

Short Communication

Citizen science detects the undetected: the case of *Abudefduf saxatilis* from the Mediterranean Sea

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Received: 14 May 2013 / Accepted: 5 June 2013 / Published online: 19 June 2013

Handling editor: Vadim Panov

Abstract

Volunteers are increasingly involved in environmental research and their role in monitoring biological invasions is rapidly expanding in the Internet Era. On November 2012, a recreational diver reported the sighting of an unidentified and unfamiliar fish to an interactive web project 'Seawatchers' (<http://www.observadoresdelmar.es>) that aims to acquire geo-referenced observations of exotic fish species in the Mediterranean Sea. The individual was spotted on August 2009 along the coast of Tarragona, Spain and it was later identified as the Sergeant major *Abudefduf saxatilis* (Teleost, Pomacentridae), a tropical Atlantic species previously unrecorded in the Mediterranean Sea. This finding highlights the potential of citizen scientists in revealing the occurrence of new exotic fishes in the marine environment, providing a small but concrete advancement towards early detection, which is important for management of biological invasions.

Key words: citizen science; biological invasions; non-indigenous fish; Pomacentridae; Western Mediterranean Sea

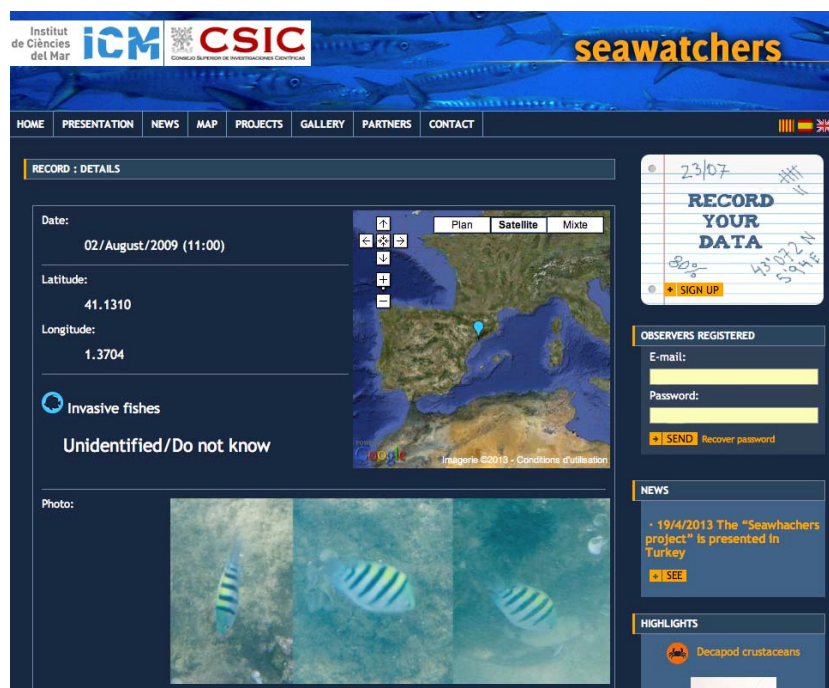
Introduction

Marine invaders spreading through new areas are typically difficult to monitor (Delaney and Leung 2010) and specific procedures for their detection are generally lacking in most marine regions (Wittenberg and Cock 2001) such as in the Mediterranean Sea (Azzurro 2008). Due to the vastness of the oceans and the difficulty of logistics required, individual scientists cannot reliably track the arrival of new species, but simply report their occurrence when an opportunity arises. Thus, non-indigenous species can remain undetected for years after the initial colonization (Crooks 2005) and this is especially true for poorly studied taxa and less monitored areas. This lag in detection (Crooks 2011) has profound consequences in our ability to be informed about the spread of tropical invaders, which is accelerating in recent decades due to increasing importance of global changes (Mooney and Hobbs 2005). Detection gap generates biases in

the observed spatio-temporal distribution of exotic species and contributes to underestimating the dimension of marine bio-invasions, with obvious consequences for management. A reliable solution to this problem is volunteer-based (citizen-science) monitoring. Indeed members of local communities, because of their broad geographic distribution and familiarity with natural environment, can be of great help to track invasive species in both terrestrial and aquatic systems (Delaney et al. 2008). Moreover the increasing use of inexpensive photo and video equipment is giving citizens unprecedented chances to provide real data and verifiable observations about the natural world.

Here we document the first occurrence of the Sergeant major *Abudefduf saxatilis* (Linnaeus, 1758) in the Mediterranean Sea. The Sergeant major is a warm water species, widely distributed through tropical and subtropical latitudes of the Atlantic Ocean at depths ranging from 0 to 20 m (Allen 1991). It belongs to the Damselfishes

Figure 1. Screenshot of 'Seawatchers', showing the posted record of *Abudefduf saxatilis*. Date of observation, location, geographical coordinates, map and pictures are reported. The full page is available at: http://www.observadoresdelmar.es/observacion-detall.php?projecte_id=9&id=409



(Pomacentridae), a family of small coloured fishes occurring primarily on the coral reefs of tropical seas (Allen 1991). This species is also abundant in the Caribbean reefs and in the tropical coast of western Africa to Angola where it can form large feeding aggregations of a few hundred individuals (Randall 1996). In the Indo-Pacific region the Sergeant major is replaced by the Indo-Pacific Sergeant major *Abudefduf vaigensis* (Allen 1991), a closely related species. The latter has already entered the Mediterranean Sea through the Suez Canal (Tardent 1959; Goren and Galil 1998; Vacchi and Chiantore 2000) and has now established itself off the coast of the Levant with increasing numbers (CIESM 2012). On the other hand, to the best of our knowledge, there is no published evidence of the occurrence of *A. saxatilis* in the Mediterranean Sea.

Materials and methods

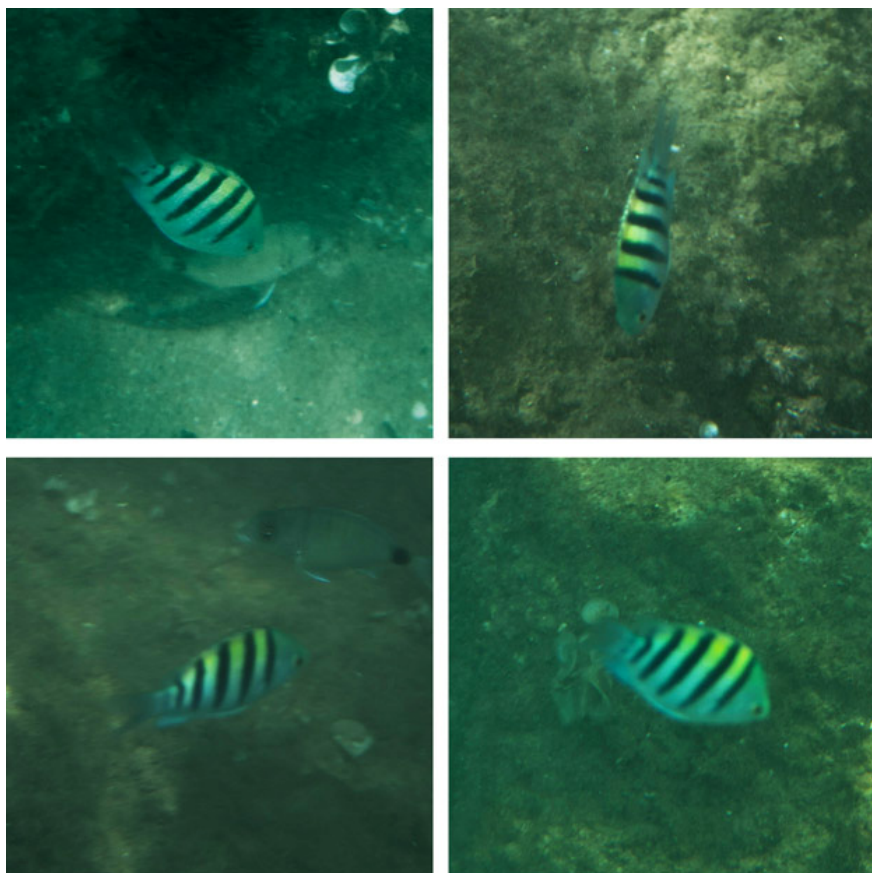
In May 2012, within the context of an online multidisciplinary citizen science web site called 'Seawatchers' (<http://www.observadoresdelmar.es>), we launched the project 'Invasive Fishes' aimed to collect citizen-generated data on the distribution of non-indigenous fish species in the Mediterranean region. People are invited to register

and report the occurrence of a number of target invaders. We also ask them to report the occurrence of "odd fishes" never captured or seen before, with the common goal of a scientific discovery. For each record, the system gives the possibility to upload one or more pictures together with additional relevant information (e.g. date, depth and geographical coordinates of the sighting). Supplementary data such as water temperature, habitat type and comments are also considered. A team of professional scientists with specific taxonomic expertise, act as editors and periodically verify-validate the records posted by the observers.

Results

On August 2nd 2009, a single specimen of *A. saxatilis* was photographed along the coast of Tarragona, Spain (Lat 41.1310, Long 1.3704) at 2 m depth, while snorkelling. The observation, realized by a recreational diver and photographer, was posted on 'Seawatchers' (Figure 1), on September 2012. We identified the species based on the provided photographs (Figures 1 and 2) that were taken with a Canon EOS 350D, Flash 580 EXII and underwater case Ewamarine, and contacted the observer to fully verify-validate the provided information.

Figure 2. High resolution pictures of *Abudefduf saxatilis* photographed on August 2nd 2009 along the coast of Tarragona, Spain (Lat 41.1310°, Long 1.3704°).



Photographs allowed the depiction of distinctive characters of *A. saxatilis*. This sufficed to distinguish this species from other damselfishes (Allen 1991) and from the co-generic *A. vaigensis*. The photographed specimen is described as follows: Oval shaped body, silvery-white belly and yellow upper body. Five prominent vertical black bars, the first from dorsal fin origin to pectoral fin base, the fifth from the posterior margin of dorsal and anal fin; two black spots on the caudal peduncle, close to the basis of caudal fin, one black spot (barely visible from the photograph) at the upper base of the pectoral fins. According to de Beaufort (1940) the extension of the fifth vertical bar, from the posterior margin of dorsal and anal fin is an unambiguous character to identify this species. Another unique and distinctive character of the Sergeant major is given by the two black spots on the caudal peduncle (Phil Heemstra, personal communication). Some authors describe this trait as an incomplete sixth bar, which may be present on the caudal extreme of the peduncle (Randall 1996).

Discussion

Spotting a new species in a new region is always a significant discovery for natural sciences but it assumes a particular original character if the observer is not a scientist but a passionate volunteer, spontaneously adhering to an online project. Certainly, this isolated record of *A. saxatilis* does not provide a clear indication of the mechanism of introduction. This species, for which aquarium trade exist, could have been released into the wild or just transported via ships, as suggested for the Indo-Pacific Sergeant major in the western Mediterranean (Tardent 1959; Vacchi et al. 2000). Natural range expansion, through the straits of Gibraltar is also a reasonable hypothesis. Whichever the mode of arrival, the Sergeant major in the Mediterranean Sea, this occurrence would have passed unnoticed without the help of volunteers, which is the reason why citizen science can be essential to the monitoring and management of invasive species. Recently, participatory actions have started to be

employed in the Mediterranean Sea with encouraging results (e.g. Azzurro et al. 2011).

In comparison to other groups of species (e.g. algae and invertebrates which require professional skills to be identified) coastal fishes present several advantages that make it easy to be spotted by volunteers. Fish species are often conspicuous, not difficult to observe and relatively easy to identify. This is the case of *A. saxatilis*, whose peculiar external morphology and colour pattern provide both an eye-catching look and unambiguous taxonomical characters.

In conclusion, the present record of *A. saxatilis* in the Mediterranean Sea has certainly an intrinsic importance, as the first documented evidence of a new species in a new marine region. In addition, the way in which this information has been retrieved, provide us with a remarkable example about the potential of citizen scientists in revealing the occurrence of new exotic species in the marine environment. To gain these inputs through trustful systematic methodologies, certainly increases the chances of early detection and it meets the urgency of tracking these newcomers in the real world. We do believe that the partnership between volunteers and scientists will lead to major advances in the field of biological invasions. Considering the rising use of social networking systems and mobile technologies (Robson 2012), promising and rapid developments are envisaged for the near future. These actions may also trigger important synergies, generating public awareness and enhancing the exchange of information within the broad public, something that is another primary goal, in the field of invasion biology.

Acknowledgements

This work could not have been realized without the voluntary contribution of Raúl Cendón Soler, the volunteer who reported the observation of an unidentified specimen to ‘Seawatchers’ (<http://www.observadoresdelmar.es>). We also kindly acknowledge Phil Heemstra of the South African Institute for Aquatic Biodiversity for his valuable help in the identification of *Abudefduf saxatilis*, Joseba Santiago, who developed the informatics platform for ‘Seawatchers’ and Luca Saponari, who participates to the scientific and coordination activities of Seawatchers. Finally we thank two anonymous referees for their useful and constructive comments. This project has been founded by FECYT (Fundación Española para la Ciencia y la Tecnología) and Generalitat de Catalunya (Departament d’Economia i Coneixement, Secretaria d’Universitat i Recerca), in collaboration with the scientific projects CLIMCARES, VECTORS, CUBOMED and EN CHANGES.

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