Edaphic Growing Conditions of Tulipa Cenopopulations in the Black Lands Nature Reserve

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Abstract – The paper studies edaphic conditions of the cenopopulation of Tulipa gesneriana, T. biflora and T. biebersteiniana growing in the Black Lands nature reserve. These cenopopulations belong to rare and protected plants in many regions of Russia, including the Republic of Kalmykia. The soil profile cuts are described in terms of the morphology of soil horizons and the content of humus, structure of cations and anions, as well as the particle size distribution of samples via standard techniques are analyzed. The physical and chemical characteristics of habitat soils made it possible to conclude that Tulipa gesneriana preferably grows in meadow chestnut soil in a steppe zone; Tulipa biflora – more often in saline alkali soil in a desert zone; Tulipa biebersteiniana has broader edaphic plasticity and grows both in steppe and in desert zones in different types of soils.

Keywords – tulip species; cenopopulation; plant community; edaphotope.

I. INTRODUCTION

A complex of environmental factors, among which the edaphic factor is particularly important, have strong effect on the structure of plant populations as a component of vegetative community [1–4]. During a complex study of ecology and biology of bulbous ephemeral cenopopulations growing in the North-West Caspian Sea region [5, 6], we analyzed the edaphic conditions of three types of Tulipa species growing in the Black Lands national nature biosphere reserve. The study covered bulbous ephemeral late tulip (Tulipa gesneriana L.), biflorate tulip (Tulipa biflora Pall.) and Bieberstein tulip (Tulipa biebersteiniana Schult. et Schult.) belonging to protected species in some regions of Russia [7–9]. In this regard the obtained data on ecology and biology of these species can be used to develop the corresponding measures for their preservation.

II. METHODS AND MATERIALS

The study of tulip species in natural populations was conducted in two parts of the Black Lands nature reserve: on its main site Stepmoy located in a desert zone of the Caspian Plain and in the Manych valley on the ornithological site of the reserve. T. gesneriana was presented by two cenopopulations (No. 1, No. 2) within the ornithological site, T. biflora – two cenopopulations (No. 3, No. 4) within the main site, T. biebersteiniana – two cenopopulations (No. 5, No. 6) within the main site and two cenopopulations (No. 7, No. 8) within the ornithological site. During the study we described the soil profile cuts in terms of the morphology of soil horizons and the content of humus, structure of cations and anions, as well as analyzed the particle size distribution of samples. Thus, selection, preparation and laboratory analysis of soil were carried out via standard techniques [10–12].

III. RESULTS

Cenopopulation Tulipa gesneriana No. 1 was part of Poacetata - Mixteherbosa plant community in the ornithological site of the reserve. This site is characterized by meadow-chestnut alkali soils salted more than 80 cm deep. The morphological profile of the top layer of A1 (horizon) is solodized, dry, light gray with whitish color, lumpy, with plant roots, compacted, average loamy, thickness – 6 cm; in A2 horizon (6-22 cm) it is dry, gray, lumpy, compacted, with plant roots, heavy loamy; in B horizon (22-47 cm) it is dry, dark-brown, varicolored, coarsely nutty, with plant roots and parts of stems, compacted, clay, bubbles; in BCA horizon (47-67 cm) it is dry, with white-eyed bream, light-brown with yellowish spots.
of carbonates, nutty, dense, clay, violently bubbles; in C horizon (67-80 cm) it is dry, yellowish-brown, with white veinlet and dots of gypsum, compacted, clay, with rare plant roots, bubbles (Tab. 1, Fig. 1).

| TABLE I. PARTICLE SIZE DISTRIBUTION OF STUDIED COMMUNITIES |
|------------------------------------------------------------|
| n/n | Cenopopulation | Depth, cm | Hygroscopic moisture content, % | 1-0.25 | 0.25-0.06 | 0.06-0.01 | 0.01-0.005 | 0.005-0.001 | <0.001 | <0.001 |
|-------------------------------|-----------------|-----------|-------------------------------|--------|-----------|-----------|------------|-------------|--------|--------|
| 1. | No. 1 | 0-6 | 2.95 | 0.97 | 1036 | 48.69 | 9.84 | 14.00 | 16.44 | 39.38 |
| 2. | No. 1 | 6-22 | 3.05 | 0.57 | 11.47 | 40.70 | 7.38 | 17.45 | 22.43 | 47.26 |
| 3. | No. 1 | 22-47 | 5.51 | 0.29 | 6.17 | 26.03 | 4.32 | 14.86 | 48.33 | 65.71 |
| 4. | No. 1 | 47-67 | 4.56 | 0.21 | 10.05 | 23.40 | 7.55 | 18.74 | 39.45 | 65.74 |
| 5. | No. 1 | 67-80 | 3.50 | 0.23 | 25.06 | 17.24 | 9.54 | 18.24 | 29.68 | 57.46 |
| 6. | No. 2, No. 8 | 0-7 | 2.25 | 0.44 | 14.04 | 50.06 | 10.35 | 14.72 | 10.39 | 35.46 |
| 7. | No. 2, No. 8 | 7-25 | 2.71 | 0.91 | 11.04 | 44.56 | 7.73 | 17.76 | 18.00 | 43.49 |
| 8. | No. 2, No. 8 | 25-47 | 4.85 | 0.81 | 4.53 | 37.31 | 3.88 | 22.46 | 31.01 | 57.35 |
| 9. | No. 2, No. 8 | 47-69 | 3.99 | 0.37 | 5.55 | 38.21 | 7.87 | 10.09 | 38.08 | 56.04 |
| 10. | No. 2, No. 8 | 69-80 | 2.95 | 32.03 | 5.11 | 16.89 | 4.49 | 14.66 | 26.82 | 45.97 |
| 11. | No. 2, No. 8 | 80-100 | 3.05 | 0.74 | 12.04 | 27.31 | 9.64 | 19.63 | 30.64 | 59.91 |
| 12. | No. 3 | 0-5 | 3.05 | 6.25 | 2.22 | 23.05 | 6.73 | 21.23 | 19.92 | 47.88 |
| 13. | No. 3 | 5-15 | 4.16 | 3.57 | 3.91 | 54.43 | 4.41 | 13.80 | 19.86 | 38.07 |
| 14. | No. 3 | 15-50 | 4.18 | 1.95 | 14.29 | 18.58 | 8.39 | 23.18 | 33.61 | 65.18 |
| 15. | No. 4 | 0-5 | 3.12 | 6.28 | 22.83 | 23.07 | 6.76 | 21.25 | 19.91 | 47.89 |
| 16. | No. 4 | 5-15 | 4.24 | 3.60 | 3.95 | 54.49 | 4.44 | 13.76 | 19.84 | 38.09 |
| 17. | No. 4 | 15-50 | 4.26 | 1.99 | 14.30 | 18.69 | 8.42 | 23.15 | 33.60 | 65.21 |
| 18. | No. 5 | 0-10 | 1.86 | 24.66 | 32.95 | 21.66 | 6.99 | 7.93 | 58.1 | 20.73 |
| 19. | No. 5 | 10-50 | 2.57 | 6.60 | 35.66 | 29.41 | 8.09 | 7.43 | 12.81 | 28.33 |
| 20. | No. 6 | 0-10 | 1.62 | 24.69 | 32.98 | 21.67 | 7.01 | 7.96 | 58.1 | 20.76 |
| 21. | No. 6 | 10-50 | 2.60 | 6.63 | 35.69 | 29.42 | 8.11 | 7.45 | 12.83 | 28.36 |
| 22. | No. 7 | 0-6 | 2.93 | 0.96 | 10.95 | 48.88 | 8.92 | 13.98 | 16.43 | 39.33 |
| 23. | No. 7 | 6-23 | 3.03 | 0.56 | 11.46 | 40.69 | 7.36 | 17.43 | 22.41 | 47.23 |
| 24. | No. 7 | 23-47 | 5.09 | 0.26 | 6.16 | 26.02 | 4.30 | 14.84 | 48.31 | 67.50 |
| 25. | No. 7 | 47-67 | 4.54 | 0.20 | 10.64 | 23.38 | 7.53 | 18.72 | 39.43 | 65.72 |
| 26. | No. 7 | 67-80 | 3.48 | 0.23 | 25.05 | 17.22 | 9.52 | 18.22 | 29.69 | 57.45 |

The analysis showed high humus content in the soil of A1 horizon (6.15%), which decreases with depth by 3.09% and more.

According to the chemical composition of water extract, the soil is not salinified up to the depth of 80 cm (Fig. 1).

Cenopopulation Tulipa gesneriana No. 2 and T. biebersteiniana No. 8 belong to Artemisia austriaica - Festuca valesiaca - Mixtheberboa communities growing in a steppe zone of the reserve. The study showed that the community of both cenopopulations is formed on meadow-chestnut alkalai soils (salted more than 100 cm deep). A1 horizon: 0-7 cm deep – solodized, dry, light gray with whitish color, lumpy, with plant roots, compacted, average loamy. A2 horizon (7-25 cm deep) – dry, gray, lumpy, compacted, with plant roots, heavy loamy. B horizon (25-47 cm deep) – dry, dark-brown, varicolored, coarsely nutty, with plant roots and parts of stems, compacted, clay, bubbles. Ban horizon (47-67 cm deep) – dry, with white-eyed bream, light-brown with yellowish spots of carbonates, nutty, dense, clay, violently bubbles. C horizon (69-80 cm deep) – dry, yellowish-brown, with white veinlet and dots of gypsum, compacted, clay, with rare plant roots, bubbles. C horizon (80-100 cm deep) – dry, whitish-light gray, varicolored, nutty-banded, with white impregnation, dry, loamy, compacted, bubbles (Tab. 1).

The hygroscopic moisture content of soil in A1 horizon makes 2.77%, which decreases by 1.03-2.03% while moving across the horizons.

According to the mineral composition of water extract the soil is not salted up to the depth of 100 cm.

Cenopopulation Tulipa biflora No. 3 grew as part of Artemisia larcheana - Poa bulbosa communities in the main site of the reserve.

The study showed that the community is formed in saline alkalai soils. Morphological description of horizons: A1 horizon (0.5 cm deep) – above natric horizon, dry, whitish-gray, lumpy-dusty, densely rooted, slightly compacted, loamy, bubbles on surface; B horizon (5-15 cm deep) – natric horizon, humified, reddish-brown with rare white veinlets of salt, cheesy in wet condition, loose in dry condition, with plant roots, heavy loamy; BC horizon (15-50 cm deep) – below natric horizon, humified, reddish-brown with rare white dots of salts, crumbling-cheesy, compacted, clay (Tab. 1).

The hygroscopic moisture content of soil in A, B and BC horizons makes 2.15%, 1.50% and 1.37% respectively.

According to the mineral composition of water extract the soil is salted from 10 cm by sodium chloride: in a layer of 10-
20 cm – to a weak degree, in a layer of 20-50 cm – to an average degree (Fig. 2). The cenopopulation of *Tulipa biebersteiniana* No. 7 was a part of *Artemisia lercheana* - *Poa cetera* – *Mixteherbosa* community in a steppe zone of the reserve. In the place of growth this cenopopulation has meadow-chestnut alkali soils (salted below 80 cm). The morphological profile of the soil in A1 horizon (0-6 cm) looks solodized, dry, light gray with white stripes, lumpy, has numerous plant roots and parts of stems, compacted, average loamy; in A2 horizon (6-22 cm) it is dry, gray, lumpy, compacted, with numerous plant roots, heavy loamy; in C horizon (22-47 cm) it is dry, dark-brown, varicolored, coarsely nutty, with numerous plant roots and parts of stems, compacted, clay, bubbles; in BCA horizon (47-67 cm) it is dry, light-brown with yellowish spots of carbonates, nutty, dense, clay, with white-eyed bream, violently bubbles; in C horizon (67-80 cm) it is dry, yellowish-brown, with white veinlets and dots of gypsum, compacted, clay, with rare plant roots, bubbles (Tab. 1).

According to the mineral composition of water extract the soil is not salted up to the depth of 80 cm (Fig. 3).

Cenopopulation *Tulipa biebersteiniana* No. 5 belongs to *Artemisia - Poa bulbosa - Ephemerosa* community in the main site of the reserve.
According to the study the community grows in brown semidesertic sandy loamy soils. The morphological profile of the top layer of two identified horizons (A horizon: 0-10 cm) is yellowish-brown, with numerous plant roots and vegetable debris, dusty, loose, sandy loamy. In C horizon (10-50 cm) it is reddish-brown, with plant roots and vegetable debris, sandy loamy, loose (Tab. 1).

Fig. 3. Composition of cations and anions of water extract of soils of vegetative communities with cenopopulation No. 5 Tulipa biebersteiniana. The analysis showed high humus content in the soil of A1 horizon (6.38%), which decreases by 3.15% and more with depth.

Fig. 4. Composition of cations and anions of water extract of soils of vegetative communities with cenopopulation No. 7 Tulipa biebersteiniana.

Weak humus content of the top layer is typical for soils of this community – 1.37%.

According to the mineral composition of water extract the soil is not salted up to the depth of 50 cm (Fig. 4).

Cenopopulation Tulipa biebersteiniana No. 6 belongs to Poa bulbosa – Ephemerosa community in the main site of the reserve.

It is found that in the place of localization of this population the soils are brown semi-dried sandy loamy. The morphological profile of the soil in the top horizon (A horizon: 0-10 cm) is yellowish-brown, with numerous plant roots and vegetable debris, dusty, loose, sandy loamy, C horizon (10-50 cm) is reddish-brown, contains roots and parts of plants and seeds, sandy loamy, loose (Tab. 1).
Weak humus content of the top layer is typical for soils of this community – 1.29%.

The analysis of water extract within this cenopopulation was similar to cenopopulation No. 6 carried out on this key site and did not reveal any salinization up to the depth of 50 cm.

IV. CONCLUSION

The physical and chemical analysis of habitat soils made it possible to conclude that Tulipa gesneriana preferably grows in meadow chestnut soil in a steppe zone; Tulipa biflora – more often in saline alkali soil in a desert zone; Tulipa biebersteiniana has broader edaphic plasticity and grows both in steppe and in desert zones in different types of soils.

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