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Evidence-Based Confirmation of Alien Species Caramote Prawn *Penaeus kerathurus* on the Turkish Coast of the Black Sea

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Abstract: This study provides the evidence-based confirmation of historical records of the prawn species *Penaeus kerathurus* on the Black Sea coast of Türkiye, highlighting a notable geographical extension of its known distribution range. A female (12.81 cm in TL) and a male (13.56 cm in TL) were captured 22 days apart using a gill net at a depth of 8 meters off the coast of Fatsa district (Ordu, Black Sea). Although the species is known for its adaptability and ecological significance, the findings suggest that its presence in the Black Sea is more likely due to anthropogenic factors, particularly introduction via ballast water from ships, rather than active swimming through the Turkish Straits System. Its rare occurrence in the Marmara Sea further supports this hypothesis. The specie's high fecundity and adaptability may facilitate its colonization in the Black Sea, while the low salinity and cooler sea water temperatures may challenge its long-term establishment.

Keywords: Range expansion, alien species, Penaeidae, ballast water, Türkiye.

Karadeniz'in Türkiye Kıyılarında Yabancı Karides Türü *Penaeus kerathurus*'un Kanıta Dayalı Doğrulanması

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Öz: Bu çalışma, *Penaeus kerathurus* karidesinin Türkiye'nin Karadeniz kıyılarındaki tarihi kayıtlarını kanıta dayalı olarak doğrulamakta ve türün bilinen dağılım alanında dikkate değer bir coğrafi genişlemeyi ortaya koymaktadır. Toplam uzunluğu 12,81 cm olan bir dişi ve 13,56 cm olan bir erkek birey, Fatsa ilçesi (Ordu, Karadeniz) açıklarında, 8 metre derinlikte fanyalı ağ kullanılarak 22 gün arayla yakalanmıştır. Yüksek adaptasyon yeteneği ve ekolojik önemi ile bilinen bu türün Karadeniz'deki varlığının, Türk Boğazlar Sistemi üzerinden aktif göçten ziyade, büyük olasılıkla gemilerin balast suyu yoluyla insan kaynaklı taşınmadan kaynaklandığı düşünülmektedir. Marmara Denizi'ndeki sınırlı dağılımı da bu hipotezi desteklemektedir. Bu türün yüksek üreme kapasitesi ve adaptasyon yeteneği, Karadeniz'de kolonileşmesini kolaylaştırırken, düşük tuzluluk ve daha soğuk deniz suyu sıcaklıkları uzun vadeli yerleşimini zorlaştırabilir.

Anahtar Kelimeler: Coğrafi genişleme, yabancı tür, Penaeidae, balast suyu, Türkiye.

INTRODUCTION

The caramote prawn, *Penaeus kerathurus* (Forsskål, 1775), is a prominent member of the family Penaeidae. This species predominantly inhabits shallow estuarine and marine environments, preferring sandy, muddy, and shell gravel substrates at common depths ranging from shoreline to 40 meters and occasionally up to 90 meters (d'Udekem d'Acoz, 1999). The caramote prawn is considered a valuable species in small-scale fisheries (Sartol et al., 2018; Şen, 2025).

The geographical distribution of the caramote prawn extends across the eastern Atlantic, from southern England to Angola, including Mauritania, and Morocco and throughout the Mediterranean Sea (González & Santana, 2014). In Turkish seas, it was also distributed in the Aegean

Sea and the Sea of Marmara (Ihsanoglu, 2020). This study presents a validated record of caramote prawn in the Turkish Black Sea, occurring eight years after the first confirmed report by Gönülal and Türetken (2019). This confirmation contributes significantly to our understanding of the species' potential establishment and persistence in the Black Sea.

MATERIAL AND METHOD

Two specimens of the caramote prawn were caught as bycatch during commercial fishing operations off the coast of Fatsa district, Ordu, in the Black Sea on October 3, 2024 (Specimen 1; 41°02'16"N – 37°30'01"E), and October 25, 2024 (Specimen 2; 41°02'21"N – 37°29'37"E), respectively. The sampling point was very close to the Fatsa Pier, 200 m away from where ships in international circulation load and unload. Both specimens were caught at a depth of 8 meters using a 40 mm mesh size (stretched measure) monofilament gill net deployed during routine commercial fishing activities. Identification of the specimens was performed using taxonomic keys specific to *Penaeus* prawns (Fischer et al., 1987; Galil et al., 2002). The scientific name was further cross-referenced with SeaLifeBase (Palomares & Pauly, 2024). Morphometric measurements included total body length (TL in cm) and carapace length (CL in cm). TL was measured in a stretched condition from the tip of the rostrum to the end of the telson while CL was measured from the tip of the rostrum to the mid-posterior dorsal margin of the carapace using digital Vernier caliper (Conides et al., 2008). Total body weight (TW in g) was recorded using a digital scale with an accuracy of 0.01 g. Sex was determined based on the presence of a petasma in males and a thelycum in females (Conides et al., 2008; Ihsanoglu et al., 2021).

RESULTS AND DISCUSSION

The captured specimens of the caramote prawn included a female (Specimen 1) and a male (Specimen 2). The female measured 12.81 cm in TL, 5.03 cm in CL, and weighed 14.27 g in TW. The male measured 13.56 cm in TL, 5.21 cm in CL, and weighed 15.35 g in TW (Figure 1).

Froglia and Scanu (2023), through an extensive literature review, revealed that the first two records of caramote prawn reported in the Black Sea (one in 2005 and the other in 2014) were initially misidentified as *P. semisulcatus*. These records were later retrospectively confirmed as *P. kerathurus*, with the individuals likely introduced into the Black Sea as larvae or post-larvae via ballast water discharge from ships. Subsequently, in 2017, Gönülal and Türetken (2019) reported the first confirmed record of *P. kerathurus* along the Turkish coast of the Black Sea. However, no additional data have been presented regarding the species' presence, population continuity, or ecological impact. This study provides a verified record of caramote prawn in the Turkish Black Sea, confirming its presence eight years after the initial documented report by Gönülal and Türetken (2019).

While some Penaeidae members have a notable swimming capacity, estimated at approximately 100 km per month (Klima, 1963; Altuve et al., 2008), the rare presence in the Marmara Sea, region it would have needed to traverse to reach the Black Sea, makes the hypothesis of natural range expansion highly unlikely. The Ordu coast of the Black Sea, located over 2500 km away from the species' established populations in the Levantine and Aegean Seas, presents a significant geographical barrier to direct swimming. This is further supported by the lack of rare historical or contemporary records of the caramote prawn in intermediate regions, despite extensive fisheries activities that would likely have detected the species. Both specimens in this study were captured near the Fatsa pier, an active hub for maritime cargo operations, further reinforcing the likelihood of introduction via anthropogenic vectors. Ships operating in international waters often serve as vectors for invasive marine species, particularly through ballast water discharge. During transport, larval stages, such as nauplius, zoea, mysis, or early post larvae, can survive and later establish populations upon release into favorable habitats. The proximity of the collection site to an active pier increases the probability that these specimens were transported as larvae or juveniles in ballast tanks or potentially attached to the hulls of ships. Froglia and Scanu (2023) also highlighted that the prior observations of the caramote prawn in the Black Sea involved a juvenile specimen likely introduced to the Black Sea via ballast water from ships.

The discovery of mature female, with body size (5.3 cm in this study) exceeding CL_{50} thresholds for reproductive maturity (3.9 cm for females) (Ihsanoglu et al., 2021), suggests that the specimens had time to settle and grow following their introduction to the Black Sea. This observation implies that the introduction occurred some time ago, allowing the shrimp to adapt and mature in their new habitat. Furthermore, environmental changes driven by climate change may have facilitated the establishment of this non-native species. The process of Mediterraneanization, characterized by warming sea temperatures and other climatic shifts, has been increasingly documented in the Black Sea (Oğuz & Öztürk, 2011). These changes have supported the introduction and proliferation of various alien migrants and other non-indigenous species in recent years (Öztürk, 2021; Eyüboğlu, 2022; Aydın et al., 2024). In this context, the ongoing warming of the Black Sea likely created more favorable conditions for the survival and establishment of the caramote prawn, which thrives in a broad range of environmental conditions.

Figure 1. The male *Penaeus kerathurus* specimen caught on 25 October 2024 (a) with distinctive rostrum (b)

The potential for the caramote prawn to colonize the Black Sea remains uncertain, as it depends on several environmental and biological factors. Body size of specimens confirm the presence of sexually mature individuals, highlighting the potential for reproduction and further establishment of the species in the Black Sea, provided environmental conditions are favorable. The presence of opposite sexes in the population increases the possibility of reproduction, as the caramote prawn exhibits high fecundity (approximately 156,000 oocytes/g) (Conides et al., 2008). This reproductive capacity may provide the foundation for the species to establish a population in the Black Sea. However, the ability of the species to complete its life cycle under the Black Sea's environmental conditions is less certain. The Black Sea's low salinity and relatively low winter temperatures could pose significant challenges, particularly during the larval stages. Therefore, while the high reproductive potential and adult adaptability of the caramote prawn suggest it could colonize the Black Sea under favorable conditions, its long-term establishment and population sustainability remain uncertain.

The introduction and presence of the caramote prawn in the Black Sea could lead to significant ecological and economic impacts. These effects can be both direct and indirect, influencing native ecosystems and fisheries in various ways. The caramote prawn dominates the ecosystem among the prawn species due to its carnivorous behavior. Its introduction may increase competition for resources with native prawn species and other benthic fauna, potentially leading to declines in native populations. If the species becomes established and thrives, it could emerge as a target species for fisheries due to its high economic value. Given its high market value and desirability, the establishment of the caramote prawn in the Black Sea could provide an alternative income source for fisheries.

CONCLUSION

This study documents the first record of the caramote prawn on the Turkish Black Sea coast, marking a significant milestone in its geographic range expansion. The findings underscore the species' ecological adaptability yet strongly support the hypothesis that its introduction occurred via ballast water discharge rather than active migration through the Turkish Straits System. Despite its high fecundity and resilience, the Black Sea's unique environmental conditions, such as lower salinity and cooler temperatures, may limit the species' potential for long-term establishment. To mitigate risks and capitalize on potential benefits, continued monitoring, coupled with genetic studies, is essential to track its population dynamics and inform management strategies for both ecological conservation and fisheries sustainability.

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COMPLIANCE WITH ETHICAL STANDARDS

Authors' Contributions: All authors contributed equally to the final version of the manuscript.

Conflict of Interests: The authors declare that they have no actual, potential, or perceived conflict of interests for this article.

Statement on the Welfare of Animals: This study does not imply any responsibility for animal welfare.

Statement of Human Rights: This study does not involve human participants.

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