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Rapid Communication

Is the mangrove red snapper *Lutjanus argentimaculatus* (Forsskål, 1775) established in the eastern Mediterranean Sea? First records from Greece through a citizen science project

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Abstract

The Indo-Pacific mangrove red snapper *Lutjanus argentimaculatus* (Forsskål, 1775) (Chordata: Actinopterygii: Perciformes: Lutjanidae) is an alien fish that has recently invaded the eastern Mediterranean Sea, with records from Israel, Lebanon, and Turkey. We here first report the presence of this species in Greece based on three specimens spearfished between July and August 2019; they also represent the westernmost observations of the species in the Mediterranean basin up to date. After a long period of latency, this taxon seems to undergo a very rapid expansion. The likely presence of an established population in the eastern part of the Mediterranean is discussed.

Key words: alien species, range expansion, Aegean Sea, Lessepsian migrant, Lutjanidae

Introduction

The family Lutjanidae Gill, 1861 is composed of ~ 110 species distributed in 17 genera (Nelson 2006; Froese and Pauly 2019a) and include marine fishes commonly known as "snappers". Several members of this family have commercial interest and are widely consumed by humans, although they may be also responsible for ciguatera fish poisoning (Ha et al. 2018). Lutjanidae occur in tropical and subtropical waters; noteworthy, three species of Red Sea origin were also recorded in the Mediterranean Sea as alien species, namely *Lutjanus argentimaculatus* (Forsskål, 1775), *Lutjanus fulviflamma* (Forsskål, 1775), and *Lutjanus sebae* (Cuvier, 1816) (Golani et al. 2006; Vella et al. 2015; Zenetos et al. 2016; Deidun and Piraino 2017).

Among them, *L. argentimaculatus* (commonly known as "mangrove red snapper") is a coastal species that mainly inhabits rocky bottoms down to 80 m depth, although juveniles are mostly found in very shallow waters and often enter estuaries. The maximum total length (TL) reported in literature

Figure 1. Map of the known records of *Lutjanus argentimaculatus* (Forsskål, 1775) in the Mediterranean Sea. Numbers corresponding to localities reported in Table S1.

is ~ 150 cm, but common sizes usually do not exceed 80 cm TL (Froese and Pauly 2019b). Until recently, this taxon was only known from the Mediterranean basin as based on a single record from Lebanon, in 1977 (Mouneimné 1979). However, within the last decade, it seems to be rapidly spreading in the area following the expansion pattern of other Lessepsian species (Kletou et al. 2016). In fact, it was again recorded in Lebanon in 2014 (Crocetta and Bariche 2016), and subsequently in Turkey and Israel in 2018 and 2019 (Akyol 2019; Sonin et al. 2019) (Supplementary material Table S1; Figure 1). All these records were not held during proper field research activities, but were based on occasional findings during commercial or recreational fishing activities. This again highlights the importance of citizen science as a tool for monitoring marine non-indigenous species (NIS) in the Mediterranean Sea (see also Zenetos et al. 2017; Azzurro et al. 2019; Tiralongo et al. 2019). In 2016, iSea launched the citizen science project "Is it alien to you? Share it!!!" (https://isea.com.gr/activities/programs/alienspecies/is-it-alien-to-you-share-it/?lang=en) with the main aim to improve the knowledge on the distribution and the expansion of NIS in Greece and the entire Mediterranean Sea. Similar projects with dedicated Facebook group/page are present in other countries, such as Italy (AlienFish, Oddfish), Malta (Spot the Alien Fish), or for the whole Mediterranean Sea (Mediterranean Marine Life) (see Giovos et al. 2019). The present paper reports the presence of *L. argentimaculatus* in Greece based on three different requests of identification posted on the iSea platform, thus first recording the mangrove red snapper in the above-mentioned country, and contributes to the knowledge of its spreading in the Mediterranean Sea.

Materials and methods

Within the framework of iSea, an online data platform was developed, 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. An identification team composed by trained taxonomists identifies the species to the lowest taxonomic level possible, and all data obtained are subsequently added to an internal database. The project holds a research permit by the Greek Ministry of Environment for the collection of biological material from NIS specimens in order to better study biological and ecological aspects and perform morphometric, meristic, and phylogenetic analysis on collected samples, when necessary.

Results and discussion

In July 2019, two posts of two unknown fish specimens from Greece were uploaded. A third specimen was subsequently posted in August 2019. The first specimen was spearfished on the 21st July 2019 at 6 m depth, at Salamina Bay (37.941186°N; 23.469715°E) (Figure 2A). The second specimen was spearfished on the 28th July 2019 at 8 m depth, at Megara Gulf (37.972858°N; 23.352642°E) (Figure 2B). The third specimen was spearfished on the 14th August 2019 at 5 m depth, at Salamina Bay (37.9411306°N; 23.470115°E). Unfortunately, no exact sizes are known for the first specimen, the second one had a total length of ~ 60 cm and a weight of ~ 2.8 kg, and the third one had a total length of ~ 40 cm and a weight of ~ 1.5 kg.

The fish specimens were identified by the project's experts as *Lutjanus argentimaculatus* following the description of Allen (1985) and in agreement with published records from the Mediterranean Sea (Mouneimné 1979; Crocetta and Bariche 2016; Akyol 2019; Sonin et al. 2019). Main characters useful to distinguish the mangrove red snapper from its congeners are: a somewhat uniform brownish-reddish body color in adults, darker dorsally and paler ventrally; a body moderately deep and a snout somewhat pointed; a pre-opercular notch poorly developed; an emarginated or nearly truncate caudal fin.

These records represent the first observation of the species in Greece and the westernmost record of the species in the Mediterranean Sea up to date. When discussing the 2014 Lebanese record, Crocetta and Bariche (2016) highlighted that *L. argentimaculatus* is easy to identify and reaches large sizes, and thus it seemed unlikely that an established population has been overlooked since the first Mediterranean record in 1977 (Mouneimné 1979). Thus, they speculated that new propagule(s) may have recently arrived in the Levant basin in a second intrusion attempt. The subsequent records held in Turkey and Israel, as well as those reported here from Greece,

Figure 2. The three specimens of *Lutjanus argentimaculatus* (Forsskål, 1775) caught in Greece. A. The first specimen from Salamina Bay. B. The specimen from Megara Gulf. C. The second specimen from Salamina Bay. Photos by Anastasios Aslanoglou.

point now to the presence of an established population in the eastern part of the Mediterranean Sea, and to the hypothesis that at least all recent records are not the results of multiple introductions. A part of that, it is worth a mention that the pattern of colonization of *L. argentimaculatus* appears to be similar to that of other Lessepsian migrant, such as *Pterois miles* (Bennett, 1828) and *Etrumeus golanii* DiBattista, Randall and Bowen, 2012. Indeed, also in these species, the time elapsing between the first and second record was immediately followed by the finding of an established population (Golani et al. 2002; Azzurro and Bariche 2017).This leaves open questions on whether those and other similar taxa may have been already

established in the Mediterranean Sea since decades, but in low densities, and have only recently spread and been detected in larger numbers, presumably enhanced by the increase of sea temperatures or other environmental factors. Conversely, an independent introduction of all Mediterranean specimens of *L. argentimaculatus* from the Red Sea trough the Canal of Suez appears now unlikely, especially when considering the presence of several recent records in a short time. Even though no juveniles were still recorded from the Mediterranean Sea, their putative absence may be easily related to small sizes and thus lower probabilities to be caught with the most common fishing methods, as well as taxonomic impediments and mostly misidentifications with several Mediterranean native wrasses. The importance of citizen science in monitoring the introduction and possible colonization of non-indigenous fish in the Mediterranean Sea is, thus, again confirmed here, especially when dealing with species with a long latent phase (Azzurro et al. 2016).

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References

Akyol O (2019) The first record of a mangrove red snapper, *Lutjanus argentimaculatus* (Actinopterygii: Perciformes: Lutjanidae), from the Aegean Sea (Gulf of Izmir, Turkey). *Acta Ichthyologica et Piscatoria* 49: 209–211, https://doi.org/10.3750/AIEP/02572

Allen GR (1985) FAO species catalogue Vol. 6. Snappers of the world. An annotated and illustrated catalogue of lutjanid species known to date. Rome, Italy, FAO of the UN, 208 pp + 27 colorplates

Azzurro E, Bariche M (2017) Local knowledge and awareness on the incipient lionfish invasion in the eastern Mediterranean Sea. *Marine and Freshwater Research* 68: 1950–1954, https://doi.org/10.1071/MF16358

Azzurro E, Maynou F, Belmaker J, Golani D, Crooks JA (2016) Lag times in Lessepsian fish invasion. *Biological Invasions* 18: 2761–2772, https://doi.org/10.1007/s10530-016-1184-4

Azzurro E, Bolognini L, Dragicevic B, Drakulovic D, Dulcic J, Fanelli E, Grati F, Kolitari J, Lipej L, Magaletti E, Markovic O, Matic-Skoko S, Mavric B, Milone N, Joksimovic A, Tomanic J, Scarpato A, Tutman P, Vrdoljak D, Zappacosta F (2019) Detecting the occurrence of indigenous and non-indigenous megafauna through fishermen knowledge: A complementary tool to coastal and port surveys. *Marine Pollution Bulletin* 147: 229–236, https://doi.org/10.1016/j.marpolbul.2018.01.016

Crocetta F, Bariche M (2016) Citizen's contribution to better knowledge of the Mediterranean marine biota: records of five alien and a native species from Lebanon. pp 620–623. In: Dailianis et al. New Mediterranean Biodiversity Records (July 2016). *Mediterranean Marine Science* 17: 608–626, https://doi.org/10.12681/mms.1734

Deidun A, Piraino S (2017) First record of an adult-size red emperor snapper *Lutjanus sebae* (Cuvier, 1816), in the Mediterranean Sea. pp. 361–362. In: Gerovasileiou et al. New Mediterranean Biodiversity Records (July 2017). *Mediterranean Marine Science* 18: 355–384, https://doi.org/10.12681/mms.13771

Froese R, Pauly D (2019a) Lutjanidae Gill, 1861. World Register of Marine Species. http://www.marinespecies.org/aphia.php?p=taxdetails&id=151453 (accessed 2019-07-30)

Froese R, Pauly D (2019b) FishBase, version 02/2019. www.fishbase.org (accessed 2019-07-30)

Giovos I, Kleitou P, Poursanidis D, Batjakas I, Bernardi G, Crocetta F, Doumpas N, Kalogirou S, Kampouris TE, Keramidas I, Langeneck J, Maximiadi M, Mitsou E, Stoilas VO, Tiralongo F, Romanidis-Kyriakidis G, Xentidis NJ, Zenetos A, Katsanevakis S (2019) Citizen-science for monitoring marine invasions and stimulating public engagement: a case project from the eastern Mediterranean. *Biological Invasions* 21: 3707–3721, https://doi.org/10.1007/s10530-019-02083-w

Golani D, Orsi-Relini L, Massuti E, Quignard JP (2002) Vol. 1. Fishes. In: Briand F (ed), CIESM atlas of exotic species in the Mediterranean. CIESM Publications, Monaco, 256 pp

Golani D, Öztürk B, Basuta N (2006) Fishes of the eastern Mediterranean. Publication No. 24, Turkish Marine Research Foundation, Istanbul, Turkey, 260 pp

Ha DV, Uesugi A, Uchida H, Ky PX, Minh DQ, Watanabe R, Matsushima R, Oikawa H, Nagai S, Iwataki M, Fukuyo Y, Suzuki T (2018) Identification of causative ciguatoxins in red snappers *Lutjanus bohar* implicated in ciguatera fish poisonings in Vietnam. *Toxins* 10: 420, https://doi.org/10.3390/toxins10100420

Kletou D, Hall-Spencer JM, Kleitou P (2016) A lionfish (*Pterois miles*) invasion has begun in the Mediterranean Sea. *Marine Biodiversity Records* 9: 46, https://doi.org/10.1186/s41200-016-0065-y

Mouneimné N (1979) Poissons nouveaux pour les côtes libanaises (Méditerranée orientale). *Cybium* 3: 105–110

Nelson JS (2006) Fishes of the World (4th Edition). John Wiley & Sons Inc., New York, 601 pp

Sonin O, Edelist D, Golani D (2019) The occurrence of the Lessepsian migrant *Lutjanus argentimaculatus* in the Mediterranean (Actinopterygii: Perciformes: Lutjanidae), first record from the coast of Israel. *Acta Adriatica* 60: 99–102, https://doi.org/10.32582/aa.60.1.11

Tiralongo F, Lillo AO, Tibullo D, Tondo E, Lo Martire C, D'Agnese R, Macali A, Mancini E, Giovos I, Coco S, Azzurro E (2019) Monitoring uncommon and non-indigenous fishes in Italian waters: One year of results for the AlienFish project. *Regional Studies in Marine Science* 28: 100606, https://doi.org/10.1016/j.rsma.2019.100606

Vella A, Vella N, Darmanin SA (2015) First record of *Lutjanus fulviflamma* (Osteichthyes: Lutjanidae) in the Mediterranean Sea. *Journal of the Black Sea/Mediterranean Environment* 21: 307–315

Zenetos A, Apostolopoulos G, Crocetta F (2016) Aquaria kept marine fish species possibly released in the Mediterranean Sea: first confirmation of intentional release in the wild. *Acta Ichthyologica et Piscatoria* 46: 255–262, https://doi.org/10.3750/AIP2016.46.3.10

Zenetos A, Çinar ME, Crocetta F, Golani D, Rosso A, Servello G, Shenkar N, Turon X, Verlaque M (2017) Uncertainties and validation of alien species catalogues: The Mediterranean as an example. *Estuarine, Coastal and Shelf Science* 191: 171–187, https://doi.org/10.1016/j.ecss.2017.03.031

Supplementary material

The following supplementary material is available for this article:

Table S1. Known records of *Lutjanus argentimaculatus* (Forsskål, 1775) in the Mediterranean Sea as shown in Figure 1, with coordinates, fishing gear, known environmental data, total length (TL) in cm, and references.