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ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

Distribution and Fishery of the Blue Crab (*Callinectes sapidus* Rathbun, 1896) in Turkey Based on Local Ecological Knowledge of Fishers

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Abstract: This study provides information on the distribution and ecology of *Callinectes sapidus* in Turkey, as well as its maximum daily catch in set nets (trammel nets and gillnets), and its commercial fishery in lagoons. Data were collected in 2020 by utilizing a telephone based questionnaire survey. Responses were gathered from fishermen (n = 6) who fish in the lagoons and the head or members of fishery cooperatives (n = 104) in 28 cities, including the coastal regions of the Mediterranean Sea (Levantine), Aegean Sea, Sea of Marmara and the Black Sea in Turkey. The results showed that *C. sapidus* is commonly distributed along the Levantine and the southern Aegean coasts of Turkey, whilst it is rarely observed in the Sea of Marmara and the Black Sea. Fishermen stated that *C. sapidus* has been seen in the Black Sea for the last decade. The maximum daily catch of blue crab in set nets showed a significant difference in the Levantine and Aegean coasts. The results indicated that the species was mainly produced in the lagoons, whereas many coastal fishermen returned it as discard and 79% of fishermen emphasized that *C. sapidus* shred the nets and caused an economic loss. Ovigerous females have been observed between March and October and we have discussed related management issues including current fishery season.

Keywords: *Callinectes sapidus*, fisheries management, invasive species, lagoon fishery, local ecological knowledge, marine invasion.

Balıkçıların Lokal Ekolojik Bilgilerine Göre Mavi Yengecin (*Callinectes sapidus* Rathbun, 1896) Türkiye'deki Dağılımı ve Balıkçılığı

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Öz: Bu çalışma, *Callinectes sapidus*'un Türkiye'deki dağılımı, ekolojisi, uzatma ağlarındaki (fanyalı ve sade ağlar) günlük maksimum avı ve dalyanlardaki ticari balıkçılığı hakkında bilgi sağlamaktadır. Veriler, 2020 yılında yapılan telefon anketleri ile toplanmıştır. Dalyanlarda balıkçılık yapan 6 balıkçı ve Türkiye'nin Akdeniz, Ege, Marmara ve Karadeniz kıyılarını kapsayan toplam 28 ildeki su ürünleri kooperatifi başkanları ya da kooperatif üyeleri (örneklem sayısı = 104) anketleri cevaplamıştır. Bulgular, *C. sapidus* türünün Türkiye'nin Akdeniz ve Güney Ege kıyılarında yaygın olduğunu, Marmara ve Karadeniz kıyılarında ise nadiren gözlemlendiğini göstermiştir. Balıkçılar, *C. sapidus*'un Karadeniz'de son 10 yıldır görüldüğünü belirtmişlerdir. Uzatma ağlarındaki günlük maksimum yengeç avı Akdeniz ve Ege Denizi'nde anlamlı fark göstermiştir. Bulgular, bu türün çoğunlukla dalyanlarda üretilirken, çoğu kıyı balıkçısının ıskarta olarak suya geri bıraktıklarını göstermiş ve kıyı balıkçılarının %79'u *C. sapidus* türünün ağları parçaladığını ve ekonomik kayba neden olduğunu belirtmiştir. Yumurtalı dişiler Mart ve Ekim ayları arasında gözlemlenmiş olup, mevcut balıkçılık sezonu dâhil olmak üzere yönetim ile ilgili konular değerlendirilmiştir.

Anahtar kelimeler: Balıkçılık yönetimi, *Callinectes sapidus*, dalyan balıkçılığı, denizel istila, istilacı türler, lokal ekolojik bilgi.

INTRODUCTION

Callinectes sapidus Rathbun, 1896, is commonly known as blue crab or Atlantic blue crab and is regionally entitled as "Chesapeake blue crab" around the western Atlantic Ocean and the Gulf of Mexico (Taybi & Mabrouki, 2020). *C. sapidus* is one of the 100 worst invasive species and causes damage to nets and target fish species caught by nets (Streftaris & Zenetos, 2006). This species has been transported to Japanese and European waters via ballast waters of vessels and appeared in the Baltic, North, Mediterranean and Black Seas (Nehring, 2011). Like many other non-indigenous species, the distribution and adaptation of *C. sapidus* in Europe has been influenced by climate change (Nehring et al., 2008).

C. sapidus prefers the sandy and muddy habitats (Hill et al., 1989) and the depths between 0 to 90 m (Stasolla & Innocenti, 2014). This species exhibits a migration pattern; after mating females migrate to areas where salinity level is higher (Eggleston et al., 2015). *C. sapidus* mainly feeds on molluscs, arthropods, fishes and polychaetes, whereas algae species are rarely consumed (Belgrad & Griffen, 2016; Hines, 2003; Laughlin, 1982; Reichmuth et al., 2009). It was reported that *C. sapidus* can reach a maximum size (carapace width (CW)) of 20.9 cm in males and 20.4 cm in females (FAO, 2020).

Estuaries are major areas for *C. sapidus* populations (Türeli, 1999). Some environmental features including depth and salinity influence the population structure of *C. sapidus* in these areas (Jivoff et al., 2017). Adult individuals of *C. sapidus* generally mate in these areas then migrate to lower estuaries or offshore waters to spawn and hatch their eggs (Fitz & Wiegert, 1992). *C. sapidus* also can be a dominant species in lagoons within relatively short periods. For instance, Kampouris et al., (2019) stated that specimens of *C. sapidus* feed on economically important molluscs, fishes, and crustaceans in the Thermaikos Gulf and Papapouli Lagoon in Greece, and have negative impacts on the Greek national fisheries and aquaculture.

Despite negative effects cited above, it was noticed that blue crab meat has high nutritional quality and various blue crab products have been sold in markets in the US and Europe (Çelik et al., 2004). The global capture of blue crab was reported as 97 896 t in 2016 and it was mainly caught around the western Atlantic coast (FAO, 2020). The decrease of *C. sapidus* population in certain regions might be related to overfishing, reduced freshwater inflow into estuaries, and problems in larval recruitment (Weatherall et al., 2018). The main fishing gear used in the capture of blue crab is a crab trap, however they are also caught by trawls and set nets (Hammerschmidt et al., 1998). In spite of the fact that crab traps are known as selective fishing gears, due to storms, vandalism and vessel propellers, these gears can be lost at sea, which is commonly known as 'ghost fishing' (Anderson & Alford, 2014; Havens et al., 2008). The minimum landing size of *C. sapidus* is 127 mm CW for hard crabs and harvesting egg-carrying females is prohibited in the Chesapeake Bay (Carver, 2001). On the other hand, blue crab is commercially fished in Turkey and Greece (Gökçe et al., 2007; Mancinelli et al., 2017). Regarding the management of blue crab fishery in Turkey, there are some restrictions including, the minimum landing size (MLS) is 130 mm CW and the fishery closed season is between 1st May and 30th September. However, the Ministry of Agriculture and Forestry gives permission rights to its Provincial Directorates; hence the fishermen operating in respective provinces may also get special permissions during closed seasons to operate in lagoons (Anon., 2020a). Regarding recreational fisheries, the MLS is 130 mm CW and there is a bag limit which is 1 kg. In contrast to commercial coastal fishers, recreational fishers can fish blue crab throughout the year in Turkey (Anon., 2020b).

It was reported that *C. sapidus* introduced to the northern Aegean Sea between 1935 and 1945 (Artüz, 1990; Enzenroß et al., 1997). Then, the occurrence of *C. sapidus* was reported in different regions of Turkey; Aegean Sea (Kocatas, 1971; Tuncer & Bilgin, 2008), Mediterranean Sea (Levantine coasts) (Enzenroß et al., 1997), Sea of Marmara (Zaitsev & Öztürk, 2001) and the Black Sea (Aydın, 2017; Bilgin, 2019; Ceylan, 2020; Yağlıoğlu et al., 2014). However, previous studies reported this species from one or several localities. The distribution of *C. sapidus* in all Turkish coasts and its fishery have not been evaluated comprehensively yet. In addition, the negative impacts of *C. sapidus* on native species and ecosystem in the Mediterranean has not been sufficiently addressed (Czerniejewski et al., 2020). This study provides information on *C. sapidus* in Turkish waters including; geographical distribution, some bio-ecological characteristics (e.g. egg-carrying period, habitat and depth selectivity), and fishing techniques in lagoons as well as estimated maximum daily catch in the small-scale fisheries (trammel nets and gill nets) in Turkey. There is no doubt that an understanding of the ecological and socio-economic impacts of invasive species in their new ecosystems will help to manage aquatic resources more effectively.

MATERIALS AND METHODS

Data sampling: The objective of the questionnaire based study was to obtain information on spatial distribution, ecology and fisheries characteristics of *C. sapidus* in Turkey. The questionnaire mainly consisted

of the open-ended questions. Telephone based questionnaires were applied in 2020 to commercial fishers (president of fishery cooperatives) who is actively performing small-scale fisheries. If the president of the fishery cooperative did not fish actively, we could apply the questionnaire to other members of the fishery cooperatives. The fishers (n = 104) who completed the questionnaire surveys reported using fishing gears including trammel nets and gillnets to catch many different target species. The data were collected from 28 cities including 110 fishing grounds, in order to reliably represent the coastal regions of Turkey (Figure 1a). The questionnaire provided information on; i) some demographic characteristics of fishers (age, gender, fishing experience), ii) bio-ecological characteristics of *C. sapidus* (e.g. distribution, depth and habitat selectivity, temporal trends in abundance, estimation of spawning and molting periods), and iii) fishery characteristics (e.g. determination of the fishing gears types caught blue crabs, estimated maximum daily catch in 2019). If *C. sapidus* did not emerge in the fishers' fishing grounds, they were exempt from answering some questions. Additionally, another questionnaire was applied to fishers (n = 6) who produce blue crabs in lagoons with barrier traps, wire pots and fyke nets. This second questionnaire included identical questions to the first one, with the addition of questions related to the lagoon fishery.

Data analysis: The SPSS (version 20.0) was used for the statistical analyses in this study. A Mann Whitney U test was utilized to ascertain whether the maximum daily catch of blue crab shows a difference in Levantine and Aegean or not.

RESULTS

The age of fishers who participated in the questionnaire survey ranged between 25 and 70 with a mean value of 49 ± 9 years. All of them were male and their fishing experience ranged between 7 and 56 years, while the mean fishing experience was 32 ± 11 years.

***Distribution and some ecological characteristics of Callinectes sapidus*:** Concerning the occurrence of *C. sapidus*, 100 %, 72 % and 46 % of fishermen who fish around the Levantine coasts, Aegean coasts and Sea of Marmara (excluding Çanakkale Strait), respectively reported that they detected this species at least once in their nets. While only 17 % of fishermen have encountered with *C. sapidus* in the Black Sea to date. In other words, *C. sapidus* is commonly distributed around the southern and western coasts of Turkey, whereas it has rarely been observed in the Sea of Marmara and the Black Sea (Figure 1b).

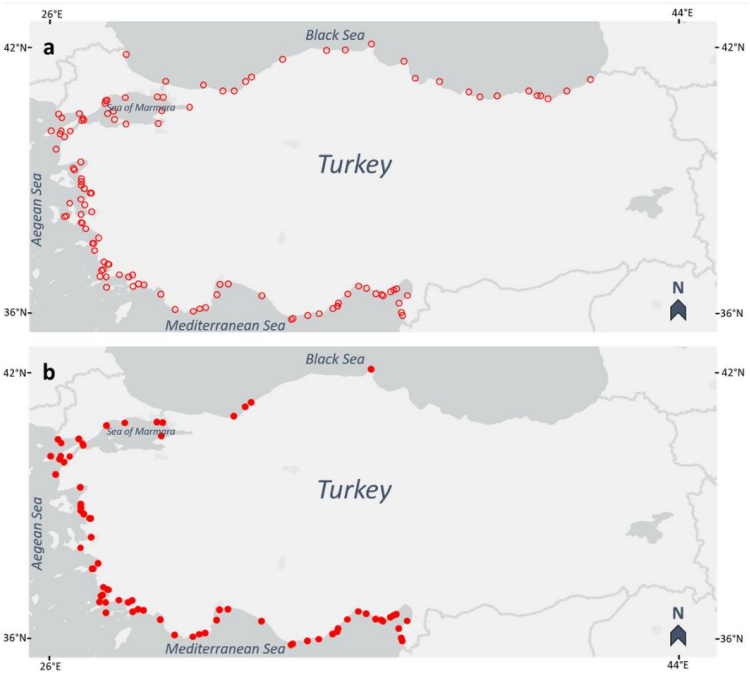

Figure 1. a) Spatial distribution of respondents, b) Spatial distribution of the recorded observations of *Callinectes sapidus* in Turkey.

In order to evaluate whether this distribution has changed over the years or not, fishermen with more than 20 years of experience were asked; "how long have you seen *C. sapidus* in your fishing grounds?" The answers related to this question proved that many fishermen around the Levantine coast of Turkey have seen this species for more than 20 years, whereas this species just started to be encountered in the Black Sea over the last several years (Table 1). Concerning the current status of *C. sapidus* population, 73 % of fishermen who fish around the Levantine coasts considered that its population has had stable characteristics for the last 10 years, whereas 44 % of fishermen who fish around the Aegean Sea reported an increased trend (Table 1). Meanwhile, a decreasing population was mainly detected by fishermen who fish around the northern Aegean Coast.

Table 1. Fishers' observations on the occurrence and population trend of *Callinectes sapidus* in Turkey.

	How long have you seen *C. sapidus*?			Population trend for the last 10 years		
Fishing ground	<10 years (%)	10-20 years (%)	>20 years (%)	Decrease (%)	Increase (%)	Stable (%)
Levantine	0	8	92	18	9	73
Aegean Sea	20	64	16	31	44	25
Sea of Marmara	90	10	0	NA	NA	NA
Black Sea	100	0	0	NA	NA	NA

The main habitats of *C. sapidus* were determined as muddy and sandy sediments by 94 % of fishermen. It was reported that this species was also rarely found in vegetated and rocky habitats. Based on commercial fishermen's responses who mainly fish at depths less than 200 m, *C. sapidus* was distributed in depths between 0.5 m to 40 m and was mainly caught in depths between 0.5 m to 10 m around Turkish coasts. In this study, ovigerous females were reported by trammel netters and gill netters from Levantine and Aegean coasts for the period between March and October, and March and September, respectively. Similarly, egg-carrying crabs were reported from lagoons between May and September. Even though we asked the question on molting periods of male and female crabs to fishermen, they could not clearly identify the molting periods. Furthermore, only a few fishermen who fished in the lagoons identified molting period as between May and August. However, they could not identify aforementioned period separately for male and female crabs.

Commercial fisheries

Coastal fishery: The results showed that *C. sapidus* was mainly caught by trammel nets and gillnets as a by-catch species. No fishermen identified the blue crab as the main target species. Fishermen who used these fishing gears noted that their main target species are red mullet, striped red mullet, shrimp, common sole, grey mullet, sea bass, blue fish and Atlantic bonito. Fishermen reported that *C. sapidus* was also rarely caught by encircling nets. In this study, a total of 9 fishermen indicated that they sold caught crabs, whereas others preferred to return them to the sea or, in rare cases, consume them. It was noticed that both male and female crabs were sold at the fishery cooperatives. The prices of *C. sapidus* ranged from 5 to 30 Turkish Lira (TL)/kg (0.56-3.36 €/kg) in 2020. There was a statistically significant difference in the reported maximum daily catch of *C. sapidus* between the Levantine and Aegean Sea (U = 48,000, P = 0.002). The higher daily catch values were found around the Levantine coasts (Figure 2).

In this study, 79 % of fishermen, used trammel and gill nets, expressed that *C. sapidus* causes damage to their fishing gears (e.g. shred the nets) and results in economic loss. Additionally, only 27 % of fishermen reported that *C. sapidus* has a negative impact on the aquatic ecosystems. Regarding blue crab fishery management in Turkey, all fishermen who sell blue crabs had information about the fishing season.

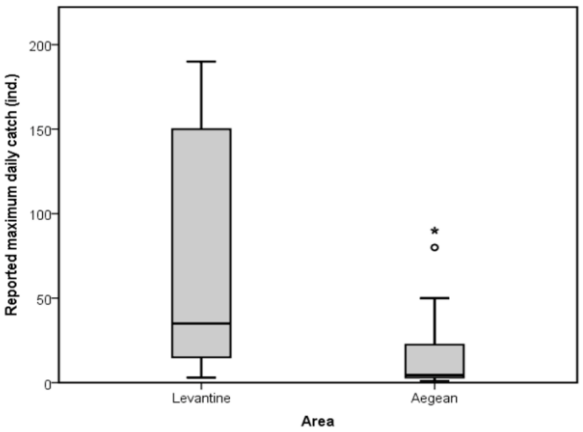

Figure 2. Reported maximum daily catch of *Callinectes sapidus* in set nets (combined data from trammel and gill nets) in Levantine coasts and Aegean coasts of Turkey in 2019.

Lagoon fishery: Blue crab fishery has been performed actively in several lagoons in Turkey. In addition to blue crab, gilthead seabream, European seabass, mullet, and European eel were stated by fishermen as the main target species in these lagoons. The blue crab has been fished at depths ranging from 0.5 to 2 m. Fishermen noticed that the main habitats of these lagoons were reported as muddy and sandy. In these lagoons, crabs have been caught mainly by barrier traps (Figure 3a). Scoop nets have been used to capture blue crabs in these barrier traps. In addition, other traps such as pots and fyke nets have been also used for catch. The pots used were mainly rectangular in shape with hexagonal wire mesh (Figure 3b) and the commonly used mesh bar size varied from 20 to 25 mm. Fish species including sardine, carp, mullet, smelt and also chicken were used as bait in traps. *C. sapidus* has been landed throughout the year in lagoons. In particular, the highest production period for blue crab was reported as between May and August. The maximum daily blue crab catch in lagoons was between 60 and 600 kg. Although the estimated annual production in these lagoons was between 1 and 15t due to limited demand, fishermen estimated the stock size of blue crabs can reach up to 150t in one lagoon in the eastern Mediterranean. Fishermen notified that the mean CW of sold crabs ranged from 13 to 16 cm in lagoons and all fishermen had information on the minimum landing size. Fishermen acknowledged that the ovigerous (sponge) was not sold from in the lagoon fishery. Both male and female crabs were exported live, however some fishermen noted that females were more resistant in transportation. Fishermen declared that these crabs were exported to China and the Netherlands and also some of them were sold at domestic markets and restaurants in Adana, Antalya,

Muğla and İstanbul. The prices of exported blue crabs ranged from 7 to 9 €/kg, while the prices of crabs sold to domestic markets ranged from 0.34 to 2.24 €/kg in 2020. All fishermen reported that blue crab causes damage to fishing nets and half of them believed blue crab also damaged other species in lagoons.

Figure 3. Fishing gears used in the lagoons; a) barrier traps, b) rectangular hexagonal mesh wire trap (photos by Gökhan Gökçe).

DISCUSSION

The occurrence of *C. sapidus* in Europe (Atlantic coast of France) has been detected since the earlier periods of the 1900's (Czerniejewski et al., 2020). The first record of *C. sapidus* in the Mediterranean was given by Giordani Soika, (1951). Due to the ballast waters, the species expanded rapidly (Mancinelli et al., 2017; Öztürk et al., 2020). *C. sapidus* was also reported from the Black Sea (Bulgurkov, 1968) and the northern Aegean Sea (Artüz, 1990). Then it spread to the Aegean and Mediterranean coasts of Turkey (Enzenroß et al., 1997). New records of *C. sapidus* found in different locations of Turkish waters were reported by Turkish Scientists (Aydın, 2017; Bilgin, 2019; Ceylan, 2020; Kocataş, 1971; Tuncer & Bilgin, 2008; Yağlıoğlu et al., 2014). The present study provided the most comprehensive information about the distribution of *C. sapidus* in Turkey. It should be noted that local ecological knowledge (LEK) is a valuable source to evaluate the distribution of invasive species in large geographical areas. Our results highlighted that the population size of *C. sapidus* was high throughout the Levantine coasts and some areas of the Aegean Sea, whereas this species was rarely observed by fishermen in the Sea of Marmara and the Black Sea (Figure 1b). This species was also recorded in some sites of the eastern Black Sea (Trabzon and Ordu-Fatsa) according to the previous studies (Bilgin, 2019; Ceylan, 2020).

The mating success and fecundity may be considered as important indicators for the adaptation of non-native species to new environments. *C. sapidus* exhibits high fecundity; ovigerous specimens can produce 8 million eggs per spawn in Chesapeake Bay (Prager et al., 1990). Previous studies showed that the Mediterranean population of *C. sapidus* also represented relatively high fecundity; which ranged from 244,000 to 7 million eggs in İskenderun, Turkey (Türeli, 1999) and from 742,652 to 7,359,642 eggs in Köyceğiz Lagoon, Turkey (Gülşahin, 2007). The success of reproduction and distribution of *C. sapidus* were dependent on water temperature (Nehring, 2011) and the optimal spawning conditions were noted as 19 – 22 ° C and 0 – 8 hr of darkness (Bembe et al., 2017). Thus, water temperature condition is proper for the reproduction and growth of *C. sapidus* in the Levantine coasts of Turkey, and this situation supports the highest catch that can be considered as relative abundance has been found in that region in the present study. However, due to the increasing trend of water temperature in the Sea of Marmara and the Black Sea, the recorded exotic species number has increased over the last years (Erdogan Saglam et al., 2010; Öztürk et al., 2020; Turan et al., 2018). Hence, the abundance of both the blue crab and other exotic species may show a dramatic increase in the Sea of Marmara and the Black Sea ecosystems in the future.

The present study revealed that, based on many fishermen's perspective, the population of *C. sapidus* was stable for the last 10 years around the Levantine coasts, whilst increase and decrease trends were reported from some fishing grounds of the Aegean Sea. Similarly, Cerri et al., (2020) collected data from recreational fishermen in Italy and reported that many fishers evaluated the population trend as "stable or fluctuating" (43.5%) or "increasing" (40.3%). On the other hand, the distribution area of *C. sapidus* widened; for instance, Mancinelli et al., (2017) noted that the number of blue crab records increased in the Mediterranean Sea and southern European waters in the last years.

Some invasive species have strong negative ecological and economic effects and cause damage to fishing gears (Galanidi et al., 2018). In the present study, many trammel netters and gillnetters (79%) reported that *C. sapidus* shredded the nets and caused significant economic loss in some fishing grounds, and 27% of coastal fishermen highlighted that this species has a negative influence on aquatic ecosystems. There is no doubt that the impact level of exotic species on fisheries depends on their abundance. For example, Cerri et al., (2020) evaluated the potential environmental consequences of *C. sapidus* in Italy, Croatia and Montenegro and many of the questionnaire survey participants did not have clear ideas about the environmental consequences, and few respondents believed *C. sapidus* has a negative effect on the environment and fishery. Besides, the economic impacts of *C. sapidus* in the small-scale fishery should be studied as a further study. However, it should be noted that not only blue crab but also other aquatic animals such as

pufferfishes, dolphins and sea turtles can cause damage to nets, such as shredding.

Our results showed that although some fishermen caught blue crab by trammel nets and gillnets around the Levantine and southern Aegean coast, due to its relatively low price compared with native species (e.g. red mullet, striped mullet, shrimp) and limited demand, this species has been mainly considered as a 'by-catch species' depending on catch rate in the coastal fishery. Hence, there is no standardized fishing gear and mesh size for the fishery of blue crab in Turkey. The size selectivity of traps and escape rates of *C. sapidus* in Turkey was evaluated in previous studies (Atar et al., 2002; Gökçe et al., 2007; Özdemir et al., 2015). For instance, Atar et al., (2002) compared the catch per unit effort (CPUE) of traps and hoop nets and noted that the mean CPUE of hoop nets was significantly higher than the mean CPUE of traps. Based on a laboratory study Gökçe et al., (2007) compared the escape success of *C. sapidus* in traps using three different square mesh barriers (35, 40, and 45 mm bar length). They reported that L50 for the 35, 40, and 45 mm bar length (mean ± s.e.) was 8.09 ± 0.12, 9.32 ±. 0.09, and 10.56 ± 0.11, respectively. Similarly, Özdemir et al., (2015) investigated the size selectivity in traps using four different mesh sizes (30, 35, 40, 45 and 50 mm) and they ascertained that using a 50 mm square mesh demonstrated high selectivity with a high escape rate of immature individuals.

The results of the present study demonstrated that the production of blue crab is mainly provided by lagoon fishery in Turkey. According to previous studies, the exploitation and management of *C. sapidus* in Turkey started in the early 1990's (Öztürk et al., 2020; Zaitsev & Öztürk, 2001). The present study also noted that the annual production of *C. sapidus* in one lagoon can reach up to 15 t. The abundance of blue crabs and its interactions with other species in lagoons should be studied in the future.

The MLS of *C. sapidus* increased from 8 to 13 cm CW in Turkey (Anon., 2020a; Anon., 2020b; Gökçe et al., 2007). The size onset of sexual maturity (SOM) of *C. sapidus* in the south coast of Turkey was determined by Türeli (1999) and the aforementioned study reported that females mature at 6.05 cm carapace length (CL), whereas males mature at 4.48 cm CL. It was reported that SOM of crabs show a difference depending on geographical areas (Gökçe et al., 2007; Türeli, 1999). Thus, to understand whether the current MLS is available or not more observations related to the SOM in the different sites of Turkey should be performed.

Another management measure related to the blue crab is fishery closed season for coastal fishery in Turkey. The current closed season of blue crab fishery (between 1st May and 30th September) spans across a relatively large period (Anon., 2020a) but according to our results ovigerous crabs can be captured from March to October. In addition, Türeli (1999) investigated the reproduction of *C. sapidus* in Yumurtalık (the southeastern coasts of Turkey) and noted that sponged females were observed from March to end of September (Table 2). Similarly, the ovigerous individuals were observed from May to October in Köyceğiz Lagoon, Turkey (Gülşahin & Erdem, 2009). On the other hand, the landing of ovigerous and soft crabs has not been prohibited in Turkey yet and the fishermen can fish blue crab with special permit throughout the year in lagoons. To develop the effective management tools, a priority should be given to investigate the ecological impacts of this invasive species on native species and the economic loss caused by *C. sapidus* in the small-scale fisheries.

Table 2. Temporal distribution of the ovigerous individuals of *Callinectes sapidus* and its current fishery closed season in Turkey.

Geographical area (Study)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Yumurtalık (LE) (Türeli, 1999)												
Köyceğiz(AS) (Gülşahin & Erdem, 2009)												
Aegean Sea (This Study, 2021)												
Levantine (This Study, 2021)												
Current fishery closed season												

The abbreviations; LE: Levantine, AS: Aegean Sea

Consequently, the knowledge on spatial distribution of *C. sapidus* in Turkey has expanded over recent years. Due to the decline in stocks of native species in Mediterranean, some exotic species may be considered as an alternative food source for this region in the future. The blue crab is one example that started to be an economically important crustacean species of Turkey's lagoon fishery, whereas it causes monetary loss in gillnet and trammel net fishery and relatively few fishermen caught it as a secondary target species. More studies are required to reveal ecological and economic impacts of *C. sapidus* on the Mediterranean ecosystem.

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