Rapid Communication

Record of *Terapon jarbua* (Forsskål, 1775) (Terapontidae) and *Acanthopagrus bifasciatus* (Forsskål, 1775) (Sparidae) in the Egyptian Mediterranean waters

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Abstract

An individual of the non-indigenous fish *Terapon jarbua* and one of *Acanthopagrus bifasciatus* were fished from the coastal waters off Alexandria, Egypt in November 2020. The former was collected with shore jigging and the latter with a trammel net. The record of *T. jarbua* constitutes the first one for the Mediterranean Egyptian waters and the second one for the entire Mediterranean basin. The record of *A. bifasciatus* is the first one for the Mediterranean Egyptian waters and the fourth for the Mediterranean. The morphometric and meristic characteristics of the recorded individuals are hereby presented, along with different hypotheses explaining the entry within the Mediterranean of these non-indigenous species.

Key words: first record, non-indigenous fish, Lessepsian migrants, Egypt, Mediterranean Sea, citizen science

Introduction

Mediterranean biodiversity is undergoing rapid alteration, driven by multiple stress factors, mostly due to anthropogenic activities (Bianchi et al. 2012). Among these factors are non-indigenous species, considered a major threat to the biodiversity of the basin. Non-indigenous species affect community synthesis, habitats, and ecosystem functioning (Katsanevakis et al. 2014), mainly in the eastern part of the Mediterranean, which is heavily affected by species introduced through the Suez Canal (Galil et al. 2017, 2020). Concerning the non-indigenous fishes, more than 100 species of Red Sea/ Indo-Pacific Ocean origin entered into the Mediterranean basin through the Suez Canal (Golani and Fricke 2018). The majority have established and integrated into the native bio-communities and within food webs; many of these species dominate the fish catches, often with evident socioeconomic and ecological impact, including danger for human health (Galil et al. 2017; Katsanevakis et al. 2020).

The family Terapontidae is currently represented by four non-indigenous species in the Mediterranean Sea: *Pelates quadrilineatus* (Bloch, 1790), *Terapon puta* (Cuvier, 1829), *Terapon theraps* Cuvier, 1829 (Golani 2010) and *Terapon jarbua* (Forsskål, 1775) (Golani and Appelbaum-Golani 2010). All four species belong to the ichthyofauna of the Red Sea (Golani and Fricke 2018).

In particular, the tropical euryhaline species *T. jarbua* has a wide Indo-Pacific distribution from the Red Sea to Fiji and Japan (Golani and Appelbaum-Golani 2010; Golani and Fricke 2018). The species was recorded as *Therapon jarbua* Forskål for the Gulf of Suez and for the entrance of the Canal by Gruvel and Chabanaud (1937). It was first recorded from the Mediterranean within the coastal waters off Haifa, Israel in 2009 (Golani and Appelbaum-Golani 2010).

To date, the non-indigenous sparids occurring in the Red Sea and introduced into the Mediterranean basin are *Crenidens crenidens* (Forsskål, 1775), *Rhabdosargus haffara* (Forsskål, 1775) and *Acanthopagrus bifasciatus* (Forsskål, 1775) (Golani and Fricke 2018). In particular, *A. bifasciatus*, in addition to the Red Sea, occurs in the Persian Gulf, and off southern Oman (not Gulf of Oman); presumably the species is present along the whole southern coast of the Arabian Peninsula and is also found from Iran to Pakistan (Iwatsuki and Heemstra 2011). The twobar seabream was listed as *Chrysophrys (Sparus) bifasciatus* Forsk. among the ichthyofauna of the Suez Canal by Gruvel (1936). In the Mediterranean basin, it was first recorded along the Tunisian coast in 2010 (Ben-Souissi et al. 2014), and later in 2018, at Izmir Bay, Turkey (Şensurat-Genç et al. 2020), and in 2019 in the Barcelona harbor, Spain (García-de-Vinuesa et al. 2020).

To date, in the Mediterranean Egyptian waters, the non-indigenous ichthyofauna of Red Sea/Indo-Pacific origin account for at least 59 species (Halim and Rizkalla 2011; Akel and Karachle 2017; Galil et al. 2020; Al Mabruk et al. 2020, 2021; Zenetos and Galanidi 2020).

In the present study, the occurrence of the jarbua terapon is documented for the first time from the Egyptian Mediterranean waters, confirming its presence within the basin after more than a decade since the first record of the species from the Israeli coastal waters in 2009. This finding adds a third alien terapontid species to the ones already known (*P. quadrilineatus* and *T. puta*) from northern Egyptian lagoons (Halim and Rizkalla 2011; Kara and Quignard 2018) and from north Egyptian coastal fisheries (Rizkalla et al. 2016; El-Aiatt and Shalloof 2019; Ragheb et al. 2019). Furthermore, the occurrence of another non-indigenous fish, *A. bifasciatus*, is reported for the first time in the Egyptian Mediterranean waters and for the fourth time in the Mediterranean basin. Different hypotheses concerning the entry within the Mediterranean of these non-indigenous fishes are discussed.

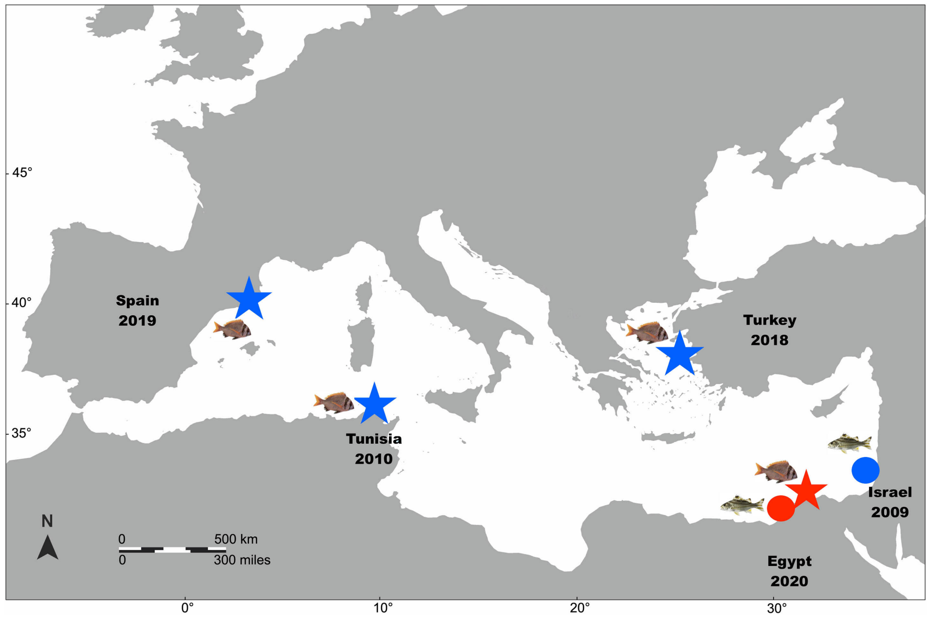

Figure 1. Map of the Mediterranean Sea showing the locations of *Terapon jarbua* (bullet) and *Acanthopagrus bifasciatus* (star) records (Red: present study; Blue: previous studies).

Materials and methods

On 12 November 2020, an individual of *Terapon jarbua*, total length 20.5 cm, weight 118.4 g, was caught through shore jigging, at a depth of 3–4 m, at Abu Talat, approximately 25 km west of Alexandria, Egypt (31.079307°N; 29.702321°E) (Figure 1) over a sandy seabed dominated by seagrass. A photo of the sample was submitted to the social media citizen science platform for Libyan waters called "Marine Biology in Libya" (https://www.facebook.com/MarineBiologyinlibya).

On 19 November 2020, a specimen of *Acanthopagrus bifasciatus*, total length 35 cm, weight 510.2 g, was caught by trammel net at a depth of 3–4 m, at El Mamoura beach, east neighborhood of Alexandria, Egypt (31.287938°N; 30.032502°E) (Figure 1), on sandy bottom. In this case, a fisherman informed directly one of the authors (OMN) about the capture of an unknown fish providing a photo.

After capture, both specimens were immediately frozen by the fishermen; a few days later, they were retrieved by one of the authors (OMN) and they are now deposited in her private collection.

The specimens were identified following Fischer and Bianchi (1984), Carpenter and Niem (2001), Golani and Appelbaum-Golani (2010), Khalaf and Disi (1997), Iwatsuki and Heemstra (2011), Ben-Souissi et al. (2014), Şensurat-Genç et al. 2020. Measurements were taken with a calliper to the nearest 0.1 mm.

Table 1. Main morphometric measurements (mm) and relative values (as % of standard length, SL) of *Terapon jarbua* and *Acanthopagrus bifasciatus* specimens recorded off Alexandria, Egypt, in November 2020.

Morphometric characters	*Terapon jarbua*		*Acanthopagrus bifasciatus*	
	mm	% SL	mm	% SL
Total length	205.0		350.0	
Standard length	171.1		293.1	
Body depth at anal fin	33.9	19.8	107.4	36.7
Maximum body depth	49.0	28.6	146.6	50.0
Snout length	17.3	10.1	21.5	7.3
Eye diameter	9.8	5.7	19.0	6.5
Caudal peduncle depth	17.3	10.1	36.6	12.5
Caudal peduncle length	18.1	10.6	41.7	14.2
Predorsal length	73.1	42.7	133.9	45.7
Preanal length	116.8	68.3	212.3	72.4
Prepelvic length	68.6	40.1	121.9	41.6
Dorsal fin base length	82.9	48.5	168.0	57.4
Anal fin base length	26.4	15.4	56.9	19.4
Pectoral fin length	31.7	18.5	123.8	42.3
Pelvic fin length	35.4	20.7	72.0	24.6
Caudal fin length	44.5	26.0	77.1	26.3
Dorsal fin height	25.6	15.0	43.0	14.7
Anal fin height	11.3	6.6	39.2	13.4

Results

Terapon jarbua (Forsskål, 1775)

(Figure 2)

Meristic counts: D XI+10, A III+8, P 12, V I+5, pored lateral line scales 88, scales above lateral line 16, scales below lateral line 18. Body oblong and slightly compressed, lower opercular spine very long and strong, extending distinctly beyond edge of opercular lobe. Mouth slightly oblique, jaws reaching back to the vertical of the anterior eye's margin. The spinous part of dorsal fin strongly arched and deeply notched; the first spine very short, the fourth to sixth spines longest, and the penultimate spine about one-half the length of the ultimate; margin of soft portion of dorsal fin straight. The second anal fin spine subequal to third spine and shorter than longest anal rays; margin of soft part of anal fin concave; caudal fin emarginate; pectoral fin small; pelvic fin origin beyond the pectoral fin origin.

The measurements in absolute and their relative values (% of standard length, SL) are given in Table 1.

Colour in fresh specimen: silvery-grey with three evident dark brown longitudinal stripes curved downward; the upper stripe begins at the origin of the dorsal fin (the anterior part appears slightly discolored) and terminates under the soft ray portion of the dorsal fin; the second stripe commences on the nape, where it is wider, and ends at the posterior end of the dorsal fin; the third stripe runs from the occiput (back of head posterior to the eye) to the end of the middle of the caudal fin (Figure 2). A fourth imperceptible straight stripe, yellowish, starts at the origin of the pectoral fin and terminates at the ventral surface of the caudal peduncle.

Figure 2. The specimen of *Terapon jarbua* captured in Abu Talat, near Alexandria, Egypt. Photo by Amr Abowelwafa.

Figure 3. The specimen of *Acanthopagrus bifasciatus* captured in El Mamoura, Alexandria, Egypt. Photo by Ola M. Nour.

There is a large black spot on the upper part of the dorsal fin between the third and sixth spines and a smaller spot lies between the eighth and ninth spines. Soft portion of dorsal fin with membranes of first 3 rays tipped with black and membranes between fifth and seventh rays entirely dark; the upper part of the last soft rays was slightly darker. Caudal fin with black stripe in the middle, hosting the extended 3rd longitudinal stripe; two crossbands above and below it and broad black tip of the upper lobe. A black spot is located at the middle of the posterior edge of the anal fin. Pectoral and pelvic fin rays are whitish, with a transparent membrane.

Acanthopagrus bifasciatus (Forsskål, 1775)

(Figure 3)

Meristic counts: D XI+12, A III+10, P 15, V I+5, pored lateral line scales 49; from the fifth dorsal fin spine, 5½ scales above lateral line, 12 scales below

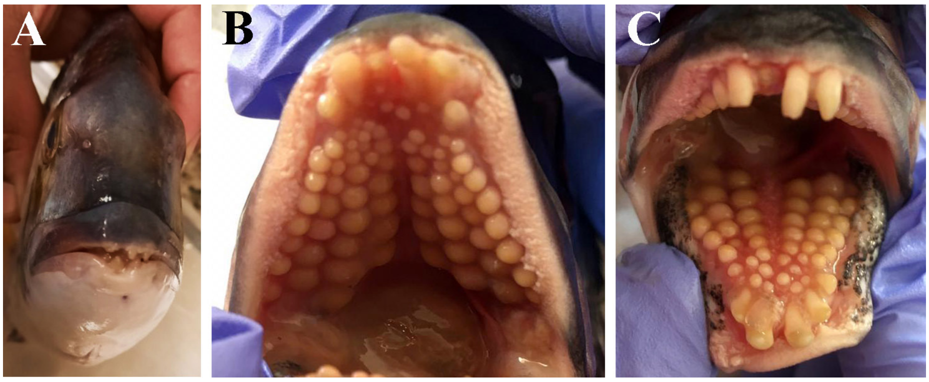

Figure 4. Frontal view of the snout (A) and teeth of *Acanthopagrus bifasciatus* from the Mediterranean waters of Egypt (B: upper jaw, C: lower jaw). Photo by Ola M. Nour.

lateral line. Body oblong, rather deep and compressed. Upper profile of head nearly straight, with a slight bulge over eye. Mouth slightly oblique, the maxilla reaching to below pupil of eye. Dorsal fin single, anal fin with first spine short, second the strongest and slightly longer than third; a scaly sheath at base of dorsal and anal fins, pectoral fin long, caudal fin forked (Figure 3). Upper jaw with 6 canines, the four middle (one was broken) of medium size, larger than the last two (Figure 4A, B). Upper jaw (Figure 4B): four rows of molars in each side; outer molar teeth row, the third right and the second left rows extend to rear end of upper jaw; the posterior molar teeth of the inner three rows well-developed. Lower jaw (Figure 4C): three molar tooth rows on each side extending to rear end of lower jaw; teeth smaller anteriorly, increasing in size posteriorly.

The measurements in absolute and their relative values (% of standard length, SL) are given in Table 1.

Colour in thawed specimen: body silvery, more shiny below, with 2 vertical black bars across head, the first ending below angle of jaw, the second larger from nape across opercle to its inferior edge; snout grayish; dorsal, pectoral and caudal fins uniformly bright yellow-orange, no black margin of dorsal-fin and black rear edge of caudal fin; pelvic and anal fins black (Figures 3, 4A).

Discussion

The size of the *T. jarbua* specimen described in the present study, along with the method and depth of capture, are in agreement with Carpenter and Niem (2001) and Froese and Pauly (2019). It is a commercially important species within coastal and marine fisheries in its native range (Gupta and Banerjee 2016) and it is also important as an ornamental fish, due to its attractive colour pattern (The Aquarium Wiki Encyclopaedia 2020; Meerwasser-lexikon 2020a). It is exported, for example, from India as an ornamental fish for the aquarium pet industry to other countries (Gupta and Banerjee 2016). The unexpected presence of a juvenile in the Zeeschelde (Belgium) can be tentatively explained as an accidental release from such an international aquarium trade (Breine et al. 2019).

Following Por (1978), "Lessepsian migration" is a phenomenon of unidirectional and successful biotic advance from the Red Sea to the Eastern Mediterranean. Among the non-indigenous terapontids, *P. quadrilineatus* and *T. puta* are considered Lessepsian migrant fish, i.e. they have been introduced into the Mediterranean basin via the Suez Canal (Lourie and Ben-Tuvia 1970; Ben-Tuvia 1977). Both species appear to follow the spatial colonization pattern within the Levantine Sea regularly observed for Lessepsian migrants, reaching their current northernmost extent within the Mediterranean in waters off southeastern Turkey and off Syria, respectively (Golani 2010; Bariche and Fricke 2020; Galil et al. 2020). The species *T. theraps* has also presumably been introduced into the Mediterranean via the Suez Canal. However, an escape of individuals from the pet/aquarium industry or other human activities is also possible, given the disparate nature of existing Mediterranean records of the species, the first record from the Adriatic (Lipej et al. 2008) and the second from the north Aegean Sea (Minos et al. 2012).

As previously mentioned, *T. jarbua* was firstly found in Israel Mediterranean waters in 2009 and it is also considered a Lessepsian migrant (Golani and Appelbaum-Golani 2010; Golani and Fricke 2018). After this initial finding, however, no other records were reported until the current study. Given the relatively long interval between the only two Mediterranean records of the species known to date, one can hypothesize that this second record of the species is independent of the first (i.e. that the species did not establish viable, self-sustaining populations). In addition, given the importance of this attractive fish to the aquarium trade, an escape or deliberate release from an aquarium introduction pathway for the species is feasible, along with a passive or vessel-mediated introduction pathway through the Suez Canal.

Although other Mediterranean non-indigenous sparids, such as *C. crenidens* and *R. haffara*, are considered as Lessepsian species (Golani 2010; Golani and Fricke 2018), the case of *A. bifasciatus* is slightly unusual. Some authors consider that *A. bifasciatus* is not a Lessepsian species because records in the Mediterranean clearly suggest a presence unrelated to a passage through the Suez Canal (Samaha et al. 2016). As mentioned above, it was first recorded along the Tunisian coast in 2010 and an introduction via the Suez Canal or direct human-mediated introduction, such as through ballast waters or by commercial vessels, were both considered feasible (Ben-Souissi et al. 2014). Recently, in 2018, a single individual of the twobar seabream was captured with a trammel net at 3 m depth in the northeastern Aegean Sea, at Izmir Bay, Turkey, near a breakwater (Şensurat-Genç et al. 2020); these authors considered the species a Lessepsian migrant. Another specimen of *A. bifasciatus* was speared in 2019, at 10 m of depth, in the Barcelona harbour, Spain, again near a breakwater (García-de-Vinuesa et al. 2020). A ship-borne introduction was hypothesized in this last case. As noted by García-de-Vinuesa et al. (2020), GBIF lists a specimen of *A. bifasciatus* collected on an unknown date from Egyptian Mediterranean waters and deposited at the MNHN (https://www.gbif.org/occurrence/583446494), while three specimens were observed underwater near Barcelona, two in 2017 and one in 2013, (https://www.gbif.org/occurrence/1585878676, https://www.gbif.org/occurrence/1585878708, https://www.gbif.org/occurrence/857014378). In agreement with García-de-Vinuesa et al. (2020), the above GBIF reports needs a proper evaluation and are not further considered in the present study.

The occurrence of the twobar seabream in the Red Sea, where it is common (Iwatsuki and Heemstra 2011), and in the Suez Canal, where it was observed (Gruvel 1936), along with the location of the Egyptian finding described in the present study, could suggest a recent introduction of the species through Lesspsian migration, in agreement with Şensurat-Genç et al. (2020). First findings of non-indigenous fish of Red Sea origin in the eastern Mediterranean Sea at locations far from the Suez Canal have been previously described, for example for *Lagocephalus sceleratus* (Gmelin, 1789) and *Tylerius spinosissimus* (Regan, 1908), respectively first detected in the southeastern Aegean Sea in 2003 (Filiz and Er 2004) and 2004 (Corsini et al. 2005). Later, these two species were recorded along the Levantine Sea coasts, the silver-cheeked toadfish *L. sceleratus* in 2004 in Israel (Golani and Levy 2005) and in Turkey (Bilecenoglu et al. 2006), and the spiny blaasop *T. spinosissimus* six years later, in 2010, in Israel (Golani et al. 2011) and Turkey (Turan and Yaglioglu 2011). Both species are now considered Lessepsian migrants. Therefore, the finding of *A. bifasciatus* reported in the present study from Egypt and the recent one from Turkey, possibly supports an introduction via the Suez Canal and the spreading of an apparently limited population along the Anatolian coasts. However, the species is easily distinguishable from the other native sparids and, up to date, no other intermediate Mediterranean records of the species northward of the Suez Canal were reported. The association between these two records will be confirmed by further findings in the Levantine Sea waters.

Linking the present twobar seabream Egyptian finding with the previous ones from Tunisia and Spain appears more difficult. As observed for *T. jarbua*, given the relatively long interval from the first Mediterranean record of *A. bifasciatus* in Tunisia, one can hypothesize that the subsequent records of the species from the Aegean waters of Turkey and from the Egyptian Mediterranean waters are unrelated to the first Tunisian one, for which introduction via the Suez Canal was initially not excluded (Ben-Souissi et al. 2014). Concerning the record from Barcelona Harbour, Spain, a ship-borne introduction is until now the most likely explanation on the basis of current knowledge, as discussed in García-de-Vinuesa et al. (2020).

In conclusion, a definitive explanation of the occurrences of *A. bifasciatus* in disparate Mediterranean locations appears for the moment a challenge. Further records and further studies including genetic analysis of the Mediterranean *A. bifasciatus* samples and comparison with samples from populations in its native range will be helpful in clarifying the probable vector or vectors of introduction and/or dispersion in the basin, taking also into account the possibility of accidental aquarium release since the species is valuable as an ornamental fish (Meerwasser-lexikon 2020b).

The warming of the Mediterranean waters due to climate change (Zenetos and Galanidi 2020) and the successive enlargements of the Suez Canal accompanied by the intensification of maritime traffic through it (Galil et al. 2017) could facilitate new introductions of non-indigenous tropical and subtropical biota from the Red Sea. Once entering into the basin and establishing a viable population, there are no significant physical barriers preventing their dispersal, in particular along the south and eastern Mediterranean coasts (Golani 2010).

It is to be noted that, in the absence of large-scale national marine monitoring campaigns, the recent surge in citizen science initiatives, even through the platforms provided by social media which involve important stakeholders such as professional and recreational fishers, is greatly improving knowledge on native and non-indigenous diversity all over the southern Mediterranean region.

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