Chalk hills of northwest Kazakhstan as biodiversity refugia

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Abstract: *This paper presents a floristic study of North-West Kazakhstan, including the West-Kazakhstan, Actobe and Atyrau regions. Notable within this area are the chalk hills of Obshii Syrt (height of 252 m. above sea level), the Sub Ural plateau (260-400 m) and Emba plateau (110-170 m). The chalk hills are refugia of floristic diversity, where 938 species were recorded and comprehensively analysed. In addition, relicts, endemics, subendemics, and rare and endangered species were listed.*

Keywords: chalk hills, biodiversity, refugia, floristic studies, endemics, relicts.

Introduction

Northwest Kazakhstan represents a natural physiographic region stretching from the Volga river in the west to the Mugodzhar mountains in the east, and from Obshii Syrt in the north to the coast of Caspian sea in the south, i.e. 52° to 48° latitude and 46° to 58° longitude (Ogureeva and others, 1999).

Within the Northwest Kazakhstan Obshii Syrt (OS) and Sub Ural plateau (SUP), the chalk hills stand out floristically. The southern part of Sub Ural plateau is known as the Emba plateau (EP).

Northwest Kazakhstan (NWK) is situated at the intersection of the Eurasian steppe and the Saharo-Gobiiskiy desert areas. There are important subzonal boundaries: northern, middle and south fescue-feather steppes adjoining temperate deserts.

This location is one reason for the high floristic diversity of NWK, in which 938 species have been recorded (Darbayeva, 2002). Regarding floristic composition, there are large differences between the various regions. In the northern part (Obshii Syrt) genera such as as *Betula*, *Corylus* and *Euonymus* are found. In the eastern part (Sub Ural plateau), *Capparis*, *Leontice*, *Anabasis*, *Lagochilus* and *Rhammatophyllum* are found. In southern part (the Emba plateau) there are species such as *Astragalus mugodsharicus*, *A. subarcuatus*, *A. temirensis*, *Rubia cretacea* and *Anabasis brachiata*.

Methods

The studies were conducted by flora routing method combined with fixed key areas of research at the Obshii Syrt, Subural plateau and Emba plateau where the observations were done on the structure and dynamics of vegetation. Collection and processing of herbarium material followed Skvortsov`s standard technique, 1977.

"Flora of the USSR" (1934-1964), and "Flora of Kazakhstan" (1956-1967) were used for the determination of plants, as well as "Flora of the south-east of the European part of the USSR" (1927-1936) and Ivanov's identification guide (1964-1989).

The flora list was created in accordance with the system of Tahtadzhyan (1997). For taxonomical nomenclature Cherepanov`s latest reports (1981, 1995) were used. In the analysis of the flora we used biological and morphological classification.

Results and Discussion

Analysis of the flora of the chalk hills concerning both taxonomic (classification) indicators and composition of life forms and eco-phytocenological analysis showed that this flora is typical for Eurasian steppe areas. According to these indicators, the areas are floristically similar to moderately dry Mediterranean region flora. The structure of the geographical elements also characterize this flora as steppe, on the border of the Holarctic kingdom and the Mediterranean region subkingdoms. The regional speciality of this flora is the significant number of north-Turanian species. Some of these species are subendemic for cretaceous landscapes of NWK and a part of an indiginous nucleus of this flora.

Based on our study of 938 species, the NWK calcium-phyto nucleus includes 218 species from 110 genera, within 29 families. The species distribution of the flora on cretaceous hills is uneven.

114 species were found on OS, 173 on SUP and 125 species on EP.

The flora of SUP turned out to be richer because it includes European, Eurasian and Turanian complexes. Here we consider in detail the SUP, where we defined the following ecotopes:

Class of ecotopes (CE) at the top, at the foot and plateau of chalk hills with montano-desert-calcicole and calcicole groupings.

CE of northern and western slopes with mesophytic-calcicole complexes.

CE of southern and eastern slopes with xerophytic-calcicole complexes.

CE of plain steppe communities.

CE of short-term pioneer communities of chalk and marl slopes, ravines and gullies.

CE of the foot of chalk slopes with a complex of halophytic-desert and petrophytic-steppe communities.

CE of springs, streams and ponds, occurring among the Cretaceous uplands with a complex of hygrophytic and mesophytic species.

In the northern part of Sub Ural plateau Utvinskiy landscape area is ecotopically richer, where seven classes of ecotopes are represented. The SUP plateau is a plain with a height of 180-280 m above sea level, divided with a system of quite wide river valleys (Utva, Ishkargan, Ilek). Salt-dome tectonics and erosive processes are pronounced.

Chalk ridges with outlays (Figure. 1, 2, 3) are included in this area, which begin from the village of Mirgorodka (263 m). Chalk hills and individual chalk outcrops are occupied by calcicole and petrophytic groupings, where 33 species are concentrated, including *Anabasis cretacea*, *Hedysarum gmelinii*, *H. grandiflorum.*, *H. razoumovianum*, *Linum flavum*, *Rhamnatophyllum pachyrhizum, Limonium macrorhizon, Orostachys spinosa, Silene cretacea, Nanophyton erinaceum* (Figure. 4-6).

Comparison of three heights showed that 66 species are frequent within these floras, and make up 30.2 % of the total number of individuals. The application of Jacquards coefficient in comparison to EP and SUP species composition showed that they are rather similar (K=0.46) and EP is strongly differs from OS (K=0.22).

Fig. 1 Cretaceous outcrop on the surrounding of Mirgorodka village. Photo: authors

Fig. 2 Shatyrly cretaceous outcrop. Photo: authors

Fig. 3 "Piramida" cretaceous outcrop. Photo: authors

Conclusion

All three flora have a cretaceous floristic nucleus, but their structure at different heights varies considerably. Similarity analysis of calcicole nuclei with the flora of chalk hills of Orenburgskiy, Samarskiy, Volgogradskiy, Rostovskiy and Voronezhskiy regions showed that the flora of the chalk landscapes of Orenburgskiy and Samarskiy regions are similar to the flora of the NWK, with about two thirds being made up of the same calcicole species. This similarity decreases sharply in the floras of the right bank of the Volgograd region and further west, in theVoronezh and Rostov regions. This gives us reason to assert that the trans-Volga West-Kazakhstan regions of chalk landscapes have their own special chalk flora, which differs from other "chalky" floras. The nucleus of this ancient flora is calcicole trans-Volga West-Kazakhstan steppe species and northturanian calcicole desert species.

In the calcicole complex of NWK, an autochthonic nucleus stands out from the 218 species, composed of 59 species, 43 genera and 20 families. An autochthonic nucleus includes 16 species on OS, 36 species on SUP, and 37 species on EP.

Among the distinctive and rare species of chalk outcrops of NWK, the endemic complex stands out including 41 species, the half of which are formed of local and narrow local endemics. Local regional elements include Aralocaspian (*Anabsis brachyata, A. cretacea, A. eriopoda, A. truncate, Asparagus inderiensis, Lagochilus acutilobus, Lepidium songaricum, Matthiola fragrans, Zygophyllum turcomanicum, Rhammatophyllum frutex*), Caspian (*Heterocaryum rigidum, Sueda dendroides, Petrosimonia glaucescens, P. monandra*) and North-caspian (*Onosma staminea*) endemics.

Among the narrow local endemics there are three Mugodzhar species (*Astragalus mugodscharicus, A. subarcuatus, A. temirensis*), one West-Kazakhstan (*Rubia cretacea*) and one area near the Uralsk, the so called "Syrtovo-poduralskoye" (*Jurinea kirgisorum*).

Probably the endemic complex was formed at the end of the Miocene to early Pliocene on the basis of regional Turanian (Neronov, 1985; Khobom, 2000) and the ancient Mediterranean calcicol and petrophytic species. The influence of the adjacent floras of Obshii Syrt, Privolzhskiy and even the Central Russian Upland (Langer, 1997) was affected on the formation of the complex. The final formation of the flora of these chalk landscapes took place over a long period from the Pliocene to the Holocene, so we can suppose that the narrow local Mugodzhar and West-Kazakhstan species are relatively young (Pleistocene-Holocene).

This analysis confirms that chalk hills of Northwest Kazakhstan is a refugium, where the unique flora of calcicole-petrophytic species has been preserved.

Fig. 4 Limonium macrorhizon. Photo: authors

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Fig. 5 Anabasis cretacea. Photo: authors

Fig. 6 Nanophyton erinaceum. Photo: authors