

The Project “*Caulerpa cylindracea* in the Egadi Islands”: citizens and scientists working together to monitor marine alien species

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ABSTRACT

The creation of early-warning systems is crucial for preventing and reducing the risk of invasive species introduction. In this respect, the contribution of citizen-scientists (tourists, students, teachers, divers and fishermen) in providing information and data (validated by taxonomic experts) on the occurrence of marine invasive species that would otherwise be impossible to collect, is crucial in understanding the phenomenon of biological invasions. The Citizen Science Project “*Caulerpa cylindracea* - Egadi Islands”, launched in 2014 and ended in 2016, aimed at creating a database on the spread dynamics and the levels of threat of the invasive green alga *Caulerpa cylindracea* within the Egadi Islands Marine Protected Area (MPA). The Project registered numerous followers and different groups of volunteers (students, tourists, divers, underwater photographers, amateurs and fishermen) were involved. In all 156 sightings (18 Divers, 9 Researchers, 91 Citizens, 38 Scientific Team) were collected. The alga was reported from all the three main Islands even though the majority of the records were from Favignana Island. Useful information on the behaviour strategies of the alga was also gathered.

KEY WORDS

Caulerpa cylindracea; Citizen Science; Invasive species; Egadi Islands Marine Protected Area.

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INTRODUCTION

Marine alien species, considered one of the most serious threats to biodiversity (Bax et al., 2003; Wallentinus & Nyberg, 2007), currently raise serious concerns in the scientific community. The Mediterranean Sea, an important hotspot for alien species (about 1,000), is one of the major areas severely affected by marine invasions (Coll et al., 2010; Lejeune et al., 2010; Zenetos et al., 2012; Galil et al., 2015). As far as marine macrophytes are concerned, a total of one hundred and thirty three

species have been listed as possible aliens in the Mediterranean Sea (Verlaque et al., 2015).

According to the report on Alien Species in Italian Seas (updated in 2016) compiled by the SIBM Allochthonous Species Group (ASG), a relatively high number of alien macrophytes (55) was reported along the Italian coasts (GSA-SIBM, 2016). Sicily and its surrounding islands, as consequence of their geographic position and the intense maritime traffic, including that related to fisheries and recreation (Occhipinti-Ambrogi et al., 2011a, b; Katsanevakis et al., 2014) that foster the

introduction of marine alien species, is a region particularly vulnerable and susceptible to biological invasions (Bianchi, 2007; Occhipinti-Ambrogi et al., 2011a, b; Katsanevakis et al., 2012, 2014), despite the high number of Marine Protected Areas (MPAs) already established. In fact, high numbers of visitors, increasing disturbance and vectors (e.g. boat anchors, SCUBA equipment, bilge water, hull fouling) (Minchinton & Bertness, 2003; West et al., 2007; Britton-Simmons & Abbott, 2008; Burfeind et al., 2013), could promote the introduction of invasive species.

For a better understanding of the invasive potential and spread dynamics of invasive species, any newly colonized area needs to be quickly detected (Klein & Verlaque, 2008). Therefore, regular monitoring programs, including public awareness campaigns, are crucial for assessing the spread dynamics of invasive species and for planning effective management strategies. Since intensive monitoring programs could be very expensive, Citizen Science, engaging citizens (e.g. tourists, fishermen, divers) in the collection of information and scientific data, could be a useful tool for providing data on the occurrence and spread of marine alien species that would otherwise be impossible to collect because of limitations on time and resources. Of course, all these data need a validation by taxonomic experts for the scientific community to accept and utilize them for scientific purposes and management decisions.

Among marine invasive species, *Caulerpa cylindracea* Sonder, 1845 (until Belton et al., 2014 it was reported in the literature as *Caulerpa racemosa* var. *cylindracea* (Sonder) Verlaque, Huisman and Boudouresque, 2003) has raised serious concern due to its ascertain impact on Mediterranean communities (Boudouresque et al., 1995; Dumay et al., 2002; Antolić et al., 2008; Klein & Verlaque, 2008; Piazzini & Balata, 2008; Papini et al., 2013; Katsanevakis et al., 2014).

So, on 27th August 2014 we launched the Citizen Science Project “*Caulerpa cylindracea* - Egadi Islands” (sponsored by the Department of Biological Chemical and Pharmaceutical Sciences and Technologies, University of Palermo and the Egadi Islands MPA), aimed at creating a database, available online, on the spread and the levels of threat of this invasive alga within the Egadi Islands MPA and

also at making aware citizens, sportsmen, fishermen, divers on the phenomenon of biological invasions. We present here the results of this Project, ended in summer 2016.

MATERIAL AND METHODS

The Egadi Islands MPA (Aegadian Archipelago) is the largest Italian MPA which was instituted in 1991. This small archipelago, located approximately 7–9 km from the western coast of Sicily (Italy, Tyrrhenian Sea), is composed of three main islands (Favignana, Marettimo and Levanzo) and a few small islets (Galeotta, Galera, Preveto, Formica and Maraone) (Fig. 1).

The Project, addressed to different group of volunteers (students, tourists, divers, underwater photographers, amateurs and fishermen), was based on the collection of data (place, date, depth, substrate coverage %) and photos concerning the occurrence of *C. cylindracea* within the MPA. Volunteers could send their data either using a mail address, a facebook page, the MPA website or filling a form available online or in the MPA's offices. Only data validated by the Scientific team of the Project were gathered in the database.

RESULTS AND DISCUSSION

The first results of the Project were presented during the International Congress GeoSub2016 (Ustica, 14–17 September). The facebook page of the Project registered numerous followers (3000 in the last month of the Project) and liked to 484 followers (90% were Italian). In all we gathered 156 sightings (Fig. 2). The alga was reported from all the three main Islands even though the majority of the records were from Favignana (Fig. 1). It was found between 0 and 40 m depth, on rock, rock with sediment, sand and in coralligenous habitat (Fig. 3). Useful information on the behaviour strategies of the alga was also gathered, e.g. the ability of the stolons to create bridges in order to reach new areas for the anchorage and the strength of the anchorage due to the high number of rhizoids (Fig. 4). These strategies allow *C. cylindracea* to spread rapidly, forming compact multilayered mats able to trap

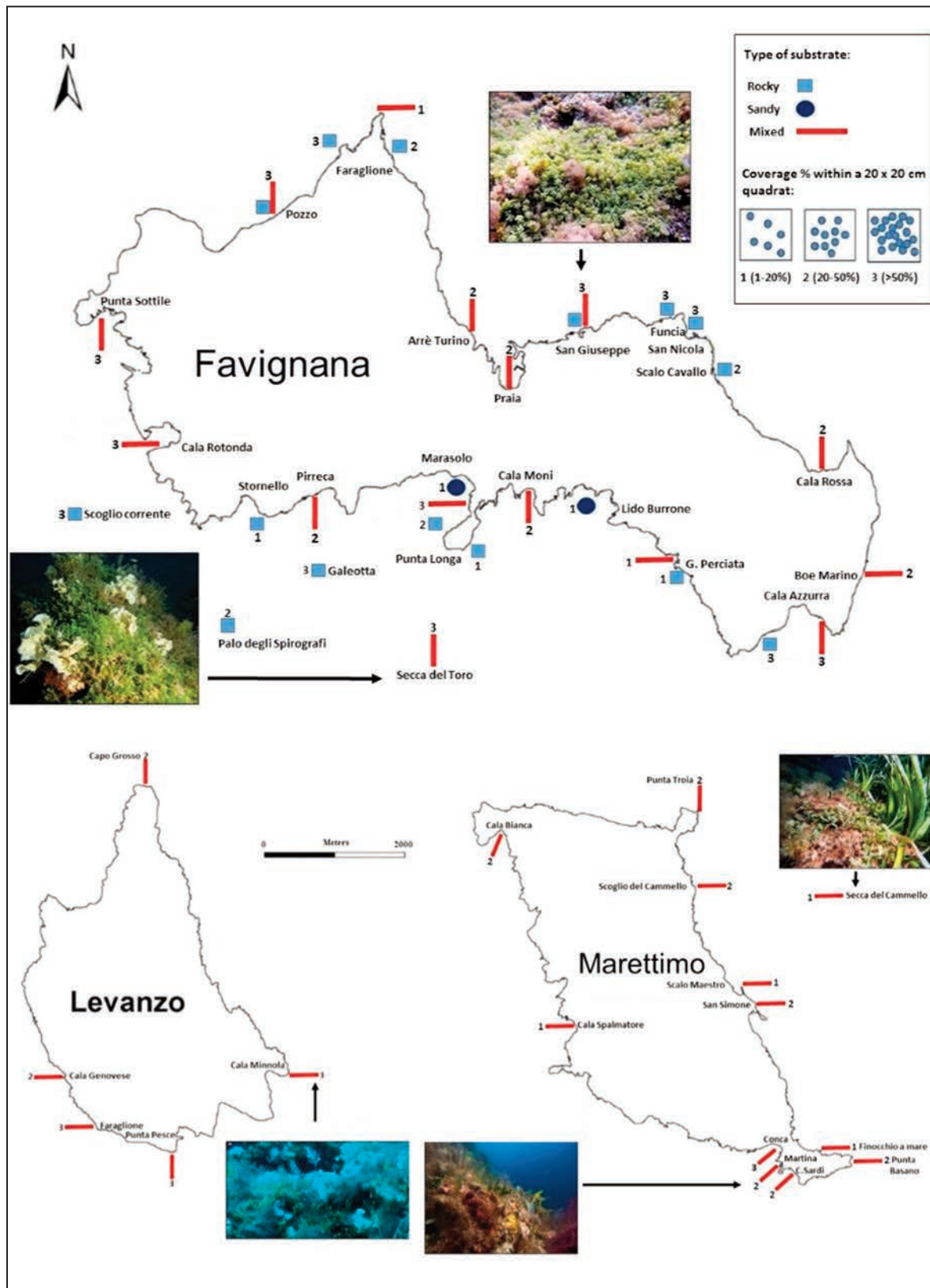


Figure 1. Occurrences of *Caulerpa cylindracea* within the Egadi Islands Marine Protected Area (MPA).

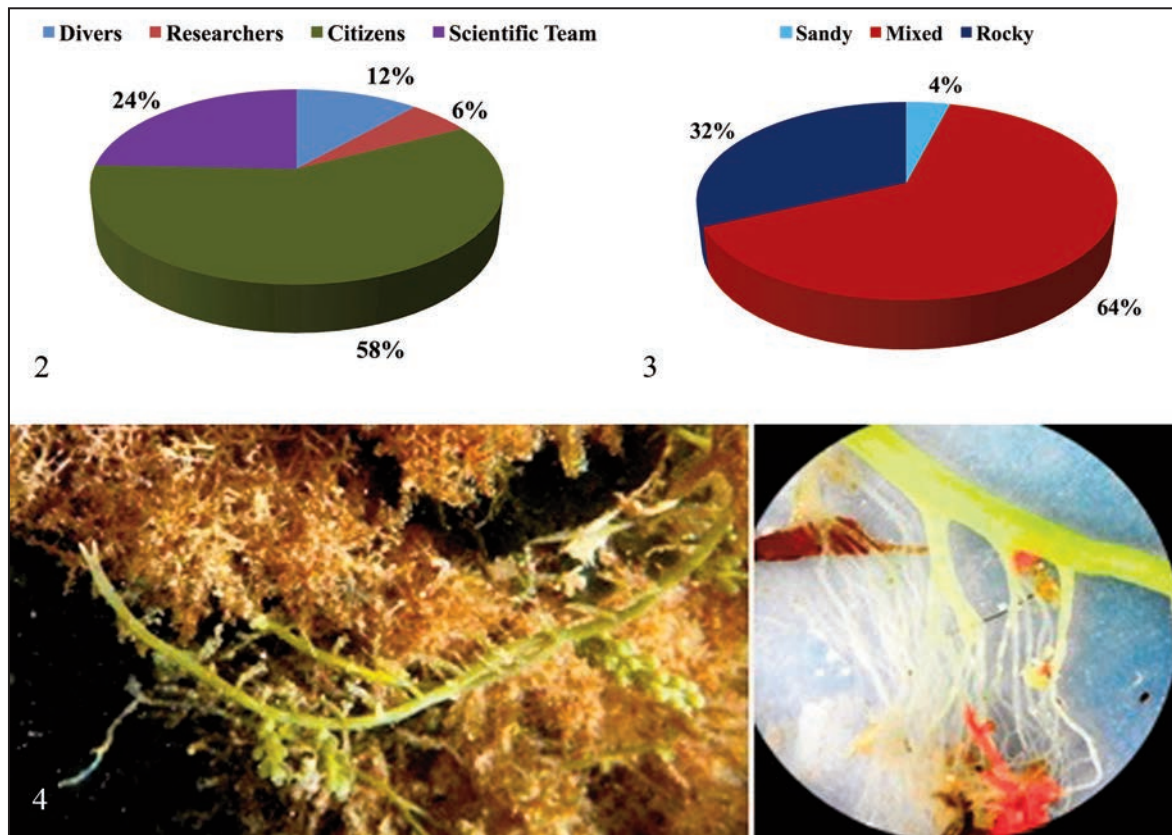


Figure 2. Percentage of the different groups of volunteers. Figure 3. Percentage of the different substrate typologies. Figure 4. A bridge created by the stolons of *Caulerpa cylindracea* (left). Cluster of rhizoids from the stolon of *C. cylindracea* (right).

the sediment that negatively affect the native assemblages (Klein & Verlaque, 2008; Holmer et al., 2009; Matijević et al., 2013). A relationship between frond length and substrate typology was also observed with longer fronds observed on sand substrates. Since higher coverage values were observed in areas where the anchorage of boats is permitted, we hypothesize that the anchorage activities, mostly carried out by pleasure boats, may also favour the spread of *C. cylindracea*.

All recorded information would allow to create a permanent observatory and an early-warning system of detection and if possible of control, that can be also a useful tool in planning suitable management programs within the MPA such as a) the regulation of the activities (e.g. anchorage, mooring, diving, maritime traffic), b) the promotion of public awareness campaigns and training on the biological invasions phenomenon and c) the planning of regular monitoring programs.

The results of this project highlight how important is the contribution of citizen scientists in understanding the phenomenon of biological invasions. Moreover, in areas particularly vulnerable to biological invasions, such as Sicily, the creation of observatories might be effective in the management of present and future introductions of alien species within the Mediterranean Sea.

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