

**Rapid Communication****Ornamental fishes in the Mediterranean Sea: first records of *Holacanthus bermudensis* Goode, 1876, *Balistes punctatus* Gmelin, 1789, *Rhinecanthus assasi* (Forsskål, 1775), and an unidentified tropical damselfish**

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**Received:** 6 April 2021**Accepted:** 16 August 2021**Published:** 18 October 2021**Handling editor:** Ernesto Azzurro**Thematic editor:** Stelios Katsanevakis**Copyright:** © Bariche et al.This is an open access article distributed under terms of the Creative Commons Attribution License ([Attribution 4.0 International - CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)).**OPEN ACCESS****Abstract**

Aquarium trade constitutes an important pathway for the introduction of non-indigenous aquatic organisms in several parts of the world. Here, based on a series of observations carried out along the Lebanese coasts, we document the first record of four non-indigenous fish species in the Mediterranean Sea. The paper discusses their occurrence as releases from home aquaria as the most plausible mean of introduction.

**Key words:** first record, Pomacanthidae, Balistidae, Pomacentridae, non-indigenous species, aquarium release, Lebanon

**Introduction**

The aquarium pet trade is an important economic sector in which millions of aquatic organisms are exported internationally on a yearly basis (Rhyne et al. 2017). The transport of countless aquatic organisms provides many opportunities for the introduction and establishment of non-indigenous species worldwide (e.g. Padilla and Williams 2004; Krishnakumar et al. 2009; Simberloff and Rejmánek 2011). In the Mediterranean region, aquarium releases seem to have increased within the last few decades, especially with the flourishing freshwater and marine aquarium business (Zenetos et al. 2012, 2016; Katsanevakis et al. 2013; Maceda-Veiga et al. 2013). A number of exotic fishes, also common in the ornamental aquarium pet trade, has already been recorded in the Mediterranean Sea and may be the result of intentional releases (e.g. Zenetos et al. 2016; Evans et al. 2017; Gerovasileiou et al. 2017; Deidun et al. 2018; Giovos et al. 2018; Zenetos and Galanidi 2020). Based on these observations, aquarium release, is recognized today as one of the main introduction pathways for non-indigenous fishes in the Mediterranean Sea (Katsanevakis et al. 2013, 2014).

The Bermuda blue angelfish *Holacanthus bermudensis* Goode, 1876 is an angelfish from the tropical western Atlantic realm. It occurs in Bermuda, the Bahamas, and from Florida to the Yucatán, possibly down to South

America (Pyle et al. 2010; Reyes-Bonilla et al. 2010). It can attain 45 cm in total length (TL) and is commonly found on coral reefs, feeding mainly on small benthic invertebrates (Steene and Allen 1985; Burgess 2002; Pyle et al. 2010). Its commercial value is relatively minor and it is mostly considered as an aquarium fish, both at the juvenile and adult stages (Pyle et al. 2010; Geomans 2012). Four species of angelfishes have already been recorded as NIS in the Mediterranean: *Pomacanthus maculosus*, *P. imperator*, *Holacanthus ciliaris* and *H. africanus* (Bariche 2010; Golani et al. 2010; Dulčić and Dragičević 2012; Deidun et al. 2017, 2020).

The bluespotted triggerfish *Balistes punctatus* Gmelin, 1789 is a triggerfish native to the eastern Atlantic, ranging across the West African coast, from Morocco to Angola, the Canary Islands and Cape Verde. This species can reach 60 cm TL and is usually present on sandy or rocky bottoms, down to about 30 m depth (Tortonese 1986; Schneider 1990). Juveniles are mainly planktivorous, while adults feed on benthic invertebrates, typically crustaceans and mollusks (Aggrey-Fynn 2007). The Picasso triggerfish *Rhinecanthus assasi* (Forsskål, 1775) is another triggerfish, but native to the Red Sea, the Gulf of Oman and the Persian Gulf. The species can attain 30 cm TL and usually inhabits shallow sandy and rubble areas of coral reefs (lagoons and seaward reefs), down to 25 m. This is a territorial fish that feeds on benthic invertebrates (Lieske et al. 2004; Froese and Pauly 2020). In the Mediterranean, *Balistes capriscus* Gmelin, 1789 is the only native triggerfish species and to date, only the clown triggerfish *Balistoides conspicillum* (Bloch and Schneider, 1801) has been recorded as non-indigenous in the Mediterranean (Weitzmann et al. 2015).

Damselfishes are a large family of small colourful fishes present in all tropical oceans around the world. The family is highly diverse (> 400 species), and characterized by the presence of species complexes, with color patterns that vary among individuals, age and localities. Among the 29 genera present within the family Pomacentridae, 38 species are recognized within the genus *Stegastes*. To date, a total of seven non-indigenous species have been recorded in the Mediterranean (Deidun et al. 2018; Dragičević et al. 2021).

## Materials and methods

The Bermuda blue angelfish was identified following Burgess (2002), fixed and stored at the marine collection of the American University of Beirut, with the access code AUBM OS3943. The bluespotted and Picasso triggerfishes were both identified based on photographs shared with the authors. Distinct anatomical characteristics allowed for the assured description of the species (Moore 1967; Fischer et al. 1981; Randall 1983; Tortonese 1986; Carpenter et al. 1997; Lieske et al. 2004). Identification of the damselfish was based on a video from which snapshots were extracted (Allen 1991).



**Figure 1.** Photos of the new fish records from the Mediterranean Sea. A, B, the Bermuda blue angelfish *Holacanthus bermudensis*; C, the bluespotted triggerfish *Balistes punctatus*; D, the Picasso triggerfish *Rhinecanthus assasi*. Photographs by Ali Harbi, Ismail Younis and Elio Nadros, respectively.

## Results

On 1 February 2018, a specimen of *Holacanthus bermudensis* was captured off the city of Sarafand (approx. 33.470371°N; 35.292322°E), in the south of Lebanon (Figure 1A, B). The specimen was speared close to an underwater rocky mount at a depth of 25 m. Its total length (TL) was 44.2 cm. Characters used for the identification of the specimen were as follows: Body deep, oval and compressed. Snout short and blunt, mouth small and terminal; teeth arranged in bands along jaws. A large spine present at an angle on the preopercle. Hind margin of preorbital without enlarged posteriorly directed spines. Dorsal fin with 14 spines and 19 soft rays; anal fin with 3 spines and 19 soft rays. Soft dorsal and anal fins greatly pronounced, as this is an adult and the tips extend beyond the posterior edge of the caudal fin. Caudal fin slightly curved at the edges, with the absence of filaments. Pectoral fins moderate, with 19 soft rays. Pelvic fins not reaching the anal fin. Scales in regular series, 47 in lateral line. The color of the scales is brown with pale edges; nape and chest, including pectoral-fin base, are blue to purple in color; preopercular spines and spinelets above are blue; dorsal and anal fins are brown to blue, edged with blue, inside of which is a narrow yellow stripe; extended tips are yellow; pelvic fins are yellow; pectoral fins are blue to purple basally, with a yellow stripe at the center; outer portion is hyaline; posterior edge of caudal fin is yellow.

On 22 June 2020, an individual of *Balistes punctatus* was caught off a marine touristic resort, north of Lebanon (34.396659°N; 35.794173°E). The individual was captured with hook and line by shore casting using a plastic lure. The bottom was mainly rocky, and the depth was around 3 m. According to the angler, the approximate TL was 20 cm. Unfortunately,

the fish was released back into the sea alive after a picture was taken by the angler. Based on the photograph (Figure 1C), the characters used for identification were as follows: Deep and laterally compressed body. Three spines at first dorsal fin, as well as 1–3 spines and 26–28 rays at second dorsal fin; the third to sixth fin rays of the second dorsal fin are filamentous and free of membrane at their ends. The anal fin has about 22–24 rays. The caudal peduncle is compressed, and caudal fin rays are elongated at the edges. The color is grey to brown with a pattern of dark spots covering most of the body and behind the eyes, fading ventrally until disappearing. Five to six light radial bluish stripes are visible at the front lower margin of the eye. Curved light blue lines extend backwards and downward across the snout, just behind the mouth. Vertical wavy lines are present above the anal fin base. Dark spots are present on both dorsal and caudal fins, as well as the base of the pectoral fin. The pectoral, tympanum and anterior side of the gill slit are bright yellow. A large distinct black patch is also visible on the upper caudal base.

On 11 December 2020, an individual of *Rhinecanthus assasi* was caught off the coast of Saida, south of Lebanon (approx. 33.553109°N, 35.362423°E). The individual was captured with hook and line, baited with shrimp from the shore. The bottom was rocky, and the depth was approximately 3 m. According to the angler, the estimated TL was 20 cm. Here again, the fish was discarded after a picture was taken. Based on the photo (Figure 1D), the characters used for identification were as follows: Deep and laterally compressed body, somewhat rhomboid with a long and pointed snout. The color is tan, shading to white ventrally, with four blue bands alternating with three black bands in the interorbital space. A narrowing blue-edged black bar on the flanks, extending from the eye to the gill opening, preceded by a yellow band and a blue line. Yellow lips, with a narrow blue band adjacent to the upper lip, bordered from above by a black streak which extends to the lower pectoral fin base. Dark stripes formed by longitudinal scale ridges, partly visible on both sides of the caudal peduncle. The caudal fin and anal region are not visible in the photograph.

On 3 June 2019, an individual of a “blue and yellow” damselfish was captured off Manara, Beirut (33.900626°N; 35.468338°E). The fish was captured in a wire trap, baited with bread and seaweeds. The bottom was a mixture of rocks and rubbles, and the depth was approximately 2 m. The size was estimated 8–10 cm TL. Unfortunately, the fish was released back into the sea alive after a video was taken. The individual can be described based on the extracted photographs (Figure 2) as follows: Moderately deep, oblong and compressed body, with a single continuous dorsal fin that extend past the caudal fin base. Caudal fin with unequal lobes that are bluntly rounded. The lateral line ends posteriorly, past the dorsal fin base. The upper head and back are dark blue, with evenly distributed blue spots running along the snout and the upper back longitudinally. The ventral



**Figure 2.** The unidentified damselfish (likely *Stegastes* sp.) captured in Lebanon. Photographs by Ayed Mansour.

body and fins, as well as the whole caudal fin, are yellow. Dark edges of scales form vertical lines, running down along the body. The anal fin is bordered by a dark margin. A large black spot is present on the dorsal fin posteriorly, and a smaller one also present on the upper caudal peduncle.

### Discussion

The Bermuda blue angelfish *Holacanthus bermudensis*, the bluespotted triggerfish *Balistes punctatus*, the Picasso triggerfish *Rhinecanthus assasi* and an undetermined damselfish are recorded here for the first time from the Mediterranean Sea.

The closest congeneric to *Holacanthus bermudensis* is the queen angelfish *H. ciliaris*, which has been recorded twice from Croatia and Malta (Dulčić and Dragičević 2012; Deidun et al. 2020). This species can be easily distinguished from the Bermuda blue angelfish by the presence of a large black blotch, circled and spotted with blue at the nape. *Holacanthus ciliaris* also has yellow pectoral fins with another black blotch, circled and spotted with blue at the base, and yellow pelvic and caudal fins. Unfortunately, the

gonads of *H. bermudensis* were not observed since the specimen was gutted by the fisherman upon capture. However, the size of the individual caught (44.2 cm) and the size of its dorsal and anal fins indicate that the specimen is clearly an adult (Figure 1A, B). This facilitates the identification of the specimen from Lebanon, since the two angelfish species are very similar at the juvenile stage. The two species are also known to hybridize in their native range. The hybrid is referred to as the Townsend angelfish in the aquarium business and shows a unique blend of characteristics from both *H. bermudensis* and *H. ciliaris* (Humann and DeLoach 2002; Pyle et al. 2010; Reyes-Bonilla et al. 2010).

The morphological and anatomical characteristics of *Balistes punctatus* are unique and easily recognizable. Among the 42 species of Balistidae known to date (Fricke et al. 2020), the closest species are the queen triggerfish *Balistes vetula* Linnaeus, 1758, an Atlantic species found in both eastern and western regions, and the starry triggerfish *Abalistes stellatus* (Anonymous, 1798), an Indo-West Pacific species (Smith and Heemstra 1986; Froese and Pauly 2020). *Balistes vetula* can be easily distinguished from *B. punctatus* by the absence of dark spots and filamentous elongate rays on the body and second dorsal fin, respectively. The queen triggerfish also has two obliquely curved bright blue bands between the mouth and the anterior of the pectoral fin base, as well as a wide bluish band around the caudal peduncle, among other characteristics (Fischer et al. 1981). *Abalistes stellatus* has very small pale to blue spots on the body and three large oval white spots along the back, with a small spot found dorsally on the caudal peduncle (may be absent in large individuals). In addition, no elongated filamentous rays are present on the second dorsal fin, and it has an oblique groove anterior to the eyes, as well as a depressed caudal peduncle (Fischer and Bianchi 1984; Froese and Pauly 2020). The species can also be easily distinguished from the native grey triggerfish *Balistes capriscus* Gmelin, 1789 by a greyish body and small bluish spots, as well as the absence of long and filamentous rays on the second dorsal fin (Fischer et al. 1981).

Similarly, the physical characteristics of *Rhinecanthus assasi* are easily recognizable on photo. The closest species are: the halfmoon picassofish *R. lunula* Randall and Steene, 1983, a Pacific species reported from the Queensland, Australia to the Pitcairn Islands; the white-banded triggerfish *R. aculeatus* (Linnaeus, 1758), a widely distributed fish found in the eastern Atlantic, from Senegal to South Africa, and the wide Indo-Pacific realm, including the Red Sea; and the blackbelly triggerfish *R. verrucosus* (Linnaeus, 1758), also an Indo-Pacific species. *Rhinecanthus lunula* can be easily distinguished by its broad, black bar on the caudal peduncle and a particularly elongate body, long snout, and concave dorsal profile; *R. aculeatus* differs by the absence of both the black/dark brown streak between the mouth and the pectoral fin base, and the white bands on the

ventral part of the body; and *R. verrucosus* by a large elliptical black blotch on the ventral part of the body (Smith and Heemstra 1986; Randall et al. 1990; Froese and Pauly 2020).

Based on physical appearance and color pattern, the undetermined damselfish likely belongs to the genus *Stegastes*, knowing that meristics are needed for confirmation. The closest species are the beaugregory *Stegastes leucostictus* (Müller and Troschel, 1848) from the western Atlantic, and juveniles of two other species: the complex cocoa damselfish *Stegastes variabilis/xanthurus*, known from Brazil and the Caribbean (Western Atlantic), as well as the beaubrummel *S. flavilatus* (Gill, 1862), native to the Eastern Pacific, from Baja California, Mexico to Bahia Santa Elena, Ecuador (Froese and Pauly 2020). However, *S. leucostictus* differs from the specimen caught in Lebanon by the dark spot present on the back of dorsal fin, which is smaller and located well above its base, and by the absence of a second spot on the caudal peduncle. It is important to highlight the setbacks when reporting the presence of some species based on photographs. It is evident that the margin of error may be relatively significant in the identification of some species, particularly when species complexes are likely to occur in nature. As such, the possibility of the damselfish belonging to another genus should not be excluded. However, it remains more crucial to report these unusual findings, as opposed to not doing so. In fact, the authors have kept this record since 2019 with the hopes of obtaining another specimen, or until the fish is reported from a different location in the Mediterranean. In any case, none of the three species listed above have ever been recorded in the Mediterranean Sea. No further discussion can be made until additional individuals are eventually captured in the Mediterranean Sea.

The occurrence of *Holacanthus bermudensis*, *Balistes punctatus* and the damselfish in the Mediterranean Sea are likely to be aquarium release events. *Holacanthus bermudensis* is a tropical western Atlantic species that cannot realistically reach the Mediterranean Sea by natural means, and it is unlikely (even virtually impossible) that *B. punctatus* would have reached the easternmost part of the Mediterranean without being noticed along the Mediterranean coast of North Africa. The same reasoning applies to the damselfish occurrence, explained by the wide geographic distances with comparable species. This is not the case for *Rhinacanthus assasi*, which is present in the Red Sea and could theoretically enter the Mediterranean by crossing the Suez Canal as a Lessepsian migrant, despite the fact that it is also present in the aquarium market. Among the known introduction pathways to the Mediterranean (Katsanevakis et al. 2013, 2014; Zenetos et al. 2016), larval transport by water ballast is theoretically possible, however we assume it is unlikely for Lebanon, mainly due to the absence of commercial vessels departing from the tropical western Atlantic and mooring in Lebanon, in addition to the adult size of the specimens

collected. The arrival through oil platforms (Pajuelo et al. 2016) can also be excluded in the context of Lebanon. The option of aquarium release seems to be the most plausible, since all species are quite common in the tropical aquarium fish trade and there is a high demand for similar species among aquarists. *Holacanthus bermudensis*, *B. punctatus* and *R. assasi* are common and expensive fishes in the Lebanese market, with a retail value ranging between 80 and 150 US\$; between 20 and 50 US\$ for damselfishes (M.B. pers. obs.). The three species require a relatively large tank and are incompatible with invertebrates and many other ornamental fish species (Geomans 2012). Their high price, local demand, as well as their ecology increase the chance of intentional release by a hobbyist in the Mediterranean environment.

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