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RESEARCH ARTICLE

Marine benthic species distributed along the western coast of Libya

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Abstract

The Mediterranean Sea is recognized as a global biodiversity hotspot, supporting a diverse array of benthic marine life. This study presents the findings of Project Snowball, a seven-year project (2018–2025) assessing marine biodiversity along the western coast of Libya. Utilizing snorkelling surveys, two natural bays were assessed: Regatta and Surman. A total of 22 benthic species were identified, representing a mix of native and non-indigenous taxa. The recorded species span six major taxonomic groups, including Porifera, Cnidaria, Platyhelminthes, Bryozoa, Crustacea, and Tunicata. Notably, this research documents the first records of three non-indigenous species in Libyan waters: cnidarians *Telmatactis* cf. *cricoides* and *Telmatactis panamensis*, and a crustacean *Gonioinfradens giardi*. By documenting these distributions over a multi-year period, this research provides a vital taxonomic baseline for the Libyan coast, offering essential data for regional conservation strategies and the monitoring of invasive species in a rapidly changing marine environment.

Keywords: Porifera, Cnidaria, Platyhelminthes, Bryozoa, Tunicata, non indigenous species (NIS)

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Introduction

While representing less than 1% of the global ocean surface, the Mediterranean Sea is recognized as a premier biodiversity hotspot, harbouring an estimated 17,000 species (Coll *et al.* 2010). This unique quality makes its conservation critical to global marine health (Lejeusne *et al.* 2010; Mannino *et al.* 2017).

Due to its particular geographical location and heavy anthropogenic pressure, however, it is one of the main regions impacted by invasive species (Edelist *et al.*

2013; Katsanevakis *et al.* 2014). There are hundreds of non-indigenous species (NIS) recorded in the Mediterranean Sea, some of which have reshaped Mediterranean fisheries over the past decades (Zenetos *et al.* 2017, 2020; Galil *et al.* 2018; Galanidi *et al.* 2023; Moutopoulos *et al.* 2025). Identifying the specific pathways through which NIS reach the Mediterranean coast is essential for understanding regional biodiversity shifts. These entry points are diverse, ranging from anthropogenic activities such as maritime shipping traffic, the release of specimens from the aquarium trade, and commercial aquaculture, to the continuous, naturalized influx of species migrating through the Suez Canal (Katsanevakis *et al.* 2014; Galanidi *et al.* 2023).

The settlement and spread of non-indigenous species are further facilitated by additional factors such as lack of predators and overarching influence of climate change (Zaouali *et al.* 2008; Beca-Carretero *et al.* 2020). This climate crisis is fuelling a gradual but consistent rise in Mediterranean Sea temperatures, leading to irreversible shifts in the region's natural biodiversity. These ecological transformations are no longer distant threats; they are being observed firsthand by the current generation in real-time (Garrabou *et al.* 2022).

Benthic organisms are species that serve as indicators of the productivity and health of marine ecosystems (Jayachandran *et al.* 2022). Currently, biodiversity records of native and non-native species across several phyla, including Porifera, Cnidaria, Platyhelminthes, Bryozoa, Crustacea, and Tunicata, are underrepresented in Libya (Rizgalla *et al.* 2019a; Shakman *et al.* 2019). However, crustaceans are more thoroughly represented and listed in recent, albeit incomplete, national checklists (Bek-Benghazi *et al.* 2025).

As part of a seven-year project aimed at assessing marine biodiversity in Libyan waters, this study seeks to fill these knowledge gaps by reporting on various species within these six phyla observed in two natural bays on Libya's western coast.

Materials and Methods

Benthic organisms were surveyed across sandy and rocky biotopes at depths ranging from 30 cm to 2 m by snorkelling at two sites along the western coast of Libya (Figure 1). Field surveys were conducted at Regatta and Surman over a seven-year period (2018–2025), totalling 307 sampling events (Table 1). Sampling frequency remained high throughout the study, with the exception of 2020, data collection was intermittently disrupted in 2020 by the global pandemic and local political unrest. The surveys at the first site, Regatta, Tripoli (32°51'14.8"N 13°03'16.3"E; Figure 1B), spanned from 2018 to 2024. The second site, located in Surman approximately 60 km west of Tripoli (32°47'49.8"N 12°33'51.0"E; Figure 1C), was surveyed between 2023 and 2025.

Species were photographed in their natural habitats using an underwater camera (Olympus Tough TG-6) and some specimens were sampled by hand. Specimens were identified to the lowest possible taxonomic rank using authoritative taxonomic keys, supplemented by expert consultation and current literature. Species nomenclature was subsequently validated against the World Register of Marine Species (WoRMS Editorial Board, 2025).

Table 1. Regatta and Surman sampling frequency; a total of 307surveys spanning between 2018–2025. Surveys were interrupted 2021 due to the global pandemic and local political unrest.

	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Regatta	59	45	1	61	47	43	9	-
Surman	-	-	-	-	-	10	13	19

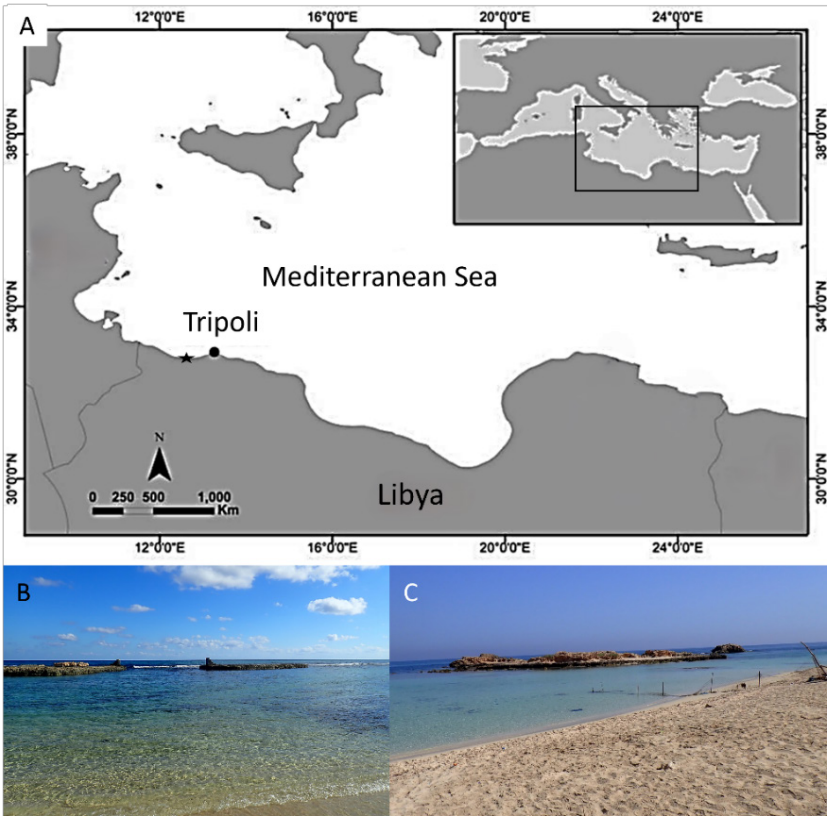

Figure 1. (A) Locations of Regatta (Tripoli) and Surman with a black star;
(B) Regatta natural bay, off the coast of Tripoli;
(C) The natural bay of Surman at low tide.

Results

A total 22 benthic species belonging to six taxonomic groups were recorded in the bays of Regatta (Reg) and Surman (Sur) in this study. Porifera (5 species), Cnidaria (2 species), Platyhelminthes (3 species), Bryozoa (2 species), Crustacea (3 species), Tunicata (7 species) (Table 2).

Porifera

Clathrina clathrus (Schmidt 1864) (Figure 2A)
Materials: The species was found in Surman at shallow depths attached to the underside of rocks with yellow variation colour of *Symplegma brakenhielmi* (Michaelsen, 1904).
Distribution*:* It has common distribution along the Mediterranean Sea (Imešek *et al.* 2013).

Clathrina rubra Sarà, 1958 (Figures 2B and C)
Materials: This species was recorded in Surman, attached to the underside of rocks and in deeper, dimly lit crevasses.
Distribution: *Clathrina rubra* was recorded from Libya (Regatta) (Rizgalla *et al.* 2025) and is known across to the Mediterranean Sea (van Soest *et al.* 2012).

Oscarella lobularis (Schmidt, 1862) (Figure 2D)
Materials: It was reported only in Surman, at shallow depths. The blue colony was seen attached to the rocks adjacent to *Lissoclinum* sp. 2 (Figure 2D).
Distribution: *Oscarella lobularis* is abundant across the basin, and encountered typically on shallow rocky substrates (Ereskovsky *et al.* 2009; Renard *et al.* 2021). It is used as a bio monitor for detecting pollutants in marine environments (De Pao Mendonca *et al.* 2023).

Cliona sp. (Figures 2E and F)
Materials: Found in Regatta and Surman at shallow depths, the round yellow colonies were observed burrowing into the flat undersides of rocks. It was not possible to identify to a species level.
Distribution: These sponges are found burrowing into calcareous substrate (Pansini and Longo 2003). The genus *Cliona* has a worldwide distribution with more than 100 species described and 12 of them are reported from the Mediterranean Sea (Rürzler 2002; Pansini and Longo 2003).

Phorbas topsenti Vacelet & Pérez, 2008 (Figures 2G and H)
Materials: *Phorbas topsenti* colony was recorded at Regatta, situated within a sheltered microhabitat beneath a protruding rock and in close proximity to another sponge. It should be noted that the orange coloration observed in Figure 2H is an artifact; the specimen is naturally red in its environment (Figure 2G).
Distribution*: Phorbas topsenti* is found in the Mediterranean Sea (Evcen *et al.* 2023).

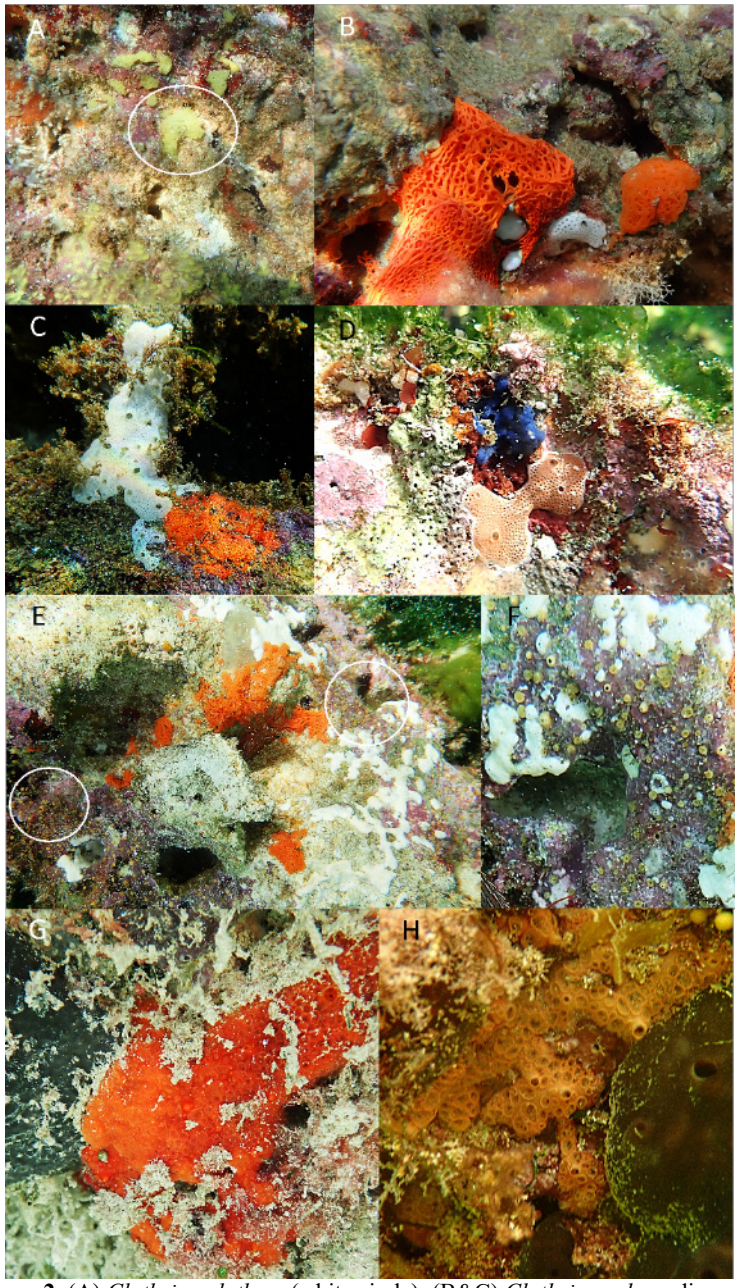

Figure 2. (A) *Clathrina clathrus* (white circle); (B&C) *Clathrina rubra* adjacent to *Lissoclinum* sp. 1; (D) *Oscarella lobularis* with *Lissoclinum* sp. 2; (E) *Cliona* sp. (white circle); (F) *Cliona* sp.; (G&H) *Phorbas topsenti*

Cnidaria

Telmatactis cf. *cricoides* (Duchassaing, 1850) (Figures 3A-C)

Materials: This species was found in Surman at a depth of 30-50 cm. The identification was made using the description provided by Den Hartog (1995) and Wirtz (1996) referring to its size, the bright orange colour, of the organism and the diagnostic characteristic clavate tentacle tips (Figure 3B and C). *Telmatactis* cf. *cricoides in situ* was found under a rock in the natural bay of Surman.

Distribution: The genus *Telmatactis* Gravier, 1916 belongs to the order Actiniaria and includes 29 species found in tropical and subtropical regions globally (Rodríguez *et al.* 2023). Among these is *Telmatactis cricoides*, a thermophilic sea anemone with an amphiatlantic distribution (Martín-Arjona *et al.* 2024). Originally described in the Caribbean by Duchassaing de Fontbressin (1850), its range extends across the tropical Atlantic to include Bermuda, Brazil, the Gulf of Guinea, and several Macaronesian archipelagos, such as the Cape Verde, Canary, Azores, and Madeira Islands (Den Hartog 1995; Wirtz 2009). While previously documented in the central and eastern Mediterranean (Den Hartog 1995), a recent record by Martín-Arjona *et al.* (2024) confirms its presence in Spain and Morocco.

Telmatactis panamensis (Verrill, 1869) (Figures 3D-F)

Materials: A sea anemone specimen located in Regatta was identified as *T. panamensis*, consistent with the diagnostic descriptions provided by Wirtz (1996), Acuña *et al.* (2012), and Arabia *et al.* (2023). Observed *in situ* attached to the underside of rocks, the specimen exhibited a short column with a thick-walled, wrinkled scapus of a brown/orange hue (Figures 3D-F). The anatomy consists of a basal disc and an oral disc, the latter of which features a tentacle-free central zone. The marginal region is densely populated by 40–45 digitiform tentacles. These reddish-brown tentacles are characterized by white crossbands and swollen tips. They vary in size, with the internal tentacles reaching lengths of approximately 10 mm, noticeably longer than those on the exterior.

Distribution: Native to the eastern Pacific, *T. panamensis* extends its distribution from the Gulf of California, Mexico, Ecuador, Chile, Panama, Costa Rica to Galápagos Islands (Fautin *et al.* 2007; Acuña *et al*. 2012; Rodríguez *et al.* 2023). It typically inhabits depths from the intertidal zone down to 60 m (Wirtz 1996). Recently, the species has emerged as an invasive presence in the Mediterranean. Following its initial regional report off the Syrian coast—likely introduced via shipping or the Suez Canal due to its biofouling nature (Arabia *et al.* 2023)—this study confirms the first record of *T. panamensis* in Libya and North Africa.

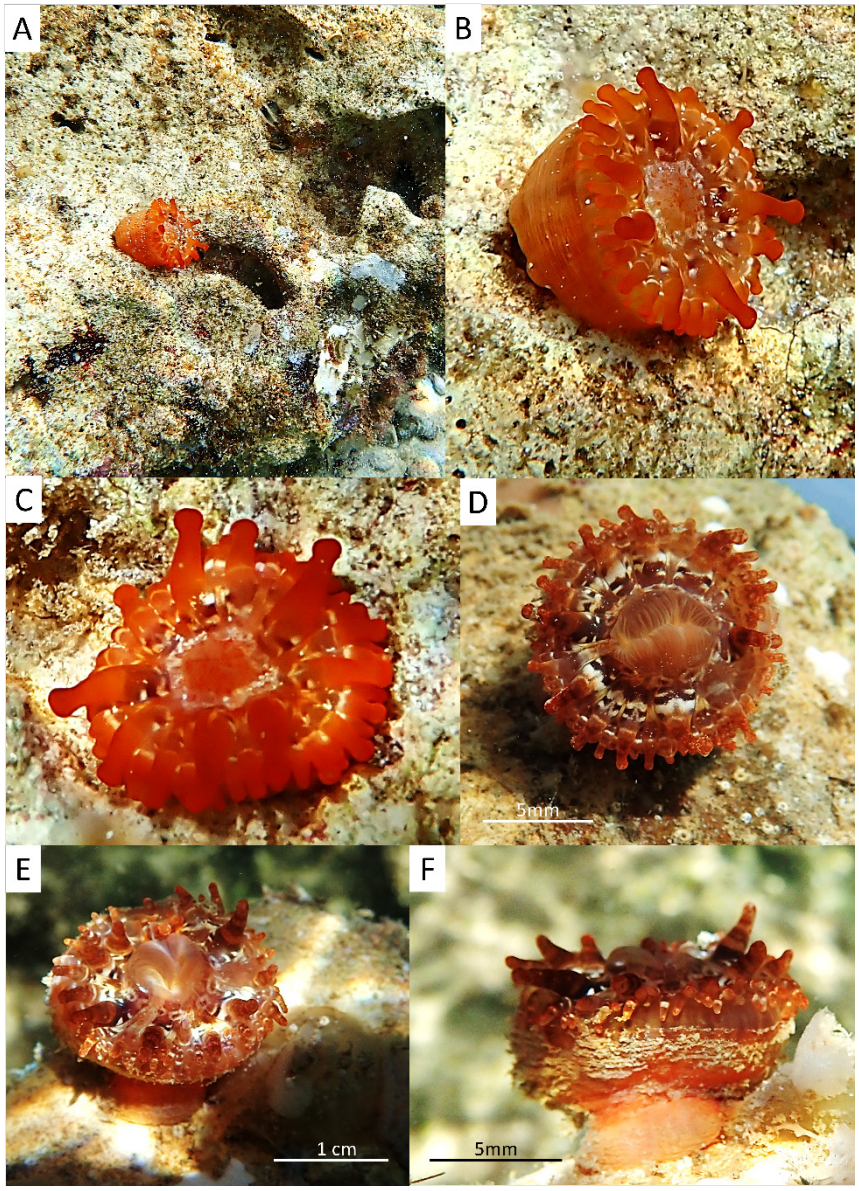

Figure 3. (A-C) *Telmatactis* cf. *cricoides*; (D) *Telmatactis panamensis*; (E) *T. panamensis* with cylindrical tentacles; (F) *T. panamensis* with lateral view detail of scapula and scapus, short column

Platyhelminthes

Prostheceraeus giesbrechtii Lang, 1884 (Figures 4AandB)

Materials: Only one individual was observed at a depth of 30-40 cm, at Regatta.

Distribution: *Prostheceraeus giesbrechtii* is a species of marine flatworm found in the Atlantic and Mediterranean Sea. It is commonly seen in different areas, including crevasses and dark areas (Wood 2015).

Figure 4. (A&B) *Prostheceraeus giesbrechtii.* (C) *Pseudoceros maximum*. (D-E) *Thysanozoon brocchii.* (F) two *T. brocchii* individuals under a rock

Pseudoceros maximum Lang, 1884 (Figure 4C)

Materials: This Turbellarian flatworm was collected exclusively from beneath rocks at shallow depths (40–50 cm) in Regatta Bay. The specimen aligns with the morphological descriptions provided by Lang (1884) and Cuadrado *et al.* (2017).

Distribution: It is reported from up to 1m depth. Recorded from its type locality was from the golf of Naples (Lang 1884). it has been recorded from various parts of the Mediterranean including, Tunis, Gulf of Tunis, La Goulette, Italy (Trieste), the coasts of Catalonia, Spain, Croatia and Türkiye (Steinböck 1933; Vàtova 1928; Novell 2001; Gammoudi *et al.* 2012, 2017; Çinar 2014). Out of the Mediterranean Sea it is recorded from the Canary Islands (Cuadrado *et al.* 2017).

Thysanozoon brocchii (Risso, 1818) (Figures 4D-F)
Materials: Found at both sites, Regatta and Surman, as either a single individual or a pair.
Distribution: *Thysanozoon brocchii* has a worldwide distribution, records from the Mediterranean include the gulf of Naples, Spain, Italy, and Croatia (Lang 1884; Steinböck 1933; Novell 2001; Gammoudi *et al.* 2012). Out of the Mediterranean Sea it is recorded from the British coasts, Cape Verde, South Africa, Brazil, Colombia, Argentina, USA, the Suez Canal, Persian Gulf, and Japan (Laidlaw 1906; Palombi 1928; Pearse 1938; Palombi 1939; Kato 1944; Marcus 1949; Howson and Picton 1997; Quiroga *et al.* 2004; Brusa *et al.* 2009; Maghsoudlou and Rahimian 2014).

Bryozoa
Electra posidoniae Gautier, 1954 (Figure 5A)
Materials: *Electra posidoniae* was found on the leaves of *Posidonia oceanica* (Linnaeus) Delile, 1813 meadows in bays of Surman and Regatta.
Distribution: A Mediterranean native species, and can be found across the basin (Lepoint *et al.* 2014)

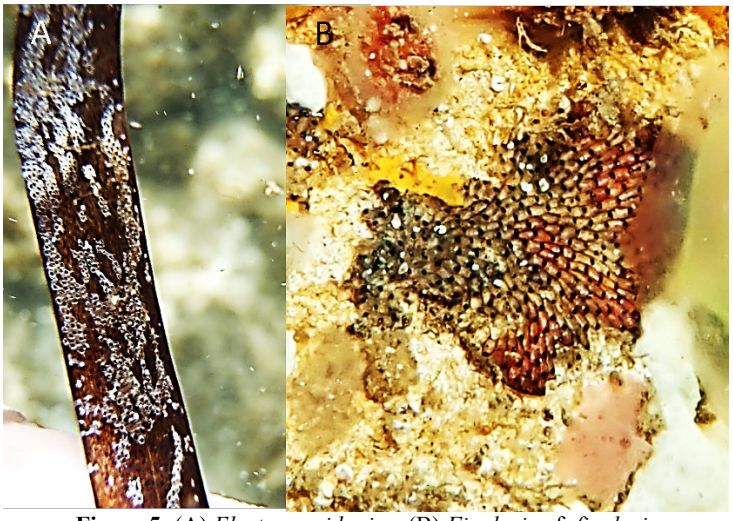

Figure 5. (A) *Electra posidoniae*; (B) *Figularia* cf. *figularis*

Figularia cf. *figularis* (Figure 5B)
Materials: *Figularia* cf. *figularis* is typically found at shallow depths, attached to the underside of small rocks in the bay of Regatta. While it has been identified as *Figularia* cf. *figularis*, a definitive identification would require a detailed laboratory analysis of its morphological characteristics, as outlined by Hayward and McKinney (2002).
Distribution: *Figularia* cf. *figularis* is distributed throughout the Mediterranean and Adriatic Seas (Novosel and Požar-Domac 2001). Its range extends into the eastern Atlantic Ocean, reaching as far north as the British Isles (Hayward and McKinney 2002).

Crustacea
Gonioinfradens giardi (Nobili, 1905) (Figures 6A and B)
Materials: Following the description by Galil *et al.* (2018), a decapod specimen collected at a depth of 50-60 cm in Regatta Bay was identified as *G. giardi*. The specimen's morphology and coloration were consistent with the original description: the chelipeds were deep red with dark tips, the legs featured reddish hues with light-coloured bands near the joints, and the anterolateral spines were light-banded with dark tips. This male specimen was identified by its triangular abdomen and three fused segments. The specimen described herein was found unsheltered and dead on the sea floor at depth of 50-60 cm (Figure 6A). This individual marks the first recorded occurrence of the species in Libya and North Africa.
Distribution: *Gonioinfradens giardi* is native to the Red and Arabian Seas (Galil *et al.* 2018). Initially, it was recorded in the Mediterranean Sea on Rhodes Island and Greece as *Gonioinfradens paucidentatus* (A. Milne-Edwards, 1861) by Corsini-Foka *et al.* (2010). The invasion dates back to 2009 when a specimen was found in the Kaş-Kekova Specially Protected Area, southern Türkiye (Karhan and Yokeş 2012). The most recent report has placed *G. giardi* in Antisamos Bay, near a ferry port and marina in the Ionian coast of Greece (Orfanidis *et al.* 2021). To date, *G. giardi* has only been reported in the Aegean and Levantine coasts (Corsini-Foka *et al.* 2010; Galil *et al.* 2018; Kondylatos *et al.* 2020). This species is typically found in shallow waters, with rocky and mixed sandy-rocky bottoms, sheltering under rocks and crevices (Corsini-Foka *et al.* 2010).

Percnon gibbesi (H. Milne-Edwards, 1853) (Figures 6C and D)
Materials: *Percnon gibbesi* was observed year-round in Regatta and Surman bays, typically found in groups of six to seven individuals within rock crevices at depths of 30–50 cm. Similar sightings were recorded off Jodayem, approximately 20 km west of Tripoli (unpublished data). Consequently, its status has been updated from "casual" to "established" in both the eastern and western regions of Libya, though further investigation is required to assess its spread into the central region.
Distribution: This species maintains a broad geographic range, spanning the Western Atlantic as well as the Eastern Atlantic from the Azores and Madeira to Angola. Though native to those regions, it is classified as an invasive species in

the Mediterranean Sea, where it was first documented off Linosa Island in southeastern Sicily in 1999 (Katsanevakis *et al.* 2011). Subsequently, its presence has been recorded along the eastern coast of Libya since 2004 (Elkrwe *et al.* 2008; Bazairi *et al.* 2013).

Figure 6. (A) Dorsal view of *Gonioinfradens giardi*; (B) Ventral view of *G. giardi*; (C&D) *Percnon gibbesi*; (E) *Portunus segnis*

Portunus segnis Forsskål, 1775 (Figure 6E)
Materials: This decapod was observed three times between July and August 2023 at a depth of 50-70 cm in Regatta Bay (Figure 5D). This species has been reported from shallow lagoon waters down to depths of 65 meters (Naderloo 2017).
Distribution: Native to the western Indian Ocean, including the Red Sea and Persian Gulf (Lai *et al.* 2010). It was first reported from the Mediterranean Sea in Egypt in 1898, followed by an extended lag period (Fox 1924; Azzurro *et al.* 2016). It established populations in the Levant Sea followed by a westward geographical expansion, successfully invading wide areas of the basin, reaching the Strait of Sicily and the Adriatic Sea (Gruvel 1931; Katsanevakis *et al.* 2020; Shaiek *et al.* 2021; Grati *et al.* 2023).

Tunicata
Botrylloides cf. *niger* Herdman, 1886 (Figures 7A and B)
Materials: The colonies of this species of various sizes were observed *in situ*, frequently overgrowing different substrates. The species exhibits a high coverage capacity; it was found in abundance at Surman and Regatta. It was observed overgrowing the invasive alga *Caulerpa racemosa f. cylindracea* (Sonder) Weber-van Bosse, 1898, and among unidentified green algae where sea slug *Elysia timida* (Risso, 1818) was also observed (Figure 7A). Additionally, colonies were recorded growing over fan worm tubes (Figure 7A). Also observed attached to rocky substrates in the intertidal zone, appearing completely exposed at a low tide (Figure 2B). This colonial ascidian is highly invasive, present year-round, and bears a strong morphological resemblance to *Botrylloides leachii* (Savigny, 1816) (Temiz *et al.* 2023)
Distribution: This colonial tunicate maintains a cosmopolitan distribution across tropical and temperate maritime regions (Sheets *et al.* 2016). Within the Mediterranean, *Botrylloides niger* (Herdman, 1886) has been extensively documented in the waters of Italy, Türkiye, and Egypt (Halim and Abdel Messeih 2016; Della Sala *et al.* 2022; Temiz *et al.* 2023; Bensari *et al.* 2025). Furthermore, recent records from the coasts of Spain, Tunisia, and Algeria classify the species as *Botrylloides* cf. *niger* (Carmona-Rodríguez *et al.* 2024; Mnasri-Afifi *et al.* 2024; Bensari *et al.* 2025).

Botryllus schlosseri (Pallas, 1766) (Figure 7C)
Materials: This species was found at shallow depths, either attached to various algae, or to hard substrate on the underside of rocks in Regatta and Surman Bays.
Distribution: *Botryllus schlosseri* is a cosmopolitan colonial ascidian encountered in several geographical locations, including the Mediterranean Sea where it is considered a cryptogenic species (Zenetos *et al.* 2017). It is also found in the Atlantic Ocean, as well as in shallow subarctic and temperate waters in both hemispheres (Chen *et al.* 2024). This species can inhabit intertidal zones at depths up to 200 meters. It exhibits significant polymorphism in colour pattern and colony shape (Cima *et al.* 2015). Due to its biofouling characteristics, it is commonly found in ports and harbours.

Diplosoma spongiforme (Giard, 1872) (Figure 7D)
Materials: It was found, but very rare, at shallow depth 40-50 cm between crevasses in Regatta Bay.
Distribution: *Diplosoma spongiforme* is present from the 0 up to 40 m depth in the Atlantic Ocean, the English Channel, the North Sea and the Mediterranean Sea (Turon and Becerro 1992).

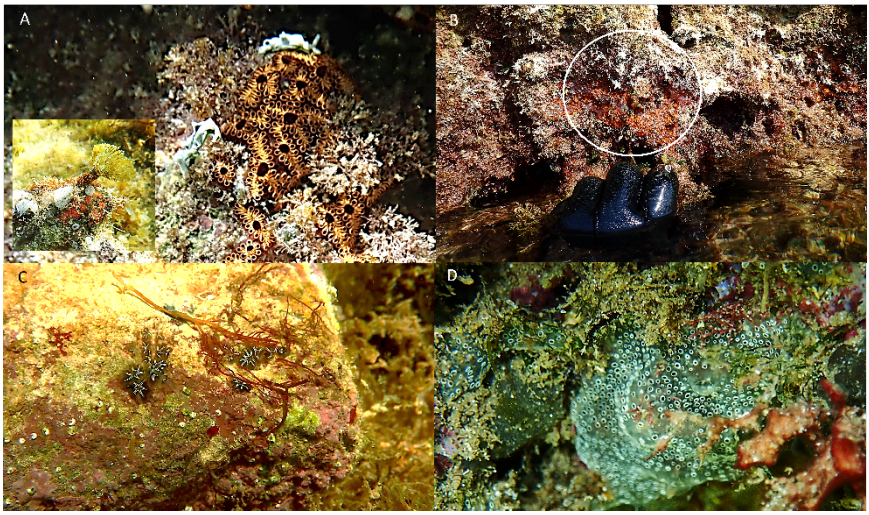

Figure 7. (A) *Botrylloides.* cf. *niger* with sea slugs *Elysia timida* and attached to tube of a fan worm (insert); (B) *B.* cf. *niger* on the rocky zone at 0 depth (white circle); (C) *Botryllus schlosseri* underside of a rock; (D) *Diplosoma spongiforme*

Lissoclinum sp.1 (Figure 8A)
Materials: The species has white-coloured colonies, was sampled underside of rocks in bays of Regatta and Surman (Figure 3A). It was often found in association with Porifera such as *C. rubra* Sarà, 1958 (Figures 8B and C).

Lissoclinum sp. 2 (Figure 8B)
Materials: It has beige colour colonies, was found at both Regatta and Surman, underside of rocks (Figure 8B) and in association with Porifera *Oscarella lobularis* (Schmidt, 1862) (Figure 8D).

Pyura dura (Heller, 1877) (Figure 8C)
Materials: It was found attached to the underside of rocks, sometimes surrounded by larger sponges.
Distribution: This Mediterranean ascidian is abundant in protected eutrophic habitats and it can be found in bays and harbours. It has the ability to tolerate adverse environmental conditions (Millar 1971).

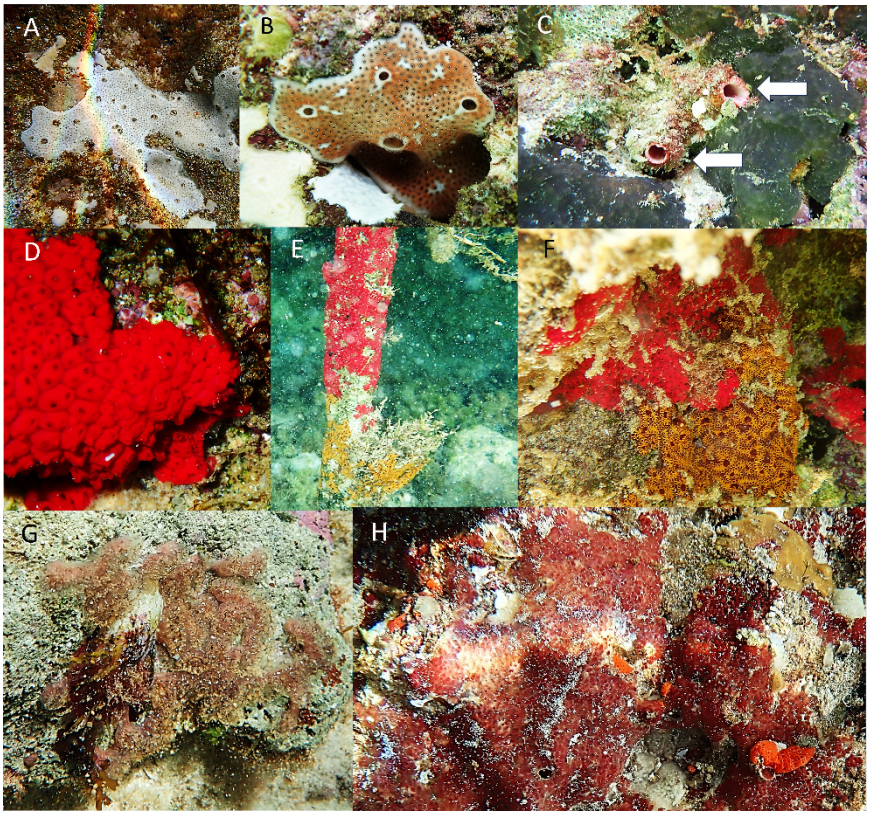

Figure 8. Ascidiacea *in situ*, found at shallow depth, from 30 cm-1 m deep. (A) *Lissoclinum* sp.1; (B) *Lissoclinum* sp.2; (C) *Pyura dura* (white arrow) with a sponge; (D-H) *Symplegma brakenhielmi*; (E) *S. brakenhielmi* on a rope and plastic; (F) *S. brakenhielmi* with natural substrate; (G) A variation of *S. brakenhielmi*; (H) *S. brakenhielmi* with *Clathrina rubra*

Symplegma brakenhielmi (Michaelsen, 1904) (Figures 8D-H)

Materials: *Symplegma brakenhielmi* was reported from Regatta in 2018 and from the harbour of Benghazi in 2019 (Rizgalla *et al.* 2019a; Ragkousis *et al.* 2023). This is the second record on the western coast of Libya. In Regatta, the colonies were predominantly the red variation type of this species. However, a variety of colours were observed, including red, yellow and brownish variations, which is typical for the species in Surman Bay (Mastrototaro *et al.* 2019). *Symplegma brakenhielmi* colonies are observed often in association with *Botrylloides* cf. *niger* colonies sharing the space (Figures 8E and F). A lighter brownish variation of *S. brakenhielmi* colony was found in Surman Bay (Figure 8G). Reddish colonies found in Surman Bay, *C. rubra* can be seen surrounded by or on the colony (it was no possible to assess) (Figure 3H).

Distribution: It has a circumtropical distribution and is reported in the Indo-Pacific and Atlantic Oceans (Lambert and Lambert 1998; Ramos-Esplá *et al.* 2020). It is believed to have invaded the Mediterranean Sea through shipping traffic as a fouling organism attached to ship hulls (Çinar *et al.* 2006). Since its first record in 1951 off Cesarea (Israel) as *S. viride* by Pérès (1958), it has expanded its range to include the eastern, and western Mediterranean Sea, being recorded in Türkiye, Lebanon, Greece, Cyprus, Egypt, Italy, Malta, and Tunisia (Bitar and Kouli-Bitar 2001; Çinar *et al.* 2006; Halim and Messeih 2016; Gerovasileiou *et al.* 2017; Mastrototaro *et al.* 2019; Ramos-Esplá *et al.* 2020).

Discussion

The present study reports 22 native and non-native biofouling species that are well-known in the Mediterranean Sea. These species are often found alongside each other, both native and NIS (Bensari *et al.* 2025).

Tunicates exhibited the highest taxonomic richness, with seven species in total. As a biofouling taxon, it shows a significant ability to invade and spread to new areas (Bensari *et al.* 2025). Although numerous species have reportedly invaded different parts of the Mediterranean basin, they have never been reported in Libyan waters and were absent from the updated list on the status of NIS in Libyan waters by Shakman *et al.* (2019).

The ascidian *B. niger* has led to extensive research in an attempt to find dissimilarities between similar species within the basin since its description in the Mediterranean Sea (Temiz *et al.* 2023). This led to the identification of the species described herein as *Botrylloides* cf. *niger*. The cryptogenic species *S. brakenhielmi* was recorded in 2018 on the coast of Tripoli (Rizgalla *et al.* 2019a). The colonies of this species described from the Bay of Surman constitute the second record and a possible westward range expansion. However, considering the prior record in Tunisia (Ramos-Esplá *et al.* 2020), an eastward expansion remains equally plausible. Furthermore, the various colours and morphologies reported for this species by Ramos-Esplá *et al.* (2020) were also observed in Surman Bay but not in the bay of Regatta. Due to the invasive success of *B. niger* and *S. brakenhielmi* across the Mediterranean Sea, and their extensive presence in both surveyed sites reported herein, both are classified as established in the western region (Ramos-Esplá *et al.* 2020; Temiz *et al.* 2023). Future confirmation is needed regarding their presence along the central and eastern Mediterranean Sea.

In the Mediterranean Sea four *Telmatactis* species have been documented to date (Häussermann 2003; Arabia *et al.* 2023). These species are *T. cricoides* and *T. panamensis*, which were only reported from Syria, *Telmatactis forskalii* (Hemprich & Ehrenberg in Ehrenberg 1834), which is widely distributed throughout the Mediterranean Sea (den Hartog 1995; Arabia *et al.* 2023), and

Telmatactis solidago (Duchassaing & Michelotti, 1864), which appears to have a limited distribution range restricted to the eastern Mediterranean Sea (den Hartog 1995). Consistent with similar reports, *T.* cf. *cricoides,* was only reported from Surman at shallow depths (Wirtz 2009). It is possible that it could have reached Surman by natural dispersal from nearby populations (den Hartog 1995). However, it cannot be said for *T. panamensis* which was only recorded in Regatta Bay, with two individuals found attached to the underside of a rock at shallow depths. The external anatomical characteristics of these individuals align with the description of *T. panamensis* by Carlgren (1951) and Fautin *et al.* (2007) and represent the second record of this species in the Mediterranean Sea. While a westward invasion from Syrian records is unlikely (Arabia *et al.* 2023), the species may have reached Regatta Bay through a separate introduction event via shipping. The invasive status of both cnidarians cannot yet be determined, as further studies are required to assess their distribution in these locations and along the Libyan coastline. Consequently, they are classified as "casual" according to the framework of Keller *et al.* (2011).

Non-native decapods have been reported along the Libyan coastline (Elkrwe *et al*. 2008; Shakman *et al.* 2017, 2019; Corsini-Foka *et al*. 2021; Nour *et al*. 2022). *Portunus segnis* is one of the decapods that has been reported from the east of Libya since 2017 by Shakman *et al.* (2017). It was also found at various shallow water locations along the western coast of Libya including the marine protected area (MPA) of the Farwa lagoon (Shakman *et al.* 2019; Corsini-Foka *et al.* 2021). This is not surprising for a species known to inhabit the shallowest of lagoons (Grati *et al.* 2023). Despite its apparent invasive success, it was only reported from Regatta and not from the bay of Surman in this study. Furthermore, in line with the trend of some non-native decapods becoming economically exploitable species, such as *P. segnis* and *Callinectes sapidus* Rathbun, 1896 (Castriota *et al.* 2024; Azzurro *et al.* 2024), *P. segnis* in Libya has become increasingly economically important and is being sold at local fish markets in the western and eastern Libya (Personal observation).

Most non-indigenous species reported from Libya were not further assessed following their initial record such as *P. gibbesi* reported since 2004 in the east of Libya (Elkrwe *et al*. 2008). There is no data on its distribution along the central and western Libyan coasts, as it seems to be confined to the eastern region, to the point that it was considered a casual invasion (Bazairi *et al.* 2013; Shakman *et al.* 2019). The present record classifies its invasive status as established on the western Libyan coast (Keller *et al.* 2011).

Shipping traffic has likely played a crucial role in the introduction of *G. giardi* in the bay of Regatta. Although the current record is based on a single dead specimen, its external morphology aligns with descriptions by Galil *et al.* (2018). While identified here as *G. giardi*, molecular analysis remains essential due to historical taxonomic ambiguities associated with morphological identification

(Galil *et al.* 2018). Notably, Galil *et al.* (2018) updated the species record to 2015 following a sighting in Israel's Rosh Ha Nikra Nature Reserve; molecular testing subsequently clarified that specimens previously identified as *G. paucidentatus,* once considered a synonym, were actually *G. giardi*. This molecular distinction was further supported by Zenetos *et al.* (2020), who confirmed the presence of *G. giardi* in the Aegean Sea.

Non-indigenous decapods are increasingly reported from Libyan waters, such as those recorded through citizen science from the eastern and central region, *Thalamita poissonii* (Audouin, 1826) from Al Tamimi harbour and *Carupa tenuipes* Dana, 1852 (Nour *et al.* 2022; Tiralongo *et al.* 2022). While both represent significant incidental findings, their respective geographical locations suggest two distinct pathways of introduction. *Carupa tenuipes* likely arrived via shipping traffic, as evidenced by its discovery within the 'oil crescent' near the ports of Zuetina and Ras Lanuf (Nour *et al.* 2022). Conversely, the introduction of *T. poissonii* may be attributed to natural dispersal. Although Al Tamimi is a small artisanal fishing harbour (Tiralongo *et al.* 2022), its proximity to the major international port of Tobruk—located roughly 50 km to the east—presents an additional potential vector for its arrival.

The proximity of the study areas to major harbours has likely influenced the introduction and establishment of the NIS reported here. Over a seven-year period, "Project Snowball" has recorded twelve non-native, range-expanding and cryptic species in Regatta, including ten NIS (*Lamprohaminoea ovalis* (Pease, 1868), *Okenia pellucida* Burn, 1967, *Biuve fulvipunctata* (Baba, 1938), *Godiva quadricolor* (Barnard, 1927), *Polycerella emertoni* A. E. Verrill, 1880, *Cerithium scabridum* R. A. Philippi, 1848, *Symplegma brakenhielmi* (Michaelsen, 1904), *Amathia verticillata* (delle Chiaje, 1822), *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004, *Abudefduf vaigiensis* (Quoy & Gaimard, 1825), one cryptic species, *Bermudella polycerelloides*, and one range expansion *Aplysia dactylomela* Rang, 1828 (Rizgalla *et al.* 2018; 2019a, b; 2023; 2024; 2025; Katsanevakis *et al.* 2020; Osca *et al*. 2020; Rizgalla 2025; Rizgalla and Crista 2025).

Table 2. List of benthic species reported in this study. Cat: Category; Crypt: Cryptogenic species; E: East; Est: Established; Loc: Location; Med: Mediterranean species; NIS: Non-indigenous species; Reg: Regatta; Status of NIS: Status of non-indigenous species; Sur: Surman; un: Unknown; W: West.

Taxonomic Group	Dat. of 1st observation	Cat	Status of NIS	Loc	Fig.	Additional references
Porifera						
Clathrina clathrus (Schmidt, 1864)	18 Oct. 2023	Med		Reg; Sur	2A	Rizgalla *et al.* 2025
Clathrina rubra Sarà, 1958	22 Sept. 2023	Med		Sur	2B&C	Rizgalla *et al.* 2025
Oscarella lobularis (Schmidt, 1862)	7 Jul. 2024	Med		Sur	2D	
Cliona sp.	28 Jul. 2018	un		Reg	2E&F	
Phorbas topsenti Vacelet & Pérez, 2008	2 Jun. 2021	Med		Sur	2G&H	
Cnidaria						
Telmatactis cf. *cricoides* (Duchassaing, 1850)	8 Sept. 2025	Amphiatlantic	Casual	Sur	3A-C	
Telmatactis panamensis (Verrill, 1869)		NIS	Casual	Reg	3D-F	
Platyhelminthes						
Prostheceraeus giesbrechtii Lang, 1884	9 Jun. 2019	Med		Reg	4A&B	
Pseudoceros maximum Lang, 1884	9 Jul. 2021	Med		Reg	4C	
Thysanozoon brocchii (Risso, 1818)	18 Jun. 2022	Med		Reg	4D-F	
Bryozoa						
Electra posidoniae Gautier, 1954	11 Jul. 2018	Med		Sur	5A	
Figularia cf. *figularis*	4 Jul. 2021	Med		Reg	5B	

Table 2. Continued

Taxonomic Group	Dat. of 1st observation	Cat	Status of NIS	Loc	Fig.	Ref
Crustacea (Decapoda)						
Gonioinfradens giardi (Nobili, 1905)	28 Oct. 2022	NIS	Casual	Reg	6A&B	
Percnon gibbesi (H. Milne-Edwards, 1853)	21 Jun. 2018; 6 Oct. 2023	NIS	Est. W&E	Reg; Sur	6C&D	Elkrwe *et al.* (2008)
Portunus segnis Forsskål, 1775	Jul.-Aug. 2023	NIS	Est. W&E	Reg	6E	Shakman *et al.* (2017; 2019)
Tunicata						
Botrylloides cf. *niger* Herdman, 1886	1 Oct. 2018	Crypt	Est. W	Reg; Sur	7A&B	
Botryllus schlosseri (Pallas, 1766)	25 Jul. 2022	Med		Reg; Sur	7C	
Diplosoma spongiforme (Giard, 1872)	20 Jun. 2019	Med		Reg	7D	
Lissoclinum sp. 1	8 Jul. 2022	un		Sur	8A	
Lissoclinum sp. 2	10 Aug. 2021	un			8B	
Pyura dura (Heller, 1877)	19 Jul. 2021	un		Sur	8C	
Symplegma brakenhielmi (Michaelsen, 1904)	21 Jun. 2018; 6 Oct. 2023	NIS	Est. W	Reg; Sur	8D-H	Rizgalla *et al.* (2019a)

Despite the recent increase in checklists documenting various marine species from specific geographical locations and national inventories (El Hassi and Muftah 2024; El Baz *et al.* 2025; Bek-Benghazi *et al.* 2025), systematic surveys are still needed to record both native and non-native species in a timelier manner. It is important to follow-up, monitor, and observe, NIS to better understand their invasive process, not only in limited geographical locations and hotspots but along the entire coastline (Bonanno and Orlando-Bonaca 2019). The list of benthic biofouling marine species reported here is far from complete; this is just the beginning. In a period where marine biodiversity is faced with increased threats from NIS, anthropogenic pressure, and climate change, the efforts to build a comprehensive national inventory of marine species in Libya are of cardinal importance (Garrabou *et al.* 2022). This would contribute to better understanding of the biodiversity along the coast, and help in the development of future national conservation strategies (Bonanno and Orlando-Bonaca 2019; Bensari *et al.* 2025).

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