BioInvasions Records (2020) Volume 9, Issue 1: 89–95

Rapid Communication

First record of the Atlantic spadefish *Chaetodipterus faber* (Broussonet, 1782) in the Mediterranean Sea: is it a new aquarium release?

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Citation: Giovos I, Tiralongo F, Langeneck J, Kaminas A, Kleitou P, Crocetta F, Doumpas N (2020) First record of the Atlantic spadefish *Chaetodipterus faber* (Broussonet, 1782) in the Mediterranean Sea: is it a new aquarium release? *BioInvasions Records* 9(1): 89–95, https://doi.org/10.3391/bir.2020.9.1.12

Received: 14 November 2019
Accepted: 8 January 2020
Published: 22 January 2020

Handling editor: Nir Stern
Thematic editor: Stelios Katsanevakis

Abstract

The Atlantic spadefish *Chaetodipterus faber* (Broussonet, 1782) belongs to the family Ephippidae Bleeker, 1859 and is a widely distributed species in the Western Atlantic. In this work we present the record of a single specimen of *C. faber* captured by a professional fisher in Argosaronikos Gulf, Greece. The present sighting, reported through the citizen science project "Is it Alien to you? Share it!!!", constitutes the first record of this species in the Mediterranean Sea. Given the distance from the Strait of Gibraltar and the absence of any report from western Mediterranean and eastern Atlantic countries, we argue that the specimen is likely to have been released from an aquarium hobbyist. With this record, a total of 27 alien fish species have been likely introduced in the Mediterranean through this pathway, all after year 2000. An increasing trend has been observed and we urge national authorities and relevant stakeholders for their cooperation on increasing the awareness of aquarium trade industry, while we also highlight the effectiveness of citizen science as an early warning system for alien species in the Mediterranean.

Key words: biological invasions, alien species, citizen science, Ephippidae, Greece, Aegean Sea

Introduction

The family Ephippidae Bleeker, 1859 comprises 20 omnivorous, deep-bodied, marine- and brackish-water fishes, commonly known as spadefishes (Froese and Pauly 2019). The Atlantic spadefish *Chaetodipterus faber* (Broussonet, 1782) is widely distributed in the Western Atlantic coast, from Boston down to south Brazil (Figueiredo et al. 2002) and can be found in large schools of up to 500 individuals along the coast over wrecks, reefs and brackish lagoons or around buoys, mangroves, under bridges and in harbors (Lieske and Myers 1994). It can be also found mimicking dead leaves or floating debris (Lieske and Myers 1994). It feeds on crustaceans, mollusks, annelids,

cnidarians, as well as plankton, and can reach up to ~ 90 cm TL (Robins and Ray 1986) (more commonly ~ 50 cm: see Figueiredo et al. 2002); it usually reaches sexual maturity at ~ 13.5 cm (Hayse 1990). Notably, this taxon is not only quite popular among recreational fishers, but also in aquarium trade, with a relatively higher market demand worldwide (Froese and Pauly 2019).

Such interest by aquarists makes it liable to be introduced to foreign ecosystems by being released outside its native range. Indeed, aquarium trade is considered as an important pathway of introductions worldwide (Padilla and Williams 2004), and it ranks fourth among the most significant pathways for the introduction of fishes, invertebrates, and plants even in Europe, including the Mediterranean Sea (Katsanevakis et al. 2013; Tsiamis et al. 2018). In Greece, several alien species were recorded with intentional or unintentional release from aquaria as the most probable pathway (Zenetos et al. 2018 and references within).

Citizen science is an effective tool for monitoring marine non-indigenous species (NIS) in the Mediterranean Sea (Crocetta et al. 2015; Tiralongo et al. 2019; Giovos et al. 2019). The number of projects and efforts has increased significantly in the last years (e.g. AlienFish, Mediterranean Marine Life, Oddfish, Spot the Alien Fish etc; see Giovos et al. 2019). In 2016, iSea launched the citizen science project "Is it alien to you? Share it!!!" with the main aim to improve the knowledge on the distribution and the expansion of NIS in Greece and the entire Mediterranean Sea. The project has an online data platform, in which citizen scientists can easily upload photographic material along with information about the specimen size, observation depth, substrate type, number of specimens, exact location (coordinates), date, and type of observation. A team of taxonomic experts identifies the species to the lowest taxonomic level possible and validates the observation before a record is uploaded in the project's database (see Giovos et al. 2019). Hereby, we present the first record of *C. faber* in the entire Mediterranean basin, based on an observation reported to the project, and the consequent examination of the specimen.

Materials and methods

The donated specimen was examined in the lab, and all the morphological measurements and meristic counts were taken to allow a definite identification following Randall (1996).

Moreover, an exhaustive review took place, based on previous work by Zenetos et al. (2016), for summarizing all the reports of alien species in the Mediterranean suspected to be introduced via aquarium trade.

Results

In November 2019, a citizen scientist reported a capture of an unknown fish species (Figure 1) in the project's platform. The specimen was captured by a professional fisher, friend of the reporter, with fixed-nets on the 6th of

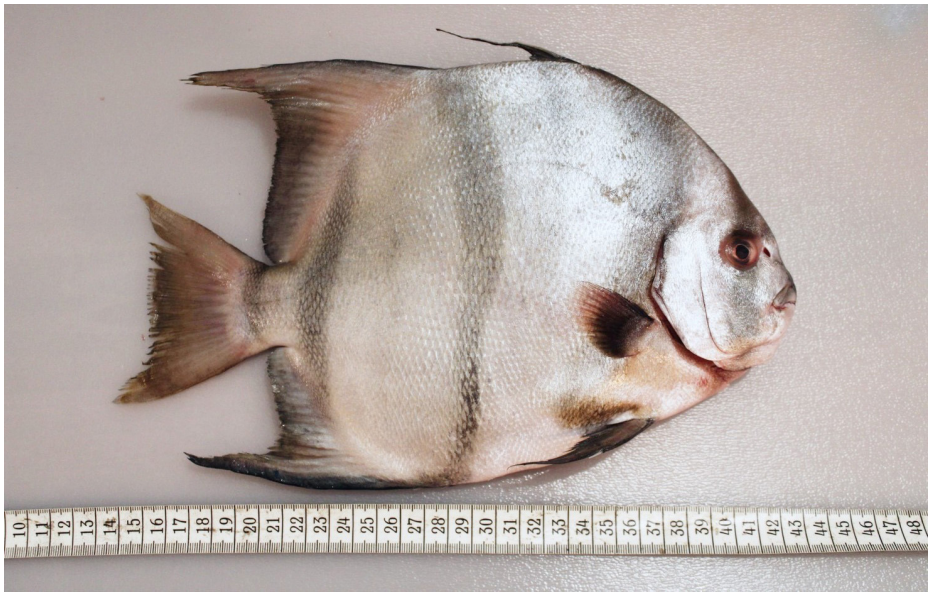

Figure 1. The Atlantic spadefish specimen captured in Argosaronikos Gulf by a small-scale fisher with nets and reported to the project "Is it Alien to you? Share it!!!"

Table 1. Morphometric and meristic measurements of the captured Atlantic spadefish specimen examined in the context of the present study.

Morphometric characteristics	cm
Total length	28,9
Fork length	27,8
Standard length	23,5
Pre-anal length	11
Head length	6,6
Eye diameter	1,5
Snout length	5,1
Body height	18
Fin rays	No
Dorsal spines	9
Dorsal rays	22
Anal spines	3
Anal rays	18
Weight	gr
Total weight	791
Liver weight	23

November 2019, at 30 m depth, in Isthmia (37.911468°N; 23.013841°E), Argosaronikos Gulf (Aegean Sea). It was soon identified by the iSea taxonomic experts as *Chaetodipterus faber* on the basis of the following morphological traits: disk-shaped body, blunt snout, irregular 4–6 black vertical bands with first running through eye and last running through caudal peduncle (Randall 1996). Consequently, the project's team contacted the reporter in order to retrieve the specimen. The fisher donated the specimen, and the identification was further confirmed on the basis of the following morphological traits: 9 dorsal spines and 21–24 soft dorsal rays, 3 anal spines and 17–19 anal rays, and jaw with small and brushlike teeth (absent on roof of mouth) (Randall 1996). Morphological measurements and meristic counts of the specimen are reported in Table 1.

Table 2. List of alien fish species suspected to be introduced in the Mediterranean via aquarium trade.

Species	Origin	Year	Country	Source
Siganus virgatus (Valenciennes, 1835)	Indo – Pacific	1975	Croatia	Ahnelt (2016)
Pseudanthias squamipinnis (Peters, 1855)	Indo-West Pacific/Red Sea	2000	Lebanon	Bitar (2013)
Epinephelus merra Bloch, 1793	Indo-Pacific	2004	France	Lelong (2005)
Lutjanus jocu (Bloch & Schneider, 1801)	West Atlantic	2005	Italy	Vacchi et al. (2010)
Platax teira (Forsskål, 1775)	Indo-West Pacific/Red Sea	2006	Turkey	Bilecenoglu and Kaya (2006)
Scatophagus argus (Linnaeus, 1766)	Indo-Pacific	2007	Malta	Zammit and Schembri (2011)
Zebrasoma flavescens (Bennett, 1828)	Pacific	2008	Spain	Weitzmann et al. (2015)
Pomacanthus imperator (Bloch, 1787)	Indo-West Pacific/Red Sea	2009	Israel	Golani et al. (2010)
Pomacanthus maculosus (Forsskål, 1775)	West Indian/Red Sea	2009	Lebanon, Israel	Bariche (2010); Salameh et al. (2012)
Lutjanus sebae (Cuvier, 1816)	Indo-West Pacific/Red Sea	2010	Greece	Zenetos et al. (2016)
Acanthurus coeruleus Bloch & J.G. Schneider, 1801	West Atlantic	2011	Cyprus	Langeneck et al. (2012)
Balistoides conspicillum (Bloch & Schneider, 1801)	Indo-West Pacific	2012	Spain	Weitzmann et al. (2015)
Acanthurus chirurgus (Bloch, 1787)	West Atlantic	2012	Italy	Langeneck et al. (2015)
Chrysiptera cyanea (Quoy & Gaimard, 1825)	Indo-West Pacific	2013	Slovenia	Lipej et al. (2014)
Stegastes variabilis (Castelnau, 1855)	West Atlantic	2013	Malta	Evans et al. (2015); Vella et al. (2015a)
Lutjanus fulviflamma (Forsskål, 1775)	Indo-Pacific/Red Sea	2013	Malta	Evans et al. (2015); Vella et al. (2015b)
Cryptocentrus caeruleopunctatus (Rüppell, 1830)	Red Sea	2014	Israel	Rothman and Goren (2015)
Abudefduf hoefleri (Steindachner, 1881)	East Atlantic	2014	Malta	Vella et al. (2016)
Zebrasoma xanthurum (Blyth, 1852)	Indian/Red Sea	2015	Italy	Guidetti et al. (2016)
Paracanthurus hepatus (Linnaeus, 1766)	Indo-Pacific	2015	Israel	Marcelli et al. (2017)
Pomacanthus asfur (Forsskal, 1775)	Indo-West Pacific/Red Sea	2015	Malta	Deidun and Bonnici in Karachle et al. (2016)
Holacanthus africanus Cadenat, 1951	Eastern Atlantic	2017	Malta	Deidun et al. (2017)
Chrysiptera hemicyanea (Weber, 1913)	Indo-West Pacific	2017	Malta	Deidun et al. (2018)
Acanthurus sohal (Forsskål, 1775)	Red Sea/Arabian Gulf	2018	Greece	Giovos et al. (2018)
Abudefduf sexfasciatus (Lacepède, 1801)	Indo-Pacific/Red Sea	2018	Greece	Giovos et al. (2018)
Chaetodon auriga Forsskål, 1775	Indo-Pacific/Red Sea	2018	Italy	Tiralongo et al. (2018)
Arothron hispidus (Linnaeus, 1758)	Indo-Pacific/Red Sea; Gulf of California and Panama	2018	Cyprus	Bariche et al. (2018)

Discussion

The present record constitutes the first observation of *Chaetodipterus faber* in the Aegean coasts of Greece and the entire Mediterranean Sea.

Given the West Atlantic origin of the species, and the lack of additional sightings from western Mediterranean countries (i.e. Spain, Morocco, France) and even Eastern Atlantic Ocean close to the Strait of Gibraltar (i.e. Portugal, Morocco, Mauritania), we suspect that this specimen was most likely released from an aquarium, given the popularity of the species in the ornamental fish industry. Zenetos et al. (2016) recently reviewed the alien fishes possibly introduced in the Mediterranean Sea through aquarium releases. By analyzing the data collected by those authors, and with the present addition, a general increase of species reported through this pathway can be noticed in the recent years (Table 2; Figure 2). This may be partially attributed to the increasing number of citizen science efforts currently taking place in the Mediterranean basin. Regardless, increasing awareness is a goal in Regulation (EU) No 1143/2014 "on the prevention and management of the introduction and spread of invasive alien species" that applies to all EU countries. Thus, such a trend must recall the attention of national authorities and relevant stakeholders for advancing their efforts for the

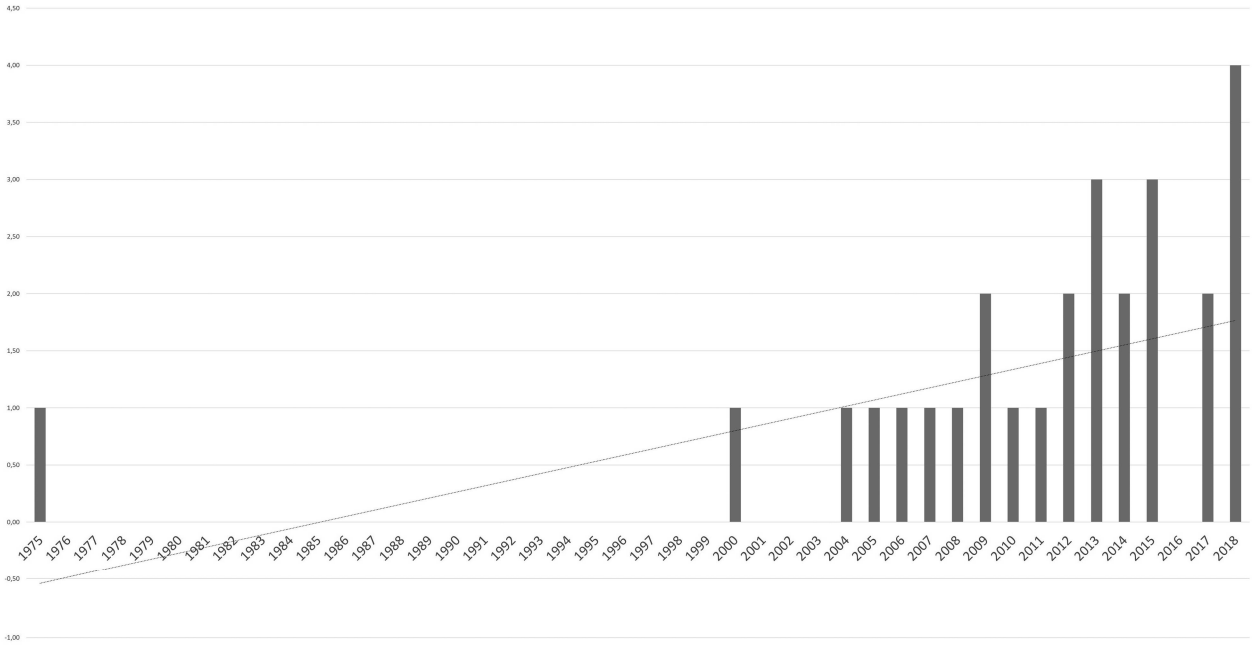

Figure 2. Number of records of alien species suspected to be introduced through an aquarium release in the Mediterranean Sea

implementation of the Regulation. At the same time efforts must also target to increase the awareness of aquarium trade industry and aquarium enthusiasts for preventing the escalation of this phenomenon.

Acknowledgements

We would like to warmly thank Kostas Fotaras for reporting the finding and donating the specimen to iSea and two anonymous reviewers and the editors for their insightful comments on the paper.

Funding declaration

The authors received no specific funding for this work.

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