



Article

Plant Diversity of Mountain and Foothill Regions: Interrelationships Between Ecological Groups, Altitudinal Zones, and Economic Significance

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Abstract: This article presents a comprehensive analysis of the ecological structure of the flora distributed across the mountainous, foothill, adyr (hilly), and plain territories of Andijan Region, as well as the interrelationships between plant ecological groups, altitudinal zonation patterns, and their economic significance. By applying the method of classifying plants into ecological groups, the degree of species adaptation to key environmental factors—such as moisture, temperature, light, soil composition, and salinity—was assessed. The research findings indicate that the flora of Andijan Region represents an ecologically complex and highly adaptive system, with mesophyte, xerophyte, mesoxerophyte, and xeromesophyte groups predominating. Mesophytic species are mainly distributed in river valleys, irrigated lands, and foothill zones, where they play a significant role from an economic perspective. In contrast, xerophytic and mesoxerophytic species prevail in arid adyr and low-mountain areas and are primarily characterized by their fodder, meliorative, and technical importance. The analysis of altitudinal zones demonstrates that gradient-based changes in environmental factors determine the ecological group affiliation of plant species, which in turn shapes their potential utilization in economic activities. Furthermore, the study revealed that out of 653 recorded plant species, 450 possess various forms of economic and biological value. The obtained results are of considerable importance for developing scientifically grounded conclusions aimed at biodiversity conservation, rational use of natural resources, and sustainable ecosystem management.

Keywords: Andijan Region, Flora, Ecological Groups, Mesophytes, Xerophytes, Altitudinal Zones, Economic Importance, Biodiversity, Phytocenosis, Adaptation.

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1. Introduction

Vegetation cover is a fundamental component of natural ecosystems, and its formation, stability, and functional activity are closely linked to environmental factors. In particular, the sharp differentiation of ecological conditions in mountainous and foothill areas makes the study of plant diversity, distribution patterns, and ecological adaptation mechanisms especially relevant. In such regions, relief, climate, moisture regime, and soil conditions change over short distances, creating favorable conditions for the formation of plant species belonging to different ecological groups.

The classification of plants into ecological groups allows for a deeper understanding of their relationships with environmental factors, their degree of adaptation to habitats,

and their morpho-physiological characteristics. Ecological classification is considered an important scientific approach for identifying species' responses to key factors such as moisture, temperature, light, soil composition, and salinity. This, in turn, enables the determination of species' associations with specific biotopes, their distribution limits, and their functional roles within ecosystems.

The flora of Central Asia, particularly that of Andijan Region, is formed within an area characterized by pronounced geomorphological and climatic heterogeneity, where plains, adyr (hilly), foothill, and low-mountain landscapes are closely interconnected. The continental nature of the climate, the seasonal and uneven distribution of precipitation, and the influence of anthropogenic factors have resulted in a highly complex ecological structure of the regional flora. Therefore, analyzing the vegetation cover of Andijan Region based on ecological groups is of significant importance for revealing the mechanisms that ensure ecosystem stability in the region.

In scientific literature, issues related to the ecological classification of plants have been extensively addressed by Ramensky (1938), Korchagin (1964), Shennikov (1964), and other researchers. Their studies consider ecological groups as a key criterion for assessing the degree of plant adaptation to environmental conditions. At the same time, in modern ecology, the results of ecological classification serve as an essential theoretical basis for biodiversity conservation, rational use of natural resources, and the development of sustainable development strategies.

The significant representation of mesophytic and xerophytic ecological groups in the flora of Andijan Region is explained by the simultaneous presence of moist and arid biotopes within the territory. Mesophytic plants are mainly distributed in river valleys, irrigated lands, and foothill areas, where they are of high economic importance. Xerophytic and mesoxerophytic species, in contrast, dominate adyr and arid plain landscapes and play an important role in livestock farming, land reclamation, and the conservation of natural pastures.

In this context, the main objective of the present study is to conduct a comprehensive analysis of the flora of Andijan Region in terms of ecological groups, altitudinal zones, and economic significance; to identify the regular relationships among these factors; and, based on the obtained results, to develop scientifically grounded conclusions aimed at the rational use of natural resources.

2. Methodology

The object of the study was the flora of higher plants forming the natural and semi-natural phytocenoses distributed within the territory of Andijan Region. The research was conducted across the plain, adyr (hilly), foothill, and low-mountain zones of the region. These areas are characterized by pronounced diversity in geomorphological structure, climatic conditions, moisture regimes, and soil types, which contributes to the formation of a broad ecological spectrum of plant species.

During the study, floristic and geobotanical methods were applied in an integrated manner. Field investigations involved recording the distribution of plant species, their associations with specific biotopes, life forms, and ecological characteristics. Species identification was carried out using national and international floristic manuals, herbarium materials, and modern taxonomic sources.

The classification of plants into ecological groups was based on the classical ecological classification principles developed by Ramensky (1938), Korchagin (1964), and Shennikov (1964). In this process, species' relationships to moisture (mesophytes, xerophytes, hygrophytes, hydrophytes), light (heliophytes, sciophytes, shade-tolerant species), and soil conditions (halophytes, psammophytes, lithophytes) were taken into account.

The analysis of altitudinal zones considered gradient changes in regional relief, climatic parameters, and soil characteristics. To determine the relationship between ecological groups and economic significance, literature data on the fodder, medicinal, food, melliferous, technical, and meliorative properties of plant species were analyzed. The obtained data were generalized and analyzed using statistical methods.

3. Results and Discussion

General Characteristics of the Flora by Ecological Groups

The research results indicate that the flora of Andijan Region represents an ecologically complex and multi-component system. The analysis of plant species according to ecological groups revealed that mesophytes, xerophytes, mesoxerophytes, and xeromesophytes occupy a dominant position in the regional flora. This pattern is explained by the simultaneous presence of both moist and arid biotopes within the territory.

Mesophytic species are widely distributed in river valleys, irrigated lands, and foothill zones, forming an ecologically stable component of the regional flora. Species belonging to this group are characterized by high biomass production under relatively stable moisture conditions and by their broad potential for utilization in various economic sectors.

Xerophytic and mesoxerophytic species dominate adyr (hilly), arid plain, and low-mountain zones. These groups are well adapted to dry climatic conditions and exhibit a range of morpho-physiological adaptations, including water-saving mechanisms, reduced leaf surface area, and deep root system development. Such species play a crucial role in the formation of natural pastures, limitation of soil erosion, and land reclamation processes.

Relationship Between Altitudinal Zones and Ecological Groups

The transitional zones from plains to low-mountain areas in Andijan Region are characterized by gradual changes in ecological factors. With increasing altitude, decreasing temperature, along with changes in moisture regimes and soil conditions, determines the ecological group affiliation of plant species.

In plains and low-altitude zones, mesophytic and xeromesophytic species predominate. These areas are widely occupied by irrigated lands and anthropogenic landscapes, where species of medicinal, food, and fodder importance are particularly abundant. In adyr and foothill zones, the ecological spectrum becomes broader, with xerophytic, mesoxerophytic, and xeromesophytic species occurring simultaneously.

Low-mountain zones are characterized by the distribution of species with high ecological plasticity, capable of performing multiple ecological and economic functions simultaneously. This feature makes these areas among the most promising zones in terms of biological resource potential.

Relationship Between Ecological Groups and Economic Significance

According to the research findings, out of 653 plant species recorded in the flora of Andijan Region, 450 possess various categories of economic importance. Fodder species constitute the dominant group. Species belonging to the families Poaceae, Fabaceae, and Chenopodiaceae form the primary forage base of natural pastures.

Medicinal plants represent the second largest group, and the presence of biologically active compounds makes them a promising resource for traditional medicine and modern pharmacology. In addition, many species simultaneously exhibit melliferous, fodder, and meliorative properties, highlighting their multifunctional nature.

Analysis by ecological groups demonstrated that species of medicinal and fodder importance occur in almost all ecological groups. This indicates that each ecological group should be evaluated not only as a natural component of ecosystems but also as a potential economic resource.

4. Conclusion

The conducted studies demonstrate that the flora of plant species distributed across the mountainous, foothill, adyr (hilly), and plain territories of Andijan Region represents an ecologically complex, multi-component, and highly adaptive system. The analysis of plant species based on ecological groups made it possible to reveal in greater detail their relationships with environmental factors, degrees of habitat adaptation, and morpho-physiological characteristics. The ecological classification approach was confirmed as an effective scientific method for identifying species' response patterns to key factors such as moisture, temperature, light, soil composition, and salinity.

The results indicate that mesophytic, xerophytic, mesoxerophytic, and xeromesophytic ecological groups dominate the flora of Andijan Region. The widespread distribution of mesophytic species is associated with the presence of river valleys, irrigated lands, and relatively moist biotopes, making this group the most significant from an economic perspective. The substantial proportion of xerophytic and mesoxerophytic species reflects the continental climate of the region, the seasonal distribution of precipitation, and the extensive occurrence of arid adyr and low-mountain landscapes.

The analysis conducted across altitudinal zones showed that gradient changes in environmental factors determine the ecological group affiliation of plant species. While mesophytic and xeromesophytic species predominate in plains and low-altitude zones, the ecological spectrum expands in adyr and foothill areas, where xerophytic, mesoxerophytic, and xeromesophytic species occur simultaneously. In low-mountain zones, species with high ecological plasticity and multifunctional traits are widely distributed, ensuring the stability and regenerative capacity of phytocenoses.

A close relationship was identified between species' ecological group affiliation and their economic significance. Of the 653 plant species recorded in the regional flora, 450 possess various forms of economic and biological value, including fodder, medicinal, food, melliferous, technical, and meliorative uses. In particular, species belonging to the families Poaceae, Fabaceae, and Chenopodiaceae were found to be of strategic importance for natural pastures and livestock production.

The widespread occurrence of medicinal plants indicates a high pharmacological potential of the regional flora and expands opportunities for their scientifically grounded utilization. At the same time, the presence of melliferous, meliorative, and ecologically stabilizing species highlights the necessity of evaluating the flora of Andijan Region as a multifunctional biological resource. It was also revealed that certain species considered poisonous or invasive weeds may represent promising raw material sources due to their chemical composition and biological activity.

Overall, the results of this study demonstrate that a comprehensive assessment of the flora of Andijan Region based on the interrelationships among ecological groups, altitudinal zones, and economic significance is essential for the rational management of biological resources, effective use of natural pastures, conservation of biodiversity, and sustainable ecosystem development. The obtained findings provide a solid theoretical basis for future regional ecological monitoring, sustainable resource use, and the development of nature conservation strategies.

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