

First Record of Half-smooth Golden Pufferfish *Lagocephalus spadiceus* (Richardson, 1845) in the Black Sea

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ABSTRACT

This study presents the first confirmed record of the half-smooth golden pufferfish (*Lagocephalus spadiceus*) in the Black Sea, marking a significant extension of its range. A male specimen of *L. spadiceus* was captured as bycatch off the coast of Ayancık, Sinop, at a depth of 17 meters using a bonito drift gillnet with a mesh size of 32 mm. The specimen was 15.6 cm in total length and weighed 53.0 g. Aside from the known possible spread pathways of invasive species, this species, which is already known to exist in the Sea of Marmara, is thought to have entered the Black Sea through direct invasion. The warming temperatures of the Black Sea, influenced by global climate change, have created suitable conditions for the spread of non-native species, and the Sea of Marmara is likely to have acted as a biological corridor. The spread of this species into the Black Sea indicates potential challenges ahead for local ecosystems, as its aggressive invasive behaviour and competitive characteristics could disrupt native food webs and pose risks to regional fisheries. This finding underscores the need for continuous monitoring and management efforts to address the potential ecological impacts of invasive species in the Black Sea.

Keywords: Range expansion, new record, Tetraodontidae, invasive species, Black Sea

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INTRODUCTION

Pufferfish (family Tetraodontidae) are represented by 28 genera and 206 species inhabiting tropical and subtropical coastal waters around the world (Froese & Pauly, 2024). The half-smooth golden pufferfish (*Lagocephalus spadiceus* Richardson, 1845), native to the Indo-Pacific region, is one of the most abundant non-indigenous pufferfish species in the Eastern Mediterranean (Tuncer, Cihangir, & Bilecenoğlu, 2008). The species inhabited in a range of Mediterranean Sea habitats, often favouring sandy or soft substrates at depths of 3 to 200 meters but primarily inhabiting shallow coastal waters less than 50 meters deep (Matsuura et al., 2014; Tuncer et al., 2008). *L. spadiceus* is a generalist predator, feeding on a variety of marine organisms, including fish, molluscs, and crustaceans (Xu et al., 2024). The population of pufferfish,

which has been established in the Mediterranean Sea for many years, is steadily increasing (Aydın, 2011). Pufferfish pose a risk to human health due to their toxic content (Aydın, Erkan, & Dal, 2017).

This species is one of the earliest lessepsian migrants enter the Mediterranean Sea through the Suez Canal (Kosswig, 1950). It is more common in the Mediterranean Sea (Başusta, Başusta, & Özer, 2013). Its aggressive expansion has resulted in a geographical range extension, reaching the northernmost part of the Mediterranean basin, including the Sea of Marmara, in addition to its known distribution along the Levant and Aegean coasts (Tuncer et al., 2008). This document reports the first confirmed record of *L. spadiceus* in the Black Sea, signalling a concerning geographical expansion of the species beyond its natural habitat.



MATERIALS AND METHODS

A specimen of *L. spadiceus* was caught as bycatch during commercial fishing operations on September 18, 2024, off the coast of Türkiye in the Black Sea (Ayancık, Sinop; 41.94694° N, 34.66190° E) (Figure 1A). The sampling location falls within Geographic Sub-Area (GSA) 29, as defined by the General Fisheries Commission for the Mediterranean (GFCM). The specimen was captured using a bonito drift gillnet with a mesh size of 32 mm at a depth of 17 meters. The taxonomic identification of the specimen was conducted using a fish taxonomic key (Fischer, Schneider, & Bauchot, 1987). Identification was further verified based on FishBase (Froese & Pauly, 2024). Fourteen traditional variables were measured on separately sample with an electronic caliper to the nearest mm (Farrag, Soliman, Akel, Elhaweet, & Moustafa, 2015; Habib, Neogi, Oh, Lee, & Kim, 2019). Body weight was recorded using an electronic scale with a precision of 0.01 g. The colour and shape of the gonads were used as primary indicators for sex determination (Rajendiran et al., 2021).

RESULTS AND DISCUSSION

A *L. spadiceus* specimen recorded in this study measured 15.6 cm in total length and weighed 53.0 g (Figure 1B). Fourteen traditional morphological measures are presented in Table 1. Macroscopic examination of the gonads revealed that the specimen was male, as indicated by the flat, white-creamy, soft texture of the gonadal tissue.

L. spadiceus is characterized by an aggressive invasion capacity, which has facilitated its spread beyond its native range. As one of the earliest lessepsian fish to enter the Mediterranean through the Suez Canal (Kosswig, 1950), this species has shown a remarkable ability to adapt to diverse environmental conditions, making it a highly resilient invader (Widhayanon & Premcharoen,

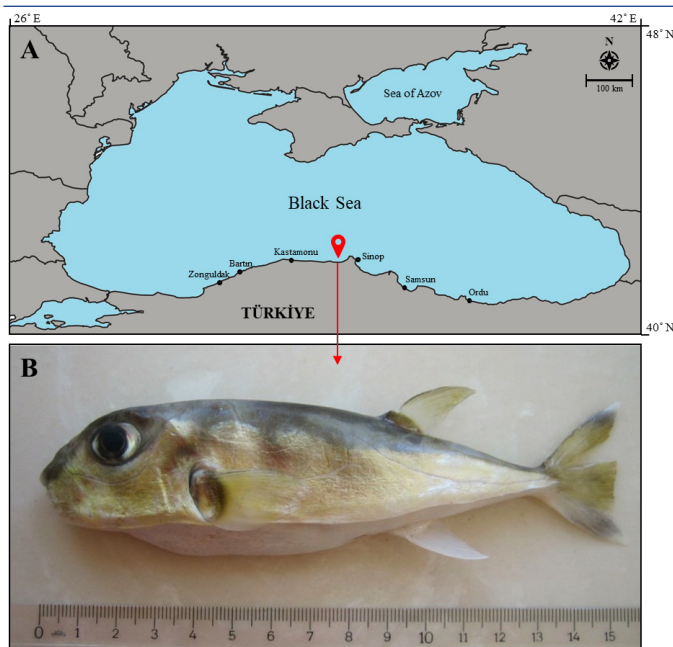


Figure 1. Sampling point (A) and first specimen of *Lagocephalus spadiceus* (B) caught in the Black Sea.

Table 1. Description and measurements of morphological characters of *Lagocephalus spadiceus* sampled in the Black Sea

Abbreviations	Character	Description	Measurement (cm)
TL	Total length	The longest distance between the tip of the snout and the end of the tail	15.6
SL	Standard length	Distance from the tip of the nose to the middle part of the end of the vertebral column	13.5
HL	Head length	Distance from the tip of snout to the upper posterior to gill cover	3.87
ED	Eye diameter	The maximum diameter of the eye with parallel to the longitudinal axis of the body	1.31
PsOL	Post-orbital length	Distance from the end of the orbit to the posterior margin of the operculum	1.35
PrDL	Pre-dorsal length	Distance from tip of snout to anterior margin of the dorsal fin base	9.01
DFL	Dorsal fin length	Longest distance from tip to tip of dorsal fin	2.03
DFBL	Dorsal fin base length	The longest horizontal distance of the dorsal fin base	1.26
PrAL	Pre-anal length	Distance from tip of snout to anterior margin of the anal fin base	9.09
AFL	Anal fin length	Longest distance from tip to tip of anal fin	2.02
AFBL	Anal fin base length	The longest horizontal distance of the anal fin base	1.36
PFH	Pectoral fin height	Distance from the lower end to the upper end of the pectoral fin	2.99
HBD	Highest body depth	The deepest distance from the lower end to the upper end of the body	3.20
CpD	Caudal peduncle depth	The minimum depth of the caudal peduncle	0.69

2002). This adaptability allows *L. spadiceus* to thrive in various habitats, from sandy substrates in shallow waters to deeper, enhancing its potential to establish in new ecosystems.

The warming of the Black Sea, often described as the "Mediterraneanization" of the region (Baltacı & Turk, 2024; Oğuz & Öz-

türk, 2011), has significant implications for the distribution and habitat suitability for non-native species like *L. spadiceus*. This process reflects an ongoing transformation where the Black Sea ecosystem increasingly resembles the warmer, saltier, and more biodiverse Mediterranean environment. Over the last decade, the Black Sea's surface temperatures have risen by an anomalous 1.8°C, with projections suggesting a continued increase of 13.3% in sea temperatures over the next 25 years (Baltacı & Turk, 2024). The ongoing Mediterraneanization thus allows *L. spadiceus* and other non-native species to form established populations in the Black Sea (Aydın, Karadurmuş, Verep, & Gözler, 2024; Bilecenoğlu, Yokeş, & Aydın, 2023; Öztürk, Karadurmuş, & Aydın, 2022; Öztürk, 2021; Uzer, Karakulak, & Kabasakal, 2024), contributing to shifts in the region's biodiversity and ecosystem dynamics. This warming trend, attributed to climate change, not only enables *L. spadiceus* to tolerate northern waters but also promotes its active dispersal through natural migration routes, such as the Istanbul Strait from the Sea of Marmara. The Sea of Marmara functions as a crucial biological corridor and climatic transition zone, enabling the spread of Mediterranean-origin invasive species, including *L. spadiceus*, into the Black Sea (Öztürk, 2021). This transitional zone enables species to gradually adjust to changing salinity, temperature, and oxygen levels as they spread northward, facilitating their geographical range expansion.

The presence of *L. spadiceus* in the Black Sea, though currently undocumented as a fully established population, poses a significant risk of colonization due to the species' remarkable resilience. *L. spadiceus* has shown the ability to traverse high-salinity barriers, such as the Bitter Lakes, and adapt to the lower salinity of the Nile estuary (Bianchi & Morri, 2003). Its tolerance to the cooler winter temperatures of the Mediterranean Sea further suggests that it may acclimate well to the Black Sea's unique conditions, highlighting its potential for rapid colonization and expansion in this new environment. The specimen's size in the Black Sea also indicates maturity, as *L. spadiceus* typically reaches reproductive maturity at around 9 cm and is capable of breeding twice annually (Naik & Jalihal, 1988). This suggests that, if additional individuals of the opposite sex are present, reproduction could begin soon, initiating a population that may be self-sustaining. If *L. spadiceus* becomes established, its generalist feeding strategy which includes a diverse diet of crustaceans, fish, molluscs, algae, and ophiuroids (Xu et al., 2024) could significantly impact the Black Sea's food webs. As an aggressive predator, *L. spadiceus* may disrupt local ecosystems by competing with native species for prey and altering the abundance and distribution of key species within the benthic and pelagic zones. This competition could potentially harm local fisheries, affecting commercially important species and altering ecosystem balance. These concerns underscore the importance of monitoring *L. spadiceus* spread and considering management strategies to mitigate its potential impact on the Black Sea ecosystem.

CONCLUSION

The first confirmed record of *L. spadiceus* in the Black Sea highlights an expanding distribution facilitated by warming seas and the Mediterraneanization of Black Sea waters. As a resilient and highly adaptable lessepsian migrant, *L. spadiceus* has leveraged

the Sea of Marmara as a biological corridor, enabling its spread into northern waters via the Istanbul Strait. The species' presence poses potential ecological and economic challenges, including disruption to native food webs and competition with local species. Continued monitoring and targeted management interventions are recommended to mitigate its impact and protect the Black Sea's ecological balance.

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Disclosure: -

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