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First Record and Geographic Expansion of the *Sebastes schlegelii* (Hilgendorf, 1880) in the Sea of Marmara (Türkiye)

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Abstract: This study reports the first-recorded presence of the Korean rockfish *Sebastes schlegelii* (Hilgendorf, 1880) in the Sea of Marmara, signifying a notable geographical expansion beyond its natural range. The sampled male specimen, with a total length of 27.5 cm and a weight of 459.20 g, aligns with known size patterns observed in the Black Sea, suggesting a consistent trend. The unexpected presence of the species in the Sea of Marmara raises intriguing questions about its potential spread in the broader Mediterranean Sea basin. The adaptability of the *S. schlegelii* to diverse environmental conditions underscores its ecological resilience. The study emphasizes the need for careful monitoring and management due to potential threats posed by invasive species, especially considering the vulnerabilities of the Sea of Marmara to climate change.

Keywords: Sebastidae, range expansion, new record, invasive species, marmara coast, mediterranean sea basin.

Sebastes schlegelii (Hilgendorf, 1880)'nin Marmara Denizi'ndeki (Türkiye) İlk Kaydı ve Coğrafi Yayılım Genişlemesi

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Öz: Bu çalışma, Pasifik iskorpiti *Sebastes schlegelii* (Hilgendorf, 1880)'nin doğal yayılışının ötesinde dikkate değer bir coğrafi yayılımı işaret ederek Marmara Denizi'nde ilk kaydını bildirmektedir. Toplam uzunluğu 27,5 cm ve ağırlığı 459,20 g olan erkek birey, Karadeniz'de gözlemlenen bilinen boyut modelleriyle aynı hizada olup tutarlı bir eğilime işaret etmektedir. Türün Marmara Denizi'ndeki beklenmedik varlığı, daha geniş Akdeniz havzasındaki yayılma potansiyeli hakkında ilgi çekici soruları gündeme getirmektedir. *S. schlegelii*'nin çeşitli çevresel koşullara uyum sağlama yeteneği, türün ekolojik dayanıklılığını göstermektedir. Çalışma, özellikle Marmara Denizi'nin iklim değişikliğine karşı hassasiyeti göz önüne alındığında, istilacı türlerin oluşturduğu potansiyel tehditler nedeniyle dikkatli izleme ve yönetim ihtiyacını vurgulamaktadır.

Anahtar kelimeler: Sebastidae, yayılış alanı genişlemesi, yeni kayıt, istilacı türler, marmara kıyıları, akdeniz havzası.

INTRODUCTION

Sebastes schlegelii (Hilgendorf, 1880), commonly known as the Korean rockfish, is a member of the *Sebastes* genus, which includes 108 species worldwide (Froese & Pauly, 2023). This species exhibits distinctive ecological characteristics, particularly its preference for rocky reefs, silt, and sand habitats (Zhang et al., 2015). The lifespan of the Korean rockfish, which has a body length of 65 cm and a weight of up to 3.1 kg, extends up to 20 years (Navikov et al., 2002). Attaining sexual maturity at four years, the Korean rockfish is carnivorous, displaying prey selectivity, primarily focusing on fishes and shrimps (Chin et al., 2013; Zhang et al., 2014). Despite its prevalence in the northwest

Pacific, the natural distribution range of species is confined to specific areas, including Japan, the Korean Peninsula, and China (Hyde & Vetter, 2007; Wang et al., 2017). An unexpected geographical expansion has been recorded in the Black Sea, which is attributed to transport by ship ballast water in the coastal waters of Crimea (Boltachev & Karpova, 2013). Subsequent observations revealed the existence of a settled population from the Northern Black Sea to the Caucasus coast (Karpova et al., 2021). The most recent records reveal a notable expansion in the geographical distribution of the Korean rockfish towards Turkish territorial waters in the southern part of the Black Sea (Bilecenoğlu et al., 2023; Yağlıoğlu et al., 2023). This study presents the first record and geographical range expansion of Korean rockfish extending to the Sea of Marmara. There are no historical records regarding the presence of the species in the Mediterranean Sea basin. The new presence of Korean rockfish in the Sea of Marmara implies the potential for this species to spread in the wider Mediterranean Sea basin and highlights the abilities of this species to adapt and colonize new environments.

MATERIAL AND METHOD

A male Korean rockfish was sampled on January 7, 2024, from the Gulf of Izmit (40°46'61" N − 29°28'99" E) (Figure 1), located in the Sea of Marmara (GFCM Geographical Sub-Area 28). The specimen was caught from the shore during an amateur fishing activity with a silicone plug integrated hand spinning rode. The taxonomic classification of the specimen was identified according to the fish identification key (Nakabo, 2002; Bilecenoğlu et al., 2023), and the scientific name was cross-referenced from FishBase (Froese & Pauly, 2023). The total length (TL) was obtained using an ichthyometer with a precision of 0.1 cm, while body weight (W) was recorded with a scale accurate to 0.01 g. Fourteen morphometric characters were measured with a digital caliper to the nearest 0.01 mm (Randall & Eschmeyer, 2001; Fischer, 2013; Karadurmuş et al., 2022; Aydın & Karadurmuş, 2023) and several morphometric characteristics were given as the percentage of standard length (SL%). Sex identification was based on gonad color and shape, following the guidelines outlined by Gunderson (1994).

Figure 1. The current record of *Sebastes schlegelii* in the Sea of Marmara (4- This study with red mark) and previous records of its occurrence in the Black Sea (1- Karpova et al., 2021; 2- Bilecenoğlu et al., 2023; 3- Yağlıoğlu et al., 2023).

RESULTS AND DISCUSSION

The classification of the captured specimen as *S. schlegelii* is based on distinctive morphological features. These distinguishing characteristics include pelvic-fin rays I/5; pectoral-fin rays 18; anal-fin rays III/6; dorsal-fin rays XII/13; caudal-fin rays 15 and convex; anal fin rounded. Furthermore, the specimen exhibits five distinct, sharp, bony, tooth-like structures on the pre-operculum and three on the operculum. Notably, the first spine of the opercular margin forms a long arch with a hook-shaped structure, providing a definitive criterion for species differentiation. The meristic counts, morphometric measurements and coloration of the individual obtained in the Sea of Marmara are consistent with the descriptions provided in previous studies on *S. schlegelii*. Upon comparing the findings with specimens previously captured in Turkish territorial waters within the Black Sea, only a few different proportions were identified (Table 1), which could be attributed to limitation in the sample size of the individuals studied. Notably, the morphometric measurements fell within the established reference ranges, as indicated by Karpova et al. (2021), reinforcing the reliability and consistency of these results. Meristic and morphometric characters are powerful tools for measuring discreteness and relationships among fish species. For this reason, analysis of morphometric and

meristic characters has been widely used by ichthyologists a reliable tool to differentiate between different species (Wainwright, 2007).

Table 1. Summary of morphometric measurements of *Sebastes schlegelii* and comparison with the previous records from the Black Sea.

Variables	This study	Karpova et al. (2021)	Bilecenoğlu et al. (2023)	Yağlıoğlu et al. (2023)
Number of specimen(s)	1	5	1	1
Total length (in cm)	27.5	32.5 – 39.1	24.5	34.9
Standard length (in cm)	24.0	27.7 - 33.1	20.6	29.9
Weight (in g)	459.2	710.0 - 1151.2	282.1	-
		(% of Standard length)		
Head length	36.7	35.5 – 40.1	34	30.4
Eye diameter	7.5	-	-	5.7
Pre-dorsal length	33.3	33.0 – 35.8	27.1	31.0
Dorsal fin base length	63.8	62.5 – 62.7	60.8	-
Pre-anal length	68.8	67.8 – 69.2	66.7	-
Anal fin base length	20.4	15.5 – 16.4	15.9	17.7
Pre-pelvic length	41.3	37.4 – 38.9	39	33.9
Pelvic fin length	22.5	20.3 – 20.6	22.7	34.0
Pre-pectoral length	37.1	33.6 – 35.5	29.8	-
Pectoral fin length	24.2	21.2 – 22.9	25.2	20.1
Body depth	38.3	-	36.5	34.0
Caudal peduncle depth	9.2	10.2 – 10.5	9.7	10.1

The first recorded presence of the Korean rockfish in the Sea of Marmara, as indicated by a specimen with TL of 27.5 cm and TW of 459.20 g (Figure 2), raises intriguing points for discussion. The sex determination of this specimen as male, based on macroscopic observations of its gonads, adds valuable information to our understanding of the reproductive dynamics of this species in the region. Bilecenoğlu et al. (2023) reported a single Korean rockfish specimen with a TL of 24.5 cm off the coast of Ünye (Ordu), while Yağlıoğlu et al. (2023) documented another specimen with a TL of 34.96 cm off the coast of Akçakoca (Düzce). The recorded size in the Sea of Marmara falls within the range reported for individuals in the Black Sea, suggesting a consistent size pattern. Moreover, considering that the Korean rockfish can grow up to 65 cm in length and 3 kg in body weight, with sexual maturity reached at 27 cm (Novikov et al., 2002), the observed specimen's size aligns with expectations for a sexually mature individual. The species, characterized by its preference for shallow waters and sheltered reef areas (Zhang et al., 2015), demonstrates a habitat consistency that transcends regional boundaries.

Figure 2. The male *Sebastes schlegelii* with 27.5 cm total length and 459.20 g weight from the Sea of Marmara.

Historically confined to the northwest Pacific, with its natural distribution limited to areas such as Japan, the Korean Peninsula, and China (Wang et al., 2017), the recent sightings in the Black Sea (Boltachev & Karpova, 2013; Karpova et al., 2021; Bilecenoğlu et al., 2023; Yağlıoğlu et al., 2023) and now the Sea of Marmara mark a notable deviation from its established range. The primary mechanism believed to facilitate this expansion is the transport of the species via ship ballast water, a hypothesis supported by the earlier introduction of the Korean rockfish into the Black Sea through similar means (Karpova et al., 2021). Additionally, the possibility of the species entering the Sea of Marmara through the Bosphorus due to long migrations along the southern coasts of the Black Sea is also considered (Yağlıoğlu et al., 2023). Adult Korean rockfish exhibit a limited ability to expand their territories due to their strong site fidelity (Zhang et al., 2015). Conversely, the pelagic larvae and juveniles of this species demonstrate a notable capability to migrate over significant distances (Gudkov, 2010). Although long-distance migration behavior is not among the life history characteristics of the Korean rockfish (Zhang et al., 2015), their ability to adapt to different environmental conditions and navigate (Chen et al., 2021) may support the existence of the species in the Sea of Marmara.

The Korean rockfish demonstrates a notable ability to adapt to various sea bottom temperature ranges, as evidenced by its presence in areas with temperatures ranging from 3 °C to 28 °C (Kim et al., 2001; Zhang et al., 2015). In the context of the Sea of Marmara, a notable body of water, the surface temperature spans from 6 to 24.5 °C. In contrast, at depths below 40 meters, the temperature remains relatively constant at approximately 14.5 °C (Beşiktepe et al., 1994). This variance in temperature profiles aligns closely with the known temperature tolerance of the Korean rockfish. The compatibility between the surface and bottom temperature changes in the Sea of Marmara and the temperature tolerance of the species, specifically the Korean rockfish variant, suggests that the environmental conditions in the Sea of Marmara may offer an ideal and supportive habitat for the species. However, the literature suggests that climate change could pose challenges (Zhang et al., 2015), emphasizing the vulnerability of the species to alterations in its habitat (Chen et al., 2021). While the adaptability of Korean rockfish contributes to its colonization success, concerns arise regarding potential threats and challenges. Notably, the economic and recreational significance of the Korean rockfish in its native regions has led to declines in both average individual weight and catch per unit effort (Chen et al., 2018). The semi-closed Marmara Sea is exposed to the highest temperature anomalies in the Mediterranean basin due to the effect of climate change. While

temperature increases provide a suitable habitat for invasive alien species, anthropogenic effects due to habitat loss, eutrophication, and overpopulation also threaten marine ecosystems and aquatic resources (Karadurmuş & Sarı, 2022; Demirel et al., 2023). As a precautionary approach, any alien species should be treated as potential invaders. This phenomenon underscores the need for careful monitoring and management to prevent potential negative impacts on local ecosystems and fisheries.

CONCLUSION

In conclusion, the unexpected expansion of the Korean rockfish into the Sea of Marmara presents a multifaceted scenario involving geographical spread mechanisms, climate change implications, and potential threats. The ability to adapt and colonize new environments of species raises questions about its future spread in the wider Mediterranean Sea basin, urging further research and conservation efforts to understand and mitigate the ecological consequences of geographic expansion.

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