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CASSIOPEA ANDROMEDA AT THE SOUTHERNMOST TIP OF ITALY: A RECENT ARRIVAL OR AN OVERLOOKED RESIDENT?

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ABSTRACT

The Lessepsian jellyfish Cassiopea andromeda is an invasive scyphozoan originating from the Red Sea and Indo-Pacific region. It was first recorded in the Mediterranean at the beginning of the 20th century and has since expanded its distribution across the basin. The main goal of this contribution is to document the first and well-documented record of this jellyfish from the Portopalo di Capo Passero area, which represents the southernmost tip of Italy (Sicily, Ionian Sea). The observation, made in October 2025, provides new evidence of the species' expansion along the Sicilian Ionian coast. This finding raises questions about whether the species is a recent colonizer or an overlooked resident and highlights the biogeographical and ecological importance of this area as a potential hotspot for the monitoring of Lessepsian and thermophilic species.

Key words: jellyfish, alien species, Ionian Sea, Mediterranean, Lessepsian migrant

CASSIOPEA ANDROMEDA ALL'ESTREMO SUD D'ITALIA: UNA PRESENZA RECENTE O UNA SPECIE PASSATA INOSSERVATA?

SINTESI

La medusa lessepsiana Cassiopea andromeda è uno scifozoo invasivo originario del Mar Rosso e della regione indo-pacifica. È stata segnalata per la prima volta nel Mar Mediterraneo all'inizio del XX secolo e da allora ha progressivamente ampliato la propria distribuzione in tutto il bacino. Il principale obiettivo di questo studio è quello di documentare la prima segnalazione di questa specie nell'area di Portopalo di Capo Passero, estrema punta meridionale d'Italia (Sicilia, Mar Ionio). L'osservazione, effettuata nell'ottobre 2025, fornisce nuove evidenze dell'espansione della specie lungo la costa ionica siciliana. Questo ritrovamento solleva interrogativi sul fatto che si tratti di un colonizzatore recente o di una specie precedentemente passata inosservata, e sottolinea l'importanza biogeografica ed ecologica di quest'area come potenziale hotspot per specie lessepsiane e termofile.

Parole chiave: medusa, specie aliena, Mar Ionio, Mediterraneo, migrante lessepsiano

INTRODUCTION

The Mediterranean Sea, recognized as a global biodiversity hotspot, hosts an exceptionally rich marine fauna with over 17,000 recorded species, representing about 7% of the world's marine animals (Coll *et al.*, 2010). Nowadays, this biodiversity is undergoing profound transformations driven by human activities, including both direct and indirect species introductions (Stock *et al.*, 2018). The spread of non-indigenous species (NIS), also referred to as alien, exotic, or non-native species, has become a key indicator of ecological imbalance and biodiversity decline (Katsanevakis *et al.*, 2014; Tiralongo *et al.*, 2020). Invasive alien species are now regarded as one of the primary threats to the integrity and functioning of Mediterranean marine ecosystems (Pyšek *et al.*, 2020).

In this context, the “upside-down jellyfish” *Cassiopea andromeda* (Forskål, 1775) is a Lessepsian immigrant native to the Red Sea and is widely distributed throughout the Indo-Pacific region. It entered the Mediterranean Sea through the Suez Canal and was first recorded off Cyprus in 1903 (Maas,

1903). Since then, it has progressively expanded westwards, with confirmed records of the species in the Levantine, Aegean and central Mediterranean sub-basins (Galil *et al.*, 1990; Çevik *et al.*, 2006; Schembri *et al.*, 2010; Ramos-Pérez *et al.*, 2025). More recently, dense aggregations of the jellyfish have been reported in semi-enclosed eutrophic environments such as harbours and salt pans (Cillari *et al.*, 2018; Deidun *et al.*, 2018; Kleitou *et al.*, 2025), while the westernmost Mediterranean record of the species was documented in Spain (Marambio *et al.*, 2025).

This species is highly tolerant to environmental fluctuations and is capable of asexual reproduction, which facilitates its rapid establishment in shallow coastal habitats (Thé *et al.*, 2021). Species of the genus *Cassiopea* exhibit a mixotrophic lifestyle sustained by an intracellular symbiosis with dinoflagellates (Symbiodiniaceae), which are acquired from the environment during the polyp stage (Djeghri *et al.*, 2019). This mutualistic association significantly shapes the holobiont's biochemical composition, nutritional strategy and overall metabolism (De Domenico *et al.*, 2025). Moreover, given the high



Fig. 1: Specimens of *C. andromeda* observed inside the harbour of Portopalo di Capo Passero (Sicily, Ionian Sea) on 19 October 2025: (A) during measurements; (B) sampled specimens; (C) in situ individuals.

Sl. 1: Primerki vrste *C. andromeda*, opaženi v pristanišču Portopalo di Capo Passero (Sicilija, Jonsko morje) 19. oktobra 2025: (A) med meritvami; (B) vzorčeni osebki; (C) osebki in situ.

interspecific morphological similarity within the genus, accurate species identification of *Cassiopea* often requires an integrative taxonomic approach, combining both morphological and molecular data (Rowe et al., 2025). From a morphological perspective, diagnostic characters such as the number and distribution of large appendages as well as the oral arm branching pattern have proven useful for species discrimination within the genus (Rowe et al., 2025).

Following its introduction from the Red Sea into the Mediterranean through the Suez Canal, *Cassiopea andromeda* has expanded its range under the influence of climate change and consequently to increasing seawater temperatures, now occurring more widely than previously recorded (Holland et al., 2004; Fumarola et al., 2025).

Here, we report the first well-documented occurrence of *C. andromeda* from the Portopalo di Capo Passero area (southeastern Sicily, Ionian Sea), providing new evidence of its range expansion within southern Italian waters. Preliminary data on individual size composition and on local abundance were also collected.

MATERIAL AND METHODS

On 19 October 2025, several individuals of *Cassiopea andromeda* were observed and photographed by the authors in a sheltered coastal area inside the fishery harbour of Portopalo di Capo Passero (36.67095N, 15.12699E), at a depth of about 0.7 m (Fig. 1). The site is characterized by sandy and muddy substrates with reduced water circulation and elevated summer temperatures. Moreover, during the survey, two alien invasive crab species, namely *Callinectes sapidus* and *Portunus segnis*, were detected. A total of 42 specimens of *C. andromeda* were measured, recording the diameter of the exumbrella using a flexible measuring tape with a 0.1 cm precision. A total of 10 specimens were sampled in order to verify the identity of the species, whose general morphology clearly matched that of *C. andromeda* (Ames et al., 2020; Karunaratne et al., 2020). After the analyses, the specimens were preserved in alcohol for potential future laboratory examinations (e.g., molecular analysis) and deposited in the zoological collection of the Ente Fauna Marina Mediterranea in Avola (Sicily) under the code #EFMM191025. A species' density (individuals/m²) estimation was carried out. Finally, an updated map (Fig. 2) based on our new record and on the data provided by Katsanevakis et al. (2020) was produced, using the recent model proposed for the Mediterranean by Ramos-Pérez et al. (2025).

RESULTS AND DISCUSSION

Specimens displayed the typical morphology and general colour pattern of *Cassiopea andromeda*: a flattened umbrella, whitish to brownish coloration, conspicuous white blotches on the exumbrella, and eight branched oral arms. However, although the general morphology and colour pattern clearly point to the genus *Cassiopea*, the absence of molecular analyses prevents a definitive species-level identification (Gamero-Mora et al., 2022; Rowe et al., 2025). The bell diameters of specimens measured from 5 to 13 cm, with a mean value of 8.6 ± 2.4 cm. This size variability reflects a population composed of both juvenile and adult individuals, suggesting that the species is able to complete different stages of its life cycle within the studied area. Individuals rested inverted on the seabed, with the oral arms oriented upward to maximize exposure of the zooxanthellae to light, an adaptive strategy associated with their mixotrophic feeding (Symbiodiniaceae symbiosis) (Arossa et al., 2021). The estimated mean jellyfish density in the area, where the species was unevenly distributed, was that of approximately 8 jellyfish individuals/m².

This record represents the southernmost occurrence of *C. andromeda* in Italian waters, about 120 km south of the population recently documented in the Augusta salt pans (Kleitou et al., 2025). The environmental conditions of Portopalo's harbour, with warm, eutrophic, and semi-enclosed calm waters, closely resemble habitats where the species has established stable aggregations elsewhere in the Mediterranean (Schembri et al., 2010; Cillari et al., 2018; Deidun et al., 2018; Kleitou et al., 2025).

Given its broad thermal (6–39 °C, with an optimum at 35.7 °C; Fumarola et al., 2025) and moderate salinity tolerance (30–50, Aljbour & Agustí, 2025), *Cassiopea andromeda* is likely to be more widespread in the Mediterranean Sea than previously assumed. This suggests that transitional environments such as saltpans, coastal lagoons, and harbours are particularly suitable for the presence of the species and should therefore be carefully inspected and monitored. The finding also raises the possibility that the species had previously remained undetected due to a limited monitoring in shallow coastal lagoons and harbour areas. The location of Portopalo, near the confluence of Ionian and Strait of Sicily currents, could act as an ecological “gateway” for a further dispersal of the species towards western and northern Mediterranean waters. Several hypotheses can be considered regarding the putative introduction pathway responsible for bringing the species to Portopalo. The proximity of Portopalo to main

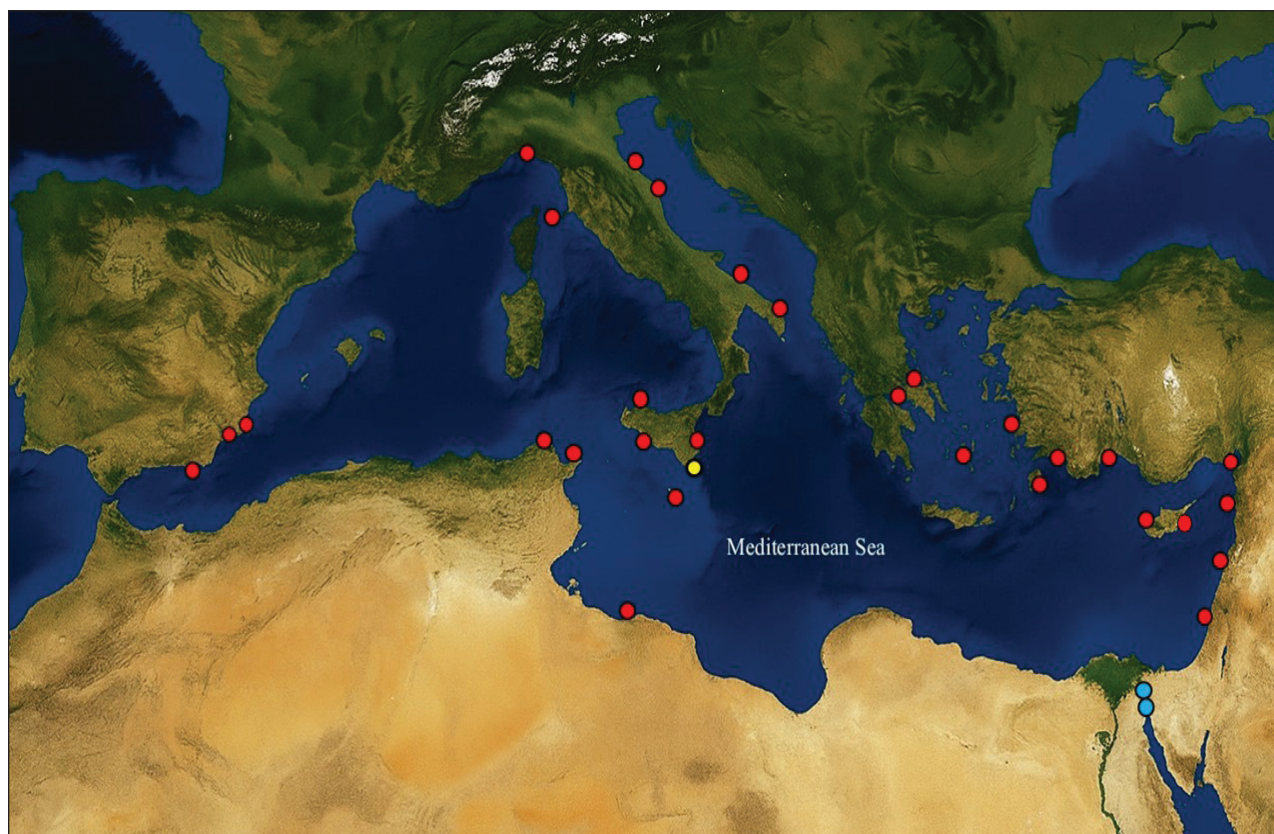


Fig. 2: Distribution map of *Cassiopea andromeda* records in the Mediterranean Sea. In red circles historical records, in light blue historical records from the Suez Canal (Red Sea), and the yellow one represents the new record from Portopalo di Capo Passero (modified from Ramos-Pérez et al., 2025 and updated with records in Katsanevakis et al., 2020).

Sl. 2: Zemljevid razširjenosti vrste *Cassiopea andromeda* na podlagi zapisov o pojavljanju v Sredozemskem morju. V rdečih krogih so zgodovinski zapisi o pojavljanju, v svetlo modrih krogih zgodovinski zapisi o pojavljanju iz Sueškega prekopa (Rdeče morje), rumeni pa predstavlja nov zapis o pojavljanju iz Portopalo di Capo Passero (spremenjen po Ramos-Pérez in sod., 2025 in posodobljen z zapisi v Katsanevakis in sod., 2020).

commercial shipping routes and its intense fishing and boating activities suggest that *C. andromeda* may have been introduced through shipping-related vectors, either via ballast water or as fouling - polyps attached to ship hulls. Alternatively, the species could have reached the area by natural dispersal or through recreational vessel traffic from already-established populations in Malta or along the eastern Sicilian coast, supported by favourable currents and rising sea temperatures that enhance larval survival and transport. The latter pathway is especially plausible given the high volumes of recreational vessel traffic between Malta and Sicily during the summer season. The ability to exploit multiple energy sources, namely photosynthates provided by symbiotic dinoflagellates and heterotrophic feeding, enables *C. andromeda* to thrive under a wide range of environmental conditions (Thé et al., 2023). *Cassiopea* genus can form

high-density blooms when environmental conditions are favourable and anthropogenic pressures intensive, particularly with rising sea temperatures linked to climate change and coastal development. Such blooms may exert competitive pressure on seagrass and other vegetal communities, primarily by limiting the availability of space, light, and food (Rowe et al., 2025). Moreover, the trophic flexibility of *Cassiopea* genus, linked to both heterotrophic feeding and photosynthetic symbionts, can influence primary productivity, nutrient cycling, and local food web dynamics, potentially generating cascading ecological effects, as observed in other symbiotic jellyfish species (Djehri et al., 2021).

Continuous monitoring with the possibility to involve citizen science networks, will be essential to evaluate whether this population is ephemeral or self-sustaining, as well as to assess its ecological effects on local benthic communities and

on dissolved oxygen dynamics. Considering the species' long history of westward expansion in the Mediterranean (Fumarola *et al.*, 2025), it remains uncertain whether its presence in Portopalo represents a recent colonization event favoured by climate warming or whether the species has remained undetected for years due to its occurrence in localised habitats and due to the lack of specific expert monitoring programs.

In the context of this study, the harbour of Portopalo di Capo Passero can be regarded as a hotspot of alien biodiversity, as evidenced by the

occurrence of several alien species, including the invasive portunid crabs *Callinectes sapidus* and *Portunus segnis*. The coexistence of these taxa highlights the ecological susceptibility of this semi-enclosed coastal system to biological invasions and its potential role as an entry point and establishment site for thermophilic and Lessepsian species in the central Mediterranean. Indeed, such environments, often characterized by anthropogenic disturbance and intense maritime traffic, may act as stepping stones for the secondary dispersal of Lessepsian and thermophilic taxa along the Sicilian coast.

TUJERODNI KLOBUČNJAK CASSIOPEA ANDROMEDA NA NAJJUŽNEJŠI KONICI ITALIJE: NEDAVNI PRIŠLEK ALI SPREGLEDAN PREBIVALEC?

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POVZETEK

Lesepski klobučnjak Cassiopea andromeda je invazivna vrsta klobučnjakov, ki izvira iz Rdečega morja in indo-pacifiške regije. V Sredozemskem morju so jo prvič zabeležili na začetku 20. stoletja in od takrat se je razširila po celotnem bazenu. Glavni cilj tega prispevka je bil dokumentirati prvi in dobro dokumentiran zapis te klobučnjaške meduze z območja Portopalo di Capo Passero, ki predstavlja najjužnejšo konico Italije (Sicilija, Jonsko morje). Opazovanje primerkov te vrste v oktobru 2025 prinaša nove dokaze o širjenju vrste vzdolž sicilijansko-jonske obale. Ta ugotovitev sproža vprašanja o tem, ali je vrsta nedavni kolonizator ali spregledan prebivalec, in poudarja biogeografski in ekološki pomen tega območja kot potencialne žariščne točke za spremljanje lesepskih in toploljubnih vrst.

Ključne besede: klobučnjaki, tujerodne vrste, Jonsko morje, Sredozemsko morje, lesepska selivka

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