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## Review of alien marine macrophytes in Tunisia

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### Abstract

In the present study, the list of alien marine macrophytes introduced into Tunisia was updated in light of available data and new observations. A total of 27 alien marine macrophytes has been recorded so far from Tunisia: 18 Rhodophyta, 3 Ochrophyta, 5 Chlorophyta and 1 Magnoliophyta. For each species, the locality (-ies), the year (or) period and the source of the first observation in Tunisia are given. The distribution and the status (casual, cryptogenic, established or questionable) of species in Tunisia were evaluated and, where appropriate, discussed. Among them, *Hypnea cornuta* is reported for the first time from Tunisia. Fourteen alien marine macrophytes are established, whereas seven cryptogenic and two casual species require further investigation. Eleven species are considered as invasive or potentially invasive in the Mediterranean Sea: *Acrothamnion preissii*, *Asparagopsis armata*, *A. taxiformis* Indo-Pacific lineage, *Hypnea cornuta*, *Lophocladia lallemandii*, *Womersleyella setacea*, *Caulerpa chemnitzia*, *C. cylindracea*, *C. taxifolia*, *Codium fragile* subsp. *fragile* and *Halophila stipulacea*. Finally, the case of four questionable species is also discussed.

**Keywords:** Alien, invasive species, marine macrophytes, *Hypnea cornuta*, Tunisia, Mediterranean.

### Introduction

Biological invasions are now recognized as a major agent of global change, following the spectacular increase in invasions by alien marine and estuarine species in various regions of the world (Occhipinti-Ambrogi, 2007). The Mediterranean Sea is one of the regions worldwide which is most severely affected by alien marine invasions, fostered by the opening of the Suez Canal, fouling and ballast transportation along shipping lines, aquaculture, the aquarium trade and global climate change (Zenetos *et al.*, 2010, 2012). The number of alien marine species reported so far from the Mediterranean Sea has almost reached 1,000 (approximately 6% of the total flora and fauna; Hoffman, 2014). The vast majority of alien species (775) occur in the eastern Mediterranean basin, whereas a lower number of species are known for the western Mediterranean (308) and the central Mediterranean (249) and, to an even lesser degree, for the Adriatic Sea (190) (Zenetos *et al.*, 2010, 2012). The origin of these species is mainly the Red Sea, followed by the Indo-Pacific and the Atlantic oceans (Zenetos *et al.*, 2012).

As far as marine macrophytes are concerned, a total of 133 species have been listed as possible aliens; of these 23 belong to the Chlorophyta, 79 to the Rhodophyta, 30 to the Ochrophyta, and one is a seagrass species (Magnoliophyta) (Verlaque *et al.*, 2015).

With more than 1,400 km of coastline, and located at the crossroads between the different Mediterranean basins, Tunisia occupies a key position in the context of the Mediterranean Sea. The Tuniso-Sicilian strait is the passageway from south to north and from east to west, and is crucial in the analysis of the spread of alien species introduced into the Mediterranean Sea.

During the last decade, the monitoring of marine aliens in the Mediterranean Sea has attracted strong interest from the scientific community, international organizations, and has been the focus of environmental programs (Marine Strategy Framework Directive, the European Strategy for Marine and Maritime Research, the Marine Spatial Planning and the Ecosystem Approach within the Barcelona Convention by UNEP/MAP, as well as many initiatives of the UNEP RAC/SPA). However, records of alien marine species from Tunisia are sparse and scat-

tered. Because of the large stretch of coastline and lack of research programs focusing on the subject, there are many gaps in the knowledge of alien marine species.

The aim of this paper is to provide a robust baseline for the monitoring of alien marine macrophytes (hereafter AMM) of Tunisia through a critical compilation of all the available historical data. In parallel, several dedicated field surveys were conducted along the coast to search for AMM and to establish their current distributions. Results will be presented online on the Marine Mediterranean Invasive Alien Species (MAMIAS) database (UNEP-MAP RAC/SPA, 2015), and questionable records are discussed.

## Materials and Methods

### Compilation of the available historical data

The list of AMM reported from Tunisia was critically established on the basis of a compilation of existing information/observations (scientific and grey literature, newspapers, online databases, internet forums and unpublished data from regional experts). Native range, locality (-ies) and date (year or period) of first sighting (or of the first publication in few cases) in Tunisia, and the status of the alien (casual, cryptogenic, established or questionable) according to Zenetos *et al.* (2010) were evaluated for each species. Casual species are those having been recorded only once. Cryptogenic species are species with no definite evidence of their native or introduced status. Established species are species known from more than two Tunisian localities or records. Finally, questionable species are species with insufficient information. The species considered as invasive are species that can have an obvious ecological and/or economic impact.

### Field studies

Sixty-seven sampling sites distributed along the whole of the Tunisian coastline were investigated, from July 2009 to April 2014 (Fig. 1, Table 1). At each site, a standardized one-hour transect was surveyed by snorkeling or/and SCUBA diving in the depth range 0 to 30 m depth. All the AMM present were listed and, if necessary, collected for confirmation in the laboratory.

The following voucher specimens were deposited in the Verlaque Herbarium (HCOM), Marseille, France, with references: *Hypnea cornuta* (Kützting) J. Agardh, H8272, dried and wet specimens preserved in 4% buffered formalin/seawater, Sidi Jmour, Jerba, Tunisia, 13/8/2014, coll. J.M. Astier. *Acanthophora nayadiformis* (Delile) Papenfuss, H8273, dried specimen, Sidi Jmour, Jerba, Tunisia, 13/8/2014, coll. J.M. Astier.

### Mapping

The updated range expansion in Tunisia was established for each alien species, taking into account both already available data and new records. In the distribution

maps, when there was a series of sightings ( $> 5$ ) with a maximum distance between consecutive sightings of less than 50 km, it was assumed that the species was present along the entire coastline and its distribution was depicted by a continuous line. In all the other cases, sightings of species were depicted by symbols.

## Results

During our survey along the 1400 km of the Tunisian coast, ten AMM were encountered at 70.1% of sampling sites: *Acanthophora nayadiformis*, *Asparagopsis armata*, *A. taxiformis*, *Hypnea cornuta*, *Lophocladia lallemandii*, *Caulerpa chemnitzia*, *C. cylindracea*, *C. taxifolia*, *Codium fragile* subsp. *fragile* and *Halophila stipulacea* (Table 1).

*Hypnea cornuta* is reported for the first time from Tunisia. Our specimens are well characterized by their habit and the presence of stellate vegetative propagules on the axes (Fig. 2). Sexual reproductive structures were not observed. The species was only found in Jerba in 2014.

On the basis of the available literature and field surveys, a total of 27 AMM is listed for Tunisia: 18 Rhodophyta, 3 Ochrophyta, 5 Chlorophyta and 1 Magnoliophyta (Table 2). For four species, *Bonnemaisonia hamifera* in 1909, *Gracilaria arcuata* in 1934, *Caulerpa chemnitzia* in 1926 and *Caulerpa cylindracea* in 1985, their discovery in Tunisia constitutes the first reports of each species in the Mediterranean Sea.

The main putative donor regions are the Red Sea and the Indo-Pacific province (Table 2). Only two species, *Chondria coerulescens* and *Polysiphonia fucoides*, have a distribution restricted to the Atlantic Ocean and the Mediterranean Sea. The other Atlantic species are also present in the Indo-Pacific Ocean. Among these 27 species, we found two casual, seven cryptogenic, 14 established and four questionable species (Table 2).

The first casual species is *Hypnea cornuta*, hitherto only known from Jerba, and the second is the Red Sea Rhodophyta *Gracilaria arcuata* that was originally described from the Red Sea (Gulf of Aqaba; Zanardini, 1858). Seven species, *Acanthophora nayadiformis*, *Anotrichium okamurae*, *Chondria coerulescens*, *Colaconema codicola*, *Polysiphonia atlantica*, *P. fucoides* and *Pylaiella littoralis*, are regarded as cryptogenic species. *Acanthophora nayadiformis* was found for the first time at Jerba.

The status of the Atlantic species *Griffithsia corallinoides*, which was collected in the Bizerte Lagoon, was not considered as cryptogenic but established because an introduction via oyster transfers is highly probable as in the case of the French lagoon of Thau (Verlaque, 2001).

The distribution of AMM (casual, cryptogenic and established) differs according the different areas in Tunisia (Figs 3 & 4). The northern zone has received the highest number of AMM (18 species of which 14 are Rhodophyta and four are Chlorophyta) compared to the



**Fig. 1:** Location of sampling sites in Tunisia. The characteristics of site numbers are given in the Table 1.

central zone (10 species of which five Rhodophyta, four Chlorophyta and one Magnoliophyta), and the southern zone (11 species: seven Rhodophyta, one Ochrophyta, two Chlorophyta and one Magnoliophyta).

On the basis of certain characteristics, such as fast dynamics in areas of introduction, development of dense populations, intense vegetative multiplication, production of repellent metabolites, broad ecological niches and obvious ecological and/or economic impact, 11 species are considered as invasive or potentially invasive in the Mediterranean Sea: *Acrothamnion preissii*, *Asparagopsis armata*, *A. taxiformis*, *Hypnea cornuta*, *Lophocladia lallemandii*, *Womersleyella setacea*, *Caulerpa chemnitzia*, *C. cylindracea*, *C. taxifolia*, *Codium fragile* subsp. *fragile* and *Halophila stipulacea* (Table 2). All of these are widely distributed along the Tunisian coasts except for *A. preissii*, *H. cornuta* and *W. setacea* (Fig. 2).

*Asparagopsis armata* was found at El Kantaoui at 1m depth on rocks. The gametophytic phase of *A. taxiformis* was recorded at eight sampling sites out of 67 (11.9 %).

*Lophocladia lallemandii* was found at 12 sampling sites out of 67 (17.9%). It was well established in the Gulf of Gabes (Kerkennah Islands, 1-13 m depth; eastern Jerba, 4-25m depth) where it was very abundant in July 2009 and 2010 on disturbed and dead *Posidonia oceanica* (Linnaeus) Delile meadows and *Cymodocea nodosa* (Ucria) Ascherson meadows. *Caulerpa chemnitzia* was found at Monastir. Given the features common to all species of *Caulerpa* (mainly: vegetative multiplication, holocarp, repellent secondary metabolites, permanent and dense meadows), this species is considered as potentially invasive for Tunisia. *Caulerpa cylindracea* was the most frequent AMM, with an occurrence at 34 sampling sites out of the 67 (50.7%). Locally abundant, it grew on soft substrates, dead *Posidonia oceanica* meadows, and in small patches (ca. 2 m<sup>2</sup>) on rocky substrates. In the Gulf of Gabes, *C. cylindracea* was very common between 0 and 15 m depth on disturbed *P. oceanica* meadows and *C. nodosa* meadows, especially in the south and west of Kerkennah, whereas it was rare at Jerba between

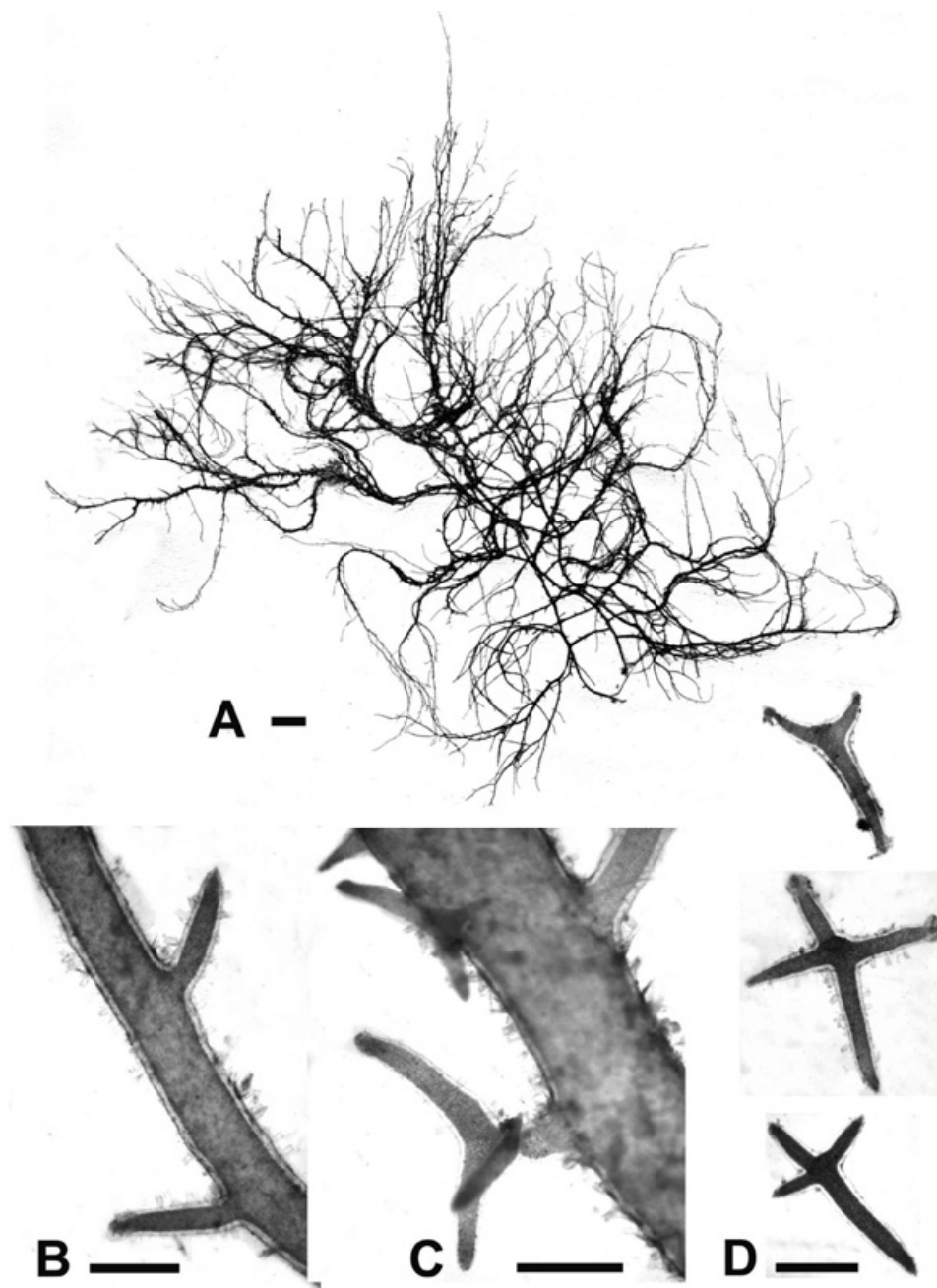
**Table 1.** Sampling sites in Tunisia: GPS coordinates, date, depth, substrate and alien marine macrophytes (AMM) observed. (An: *Acanthophora nayadiformis*; Aa : *Asparagopsis armata*; At : *Asparagopsis taxiformis*; Hc : *Hypnea cornuta*; Ll : *Lophocladia lallemandii*; Cch : *Caulerpa chemnitzia*; Ccy : *Caulerpa cylindracea*; Ct : *Caulerpa taxifolia*; Cf: *Codium fragile* subsp. *fragile* and Hs : *Halophila stipulacea*).

Locality (north to south Tunisia)	Coordinates (Lat. N - Long. E)	Date	Depth (m)	Substrate	Alien marine macrophytes
1 Malloula	36.9628-08.7139	July 2010	0-5	Sand/Rock	
2 TabarkaBay	36.9708-08.7400	June 2010	0-8	Sand	
3 TabrakaCap	36.9603-08.7556	June 2010	0-15	Sand/Rock	
4 Tabarka Fort	36.9631-08.7628	June 2010	0-10	Sand/Rock	
5 Sounine	37.2114-10.1811	July 2010	0-5	Sand	
6 Rafraf - Ras Blat	37.1969-10.2089	July 2010	0-5	Sand/Rock	Ccy, At
7 Rafraf - Ras Ettarf	37.1822-10.2653	July 2010	0-5	Sand	At
8 Ghar El Melh lagoon	37.1625-10.2147	July 2010	0-2	Sand/Mud	Ccy
9 La Marsa	36.8956-10.3219	May 2011	0-5	Sand/Rock	Ccy
10 Sidi Bou Saïd	36.8661-10.3519	April 2014	0-1	Rock	
11 Salamambo Port punique	36.8447-10.3272	April 2014	0-2	Rock	
12 Le Kram	36.8294-10.3181	April 2014	0-3	Rock	
13 La Goulette	36.8172-10.3081	April 2014	0-4	Rock	
14 Sidi Rais	36.7703-10.5483	July 2010	0-6	Sand	Ccy
15 Hammamet	36.3956-10.5819	July 2010	0-7	Sand	Ccy
16 Hergla City	36.0353-10.5053	June 2010	0-5	Sand	Ccy
17 Hergla - Falaise	36.0017-10.5231	June 2010	0-5	Sand/Rock	
18 Chott-Mariem Aquaculture	35.9650-10.5403	July 2012	0-5	Sand/Rock	Ct,Cf
19 Chott-Mariem	35.9394-10.5603	July 2010	0-7	Sand	Ccy, Ct, At, Cf
20 Tantara	35.9283-10.5728	July 2013	0-7	Sand	At, Ct
21 El Kantaoui	35.9033-10.5914	March to Dec. 2012	0-8	Dead matt/Sand	Ccy
22 El Kantaoui	35.8983-10.5961	March to Dec. 2012	0-8	Dead matt/Sand	At
23 El Kantaoui	35.8919-10.6006	March to Dec. 2012	0-8	Dead matt/Sand/Rock	At,Ct,Ccy,Cf,Aa
24 El Kantaoui	35.8772-10.6053	March to Dec. 2012	0-8	Sand	Ccy
25 Monastir Dkhila	35.7772-10.7736	July 2010	0-5	Sand	Ct, Ccy
26 Monastir Marina Cap	35.7789-10.8353	May 2011	0.5-2	Sand/Muddy sand	Ccy, Hs, At
27 Monastir Climant	35.7900-10.8383	August 2013	20-25	Rock/Muddy sand	
28 Monastir - Karraïa	35.7739-10.8378	May 2011	0-5	Sand	At, Cch
29 Kuriat Island	35.7650-11.0075	July 2010	0-1	Sand	Ccy
30 Kuriat Island	35.7661-11.0142	July 2010	0-5	Sand	Ccy
31 Kuriat Island	35.7978-11.0233	July 2010	0-3	Sand	Ccy
32 Kuriat Island	35.8033-11.0286	July 2010	0-3	Sand/Rock	At
33 Bekalta	35.6333-11.0400	July 2010	0-1	Sand	
34 Kerkennah Islands - Abbassya	34.7097-11.2408	July 2010	0-1	Sand	
35 Kerkennah Islands – Ouled Yaneg	34.6725-11.1458	July 2010	0-1	Sand	
36 Kerkennah Islands – Ouled Ezzedine	34.6447-11.0903	July 2010	0-1	Sand	
37 Kerkennah Islands - Allama	34.6128-11.0478	July 2010	0-1	Sand	Hs, Ccy
38 SE Kerkennah Islands	34.6650-11.2769	July 2009	1.0	Muddy sand/ <i>C. nodosa</i> meadow	Ccy
39 SE Kerkennah Islands	34.6872-11.3894	July 2009	1.3	Muddy sand/ <i>C. nodosa</i> meadow	Ccy, Ll
40 SE Kerkennah Islands	34.6414-11.2797	July 2009	11.9	Dead <i>P. oceanica</i> meadow/Sand	Ccy
41 SW Kerkennah Islands	34.4383-11.0917	July 2009	30.4	Muddy-Sand	Ccy
42 Kerkennah Islands Al Attaya	34.6869-11.3906	July 2010	1.5	<i>P. oceanica</i> meadow	Ccy, Hs
43 SE Kerkennah Islands	34.6517-11.2717	July 2010	6.6	<i>P. oceanica</i> meadow	Ccy, Ll
44 SW Kerkennah Islands	34.5044-11.0164	July 2010	12.4m	<i>P. oceanica</i> meadow	Ccy, Ll
45 SW Kerkennah Islands	34.5944-11.2756	July 2010	20.4m	Muddy sand	Ccy
46 Kneiss Islands	34.3719-10.3183	July 2010	0-1	Sand	
47 Kneiss Islands Jaboussa	34.3472-10.2094	July 2010	1.0	Muddy sand	Hs
48 W-Jerba	33.7831-10.7231	July 2009; 2014 (for Hc)	8.2	Rock/sand/ <i>C. nodosa</i> meadow	An, Hc, Ccy
49 W-Jerba	33.9475-10.6381	July 2009	15.2	Dead <i>P. oceanica</i> meadow/Sand	Ll
50 W-Jerba	33.9550-10.6928	July 2010	13.5	Dead <i>P. oceanica</i> meadow	Ccy
51 E-Jerba	33.7494-11.0139	July 2009	4.2	<i>C. nodosa</i> & <i>P. oceanica</i> patches	Ll
52 E-Jerba	33.8086-11.0631	July 2009	6.9	<i>C. nodosa</i> & <i>P. oceanica</i> patches	Ll
53 E-Jerba	33.7161-11.1358	July 2009	20.4	Dead <i>P. oceanica</i> meadow	Ccy, Ll
54 E-Jerba	33.8936-11.1256	July 2009	25.0	Dead <i>P. oceanica</i> meadow	Ccy, Ll
55 E-Jerba	33.7492-11.0139	July 2009	4.2	<i>C. nodosa</i> meadow/Coarse sand	Ll

(continued)

**Table 1.** (continued)

	Locality (north to south Tunisia)	Coordinates (Lat. N - Long. E)	Date	Depth (m)	Substrate	Alien marine macrophytes
56	E-Jerba	33.8931-11.0947	July 2009	19.6	Dead <i>P. oceanica</i> meadow	Ccy
57	E-Jerba	33.7261-11.1753	July 2009	25.8	Dead <i>P. oceanica</i> meadow	Ccy
58	E-Jerba	33.7814-11.0658	July 2010	4.4	Rock/ <i>P. oceanica</i> meadow	Ccy, Ll
59	E-Jerba	33.8119-11.0922	July 2010	8.8	Dense <i>P. oceanica</i> meadow	Ll
60	E-Jerba	33.8136-11.1086	July 2010	14.6	Sparse <i>P. oceanica</i> meadow	Ll
61	E-Jerba	33.7572-11.1097	July 2010	17.1	Dead <i>P. oceanica</i> meadow	Ccy
62	Jerba Island - Ajim	33.7417-10.7342	July 2010	0-1	Sand	Ccy
63	Jerba Island - Borj Jeliz	33.8889-10.7467	July 2010	0-1	Sand	
64	Bou Ghrara Lagoon	33.6914-10.7428	July 2009	2.0	<i>Caulerpa prolifera</i> meadow	Ccy
65	Bou Ghrara Lagoon	33.6222-10.9303	July 2010	0-1	Sand	
66	El Bibane Lagoon - Jedeiria	33.2869-11.2667	July 2010	0-1	Sand	
67	El Bibane Lagoon - Ben Guerdane	33.1950-11.3006	July 2010	0-1	Sand	



**Fig. 2:** *Hypnea cornuta* (Kützting) J. Agardh, specimens H8272. A. Dried specimen. B. Axis with young branches. C. Stellate vegetative propagules on the axis. D. Three detached stellate vegetative propagules. Scale bars: A = 1 cm; B-D = 500  $\mu$ m.

**Table 2.** Alien marine macrophytes introduced in Tunisia with the native range, the locality and the date of first sighting, with references. Abbreviations: Atl = Atlantic Ocean; Cos = Cosmopolite; Ind = Indian Ocean; Pac = Pacific Ocean; Pan = Pan-tropical; Ques = Questionable; RS = Red Sea; Cas = Casual; Cry = Cryptogenic; Est = established. \*: Species potentially invasive for Tunisia.

note <sup>1</sup>: Athanasiadis (1996) separated two other introduced species, *A. boergeseni* (Cormaci & Furnari) Athanasiadis and *A. sublittoralis* (Setchell & Gardner) Athanasiadis, from *A. elegans*. It is not possible to say if other members of this species complex have been introduced in Tunisia.

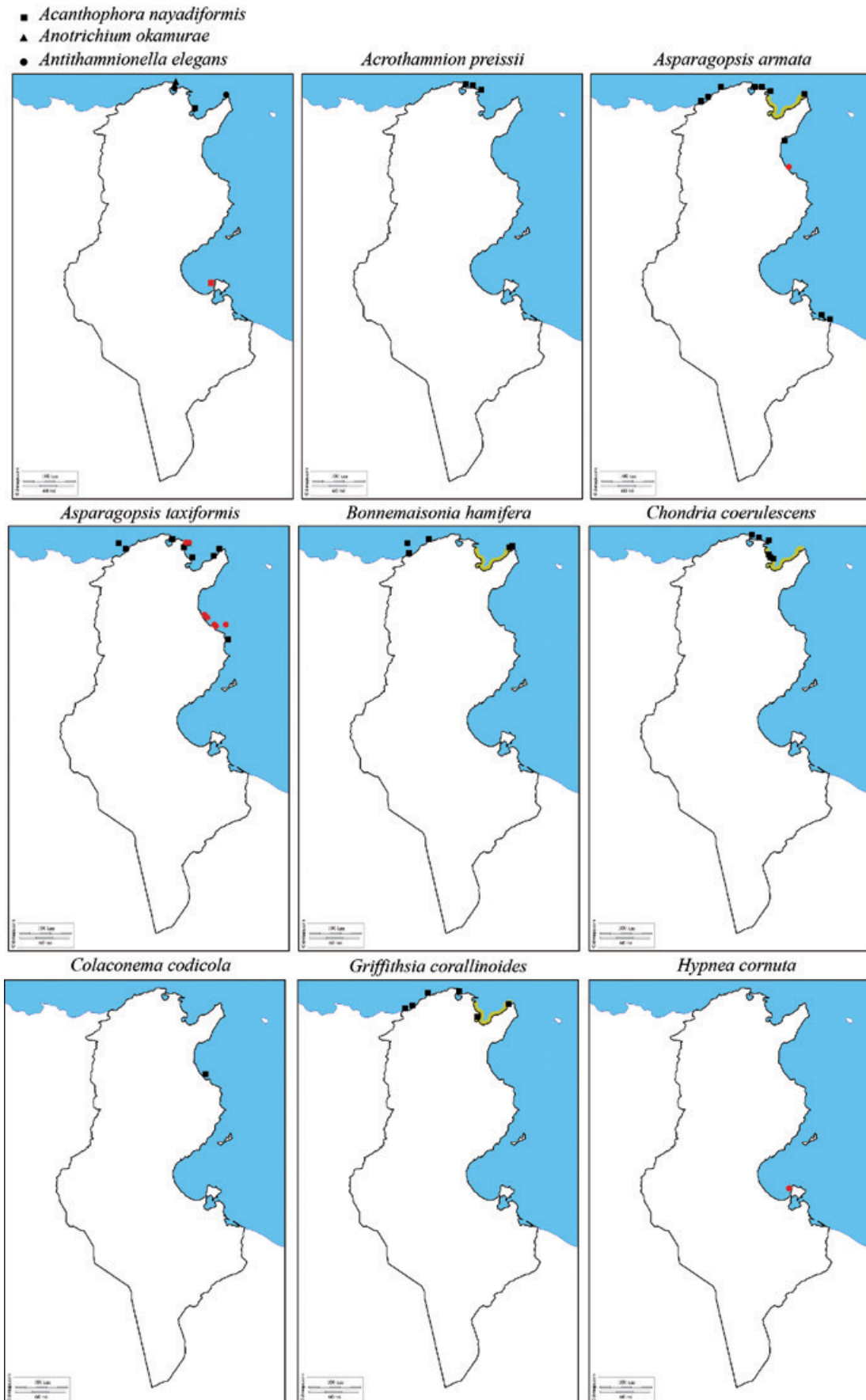
Species	Native range	First sighting	North Tunisia (Western Mediterranean)		Central-South Tunisia (Central Mediterranean)		
			Status	References	First sighting	Status	References
<b>Rhodophyta</b>							
<i>Acanthophora nayadiformis</i> (Delile) Papenfuss = <i>A. delilei</i> J.V. Lamouroux	RS - Pan	Carthage, 1931	Cry	Feldmann, 1937; Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	Jerba, 2009	Cry	Present study
<i>Acrothamnion preissii</i> (Sonder) E.M. Wollaston *	Ind - Pac	Bizerte, Cap Zebib, Raf-Raf, 2005-2006	Est	Zerzeri <i>et al.</i> , 2010			
<i>Anotrichium okamuruae</i> Baldock as <i>Neomonospora furcellata</i> ; Feldmann-Mazoyer and Meslin	Pac	Bizerte, 1926	Cry	Herbier J. Feldmann, sonneratphoto.mmhn.fr, 1938; Ben Maiz <i>et al.</i> , 1987			
<i>Anthamionella elegans</i> (Berthold) J.H. Price & D.M. John = <i>Anthamion elegans</i> Berthold <sup>1</sup>	Pac	Zembra, 1969	Est	Boudouresque, 1970; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995; Djellouli <i>et al.</i> , 2000; Boudouresque <i>et al.</i> , 2006			
<i>Asparagopsis armata</i> Harvey *	Ind - Pac	Cap Serrat, 1973-1975	Est	Meñez & Mathieson, 1981; Ben Maiz & Boudouresque, 1986; Ben Maiz, 1995; Boudouresque <i>et al.</i> , 2006; Shili <i>et al.</i> , 2010; Zerzeri <i>et al.</i> , 2010; present study	Hammamet, 1985	Est	Ben Maiz <i>et al.</i> , 1987
<i>Asparagopsis taxiformis</i> (Delile) Trevisan de Saint-Léon *	Ind-Pac	North coast, 2009	Est	Shili <i>et al.</i> , 2010; present study	Mahdia, 2003	Est	Andreakis <i>et al.</i> , 2004, 2007, 2009; present study
<i>Bonnemaisonia hamifera</i> Harriot = <i>Trailiella intricata</i> Batters	Pac	La Galite, 1909	Est	Petersen, 1918; Feldmann, 1931; Meñez & Mathieson, 1981; Ben Maiz & Boudouresque, 1986; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995; Boudouresque <i>et al.</i> , 2006			
<i>Chondria coerulea</i> (J. Agardh) Falkenberg	Atl	Raouad, Sidi Bou Said, La Marsa, 1973-1975	Cry	Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995; Zerzeri <i>et al.</i> , 2010			
<i>Colaconema codicola</i> (Børgesen) H. Stegenga, J.J. Bolton & R.J. Anderson = <i>Acrochaetium codicola</i> Børgesen	Cos						
<i>Gracilaria arcuata</i> Zanardini	RS - Ind-Pac	Carthage, 1931	Cas/Requires confirmation	Feldmann, 1931; Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	Sousse, 1973-1975	Cry	Meñez & Mathieson, 1981, misspelled <i>Acrochaetium codicatum</i> ; Ben Maiz <i>et al.</i> , 1987
<i>Griffithsia corallinoidea</i> (Linnaeus) Trevisan	Atl - Pac	Tabarka, Rass El Fariass, 1969; Bizerte, 1989	Est	Boudouresque, 1970, with doubts; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995; Djeloulli <i>et al.</i> , 2000			
<i>Hypnea cornuta</i> (Kützting) J. Agardh*	RS - Pan	Zembra, 1986	Est	Ben Maiz & Boudouresque, 1986; Ben Maiz, 1995; Boudouresque <i>et al.</i> , 2006; Zerzeri <i>et al.</i> , 2010	Jerba, 2014	Cas	Present study
<i>Hypnea spinella</i> (C. Agardh) Kützting = <i>H. cervicornis</i> J. Agardh	RS - Pan				Kerkennah, 1995	Est	Ben Maiz, 1995
<i>Lophocladia lallemandii</i> (Montagne) F. Schmitz *	RS - Ind-Pac				Gabes, 1938	Est	Feldmann & Feldmann, 1939; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995; present study

(continued)

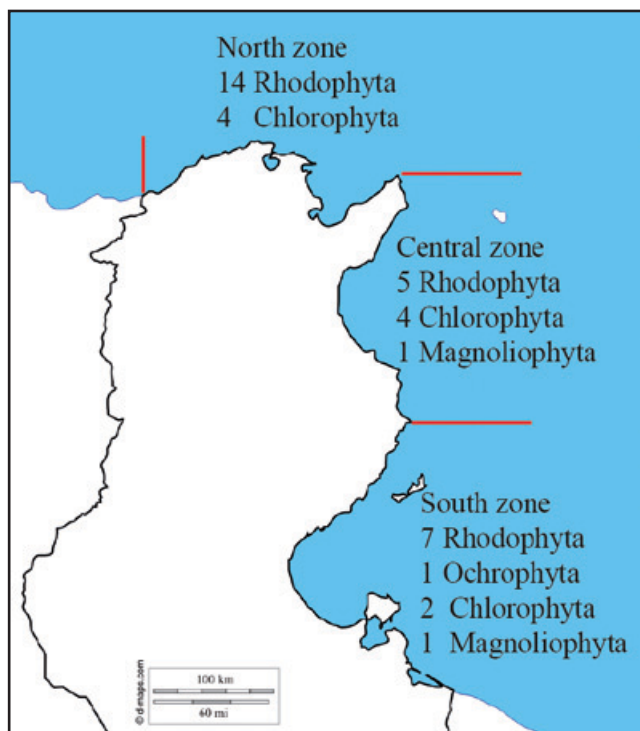
Table 2. (continued)

Species	North Tunisia (Western Mediterranean)				Central-South Tunisia (Central Mediterranean)			
	Native range	First sighting	Status	References	First sighting	Status	References	
<i>Polysiphonia atlantica</i> Kapraunand J.N. Norris = <i>P. macrocarpa</i> Harvey	Atl - Pac	Raouad, 1973-1975	Cry	Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	Jerba, 1973-1975	Cry	Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	
<i>Polysiphonia fucoides</i> (Hudson) Greville = <i>P. nigrescens</i> (Hudson) Greville ex Harvey	Atl	Carthage, 1969	Cry	Ben Alaya, 1972; Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	Nabeul and Jerba, 1973-1975	Cry	Meñez & Mathieson, 1981; Ben Maiz <i>et al.</i> , 1987; Ben Maiz, 1995	
<i>Womersleyella setacea</i> (Hollenberg) R.E. Norris*	Pan	Cap Bon, 1996-1997	Est	Piazzì <i>et al.</i> , 2001; 2002				
<i>Neosiphonia sphaerocarpa</i> (Børgesen) M.S. Kim & I.K. Lee	Cos	Golf of Tunis, 1970	Ques	Ben Alaya, 1970				
<b>Ochrophyta</b>								
<i>Pylaeella littoralis</i> (Linnaeus) Kjellman	Atl							
<i>Leathesia marina</i> (Lyngbye) Decaisne = <i>Leathesia difformis</i> Areschoug	Atl	Tunisia, 1992	Ques	Ribera <i>et al.</i> , 1992				
<i>Padina boryana</i> Thivy = <i>P. tenuis</i> Bory	Pac	Bay of Tunis, Tabarka and Ain Oktor, 1991	Ques	Nizamuddin, 1981	Gulf of Gabes, 1991	Ques	Nizamuddin, 1981	
<b>Chlorophyta</b>								
<i>Caulerpa chemnitzia</i> (Esper) J.V.Lamouroux* = <i>C. racemosa</i> var. <i>chemnitzia</i> (Esper) Weber-Van Bosse = <i>C. racemosa</i> var. <i>turbinata</i> (J. Agardh) Eubank	RS - Pan	Cani Island and Bizerte harbour, 1997	Est	Verlaque <i>et al.</i> , 2000, 2003; Djellouli <i>et al.</i> , 2006	Sousse, 1926	Est	Hamel, 1926; Ben Alaya, 1971; Ben Maiz, 1985; 1995; Ben Maiz <i>et al.</i> , 1987; Ben Mustapha & Hattour, 1992; Bradai & Jribi, 1997; Belkhiria, 1999; Verlaque <i>et al.</i> , 2000, 2003; Ben Mustapha <i>et al.</i> , 2002, 2004; Langar <i>et al.</i> , 2002, 2007; Ben Mustapha & Afi, 2007; Mezgui <i>et al.</i> , 2007; Shili <i>et al.</i> , 2010; Zerzeri <i>et al.</i> , 2010; present study	
<i>Caulerpa cylindracea</i> Sonder* = <i>C. racemosa</i> var. <i>cylindracea</i> (Sonder) Verlaque, Huisman & Boudouresque	Ind-Pac	North coast, 1996	Est	Djellouli, 2000; Ben Mustapha <i>et al.</i> , 2002; 2004; Langar <i>et al.</i> , 2006; 2007; Piazzì <i>et al.</i> , 2005; Djellouli <i>et al.</i> , 2006; Ben Mustapha & Afi, 2007; Mezgui <i>et al.</i> , 2007; 2010a, b; 2014; Shili <i>et al.</i> , 2010; Zerzeri <i>et al.</i> , 2010; present study	Mellita, 1985	Est	Hamza <i>et al.</i> , 1995; Djellouli, 2000; Ben Mustapha & Hattour, 1992; Ben Mustapha <i>et al.</i> , 2002; Langar <i>et al.</i> , 2002, 2006, 2007; Piazzì <i>et al.</i> , 2005; Djellouli <i>et al.</i> , 2006; Ben Mustapha & Afi, 2007; Zaouali & Ben Charrada, 2010; Shili <i>et al.</i> , 2014; present study	
<i>Caulerpa taxifolia</i> (Vahl) C. Agardh*	Pac	Sidi Daoud, 2001	Est	Langar <i>et al.</i> , 2006, 2007, 2010; Ben Mustapha <i>et al.</i> , 2004; Ben Salem <i>et al.</i> , 2004; Ben Mustapha & Afi, 2007; Ben Salem & Gaamour, 2007	Sousse, 2000	Est	Langar <i>et al.</i> , 2000, 2001, 2002, 2006, 2007, 2010; Ben Mustapha <i>et al.</i> , 2002; 2004; Ben Mustapha & Afi, 2007; present study	
<i>Codium fragile</i> subsp. <i>fragile</i> (Suringar) Hartot*	Pac	Bizerte, 1985	Est	Djellouli, 1987; Ben Maiz, 1995; Shili <i>et al.</i> , 2010, 2014; Zerzeri <i>et al.</i> , 2010	Chott-Maniem, 2010	Est	Present study	
<i>Ulva lactuca</i> Linnaeus	Cos	North Coast, Bay of Tunis, 1987	Ques	Ben Maiz <i>et al.</i> , 1987	Hamamet Golf, 1987	Ques	Ben Maiz <i>et al.</i> , 1987	
<b>Magnoliophyta</b>								
<i>Halophila stipulacea</i> (Forsskål) Ascherson*	RS - Ind	Sfax, 2003	Est	Missaoui <i>et al.</i> , 2003, 2006; Sghaier <i>et al.</i> , 2011, 2014; present study	Sfax, 2003	Est	Missaoui <i>et al.</i> , 2003, 2006; Sghaier <i>et al.</i> , 2011, 2014; present study	





**Fig. 3:** Records of alien marine macrophytes (established, casuals, cryptogenic) by species in Tunisia until 2014. Black symbols and yellow lines: available historical data; red symbols: new records.



**Fig. 4:** Number of alien marine macrophytes (established, casuals, cryptogenic) recorded in Tunisia until 2014.

9 and 24 m depth. *Caulerpa taxifolia* was found at five sampling sites out of 67 (7.5%). *Codium fragile* subsp. *fragile* was uncommon in Tunisia, with occurrences at only three sampling sites out of the 67 (4.5 %). It grew between 1 and 5 m depth on hard substrates.

Like *Asparagopsis taxiformis*, *Halophila stipulacea* is a recent invader in Tunisia with a first sighting in 2003 at Sfax (Missaoui *et al.*, 2003). During field studies, the species was observed at the Cap Monastir and the Kerkennah Islands (4.5% of sampling sites).

### Questionable species

*Neosiphonia sphaerocarpa* (Børgesen) M.S. Kim & I.K. Lee (Rhodophyta)

Cormaci *et al.* (2004) considered *N. sphaerocarpa* to be introduced in the Mediterranean Sea where the species was first recorded in 1970 from Tunisia (Ben Alaya, 1970, misspelled *P. sphaerocarpa*). However, the species is distributed worldwide and molecular data are needed to locate its place of origin. Moreover, its identification is not easy, so the absence of *N. sphaerocarpa* in the Mediterranean prior to 1970 could simply mean that it was overlooked or mistaken for another species. Pending further investigations, Tsiamis *et al.* (2010) provisionally consider this species as native in the Mediterranean Sea.

*Leathesia marina* (Lyngbye) Decaisne (Ochrophyta)

Described from Scandinavia (Lyngbye, 1819, as *Chaetophora marina*), *L. marina* was introduced along the French Mediterranean coasts (Verlaque, 2001). Ribera *et al.* (1992) reported the species (as *L. difformis*)

from Tunisia, referring to Ben Maiz *et al.* (1987), but these authors cited only the native species *L. mucosa* J. Feldmann. The occurrence of *L. marina* in Tunisia is possible since it was recorded from Sicily (Marino *et al.*, 1998), but as for other Atlantic species, its status in the southern Mediterranean Sea is cryptogenic.

*Padina boryana* Thivy (Ochrophyta)

The species was reported from Tunisia (Bay of Tunis, Gulf of Gabes, Tabarka and Ain Oktor) (Nizamuddin, 1981, as *P. tenuis* Bory) but Verlaque *et al.* (2015) considered these records as doubtful.

*Ulva lactuca* Linnaeus (Chlorophyta)

This species has frequently been reported from Tunisia (see Ben Maiz *et al.*, 1987). However, all the records of *U. lactuca* over the past 200 years refer to another species (Butler, 2007; F. Mineur, pers. comm.) and should be cited as *U. lactuca auctores*. The genuine *U. lactuca* is a warm water species long misspelled as *U. fasciata* Delile, a later heterotypic synonym taxon described from Alexandria (Egypt) (Delile, 1813, 1826) and distributed worldwide. Its introduction, probably from Japan, was identified with certainty in France (Verlaque, 2001; Verlaque *et al.*, 2015). Along the North Africa coasts, the species was reported as *U. fasciata* from Algeria, Egypt, Libya and Morocco (Bazairi *et al.*, 2013; Verlaque *et al.*, 2015), so its presence in Tunisia is highly probable. The introduced status of *U. lactuca* in the southern Mediterranean Sea is cryptogenic.

### Discussion

A total of 27 alien marine macrophytes were recorded from Tunisia, which is low compared to the 129 AMM listed for the Mediterranean Sea (Verlaque *et al.*, 2015). However, compared to nearby Mediterranean regions, this number is close to that reported in the Straits of Sicily (18) (Occhipinti-Ambrogi *et al.*, 2011) and Algeria (17) (Verlaque *et al.*, 2015), and higher than those recorded in Malta (12) (Sciberras & Schembri, 2007; Evans *et al.*, 2015a,b; Schembri *et al.*, 2015), and Libya (14) (Bazairi *et al.*, 2013). This number has greatly increased since the late 20<sup>th</sup> century, with sixteen new AMM reported after 1960. *Hypnea cornuta* is reported for the first time from Tunisia. This pantropical species was recorded first in the Mediterranean Sea in 1894 from Rhodes Island, Greece (Reinbold, 1898, as *H. valentiae* (Turner) Montagne), and was successively recorded in Israel (Nemlich & Danin, 1964; Hoffman & Dubinsky, 2010), Syria (Mayhoub, 1976, as *H. hamulosa* (Esper) J.V. Lamouroux), Egypt: Alexandria (Aleem, 1993), Lebanon (Lakkis & Novel-Lakkis, 2000, as *H. hamulosa*), Italy: Mar Piccolo di Taranto (Cecere *et al.*, 2004) and Sicily: Cape Peloro Lagoon (Manghisi *et al.*, 2011), and Saronikos Gulf, Greece (Tsiamis *et al.*, 2010). Although *H. cornuta* was only found at Jerba, its

casual status needs to be confirmed. The species could be more widely distributed in Tunisia since, in the absence of the characteristic propagules, the species can be easily confused with *H. spinella*.

*Gracilaria arcuata*, the second casual species, was first reported in the Mediterranean Sea from Carthage (Feldmann, 1931), before being successively recorded from Egypt (Alexandria; Aleem, 1993) and Turkey (Sea of Marmara; Taşkin *et al.*, 2008). A report without description from France (Corsica; De Casabianca *et al.*, 1972-1973, as *G. cf. arcuata*) is considered as a misidentification (Verlaque *et al.*, 2015). According to Gargiulo *et al.* (1992), all the Mediterranean records of *G. arcuata* are doubtful. Consequently, its introduction into the Mediterranean Sea and its occurrence in Tunisia require confirmation.

Of the 27 alien marine macrophytes of Tunisia, 14 species (51.9% of total number of species) are classified as established and seven as cryptogenic (25.9%). Most of AMM are widely distributed and the apparently restricted distribution of the others may be an artifact due to insufficient investigation.

As far as the cryptogenic species are concerned, *Acanthophora nayadiformis*, a species described from both the Red Sea (Suez, Egypt) and the Mediterranean Sea (Alexandria, Egypt) (Delile, 1813, 1826, as *Fucus nayadiformis*), was successively reported throughout the Mediterranean basin. Although Cormaci *et al.* (2004) did not consider the species as introduced into the Mediterranean Sea, the oldest Mediterranean records are after the opening of the Suez Canal. Jerba constitutes its southernmost locality for the Tunisia.

Under the name *Anotrichium okamurae*, two cryptic taxa have been confused in the Atlantic Ocean and the Mediterranean Sea: *A. furcellatum* (J. Agardh) Baldock, a Mediterranean species described from Naples (Agardh, 1842, as *Griffithsia furcellata*), and *A. okamurae*, an introduced species described from Japan (Okamura, 1934, as *Monospora tenuis*) exhibiting an invasive behaviour pattern. Cormaci *et al.* (2004) did not consider *A. okamurae* as a putative introduced species. However, in the absence of molecular studies, we consider that it is preferable to maintain *A. okamurae* and *A. furcellatum* as distinct species. The identity and the introduced or native status of the Tunisian populations need further investigation.

The introduction of *Chondria coerulescens*, *Colaconema codicola*, *Polysiphonia atlantica*, *P. fucooides* and *Pylaiella littoralis*, five species described from the north-eastern Atlantic Ocean (Linnaeus, 1753; Hudson, 1762; Agardh, 1863; Børgesen, 1927; Kapraun & Norris, 1982), were identified with certainty along the French Mediterranean coasts (Ben Maiz, 1986; Verlaque & Rioual, 1989; Verlaque, 2001; Verlaque *et al.*, 2015). However, these species are widely distributed in the Mediterranean Sea and the co-occurrence of introduced and native populations cannot be excluded, especially along the North African coasts where the native flora pos-

sesses many Atlantic-Mediterranean species. Moreover, although the introduction of *C. codicola* in Tunisia is highly probable since its privileged host *Codium fragile* is established, this requires confirmation because the single Tunisian record was epiphytic on *Cymodocea nodosa* (Meñez & Mathieson, 1981). Consequently, the confirmation of the introduced status for each of these species in Tunisia calls for further studies.

Some localities such as Bizerte, El Kantaoui, Cap Monastir and Tunis displayed a high number of recorded aliens compared to the average, confirming that hotspots for marine species introduction are coastal lagoons and harbours where human activities such as shipping and fishing activities, recreational marinas and aquaculture affect the health of ecosystems and facilitate the introduction and the secondary dispersal of alien species (Cohen & Carlton, 1998; Verlaque, 2001; Occhipinti-Ambrogi & Savini, 2003; Rilov & Crooks, 2009; Hoffman *et al.*, 2011; Occhipinti-Ambrogi *et al.*, 2011).

Most of the AMM in Tunisia show warm-water affinities since only five North Atlantic AMM can be considered as cold-water species. As expected, the main donor regions are the Red Sea and the Indo-Pacific province. The identity and abundance of AMM in Tunisian waters could be explained by its southern geographical position located at the crossroads between the eastern and western basins of the Mediterranean Sea.

On the 21 invasive or potentially invasive AMM listed by Zenetos *et al.* (2010), nine have been identified in Tunisia: *Acrothamnion preissii*, *Asparagopsis armata*, *A. taxiformis*, *Lophocladia lallemandii*, *Womersleyella setacea*, *Caulerpa cylindracea*, *C. taxifolia*, *Codium fragile* subsp. *fragile* and *Halophila stipulacea*. To this list, we have added *Caulerpa chemnitzia* and *Hypnea cornuta* that are spreading in the Mediterranean Sea. In Tunisia, all of them were already widely distributed in 2014 except for *A. preissii*, *H. cornuta* and *W. setacea*, whose apparent scarcity could be merely an artefact due to problems of identification in the field.

*Asparagopsis armata* was first recorded in Tunisia (Cap Serrat) in the 1970s (Meñez & Mathieson, 1981). By 2010, it was reported on the north-east coast of Tunisia (Bizerte, Cap-Zebib and Raf-Raf) (Zerzeri *et al.*, 2010). Our new record was approximately 300 km south of its previously documented distribution in Tunisia.

*Asparagopsis taxiformis* was only recently recorded from Tunisia (Andreakis *et al.*, 2004). Since 2003, it has been observed, from 0 to 10 m depth, on rocky substrates and dead *Posidonia oceanica* meadows. On the four *Asparagopsis taxiformis* lineages hitherto identified in the world, two occur in the Mediterranean Sea: the non-invasive lineage 3 of putative Atlantic origin and the invasive lineage 2 originate from the Indo-Pacific region. The invasive lineage 2 was identified at Mahdia (Andreakis *et al.*, 2004, 2007, 2009). The identification of lineage(s) occurring in the other Tunisian localities requires further

investigation; however, the recent spread observed in the central zone of Tunisia is in good agreement with the invasive behaviour of lineage 2.

*Caulerpa chemnitzia* was first reported from the Mediterranean Sea in 1926 in Tunisia (Sousse Harbour; Hamel, 1926). Hereafter, it remained restricted to the eastern basin (Cyprus, Egypt, Israel, Lebanon and Syria) for a long time. Since the early 21<sup>st</sup> century, the species has been spreading in the Mediterranean Sea. It was recently discovered in Algeria (Verlaque *et al.*, 2015) and the number of populations is increasing in Tunisia.

Until 2010, *Caulerpa taxifolia* was locally very abundant in Tunisia, forming dense extensive meadows on soft substrates and dead *Podisonia oceanica* meadows. However, in late 2011 and early 2012, the abundance of *C. taxifolia* declined significantly (up to 90%) in the central zone of Tunisia (pers. obs.).

The record of *Codium fragile* at El Kantaoui was approximately 300 km south of the previously documented range of distribution in Tunisia.

The most harmful alien marine macrophytes in Tunisia is probably *Caulerpa cylindracea*. Its rapid spread in the Mediterranean Sea has profoundly altered benthic communities and reduced seaweed diversity (Piazzi *et al.*, 2005; Klein & Verlaque, 2008). It is worth noting that, contrary to the generally accepted opinion, the first observation of the species in the Mediterranean Sea was not in Libya in 1990 (Nizzamudin, 1991), but five years earlier in 1985 in Tunisia, at Mellita (see Hamza *et al.*, 1995). This point, which has hitherto gone unnoticed, is important because it dates the introduction of the two invasive *Caulerpa* species, *C. cylindracea* and *C. taxifolia*, into the Mediterranean Sea during the same period (1984-1985) (see Meinesz & Hesse, 1991, for *C. taxifolia*).

As far as the other potentially invasive AMM in Tunisia are concerned, the literature reports a conspicuous ecological impact in the invaded regions for *Acrothamnion preissii*, *Lophocladia lallemandii*, *Womersleyella setacea*, *Caulerpa taxifolia*, *Codium fragile* and *Halophila stipulacea* (Verlaque & Fritayre, 1994; Villèle & Verlaque, 1995; Piazzi *et al.*, 2001, 2002, 2012; Provan *et al.*, 2005; Ballesteros *et al.*, 2007; Willette & Ambrose 2009, 2012).

In conclusion, the high number of potentially invasive alien marine macrophytes already introduced in the country and its geographical position between the eastern and the western Mediterranean basins, on the westward migration route of Lessepsian species, make the monitoring of alien marine species in Tunisia a scientific priority.

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## References

- Agardh, J.G., 1842. *Algae maris Mediterranei et Adriatici, observationes in diagnosis specierum et dispositionem generum*. Masson et Cie, Paris, 164 pp.
- Agardh, J.G., 1863. *Species genera et ordines algarum, seu descriptiones succinctae specierum, generum et ordinum, quibus algarum regnum constituitur. Volumen secundum: algas florideas complectens. Part 2, Fasc 3*, 351 pp.
- Aleem, A.A., 1993. *Marine algae of Alexandria*. Privately published, Alexandria, 135 pp.
- Andreakis, N., Kooistra, W.H., Procaccini, G., 2009. High genetic diversity and connectivity in the polyploid invasive seaweed *Asparagopsis taxiformis* (Bonnemaisoniales) in the Mediterranean, explored with microsatellite alleles and multilocus genotypes. *Molecular Ecology*, 18, 212–226.
- Andreakis, N., Procaccini, G., Kooistra, W.H.C.F., 2004. *Asparagopsis taxiformis* and *Asparagopsis armata* (Bonnemaisoniales, Rhodophyta): genetic and morphological identification of Mediterranean populations. *European Journal of Phycology*, 39 (3), 273-283.
- Andreakis, N., Procaccini, G., Maggs, C., Kooistra, W.H.C.F., 2007. Phylogeography of the invasive seaweed *Asparagopsis* (Bonnemaisoniales, Rhodophyta) reveals cryptic diversity. *Molecular Ecology*, 16 (11), 2285-2299.
- Athanasiadis, A., 1996. Morphology and classification of the Ceramioideae (Rhodophyta) based on phylogenetic principles. *Opera Botanica*, 128, 5-216.
- Ballesteros, E., Cebrian, E., Alcoverro, T., 2007. Mortality of shoots of *Posidonia oceanica* following meadow invasion by the red alga *Lophocladia lallemandii*. *Botanica Marina*, 50, 8-13.
- Bazairi, H., Sghaier, Y.R., Benamer, I., Langar, H., Pergent, G. *et al.*, 2013. Alien marine species of Libya: first inventory and new records in El-Kouf National Park (Cyrenaica) and the neighbouring areas. *Mediterranean Marine Science*, 14(2), 451-462.
- Belkhiria, S., 1999. Tunisia. p. 295-296. In: *Proceedings of the Workshop "Invasive Caulerpa Species in the Mediterranean"*. Heraklion, Crete, Greece, 18-20 March 1998. UNEP/ MAP, Athens, Greece.
- Ben Alaya, H., 1970. Flore marine de Tunisie. I. Liste préliminaire des algues du golfe de Tunis. *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 1, 205-212.
- Ben Alaya, H., 1971. Sur la présence de *Caulerpa racemosa* J. Agardh dans le golfe de Gabès et le port de Mahdia. *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 2, 53-54.

- Ben Alaya, H., 1972. Répartition et conditions d'installation de *Posidonia oceanica* Delile et de *Cymodocea nodosa* Ascherson dans le golfe de Tunis. *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 2(3), 331-416.
- Ben Maiz, N., 1985. Quelques algues rares ou nouvelles pour la flore marine de la Tunisie. *Rapports et Procès-Verbaux des Réunions Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée*, 29(5), 269-270.
- Ben Maiz, N., 1986. Sur la présence de *Pylaiella littoralis* (Linnaeus) Kjellman (Phaeophyceae, Ectocarpale) dans l'Étang de Thau (Hérault, France). *Rapports et Procès-Verbaux des Réunions Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée*, 30(2), 6.
- Ben Maiz, N., 1995. *Etude nationale sur la diversité biologique de la flore marine et aquatique de Tunisie (Monographie)*. Projet MEAT/PNUE/GEF Ministère de l'Environnement et de l'Aménagement du territoire, Tunisie, 78 pp.
- Ben Maiz, N., Boudouresque, C.F., 1986. Les algues. p. 85-97. In: *Le benthos marin de l'île de Zembra (Parc National, Tunisie)*. Boudouresque, C.F., Harmelin, J.G., Jeudy de Grissac, A. (Eds). UNEP-UICN-RAC/SPA, GIS Posidonie pub, Marseille.
- Ben Maiz, N., Boudouresque, C.F., Ouahchi, F., 1987. Inventaire des algues et phanérogames marines benthiques de la Tunisie. *Giornale Botanica Italiano*, 121, 259-304.
- Ben Mustapha, K., Afli, A., 2007. Quelques traits de la biodiversité marine de Tunisie. Proposition d'aires de conservation et de gestion. *Report of the MedSudMed Expert Consultation on Marine Protected Areas and Fisheries Management*. FAO, MiPAAF pub. *MedSudMed Technical Documents*, 3, 32-55.
- Ben Mustapha, K., Hattour, A., 1992. Les herbiers de posidonies du littoral tunisien. I. Le Golfe de Hammamet. *Notes de l'Institut National Scientifique et Technique d'Océanographie et de Pêche de Salammbô*, 2, 1-40.
- Ben Mustapha, K., Komatsu, T., Hattour, A., Sammari, C., Zarrouk, S. *et al.*, 2002. Tunisian megabenthos from infra (*Posidonia* meadows) and circalittoral (Coralligenous) sites. *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 29, 23-36.
- Ben Mustapha, K., Afli, A., Hattour, A., El Abed, A., 2004. *Sessile megabenthic species from Tunisian littoral sites*. *Report of the Expert Consultation on the Spatial Distribution of Demersal Resources in the Straits of Sicily and the Influence of Environmental Factors and Fishery Characteristics*. FAO, MiPAAF pub. *MedSudMed Technical Documents*, 2, 82-97.
- Ben Salem, S., Gaamour, A., 2007. *Caulerpa taxifolia* impact on exploitable marine resources of the Cap Bon area. Preliminary data. *Report of the MedSudMed Expert Consultation on Marine Protected Areas and Fisheries Management*. FAO, MiPAAF pub. *MedSudMed Technical Documents*, 3, 89-92.
- Ben Salem, S., Gaamour, A., El Abed, I., Missaoui, H., El Abed, A., 2004. *Caulerpa taxifolia* impact on fish catch in the area of Cap Bon. Preliminary data. *Biologia Marina Mediterranea*, 11(2), 679-682.
- Børgesen, F., 1927. Marine algae from the Canary Islands especially from Teneriffe and Gran Canaria. III. Rhodophyceae. Part I. Bangiales and Nemalionales. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser*, 6(6), 1-97.
- Boudouresque, C.F., 1970. *Recherches de bionomie analytique, structurale et expérimentale sur les peuplements benthiques sciaphiles de Méditerranée occidentale (fraction algale)*. PhD Thesis. Université Aix-Marseille II, France, 624 pp.
- Boudouresque, C.F., Harmelin, J.G., Jeudy de Grissac, A., 2006. Annexe III. Index des espèces signalées à Zembra. p. 185-196. In: *Le benthos marin de l'île de Zembra (Parc National, Tunisie)*. Boudouresque, C.F., Harmelin, J.G., Jeudy de Grissac, A., (Eds). UNEP/UICN/RACSPA, GIS Posidonie pub., Marseille.
- Bradai, M.N., Jribi, I., 1997. *Les îles Kuriat : nidification de la tortue marine Caretta caretta et faune et flore marines*. Convention ANPE-CAR/ASP-INSTM, rapport scientifique final, Tunisie, 69 pp.
- Butler, D., 2007. Ancient algal mixup sorted. *Nature News*, 20 Dec 2007, doi: 10.1038/news.2007.396.
- Cecere, E., Petrocelli, A., Verlaque, M., 2004. Morphology and vegetative reproduction of the introduced species *Hypnea cornuta* (Rhodophyta, Gigartinales) in the Mar Piccolo of Taranto (Italy, Mediterranean Sea). *Botanica Marina*, 47:381-388.
- Cohen, A.N., Carlton, J.T., 1998. Periwinkle's progress: the Atlantic snail *Littorina saxatilis* (Mollusca: Gastropoda) establishes a colony on a Pacific shore. *Veliger*, 41, 333-338.
- Cormaci, M., Furnari, G., Giaccone, G., Serio, D., 2004. Alien macrophytes in the Mediterranean Sea: a review. *Recent Research Developments in Environmental Biology*, 1, 153-202.
- De Casabianca, M.L., Kiener, A., Huvé, H., 1972-1973. Biotopes et biocénoses des étangs saumâtres corses: Biguglia, Diana, Urbino, Palo. *Vie et Milieu*, 23, 187-227.
- Delile, A.R., 1813. Flore d'Égypte. p. 145-320. In: *Description de l'Égypte - Recueil et des observations et des recherches qui ont été faites en Égypte pendant l'expédition de l'armée française, publié par les ordres de Sa Majesté l'Empereur Napoléon le Grand*. Histoire naturelle. Tome Second. Histoire naturelle. Imprimerie Impériale, Paris.
- Delile, A.R., 1826. Flore d'Égypte. p. 1-62. In: *Description de l'Égypte - Recueil et des observations et des recherches qui ont été faites en Égypte pendant l'expédition de l'armée française, publié par les ordres de Sa Majesté l'Empereur Napoléon le Grand*. Histoire naturelle. Histoire naturelle. Imprimerie Impériale, Paris.
- Djellouli, A., 1987. Sur la présence de *Codium fragile* (Surin-gar) Hariot (Codiaceae, Ulvophyceae) en Tunisie. *Bulletin de la Société Linnéenne de Provence*, 39, 103-105.
- Djellouli, A., 2000. *Caulerpa racemosa* (Forsskål) J. Agardh en Tunisie. p. 124-127. In: *Proceedings of the First Mediterranean Symposium on Marine Vegetation, Ajaccio, France, 3-4 October 2000*. RAC/SPA, Tunis.
- Djellouli, A., Verlaque, M., Rais, C., 2000. Macroflore benthique de la lagune de Bizerte. p. 128-131. In: *Proceedings of the First Mediterranean Symposium on Marine Vegetation, Ajaccio, France, 3-4 October 2000*. RAC/SPA, Tunis.
- Djellouli, A.S., Langar, H., El Abed A., 2006. Mollusques ascoglosses associés aux peuplements de *Caulerpa racemosa* en Tunisie : espèces observées et description des effets trophiques. p. 88-92. In: *Proceedings of the Second Mediterranean Symposium on Marine Vegetation, Athens, Greece, 12-13 December 2003*. RAC/SPA, Tunis.

- Evans, J., Barbara, J., Schembri, P.J., 2015a. Updated review of marine alien species and other 'newcomers' recorded from the Maltese Islands (Central Mediterranean). *Mediterranean Marine Science*, 16(1), 225-244.
- Evans, J., Farrugia Drakard, V., Schembri, P.J., 2015b. First record of *Acrothamnion preissii* (Rhodophyta: Ceramiaceae) from the Maltese Islands (central Mediterranean Sea). *Marine Biodiversity Records*, 8, e6.
- Feldmann, J., 1931. Note sur quelques algues marines de Tunisie. *Notes de la Station Océanographique de Salammbô*, 24, 3-20.
- Feldmann, J., 1937. Recherches sur la végétation marine de la Méditerranée. La côte des Albères. *Revue Algologique*, 10, 1-139.
- Feldmann, J., Feldmann, G., 1939. Additions à la flore des algues marines de l'Algérie. *Bulletin de la Société de l'Histoire Naturelle de l'Afrique du Nord*, 30(2), 453-464.
- Gargiulo, G.M., de Masi, F., Tripodi, G., 1992. Morphology, reproduction and taxonomy of the Mediterranean species of *Gracilaria* (Gracilariales, Rhodophyta). *Phycologia*, 31, 53-80.
- Hamel, G., 1926. Quelques algues rares ou nouvelles pour la flore méditerranéenne. *Bulletin du Muséum national d'Histoire naturelle*, 32(6), 420.
- Hamza, A., Bradai, M.N., Ghorbel, M., Abdelmouleh, A., 1995. New mentions of *Caulerpa racemosa* (Forsskål) J. Agardh in the Gabès Gulf (Tunisia). *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 22, 81-87.
- Hoffman, R., 2014. Alien Benthic Algae and Seagrasses in the Mediterranean Sea and Their Connection to Global Warming. p 159-181. In: *The Mediterranean Sea: Its history and present challenges*. Goffredo, S., Dubinsky, Z. (Eds.). Springer Netherlands.
- Hoffman, R., Dubinsky, Z., 2010. Invasive and alien Rhodophyta in the Mediterranean and along the Israeli shores. p. 47-60. In: *Red Algae in the Genomic Age*. Seckbach, J., Chapman, D.J., (Eds). Vol. 13. Springer Publishers, Netherlands.
- Hoffman, R., Shemesh, E., Ramot, M., Dubinsky, Z., Pinchasov-Grinblat, Y. et al., 2011. First record of *Codium arabicum* Kütz. (Bryopsidales, Chlorophyta) in the Mediterranean Sea *Botanica Marina*, 54(4), 487-495.
- Hudson, W., 1762. *Flora anglica; exhibens plantas per regnum angliae sponte crescentes, distributas secundum systema sexuale: cum differentiis specierum, synonymis auctorum, nominibus incolarum, solo locorum, tempore florendi, officinalibus pharmacopoeorum*. London, 506 pp.
- Kapraun, D.F., Norris, J.N., 1982. The red algal *Polysiphonia* Greville (Rhodomelaceae) from Carrie Bow Cay and vicinity, Belize. p. 225-238. In: *The Atlantic Barrier Reef Ecosystem at Carrie Bow Cay, Belize. I. Structure and Communities*. Rützler, K., Macintyre, I.G. (Eds). Vol 12, Smithsonian Contributions to the Marine Sciences. Washington D.C.
- Klein, J., Verlaque, M., 2008. The *Caulerpa racemosa* invasion: A critical review. *Marine Pollution Bulletin*, 56(2), 205-225.
- Lakkis, S., Novel-Lakkis, V., 2000. Distribution of phytobenthos along the coast of Lebanon (Levantine Basin, East Mediterranean). *Mediterranean Marine Science*, 1(2), 143-164.
- Langar, H., Djellouli, A., Ben Mustapha, K., El Abed, A., 2000. Première signalisation de *Caulerpa taxifolia* (Vahl) C. Agardh en Tunisie. *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 27(1), 1-8.
- Langar, H., Djellouli, A., El Abed, A., 2001. *Caulerpa* genus in Tunisia. p. 585-591. In: *Proceedings of the Fifth International Conference on the Mediterranean Coastal Environment, MEDCOAST 01, Hammamet, Tunisia, 23-27 October 2001*. MEDCOAST, Ankara.
- Langar, H., Djellouli, A.S., Sellem, F., El Abed, A., 2002. Extension of two *Caulerpa* species along the Tunisian coast. *Journal of Coastal Conservation*, 8(2), 163-167.
- Langar, H. Djellouli, A.S., El Abed A., 2006. *Caulerpa taxifolia*: situation connue en Tunisie au 31 juillet 2003. p. 100-106. In: *Proceedings of the Second Mediterranean Symposium on Marine Vegetation, Athens, Greece, 12-13 December 2003*. RAC/SPA, Tunis.
- Langar, H., Jellouli, A., Riveill, S., El Abed, A., 2007. Monitoring of *Caulerpa taxifolia* (Vahl) C. Agardh and *Caulerpa racemosa* (Forsskål) J. Agardh in Tunisia: Strategy and results. p. 83-88. In: *Report of the MedSudMed Expert Consultation on Marine Protected Areas and Fisheries Management*. Vol 3, FAO, MiPAAF pub. *MedSudMed Technical Documents*.
- Langar, H, Belgacem, W., Djellouli, A.S., Pergent, G., 2010. Suivi de l'expansion de *Caulerpa taxifolia* le long du littoral Tunisien : situation au 30 avril 2009. p. 66-70. In: *Proceedings of the Fourth Mediterranean Symposium on Marine Vegetation. Yasmine-Hammamet, Tunisia, 2-4 December 2010*. RAC/SPA, Tunis.
- Linnaeus, C., 1753. *Species plantarum, exhibentes plantas rite cognitatas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas*. Holmiae [Stockholm]: Impensis Laurentii Salvii, 2, 561-1200 pp.
- Lyngeby, H.C., 1819. *Tentamen hydrophytologiae danicae continens omnia hydrophyta cryptogama Daniae, Holsatiae, Faeroae, Islandiae, Groenlandiae hucusque cognita, systematice disposita, descripta et iconibus illustrata, adjectis simul speciebus norvegicis*. Hafniae [Copenhagen]: typis Schultzianis, in commissis Librariae Gyldendaliae. 248 pp.
- Manghisi, A., Armeli Minicante, S., Bertuccio, C., Morabito, M., Fiore, V. et al., 2011. Identifying alien macroalgae through DNA barcoding: the case of *Hypnea cornuta* (Cystocloniaceae, Rhodophyta). *Transitional Waters Bulletin*, 5, 42-49.
- Marino, G., Di Martino, V., Giaccone, G., 1998. La vegetazione marina nella Penisola Maddalena (Siracusa, Sicilia S-E). *Bollettino delle sedute dell'Accademia Gioenia di Scienze Naturali, Catania*, 31, 235-287.
- Mayhoub, H., 1976. *Recherches sur la végétation marine de la côte syrienne. Etude expérimentale sur la morphogénèse et le développement de quelques espèces peu connues*. PhD Thesis, Université de Caen, France, 286 pp.
- Meinesz, A., Hesse, B., 1991. Introduction et invasion de l'algue tropicale *Caulerpa taxifolia* en Méditerranée nord-occidentale. *Oceanologica Acta*, 14, 415-426.
- Meñez, E.G., Mathieson, A.C., 1981. The marine algae of Tunisia. *Smithsonian Contributions to the Marine Sciences*, 10, 1-59.
- Mezgui, Y., Djellouli, A.S., Ben Chikh Almi, I., 2007. Etude biométrique (biomasse et phénologie) des populations à

- Caulerpa racemosa* dans la région de Bizerte (Tunisie). p. 111-116. In: *Proceedings of the Third Mediterranean Symposium on Marine Vegetation, Marseille, France, 27-29 March 2007*. RAC/SPA, Tunis.
- Mezgui, Y., Djellouli, A.S., Zerzeri, A., 2010a. Etude biométrique de *Caulerpa racemosa* var. *cylindracea* (Bryopsidales, Chlorophyta) se développant sur différents types de substrats. *Rapports et Procès-Verbaux des Réunions, Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée*, 39, 777.
- Mezgui, Y., Zerzeri, A., Djellouli, A.S., 2010b. Variations des paramètres biométriques de la Bryopsidophyceae *Caulerpa racemosa* var. *cylindracea* en interaction avec la Magnoliophyte marine *Posidonia oceanica*. p. 71-76. In: *Proceedings of the Fourth Mediterranean Symposium on Marine Vegetation. Yasmine-Hammamet, Tunisia, 2-4 December 2010* RAC/SPA, Tunis.
- Mezgui, Y., Djellouli, A.S., Ben Hassine, O.K., 2014. *Posidonia oceanica* and *Caulerpa racemosa* var. *cylindracea* co-effects on phenological parameters. p. 228-229. In: *Proceedings of the Fifth Mediterranean Symposium on Marine Vegetation. Portorož, Slovenia, 27-28 October 2014*. RAC/SPA, Tunis.
- Missaoui, H., Mahjoub, M.S., Chalghaf, M., 2003. Sur la présence de la phanérogame marine *Halophila stipulacea* (Forsk.) dans le golfe de Gabès (Tunisie). *Bulletin de l'Institut National des Sciences et Technologies de la Mer de Salammbô*, 30, 111-114.
- Missaoui, H., Mahjoub, M.S., Chalghaf, M., 2006. Apparition de la phanérogame *Halophila stipulacea* dans le golfe de Gabès (Tunisie). p. 115-117. In: *Proceedings of the Second Mediterranean Symposium on Marine Vegetation. Athens, Greece, 12-13 December 2003*. RAC-SPA, Tunis.
- Nemlich, C., Danin, Z., 1964. *Marine algae of the coast of Israel*. Hakibbutz Hameuchad Publisher 199 pp.
- Nizamuddin, M., 1981. Contribution to the marine algae of Libya. Dictyotales. *Bibliotheca Phycologica*, 54, 1-122.
- Nizamuddin, M., 1991. *The Green Marine Algae of Libya*. Elga Publ., Bern, 230 pp.
- Occhipinti-Ambrogi, A., 2007. Global change and marine communities: Alien species and climate change. *Marine Pollution Bulletin*, 55, 342-352.
- Occhipinti-Ambrogi, A., Savini, D., 2003. Biological invasions as a component of global change in stressed marine ecosystems. *Marine Pollution Bulletin*, 46 (5), 542-551.
- Occhipinti-Ambrogi, A., Marchini, A., Cantone, G., Castelli, A., Chimenz, C. et al., 2011. Alien species along the Italian coasts: an overview. *Biological Invasions*, 13, 215-237.
- Okamura, K., 1934. *Icones of Japanese algae*. Vol. 7 pp. 19-48 (English), 17-44 (Japanese), Plates CCCXI-CCCXXV. Tokyo.
- Petersen, H.E., 1918. Algae (excl. calcareous algae). pp. 1-20. In: *Report on the Danish Oceanographical Expeditions 1908-1910 to the Mediterranean and adjacent seas. Vol. II. Biology* K.3. Schmidt, J. (Eds). København.
- Piazzini, L., Balata, D., Cinelli, F., 2001. Incidence des Rhodophyceae exotiques *Acrothamnion preissii* et *Womersleyella setacea* sur le peuplement algal des rhizomes de *Posidonia oceanica*. p. 403-406. In: *Fourth International Workshop on Caulerpa taxifolia*, Marseille, 19-20 September 1997. Gravez, V., Ruitton, S., Boudouresque, C.F., Le Direac'h, L., Meinesz, A. et al., (Eds), Marseille.
- Piazzini, L., Balata, D., Cinelli, F., 2002. Epiphytic macroalgal assemblages of *Posidonia oceanica* rhizomes in the western Mediterranean. *European Journal of Phycology*, 37, 69-76.
- Piazzini, L., Meinesz, A., Verlaque, M., Akçali, B., Antolic, B. et al., 2005. Invasion of *Caulerpa racemosa* (Caulerpales, Chlorophyta) in the Mediterranean Sea: an assessment of the spread. *Cryptogamie, Algologie*, 26, 189-202.
- Piazzini, L., Gennaro, P., Balata, D., 2012. Threats to macroalgal coralligenous assemblages in the Mediterranean Sea. *Marine Pollution Bulletin*, 64, 2623-2629.
- Provan, J., Murphy, S., Maggs, C.A., 2005. Tracking the invasive history of the green alga *Codium fragile* ssp. *tomentosoides*. *Molecular Ecology*, 14, 189-194.
- Reinbold, T., 1898. Meeresalgen von der Insel Rhodos. *Hedwigia*, 37, 87-90.
- Ribera, M.A., Gómez-Garreta, A., Gallardo, T., Cormaci, M., Furnari, G. et al., 1992. Check-list of Mediterranean Seaweeds. I. Fucophyceae (Warming 1884). *Botanica Marina*, 35, 109-130.
- Rilov, G., Crooks, J.A., 2009. Marine bioinvasions: conservation hazards and vehicles for ecological understanding. p. 3-11. In: *Biological invasions in marine ecosystems*. Rilov, G., Crooks, J.A. (Eds). Springer, Berlin.
- Schembri, P.J., Barbara, J., Deidun, A., Lanfranco, E., Lanfranco, S., 2015. It was only a matter of time: occurrence of *Caulerpa taxifolia* (Vahl) C. Agardh var. *distichophylla* (Sonder) Verlaque, Huisman and Procaccini in the Maltese Islands (Chlorophyta, Ulvophyceae, Caulerpales). *BioInvasions Record*, 4, 9-16.
- Schiffner, V., 1926. Beiträge zur Kenntnis der Meeresalgen. II. Ein Beitrag zur algen flora von Tunesien. *Hedwigia*, 66, 300-311.
- Sciberras, M., Schembri, P.J., 2007. A critical review of records of alien marine species from the Maltese Islands and surrounding waters (Central Mediterranean). *Mediterranean Marine Science*, 8 (1), 41-66.
- Sghaier, Y.R., Zakhama-Sraieb, R., Benamer, I., Charfi-Cheikhrouha, F., 2011. Occurrence of the seagrass *Halophila stipulacea* (Hydrocharitaceae) in the southern Mediterranean Sea. *Botanica Marina*, 54 (6), 575-582.
- Sghaier, Y.R., Zakhama-Sraieb, R., Charfi-Cheikhrouha, F., 2014. Effects of the invasive seagrass *Halophila stipulacea* on the native seagrass *Cymodocea nodosa*. p. 167-171. In: *Proceedings of the Fifth Mediterranean Symposium on Marine Vegetation. Portorož, Slovenia, 27-28 October 2014*. RAC/SPA, Tunis.
- Shili, A., Ben Maiz, N., Boudouresque, C.F., Verlaque, M., 2010. Données sur la prolifération de la Rhodobionte *Asparagopsis taxiformis* (Delile) Trévisan de Saint-Léon sur les côtes Nord de Tunisie. p. 223-224. In: *Proceedings of the 4th Mediterranean symposium on Marine Vegetation, Yasmine-Hammamet, Tunisia, 2-4 December 2010*. RAC/SPA, Tunis.
- Shili, A., Baccar, L., Ben Maiz, N., Boudouresque, C.F., 2014. Dynamics of benthic macrophytes in the southern Tunis lagoon (Tunisia, Mediterranean Sea). p. 172-177. In: *Proceedings of the Fifth Mediterranean Symposium on Marine Vegetation. Portorož, Slovenia, 27-28 October 2014*. RAC/SPA, Tunis.
- Taşkın, E., Öztürk, M., Kurt, O., Öztürk, M., 2008. *The check-list of the marine flora of Turkey*. Manisa, Turkey, 87 pp.

- Tsiamis, K., Montesanto, B., Panayotidis, P., Katsaros, C., Verlaque, M., 2010. Updated records and range expansion of alien marine macrophytes in Greece (2009). *Mediterranean Marine Science*, 11 (1), 61-79.
- UNEP-MAP-RAC/SPA, 2015. *Marine Mediterranean Invasive Alien Species*. <http://www.mamias.org> (in project)
- Verlaque, M., 2001. Checklist of the macroalgae of Thau Lagoon (Hérault, France), a hot spot of marine species introduction in Europe. *Oceanologica Acta*, 24, 29-49.
- Verlaque, M., Fritayre, P., 1994. Modifications des communautés algales méditerranéennes en présence de l'algue envahissante *Caulerpa taxifolia* (Vahl) C. Agardh. *Oceanologica Acta*, 17, 659-672.
- Verlaque, M., Riouall, R., 1989. Introduction de *Polysiphonia nigrescens* et d'*Antithamnion nipponicum* (Rhodophyta, Ceramiales) sur le littoral Méditerranéen Français. *Cryptogamie Algologie*, 10, 313-323.
- Verlaque, M., Boudouresque, C.F., Meinesz, A., Gravez, V., 2000. The *Caulerpa racemosa* complex (Caulerpales, Ulvophyceae) in the Mediterranean Sea. *Botanica Marina*, 43, 49-68.
- Verlaque, M., Durand, C., Huisman, J.M., Boudouresque, C.F., Le Parco, Y., 2003. On the identity and origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta). *European Journal of Phycology*, 38, 325-339.
- Verlaque, M., Ruitton, S., Boudouresque, C.F., Mineur, F., 2015. Macrophytes. In: CIESM Atlas of exotic species in the Mediterranean. Briand, F. (Eds). CIESM Publishers, Monaco. 364 pp.
- Villèle, X. de, Verlaque, M., 1995. Changes and degradation in a *Posidonia oceanica* bed invaded by the introduced tropical alga *Caulerpa taxifolia* in the north western Mediterranean. *Botanica Marina*, 38(1-6), 79-88.
- Willette, D.A., Ambrose, R.F., 2009. The distribution and expansion of the invasive seagrass *Halophila stipulacea* in Dominica, West Indies, with a preliminary report from St. Lucia. *Aquatic Botany*, 91, 137-142.
- Willette, D.A., Ambrose, R.F., 2012. Effects of the invasive seagrass *Halophila stipulacea* on the native seagrass, *Syringodium filiforme*, and associated fish and epibiota communities in the Eastern Caribbean. *Aquatic Botany*, 103, 74-82.
- Zanardini, G., 1858. Plantarum in mari Rubro hucusque collectarum enumerato (juvante A. Figari). *Memorie del Reale Istituto Veneto di Scienze, Lettere ed Arti*, 7, 209-309.
- Zaouali, J., Ben Charrada, R., 2010. Impacts des actions anthropiques sur le phytobenthos de la Baie de Monastir. p. 135-140. In: *Proceedings of the Fourth Mediterranean Symposium on Marine Vegetation*. RAC/SPA, Tunis.
- Zenetos, A., Gofas, S., Verlaque, M., Cinar, M.E., García Raso, E. et al., 2010. Alien species in the Mediterranean Sea by 2010 A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science*, 11 (2), 381-493.
- Zenetos, A., Gofas, S., Morri, C., Rosso, A., Violanti, D. et al., 2012. Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. *Mediterranean Marine Science*, 13 (2), 328-352.
- Zerzeri, A., Djellouli, A.S., Mezgui, Y., Ben Hassine, O.K., 2010. Contribution à la caractérisation de la macroflore benthique des régions de Bizerte, Cap Zebib et Raf-Raf (Tunisie, Méditerranée). *Rapport P.V. Réunion de la Commission Internationale pour l'Exploration Scientifique de Méditerranée*, 39, 706 pp.