoming individuals of *Ferula foetida* in places of natural growth

Location	Communities with participation of <i>Ferula foetida</i>	Height of plants, cm		Diameter of radical leaf basket, cm		Diameter of blossom, cm	
		$\frac{M \pm m}{\text{min-max}}$	Cv	$\frac{M \pm m}{\text{min-max}}$	Cv	$\frac{M \pm m}{\text{min-max}}$	Cv
Sands in the neighborhood of a wintering Karkol	Cereal-wormwood-ferula	$\frac{98.5 \pm 5.4}{74-128}$	5.5	$\frac{88.4 \pm 5.9}{68-110}$	6.7	$\frac{56.7 \pm 5.8}{28-90}$	10.3
	Eremopyron-wormwood-herba varia	$\frac{100.5 \pm 3.6}{80-115}$	3.6	$\frac{93.4 \pm 9.6}{60-144}$	10.3	$\frac{55.9 \pm 6.3}{30-81}$	11.3
Tuyesu sands	Saxaul-wormwood	$\frac{110.2 \pm 2.9}{97-129}$	2.7	$\frac{70.4 \pm 4.4}{50-90}$	6.2	$\frac{53.7 \pm 4.8}{42-84}$	8.9
	Wormwood-ferula-herba varia	$\frac{110.4 \pm 4.6}{88-131}$	4.2	$\frac{81.0 \pm 3.3}{55-98}$	4.1	$\frac{58.9 \pm 2.8}{29-87}$	4.8
	Saxaul-wormwood-herba varia	$\frac{98.0 \pm 3.8}{75-122}$	3.9	$\frac{78.5 \pm 5.2}{45-112}$	6.6	$\frac{56.1 \pm 5.0}{29-90}$	8.9
Plateau Tynymbay shoky	Wormwood-ferula-arthrophytum	$\frac{106.7 \pm 6.1}{79-135}$	5.7	$\frac{88.0 \pm 5.2}{46-95}$	5.9	$\frac{54.9 \pm 4.0}{36-88}$	7.3

Results showed that in all surveyed points indicators of morphology of *Ferula foetida* differed not considerably. So, the maximum values of height of the blossoming individuals are revealed in Tuyesu sands in a wormwood-ferula-herba varia community, minimum — also in Tuyesu sands in saxaul-wormwood-herba varia community.

The largest size of the radical leaf basket is revealed on sands in the neighborhood of a wintering Karkol in eremopyron-wormwood-herba varia community. The smallest of diameter of the radical leaf basket are recorded in Tuyesu sands in saxaul-wormwood-herba varia community.

The sizes of diameter of inflorescences changed from 28 to 90 cm. The minimum sizes are revealed at the individuals growing in saxaul-wormwood-herba community in Tuyesu sands, whereas maximum size was noted in a wormwood ferula-herba varia community, also in Tuyesu sands.

Conclusion

Six natural populations of *Ferula foetida* with the analysis of geobotanical indicators, structures of populations, morphological indicators are studied. It is shown that communities with participation of *Ferula foetida* can successfully growing on various types of soils — from sandy to loamy and stony. The following types of communities are described: saxaul-wormwood communities (*Artemisia terrae-albae* — *Haloxylon aphyllum*), wormwood-ferula-herba varia community (*Herba xerophytica* — *Ferula foetida* — *Artemisia arenaria*), saxaul-wormwood-herba varia community (*Herba xerophytica* — *Artemisia arenaria* — *Haloxylon aphyllum*), cereal-wormwood-ferula community (*Ferula foetida* — *Artemisia terrae-albae* — *Poa bulbosa*), eremopyron-wormwood-herba varia community (*Herba xerophytica* — *Artemisia terrae-albae* —

Eremopyron orientale), wormwood-ferula- arthrophytum community (*Arthrophytum lehmannianum* — *Ferula foetida* — *Artemisia terrae-albae*).

It is revealed that in all studied communities *Ferula foetida* carries out a role a dominant or the sodominant with abundance from sp to cop 2, has good vitality from 4 to 5 points. In structure of a coenopopulation ferula can enter as in lower grassy vertical (the virgin age period), so average shrubby and grassy tier (during generative period).

The point distribution map of populations of *Ferula foetida* on Mangyshlak with coverage of sands Karynzhar'yk, Tuyesu, Sam, Akkum, Kyzyl Kum, Bostankum, loamy hills in the neighborhood of plateau Tynymbay shoky, sandy massifs around a wintering Karkol is made.

The assessment of some morphological indicators of elevated bodies of *Ferula foetida* is carried out. Assessment of coefficient of variability showed that the studied morphological parameters vary at a low level variability that testifies to sign stability.

The received results of phytocenotic descriptions, structures of the revealed populations and morphological assessment testify to a possibility of practical using of the natural communities of *Ferula foetida*.

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Маңғыстау облысы жағдайында *Ferula foetida* (Bunge) Regel популяциясының құрылымын зерттеу

Мақалада Маңғыстау облысы аумағындағы сасық курайдың (*Ferula foetida*, *Apiaceae*) популяцияларының жай-күйін зерттеу нәтижелері келтірілген. Кезінде сасық курайдың табиғи популяцияларының өсу жағдайлары және күйі, популяцияның құрамы, құрылымы, онтогенез және полиморфизмі зерттелген. Қоғамдастықта жалпы проекциялық жамылғы 35–80 %-ды құрайды. Зерттелген аумақта жайылым жүктемесінің іздері байқалды. Сасық курайдың үлгілерінің кездесушілігі 0,1–0,8 дана/м². Табиғи популяцияларда бүкіл жастағы үлгілер анықталған — 1 жастан бастап 7 жастағы даналарға дейін. Генеративті фазада 5-6-7 жастағы даналар. Өртүрлі популяцияларда 15–55 % жуық даналар гүлдеді, ал қалған өсімдіктер жапырақтардың жертараған жапырақтар фазасында болды. Әрбір сипатталған популяцияда өсімдіктердің негізгі жас топтарының арақатынасы анықталған, фитоценотикалық құрамы мүшелерінің кейбір морфологиялық көрсеткіштері анықталған. Осы нәтижелер сасық курайдың анықталған табиғи қопаларын практикада пайдалануға болатынын дәлелдеді.

Кілт сөздер: *Ferula foetida*, Маңғыстау, молшылық, таралу, флористикалық құрамы, қауымдастық, морфология, жас тобы.

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Изучение структуры популяций *Ferula foetida* (Bunge) Regel в условиях Мангистауской области

В статье приведены результаты исследования состояния популяций ферулы вонючей (*Ferula foetida*, *Apiaceae*) на территории Мангистауской области. Изучен состав, структура популяций, полиморфизм, условия произрастания и состояние природных популяций ферулы вонючей. Общее проективное покрытие в сообществе составило от 35 до 80 %. Встречаемость особей ферулы вонючей 0,1–0,8 шт./м². В природных популяциях выявлены все возрастные состояния — от 1-летних до 7-летних особей; в генеративной фазе отмечены 5-6-7 летние особи. На различных популяциях отмечено цветение порядка 15–55 % особей, остальная часть растений находится в фазе прикорневой розетки листьев. Определено соотношение основных возрастных групп растений на каждой описанной популяции, определен фитоценотический состав, некоторые морфологические показатели надземных органов. Полученные результаты фитоценологических описаний и площадей выявленных зарослей свидетельствуют о возможности практической эксплуатации природных зарослей ферулы вонючей.

Ключевые слова: *Ferula foetida*, Мангышлак, обилие, распространение, флористический состав, сообщество, морфология, возрастная группа.

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