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The thermophilic sea anemone *Telmatactis cricoides* (Cnidaria, Hexacorallia) in the western Mediterranean: filling gaps in the knowledge of the distribution

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Abstract

Several individuals of the sea anemone *Telmatactis cricoides* (Duchassaing, 1850) (order Actiniaria) were observed in the Mediterranean continental Spanish coast (Almeria) and the Balearic Islands (Mallorca) showing an expansion of the species, possibly related to rising sea water temperatures. This finding contributes to increase the knowledge on the geographical distribution range of this actiniarian in the Mediterranean basin.

Introduction

The genus *Telmatactis* Gravier, 1916 (Cnidaria, Anthozoa, Actiniaria) contains 29 tropical to subtropical species distributed worldwide (Rodríguez *et al.*, 2023). Individuals display hexameric body plan with an adherent pedal disc, a column divided into a large scapus and a narrow, naked scapulus, and an oral disc with 24 to 96 entacmaceous tentacles rather short to moderately long with acute to distinctly clavate tips, those of the primary cycle often considerably larger than the rest (Cairns *et al.*, 1986; den Hartog, 1995).

In the Mediterranean Sea, a total of three *Telmatactis* species occur (Häussermann, 2003): *Telmatactis forskalii* (Hemprich & Ehrenberg in Ehrenberg, 1834), widely distributed throughout the Mediterranean basin (den Hartog, 1995); *Telmatactis solidago* (Duchassaing & Michelotti, 1864), which seems to have a restricted distributional range limited to the eastern Mediterranean (den Hartog, 1995); and *Telmatactis cricoides* (Duchassaing, 1850), described from the Caribbean area (Antilles) in Duchassaing de Fontbressin (1850) and occurring throughout the tropical Atlantic Ocean, where the species shows an amphiatlantic distribution in tropical and subtropical waters (Bermuda, Brazil, Gulf of Guinea, Cape Verde Islands, Senegal, Canary Islands, Azores Islands, and Madeira Island, among other locations) (see den Hartog, 1995 and references therein; Wirtz, 2009), together with the Mediterranean Sea where it has been reported along the central and eastern basin (den Hartog, 1995), with some observations registered in citizen science platforms (e.g. iNaturalist).

In 2016, the sea anemone *T. cricoides* was observed at Chafarinas Islands (southern Alboran Sea, western Mediterranean), a small archipelago consisting of three islets: Congreso, Isabel II, and El Rey, located at 3.2 km from the coast of Morocco, during a sampling campaign (Sánchez-Tocino *et al.*, 2016). Nevertheless, the presence of this species in the Spanish continental coast and the northwestern Mediterranean has not been reported to date.

Materials and methods

In the aim to describe and asses the status of rocky infralittoral habitats within the mandatory European Directive 2008/56/EC (Marine Strategy Framework Directive; https://www.msfd.eu/index.html), the project 17-ESMARES2-INFRA (a sub-project within the ESMARES project; see details at https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas.html) carries out annual surveys called INFRAROCK expeditions performing underwater visual censuses (UVC) using scuba diving along littoral Spanish waters between 5–15 m depth (average depth of 11.2 m).

Between 2020 and 2022, a total of 787 transects in 148 sampling stations have been carried out along the Spanish Mediterranean including the continental coast, the Columbretes and the Balearic Islands, and the Strait of Gibraltar area as far as Chipiona (expeditions INFRAROCK_1120, INFRAROCK3D_0521 and INFRAROCK3D_0721 on board R/V SOCIB, and INFRAROCK3D_0522 on board R/V Francisco de Paula Navarro) (Figure 1). In every sampling station, a total of 25 replicates using a 50 × 50 cm (0.25 m^2) PVC quadrat were performed in each one of the 4 transects performed for macroinvertebrates presence and abundance evaluation through UVC.

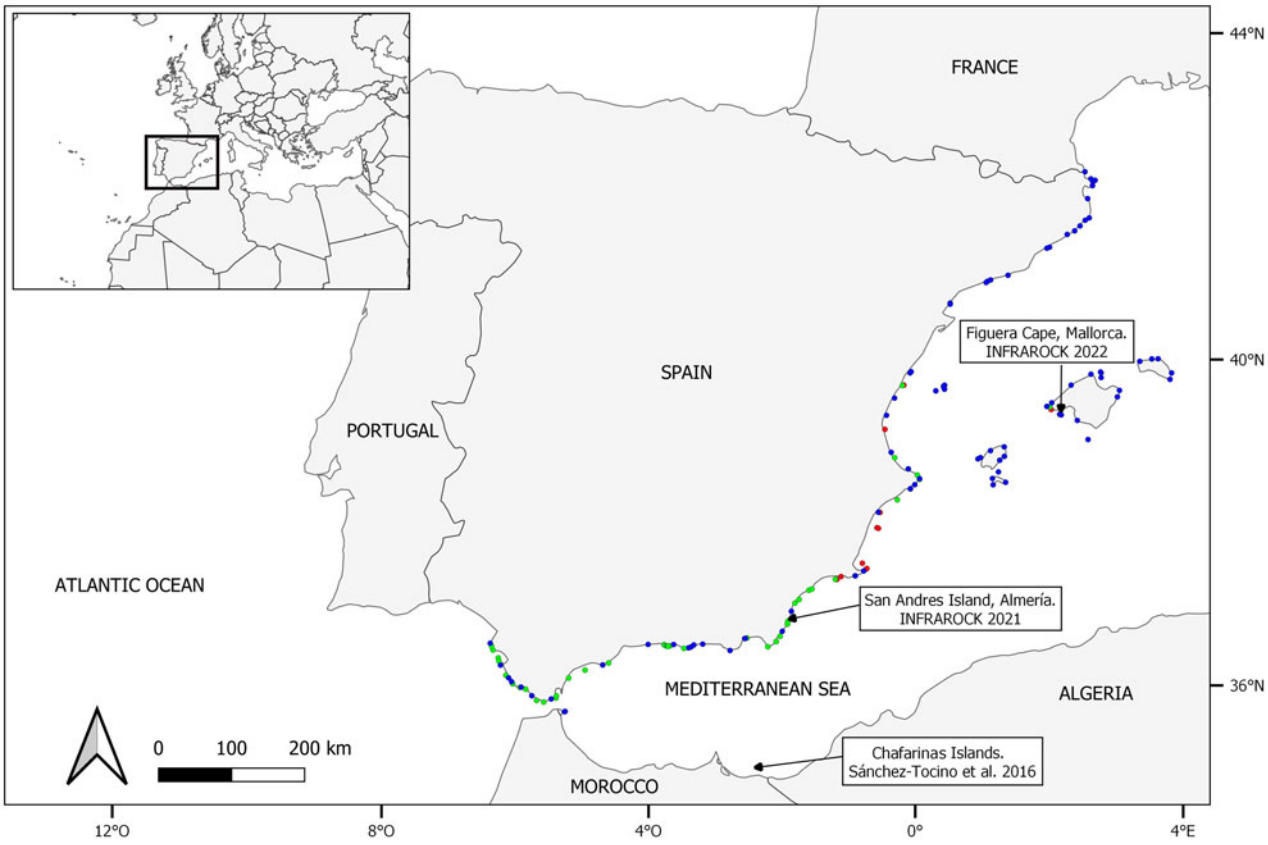

Figure 1. Map of the study area with the stations sampled during the INFRAROCK diving expeditions (year 2020 in red, 2021 in green, and 2022 in blue). Locations where *Telmatactis cricoides* specimens have been observed are indicated.

The identification of the specimens observed in the expeditions was done visually *in situ*, and their size recorded with a plastic calliper; moreover, every specimen was photographed. No specimens were collected for laboratory identification.

Results

A total of four specimens of *T. cricoides* were observed and identified *in situ* by visual censuses in two stations visited during the INFRAROCK expeditions in 2021 and 2022 (Figure 1). No specimens were collected or examined, the general shape and size of the specimens, together with the characteristic clavate tentacle tips left no doubt about their identity.

The first observation, 7th August 2021, corresponds to three specimens (Figure 2A) found inside a small cave at 8.5 m depth on the rocky bottom of the San Andres Island (Almeria), a Special Area of Conservation (Natura 2000 network) and a regional Natural Monument (SE Spain; 36.9917°N; 1.8844°W) (Figure 1). This corresponds to the first record of *T. cricoides* in the Mediterranean continental Spanish coast. The specimens showed a size ranging between 6–8 cm diameter of the oral disc and tentacles. They were associated with a faunal assemblage characterized by sciaphilic species such as the bryozoans *Myriapora truncata* (Pallas, 1766) and *Cellepora pumicosa* (Pallas, 1766), the sponges *Oscarella lobularis* (Schmidt, 1862) and *Crambe crambe* (Schmidt, 1862), the scleractinian *Polycyathus muellerae* (Abel, 1959), and the tube worm *Protula tubularia* (Montagu, 1803).

The second observation, 18th September 2022, corresponds to one specimen (Figure 2B) found inside a small crevice on a

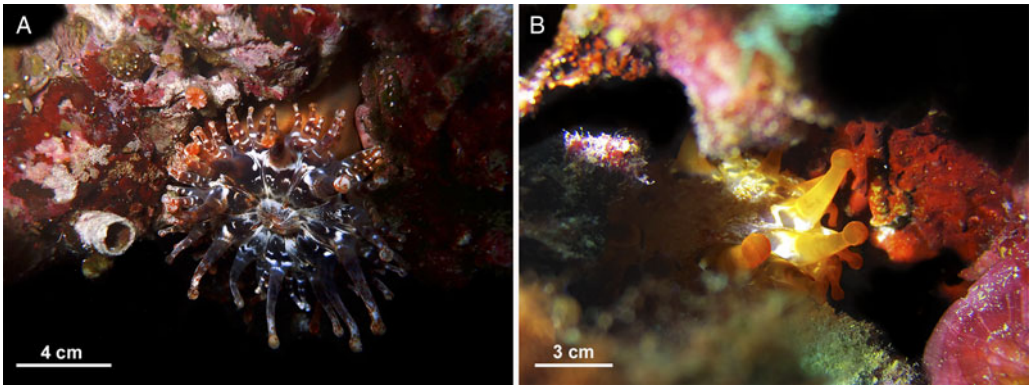

Figure 2. Specimens of *Telmatactis cricoides* observed at (A) San Andrés Island (Almeria) in September 2021, and (B) Figuera Cape (Mallorca Island) in September 2022.

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vertical rocky cliff at 10.5 m depth off Figuera Cape (SW Mallorca; 39.4580°N, 2.5234°E) (Figure 1). This specimen had a size of ca. 6 cm diameter of the oral disc and tentacles. In this case, the specimen was associated with a faunal assemblage characterized by the sponges *C. crambe* and *Chondrosia reniformis* (Nardo, 1847), the echinoderms *Ophidiaster ophidianus* (Lamarck, 1816) and *Paracentrotus lividus* (Lamarck, 1816), the annelids *Bonelia viridis* (Rolando, 1822) and *Protula intestinum* (Lamarck, 1818), and the scleractinian *Cladocora caespitosa* (Linnaeus, 1767).

Discussion

This is the first documented report of the presence of the subtropical sea anemone *T. cricoides* in the continental Spanish coast (Almeria) and the Balearic Islands (Mallorca). These findings enlarge the knowledge of the geographical distribution of this actiniarian in the western Mediterranean, where up to date it had only been reported at Chafarinas Islands (southern Alboran Sea) by Sánchez-Tocino *et al.* (2016). The presence of tropical and subtropical benthic species in the western Mediterranean has been documented mostly for molluscs (e.g. *Ungulina rubra* de Roissy, 1804, *Sinum bifasciatum* (Récluz, 1851), *Tritia vaucheri* (Pallary, 1906) and *Gibberula epigrus* (Reeve, 1865), among others; see Rueda *et al.*, 2009; Urra *et al.*, 2017) but also for other phyla (Rueda *et al.*, 2010), including echinoderms (e.g. *Luidia atlantidea* Madsen, 1950; see Gallardo-Roldán *et al.*, 2015), decapod crustaceans (e.g. *Cryptosoma cristatum* (Brullé, 1837), *Pagurus mbizi* (Forest, 1955), among others; see García Raso, 1993; García Raso *et al.*, 2014) and fishes (e.g. *Acanthurus monroviae* (Steindachner, 1876) and *Parapristipoma octolineatum* (Valenciennes, 1833), among others; Golani *et al.*, 2021). The presence of the abovementioned species along the northern Alboran basin, with records spanning several decades, would indicate the existence of persistent local populations in the westernmost Mediterranean basin. This could be supported by the oceanographic dynamics of this region, with a constant eastwards flux of superficial Atlantic waters through the Strait of Gibraltar, which may promote larval transport from northwestern Africa to the Alboran basin, and facilitated by the global warming derived from the climate change, as sea surface temperature has increased globally in the last decades, including the Alboran basin (Nykjaer, 2009).

In the case of *T. cricoides*, Sánchez-Tocino *et al.* (2016) does not support the hypothesis that this sea anemone arrived via the Strait, as this species had not been reported from the well-studied Gulf of Cadiz and northern Alboran sea, especially considering the monitoring programme carried out by the regional authorities since 2006 (Junta de Andalucía, 2021), together with a specific programme aimed to evaluate actiniarian species caught by the artisanal fleet. This absence could be related with colder

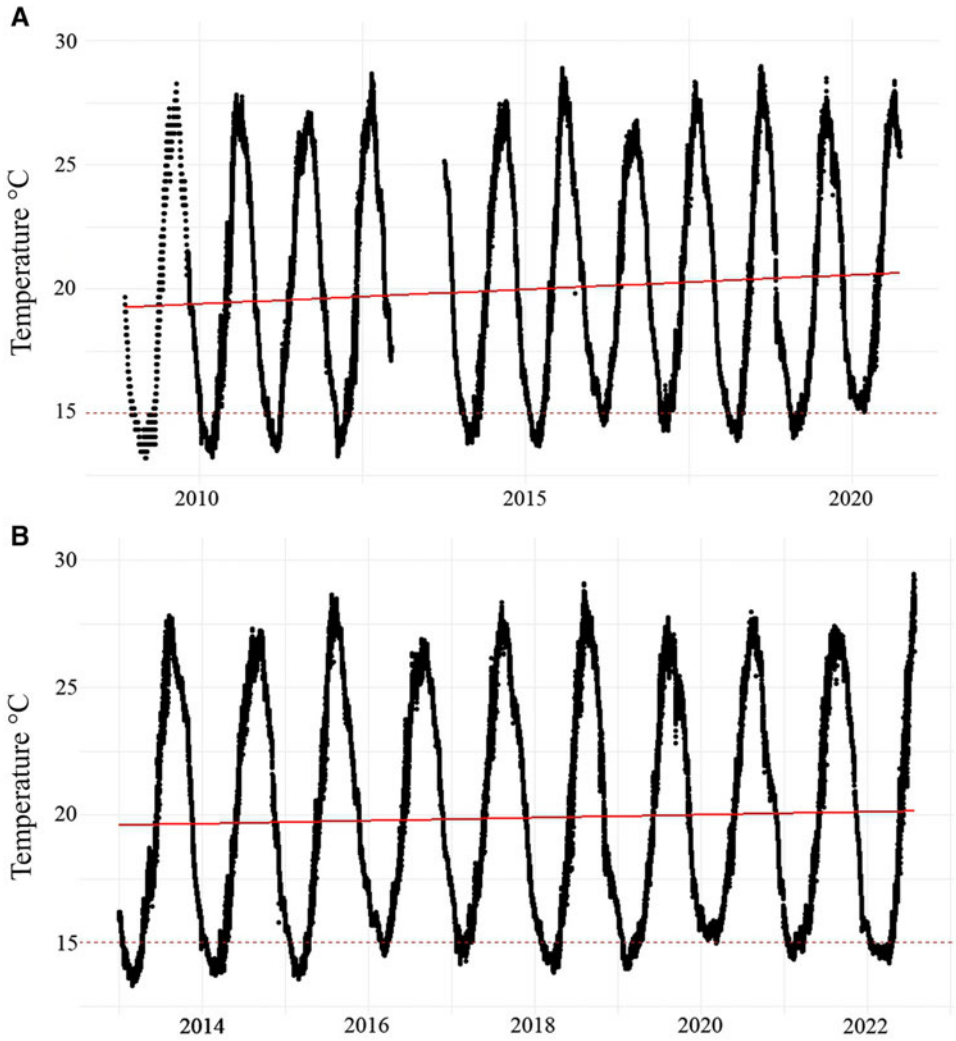

Figure 3. Seawater temperature temporal trend registered from 2008 to 2020 in Cabrera Island at 5 m depth (A) and Sa Foradada islet at 10 m depth (B). The red dashed line indicates 15°C and the red solid line indicates the trend considering mean annual values. Dataset was provided by the regional temperature observation network T-MEDNet (www.t-mednet.org).

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winter waters that are not favourable for this subtropical species; however, it could survive in the warmer coasts of Almeria and the Balearic Islands. On the other hand, its presence inside a horizontal crack close to Congreso Island (Chafarinas Islands) could be promoted by the arriving of larva with the secondary Alboran anticyclonic gyre that brings warmer surface Atlantic water than that of the northern Alboran Sea. Here, almost constant upwelling processes of deep waters take place along the coasts of Malaga and Granada (Sarhan *et al.*, 2000; Cebrián and Ballesteros, 2004; Garcia-Jove *et al.*, 2022), which is reflected in the presence of species commonly found at deeper bottoms (Marina *et al.*, 2015).

The specimens documented here were found in a sciaphilous habitat and in a depth range (8–10 m) similar to those documented for the species (den Hartog, 1995; Wirtz, 1996); however, the size and the colour morph are more similar to those of *T. cricoides* populations from the central and eastern Mediterranean Sea (https://www.inaturalist.org/observations/67573632 for Italian observations; https://www.inaturalist.org/observations/60295772 for Greek observation) than to the highly variable colour morphs of the giant Madeiran and Canarian specimens, which can reach diameters of the oral disc and tentacles up to 20 cm (den Hartog, 1995; Wirtz, 1996). This is not necessarily linked to the origin of the specimens reported here and, therefore, genetic analyses would be of interest to determine if they come from larva transported by the incoming Atlantic water masses or from central/eastern Mediterranean populations. Regarding this and according to den Hartog (1995), *T. cricoides* is only found in waters where the mean temperature of the coldest month does not drop below ca. 15°C; hence, its distribution in the Mediterranean Sea was limited to its central and eastern regions. Nevertheless, the seawater temperature of the Balearic Sea has been increasing at a rate of 0.04 ± 0.004°C year^{-1} between 1993–2016 (von Schuckmann *et al.*, 2018), reaching over 15°C in the coldest month of the past winters (Barrientos *et al.*, 2021) (Figure 3). This increase of seawater temperature, especially the minimum in winter, would favour a spreading and settlement of species unable to survive previously, as seems to be the case with *T. cricoides*.

This would suggest that central and eastern populations of this species could be extending their range to the western Mediterranean basin following the increase of water temperature. These observations could be part of the tropicalization of temperate marine ecosystems (Vergés *et al.*, 2014), phenomenon that refers to the increase in seawater temperature and the expansion of species into the Mediterranean basin due to Atlantic influence, Lessepsian migration (i.e. migration of marine species across the Suez Canal, usually from the Red Sea) and/or driven by human activities (e.g. shipping, aquaculture, release of ornamental species) (Bianchi and Morri, 2003). Overall, the establishment of tropical and subtropical species along the Mediterranean coasts may cause native communities that support high levels of biodiversity and complexity to modify or even lose their particular character (Bellan-Santini and Bellan, 2000). This puts at risk the identity of Mediterranean communities, becoming similar to their tropical analogues, as it has been observed in the southern Mediterranean basin in the last decades, especially in certain areas such as the Levant region (Fishelson, 2000).

The Mediterranean Sea is home to a diverse array of marine life, including many native species. It has been identified as the recipient of the greatest number of exotic species in the world, with an average of one introduction every 4 weeks (Streftaris *et al.*, 2005). This can have significant impacts in Mediterranean ecosystems as tropical species may alter the balance of native communities, particularly if they develop an invasive character under certain conditions. For these reasons, long term monitoring programmes of infralittoral rocky habitats are essential, not only to assess the environmental status of marine benthic habitats, but also to monitor the existing species status and investigate the presence of new records and their effects on littoral ecosystems.

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Authors' contributions. Conceptualization and design of the article AM-A, JU; writing-original draft preparation AM-A, JU; writing – review AM, AS, DD-V; data acquisitions JU, AS, AM, AM-A, DD-V; data visualization AM-A, AM. All authors have read and agreed to the published version of the manuscript.

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Competing interest. None.

Data. All relevant data are within the manuscript.

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