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STOCK ASSESSMENT, CARTOGRAPHY AND SEXUALITY OF THE WEDGE CLAM *DONAX TRUNCULUS* IN THE GULF OF GABES (TUNISIA)

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ABSTRACT

In Tunisia, the wedge clam Donax trunculus is one of the most dominant species of the sandy beach macrofauna. Despite its economic value, this target species is still unexploited and there have been no studies focusing on its current status. This study is the first attempt to investigate the stock assessment, spatial distribution, and sexuality of D. trunculus. The obtained results revealed that densities ranged from 0 to 278 ind. m⁻², and biomass varied between 0 and 444 g m⁻². The amount of the latter was equal to 130.1 tons, with high abundance levels reaching over 129.5 million individuals in an area of 4935 hectares. The shell length within the population varied substantially from one locality to another, ranging from 4.8 to 32.7 mm. The overall sex ratio (F:M) was 1:1.52. The species proliferates in Tunisia and is subjected to a congregated demand of markets through regulated fisheries.

Key words: *Donax trunculus*, stock assessment, cartography, sexuality, Gulf of Gabes, Tunisia

VALUTAZIONE DELLO STOCK, CARTOGRAFIA E SESSUALITÀ DELLA TELLINA *DONAX TRUNCULUS* NEL GOLFO DI GABES (TUNISIA)

SINTESI

In Tunisia, la tellina Donax trunculus è una delle specie di macrofauna più dominanti delle spiagge sabbiose. Nonostante il suo valore economico, questa specie non è ancora sfruttata e non ci sono studi che si concentrino sullo stato attuale. Il presente studio è il primo tentativo di valutazione dello stock, della distribuzione spaziale e della sessualità di D. trunculus. I risultati ottenuti hanno rivelato che le densità variano da 0 a 278 ind. m⁻², e la biomassa varia tra 0 e 444 g m⁻². La quantità di quest'ultima è pari a 130,1 tonnellate, con alti livelli di abbondanza che raggiungono oltre 129,5 milioni di individui in un'area di 4935 ettari. La dimensione delle conchiglie della popolazione varia sostanzialmente da una località all'altra, variando da 4,8 a 32,7 mm. Il rapporto complessivo tra i sessi (F:M) è pari a 1:1,52. La specie prolifera in Tunisia ed è sottoposta ad una domanda di mercato attraverso la pesca regolamentata.

Parole chiave: *Donax trunculus*, valutazione degli stock, cartografia, sessualità, Golfo di Gabes, Tunisia

INTRODUCTION

The wedge clam *Donax trunculus* is an Atlantic-Mediterranean warm-temperate species. It enjoys a wide distribution throughout the Mediterranean and Black Seas, and from North Africa to the northern Atlantic coast of France (Ansell & Bodoy, 1979). This species lives in highly energetic environments on sandy beaches, where it is exposed to tidal rhythms, intense wave action and sediment instability (Brown & McLachlan, 1990; Tlili & Mouneyrac, 2019). The target species is encountered in the 0–2 m depth range in the Mediterranean Sea, and between 0–6 m on the Atlantic coasts, with higher concentrations at depths ranging from 0 to 3 m (Gaspar *et al.*, 2002).

D. trunculus is widely distributed along Tunisian coasts. It could acquire an important role in solving the problem of shortage and elevated price of protein source in Tunisia. Moreover, the wedge clam *D. trunculus* could play an important role in the social-economic context, mainly due to the number of fishermen involved in this activity off the Gulf of Gabes. Tunisian coasts extend over long distances and it has become necessary to take a closer look at the exploitation of bivalves inhabiting these areas. To date, shellfish exploitation has focused particularly on the carpet shell clam *Ruditapes decussatus* (Linnaeus, 1758) which, in Tunisia, is heavily harvested from natural populations and represents one of the most important economic products in the country in terms of export.

In areas where the resource exists, the wedge clam *D. trunculus* has often attracted researches for economic interests. Most of the studies have been carried out in Egypt (Kandeel, 2017), Italy (Manca Zeichen *et al.*, 2002), Portugal (Gaspar *et al.*, 1999), Algeria (Degiovanni & Moueza, 1972; Moueza & Frenkiel-Renault, 1973), Morocco (Lamine *et al.*, 2020), Turkey (Colakoglu & Tokac, 2011) and Spain (Ruiz-Azcona *et al.*, 1996), particularly focusing on the Mediterranean Sea and North Atlantic populations. These investigations have mainly dealt with bivalve stocks assessment (Charef *et al.*, 2011; Pinello *et al.*, 2020), growth and reproduction (Ansell & Bodoy, 1979; Deval, 2008; Gaspar *et al.*, 1999; Kandeel *et al.*, 2018), population structure, and production (Manca Zeichen *et al.*, 2002; Colakoglu & Tokac, 2011; Colakoglu, 2014). Several studies on the burrowing behaviour of many species of *Donax* have been conducted by McLachlan & Young (1982), Donn & Els (1990), Ansell *et al.* (1998) and Huz *et al.* (2002). In Tunisia, although there is now an extensive literature on the reproductive cycle and biochemical composition (Boussoufa *et al.*, 2011, 2015; Aouini *et al.*, 2017, 2018), no studies have been carried out about the spread of the wedge clam *D. trunculus*; it is of interest therefore, to record its current status in an area of extensive shellfish production.

This species could be relevant in terms of its poten-

tial for exploitation. At present, there are no artisanal fisheries for *D. trunculus* in the southern coasts of Tunisia. Therefore, this paper represents the first attempt to obtain basic information on the target species by investigating its stock size, geographical distribution, and some biological aspects related to the role of certain abiotic factors.

MATERIAL AND METHODS

Study area

The Gulf of Gabes is located in southern Tunisia and in the southern Mediterranean Sea. Its shoreline extends for 750 km from La Chebba 35°N to the Libyan border (Fig. 1). It has an arid and semiarid Mediterranean climate largely influenced by the area's mild topography and maritime exposure (Chamtouri *et al.*, 2008). Both wide and shallow continental shelves are topographically regular. The bottom slightly declines towards the sea and the 60 m depth occurs at 110 km from the coast (Ben Othman, 1973). It is divided into two intertidal zones, soft sand and muddy sand shores (with or without seagrass beds) (Derbali, 2011). The latter are mostly covered by the seagrasses *Cymodocea nodosa* (Ucria) Ascherson and *Zostera noltei* Hornemann. Moreover, the Gulf of Gabes is known for its benthic community and an exceptional bionomy made up of extensive magnoliophytes *Posidonia oceanica* and *C. nodosa* meadows (Ben Mustapha & Hat-tour, 2013). Their leaves provide suitable substrate for shellfish establishment and growth.

Field sampling and sample processing

Samples were collected during three years (2016–2018) in the coast of the southern part of Tunisia. The study area was roughly divided into fourteen sites with respect to *Donax* occurrence (Fig. 1). Transects were systematically performed in the sampling area during low tides. Replicates were taken every 50 m along transect lines from extreme high water tide to extreme low water tide. Along transects, 4–10 stations were sampled by quadrats (0.25 m²) using a shovel. Large and small specimens were collected by hand and using a 2 mm mesh sieve, respectively. During the sampling period, seawater temperature and salinity were measured near the bottom immediately after sampling using a multi-parameter kit (Multi 340 i/SET).

Samples of clams were placed in labelled plastic bags and subsequently preserved in a 7% formaldehyde solution. In the laboratory, the material was sorted and washed to remove sediments and debris. Individuals were identified and counted, while shell length (SL = maximum distance along the antero-posterior axis) was measured with a digital caliper to the nearest 0.01 mm and weighed on a toploading digital scales

(precision of 0.001 g) to determine the total weight (TW). The obtained data set was registered and maps were drawn. Moreover, mean densities (ind. m⁻²) and biomass (g m⁻²) were obtained per site, and afterward pooled across areas to assess stocks based on the method of kriging using Arc View v. 3.2 software and according to the following equation (Gulland, 1969): $B_i = N_i \times A_i/a_i \times 1/X_i$ where B_i – represents total biomass; N_i – mean abundance of all quadrat samples in each site; A_i – site area surface; a_i – quadrat swept area; and X_i – retained proportion. The impact of sites on SL and on densities was estimated using one way ANOVA. Similarities among sites in terms of stock levels were processed by cluster analysis. Similarly, the harmonic Spearman correlation coefficient was applied to identify any significant correlations between density and biomass of clams in each site. The results are presented as a means $\pm$ standard error (SE) and the significance level used for the tests was $p < 0.05$.

For biological study, the sexuality of specimens of wedge clam *D. trunculus* was determined by (1)

examination of the macroscopic appearance of the gonad and (2) microscopic examination of gametes. The visceral mass was then teased apart, smears of the visceral wall with attached gonad were examined at 100 $\times$ magnification, and sex of individuals was determined. The sex ratio (expressed as number of females per males; F:M) was also determined. Statistically significant deviations from a balanced sexual proportion of 1:1 were assessed by the χ^2 test, with statistical significance considered at $p < 0.05$ (Zar, 1996).

Results

Habitat and distribution

A total of 300 transects were made from extreme high water tide to extreme low water tide, corresponding to 2198 replicates. Based on the results of this study, *D. trunculus* was encountered throughout the surveyed areas, inhabiting sandy bottoms at depths between 0 and 1 m. Regarding the substratum cover,

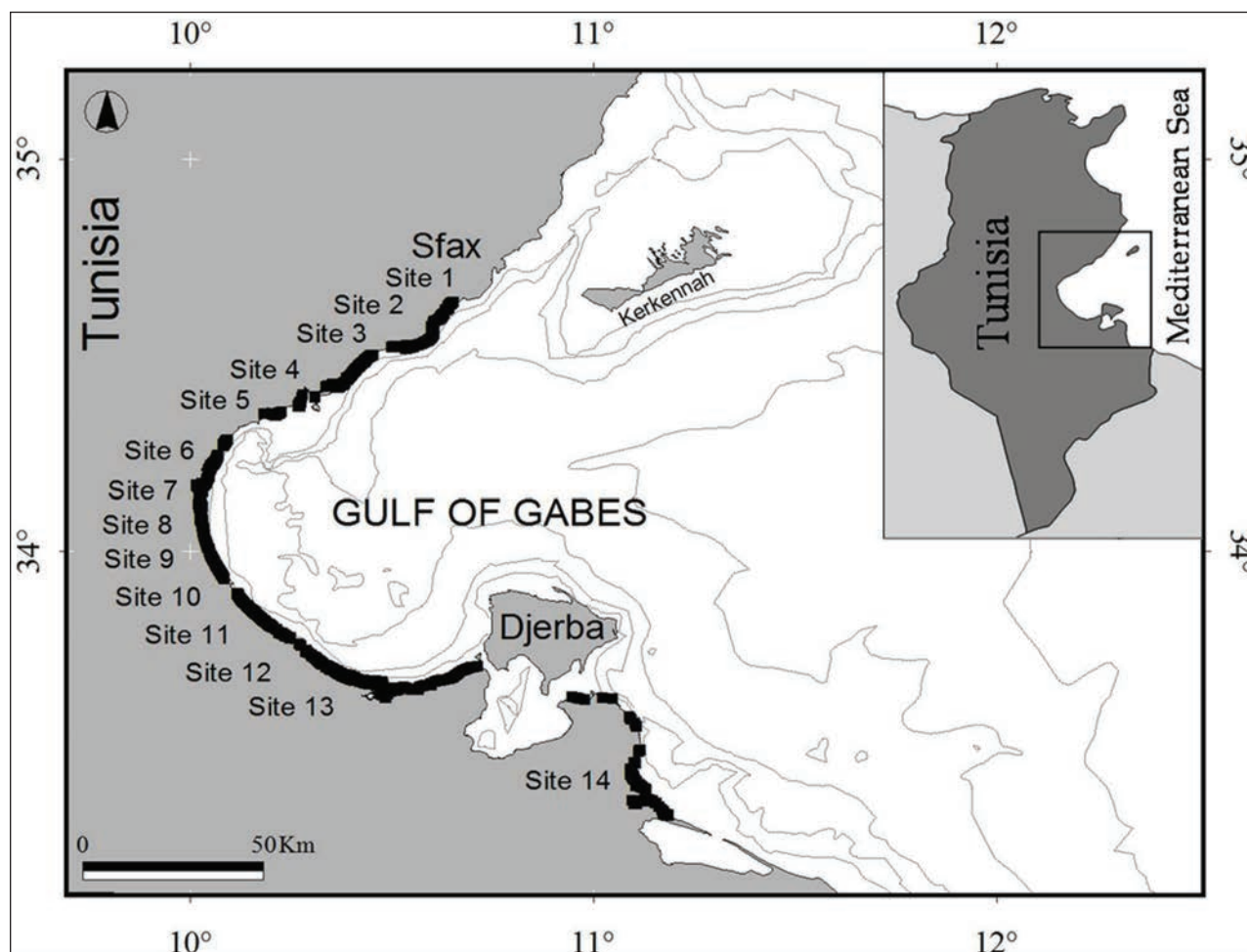


Fig. 1: Geographic position of sampling transects in the Gulf of Gabes (Tunisia).

Sl. 1: Geografski položaj vzorčevalnih transektov v zalivu Gabes (Tunizija).

Tab. 1: Surface area, number of transects and replicates and stock levels (means $\pm$ SE) of the wedge clam *Donax trunculus* along the coast of the Gulf of Gabes (Tunisia).**Tab. 1: Površina, število transektov in ponovitev ter ocena staleža (povprečje $\pm$ SE) klinaste školjke *Donax trunculus* ob obali zaliva Gabes (Tunizija).**

Sites	Surface (ha)	% of all surface	Number of transects	Number of replicates	Means densities (ind. m ²) $\pm$ SE	Means biomass (g. m ²) $\pm$ SE
Site 1	265	5.37	11	62	0.32 $\pm$ 0.13	0.65 $\pm$ 0.27
Site 2	146	2.96	12	50	4.64 $\pm$ 0.79	10.46 $\pm$ 1.78
Site 3	379	7.68	16	82	1.46 $\pm$ 0.46	2.62 $\pm$ 0.89
Site 4	87	1.76	8	72	0.06 $\pm$ 0.01	0.23 $\pm$ 0.04
Site 5	395	8.01	28	226	0.23 $\pm$ 0.18	0.20 $\pm$ 0.17
Site 6	202	4.09	31	168	2.67 $\pm$ 1.85	4.84 $\pm$ 3.48
Site 7	106	2.15	40	112	14.64 $\pm$ 4.24	26.79 $\pm$ 7.66
Site 8	148	3.00	20	66	6.18 $\pm$ 2.78	9.72 $\pm$ 4.75
Site 9	40	0.81	9	50	21.68 $\pm$ 11.12	27.35 $\pm$ 17.62
Site 10	241	4.88	23	134	8.12 $\pm$ 4.63	2.74 $\pm$ 1.02
Site 11	595	12.06	11	68	4.41 $\pm$ 2.20	1.63 $\pm$ 0.57
Site 12	547	11.08	19	290	0.74 $\pm$ 0.20	0.71 $\pm$ 0.20
Site 13	179	3.63	27	552	1.27 $\pm$ 0.31	0.94 $\pm$ 0.23
Site 14	1605	32.52	45	266	0.23 $\pm$ 0.20	0.05 $\pm$ 0.04
Total	4935	100	300	2198	2.89 $\pm$ 0.49	3.57 $\pm$ 0.67

almost all of the study area hosting the highest population densities (sites 2, 3, and 6 to 13) was dominated by the seagrass *C. nodosa*, and the substrates consisted predominantly of very fine sand. In some areas, *D. trunculus* was also found loose on soft sand. During the sampling operations, the highest and lowest temperature values were recorded in July (27 °C) and in February (12 °C), respectively. Salinity measurements showed an annual fluctuation between 30 in winter and 48 in summer.

In this study, mean stock levels for each site are presented in Table 1. The distribution of *D. trunculus* revealed a discrepancy between the northern, middle and southern gulf shores. The central part was more populated and included two areas (sites 7 and 9) of high clam densities and biomass (Figs. 2 & 3). In these sites, the density per station reached 278 ind.m² and biomass recorded remarkable levels of over 444 g m⁻². Overall, significant differences in *D. trunculus* distribution among all sites were shown. Density ranged from 0 to 278 ind. m⁻² and biomass between 0 and 444 g. m⁻² (Fig. 2 & 3). Both K–S and Levene’s tests revealed significant

statistical differences in clam abundances ($p < 0.05$). In the same way, pairwise comparisons between biomass values also indicated that obtained data for all production sites were significantly different ($p < 0.05$).

Abundance and biomass

The total biomass was estimated to be 130.1 $\pm$ 48.6 tons of total fresh weight, with a mean biomass around 3.6 $\pm$ 0.7 g m⁻² and a total abundance reaching over 129.5 $\pm$ 54.1 million individuals. The mean density of the quadrats was equal to 2.9 $\pm$ 0.5 ind. m⁻². Overall, 1594 individuals were collected from all studied sites (4935 hectares). A layout of significant variation in stock levels among colonised areas is set out in Figure 4. In terms of biomass, there were significant differences among sampling sites ($p < 0.05$) with the exception of site 1 with respect to sites 5 and 14, and site 3 with respect to site 9 ($p > 0.05$). As for biomass, significant variations in total abundances were recorded among sites ($p < 0.05$), with the exception of site 1 with respect to site 5, and sites 8, 9, and 12 with

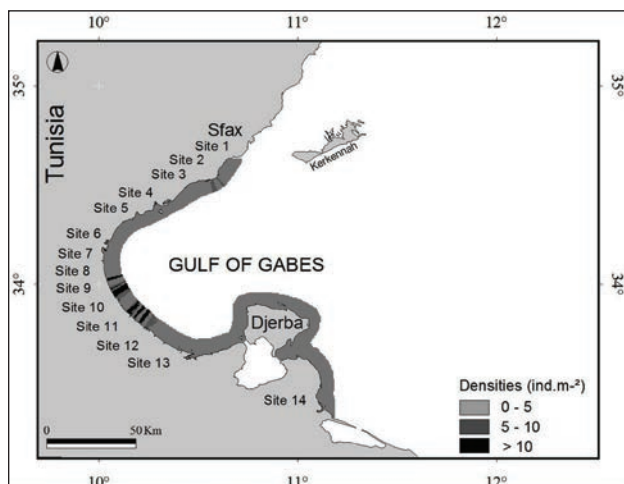


Fig. 2: Spatial distribution of densities of *Donax trunculus* in the littoral zone of the Gulf of Gabes (Tunisia).
Sl. 2: Prostorska porazdelitev gostote klinaste školjke (*Donax trunculus*) v obalnem območju zaliva Gabes (Tunizija).

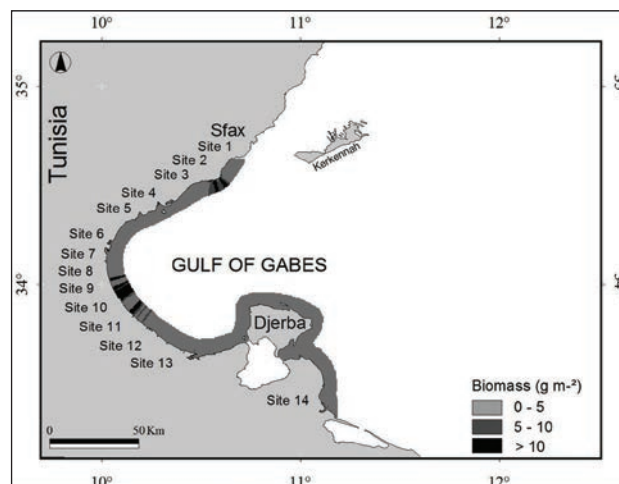


Fig. 3: Spatial distribution of biomass of *Donax trunculus* in the littoral zone of the Gulf of Gabes (Tunisia).
Sl. 3: Prostorska porazdelitev biomase klinaste školjke (*Donax trunculus*) v obrežnem pasu zaliva Gabes (Tunizija).

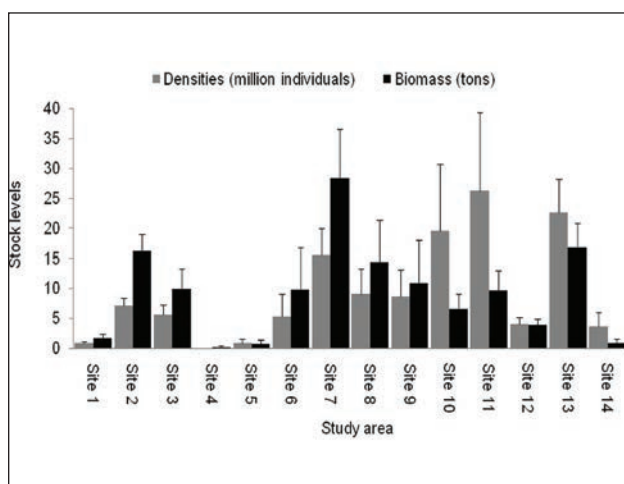


Fig. 4: Stock levels of *Donax trunculus* in the colonised zones and their standard error ($\pm$ SE) along the coast of the Gulf of Gabes (Tunisia).
Sl. 4: Ocena staleža klinaste školjke (*Donax trunculus*) na območjih pojavljanja in standardna napaka ($\pm$ SE) ob obali zaliva Gabes (Tunizija).

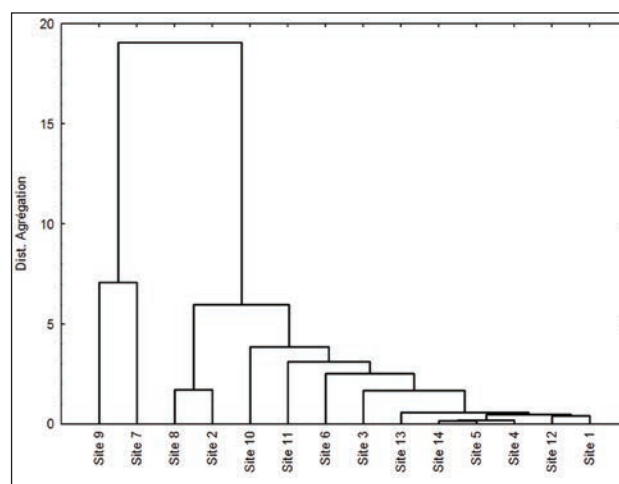


Fig. 5: Similarity dendrograms of colonised zones of *Donax trunculus* (average group) along the coast of the Gulf of Gabes (Tunisia).
Sl. 5: Podobnostni dendrogrami klinaste školjke (*Donax trunculus*) na območjih pojavljanja območjih ob obali zaliva Gabes (Tunizija).

respect to site 14 ($p > 0.05$). Additionally, through cluster analysis of sites (group average) applied to compare similarities between sites, a principal group was defined from among all sites (Fig. 5). Similarity tests showed that the aforesaid group and sites 7 and 9 were significantly different (global R superior to 0.87; $p < 0.05$). This was generally due to clam stocks being most abundant in sites 7 and 9 with respect to the rest of the sampling area.

Size structure

The size in terms of shell length of the *D. trunculus* collected over the sampling period ranged broadly from 4.8 to 32.7 mm SL. One peak was apparent, corresponding to individuals of 25 mm SL (Fig. 6). The majority of *D. trunculus* population was assigned to size classes 11–29 mm SL, which represented 97.2% of the total samples. Only 0.01% of the sampled specimens were

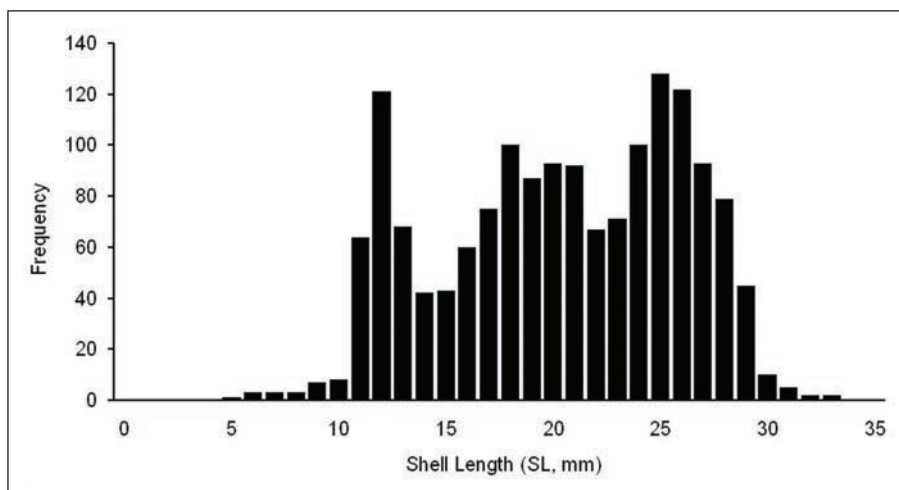


Fig. 6: Length–frequency distribution of *Donax trunculus* along the coast of the Gulf of Gabes (Tunisia).

Sl. 6: Velikostna porazdelitev klinaste školjke (*Donax trunculus*) vzdolž obale zaliva Gabes (Tunizija).

larger than 30 mm SL, collected in sites 2 and 7, situated in the northern and central parts of the study area. This could mainly be attributed to natural mortality caused by pollution and increased temperatures in summer. Unfortunately, the mortality rate was not estimated.

The mean length was 20.42 ± 0.14 mm SL in this study. Statistical analysis revealed there was a significant difference ($p < 0.001$) among mean shell lengths recorded in individual studied sites. Mean sizes ranged from 9.36 ± 0.8 mm in site 14 to 26.80 ± 0.31 mm in site 2 (Tab. 1), and the sizes of the individuals appearing greatly influenced by location. Significant variations were observed between mean shell lengths of specimens collected from sites 1 to 9 when compared to those from other sites (10–14, $p < 0.001$). Furthermore, the shell length–weight relationship for overall data (1594 individuals) showed positive correlation ($R^2 = 0.9695$; $p < 0.001$, Fig. 7)

Sex ratio

Of the specimens analysed, 794 were males (49.8%), 522 females (32.7%), and 278 of indeterminate sex (17.4%). The wedge clam specimens presented a broad size range, both in term of shell length (4.8–32.7 mm) and total weight (0.03–4.25 g). The overall sex ratio (F:M = 1:1.52) was significantly divergent from parity (F:M = 1:1; χ^2 -test, $p < 0.001$).

DISCUSSION

The current study reports for the first time the spread of the wedge clam *D. trunculus* over the largest shellfish production area in the south of Tunisia by

investigating the stock levels, population distribution and some biological aspects. Maps show a scattered distribution pattern both in terms of density and biomass. The wedge clam has colonised areas with a depth range of 0–1 m, which supports an important stock representing 71.7 tons of total fresh weight and high abundance levels reaching over 11.7 million individuals. Generally, this study is aimed at ascertaining whether the stock of a given species is large enough to warrant the beginning or continuation of the management of its stocks. On comparison, data on biomass assessment and distribution are insufficient. This stock is much larger than that recorded in the Gulf of Tunis (3 tons) located in the north of Tunisia (Charef *et al.*, 2011). Our sampling operations showed that the variance within and among sites was large, and standard errors (SE) of densities and biomass were correspondingly wide. A gradient similar to this can be observed in another clam species (*Macra stultorum*), with about 113 tons estimated in the same study area (unpublished data).

Maps of stocks revealed the fluctuation of *D. trunculus* habitats in the prospected area. As a result, the *D. trunculus* stocks varied considerably across the sites. It seems mainly that clam populations have been strongly influenced by various factors related to the study area (e.g., physicochemical, edaphic and hydrological) (Derbali, 2011). During our sampling operations, the hydrodynamic conditions were found to be similar within the sampling area and it might be assumed that relative *D. trunculus* stocks were influenced by other environmental parameters such as sediment type, organic matter content, the burrowing behaviour of bivalve species and their subsequent

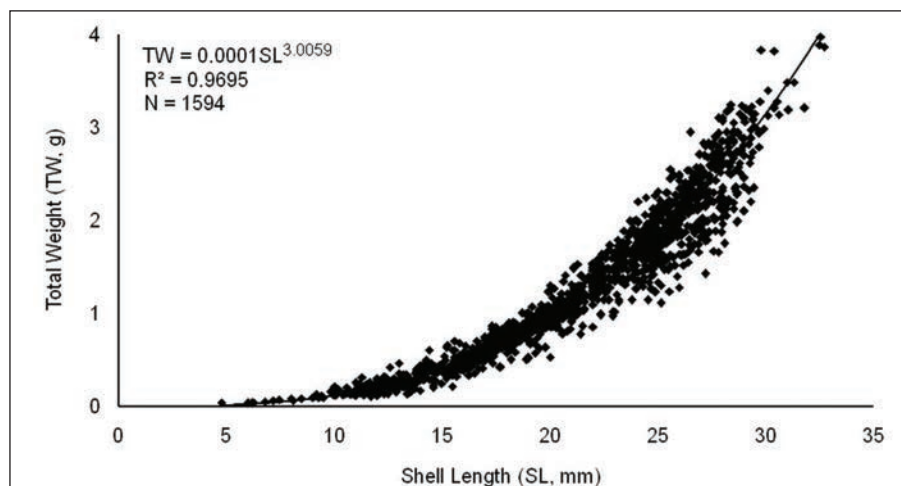


Fig. 7: Relationship between shell length (SL) and total weight (TW) of *Donax trunculus* along the coast of the Gulf of Gabes (Tunisia).

Sl. 7: Odnos med dolžino lupine (SL) in celotno težo (TW) klinaste školjke (*Donax trunculus*) vzdolž obale zaliva Gabes (Tunizija).

strategies to counter dislodgement and avoid predation (Derbali, 2011). In fact, some interesting connections between environmental conditions and bivalve lifestyles were detected in this study area, with the elevated water temperatures and phytoplankton levels possibly promoting rapid growth rates in many local bivalve species. Due to high water temperature levels (12–27 °C) and shallowness, the salinity remains fairly stable and high throughout the year, peaking during summer (47–48) and often in winter (28–30). This indicates that *D. trunculus* has a high salinity tolerance. The maximum value recorded from the present study area (48) was much higher than that recorded along the north Tunisian coast, where salinity ranged between 34 and 39 (Boussoufa *et al.*, 2011). These authors demonstrated that *D. trunculus* tolerated a hypo- to hyperhaline salinity range and the fluctuations observed did not have any significant effect on the wedge clam reproduction. Similar results have been reported for other bivalve species, including the cockle *Cerastoderma glaucum* and the pearl oyster *Pinctada radiata* (Derbali, 2011). Conversely, Neuberger-Cywiak *et al.* (1990) argued that low population densities of *D. trunculus* in the Mediterranean coasts of Israel were caused by the low temperature and reduced salinity of the surface waters due to heavy rains.

Overall, in these conditions, *D. trunculus* can be the most dominant at a depth range of 0–1 m. In the same way, Manca Zeichen *et al.* (2002) mentioned that the target species proved to be the dominant species of the macrofauna community in the south Adriatic coast (Italy) at 0–2 m depth ranges, beyond which the species disappeared abruptly, giving way

to a progressive dominance of *D. semistriatus*. Similarly, Colakoglu (2020) reported that *D. trunculus* was found at depth ranges from 0 to 2 m in Marmara Sea (Turkey).

Other additional mechanisms affecting *D. trunculus* populations include soft bottoms and nutrients. Indeed, mud sandy substrates (sites 1, 4, 5 and 14) prevent the species proliferation, as evidenced by the small densities recorded in these areas. *D. trunculus* requires a particular type of sediment in its habitat. The distribution of the wedge clam might be a result of substratum selectivity. *Donax* species are highly selective of substratum (Ansell & Trevallion, 1969; Degiovanni & Moueza, 1972), but the influence of other environmental factors on shellfish aggregations is also interesting. *D. trunculus* was harvested from areas in which the seagrass *C. nodosa* covered almost all the colonised habitat (sites 2 and 3, and 6–13). It seems that the scattered distribution of *D. trunculus* was considerably correlated with the seagrass beds, suggesting that these sites provide good conditions for the proliferation of wedge clam. It can thus be deduced that this seagrass species improves the nutritive resources and dissolved oxygen levels. Other parameters such as light and tides can also have an influence on bivalves' lifestyle (Drummond *et al.*, 2006; da Costa *et al.*, 2013). In fact, *D. trunculus* has a wedge-shaped shell which seems to be an adaptation for rapid burrowing and for migrating between tide levels (Stanley, 1970). These properties were confirmed by the omnipresence of the wedge clam in the most colonised sites corresponding to energy beaches (Fig. 4). Nevertheless, the low abundance of the wedge clam recorded in sites 1 to 6 in the northern

and central parts of the study area is attributable to the continuous inputs of the industrial waste (Bejaoui *et al.*, 2004).

Regarding shellfish richness, the colonised area constitutes an ecosystem with macrofaunal diversity with bivalve and gastropod species (Derbali, 2011). This faunal group, which includes *Donax trunculus*, feeds by filtering nutrients from the water column. The spatial distribution of shellfish colonisation might be linked to ecological and physiological properties of the encountered bivalves, namely their affinity for substrate type. The high diversity of shellfish species is particularly interesting when the relative organic matter content and depth range (0–1 m) are considered. In fact, these factors can provide ecological conditions that are able to maintain highly diverse reef communities in the present studied area. Extensive works have confirmed the correlation between community structure and the primary production (Menge & Olson, 1990; El Lakhrach *et al.*, 2012). Indeed, density and biomass of filter-feeders was proved to be correlated with both intertidal productivity and nearshore primary productivity (Menge & Olson, 1990; Agirbas *et al.*, 2014). These findings may explain the prevalence of shellfish species in these particular grounds. In addition, this corroborates the importance of environmental conditions in controlling shellfish abundance. As such, physical parameters, namely surface and depth, might play a major role in affecting distribution patterns and aggregation densities of shellfish in shallow waters (Neuberger-Cywiak *et al.*, 1990; Tlili & Mouneyrac, 2019).

In our study, the wedge clam *D. trunculus* exhibited characteristics similar to those reported for other bivalve species. The condition factor estimated from the length-weight relationship can serve as an indicator of the “well-being” of a given species and an indicator of food abundance for the species in a given area or time (Mzighani, 2005). In bivalve species, several environmental factors are known to influence shell morphology and relative proportions, such as depth (Claxton *et al.*, 1998), shore and tidal levels (Franz, 1993), wave exposure (Akester & Martel, 2000), type of bottom (Claxton *et al.*, 1998) and substratum type (Newell & Hidu, 1982). Tlig-Zouari *et al.* (2010) and Derbali *et al.* (2011, 2012) from Tunisia noticed that these aspects varied within bivalve species in localities with different environmental conditions. In fact, the size ranges of some bivalve species are highly variable among studies, complicating comparisons from different geographical areas. In the present study, the shell length ranged between 4.8 and 32.7 mm SL, with the mean length at 20.42 mm SL. The majority of clams belonged to size classes (11–29 mm), with only specimens of 25 mm SL standing out

for numerosity. In fact, the length–frequency distribution was almost normal. We can speculate that this size structure might be a result of the nonexploitation of the natural populations of *D. trunculus*. One can assume that the growth, development and survival of bivalves are generally conditioned by physical and chemical parameters. This conclusion is the same as that given by Carlier *et al.* (2007), Le Pape *et al.* (2007) and Strachan (2010) in relation to the bivalve species from the northwestern Mediterranean, the Bay of Biscay (France) and the North Sea (UK), respectively.

The sex ratio of the wedge clam *D. trunculus* (F:M = 1:1.52) was significantly divergent from parity (1:1), with males outnumbering females. On comparison, Boussoufa *et al.* (2015) came to the same conclusion for the clam *D. trunculus* from the Bay of Tunis (F:M = 1:1.41). Our result is also in agreement with those reported for *D. trunculus* populations from Turkey (Deval, 2009), Egypt (Kandeel *et al.*, 2018) and Portugal (Gaspar *et al.*, 1999). Additionally, previous studies reported that males of the wedge clam generally make up a slightly higher share but they do not show a statistically significant difference from parity (1:1) (Lucas, 1965; Badino & Marchionni, 1972; Moueza & Frenkiel-Renault, 1973). Our findings are in accordance with those of Derbali *et al.* (2021) for the surf clam *Macra stultorum* in southern Tunisian waters (F:M = 1:1.37), Chung *et al.* (1988) for *Macra veniformis* in Korea, and Kandeel (1992) for the clam *Polititapes aureus* from Lake Timsah in Egypt (F:M = 1:1.15).

The increased proportion of males compared to females is probably due to differential growth or differential mortality as a probable result of spawning effort.

To conclude: the wedge clam *Donax trunculus* is a native Tunisian species widely distributed along southern Tunisian coasts. Due to its economic value, it could represent a valuable species for commercial exploitation in Tunisia. This study gives more information about its stock in the most extensive area of shellfish production. The data may help to determine future quantitative changes and trends in southern Tunisian waters, which are exposed to various environmental factors and human activities. Future studies are needed to obtain data on population dynamics.

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OCENA STALEŽA, KARTOGRAFIJA IN SPOLNOST KLINASTE ŠKOLJKE *DONAX TRUNCULUS* V GABEŠKEM ZALIVU (TUNIZIJA)

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POVZETEK

Klinasta školjka (Donax trunculus) je ena izmed prevladujočih vrst makrofavne peščenega dna. Kljub svoji gospodarski vrednosti je ta ciljna vrsta še vedno neizkoriščena in doslej ni bilo opravljenih nobenih študij, ki bi se osredotočale na njen trenutni status. Ta študija je prvi poskus raziskovanja ocene staleža, prostorske porazdelitve in spolnosti vrste D. trunculus. Dobljeni rezultati so pokazali, da so njene gostote med 0 in 278 os. m⁻², njena biomasa pa med 0 in 444 g m⁻². Na območju velikem 4935 hektarjev je bila biomasa ocenjena na 130,1 tone, število osebkov pa na 129,5 milijona. Dolžina lupine v populaciji se je od lokacije do lokacije močno razlikovala in se je gibala od 4,8 do 32,7 mm. Delež med spoloma (samice: samci) je znašal 1:1.52. Vrsta se razmnožuje v Tuniziji in je zaradi reguliranega ribolova izpostavljena povpraševanju na trgu.

Ključne besede: *Donax trunculus*, ocena staleža, kartografija, spolnost, gabeški zaliv, Tunizija

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