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The role of social media in compensating for the lack of field studies: five new fish species for the Mediterranean Egypt

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Abstract

In the Mediterranean Sea, where biological invasions constitute a serious threat, the combination of citizen science and social networks amplified the power of proper field studies, recording species that would have otherwise presumably pass unnoticed. Based on data collected on several Facebook groups, we hereby first report the presence of five fish taxa (*Kyphosus* sp., *Heniochus intermedius*, *Pomacanthus imperator*, *Pomacanthus maculosus* and *Abudefduf* sp.) new for the Mediterranean Egypt, revise their distribution in the Mediterranean Sea, and discuss their possible introduction pathways. Finally, we provide some considerations on the potentiality of social media for citizen science projects.

KEYWORDS: non-indigenous species, Lessepsian immigrants, Facebook groups, citizen science, social networks.

The Mediterranean Sea represents one of the main biodiversity hotspots in the world, hosting over 8500 macroscopic species and a fish diversity of about 700 species (Bianchi & Morri, 2000; Coll *et al.*, 2010; Psomadakis *et al*., 2012). Its biodiversity is threatened by non-indigenous species (NIS) –

i.e. those introduced outside their natural range directly or indirectly by human activities (Essl *et al*., 2018), with about 1000 taxa recorded from the basin and introduced via pathways such as shipping, aquaculture, and corridors (Katsanevakis *et al*., 2014a; Zenetos *et al*., 2017). The Mediterranean Sea is also increasingly colonized by species of Atlantic origin that presumably entered the area through the Strait of Gibraltar (Crocetta *et al*., 2013; Canning-Clode & Carlton, 2017).

Monitoring species movements over the years represents an important target for the study of marine biodiversity on a large spatial scale and to address fundamental ecological questions across a diverse range of contexts and guide conservation practices and management (Kremen *et al*., 1994; Manley *et al*., 2004). Particular attention should be also paid to the early detection of NIS that may become invasive and cause adverse ecological and socioeconomic threats at a local or Mediterranean scale level (Katsanevakis *et al*., 2014b). In this view, citizen science constitutes a useful and efficient tool even in widely-studied biogeographic marine regions such as the Mediterranean Sea, and the use of social media amplifies data collection in a relatively short period of time (Ambrose-Oji *et al*., 2014; Bariche & Azzurro, 2016; Liberatore *et al*., 2018; Azzurro & Tiralongo, 2020). Indeed, in recent decades, the emergence of internet and crowdsourcing platforms provide an unprecedented source of diverse and accessible ecological data made available thanks to citizen scientists that researchers only beginning to explore (Kobori *et al*., 2016; Giovos *et al*., 2019; Tiralongo *et al*., 2019a). In this context, Facebook groups dealing with marine biodiversity and/or fishing activities cover a fundamental role in grouping people with a common interest in sharing photos/videos and offer novel opportunities for regular spatio-temporal data on "oddities", which improve the knowledge on the ecology, occurrence and distribution of the selected species (e.g. Giovos *et al*., 2019; Tiralongo *et al*., 2019b, 2020).

This is even more true for areas that received scarce attention due to objective constrains, such as the Mediterranean Egyptian coast, a region that also constitutes the frontline for the Lessepsian species spreading through the Suez Canal (Mavruk & Avsar, 2007; Galil *et al*., 2017). In fact, despite the Egyptian Mediterranean coastline extends for more than 1000 km, it has so far received little attention by the scientific community, with records of rare or non-indigenous species often scattered in specialist literature produced by few authors (e.g. Halim & Rizkalla, 2011; Moussa & Zenetos, 2015, 2016; Moussa *et al*., 2016; Akel, 2017a, 2017b; Akel & Rizkalla, 2017; Al Mabruk *et al*., 2020).

We hereby contribute to widen the knowledge of the local biota by reporting the presence of five fish taxa new from the Mediterranean coastline of Egypt, revising their distribution in the Mediterranean Sea, and discussing their possible introduction pathways.

Data were collected through periodic and regular search in Egyptian fishing groups on Facebook™ (Tuna – تونة; صيادين اسكندرية الريس عبدالله الصياد; خبراء الغوص و الصيد بالهربون; جروب الصياد

السكندرى; صيآدين في بحر مطروح; PATHOS Egypt; محترفي صيد الاسكندرية و الساحل; صيد السمك فى مصر; صيادين
اسكندرية والصيد بالهاربون) conducted during the entire year 2020. When one or more photos/videos of species of interest (non-indigenous and rare fish species) were posted in a group, the author of the posting was soon contacted in order to obtain additional data about the record (date, location, geographical coordinates, depth, fishing method, and notes) and to verify its credibility for the validation of the observation. For each species here reported, literature review of known Mediterranean records per species was performed.

Class Actinopterygii Klein, 1885

Order Perciformes Bleeker, 1863

Family Kyphosidae Jordan, 1887

Genus Lacepède, 1801

Kyphosus sp.

Material examined: 1 specimen (photo), Alexandria – El Montazah beach (31°17'27.4"N 30°01'17.6"E), 30th March 2017, 9 m, sandy bottom, *legit* Mohamed Khamis (Figure 1A).

Remarks: As the present specimen was not preserved, we cannot provide an identification at a species level. However, only two species of *Kyphosus* are recognized as being present in the Mediterranean Sea, namely *Kyphosus sectatrix* (Linnaeus, 1758) and *Kyphosus vaigiensis* (Quoy & Gaimard, 1825) (see Mannino *et al*., 2015). These species are both widely distributed in all oceans, including the Atlantic and Indo-Pacific regions and the Red Sea (Mannino *et al*., 2015). *Kyphosus sectatrix* was recorded in the western and central Mediterranean Sea since the 19th century, and recently reported also from Greece (Kiparissis *et al*., 2012). On the other hand, records of *K. vaigiensis*, although more recent, extend from the western to the eastern part of the basin (see Francour & Mouine, 2008; Orsi-Relini *et al*., 2010; Ligas *et al*., 2011; Azzurro *et al*., 2013; Mannino *et al*., 2015; Goren *et al*., 2016; Michailidis & Rousou, 2017; Kiyaga *et al*., 2019). Both fish are pelagic inshore species, but often also occur offshore under floating objects or ships. In the Mediterranean Sea, specimens were caught in shallow waters (generally up to 16 m on rocky or mixed bottom) with both recreational and professional fishing gears (Francour & Mouine, 2008; Orsi-Relini *et al*., 2010; Ligas *et al*., 2011; Kiparissis *et al*., 2012; Azzurro *et al*., 2013; Mannino *et al*., 2015; Kiyaga *et al*., 2019). The present sighting constitutes the first record of the genus *Kyphosus* in the Mediterranean waters of Egypt.

Family Chaetodontidae Rafinesque, 1815

Genus *Heniochus* Cuvier, 1816

Heniochus intermedius Steindachner, 1893

Material examined: 1 specimen (photo), El Dabaa – Marsa Matruh (31°04'07.4"N 28°28'13.7"E), 16th November 2017, 13 m, mixed bottom (sand and rocks), *legit* Fathi Nagi Abou Nagi (Figure 1B).

Remarks: Species identification was performed following Pyle (2001). Early Mediterranean records of this species, widespread in the Indo-West Pacific and the Red Sea (Erguden *et al*., 2016), date back to 2002, when a single specimen was observed in Turkey (Gökoglu *et al*., 2003). The species was subsequently recorded in Lebanon (2011: Bariche, 2012), again in Turkey (2011: Erguden *et al.*, 2016), and in Israel (2014: Tsadok *et al*., 2015) and Malta (2014: Evans *et al*., 2015). All specimens were recorded in 3–19 m depth on hard substrates. The present sighting constitutes the first record of the species in the Mediterranean waters of Egypt.

Family Pomacanthidae Jordan & Evermann, 1898

Genus *Pomacanthus* Lacepède, 1802

Pomacanthus imperator (Bloch, 1787)

Material examined: 1 specimen (photo), El Dabaa – Marsa Matruh (31°05'12.2"N 28°26'12.3"E), 15th May 2019, 12 m, mixed bottom (sand and rocks), *legit* Fathi Nagi Abou Nagi (Figure 1C).

Remarks: Species identification was performed following Golani *et al*. (2010). The first Mediterranean record of this species, widely distributed in the Indo-Pacific region (Randall, 2007), dates back to 2009 (Golani *et al*., 2010), when a single specimen was caught in Israel. The species was subsequently recorded in Syria (2017 and 2018: Capapé *et al*., 2018; Saad *et al*., 2018) and in Turkey (2019: Gurlek *et al*., 2019). All specimens were caught in 5–40 m depth on rocky and sandy bottoms. The present sighting constitutes the first record of the species in the Mediterranean waters of Egypt.

Pomacanthus maculosus (Forsskål, 1775)

Material examined: 1 specimen (photo), Alexandria (31°12'43.4"N 29°53'02.8"E), 27th August 2019, 10 m, mixed bottom (sand and rocks), *legit* Ahmed Elbarawy (Figure 1D); 1 specimen (photo),

Alexandria (31°18'36.7"N 30°04'23.7"E), 27th September 2019, 5 m, sandy bottom, *legit* Frass Fathy; 1 specimen (photo), Alexandria (31°13'26.1"N 29°53'56.3"E), 5th May 2020, 20 m, sandy bottom, *legit* Mohamed Hussein; 1 specimen (photo), Alexandria (31°16'14.7"N 29°59'17.5"E), 26th September 2020, 12 m, mixed bottom (sand and rocks), *legit* Mohammad Adel.

Remarks: Species identification was performed following Allen *et al*. (1998). The first Mediterranean record of this species, whose natural distribution extends from the Red Sea and Persian Gulf to Mozambique (Allen *et al*., 1998), dates back to 2009, when two specimens were observed in Lebanon and another specimen was caught in Israel (Bariche, 2010; Salameh *et al*., 2012). More recently, a specimen was recorded in Malta in 2012 (Evans *et al*., 2016). Three specimens were spearfished and one caught with trolling line in 10–25 m depth on rocky and mixed bottoms. The present sightings constitute the first records of the species in the Mediterranean waters of Egypt.

Family Pomacentridae Bonaparte, 1831

Genus *Abudefduf* Forsskål, 1775

Abudefduf sp.

Material examined: 1 specimen (video), Al Montazah-Askandria (31°17'39.3"N 30°01'10.4"E), 30th March 2013, 3 m, mixed bottom (sand and rocks), *legit* Mohammad Adel (Figure 1E).

Remarks: As the present specimen was not sampled, we cannot provide an identification at a species level. Four non-native *Abudefduf* species were recorded in the Mediterranean Sea so far, although the majority of the records regard the Atlantic *A. saxatilis* (Linnaeus, 1758) and the Indo-Pacific *A. vaigiensis* (Quoy & Gamard, 1825), that were recorded from all over the Mediterranean Sea (see Osca *et al*., 2020; Pirkenseer, 2020; Zenetos & Miliou, 2020; Dragičević *et al*., 2021). All specimens were generally observed in very shallow waters, in 2–4 m depth on hard bottoms. The present sighting constitutes the first record of the genus *Abudefduf* in the Mediterranean waters of Egypt.

This study reports five new fish taxa for the Mediterranean waters of Egypt, whose data were collected through various Facebook groups dedicated to fishery. Notwithstanding the evident limitations of this approach and the absence of concrete material, three of them were positively identified up to species level, namely *Heniochus intermedius*, *Pomacanthus imperator* and *Pomacanthus maculosus*, while the two remaining species were only identified up to genus level. With regards the former group of species, the details acquired are consistent with bathymetric range

(coastal shallow waters) and habitat type (mixed bottom) commonly reported in the literature from the Mediterranean Sea (see above). However, present sightings fill a gap in their known distribution and those of *P. maculosus* also double the number of individuals recorded so far from the entire Mediterranean basin from 4 to 8 specimens. These taxa all have a native distribution in the Indo-Pacific region, including the Red Sea, and were often considered as Lessepsian immigrants (Gökoglu *et al*., 2003; Bariche, 2010, 2012; Salameh *et al*., 2012; Tsadok *et al*., 2015; Gurlek *et al*., 2019). However, other pathways have been also proposed, such as aquarium release and shipping — taking also into account absence of records from the Mediterranean Egypt and isolated records held far from the Suez Canal (Golani *et al*., 2010; Evans *et al*., 2015, 2016; Erguden *et al*., 2016; Zenetos *et al*., 2016; Capapé *et al*., 2018; Saad *et al*., 2018; Giovos *et al*., 2020). Although also in the present case there are no certainties regarding a potential pathway of arrival, which may involve Lessepsian spreading, shipping, or aquarium release, or a combination of them, the vicinity between the Red Sea and the Egyptian areas where the records occurred suggests that all these species most likely entered unaided in the Mediterranean Sea via the Suez Canal. In addition, this may also have happened long time ago, with species remaining unnoticed in the area due to absence of targeted field studies, and thus the record of their presence in the Mediterranean Egypt may be presumably happening with a wide time lag — about 20 years for *H. intermedius* and 10 years for both *Pomacanthus* taxa, at least as based on their first records in the Mediterranean Sea. On the other hand, with regards the latter group of species (those of the genera *Kyphosus* and *Abudefduf*), their presence in the Mediterranean Egypt could be the result of a secondary introduction from populations already established in the nearby countries (Goren *et al*., 2016; Dragičević *et al*., 2021) or that may have reached the area through the Suez Canal, thus accounting for new alien introductions. Unfortunately, uncertainties in the identifications explained above prevent us to further discuss potential hypotheses.

Apart of that, the present paper confirms the importance of citizen science integrated with the use of social networks for the early detection and monitoring of alien and rare fish species in the Mediterranean Sea, especially in areas where targeted and/or in general field studies are scarce to absent. This is particularly true for the Mediterranean coast of Egypt, where the number of alien species occurring in the area is in all likelihood considerably underestimated and that has a pivotal role for the early detection of Lessepsian species. A close collaboration between researchers and sea users through social networks should be further improved and widened to species with no commercial interest or that are not consumed.

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AUTHOR CONTRIBUTIONS

S. A. A. A. M. collected data, wrote and revised drafts of the paper. A. A. collected data, wrote and revised drafts of the paper. O. N. collected data, wrote and revised drafts of the paper. M. A. collected data, wrote and revised drafts of the paper. F. C. wrote and revised drafts of the paper. N. D. wrote and revised drafts of the paper. P. K. wrote and revised drafts of the paper. F. T. wrote first draft of the manuscript, prepared figure and revised drafts of the paper.

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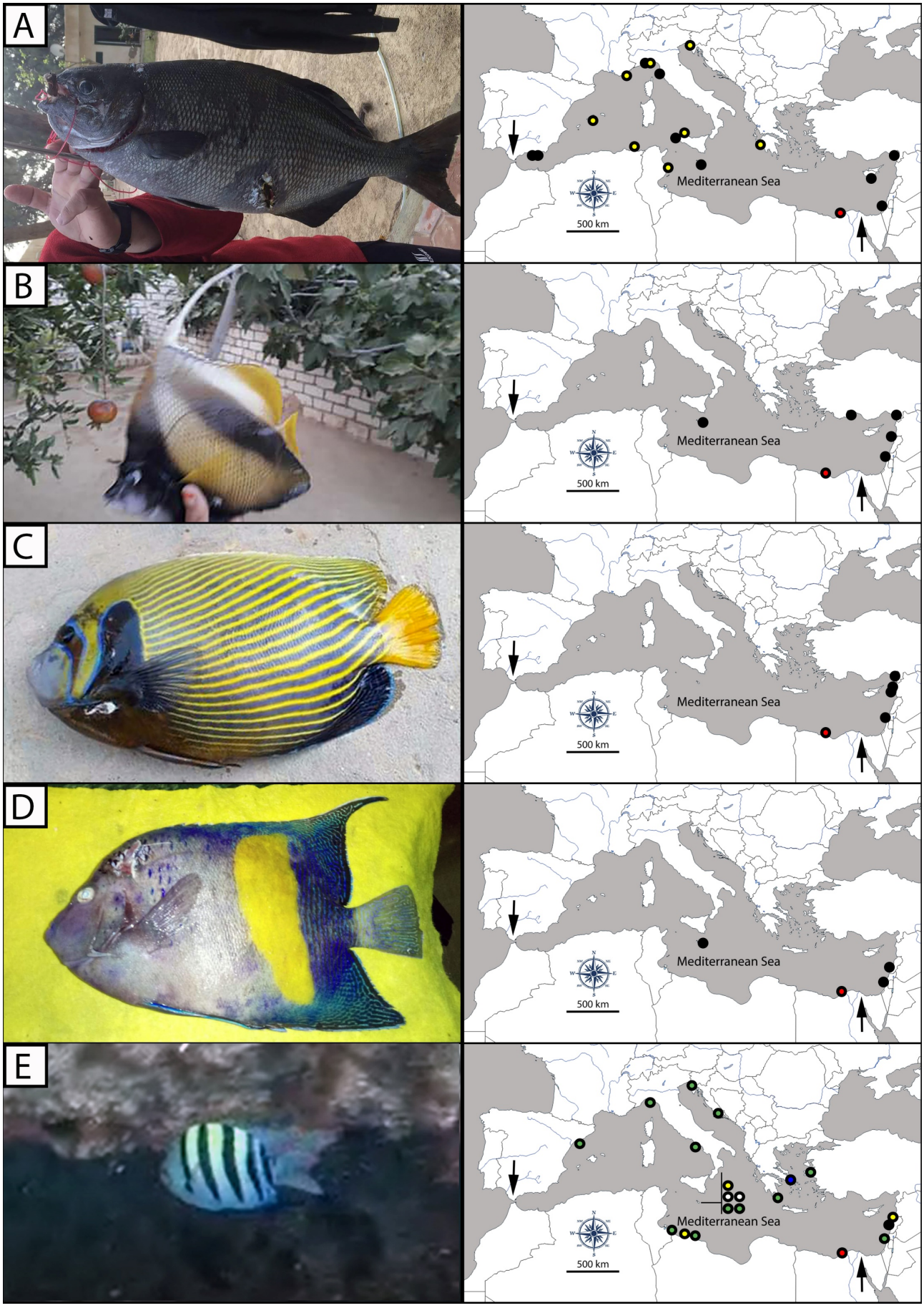

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Figure 1. *Kyphosus* sp. and map with all Mediterranean records for *K. sectatrix* (yellow circles) and *K. vaigiensis* (black circles), after Ligas *et al*., 2011; Azzurro *et al*., 2013; Mannino *et al*., 2015; Goren *et al*., 2016; Michailidis & Rousou, 2017; Kiyaga *et al*., 2019 (**A**). *Heniochus intermedius* and map with all Mediterranean records (black circles), after Evans *et al*., 2015; Tsadok *et al*., 2015; Erguden *et al*., 2016 (**B**). *Pomacanthus imperator* and map with all Mediterranean records (black circles), after Capapé *et al*., 2018; Saad *et al*., 2018; Gurlek *et al*., 2019 (**C**). *Pomacanthus maculosus* and map with all Mediterranean records (black circles), after Salameh *et al*., 2012; Evans *et al*., 2016 (**D**). *Abudefduf* sp. and map with all Mediterranean records for *A. hoefleri* (white circles), *A. saxatilis* (black circles), *A. sexfasciatus* (blu circle), *A. vaigiensis* (yellow circles) and *Abudefduf* sp. (green circles), after Pirkenseer, 2020; Zenetos & Miliou, 2020; Dragičević *et al*., 2021 (**E**). New record from Egypt are marked with red circles for all taxa in each map.