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First Record of the Invasive Species *Indothais malayensis* (Gastropoda) and New Record of *Isognomon bicolor* (Bivalvia) in the Mediterranean Sea

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ABSTRACT
The present study reports the occurrence of two alien molluscan species in the Egyptian Mediterranean Sea. It documents the first record of the gastropod *Indothais malayensis* in both the Mediterranean Sea and Egypt, as well as a new record of the bivalve *Isognomon bicolor* in the Mediterranean Sea and its first occurrence in Egypt. In 2024, specimens of *I. malayensis* and *I. bicolor* were manually collected during a surveillance study of rocky shore molluscs in Abu Qir Bay, Alexandria, Egypt. Specimens were found in sediments associated with rocky shores and intertidal zones, at depths ranging from 0.4 to 0.6 meters. During sampling in October 2023, January 2024, April 2024, and July 2024, approximately 312, 298, 79, and 27 individuals per square meter of *I. malayensis* were collected, respectively. In the same periods, 45, 9, 15, and 3 individuals per square meter of *I. bicolor* were recorded. All specimens were identified to the species level based on morphological characteristics of the shell.

INTRODUCTION

The Mediterranean Sea is one of the most biodiverse marine ecosystems in the world. It is a major hotspot for non-indigenous species (NIS) introductions, boasting the highest number of recorded NIS globally **(Costello *et al.*, 2021)**. The eastern Mediterranean basin is particularly affected due to the Suez Canal, a significant pathway for these introductions **(Galil, 2012; Zenetos *et al.*, 2012; Nunes *et al.*, 2014)**. It has undergone rapid climatic changes, resulting in high average temperatures and salinity **(Schroeder *et al.*, 2017; Menna *et al.*, 2022)**. Warmer conditions in the Mediterranean Sea are promoting the invasion of NIS **(Amarasekare & Simon, 2020)**, leading to a continuous increase in their numbers and permanently altering the taxonomic and functional composition of the Mediterranean ecosystems **(Steger *et al.*, 2021; Zenetos *et al.*, 2022)**.

Indothais malayensis is a marine gastropod mollusc in the family Muricidae, commonly known as murex snails or rock snails. It is a predatory sea snail typically

found in intertidal and shallow subtidal zones on rocky shores, coral reefs, and mangrove forests. This species tolerates a wide range of salinities (20–40 ppt) and prefers warm waters **(Tan, 2000)**. It is native to the Indo-Pacific region **(Palomares & Pauly, 2024)**.

The genus *Isognomon* is a marine bivalve mollusc in the family Isognomonidae. *Isognomon bicolor*, a native Caribbean mollusc, is recognized as a potential exotic invader with significant dispersal capabilities **(Martinez, 2012; Agostini & Ozorio, 2016)**. Recently, *I. bicolor* has become widely distributed throughout the central and eastern Mediterranean **(Garzia *et al.*, 2022)**. It typically inhabits subtidal and intertidal zones at depths of 0–6 meters and is commonly known as the bicolor purse-oyster **(Rosenberg, 2009)**.

MATERIALS AND METHODS

Sampling

The specimens were manually collected during fieldwork conducted along the rocky shores of Abu Qir Bay, Alexandria, Egypt, in the eastern Mediterranean Sea (31°16'–31°28' N; 30°03'–30°22' E). The survey focused on rocky shore molluscs. Specimens were found attached to the rocky substrate at low tide, at depths ranging from 0.4 to 0.6m. Five random replicate units were sampled using five randomly placed quadrats, each measuring 1m² **(English *et al.*, 1997)**.

In October 2023, January 2024, April 2024, and July 2024, approximately 312, 298, 79, and 27 individuals per square meter of *I. malayensis* were collected, respectively. During the same periods, 45, 9, 15, and 3 individuals per square meter of *I. bicolor* were recorded.

Species identification

Specimens were identified to the species level based on morphological characteristics of the shell, using taxonomic identification keys **(Pallary, 1912; Thiele, 1992; Tan, 2000; Crothers, 2003; Albano *et al.*, 2024)**. Scientific names were reviewed and confirmed using the **World Register of Marine Species (WoRMS) database (2024)**. Shell measurements were taken with vernier calipers, ensuring an accuracy of ±0.01 mm, and specimens were photographed using a Nikon D7000 digital SLR camera.

RESULTS

New records: *Indothais malayensis* (Tan & Sigurdsson, 1996)

Egypt — Live specimens collected from rocky shores in Abu Qir Bay, Alexandria, eastern Mediterranean Sea (31°16'–31°28' N; 30°03'–30°22' E) (Fig. 1).

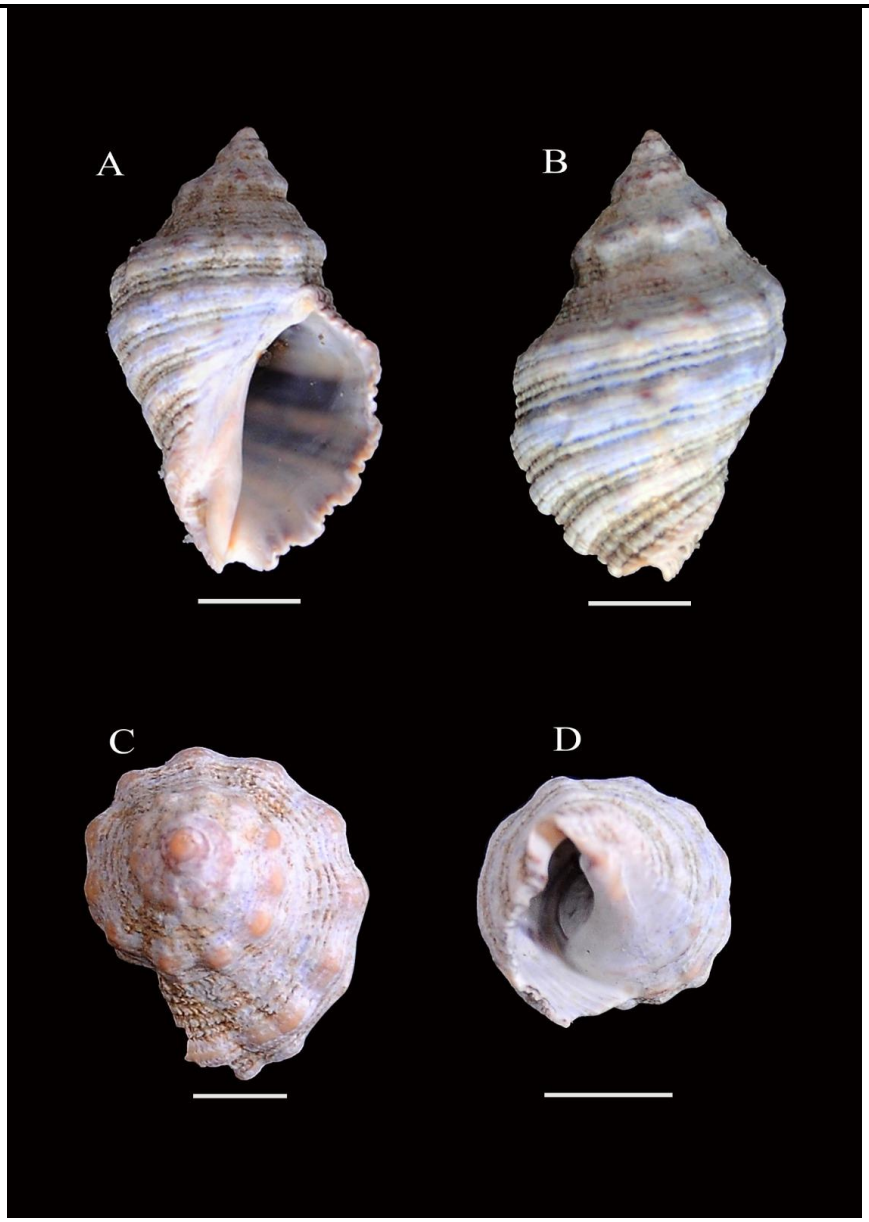

Fig. 1. *I. malayensis* , A) apertural view, B) lateral view, C) apical view and D) umbilical view. Scale bars: 2.4 mm (A and B), 2.2 mm (C), 3 mm (D)

Phylum: Mollusca
Class: Gastropoda
Order: Neogastropoda
Family: Muricidae
Genus: *Indothais*
Species: *I. malayensis* **(Tan & Sigurdsson, 1996)**

Measurements

Shell length: 32.9 ± 1.4 mm
Shell width: 20.7 ± 0.8 mm
Spire length: 10.5 ± 1.0 mm

Remarks

The shell is biconical with a distinct protoconch. The body whorl bears four rows of spiral cords adorned with prominent tubercles. The aperture is ovate, and the siphonal canal is very short. The peristome is beige, with a crenulate outer lip and a smooth inner lip.

I. malayensis is a predatory sea snail in the family Muricidae. It is native to the western central Pacific **(Palomares & Pauly, 2024)**, with a range extending across Southeast Asia, South Asia, East Asia, and Oceania. It has been reported from eight countries: Malaysia, Singapore, Australia, China, Hong Kong, Indonesia, Thailand, and the Philippines (Table 1 & Fig. 2).

Table 1. Distribution of *I. malayensis*

Continent	**Country**	**Record**	**Basis of record**	**Reference**
Asia	Malaysia	31	Preserved specimen	**European Bioinformatics Institute (EMBL-EBI), GBIF Helpdesk (2025)**
	Indonesia	5		
	Singapore	4		
	Thailand	2		
	China	1		
	Hong Kong	1		
	Philippines	1		
Oceania	Australia	3		

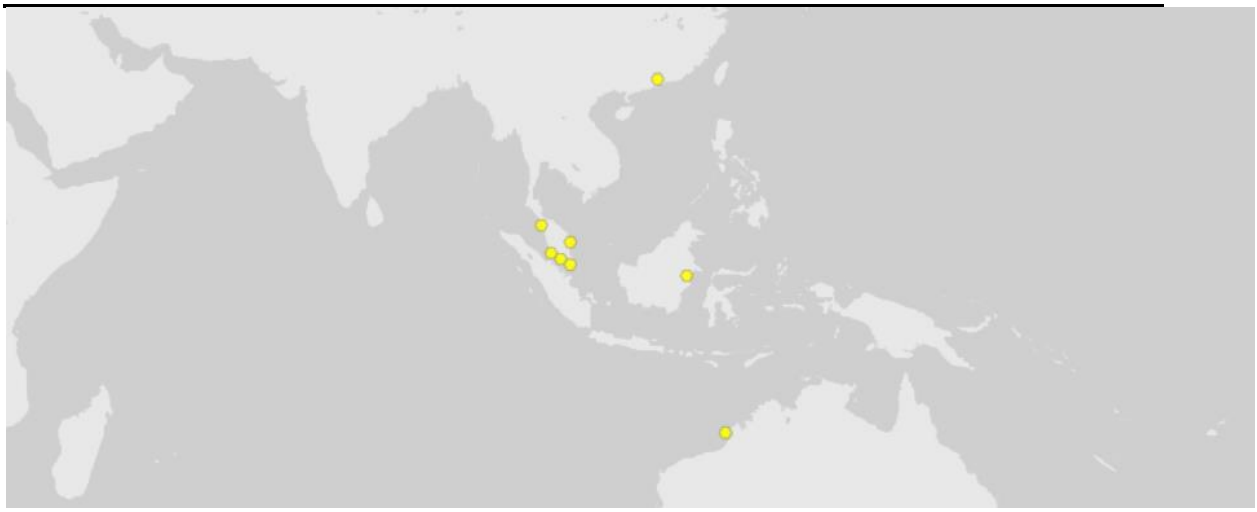

Fig. 2. Distribution of *I. malayensis* **(GBIF, 2025)**

New records: *Isognomon bicolor* (Adams, 1845)

Egypt • Live specimens, rocky shore, Abu Qir Bay, Alexandria, eastern Mediterranean Sea, 31° 16'-31° 28' N and 30° 03'-30° 22' E (Fig. 3)

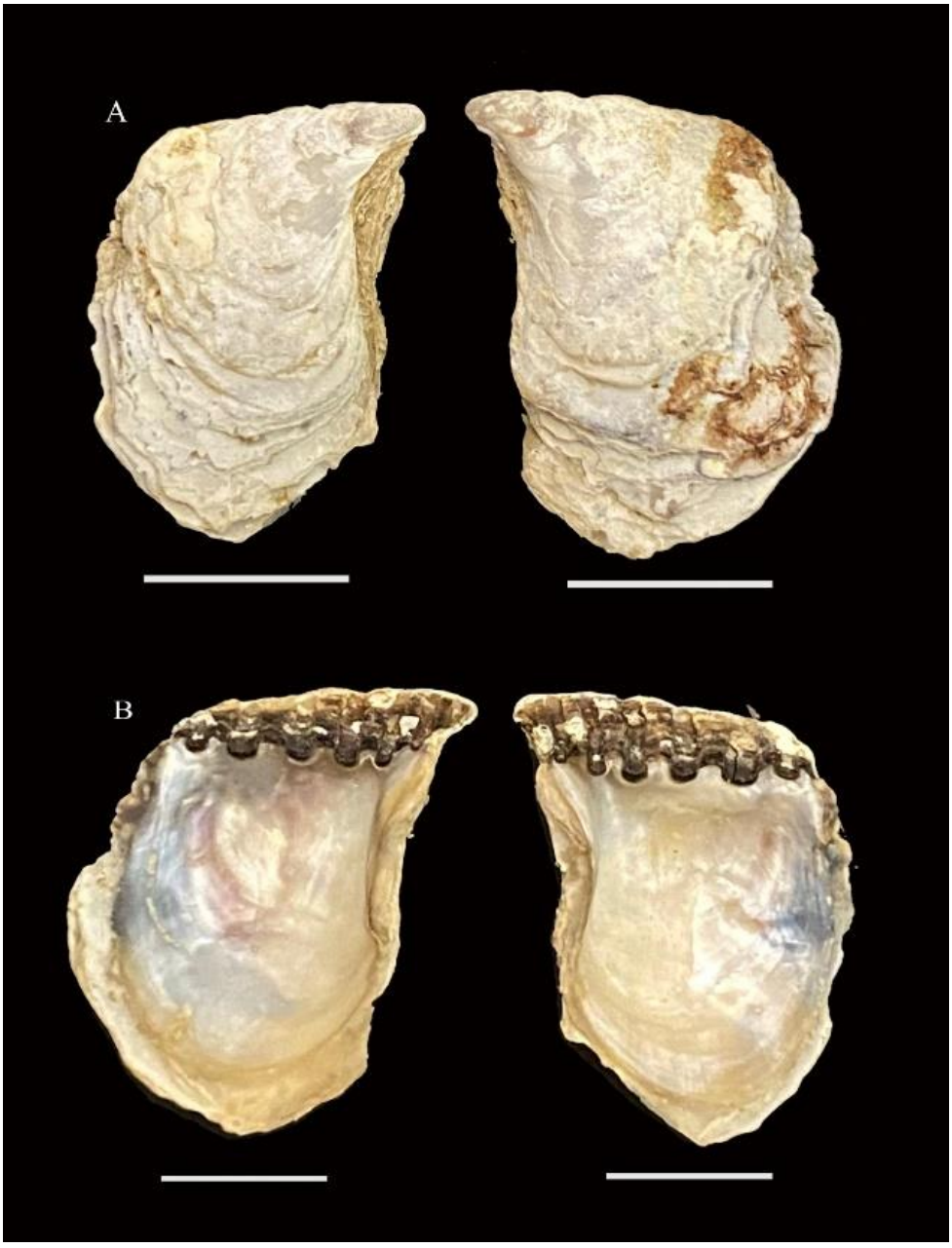

Fig. 3. *Isognomon bicolor*, A, left and right valve outer view, B, left and right valve inner view. Scale bars: 4.2 mm (A), 3.4 mm (B)

Phylum: Mollusca

Class: Bivalvia

Order: Pteriida

Family: Isognomonidae

Genus: *Isognomon*

Species: *bicolor*

Isognomon bicolor (Adams, 1845)

Measurements

Shell length: 16.1 ± 0.98 mm; shell width: 11.5± 0.4 mm

Remarks

The *I. bicolor* shell is distinguished by its ornamented outer surface featuring irregular, concentric and overlapping lamellae. The valves are slightly inequivalve and relatively thick. The inner side of the valves is nacreous, often showing dark violet areas near the margin. The native range of *I. bicolor* includes the Western Central Atlantic Coast and is commonly found in the Caribbean region (Table 2 & Fig. 4).

Table 2. Distribution of *I. bicolor* **(GBIF, 2025)**

Country	Record	Basis of record				
		Preserved specimen	Human observation	Material sample	Fossil specimen	Occurrence
United States of America	337	319	1	4	13	
Brazil	218	155	62			1
Mexico	64	63				1
Bahamas	51	50	1			
Panama	39	37			1	
Unknown country	31	30				1
Virgin Islands (U.S.)	24	24				
Venezuela	19	4	15			
Colombia	16	11	5			
Dominican Republic	16	16				

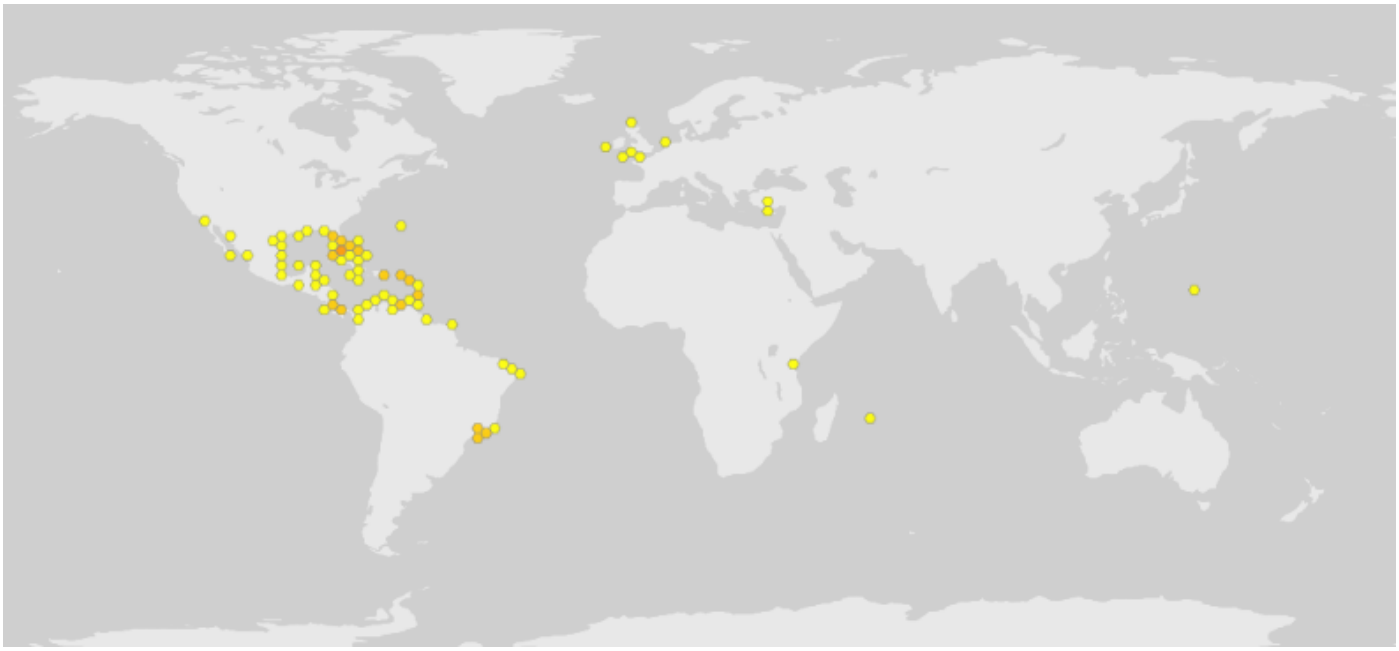

Fig. 4. Distribution of *I. bicolor* **(GBIF, 2025)**

I. bicolor was recently recorded in the Mediterranean Sea (Table 3 & Fig. 5).

Table 3. Recent records of *I. bicolor* in the Mediterranean Sea

	Location	**Year of collection**	**Reference**
Isognomon bicolor	Messina, Sicily, **Italy**	2019	**Garzia *et al.* (2022)**
	Briatico, Calabria, **Italy**	2020	
	Shikmona, **Israel**	2021	**Albano *et al.* (2024)**
	Palmachim, **Israel**	2021	
	Agia Triada, **Cyprus**	2021	
	Gouves, Crete, **Greece**	2022	
	Lefkada, **Greece**	2022	**Micali *et al.* (2022)**

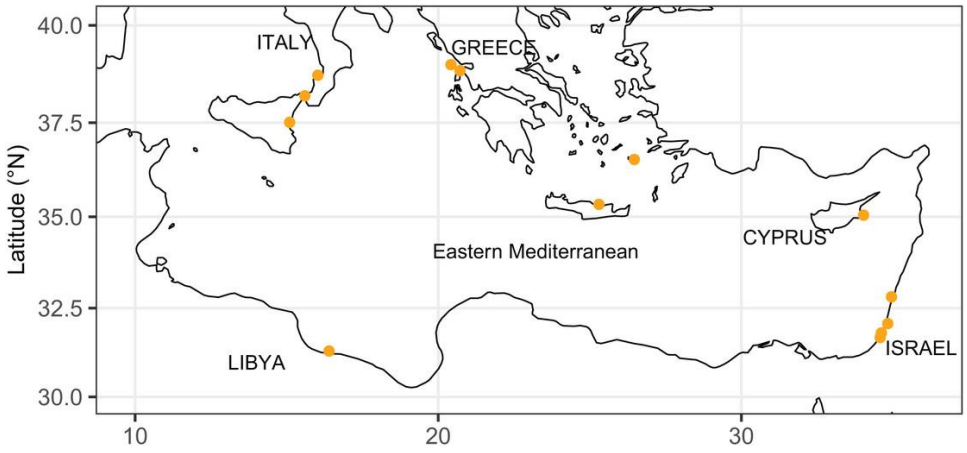

Fig. 5. Distribution of *I. bicolor* in the Mediterranean Sea. Countries where the species occur are labelled yellow **(Albano *et al.*, 2024)**

DISCUSSION

Bays and coastal regions with high port activity are especially susceptible to marine invasions **(Ruiz *et al.*, 1999)**. Invasions by non-indigenous species (NIS) are recognized as significant stressors affecting numerous marine communities worldwide. Recently, the introduction of exotic species has raised growing concerns due to the potential threats they pose to native ecosystems. Marine invasions can have severe impacts on ecosystem functioning and biodiversity. In Egypt, the Egyptian Environmental Affairs Agency **(EEAA, 2023)** is monitoring the situation of NIS and implementing measures to prevent their introduction.

The present study recorded the invasion of Abu Qir Bay, Egypt, by the alien species *Indothais malayensis* and *Isognomon bicolor*. The seasonal abundance of individuals of both species followed the order: Autumn > Winter > Spring > Summer. These fluctuations may be linked to seasonal changes in plankton availability and water quality. Temperature shifts can influence pollutant solubility, toxicity, and the metabolic rates of aquatic organisms, thereby affecting survival and reproduction **(Nwinyimagu *et al.*, 2021)**. In summer, elevated temperatures can exacerbate the effects of pollution. Rising temperatures may also disrupt phytoplankton populations, which form the foundation of aquatic food webs, potentially causing cascading effects on biodiversity **(Xu *et al.*, 2024)**.

According to **Molluscabase (2025)**, there are no documented records of *I. malayensis* and *I. bicolor* in Egypt. **Zenetos and Galanidi (2020)** compiled an updated inventory of Mediterranean marine NIS for 2017–2019, based on continuous literature reviews and updates from the Hellenic Centre for Marine Research (HCMR) database.

Their findings indicate that these two species had not yet been reported in the Mediterranean Sea. *I. malayensis*, native to the Indo-Pacific region, has no prior evidence of occurrence in the Mediterranean **(Steger *et al.*, 2018; Albano *et al.*, 2021)**. Thus, the present survey represents the first documented record of this species in the region. The continuous detection of *I. malayensis* throughout the study period strongly supports its establishment in Egypt. This finding suggests that the species is spreading and may threaten native biota in the eastern Mediterranean. Being a voracious predator, *I. malayensis* feeds on a variety of invertebrates, including mussels, barnacles, and sea urchins, and may also compete with native species for food and habitat resources **(Pedro *et al.*, 2023)**.

The Caribbean species *I. bicolor* has been reported recently in the Mediterranean, with confirmed records from Italy **(Garzia *et al.*, 2022)**, Greece **(Micali *et al.*, 2022)**, as well as Israel, Cyprus, and Greece **(Albano *et al.*, 2024)**. The present survey provides the first confirmed record of *I. bicolor* in Egypt, with specimens observed throughout the year. The bicolor purse oyster exhibits high dispersal capacity and may negatively affect native species through competition and habitat modification **(Queiroz *et al.*, 2023)**.

CONCLUSION

Bioinvasions are a major driver of native biodiversity decline. Investigating the ecological niches and behaviors of *Indothais malayensis* and *Isognomon bicolor* can provide valuable insights into their patterns of distribution and establishment. Overall, the Mediterranean Sea appears capable of supporting populations of both species; however, further research is required to clarify their precise distribution, abundance, and ecological roles within this unique marine ecosystem. To strengthen species classification and confirm identification, additional genetic analyses are recommended.

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