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Species Diversity of the Family Cyprinidae in the Middle and Southern Caspian Sea

Abstract

The species diversity of the *Cyprinidae* family distributed in the Middle and Southern Caspian Sea is of particular importance for the conservation of the ichthyological biodiversity of the region. The research has revealed that several genera and species of the *Cyprinidae* family are widely distributed in this area. Among them, kutum (*Rutilus frisii kutum*), common carp (*Cyprinus carpio*), bream (*Abramis brama orientalis*), crucian carp (*Carassius carassius*), roach (*Rutilus rutilus caspicus*), and other representatives are dominant. The formation of species composition is significantly influenced by ecological factors such as water temperature, salinity, food resources, and anthropogenic impacts. In particular, industrial pollution, regulation of water resources, and fishing pressure have led to a decline in the population density of several species. Nevertheless, some adaptive species have managed to preserve their ranges by adjusting to new environmental conditions. The research results indicate that in order to conserve the biodiversity of cyprinids in the Middle and Southern Caspian Sea, it is essential to conduct modern ecological monitoring, restore natural spawning grounds, and apply scientifically based methods in fish stock management.

Keywords: *Middle and Southern Caspian Sea, Cyprinidae, fish, species, biodiversity*

Introduction

The Caspian Sea is considered the largest lake on Earth and represents a closed water basin located in a vast continental depression. The total length of its coastline, including islands, is approximately 7,000 km. Along its 6,500–6,700 km shore, five countries are located: the Republic of Azerbaijan, the Republic of Kazakhstan, the Islamic Republic of Iran, the Russian Federation, and Turkmenistan. The length of the coastline in these countries is as follows: Azerbaijan – 825 km, Kazakhstan – 2,320 km, Iran – 900 km, Russia – 695 km, and Turkmenistan – 1,200 km.

The Caspian extends about 1,200 km in the meridional direction, with an average width of 310 km. Its widest part reaches 435 km, while the narrowest is 195 km. At this level, the total surface area is 392,600 km², and the water volume equals 78,648 km³. These parameters indicate that the Caspian Sea contains approximately 44% of the total lake waters of the planet (Mammadov, 2005).

One of the unique features of the Caspian is that it combines both marine and lacustrine characteristics. Salinity levels vary across regions and are primarily regulated by the inflow of large rivers such as the Volga, Ural, Terek, and Kura. This feature makes the Caspian a hydrologically and ecologically unique water body.

Although called a “sea,” the Caspian is in fact a closed lake with no natural connection to the world ocean. The absence of such a connection determines distinct dynamics in hydrology, salinity regime, and level fluctuations (Kosarev & Yablonskaya, 1994; Dumont, 1998).

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In terms of hydrological parameters, salinity is about 1–2‰ in the northern part, 10–12‰ in the middle, and 13–14‰ in the southern region (Kosarev, 2005). This factor significantly affects the distribution of fish species in different parts of the Caspian.

In the north, water temperature often drops below freezing in winter (Kosarev & Yablonskaya, 1994), whereas in the south, it varies between +10 and +25°C throughout the year. The main inflows are the Volga, Ural, Kura, and Terek rivers, with the Volga providing about 80% of the total freshwater input. Water level changes are characterized by periodic rises and falls occurring several times per century. At the end of the 20th century, the level rose by about 2.5 meters, while a decreasing trend has been observed in the 21st century. The sharp rise (≈2.5 m) during the late 1970s–1990s and subsequent stabilization are explained by overlapping factors such as increased precipitation in the Volga basin and variations in evaporation rates (Klige, 1997; Panin & Diaconu, 2014).

Aladin and Plotnikov (2004) noted that the hydrological balance is the main determinant of level fluctuations, while short-term effects such as wind-driven surges and seiches can cause local risks in coastal zones.

The Middle and Southern Caspian basins are characterized by a more complex hydrological structure and possess strategic importance for fisheries. In these zones, the common carp (*Cyprinus carpio*) and other representatives of the *Cyprinidae* family play an important ecological and economic role. Their population structure, feeding, and reproductive characteristics are closely related to salinity, the hydrological regime of river deltas, and anthropogenic factors (Hedayati et al., 2017). Therefore, studying the species diversity and biological characteristics of cyprinids in the Middle and Southern Caspian is relevant both scientifically and practically.

Research

Research on *Cyprinidae* fish has examined the ecological features and population dynamics of cyprinids in the Middle and Southern Caspian. However, these studies are mainly based on local observations, and the available data do not provide a comprehensive picture. In the modern era, against the background of climate change, anthropogenic impacts, and fluctuations in water levels, the study of the biological characteristics, adaptation mechanisms, and genetic diversity of cyprinids has become particularly important (Hedayati et al., 2017). Since studies in this field are limited, the scientific investigation of *Cyprinidae* fish in the Middle and Southern Caspian still remains an insufficiently explored area.



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The general systematic position of species belonging to the family *Cyprinidae* is as follows:

Order – *Cypriniformes*

Family – *Cyprinidae* Fleming, 1822

Genus – *Cyprinus* Linnaeus, 1758

Species – *Cyprinus carpio* Linnaeus, 1758

At present, 37 species and subspecies of cyprinids are distributed in the inland water bodies of Azerbaijan. Among them, five species – Shirvan roach, zardaper, Caspian barbel, swordfish, and poru – are included in the *Red Book of Azerbaijan*. In the Kura and Artek basins of the Southern Caspian, the number of species such as the Caspian barbel, shamai, and garasol is low, and therefore their commercial (industrial) importance is insignificant. Since the 1970s, three new cyprinid fish species – grass carp, colorful carp, and silverhead – have been successfully acclimatized in the Caspian Sea (Asgarov & Zaitsev, 1999).

Comparative studies based on various morphometric features have shown that among 20 species and subspecies, clear sexual dimorphism is observed in four (*Pseudorasbora parva*, Lankaran shamai, *Rhodeus sericeus*, and *Carassius gibelio*), weak in fourteen, and absent in two species (Kura barbel and Transcaucasian flatstomach).

During the studies, the number of gill rakers in all gudgeons (368 specimens) collected from different water bodies of Azerbaijan ranged between 36–51. Since this indicator is characteristic only of the silver gudgeon, it has been determined that this is the only species of gudgeon existing in the country's waters. The body color of this fish may vary depending on environmental conditions, ranging from light-silver to dark-golden tones. Some researchers, based on color differences, have described them as a separate species under the name golden gudgeon.

In the mid-20th century, Y.A. Abdurrahmanov described a new species for science – the Soyuqbulaq roach (*Rutilus sojuchbulagi*) – in the spring-fed rivers around the village of Soyuqbulaq, Aghstafa district (*Fauna of Azerbaijan. Vertebrates*, Vol. III, 2004). However, in subsequent studies, including research conducted between 2008 and 2014, this species was not found in that region. It is assumed that due to changes in ecological conditions, its habitat was destroyed, and the species has become extinct in Azerbaijan.

Among other representatives of cyprinids, the *Pseudorasbora parva* and *Hemiculter leucisculus* (Basilewsky, 1855) have been recorded in the water bodies of Azerbaijan. The morphological and biological features of these species have been studied in detail. Their occurrence in the fauna of the country is associated with the process of acclimatization of herbivorous fish. In the external appearance of the *Pseudorasbora parva*, age-related changes are observed: in young individuals, a black stripe is visible along the lateral line, but it disappears with maturity. Its meristic features are similar across different populations, indicating the species' high adaptive capacity. Although biological indicators (length, weight, condition factors, etc.) vary in different regions of the country, the species generally demonstrates adaptation to a wide ecological range. Males are larger and reach sexual maturity at 1–2 years of age.

The *Hemiculter leucisculus* was first recorded in Azerbaijan in the Vilash River, and later became widely distributed in other rivers, reservoirs, and even in the Small Gizilaghaj Bay. Molecular-genetic analyses have confirmed that it belongs to the *Hemiculter leucisculus* species. Morphometric characteristics of the fish show that sexual dimorphism is weakly expressed; however, during the spawning period, certain external changes occur in males. This species is abundantly distributed in freshwater and slightly brackish areas rich in aquatic vegetation. The biological parameters of populations (length, weight, condition factor, fecundity, etc.) vary according to season and age. Females are generally larger than males. The spawning process takes place from May to October, when the water temperature is between 20–23°C.

The *Hemiculter leucisculus* mainly feeds on aquatic plants, but at younger stages it also consumes insect larvae and small crustaceans. Introduced into the Azerbaijani fauna as a result of acclimatization, this fish has now become widespread, affecting native fish species through food

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competition, while simultaneously serving as an important food source for predatory fish (Mustafayev, 2017).

Among the fish species inhabiting the southwestern Caspian, one of the most popular among local populations is the kutum (*Rutilus frisii kutum*), which is found only in the Caspian Sea. Its range extends from the Terek River to the Gorgan Bay. Throughout the year, kutum is mainly observed along the western coasts of the Middle and Southern Caspian, at depths of 9–24 meters. During the summer season, the fish predominantly gathers in the southwestern parts of the sea, particularly around the Gizilaghaj and Anzali bays. On the eastern coast of the Caspian, kutum is less common, but in the Artek–Caspian region, as well as in the Krasnovodsk (now Türkmenbaşy) Gulf and Karshi Bay, it occurs more frequently.

A semi-migratory species, kutum lives mainly in the sea but migrates to rivers for spawning once it reaches sexual maturity — particularly to the Gumbashi, Sefidrud, Lankaran, Kura, Samur, Terek, Sulak, and other rivers (Abdurrahmanov, 1962). Males reach sexual maturity at 3 years of age, while females mature at 4 years. Kutum is a valuable commercial fish species in the Southern and Middle Caspian. In certain years, the annual catch of kutum in the Caspian reached up to 7,000 tons. According to data from 1991–1998, annual kutum catches in Azerbaijan ranged from 3 to 10 tons (Asgarov & Gasimov, 2003).

During 2008–2012, studies conducted in the Lankaran, Boladi, Veravul, Aghstafa, and Soyuqbulaq rivers recorded for the first time in Azerbaijan the presence of the Amur stone moroko – *Pseudorasbora parva* (Temminck et Schlegel, 1846), a representative of the *Cyprinidae* family. A total of 162 specimens of this species were examined using ichthyological methods, and their morphometric and biological parameters were determined. The study also proposed hypotheses regarding the possible routes of introduction of this fish into Azerbaijani waters and its potential impact on local fauna (Mustafayev & Ibrahimov, 2012).

The role of the *Cyprinidae* family in the ecology of the Middle and Southern Caspian Sea is considered multifaceted and significant.

This family represents one of the dominant groups within the ichthyofauna of the Caspian basin and plays an important role in maintaining biodiversity and trophic stability:

1. Formation of biomass – Various cyprinid species such as the common carp (*Cyprinus carpio*), Caspian roach (*Rutilus rutilus caspicus*), Caspian barbel (*Barbus caspius*), and Caspian vimba (*Vimba vimba persa*) are widely distributed in the freshwater and brackish zones of the Caspian Sea. Acting as primary consumers, they feed on benthic and planktonic organisms, forming a large biomass and creating strategic resources for fisheries.
2. Mediator role in the trophic chain – Cyprinids have a wide feeding spectrum, consuming phytoplankton, zooplankton, benthic invertebrates, and detritus, thus functioning as an important link in nutrient cycling. At the same time, they serve as a major food source for predatory fish (e.g., zander – *Sander lucioperca*, sturgeons – *Acipenseridae*) and aquatic birds.
3. Maintaining ecosystem stability – The presence of diverse ecological groups among cyprinids helps to sustain biological balance in aquatic ecosystems. For instance, planktivorous species regulate phytoplankton abundance, while benthophagous species influence the structure of bottom-dwelling communities.
4. Sensitivity to anthropogenic factors and indicator role – In the Middle and Southern Caspian, industrial pollution, hydrotechnical constructions, and fishing pressure have caused notable changes in cyprinid population dynamics. Their abundance and biodiversity indices are widely used as bioindicators of the ecological condition of aquatic ecosystems (Shabani & Fazli, 2018).

Many species of cyprinids (such as the common carp and Caspian roach) constitute the main part of fish stocks in the Caspian Sea and are of strategic importance for both industrial and local fisheries. They are also widely used in aquaculture.

The analysis of existing studies indicates that the Kura basin and the Middle–Southern Caspian region represent one of the main diversity centers of the *Cyprinidae* family. Ichthyological research carried out over the last decade has confirmed the presence of 27 fish species in this basin, most of

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which belong to *Cyprinidae*. Investigations in the Nakhchivan and Kura Delta regions have shown that species such as the common carp (*Cyprinus carpio*) and silver carp (*Carassius gibelio*) are dominant.

Morphometric and bioecological analyses reveal that cyprinid populations exhibit both age and morphological differentiation. Studies conducted in the Southern Caspian confirm that *C. carpio* possesses at least three distinct populations. Feeding and reproductive characteristics indicate that the common carp is a broadly omnivorous species, with its reproductive period mainly occurring during the spring months (Tagiyeva, 2014).

Conclusion

In recent years, the phenomenon of "rejuvenation" observed in Kura River populations indicates that, in addition to intensive fishing pressure, anthropogenic factors also significantly influence the biological structure of the population. This process is accompanied by a decrease in both biomass and the proportion of long-lived individuals.

Existing data on the biological parameters of the common carp in the Caspian basin (length, weight, age, and fecundity) confirm that, although this species possesses a high adaptive potential, it remains sensitive to ecological and anthropogenic pressures. Since the Kura River and its adjacent zones serve as the main reproductive area for the population, their protection and sustainable management are of strategic importance for the persistence of cyprinid species.

Overall, representatives of the *Cyprinidae* family constitute the core of the ichthyofaunal biodiversity and biological stability of the Caspian and Kura basins. The conservation and sustainable use of these species are essential not only on a regional but also on an international scale.

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