Aquatic Invasions (2010) Volume 5, Supplement 1: S97-S101
doi: 10.3391/ai.2010.5.S1.020

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Aquatic Invasions Records

First record of the invasive alga *Caulerpa racemosa* (Caulerpales, Chlorophyta) in the Gulf of Arzew (western Algeria)

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Received: 14 May 2010 / Accepted: 6 August 2010 / Published online: 6 September 2010

Abstract

The first invasive record of the green alga *Caulerpa racemosa* (Forsskål) J. Agardh in the Mediterranean Sea was in 1990 in Tripoli (Libya) (J. Agardh) and since that period, this Chlorophyta has been rapidly spreading to all Mediterranean countries. However, very few assessment studies have been carried out along the Algerian coast. In this paper, we present, for the first time new observation data concerning an indicated proliferation of this invasive species in Salamandre and Stidia (Gulf of Arzew, western Algeria); both these sites are very important for sea fishing activities and traffic.

Key words: *Caulerpa racemosa*, Biological invasion, Gulf of Arzew, Mediterranean

Introduction

Biological invasions are a widespread and significant component of human-caused global environmental change (Rejmánek 2008). In recent decades, marine and coastal bioinvasions represent a serious threat to ecosystems and native biodiversity and cause profound economic impacts (Ribera and Boudouresque 1995; Grosholz 2002; Ruesink et al. 2006; Occhipinti-Ambrogi 2007; Antolić et al. 2008).

The Mediterranean sea, particularly harbour areas, are considered to be the most severely affected regions for marine species invasions, where around 600 flora and fauna species are considered as introduced species (Boudouresque and Verlaque 2005; Boudouresque et al. 2005; Zenetos et al. 2005) and from which 100 macrophyte species (Ribera Siguan 2002) can be counted.

Since 1990, the Chlorophyta *Caulerpa racemosa* var. *cylindracea* has colonised 15 Mediterranean countries: Albania, Algeria, Croatia, Cyprus, France, Greece, Italy, Libya, Malta, Monaco, Montenegro, Morocco (Spanish city of Ceuta), Spain, Tunisia, Turkey (Verlaque et al. 2003; Klein and Verlaque 2008; Rivera-Ingraham et al. 2009), and all the major Mediterranean islands (Balearic Islands, Corsica, Crete, Cyprus, Sardinia, Sicily) (Verlaque et al. 2003), strongly interfering with native species (Verlaque et al. 2000; 2003; Piazzi et al. 2001a,b; Balata et al. 2004; Ruitton et al. 2005a; Piazzi and Balata 2008) and outcompeting the endemic Mediterranean sea-grass *Posidonia oceanica* (Linnaeus) Delile (Piazzi et al. 2001a, b; Antolić et al. 2008).

In the Algerian coast, the presence of *C. racemosa* was recently and for the first time reported in Algiers Bay (Ould-Ahmed and Meinesz 2007) (Figure 1; Table 1). The present paper reports the first occurrence of the *C. racemosa* "invasive variety" in the gulf of Arzew (western Algeria) in the framework of the macrophyte diversity assessment and marine pollution biomonitoring (Taleb et al. 2009) in

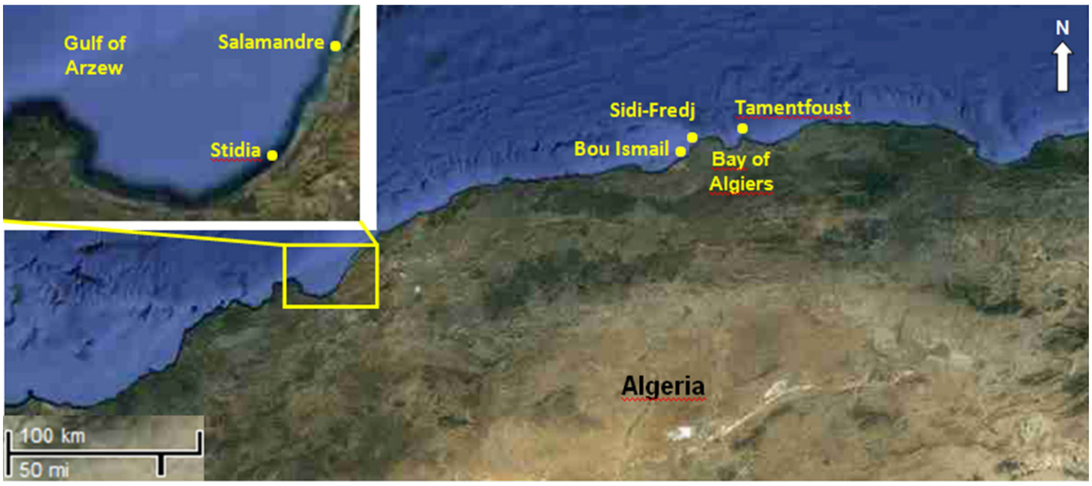

Figure 1. Geographical location of all records of *Caulerpa racemosa* in Algeria and our study area (yellow rectangle) (adapted from Google Earth, 2010).

Figure 2. *Caulerpa racemosa* in Salamandre site (- 1m) (left plate); (B) Thallus of *Caulerpa racemosa* of Stidia site (-0,5m) (right plate) (Photographs by B. Bachir Bouiadjra).

Table 1. Characteristics of the sampling areas colonized by *Caulerpa racemosa*.

Location		Geographic coordinates*		Depth (m)	Substratum	Surface (m^2)	Reference
		Latitude, N	Longitude, E				
Tamentfoust		36°48'29.64''	03°13'52.56''	0.50	-	-	Ould-Ahmed and Meinesz 2007
Sidi-Fredj		36°45'55.2''	02°50'50.82''	0.50	-	-	
Bou Ismail		36°41'39.23''	02°47'50.67''	0.50	-	-	
Salamandre	Station 1	35°55'12.46''	00°03'28.32''	0.50	Sand	1.30	Present study
	Station 2	35°55'11.62''	00°03'28.30''	0.50	Sand	2.24	Present study
	Station 3	35°55'08.07''	00°03'27.20''	0.60	Rock	04	Present study
	Station 4	35°55'06.15''	00°03'27.09''	0.80	Sand	150	Present study
Stidia	Station 1	35°50'1.45''	00°00'49.79''	0.50	Sand – Rock	200	Present study
	Station 2	35°50'2.29''	00°00'49.12''	0.40	Sand – Rock	1.30	Present study
	Station 3	35°50'3.96''	00°00'48.94''	0.40	Sand – Rock	210	Present study
	Station 4	35°50'4.22''	00°00'47.30''	0.30	Sand – Rock	2.80	Present study

* Positions were recorded using differencial Garmin 12 GPS

this coastal marine area, and will contribute to fill the data gaps of this algal proliferation in the south west of the Mediterranean basin.

Materials and methods

Sampling was focused on the Stidia and Salamandre sites located in the west of the industrial and fishery harbour of Mostaganem City (Figure 1; Table 1), where a large population of *C. racemosa* was observed during November 2009, the period corresponding to the annual maximum development of these species in the northwest of the Mediterranean sea (Capiomont et al. 2005; Ruitton et al. 2005b).

In order to record the scale of distribution and the density of *C. racemosa* as well as the associated native macroalgae and seagrass at each site, four 1 m^2 quadrats were laid at random on the bottom of four stations spread out along a 500 m transect. The abundance of the seaweed and seagrass species occurring within the quadrats was estimated in percentage cover.

Results and discussion

Caulerpa racemosa' (Figure 2) observed percentage cover in all stations varied between 92 to 100% and 72 to 100% respectively in Salamandre and Stidia monitored sites (Figure 3).

The absence of the phaeophyceae *Cystoseira* spp., indicators of high ecological status was also noted, while on the other hand the presence of both *Corallina elongata* J. Ellis and Solander and *Ulva lactuca* Linnaeus (Figure 3) were recorded, indicating poor to bad coastal water quality (Arévalo et al. 2007).

The recent appearance of the invasive alga *C. racemosa* in this study area can be attributed to the importance of sea traffic in this Mediterranean zone, because our observation stations are very close to the large petrochemical harbour of Arzew and the industrial and fishery harbour of Mostaganem. However, the increased occurrence of *C. racemosa* at the proximity of large cities, industrial, cargo, passenger, fishery and recreational boating harbours does not necessarily demonstrate an affinity for polluted areas but may be an artefact due to secondary dispersal mechanisms via ship traffic and fishing activities (Klein and Verlaque 2008). At least, it attests to the tolerance of *C. racemosa* to high levels of pollution.

Posidonia oceanica was recorded only at two stations at the Salamandre site (Figure 3). The percentage cover rate ranges from 26 to 62%. Several studies conducted on the impact of *C. racemosa* on macrophyte assemblages (rocky substrate, dead *Posidonia oceanica* mats, coralligenous and detritic assemblages) indicate a decrease in the total number of species and in the total macrophyte cover in the presence of *C. racemosa* (Ceccherelli et al. 2001; Piazzi et al. 2001a, b; 2005; Piazzi and Cinelli 2003; Balata et al. 2004; Cinelli et al. 2007; Klein and Verlaque 2007; Antolić et al. 2008).

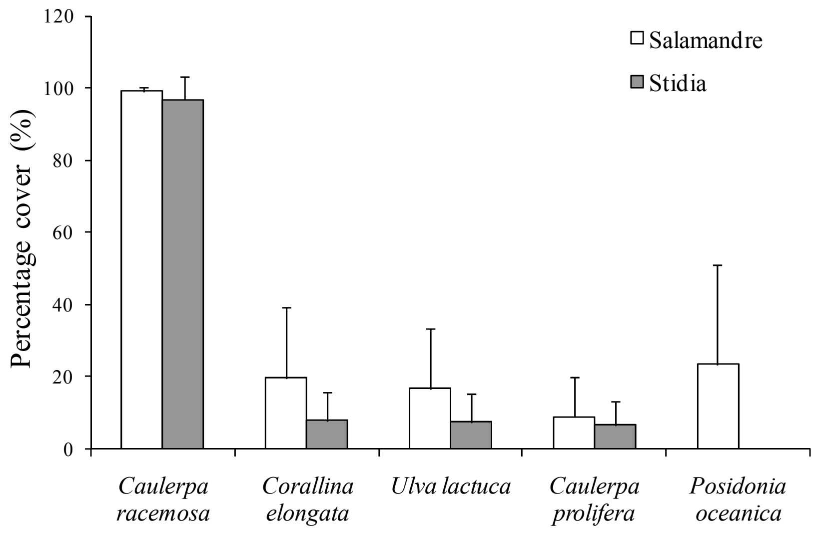

Figure 1. Percentage cover of *Caulerpa racemosa* and native *Corallina elongata*, *Ulva lactuca*, *Caulerpa prolifera* and *Posidonia oceanica* in Salamandre and Stidia sites.

The exposure of the Salamandre and Stidia colonised area to winds, strong waves and important hydrodynamic flow, resulting from prevailing West to South-West winds (43%) from October to February and East to the North-East winds (40%) from May to September (ONM 2009), in addition to the flow of the coastal cyclonic currents in the Gulf of Arzew (Mega 2002; Mega and Lensari 2006) could reinforce the hypothesis of the dispersion of *C. racemosa* to this coastal zone.

The Stidia site represents a small fishery harbour where fishermen clean their nets, sometimes charged with algae, in particular *C. racemosa*. On this subject, the economic impact of *C. racemosa* has never been quantified (Klein and Verlaque 2008). However, there has been some speculation on the basis of observations by fisherman in Italy who found their fishing nets clogged with *C. racemosa* (Magri et al. 2001).

Conclusion

The data of this preliminary survey reflect the possible consequences of the *C. racemosa* invasion event in this area including modifications of physical and chemical conditions (water movement, sediment deposition, substrate characteristics), as well as profound modifications of benthic assemblages. The study emphasises the need to develop more monitoring research program and policies aimed at prevention and mitigation of the impacts of aquatic invasive alien species on the biological diversity of the Algerian coast.

Acknowledgements

This research is a part of Doctorate thesis on macrophytes diversity assessment in the gulf of Arzew (western Algeria) supported by a grant of the University Abdelhamid Ibn Badis (Mostaganem, Algeria), and the scientific cooperation of the University Abdelmalek Essaâdi (Tétouan, Morocco). Authors thank the assistants, Saïd Kaida and Houcine Boussena, for their invaluable field help.

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