



Presence of the Pacific oyster (*Crassostrea gigas* Thunberg, 1793) in the Black Sea

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Abstract: Pacific oyster (*Crassostrea gigas*), as an alien species to Black Sea ecosystem, is a highly commercial species with the highest production rate in aquaculture in the world. This species has been raised on the Crimean and Romanian Coasts since 1980s with reports of potentially breeding wild populations in those regions. However, the presence of this species on the Turkish coast of Black Sea is literally unknown. Therefore, here we investigated the occurrence and population density of the wild colonies of Pacific oyster on Ordu Coasts. We found that *C. gigas* has created breeding populations on the Turkish coasts with becoming the dominant species on some hard substrate including rocky bottoms and large rocks that were used for the fulfilment of the coastal regions to gain more land. Further, the population density was 94.58 ind./m² with an average shell length of 3.33 ± 0.724 cm. Our results here showed that *C. gigas* has adapted to the Turkish coasts of Black Sea with creating breeding populations, therefore a management plan should be applied in order to reduce the potential influence of this species on the natural communities.

Keywords: Black sea, invasive, pacific oyster, *Crassostrea gigas*.

Pasifik istiridyasının (*Crassostrea gigas* Thunberg, 1793) Karadeniz'de varlığı

Öz: Pasifik istiridyesi (*Crassostrea gigas*) yüksek ekonomik değeri olan ve dünyada en çok üretimi yapılan türdür. Kırım ve Romanya kıyılarında 1980'li yıllarda kültür çalışmaları yapılmış ve bölgede doğal stokların ürettiği rapor edilmiştir. Ancak, türün Karadeniz'in Türkiye kıyılarında varlığı bilinmemektedir. Bu çalışmada pasifik istiridyasının Ordu sahillerinde varlığı, popülasyon yoğunluğu ve boyutları araştırılmıştır. *C. gigas* türünün Türkiye sahillerinde üreyip popülasyon oluşturduğu, sert zeminlerde, doğal kayalık bölgelerde ve dolgu alanlarında dominant tür haline geldiği belirlenmiştir. Ayrıca popülasyon yoğunluğu 94,58 birey/m² olarak, ortalama kabuk boyu ise 3,33 ± 0,724 cm olarak hesaplanmıştır. Sonuç olarak, pasifik istiridyasının Karadeniz'in Türkiye sahillerine adapte olduğu ve doğal bir popülasyon oluşturduğu söylemek mümkündür. Ayrıca türün bölgedeki doğal stoklara etkisinin araştırılması için bir yönetim planının hazırlanması gerektiği düşünülmektedir.

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Anahtar kelimeler: Karadeniz, istilacı, pasifik istiridyesi, *Crassostrea gigas*.

INTRODUCTION

The Pacific oyster, *Crassostrea gigas* (Thunberg, 1793) is a highly commercial Bivalvia species (Wolff & Reise 2002; Batista et al., 2008). It is native to Japanese coast of Pacific Ocean; however, it is the most common

aquaculture species in the world with high ability of adaptations to various environmental conditions (Shatkin et al., 1997; Ruesink et al., 2005). Pacific oyster has been introduced to more than seventy countries and has established breeding populations in seventeen of these (Ruesink et al., 2005). Aquaculture productions of this

species started in 1920s in the USA and in 1966 in France. Further, Italy has the highest production and consumption rates of this species in Europe (FAO, 2018). Besides its high rate of production in aquaculture in different countries, it has been introduced to the new aquatic areas via unintentionally ships and intentionally shellfish farming. Both larvae and eggs in the ballast waters and the adults attached to the bottom of the ships have been unintentionally distributed globally (Schmidt et al., 2008; Keller et al., 2011; Pecarevic et al., 2013).

C. gigas was first introduced to the Black Sea in 1980 for aquacultural purposes on the Crimean coast (Zolotarev, 1996). Following to this first introduction, the species was reported in the natural areas in 1995 (Micu, 2004). The species was cultured between 2001- 2003 on the Romanian coasts (Zaharia & Crivăţ, 2017). Pacific oyster has been reported in the natural areas out of the aquacultural areas in the Black Sea (Skolka & Gomoiu, 2004) with rapid adaptations to the environmental conditions on the coast of Romania (Krapal et al., 2019). Additionally, Pacific oyster has been reported in the Sea of Marmara, Aegean and Mediterranean Seas (Acarli et al., 2017; Gökçek et al., 2020). However, bio-ecological characteristics including occurrence, distribution and reproduction etc. of Pacific oyster on the Turkish coast of Black Sea are still unknown. Therefore, occurrence, density and size-age distribution of the wild colonies of this species have been investigated. Additionally, the potential relationships of Pacific oyster with other native and none native species in the Black Sea were discussed.

MATERIAL AND METHOD

This study was conducted on the Ordu Coast of Southern Black Sea in July 2020 (41°06'57.79"N 37°20'51.26"E - 41°02'02.42"N 37°30'08.88"E) (Figure 1).

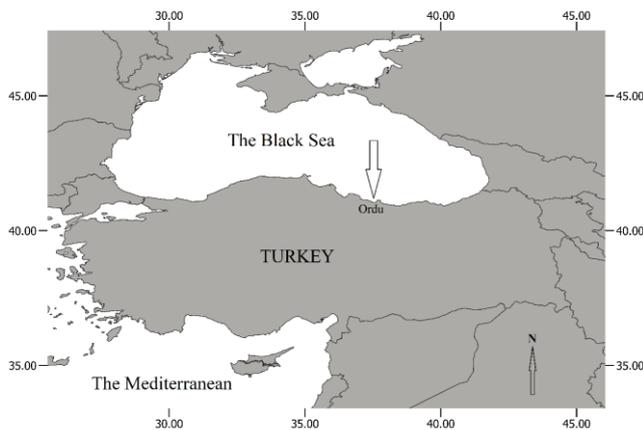


Figure 1. Sampled area.

We investigated the occurrence and density of Pacific oyster at 5 sites via a total of 15 times SCUBA

diving on 2 consecutive days. At each site, we sampled 4800 cm² of benthic habitat in three quadrats (40x40 cm) from 0m to 3m at depth. We also photographed each quadrat for further investigations (Figure 2)

For species identification, we collected a few individuals from each quadrat and moved to the laboratory in which species identification was made using morphological characteristics (Lucas, 1982; NOBANIS, 2020; Poppe & Goto, 2000). Following this, we determined the size distributions of the individuals observed in quadrats using ImageJ (with 64-bit Java 1.8.0_152) (Schneider et al., 2012). Since the length and the width of the individuals vary independently between individuals, we used body surface area as size variation of the oysters (length X width).

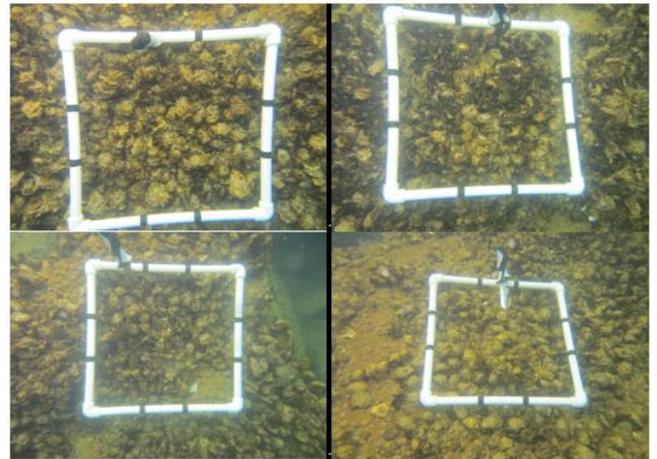


Figure 2. Quadrat sampled of different 4 site in Ordu (southern Black Sea).

RESULTS

We determined that Pacific oyster was the dominant species both on the large rocks used for land fulfilment and on the natural substrate on the coast (Figure 3).



Figure 3. *Crassostrea gigas* habitat from the Black Sea littoral Turkey.

We further observed that Pacific oyster share the same environment with other species on the Turkish coast of Black Sea. Specifically, Mediterranean mussel (*Mytilus galloprovincialis*) and Pacific oyster were mostly found in the same quadrat (Figure 4). Additionally, Patella species and rapa whelk (*Rapana venosa*) were evident in a few quadrats.

We examined a total of 227 oysters and the average length was found to be 3.33 ± 0.724 cm (Min: 0.967 cm-Max: 6.538 cm) (Table 1).

We further observed that some shells were just opened and the meat of the oysters were removed, suggesting that Eurasian otter was feeding on this species in the region.

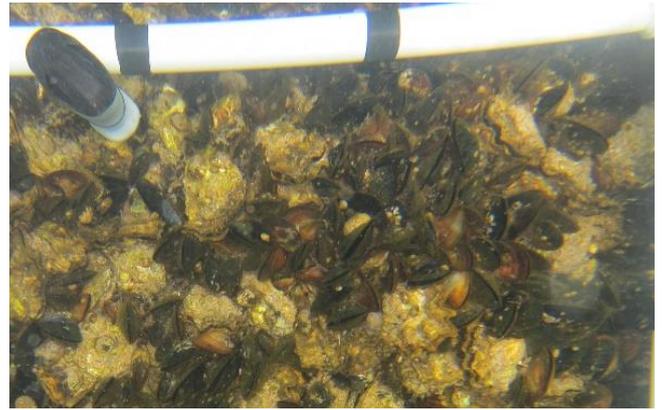


Figure 4. Mediterranean mussel and pacific oyster on the same habitat.

Table1. *Crassostrea gigas* density and morphometry in the Fatsa Region.

	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5
Scanned Area (cm ²)	4800	4800	4800	4800	4800
Density (individual)	53	66	35	33	40
Mean Length (cm)	3.56 ± 0.794	3.40 ± 1.083	3.03 ± 1.062	3.51 ± 1.022	3.00 ± 0.752
Mean Width (cm)	2.51 ± 0.663	2.75 ± 0.982	1.95 ± 0.656	2.58 ± 0.653	2.12 ± 0.543
Surface area of shell (cm ²)	9.19 ± 4.144	9.26 ± 4.276	6.42 ± 4.594	9.48 ± 4.663	6.61 ± 3.203

DISCUSSION

During SCUBA diving operations with scientific and recreational purposes, a rapid increase in the abundance of Pacific oyster has been observed (Dr. Aydın, personal observation), suggesting the results from the potential arrival of the larvae and/or eggs in the ballast water and/or adults attached to the bottom of the ships. Further, Pacific oyster is the dominant species in the habitats that has been observed. Similarly, wild populations of Pacific oyster on the Romanian coasts of the Black Sea have been reported (Krapal et al., 2019).

Different studies investigated the size-age relationship of Pacific oyster in different regions in the world. The average size (e.g. shell length) for each age class found to be as 46 mm for the 1st year, 72.1mm for the 2nd year, and 91.6 mm for the 3rd year (Diederich, 2006; Cardoso et al., 2007; Christensen & Elmedal, 2007; Wang et al., 2007; Walles et al., 2015). Considering the average shell length for the given age classes of the oysters found in those studies, the population on the Ordu Coast comprises mostly young individuals with an average shell length of 3.3 cm. However, this inference should cautiously be accepted, since the growth may differ across habitats and regions.

C. gigas has the highest production rate among the aquaculture species due to its rapid and high capacity of adaptation and high reproduction abilities (Shatkin et al., 1997; Ruesink et al., 2005). The species reproduces at 18 °C (Enríquez-Díaz et al., 2009). The average water temperatures in the Black Sea reach these temperature

values around in June, suggesting that reproduction starts in June in this region (MGM, 2020).

In this study, the wild colony of Pacific oyster in the southern Black Sea has been detected. In addition, this study indicates Pacific oyster is well adapted to the ecosystem of the southern Black Sea and suggests that they formed a stock in the southern Black Sea.

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