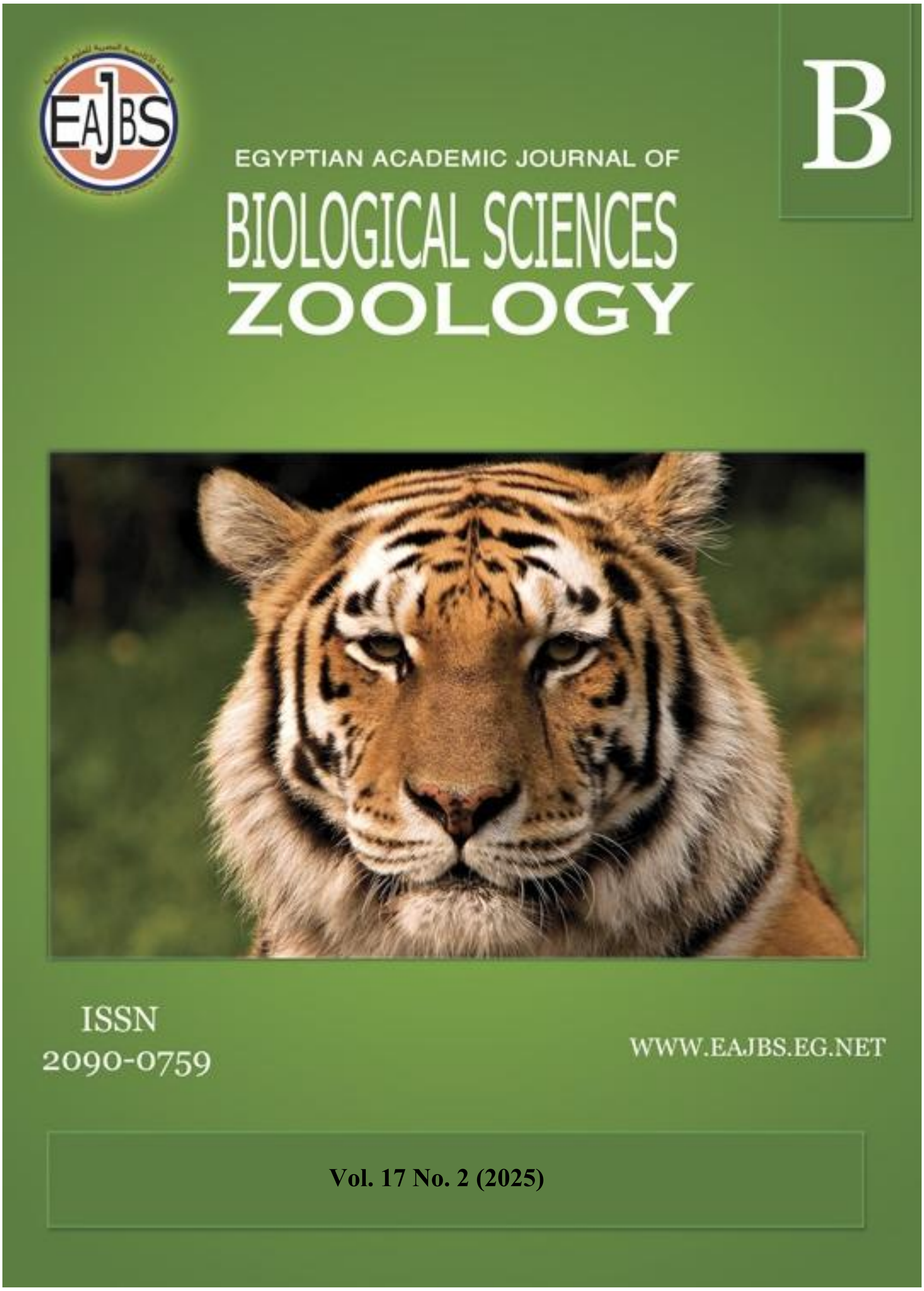

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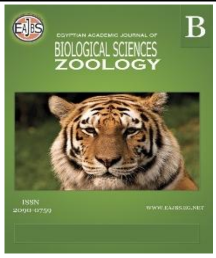

New Records and Redistribution of Intertidal Mussels *Brachidontes pharaonis*, *B. puniceus*, *B. exustus*, and *Perna perna* (Mytilidae) from the Eastern Mediterranean, Egypt

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ABSTRACT

Mussel populations are recognized as key components of coastal ecosystems. They are highly dynamic in response to environmental stressors and play a crucial role in understanding the effects of climate change and human activities on marine ecosystems. In Egypt, long-term environmental monitoring faces challenges due to lack of funding, leading to data discontinuity. Critically, there is a 20-year gap in registered mussel bed cover data for the study area. This study aims to document the current occurrence, seasonal abundance, and distribution of rocky shore mussels along the eastern Mediterranean coast of Egypt, with an emphasis on detecting and quantifying invasive species. Specimens of the bivalved mussels *Brachidontes* and *Perna* (Mytilidae), were collected during a surveillance study focused on rocky shore mussels at Abu Qir Bay, Alexandria, Egypt, eastern Mediterranean Sea. Specimens were collected seasonally at depths ranging from 0.4 to 0.6 meters and were identified to the species level based on morphological characteristics of the shell. The brown mussel *Perna perna* and three species of *Brachidontes*, the native Red Sea mussel *B. pharaonis,* and two non-indigenous species, *B. puniceus and B. exustus,* were recorded. During the study period from March 2023 to January 2024, a total of 415, 2663, 2353, and 704 individuals per square meter of *P. perna*, *B. pharaonis*, *B. puniceus*, and *B. exustus* were collected, respectively. The highest mean abundances were recorded in Spring for all the collected mussels, with the highest value recorded for *B.pharaonis*. Among the four identified mussel species, *P. perna, B. puniceus, and B. exustus* are new records for the eastern Mediterranean coast of Egypt, whereas *B. pharaonis* is one of the successful Lessepsian immigrants previously recorded.

INTRODUCTION

Mussels are found globally in both marine and freshwater environments, mostly in the littoral zone where they attach in clusters forming mussel beds, thus altering the nature and complexity of the substrate. In intertidal habitats mussels are vital ecosystem engineers, that offer food and shelter to a variety of diverse communities (Borthagaray and Carranza,2007; Arribas *et al.,* 2014). Mussels concerned with nutrient cycling in coastal ecosystems through four main pathways, filtration of seston, nutrient storage, excretion of fecal material, and

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excretion of inorganic metabolic waste (Jansen *et al.,*2012).*Brachidontes* is a marine bivalve mollusc in the family Mytilidae ,with a mussel-like outline. The family Mytilidae comprises about 510 species across 53 genera. They often dominate the intertidal zone where most species inhabit shallow waters attached to the hard substrate by byssus threads. The most prominent characteristic of *Brachidontes* shells is the presence of numerous fine radial ribs which may bifurcate and become more pronounced posteriorly. The shells are typically equivalve and inequilateral, with terminal umbones (Gilboa, 1976).

The Mediterranean Sea is a semi-enclosed body of water and has undergone rapid climatic changes during the period 1993-2020, with high average temperatures, salinity and sea level (Schroeder *et al.*, 2017; Menna *et al.,* 2022).The rising temperatures create favorable conditions for tropical non-indigenous species (NIS) (Amarasekare and Simon, 2020). The Mediterranean Sea is a major hotspot for NIS introductions, boasting the highest number of recorded NIS globally (Costello *et al.,* 2021). The Mediterranean Sea is home to approximately 1000 NIS (Zenetos *et al.,*2022). Consequently, the number of established NIS is continuously increasing, permanently altering the taxonomic and functional composition of Mediterranean ecosystems (Steger *et al.,* 2021; Zenetos *et al.,* 2022). In the Mediterranean Sea, while shipping and aquaculture are widely recognized as the primary pathways for global NIS introduction, the Suez Canal is also frequently cited as a significant route for the migration of Indo-Pacific species (Nunes *et al.,* 2014). Recently, the expansion of the Suez Canal was expected to pose a threat to the Mediterranean ecosystem, potentially increasing the rate of invasive marine species introduction (Galil *et al.,* 2015, 2017**).**

To date, there is a significant lack of data regarding the distribution of mussels in Egypt. The present study was conducted to record distribution of mussels in Abu Qir to enhance the available biodiversity records and provide baseline data for future ecological monitoring.

MATERIALS AND METHODS

Study Area:

The survey was conducted at a rocky shore in Abu-Qir Head in Alexandria, Egypt (Fig. 1). Abu Qir Bay is in the southeastern Mediterranean Sea. The bay extends 50 km in length and 12 m in depth. It is bounded to the southeast corner by Abu-Qir headland, with coordinates ranging from 30° 5′ E to 30 ° 22′ N, and to the northeast by the Rosetta mouth of the Nile River, with coordinates from 30 ° 22 ′ E to 31 °28 ′ N (Ibrahim *et al.,* 2023).

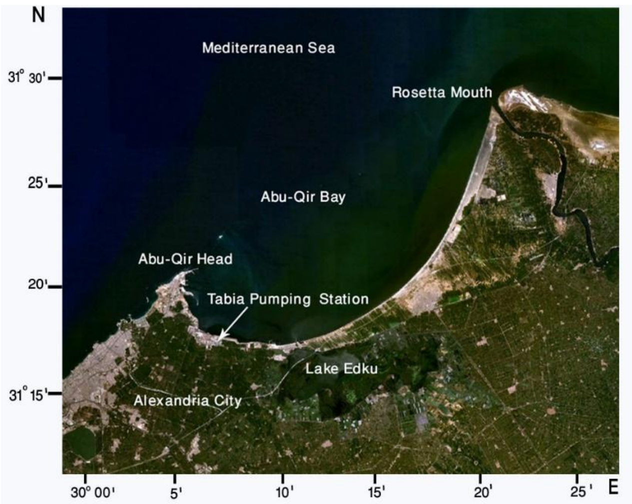

Fig. 1: Satellite image shows the location of the study area, Abu-Qir Head.

Sampling:

Mussels were manually collected during a surveillance study focused on rocky shore mussels from intertidal seashores in Abu Qir Bay, Alexandria, Egypt. This study was conducted seasonally over the years 2023–2024. The abundance of mussels was determined by collecting and counting individuals within 5 randomly selected replicate quadrats of 1 m 2 (Cruz-Motta *et al.,* 2010). Mussels were found in sediments associated with rocky shores and intertidal zones, at depths ranging from 0.4 to 0.6 meters.

Species Identification:

Specimens were identified at the species level based on morphological characteristics of the shell using taxonomic identification keys according to Pallary (1912), Siddall (1980), Thiele (1992), Hicks and Tunnell (1993), Reguero and García-Cubas (1994), Abbott and Morris (1995), Swennen *et al.* (2001),Mikkelsen and Bieler (2008), Rajagopal *et al.* (2006), Tunnell *et al*., (2010), and Bieler & Mikkelsen (2025). The accepted identification of the collected specimens was reviewed and confirmed using the World Register of Marine Species (WoRMS database, 2024). For morphometric data, shell length (L), the maximum antero-posterior dimension of the shell and shell width (W), the maximum left-right dimension with both valves compressed, were measured using vernier calipers with ±0.01 mm accuracy. Specimens were photographed using a Nikon D7000 Digital SLR camera.

All the collected specimens are held in a private archive maintained by the author and are available upon request.

Data Analysis:

All statistical analyses were performed using SPSS (v.26) and GraphPad Prism (v.9)**. A** two-way analysis of variance (ANOVA) was conducted. Results were considered statistically significant at $p < 0.05$**.**

RESULTS AND DISCUSSION

The present study focuses on rocky shore mussels collected seasonally from Abu Qir, Alexandria, Egypt. Rocky shore intertidal communities are dominated by the mussels of the genus *Brachidontes* . Three species of *Brachidontes*, *Brachidontes pharaonis* (Fischer, 1870), *Brachidontes puniceus* (Gmelin,1791), and *Brachidontes exustus* (Linnaeus, 1758) were recorded. In addition, one species of *Perna,* the brown mussel *Perna perna* (Linnaeus, 1758) was collected.

Brachidontes sp.:

Phylum : Mollusca
Class : Bivalvia
Subclass: Pteriomorphia
Order : Mytiloida
Family : Mytilidae
Genus : *Brachidontes*
Species : *Brachidontes pharaonis* (Fischer, 1870)
Species : *Brachidontes puniceus* (Gmelin, 1791)
Species : Brachidontes exustus (Linnaeus, 1758)

***Brachidontes pharaonis* (Fischer, 1870):**

The Red Sea mussel, *Brachidontes pharaonis* **(**Fischer, 1870), is characterized by a mussel-like outline with terminal umbones (Fig. 2). Externally dark brown and internally with violaceous shades. Sculpture of numerous fine radial bifurcating ribs, which become coarser posteriorly. The beak is not quite terminal and is characterized by the absence of a septum beneath the beak. The hinge has dysodont teeth. The inner margin is crenulate on the posterior side (Swennen *et al.,* 2001).

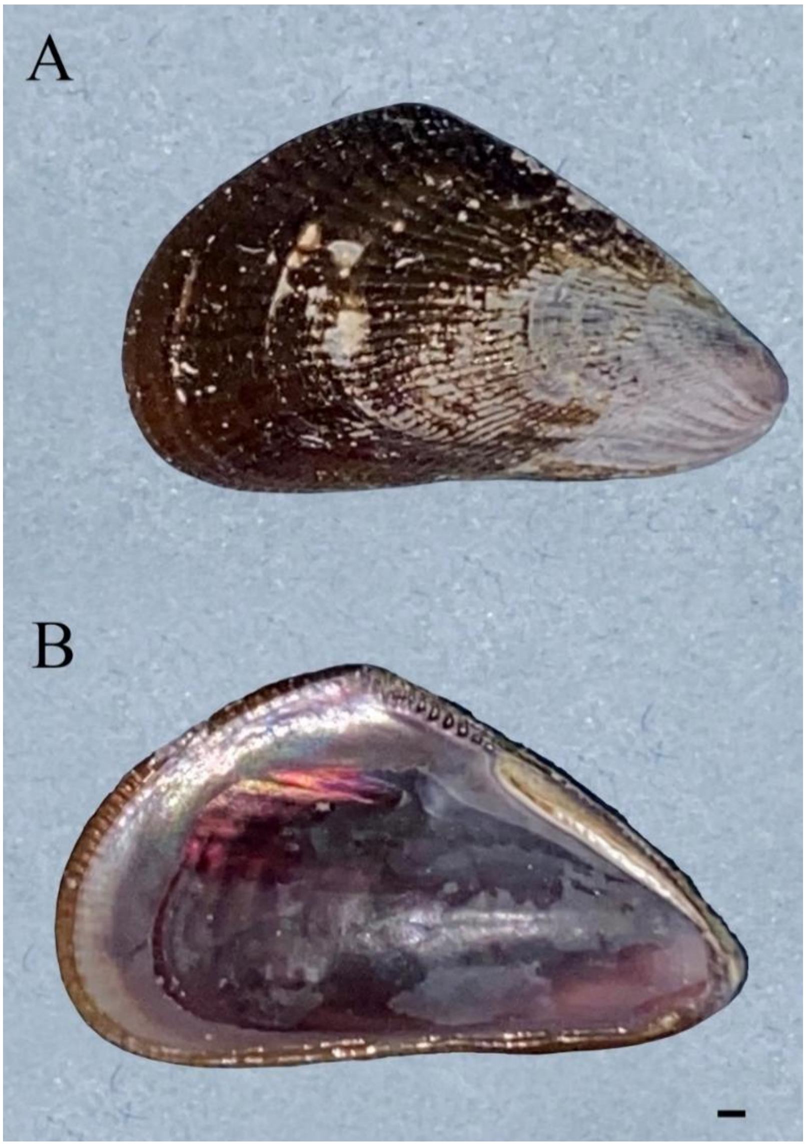

Fig. 2: ***Brachidontes pharaonis***. (A) External view of the shells, depicting the characteristics of fine radial bifurcating ribs, terminal umbones. (B) Internal view of the shells, depicting the violaceous shades, hinge has dysodont teeth and crenulate marginal edge. (Scale bar 2.7mm)

Originally from the Indian Ocean (Gilboa,1976), *B. pharaonis* has extensively spread throughout the Red Sea, often forming dense mussel mats (Oliver,1992) (Fig.3). It inhabits most of the rocky shores along the Red Sea coasts of Egypt and has become an invasive species in the Mediterranean Sea, entering via the Suez Canal from its native Red Sea and Indo-Pacific origins (Shefer *et al.,* 2004; Mohammed-Geba *et al.,* 2020; Ragab *et al.,*2023).It entered Mediterranean Sea via the Suez Canal, with the first record was in Port Said, Egypt in 1876 by Fuchs (1878) , as an exotic species. It colonized the eastern Mediterranean and successively becoming abundant in Lebanon (Gruvel and Moazzo, 1931); Israel (Haas, 1937); Sicily (Di Geronimo, 1971); Greece, Chalkida, Evvoikos (Koroneos, 1979); Syria (Kinzelbach, 1985); southern Turkey (Kinzelbach, 1985); Greece, Rhodes (Tenekides, 1989); northern Cyprus (Cecalupo and Quadri, 1996); Croatia, northern Adriatic (De Min and Vio, 1997).It successively propagated and considered invasive to the Mediterranean Sea, including west of Sicily (Zenetos *et al.*, 2005 ; Sarà *et al.,* 2006);Turkey (Doğan *et al.,*2007); Lebanon; Israel (Sara′ *et al*., 2008); Tunisia in 2007, 2011 & 2018 (Hamza *et al.,* 2018);Egypt (El-Deeb *et al.,*2018;Abdel Razek *et al.,*2020).

Fig. 3: Dataset global distribution map of *Brachidontes pharaonis* in GBIF. https://doi. org/ 10.15468/39omei accessed via GBIF.org on 2025-09-1.

In various regions of the Mediterranean Sea, the Red Sea mussel *B. pharaonis* has been observed to outcompete and displace the native mytilid, *Mytilaster minimus* (Safriel and Sasson-Frostig,1988; Sará and De Pirro,2011).It has dominated offshore platforms, threatening native species that have lower reproductive potential (Abdel Razek *et al*., 2017,2020; El-Deeb *et al*., 2018; Sará *et al.,* 2018) and is regarded as one of the most successful Lessepsian migrants, with the potential to significantly reshape the Mediterranean biodiversity (Mohammed-Geba *et al.,* 2020).Studies suggest that *B. pharaonis* exhibits extraordinary physiological and population characteristics that have contributed to its success as an invasive species in the Mediterranean Sea. The remarkable metabolic plasticity and exceptional tolerance and adaptation to highly stressed conditions such as varying temperature and salinity conditions enable this bivalve to outcompete and potentially replace native species (Sará *et al.,* 2000,2011; Hamza *et al.,*2018; Mohammed-Geba *et al.,* 2020; Battiata, *et al.,* 2024). In the current survey, *B. pharaonis* was the most abundant species across all seasons and is expected to spread and invade the whole Mediterranean Sea.

***Brachidontes puniceus* (Gmelin ,1791):**

Brachidontes puniceus (Gmelin 1791) has dark brown to black thickened shells ornamented with oblique radial ribs and contrasting with the greenish yellow furrows between the radial pigment bands (Cunha *et al.,*2011; Morton, 2012). The shell surface exhibits fine, closely spaced commarginal lines. Internally, the shell has well developed marginal denticles and hinge teeth. The species is typically heteromyarian, where the posterior retractor muscle scar is very large (Morton, 2012) (Fig. 4).

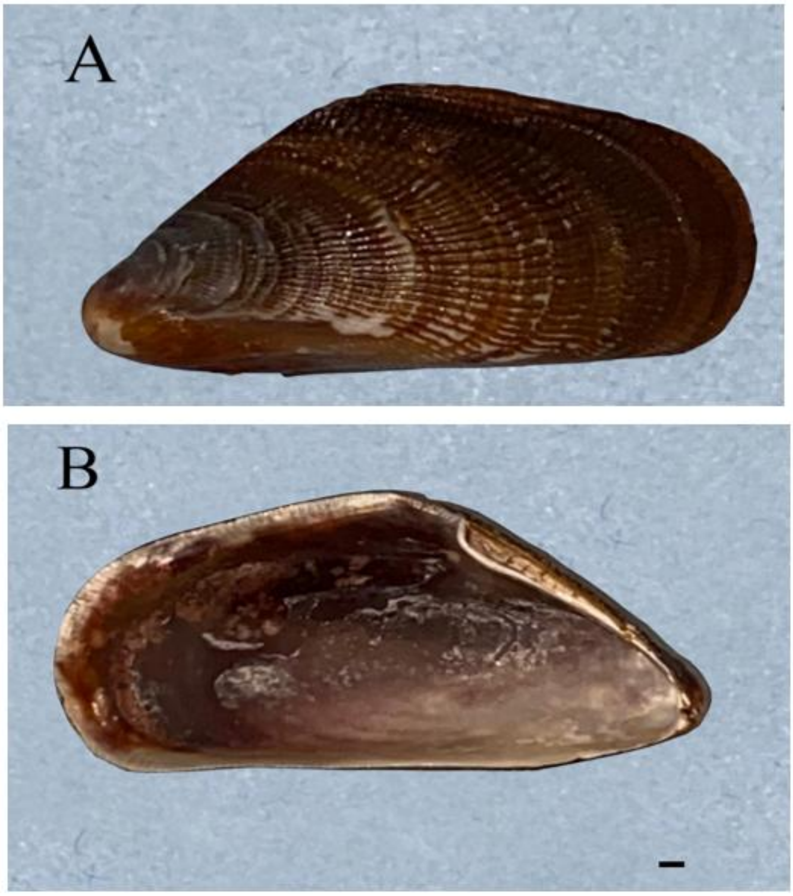

Fig.4: ***Brachidontes puniceus***. (A) External view of the shells, depicting the characteristic oblique radial ribs, greenish yellow furrows and closed commarginal lines (B) Internal view of the shells, showing hinge teeth, marginal denticles and large retractor muscle scar. (scale bar 2.5mm)

Brachidontes puniceus is a widely distributed species and intimately adapted to life in the tropical rocky intertidal. It is native to the west African coast including the Cabo Verde archipelago (Morton, 2012) (Fig .5).

Fig.5: Dataset global distribution map of *Brachidontes puniceus* in GBIF. https://doi. org/ 10. 15468/39omei accessed via GBIF.org on 2025-09-1.

Brachidontes exustus **(Linnaeus, 1758):**

The scorched mussel, *B. exustus* (Linnaeus, 1758), is characterized by its elongated, fan-shaped shell, which is triangular and adorned with numerous rounded, interrupted fine to coarse radial ribs (Fig.6). The beak is slightly rolled inward and the umbones are situated at the extreme anterior end. The antero-marginal edge is slightly arched. Externally, the shell ranges in color from yellow to dark brown with darker commarginal bands. Internally, the shell is metallic purple with white splotches and contains small purplish dysodont hinge teeth, with a denticulate margin (Mikkelsen and Bieler, 2008, Tunnell *et al.,* 2010). *B. exustus* distinguished from other *Brachidontes* in having finer and more numerous ribs and a deeper body cavity (Reguero and García-Cubas ,1994).

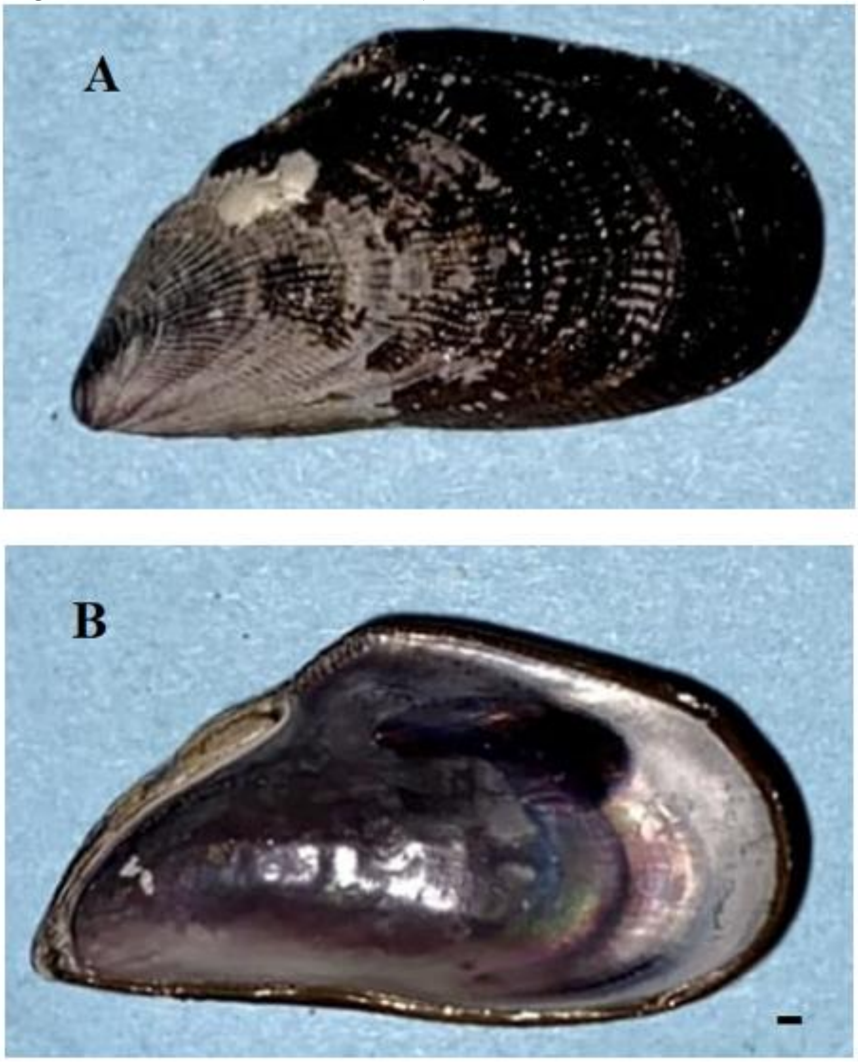

Fig. 6: *Brachidontes exustus.* (A) External view of the shells, depicting the umbo at the extreme anterior end, the characteristic fine and more numerous radial ribs with darker commarginal bands. (B) Internal view of the shells, showing the metallic purple color, the small purplish dysodont hinge teeth and denticulate margin. (scale bar 2.9mm)

B. exustus was widely considered the most widespread species distributed along the Atlantic coast of North America, extending from North Carolina through Central and South America to Brazil and Argentina (Rios, 1994, Abbott and Morris ,1995) and across Central America (Quintanilha *et al.,*2022) (Fig.7).Trovant *et al.,* (2016) suggested that the distribution of *B. exustus* is restricted to the tropical regions. The intertidal species *B. exustus* has a broad temperature and salinity tolerances (Barber *et al.,*2005).

Fig.7: Dataset global distribution map of *Brachidontes exustus* in GBIF.https://doi. org/10.15468/39omei accessed via GBIF.org on 2025-09-1.

The species *B. exustus* was found occupying a wide variety of habitats, inhabiting brackish environments such as river outlets, estuaries, and mangrove swamps (Bennett *et al.,* 2011; Morton,2012), as well as marine environments ranging from coastal zones to the open ocean (Lee and Foighil, 2004; Trovant *et al.,* 2016).

Perna:

Phylum: Mollusca
Class: Bivalvia
Subclass: Pteriomorphia
Order: Mytiloida
Family: Mytilidae
Genus: *Perna*
Species: *Perna perna* (Linnaeus, 1758)

***Perna perna* (Linnaeus,1758)**

It is commonly known as the brown mussel or the Mexilhao mussel. *P. perna* shells are mussel-shaped with a straight ventral margin and a rounded posterior end (Fig.8). The periostracum is flaky and the shell surface is smooth, marked only by concentric fine growth lines. The hinge typically has one or two teeth. The external color ranges from brown to light brown, often featuring concentric yellow bands near the ventral margin. Internally, the shell is purple and nacreous. The anterior adductor muscle is absent (Hicks and Tunnell, 1993). The posterior retractor muscle leaves a three-part scar (Siddall, 1980; Rajagopal *et al.*, 2006).

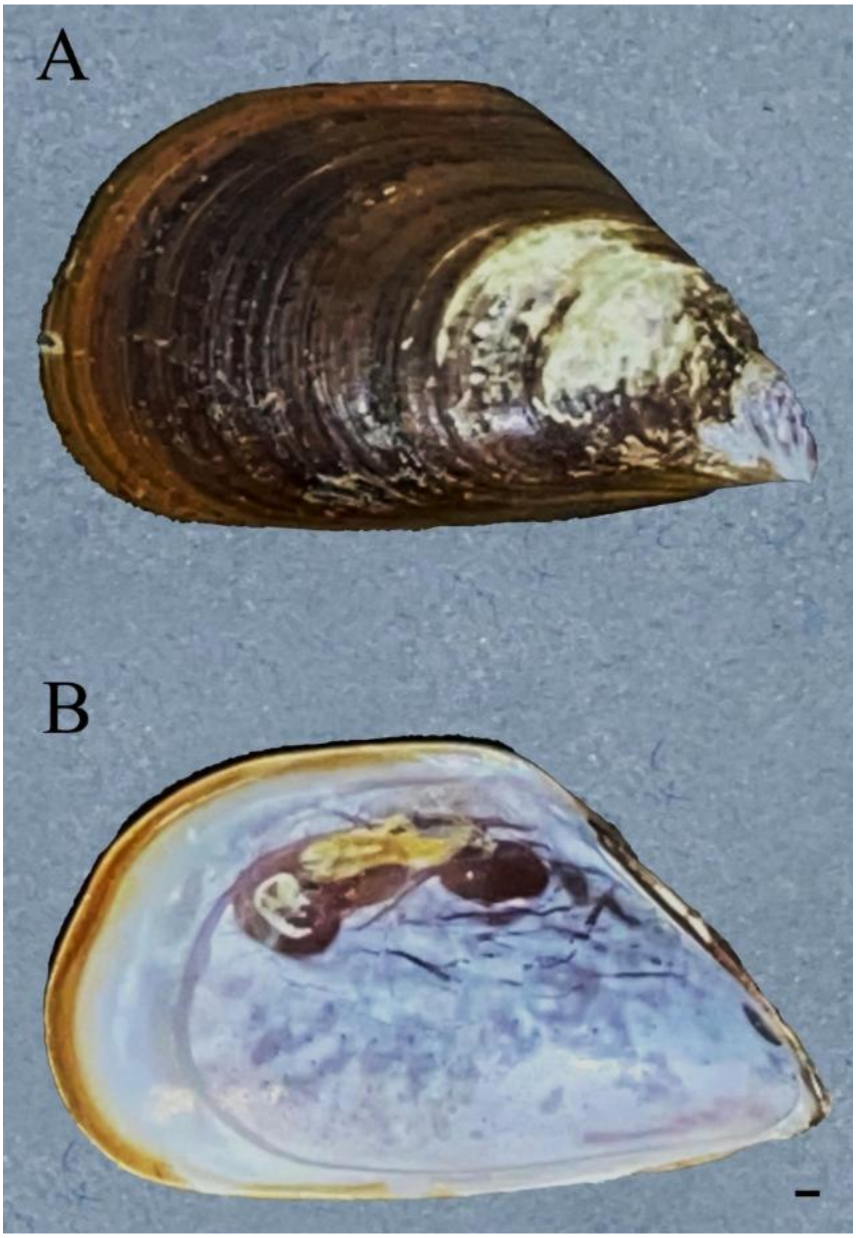

Fig. 8: *Perna perna.* (A) External view of the shells, depicting the characteristic concentric fine growth lines and flaky periostracum. (B) Internal view of the shells, depicting the nacreous purple color and the three retractor muscle scars and a straight ventral margin. (Scale bar 2.1mm)

P. perna is native to the western Indian Ocean, from the Bay of Bengal and the Red Sea to South Africa, and the west coast of Africa (Siddall 1980; Rajagopal *et al.*, 1997) (Fig.9). It has been introduced to the Gulf of Mexico, the Atlantic coast of South America, and New Zealand. Additionally, it has been established as non-indigenous in the Gulf of Mexico, the Atlantic coast of South America, southern India and Sri Lanka (Gardner *et al.,* 2016).

Fig.9: Dataset global distribution map of *Perna perna* in GBIF. https://doi.org/10.15468/39omei accessed via GBIF.org on 2025-09-1.

The present study documented the occurrence of the bivalve *P. perna* in Egypt, marking a new record in the Mediterranean Sea. It was discovered for the first time in east of Mediterranean Sea in Haifa Bay, Israel (Douek *et al.,* 2021) and was recently recorded in Zikim, Israel (Ragkousis *et al.,* 2023). In spite of the extreme marine heatwave event in June 2021 which led to localized mortality of *P. perna* in Haifa Bay, the species has successfully maintained established populations along the coastlines of Syria, Türkiye, and, more recently, Lebanon (Douek *et al.,* 2021, Galil *et al.,* 2022). This continued persistence underscores the species' remarkable ecological resilience and its capacity to tolerate and endure fluctuating and increasingly extreme climatic conditions. Consequently, the recent proliferation of *Perna perna* within the eastern Mediterranean basin presents significant ecological concerns.

Quantitative Analysis of The Collected Mussels:

Seasonal monitoring revealed that rocky shore intertidal communities were dominated by mussels of the genus *Brachidontes*, while *Perna* occurring in lower densities (Table 1).
The order of abundance among the collected species was *B. pharaonis* > *B.puniceus* > *B. exustus* > *P. perna*,

Table 1: Seasonal relative density /m^2 of rocky shore mussel collected from Abu Qir

Species	Season			
	Spring	Summer	Autumn	Winter
B.pharaonis	1350±300.7	254±113	900±157.3	159±42.35
B. puniceus	1100±392.8	213±38.6	876±156	164±29.36
B. exustus	400±71.7	79±28.66	188±90.6	39±11.26
P. perna	250±67.24	63±16.62	91±17.8	11±7.48

Data are represented as mean ± SD.

The comparative analysis of seasonal abundance of the collected mussel species was performed based on the Two-Way ANOVA ($p < 0.05$). There is a statistically significant difference in the mean values among the collected species and across the four seasons. The highest mean abundances of all collected mussel species were recorded during Spring, with *B.*

pharaonis exhibiting the peak value. In contrast, the lowest abundances were consistently observed in Winter (Fig. 10). *B. pharaonis* and *B. puniceus* consistently exhibit higher population densities, and in contrast, *B. exustus* and *P. perna* maintain relatively lower abundances throughout the year. Statistical evaluation confirmed that seasonal variation significantly influences species abundance. *B. pharaonis* and *B. puniceus* exhibited significantly higher abundances during spring and autumn than in summer and winter, suggesting these seasons provide optimal environmental conditions for growth and reproduction. These findings underscore the ecological dominance and the invasive success of *B. pharaonis* and *B. puniceus* in the studied habitat and highlight the importance of seasonal dynamics in shaping the studied mussel beds. Seasonal fluctuations in species abundance are likely influenced by variations in plankton availability. Rising temperatures can significantly disrupt phytoplankton populations, which are foundational to aquatic food webs. Such disturbances may trigger cascading effects throughout the ecosystem, influencing the overall biodiversity (Xu *et al.,* 2024). Additionally, changes in temperature across seasons can affect the solubility and toxicity of pollutants, as well as the metabolic rates of aquatic organisms, factors that directly impact their survival and reproductive success (Nwinyimagu *et al.,* 2021). During summer, elevated temperatures may intensify the adverse effects of pollution. Zooplankton which play an important role in aquatic food webs, are highly sensitive to decreased temperature in Winter that significantly affect their growth rates and behavior(Urabe, 1991; Lampert and Trubetskova, 1996).Overall, zooplankton abundance and biomass were lower in winter(Jensen, 2019).

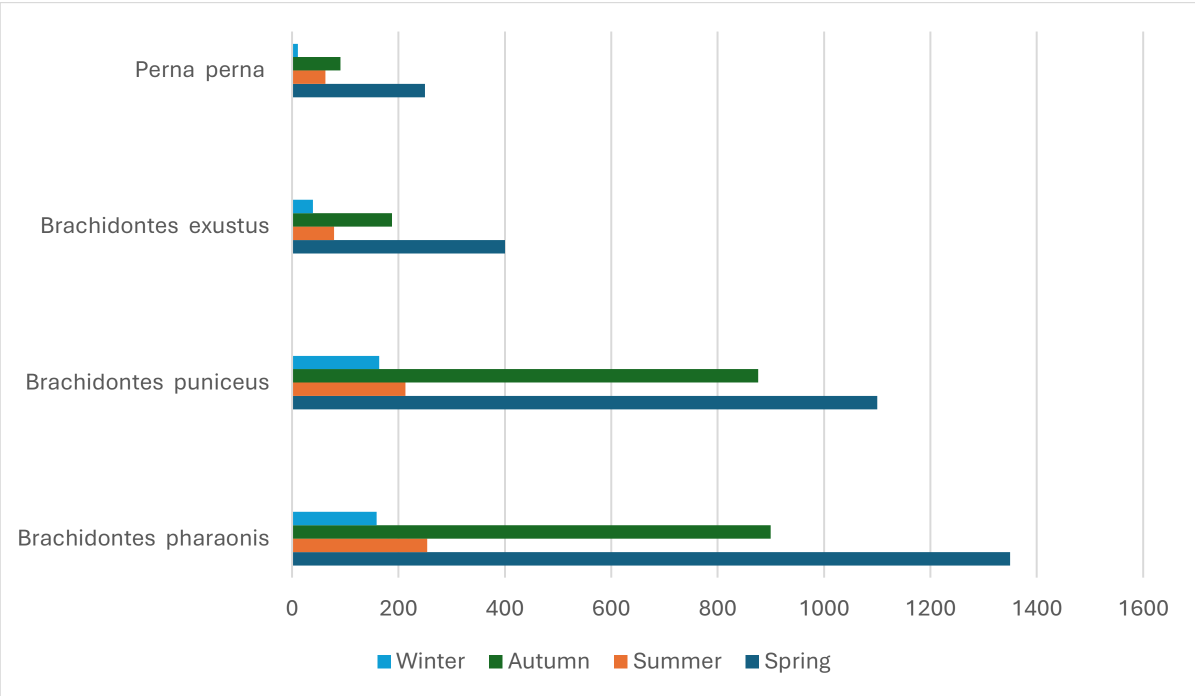

Fig. 10: Seasonal abundance of *B. pharaonis, B.puniceus* , *B. exustus* and *P.perna* collected during the study period

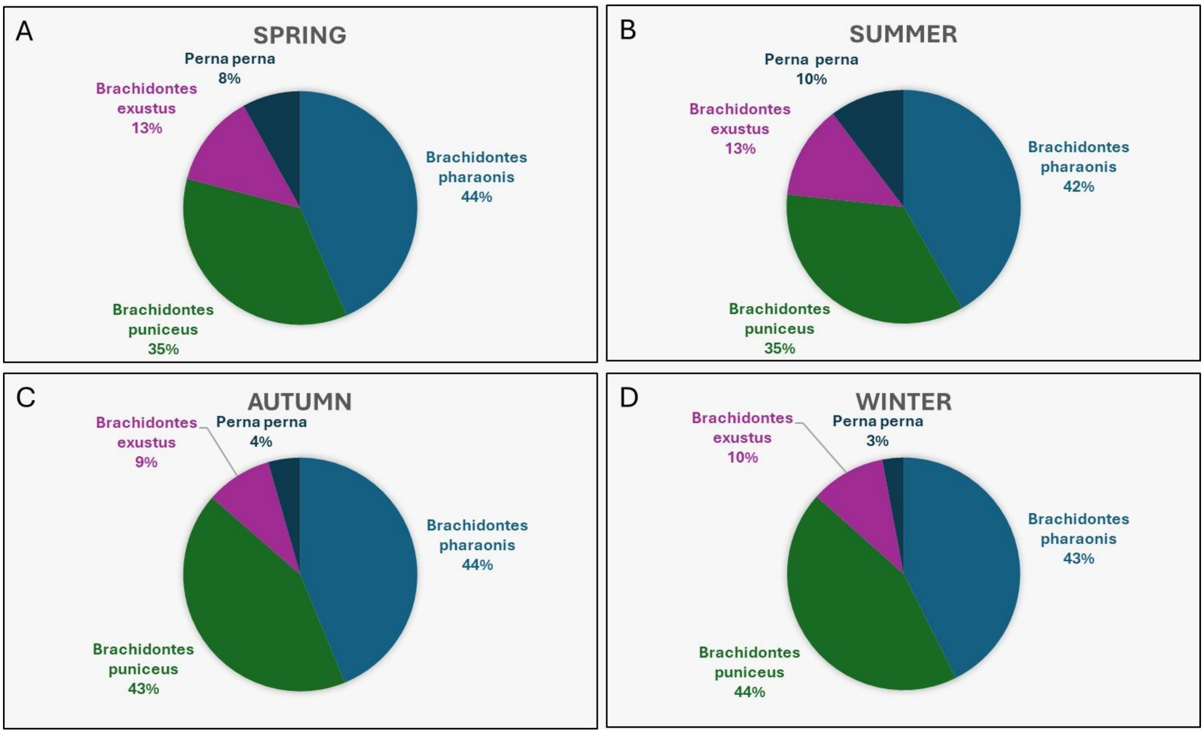

Fig. 11. Seasonal percentages of the collected mussels from Abu Qir.

The relative order of abundance among the collected mussels clearly highlights the ecological dominance of *B. pharaonis* within the surveyed habitat (Fig. 11). *B. pharaonis* extraordinary physiological and population features made it one of the most successful invaders in the Mediterranean Sea (Mohammed-Geba *et al.,* 2020). It appears to be able to tolerate wide temperature variations, but low winter temperatures may inhibit their physiology. Out of the above-reported species, *B. pharaonis* was among the early migrants recorded in the Red Sea (Fuchs,1878)and the eastern Mediterranean Sea (Safriel and Sasson-Frostig,1988). On the other hand, *B. puniceus, B. exustus* and *P. perna* are new reports for the Mediterranean fauna (Table 2).

The current surveillance study recorded and confirmed the first occurrence of three invasive species, *B. puniceus, B.exustus and P. perna* to Abu Qir Bay, eastern Mediterranean Sea. The phenomenon known as lessepsian migration has allowed numerous NIS to migrate from the Red Sea to the Mediterranean Sea. The opening of the Suez Canal has facilitated the entry of numerous NIS (Zenetos *et al.,* 2012**).** Galil *et al.* (2015;2017) argued that the recent expansion of the Suez Canal could initiate a new wave of biological invasions in the 21st century, facilitated by what they termed a 'next generation' Suez Canal. Furthermore, ballast water, used to stabilize ships during transit, often contains a variety of marine organisms, including plants, animals, viruses, and microorganisms (Carlton and Geller,1993; Lakshmi *et al.,*2020). Thus, it act as a medium for non-indigenous invasive species and serving as a dispersal pathway. The introduction of species through the release of ballast water has emerged as a significant threat to marine biodiversity and the functioning ecosystem globally.

Table 2: Global distribution of *B. pharaonis, B. puniceus, B. exustus* and *P. perna*

Species	Occurrence record		Occurrence dataset
Brachidontes pharaonis	Isreal	240	GBIF (2025). Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2025-09-1.
	Egypt	80	
	Cyprus	38	
	Italy	14	
	Greece	68	
	Türkiye	29	
	Australia	7	
	Oman	7	
	Saudi Arabia	6	
	Spain	5	
Brachidontes puniceus	Cabo Verde	138	GBIF (2025). Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2025-09-1.
	Senegal	23	
	Angola	17	
	Sierra Leone	11	
	Spain	7	
	Sao Tome and Principe	7	
	Unknown country	8	
	Guinea	4	
	Equatorial Guinea	3	
	Democratic Republic of the Congo	2	
Brachidontes exustus	United States of America	1,244	GBIF (2025). Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2025-09-1.
	Mexico	223	
	Bahamas	165	
	Brazil	101	
	Cuba	84	
	Unknown country	66	
	Venezuela	6	
	Panama	49	
	Bermuda	43	
	Virgin Islands (U.S.)	36	
Perna perna	Brazil	764	GBIF (2025). Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2025-09-1.
	South Africa	605	
	Isreal	18	
	Spain	134	
	Morocco	86	
	Uruguay	55	
	Algeria	54	
	Namibia	48	
	Angola	45	
	Mauritania	36	
	Mozambique	34	

Overall, the Mediterranean Sea has the potential to support populations of tropical origin (Raitsos *et al.,* 2010). It is warming at a rate two to three times than the global ocean (Vargas-Yáñez *et al.,* 2008), with surface water temperatures in the easternmost Mediterranean rising by approximately 3°C in less than 10 years (Ozer *et al.,* 2017). Many native species are struggling to adapt to the rapidly warming sea temperatures, which are increasingly leading to frequent and severe mass mortality events (Frölicher *et al.,* 2018; Oliver *et al.*, 2021; Smith *et al.*, 2023).The rapid warming of the Eastern Mediterranean is contributing to a significant decline in native species, while simultaneously creating more favorable conditions for the establishment and spread of tropical species (Rilov, 2016; Albano *et al.,* 2021).On the other hand, the salinity has risen by at least 1–2 PSU (Root *et al.,* 2005). These changes create suitable conditions for the establishment and spread of exotic species, especially tropical NIS and permanently altering the taxonomic and functional composition of Mediterranean ecosystems (Amarasekare and Simon, 2020; Steger *et al.,* 2021; Zenetos *et al.,* 2022). Successful invasive species exhibit a remarkable tolerance to fluctuations in salinity and temperature. Most of the introduced species are thermophilic species from tropical origin.

Given that bays and other coastal regions with high port activity are common hotspots for marine invasions (Ruiz *et al.,* 1997), there is an urgent need for stricter and more efficient methods to control and prevent bio invasions to protect native marine ecosystems and maintain biodiversity (Darrigran *et al.,* 2020). The invasion of *B. pharaonis,B. puniceus, B.exustus and P. perna* into Abu Qir Bay highlights their adaptability and potential impact on various marine ecosystems, threatening indigenous species. Their establishment may cause changes to the ecology of the native mussel beds. Marine invasions can significantly impact ecosystems and biodiversity. Invasive species represent one of the primary drivers of biodiversity loss and species extinctions across terrestrial, freshwater, and marine ecosystems worldwide (Dueñas *et al.,* 2021; Tamburello and Litt, 2023). Over the past 50 years, both the rate of biological invasions and the number of established non-native species have increased sharply, a trend expected to persist in the coming years. This escalating pattern poses serious challenges for the conservation of vulnerable species and the protection of global biodiversity (Dawson *et al.,* 2017; Seebens *et al.,* 2021). Continued monitoring and ecological assessment are essential to understand the long-term impacts of these non-native species on the bay's marine ecosystem.

CONCLUSION

The present investigation focuses on the detailed morphological description and distribution patterns of four rocky shore bivalved mollusc species collected from Abu Qir Bay, Egypt, eastern Mediterranean Sea. It recorded the successful colonization of *Brachidontes* in Abu Qir, the eastern Mediterranean Sea, where it is regarded as an invasive species. This finding suggests that *Brachidontes* species is continuing to spread and may pose a threat to the native populations of the eastern Mediterranean Sea. Finally, the introduction of exotic species has raised growing concerns due to the potential threats that they pose to native ecosystems. Future research should prioritize comprehensive long-term monitoring of invasive mussel populations along the eastern Mediterranean coast, coupled with molecular analyses to confirm the presence of cryptic species and guide effective biodiversity management in the face of ongoing marine bioinvasions.

Declarations:

Ethical Approval: The present study was carried out in Abou Qir, Alexandria, Egypt, and was accepted according to the ethical standards of scientific research.

Competing interests: The author has no competing interests to declare that are relevant to the content of this article.

Author's Contributions: Main author.

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