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Research Article

The alien coral *Oculina patagonica* De Angelis, 1908 (Cnidaria, Scleractinia) in Algeria and Tunisia

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Abstract

The invasive zooxanthellate coral *Oculina patagonica* is recorded for the first time from Algeria (2005, 2007) and Tunisia (2006, 2008). Its occurrence in the Mediterranean is summarized and aspects of its biology are discussed in an attempt to understand how the new sites may have been colonized.

Key words: Algeria, invasive species, Mediterranean, Scleractinia, Tunisia

Introduction

Recording the arrival, progression, geographic distribution and impact of alien species in areas distant from their origin has become a major preoccupation in marine biology and ecology (e.g., Ruiz et al. 1997; Zibrowius 1992; Streftaris et al. 2005; Streftaris and Zenetos 2007; Zenetos et al. 2006; www.ciesm.org/online/atlas). It has long been known that certain species have been carried across the oceans by ship fouling. Dissemination by means of ballast water is considered another major factor of globalisation of marine biota. Aquaculture is responsible for many other accidental introductions. Another major cause of interchange of marine biota is man-made waterways, the sea-level Suez Canal having allowed the influx of hundreds of Red Sea species into the Mediterranean. Besides that large-scale change in faunal composition from the Suez Canal, the Mediterranean Sea is receptive to biological invasions from various other sources. This is enhanced by the basin's diversified regional climatic conditions ranging from temperate to sub-tropical (Galil 2000). The invasion of the Mediterranean has led to the production of a 3-volume atlas of alien species, each volume covering a major and "popular" zoological group (Golani et al. 2002: fishes; Galil et al. 2003: decapod crustaceans; Zenetos et al. 2003: molluscs), but it should be noted that all groups of marine life are concerned (Zibrowius 1992; Zenetos et al. 2006).

Scleractinian corals would be expected to be less prone long distal dispersal than various other groups. However, two examples are known of scleractinian corals that invaded new areas after accidental transfer related to human activities. The brightly coloured *Tubastraea* (a genus mainly represented in coral reefs in the

tropical Indo-Pacific but also reported from tropical West Africa) has invaded the Caribbean and the Gulf of Mexico during the 20th century and about two decades ago has reached Brazil (Cairns 2000; Fenner and Banks 2004; Ferreira 2003; Ferreira et al. 2004; Figueira de Paula and Creed 2004). It was argued that the arrival of *Tubastraea* (several species names have been used) in the West Atlantic was due to the petroleum industry (tankers and off shore platforms). *Tubastraea* may successfully colonize the warmer southern parts of the Mediterranean where heavily fouled platforms occasionally arrive towed in from the tropics (Mienis 2004).

In the Mediterranean Sea the first finding of an alien scleractinian was due to an amateur diver by name of Luigi Morra. In the 1960s he discovered a large colony of an encrusting zooxanthellate coral on the Ligurian coast of Italy, about one km from the harbour of Savona. Previously unknown in the Mediterranean, it was tentatively identified as *Oculina patagonica* De Angelis, 1908 and considered as a species accidentally transferred to the Mediterranean by shipping from the temperate SW Atlantic (Zibrowius 1974). The still puzzling problem is that the original description of *O. patagonica* is based on material from Holocene beach deposits some thousands of years old and that live specimens are yet to be found along the coast of temperate South America, perhaps between northern Argentina and southern Brazil. Pending the definite identification of the Mediterranean invasive coral with living South American counterparts, its present identification as *O. patagonica* remains tentative.

Some 40 years after the discovery of a large colony in Italy, probably some decades old at that time, *O. patagonica* is widely known throughout the Mediterranean: Italy (Liguria, four localities along a coastline of about 50 km; Zibrowius 1974; Zibrowius and Ramos 1983; and more recent observations); France (experimental transplantation near Marseille started in 1972; Zibrowius 1974; Zibrowius and Ramos 1983); Spain (Algeciras to Catalonia, Alboran, Cabrera and Columbretes; spreading is evident since the late 1970s when the coral was found abundant in Alicante harbour; Zibrowius and Ramos 1983; Templado and Calvo 2006; Izquierdo et al. 2007; additional records by various persons); Algeria and Tunisia (this paper); Egypt, (Alexandria area; Bitar and Zibrowius 1997; additional records by J. Laborel); Israel (various localities; Fine et al., 2001); Lebanon (various localities; Bitar and Zibrowius 1997; additional records by the same authors); Turkey (a single locality on the south-eastern coast; Cinar et al. 2006); Greece (several localities near Piraeus; Salomidi et al. 2006; additional records by M. Salomidi).

O. patagonica has been the subject of intense biological and ecological studies, particularly in Israel (e.g., Fine and Loya 2002; Fine et al. 2002; Shenkar et al. 2005; Fine and Tchernov 2007; Rodolfo-Metalpa et al. 2006). Field studies and laboratory experiments have revealed that it is hardy, able to thrive in various littoral habitats, in pristine conditions as well as in marinas, harbours and industrial environments, and in heavily polluted areas. It is known to reproduce asexually by shedding polyps (Kramarsky-Winter et al. 1997).

Observations

Observations in three localities along the Maghreb North African coast were made by SCUBA diving during four benthos surveys (Figure 1, Annex 1):

(1) Western Algeria, Habibas Islands, 1-13m, west of Oran (= Wahran), 28/06/2005-1/07/2005 (FB, 1 colony recorded); 2/05/2007-4/05/2007 (JGH, 2 colonies recorded).
(2) Northern Tunisia, Rass El Assoued (= Cap Négro), 1-2m, between Bizerte (= Banzart) and Tabarka, 22/07/2006-29/07/2006 (SS, OL, 13 colonies recorded).
(3) Northern Tunisia, Galite Island, 4m, 6/05/2008 (JGH, 1 colony recorded).

The colonies were photographed and measured in situ. Some fragments were collected to verify the in situ identification (Figure 2).

Algeria, Habibas Islands. Two colonies were found, each at a different site in these small islands ca. 9 km off the mainland. (a) Lighthouse cove, 0.7-1.0 m depth, on the vertical wall of a small damaged quay now partially excavated by the sea. The rather large encrusting colony (width: 52 cm), observed in 2005 and 2007, formed a prominent rim along the upper edge of one of the cavities and extends inside on the roof over a distance of 28-38 cm from the edge (Figure 3). The colony surface was estimated to be about 1900 cm^2. (b) Cove on the opposite side of the main island (Dead Woman's cove = Baie de la Morte), 13 m depth, on a sub-horizontal

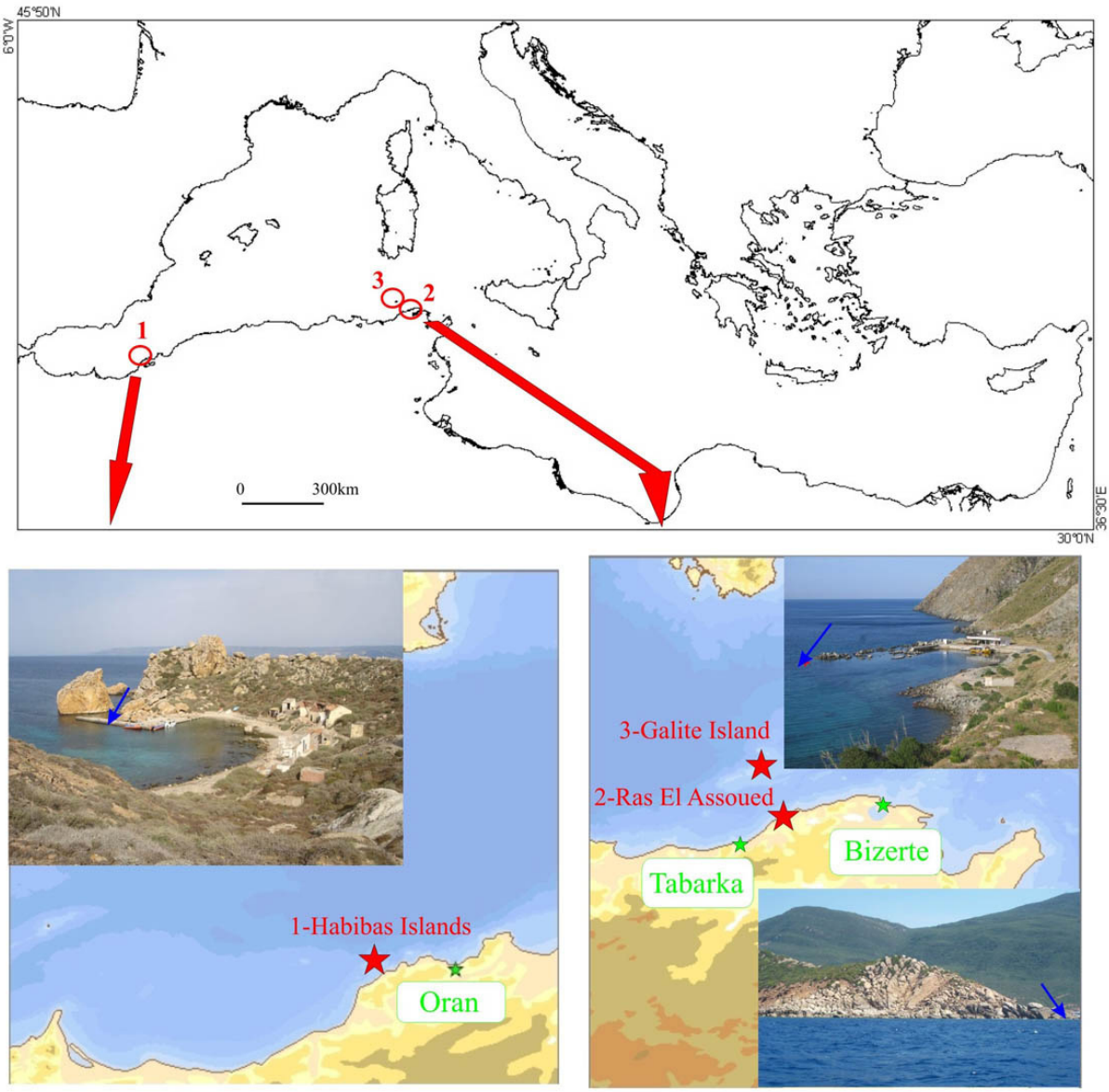

Figure 1. *Oculina patogonica* – new sites in Algeria and Tunisia detailed in inserts (arrows). Photographs by Jean-Georges Harmelin (Habibas, Galite) and Stéphane Sartoretto (Ras El Assoued).

rocky bottom covered by a rich assemblage of photophilic algae. This colony, discovered in 2007, formed a hemispherical mound about 15 cm in height and 20-25 cm in diameter, but possibly in the centre covered some more prominent part of the substrate (Figure 3). It showed a white scar of denuded skeleton about 7 cm wide, probably the result of a recent impact by some heavy object, perhaps the anchor of fishing boat.

In addition to common photophilic algae (e.g., *Dictyota* spp.; *Sphaerococcus coronopifolius* Stackhouse, *Stypocaulon scoparium* (Linnaeus) Kützing) three non-indigenous algae were found to co-occur with the coral: *Asparagopsis armata* Harvey, *A. taxiformis* (Delile) Trévisan de Saint-

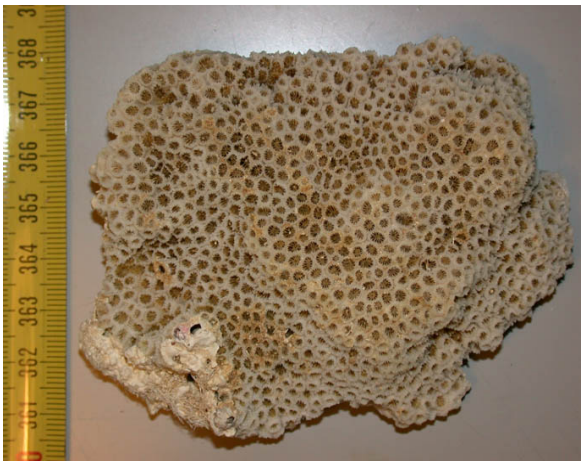

Figure 2. *Oculina patagonica*, colony sampled at Rass El Assoued (Tunisia). Photograph by Helmut Zibrowius.

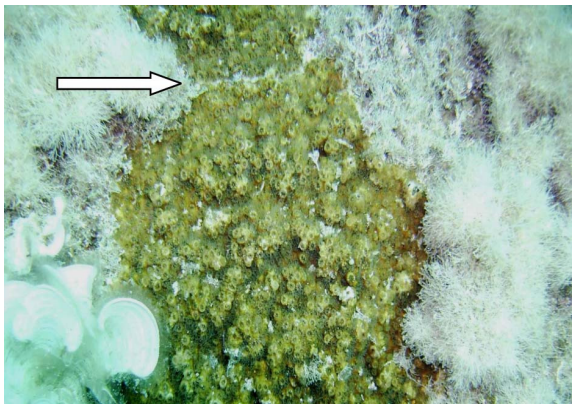

Figure 4. *Oculina patagonica*, Rass El Assoued (Tunisia), two colonies almost in touch (white arrow), ready to fuse if genetically identical, i.e., if resulting from asexual cloning. Photograph by Stéphane Sartoretto.

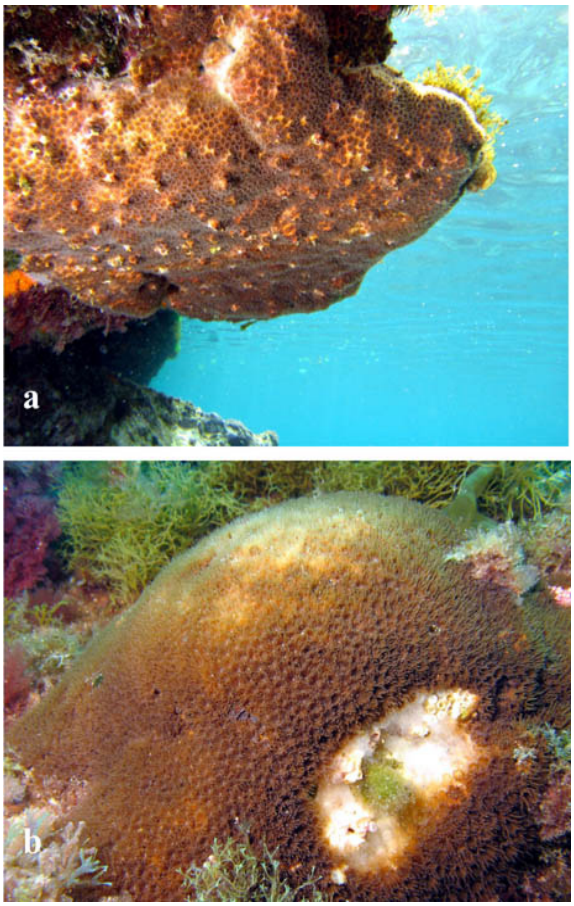

Figure 3. *Oculina patagonica*, two colonies at Habibas Islands (Algeria). **a**: small quay of Lighthouse cove, **b**: Dead Woman's cove. Photograph by Jean-Georges Harmelin

Léon and *Codium fragile* (Suringar) Hariot. The *Asparagopsis* species were common (especially *A. taxiformis*) from 1 to ca. 30 m, the *Codium* relatively rare (observation in summer). The bright orange scleractinian *Astroides calycularis* (Pallas, 1766) was common on the vertical walls and under small overhangs which are less exposed to light.

The near-surface temperature noted in late June 2005 was 24°C.

Tunisia, Rass El Assoued. At least 13 encrusting colonies, some of them more massive, were found on large boulders at 1-2 m depth. They tended to be circular, are 10 to 40 cm in diameter, with a surface area estimated as 80-1200 cm^2. In some cases, closely aggregated colonies may have been ready to fuse (Figure 4).The assemblage surrounding the coral colonies was dominated by photophilic algae (*Acetabularia acetabulum* (Linnaeus) P.C. Silva, *Cladostephus* spp., *Dictyota fasciola* (Roth) J.V. Lamouroux; *Dictyota spiralis* Montagne, *Padina pavonica* (Linnaeus) Thivy). As at the Habibas Islands, *Astroides calycularis* was common on the vertical walls and under small overhangs, where light is reduced (Figure 5).

The near-surface temperature noted in late July 2006 was 28°C.

Tunisia, Galite Island. One colony was found at 4 m depth encrusting the vertical surface of a large boulder which had been part of a jetty destroyed by particularly heavy storms (the last one said to have occurred in 2000). The colony covered an approximately rectangular surface of 35 cm in vertical and 41 cm in horizontal

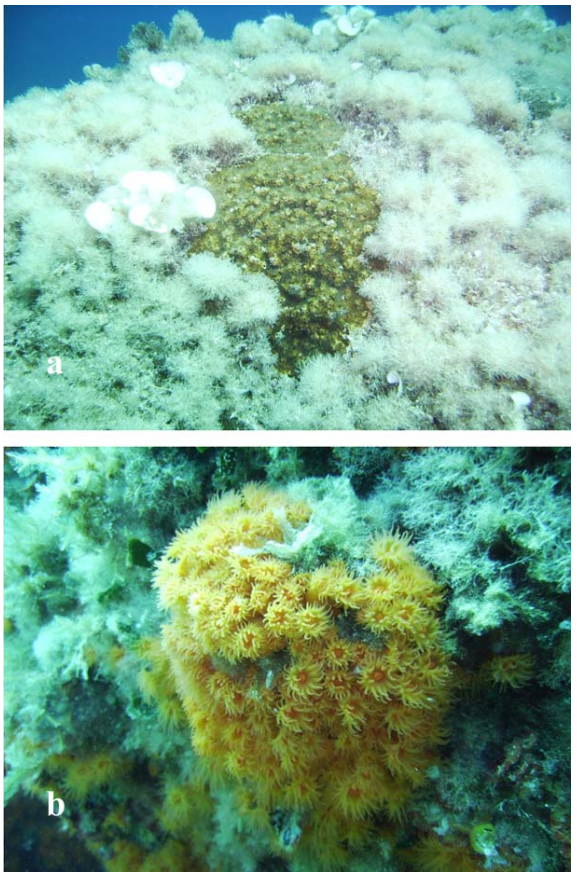

Figure 5. Rass El Assoued (Tunisia). **a**: Photophilic algae community surrounding the same pair of almost in touch *Oculina patagonica* colonies. **b**: *Astroides calycularis* as typical on more shaded rock surfaces. Photograph by Stéphane Sartoretto.

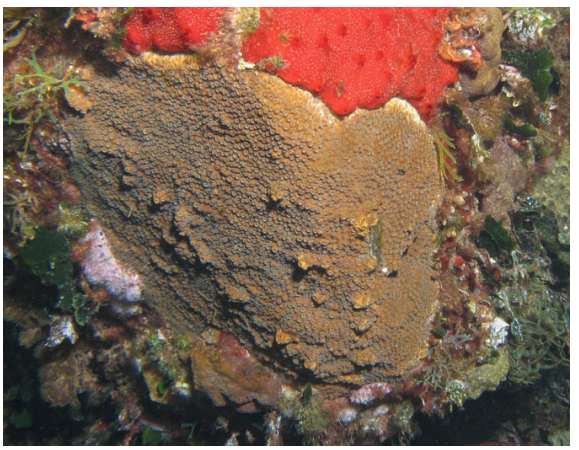

Figure 6. *Oculina patagonica* colony at Galite Island (Tunisia). Photograph by Jean-Georges Harmelin.

extension (Figure 6). The surrounding assemblage included algae (*Asparagopsis taxiformis*, *Dictyota* sp.; *Flabellia* sp.; *Peyssonnelia* sp.; *Valonia* sp.) and demosponges (*Chondrosia reniformis* Nardo, 1847, *Hamigera hamigera* (Schmidt, 1862)). The non-indigenous *A. taxiformis* was observed from 5 to 24 m depth. The near-surface temperature noted in early May 2008 was about 18°C.

Discussion

The type of habitat where *O. patagonica* was observed in Algeria and Tunisia (infralittoral rock, photophilic algae community) conforms to observations made elsewhere in the Mediterranean Sea. In both areas the coral colonies are encrusting, thicker in the centre with a thin edge spreading over the substrate, soft tissues brownish as common in zooxanthellate corals (including the indigenous zooxanthellate *Cladocora caespitosa* (Linnaeus, 1767)).

In the Mediterranean, *O. patagonica* is an invasive species adapted to shallow-water habitats in both pristine and polluted areas. Its dissemination and proliferation is favoured by a combination of biological features, such as sexual and asexual reproduction, early reproductive age, and high growth rate (Fine et al. 2001). It is an "opportunistic dominant settler" overgrowing the calcareous structures of serpulids, vermetids, barnacles, etc., and eliminating algae and other soft organisms at its growing edge. It out-competes the indigenous *Cladocora caespitosa* which is overgrown when the two species come into contact (HZ, observations in south-eastern Spain and on the Ligurian coast of Italy).

Monitoring colonies in Israel showed a linear mean growth rate of about 0.60-0.75 cm year^{-1} (Fine et al. 2001). Extrapolation on the basis of transplantation experiments at Marseille gave a value slightly lower than 1 cm year^{-1} (HZ). Thus, a circular colony of 20 cm in diameter having grown regularly may be about 15 years old. The age of larger, irregular colonies is more difficult to estimate. Asexual reproduction can result in a clone of genetically identical crowded colonies, which are ready to fuse when in contact. Likewise, perfect fusion into a large colony has been obtained experimentally at Marseille using individual colonies that had been produced by transplanting fragments from one parent colony (HZ). Thus, the largest colonies observed at the

Algerian and Tunisian sites are probably only a few decades old. This conforms to our present ideas about a rather recent and on-going spread of *O. patagonica* in the Mediterranean Sea.

Historically speaking, two aspects should be distinguished. The history of discovery of *O. patagonica* sites may be independent of the invasion and spreading of the species itself. The very first discovery was from Liguria (Italy), but soon afterwards when many sites with abundant colonies became known from Spain, it was concluded that colonization of Spain had started at an earlier date (Zibrowius and Ramos 1983). The presence in Egypt (Alexandria area) can be dated to 1981, but the first small Alexandrian sample was published much later (Bitar and Zibrowius 1997), jointly with information on several localities in Lebanon. The species was recognized in Israel in 1994, but according to the then-observed colony size it had already been present for perhaps two or three decades (Fine et al. 2001). It should be kept in mind that the sequence of discovered sites does not necessarily illustrate the advancing front of the invader and that the colonies discovered up to the present are surely not the only ones in the respective areas.

O. patagonica may have been present for a long time in southern Spain when first recorded (Zibrowius and Ramos 1983). Lately it has even been reported from isolated Alboran Island, which at the scale of the Mediterranean is relatively close to the Algerian Habibas Islands. Given the presence of the coral at the eastern end of the Mediterranean for at least several decades, its discovery along the Maghreb North African coast is not a surprise. The intriguing question is: how did the species arrive in these Algerian and Tunisian sites where there is still little, immediate, human impact? However, the answer must await further research.

The Habibas Islands is a rather pristine site (now a protected area), with only the lighthouse keeper as a permanent resident, but it is relatively close to Oran (Wahran) and Arzew (Arziw), both important commercial ports. Thus, contrary to first impressions, the islands may be more exposed to larval transport by commercial shipping or to the larval flow from some older population upstream of the dominant local water circulation. Introduction by boats mooring around the islands is conceivable too. The lighthouse cove is mainly used by small fishing boats crossing over from mainland ports that possibly shelter populations of the coral.

Similar ways of introduction can be speculated for the presence of the coral populations in Tunisia, at Rass El Assoued and Galite Island. Commercial shipping occurs off the northern coast of Tunisia. Fishing boats and yachts occasionally shelter in a cove near Rass El Assoued, which over a large distance is the only sheltered place on a coast largely exposed to northern winds. The nearest fishing ports are Tabarka 40 km to the west and Sidi Mechreg about 20 km to the east. The site is far from any major harbour zone, Bizerta being 70 km to the east. Conditions are similar at Galite Island, about 40 km distant from Rass El Assoued, with only a small permanent human population. The bay on the south side of the main island where the colony of *O. patagonica* was found is the only shelter when northern winds are blowing, and it is regularly visited by fishing boats from Tabarka, Sidi Mechreg, Bizerte, or even from Italy. Most of these (up to 13 boats at a time observed in May 2008), and occasionally yachts calling during summer, lay at anchor in the bay, while only 2 or 3 boats may stay alongside the partly destroyed jetty. Presently, fishing is prohibited within 1.5 miles from land.

In the Levant area, the warmest part of the Mediterranean, *O. patagonica* has suffered seasonal bleaching events in recent years, caused by temperatures exceeding 29°C for a longer period, with the combined effects of bacterial proliferation (Fine et al. 2001). During occasional observations of the coral in summer at the Algerian and Tunisian sites no such bleaching was noticed. The near-surface temperature measured (24°C at Habibas Islands, 28°C at Rass El Assoued) was not yet critical and was similar to or even higher than that reported previously from the respective areas. For the Habibas Islands, Grimes et al. (1999) had recorded a mean near-surface temperature of 23.67 ± 0.38°C in summer and a mean salinity of 36.31 ± 0.36 psu. The latter values attest to the Habibas Islands being influenced by the Atlantic water inflow through the Straits of Gibraltar. For the northern coast of Tunisia, with a more attenuated effect of the Atlantic inflow, old data (Azouz 1973) indicated an annual temperature range of 14.4-22.4°C and of salinity of 36.7-37.5 psu. The discovery of colonies at Habibas Islands, Rass El Assoued and Galite Island strongly suggests that a thorough survey of the Algerian and Tunisian coasts would probably disclose additional populations of the coral.

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Annex 1
Records of *Oculina patagonica* in Algeria and Tunisia

Map reference	Location	Depth	Geographic coordinates *		Record Date	Observer
			Latitude, N	Longitude, W		
1	Habibas Islands	1-13 m	35°44'04"	01°06'55"	June 2005 May 2007	F Bachet JG Harmelin
2	Ras El Assoued	1-2 m	37°06'14"	08°58'41"	July 2006	S Sartoretto O Lebrun
3	Galite Island	4 m	37°31'22"	08°56'14"	May 2008	JG Harmelin

* Geographic coordinates are based on Google Earth data