

RESEARCH ARTICLE OPEN ACCESS

# First Record of the Yellowbar Angelfish, *Pomacanthus maculosus* (Forsskål, 1775) (Teleostei, Pomacanthidae) in Greek Waters

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## ABSTRACT

We report the first sighting of the yellowbar angelfish *Pomacanthus maculosus* (Forsskål, 1775) (Teleostei, Pomacanthidae) in Greece. We observed a young adult multiple times in the summer of 2025 over the course of 10 weeks on a rocky pinnacle on the island of Crete. Identification was based on visual underwater observations and analysis of video material. *P. maculosus* is a coral reef fish native to the western Indian Ocean. We suggest that the individual reached the Mediterranean through the Suez Canal, possibly aided by the intense ship traffic around our study location.

The Mediterranean Sea (hereafter, Mediterranean) is the largest enclosed sea on Earth, and it is considered a basin of high ecological importance [1]. In recent decades, the Mediterranean has also become the most invaded sea in the world [2, 3]. This is largely due to the Suez Canal, an artificial canal connecting the Red Sea and the Mediterranean. First opened in 1869, the Suez Canal has been widened multiple times to cater the increasing traffic of cargo ships [4, 5]. The construction and widening of the canal have given origin to a phenomenon known as Lessepsian invasion; exotic species from the Red Sea establishing invasive populations in the Mediterranean Sea after migration through the Suez Canal [6].

The number of Lessepsian species has increased in recent decades, likely due to higher traffic through the canal, increasing the influx of new organisms [4, 7]. Species movement through the canal can occur passively, via ballast water discharge from cargo ships and actively, as the continuous deepening and widening of the canal facilitates swimming in mobile species. Establishment of exotic species is probably further favoured by climate change, particularly the rising temperatures of the

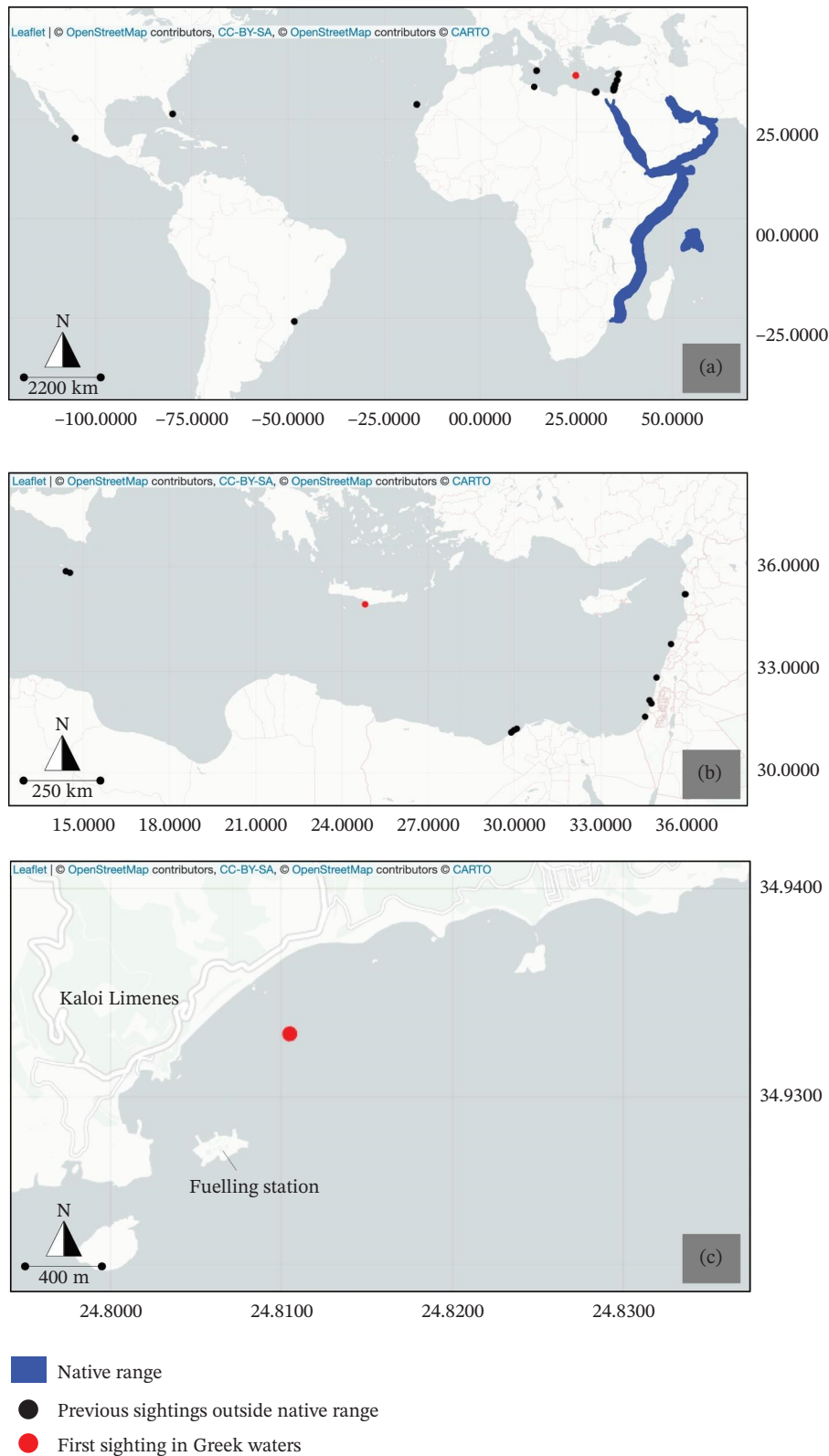
Mediterranean [8]. In the eastern Mediterranean, some Lessepsian species have almost entirely replaced native organisms with similar ecological niches, reaching population densities higher than Mediterranean species [5, 9].

The yellowbar angelfish, *Pomacanthus maculosus* (Forsskål, 1775) (Teleostei, Pomacanthidae), is a coral reef fish native to the western Indian Ocean and the Red Sea (Figure 1(a)). Individuals have been sighted outside their natural distribution in the western and eastern Atlantic Ocean [10–12] and eastern Pacific Ocean [13] (Figure 1(a)). In the Mediterranean, *P. maculosus* was sighted for the first time in Lebanon in 2009 [14]. Subsequent sightings took place along the coast of Israel [15, 16], Malta [17–19], Egypt [20] and Syria [21, 22] (Figure 1(b)). Here, we report the presence of *P. maculosus* in Greek waters for the first time.

Our sightings of *P. maculosus* (Figure 2) took place around a rocky pinnacle (34.9330, 24.8105) (Figure 1(c)) located in a large, sandy bay in the southern coast of Crete (Greece). A video of one of the sightings is available in the supporting information. The pinnacle is located on a sandy bottom at approximately

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**FIGURE 1** | Global distribution and new record of *P. maculosus*. (a) Native range of *P. maculosus* and previous sightings outside its native range. (b) Detail of sightings of *P. maculosus* in the Mediterranean Sea. (c) Location of the pinnacle where *P. maculosus* was first sighted in Greece.

300 m from the closest rocky reef. The pinnacle measures approximately  $55 \times 18$  m at the surface and extends from the water surface to a depth of approximately 14 m. It is surrounded by sand and patches of *Posidonia oceanica* (Delile, 1813). The first

sighting took place in May 2025, when the water temperature around the pinnacle was 18 C. Similar to many areas in the eastern Mediterranean, the fish community around the pinnacle includes numerous individuals of several Lessepsian species. The



**FIGURE 2** | *Pomacanthus maculosus*. Frame from one of the videos of the individual observed in Crete (Greece). A video of one of the sightings is available in the supporting information.

area has intense traffic of cargo ships, due to the presence of a ship-fuelling station on an islet located at approximately 600 m of distance (Figure 1(c)). We were performing experiments on fish behaviour around the pinnacle using SCUBA gear when we incidentally sighted *P. maculosus*. SCUBA diving and underwater work was approved by the local port authorities and government through a sample collection permit (permit number: 6PΔA4653Π8-I9P).

The fish was never caught, making close inspection of morphological and meristic features impossible. We identified the species by closely inspecting videos and observing the same individual in situ multiple times over the course of 10 weeks. The quality of our videos and observations allowed us to exclude any possibility of misidentification with the similar species *Pomacanthus asfur* (Forsskål, 1775), *Holacanthus passer* (Valenciennes, 1846) and *Pomacanthus zonipectus* (Gill, 1862) [13]. The specimen had an estimated length of approximately 15–20 cm and the morphological features of a young adult of *P. maculosus* [17]. The length of the specimen was visually estimated underwater by multiple divers experienced with visual estimation for fish surveys.

Our report is the first of *P. maculosus* in Greek waters. We suggest that the individual reached the Mediterranean through the Suez Canal as an egg or a larva, possibly through ballast water.

*P. maculosus* is a species present in the aquarium trade, so we cannot exclude that the individual that we observed is the result of an aquarium release [10, 13]. However, this species has already been reported in the Mediterranean in areas with intense ship traffic [17]. In addition, we found our individual in a remote area, far from major cities or public aquaria, making an aquarium release unlikely. This is in contrast with most of the sightings reported in the Atlantic and eastern Pacific, which occurred around densely populated areas and are probably the result of aquarium releases [10, 13].

In general, it is not clear if Lessepsian species actively migrate through the Suez Canal or if and to what extent they are passively transported by ships [23]. Biofouling on ship hulls can be enough for sessile invertebrates to travel across continents, and fishes could be carried through ballast water either as larvae or eggs [24]. This could be a fruitful research avenue for the future and could be one of the main factors underpinning which fish species become invasive in the Mediterranean and which ones do not. If ballast water is the most prominent vector of fish propagules through the Suez Canal, we can predict that the species that have entered the Mediterranean have propagules that can better cope with the conditions presented by ballast water.

It has been suggested that *P. maculosus* has established populations in the eastern Mediterranean [15]. However, there is no

evidence yet of established populations at any locations nor that the species is actively reproducing in the Mediterranean. In fact, previous reports are always of one or two individuals, at locations and time scales that do not reflect the typical spread of Lessepsian species that are reproducing in the basin [14, 15, 18, 20]. We cannot exclude that *P. maculosus* can become part of the many Lessepsian invaders in the eastern Mediterranean in the future. Although this species is typically associated with coral reefs, their diet consists mostly of tunicates, sponges and algae [25, 26], all of which are present in the Mediterranean. In addition, many angelfishes are protogynous and their sex change is determined by the number of individuals of either sex present in a group ([27, 28], but see [29, 30]). This could make angelfishes more likely to reproduce in a new area at extremely low densities as any two individuals would be enough to have the formation of a reproductively active pair. To date, we suggest that *P. maculosus* should be considered an exotic vagrant in the Mediterranean rather than an invasive species.

### Author Contributions

Conceptualisation: Davide Bottacini, Piotr Fromentin, Inge Franse and Alexander Kotschal. Data curation, formal analysis, visualisation, software and writing—review and editing: Davide Bottacini. Funding acquisition, resources and project administration: Davide Bottacini and Alexander Kotschal. Investigation: Davide Bottacini, Piotr Fromentin and Inge Franse. Methodology: Davide Bottacini, Piotr Fromentin, Inge Franse and Alexander Kotschal. Supervision and validation: Alexander Kotschal. Writing—review and editing: Davide Bottacini, Piotr Fromentin, Inge Franse and Alexander Kotschal.

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### Ethics Statement

No ethical statement is reported.

### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

All data that support the findings of this study are available in the main text.

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### Supporting Information

Additional supporting information can be found online in the Supporting Information section. (*Supporting Information*)

A video of one of the sightings is available in the electronic version of the manuscript.