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BIOMORPHOLOGICAL AND ECOLOGICAL ANALYSIS OF THE FLORA OF THE CASPIAN COAST

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БИОМОРФОЛОГИЧЕСКИЙ И ЭКОЛОГИЧЕСКИЙ АНАЛИЗ ФЛОРЫ КАСПИЙСКОГО ПОБЕРЕЖЬЯ

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Abstract. The biomorphological and ecological structure of plant species on the coast of the Caspian Sea is presented. The coastal flora encompasses a range of life forms, with herbaceous plants (45.5%) being the most prevalent. Biomorphological classifications indicate that therophytes, hemicryptophytes, and cryptophytes are the dominant groups. Based on ecological grouping, most plants belong to mesophytes (40.7%) and psammophytes (23.0%), reflecting the adaptation of the local vegetation to the climate and soil characteristics of the area. This diversity underscores the unique botanical composition of the Caspian coast and its ecological adaptations. The study highlights the significance of biomorphological and ecological analyses for understanding the region's biological diversity and ecosystem balance, providing valuable insights for sustainable ecosystem management.

Аннотация. Представлена биоморфологическая и экологическая структура видов растений на побережье Каспийского моря. Прибрежная флора охватывает ряд жизненных форм, при этом наиболее распространены травянистые растения (45,5%). Биоморфологическая классификация показывает, что доминирующими группами являются терофиты, гемикриптофиты и криптофиты. Большинство растений относятся к мезофитам (40,7%) и псаммофитам (23,0%), что отражает адаптацию местной растительности к климатическим и почвенным характеристикам района. Это разнообразие подчеркивает уникальный ботанический состав побережья Каспийского моря и его экологическую адаптацию. Показана важность биоморфологического и экологического анализа для понимания биологического разнообразия и баланса экосистемы региона, что дает ценную информацию для устойчивого управления экосистемой.

Keywords: Caspian coast, biomorphological analysis, ecological analysis, plant life forms, ecosystem balance.

Ключевые слова: побережье Каспия, биоморфологический анализ, экологический анализ, жизненные формы растений, баланс экосистемы.

The flora along the Caspian Sea coast exhibits a rich diversity of plant life forms, influenced by the region's unique ecological and biomorphological characteristics. Due to its geographical location and climate, the Caspian coast supports a wide range of vegetation types, including desert, semi-desert, wetland, and meadow species [1-6]. The local flora, shaped by variable moisture levels and diverse soil types, represents significant adaptability among plant species, which contributes to the overall biodiversity and resilience of these ecosystems (<https://www.worldfloraonline.org/>).

A systematic study of the Caspian coast flora's life forms can reveal much about the strategies plants use to survive under different environmental pressures, from water scarcity to salt tolerance. This study, grounded in the classifications developed by Raunkier (1934), Serebryakov (1964), and Shennikov (1963), explores how plants' biomorphological and ecological adaptations enhance ecosystem stability and allow vegetation to thrive across varying microhabitats [27-30].

Understanding these adaptations and ecological roles is crucial for effective conservation and sustainable management of this ecosystem, which is increasingly under threat from human activity and climate change (<https://lyl.su/y4Q0>).

Methodology

Biomorphological Classification. The biomorphological classification framework adopted in this study is based on established methodologies by Raunkier (1934), Serebryakov (1964), and Shennikov (1963). Raunkier's life-form classification categorizes plants by the location of their perennating organs, while Serebryakov and Shennikov expand upon these foundations, emphasizing ecological-morphological adaptations and environmental conditions influencing plant structure. Key life forms considered in this study include therophytes, hemicryptophytes, cryptophytes, phanerophytes, and chamaephytes. By examining morphological adaptations, such as underground storage organs in cryptophytes or reduced transpiration in xerophytic therophytes, this classification provides a structural and functional overview of the vegetation across the Caspian coast [27, 29, 30].

Ecological Classification. The ecological classification focuses on water requirements, categorizing plants as mesophytes, xerophytes, psammophytes, halophytes, and hydrophytes. This classification is particularly relevant to understanding the Caspian coast, where moisture availability and soil composition vary significantly. Each ecological group represents distinct adaptations: mesophytes thrive in moderate moisture, xerophytes in arid conditions, psammophytes on sandy soils, halophytes in saline environments, and hydrophytes in water-rich areas. This approach offers insights into the types of habitats each plant group occupies and their role within the coastal ecosystem [25, 26].

Data Collection. Fieldwork was conducted along various Caspian coast locations, covering diverse habitats, including semi-deserts, sandy dunes, wetlands, and coastal meadows. Species were identified, cataloged, and recorded for analysis. Using observational and sampling methods, data were collected on species distribution and morphological characteristics, and plants were categorized into appropriate biomorphological and ecological groups [1-8].

Results

Biomorphological Analysis. The biomorphological composition of the Caspian coastal flora shows a clear predominance of herbaceous plants, constituting 45.5% of the total species [1-9]. This distribution of life forms reflects the adaptations of plants to the region's specific environmental conditions, as detailed in Table 1.

Table 1

BIOMORPHOLOGICAL CLASSIFICATION OF CASPIAN COASTAL FLORA

<i>Life Form</i>	<i>Species</i>	<i>Percentage (%)</i>
Therophytes	479	45.5
Hemicryptophytes	287	27.2
Cryptophytes	150	14.2
Phanerophytes	67	6.4
Bryochamephytes	40	3.8
Chamaephytes	31	2.9

Therophytes are the most abundant, highlighting a strategy of rapid life cycle completion in response to seasonal moisture changes. These annuals capitalize on favorable conditions and enter dormancy through their seeds when resources are scarce. Hemicryptophytes and cryptophytes, forming 27.2% and 14.2%, respectively, are perennials that use structural adaptations, such as soil-surface or underground buds, to survive unfavorable seasons like winter or drought [10-15].

Phanerophytes, at 6.4%, include woody species that maintain above-ground growth year-round, adapting to more stable, protected microhabitats. Bryophytes and chamaephytes, although comprising smaller proportions of the flora, contribute to soil stability and moisture retention with their low-growing, dense structures that minimize water loss and protect the soil from erosion. In summary, the biomorphological diversity in the Caspian flora reflects a range of survival strategies, with therophytes leading in adaptation to the region's semi-arid and seasonally variable conditions [16].

Ecological Analysis. The ecological classification reveals that mesophytes are the largest group, followed by psammophytes and xerophytes. Table 2 outlines the ecological distribution:

Table 2

ECOLOGICAL GROUPING OF CASPIAN COASTAL FLORA

<i>Ecological Group</i>	<i>Species</i>	<i>Percentage (%)</i>
Mesophytes	429	40.7
Psammophytes	242	23.0
Xerophytes	203	19.3
Hydrophytes	92	8.7
Halophytes	88	8.3

Mesophytes, making up 40.7% of the flora, indicate a preference for moderate moisture environments, commonly found in meadows, moist forest clearings, and other areas with stable water sources. This prevalence suggests that the Caspian coast supports a considerable range of habitats with regular moisture availability [17-20].

In contrast, psammophytes (23%) and xerophytes (19.3%) reflect adaptations to challenging conditions. Psammophytes are adapted to sandy soils, often with minimal nutrients and limited water retention, while xerophytes are specialized for dry, arid areas where water conservation is essential.

The ecological diversity in the Caspian flora reflects the region's varied conditions, supporting both mesic (moderate moisture) and xeric (dry) habitats. This range of adaptations contributes to the overall resilience of the Caspian coastal ecosystem, allowing a broad spectrum of plant species to thrive under distinct environmental constraints [21-26].

Discussion

The biomorphological and ecological analysis underscores the Caspian coast's environmental heterogeneity and the adaptability of its flora. The dominance of therophytes in biomorphological groups highlights the ecological significance of annual plants in arid and semi-arid environments. Their ability to rapidly complete their life cycle in response to seasonal water availability is a crucial adaptation for survival under fluctuating climatic conditions. This feature aligns with the coast's desert and semi-desert landscapes, where plants must exploit short periods of favorable conditions to reproduce and disperse seeds.

In terms of ecological grouping, the prevalence of mesophytes suggests the importance of moderate moisture availability in maintaining the stability of coastal ecosystems. Mesophytes play a critical role in supporting diverse plant communities by thriving in habitats with balanced water levels. The significant representation of psammophytes and xerophytes indicates that much of the Caspian coast consists of sandy and arid areas where plants must adapt to low water availability. Psammophytes, for instance, are well-suited to sandy soils with their tolerance to soil movement and sparse nutrient availability.

Additionally, the presence of hydrophytes and halophytes reveals specialized plant adaptations to waterlogged and saline environments. Hydrophytes thrive in aquatic conditions, while halophytes have evolved mechanisms to tolerate high salt levels, commonly found in coastal areas affected by saline groundwater or sea spray. These adaptations are essential for sustaining plant diversity and enabling vegetation to persist in challenging habitats.

Conclusion

This study provides a comprehensive biomorphological and ecological analysis of the Caspian coastal flora. The dominance of herbaceous plants and mesophytes reflects the flora's adaptation to the region's moderate moisture levels, while the presence of xerophytes and psammophytes demonstrates the adaptability of plants to the arid and semi-arid landscapes characteristic of the Caspian coast. The findings emphasize the ecological resilience of the Caspian coast, supported by diverse life forms and ecological groups that enable plants to survive and thrive in various microenvironments.

Understanding the structure and function of the Caspian coastal flora is crucial for developing effective conservation strategies. As climate change and anthropogenic pressures continue to impact these areas, it is essential to monitor and preserve the ecosystem balance to maintain biodiversity and habitat stability. Future research should focus on long-term ecological monitoring to assess the effects of environmental changes on the flora and to guide conservation efforts.

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