HIGH-MOUNTAIN STEPPE ALPINE MEADOWS OF AZERBAIJAN: FLORISTIC DIVERSITY, PHYTOCENOTIC STRUCTURE AND ECOLOGICAL CHARACTERISTICS

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Abstract

The article studies the floristic composition, phytocenotic structure and distribution characteristics of cereal-mixed steppe alpine meadows spread in the high mountainous areas of Azerbaijan. During the study, the *Festuceta-Thymetum* and *Festuceta-Kobresietum* formation groups formed in the alpine and subalpine belts of the Greater and Lesser Caucasus, as well as the Nakhchivan Autonomous Republic, were studied. It was determined that the main edificators of steppe alpine meadows are *Festuca versicolor* Tausch, *Festuca picta* Kit and various *Thymus* species. These phytocenoses develop mainly on peaty-grassy mountain-meadow soils at altitudes of 2600–3200 m.

As a result of the studies, the floristic composition, storeying and project cover of the *Festuceta picta-Thymetum nummularius* and *Festuceta versicolor-Thymetum collinus* associations were determined. In the studied associations, 21–27 species of higher plants were recorded, and it was determined that the grass cover varied between 60–80% of the design cover. In addition to species belonging to the *Poaceae* family, representatives of the genera *Thymus, Poa, Alchemilla, Taraxacum, Trifolium* and others predominate in the composition of phytocenoses.

The article also assesses the current state of steppe alpine meadows, degradation processes occurring as a result of anthropogenic impacts and grazing load. It was determined that in some areas, thinning of phytocenoses, soil erosion and a decrease in productivity are observed. Therefore, the protection of high-mountain pasture ecosystems, the implementation of anti-erosion measures and the application of efficient pasture management are of great importance.

Keywords: steppe alpine meadows, high mountain vegetation, phytocenosis, floristic composition, *Festuca versicolor*, *Thymus*, alpine belt, subalpine meadows, phytocenological structure, biodiversity.

Introduction

Alpine and subalpine meadows are an important component of high mountain ecosystems and are distinguished by their rich biodiversity, phytocenotic diversity and high fodder value. Alpine meadows, widespread in the Greater and Lesser Caucasus mountain systems of Azerbaijan, as well as in the high mountainous areas of the Nakhchivan Autonomous Republic, form the basis of natural pasture ecosystems [4. 8. 12. 17]. These meadows have a complex floristic composition and specific plant communities, formed under the influence of various ecological conditions.

Steppe alpine meadows develop mainly in high mountainous areas characterized by harsh climatic conditions, strong winds, intense solar radiation and limited soil moisture. As a result of the influence of these ecological factors, drought-resistant cereals and various herbaceous plants prevail here. In particular, *Festuca versicolor* Tausch, *Festuca picta* Kit and *Thymus* L species are considered the main edificators of steppe alpine meadows.

Researchers have conducted various studies on the distribution, floristic characteristics and phytocenotic structure of steppe meadows in the high mountain vegetation of the Greater and Lesser Caucasus. The literature indicates that the Festuca versicolor species has a dominant position in the alpine and subalpine belts, and that steppe meadows are relict in nature.

In recent years, as a result of anthropogenic influences, especially overgrazing and climate change, degradation processes have intensified in high mountain meadows. As a result, sparseness of phytocenoses, intensification of erosion processes and a decrease in forage productivity are observed. In this regard, the study of the floristic composition, phytocenotic structure and ecological state of steppe alpine meadows is of great scientific and practical importance.

The purpose of the study is to study the floristic composition, phytocenotic structure, distribution characteristics and modern ecological state of the formations and associations of cereal-variegated steppe alpine meadows distributed in the high mountainous areas of Azerbaijan.

Materials and methods

Research materials were collected from the steppe alpine meadow vegetation of the Greater and Lesser Caucasus mountain systems of Azerbaijan, as well as the high mountainous areas of the Nakhchivan Autonomous Republic. The study areas included the Shekarbay elevation (2720 m) of the Gadabay region, the vicinity of the Goyemli village (2850 m), the high mountainous areas of the Kecheldagh, Aghdaban and Hamzacholu ranges of the Kalbajar region, as well as the Khan plateau of the Sheki region located in the southern part of the Greater Caucasus.

Geobotanical studies were conducted based on route and stationary observation methods. The floristic composition of phytocenoses belonging to the steppe alpine meadows in the areas, the abundance of species, the stratification and the design cover were determined. The abundance of plant species was assessed according to the Drude scale, dominant and subdominant species were identified. During the study, phytocenological descriptions were given for formation, formation group and associations.

In order to study the structure of the vegetation cover, the stratification of phytocenoses and the

average height of the grass cover were recorded. The life forms of species in the associations, ecological characteristics and their participation in the project cover were determined. The project cover was estimated in percentage and the productivity status of phytocenoses was investigated.

The systematic designation of species was carried out according to the Flora of Azerbaijan. The classification of phytocenoses was carried out according to the dominant-determinant principle, and the *Festuceta-Thymetum* and *Festuceta-Kobresietum* formation groups belonging to steppe alpine meadows were identified. During the study, the impact of anthropogenic impacts, especially grazing and erosion processes, on the vegetation cover was also assessed.

Results and discussion

As a result of the conducted geobotanical studies, it was determined that the steppe alpine meadows with cereal-variegated grasses spread in the high mountainous areas of Azerbaijan have a rich floristic composition and a complex phytocenotic structure. *Festuceta-Thymetum* and *Festuceta-Kobresietum* formation groups dominate in the studied areas. These formation groups were mainly formed by the edification of *Festuca versicolor* Tausch, *Festuca picta* Kit and various thyme species.

During the study, the associations *Festuceta picta-Thymetum* nummularius and *Festuceta versicolor-Thymetum collinus* were identified in the steppe alpine meadows [1. 3. 11] In the first association, the dominant species was *Thymus nummularius* M Bieb, and the subdominant was *Festuca picta* Kit. 21 species of higher plants were recorded in the association. A total of 21 species of higher plants were recorded in the association. In the first layer of the phytocenosis, *Festuca picta* Kit., *Poa badensis* Haenke and other grasses predominated; in the second layer, *Thymus nummularius* M. Bieb., *Taraxacum stevenii* DC., and *Poa iberica* Fisch. et C.A. Mey. were dominant; while in the third layer, species such as *Trifolium canescens* Willd., *Hypericum perforatum* L., and *Alchemilla sericata* Reichenb. ex. Bus. prevailed. The average height of the grass cover varied between 15–40 cm, and the design cover varied between 60–80%. In the *Festuceta versicolor-Thymetum collinus* association, *Thymus collinus* Bieb was dominant, and *Festuca versicolor* Tausch was subdominant [1. 4. 9. 14. 27] species of higher plants were identified in this association, among which perennial grasses predominated. In the upper tier of the phytocenosis, species such as *Festuca versicolor* Tausch, *Festuca ovina* L, *Poa badensis* Haenke and *Poa pratensis* L are widespread, in the middle tier *Alchemilla sericata* Reichenb ex Bus, *Thymus* collinus Bieb. and *Bromopsis variegata* Bieb Holub, and in the lower tier *Amoria ambigua* Bieb Sojak, *Taraxacum stevenii* DC and *Plantago saxatilis* Bieb are widespread. The presence of mosses and lichens was observed in the lower tier. The total project cover was 60–80%.

Studies have shown that representatives of the *Poaceae* family are the main phytocenosis-forming species in steppe alpine meadows. In addition, species belonging to the genera *Thymus, Alchemilla, Trifolium, Astragalus* and *Veronica also* play an important role in the formation of phytocenoses [14. 18. 21. 4]. The predominance of xerophyte and mesoxerophyte species in the studied meadows is due to the harsh climatic conditions and limited moisture reserves of high-mountainous areas.

It has been established that in recent years, as a result of anthropogenic influences, especially intensive grazing and trampling, degradation processes have intensified in alpine meadows that have become steppe. In some areas, thinning of phytocenoses, washing of the soil surface and increased erosion phenomena are observed. Observations conducted in the Khan plateau of the Sheki region have shown that changes have occurred in the species composition of phytocenoses, and in some areas, productive grass cover has weakened and turned into unproductive pastures. The results obtained show that steppe alpine meadows, in addition to having high biodiversity, play an important role in maintaining the ecological stability of mountain ecosystems [23-27]. Therefore, the protection of these phytocenoses, regulation of grazing load, implementation of anti-erosion measures and the application of efficient use methods are considered important.

Conclusion

The conducted studies revealed that the grass-forb steppified alpine meadows widespread in the high mountainous regions of Azerbaijan are characterized by rich floristic composition and a complex phytocenotic structure. In the studied phytocenoses, species belonging mainly to the Poaceae family predominated, particularly *Festuca versicolor* Tausch and *Festuca picta* Kit. Various thyme species (*Thymus* spp.) also acted as dominant and subdominant components of these meadows.

It was determined that the steppified alpine meadows mainly develop at elevations of 2600–3200 m on peaty-sod mountain-meadow soils, where xerophytic and mesoxerophytic species prevail in the phytocenotic structure. The associations exhibited high stratification, projective cover, and biomorphological diversity. The investigated phytocenoses play an important role in the conservation of biodiversity in high-mountain ecosystems, protection of soils against erosion, and maintenance of the productivity of summer pastures.

The research also demonstrated that anthropogenic impacts, particularly intensive grazing, trampling, and the influence of natural ecological processes, lead to degradation within the steppified alpine meadows. In several areas, thinning of the vegetation cover, intensification of erosion processes, and a decline in productivity were observed. Therefore, it is necessary to implement comprehensive measures aimed at the conservation of high-mountain pasture ecosystems, regulation of grazing pressure, erosion control, and restoration of phytocenoses.

Thus, the study of the floristic and phytocenotic characteristics of steppified alpine meadows has significant scientific and practical importance for the conservation and sustainable use of Azerbaijan's high-mountain ecosystems.

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