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Update of Red Sea (Lessepsian) fish species in the Mediterranean Sea since the 2nd CIESM Atlas of Exotic Fish

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Abstract

The article presents data about Red Sea fishes in the Mediterranean (Lessepsian migrants) collected since the publication of the 2nd edition of the Atlas of Exotic Fishes in the Mediterranean, which included material until 2020. In the past five years, a total of 18 Lessepsian fish species were recorded, representing 12 families. Five of these have established populations in the Mediterranean and ten have significantly expanded their distribution (by at least 400 km) in the Mediterranean. Three of the species reported as Lessepsian migrants were based on misidentifications.

Keywords: Lessepsian migration; first records; distribution expansion.

Introduction

The opening of the Suez Canal in 1869 connected the Red Sea and the Mediterranean, two seas with very different faunas. Red Sea organisms originate from the Indo-Pacific region, while the Mediterranean ones are of Atlantic origin. A very small number of cosmopolitan species have been found in both seas. The opening of the Suez Canal resulted in the mixing of these very different faunas, although this took place in an almost unidirectional migration of Red Sea species into the Mediterranean, a phenomenon termed Lessepsian migration, in honour of engineer and Suez Canal promoter Ferdinand de Lesseps (Por, 1978). This phenomenon is also, although rarely, termed Red-Med migration (Diamant, 1998) or Eritrean migration (Galil, 2006).

In the year 2021, the *Commission Internationale pour l'Exploration Scientifique de la Méditerranée* (CIESM) published the 2nd edition of the *Atlas of Exotic fishes in the Mediterranean Sea* (Golani *et al.,* 2021) that summarizes the knowledge of Lessepsian fish migrants until the year 2020. In the year preceding this publication, an additional six species were considered as likely to be exotic; among these, two were Red Sea species, namely, *Siganus argenteus* and *Acanthurus gahham*. A total of 115 Lessepsian fish species have been included in this publication, which has three objectives: 1. to update the list of new fish arriving in the Mediterranean from the Red Sea and are now established in the new region, 2. to list the species that have substantially increased their distribution in the Mediterranean and 3. to evaluate the validity and clarify the status of species believed to have been mistakenly classified as Lessepsian migrants.

Materials and Methods

Data for this study was gathered from scientific publications in professional journals. Species with western Indian Ocean distribution but not yet recorded in the Red Sea were considered as Lessepsian migrants as well. (e.g., *Equulites leuciscus, Oxyurichtys keiensis* and *Acanthurus xanthopterus*). The boundaries of the distribution range expanded substantially; at least 400 km compared to the previously known distribution range. The status of established Lessepsian fish species in the Mediterranean was adopted from Golani *et al.* (2021), namely, those species that were reported by confirmed records of at least three specimens collected at different and well-separated time points.

Results and Discussion

Species account

First records

RHINCODONTIDAE

Rhincodon typus Smith, 1828

The Whale Shark was first recorded in the eastern Mediterranean from the eastern coast of Turkey, based on video footage, and was estimated to have a length of ca. 300 cm (Turan *et al.,* 2021). This specimen most likely originates from the Red Sea. However, its recent record from the western Mediterranean (Spinelli & Alvaro García de los Ríos y los Huertos, 2023) and its cosmopolitan distribution (including the Atlantic Ocean), suggests that it may have entered the Mediterranean via the Strait of Gibraltar.

SYNODONTIDAE

Saurida gracillis (Quoy & Gaimard, 1824)

A single specimen, 242 mm TL, was recorded from northern Tunisia (Khamassi *et al.,* 2022). Its Indo-West Pacific distribution, including the Red Sea (Golani & Fricke, 2018), clearly indicates that it is a Lessepsian migrant.

Synodus randalli Cressey, 1981

A single specimen of 187 mm TL was collected at depths of ca. 80 m in June 2023, at Iskenderun Bay, Turkey (Turan & Doğdu, 2023). At a later date, it was also reported from Greece (Christidis & Kosology, 2024). This species originates from the western Indian Ocean and the Red Sea; therefore, it is considered to be a Lessepsian migrant.

HOLOCENTRIDAE

Neoniphon sammara (Forsskål 1775)

Mehanna and Osman (2022) reported 17 specimens of this species in the commercial catch at Mersa Martuh, Mediterranean coast of western Egypt. This species has a wide Indo-Pacific distribution, including the Red Sea (Golani & Fricke, 2018), hence it can be considered a Lessepsian migrant.

Sargocentron caudimaculatus (Rüppell, 1838)

A single specimen of 214 mm TL was collected from Cape Bon, Tunisia in October 2021 (Ghanem *et al.,* 2022). This species has a wide Indo-Pacific distribution, including the Red Sea (Golani & Fricke, 2018), hence it can be considered a Lessepsian migrant.

AMBASSIDAE

Ambassis dussumieri Cuvier, 1828

Stern *et al.* (2022) reported a large sustainable population from a protected artificial port in Tel-Aviv during October-November 2021. Later, a small school was observed and photographed near Herzliya, Israel, about 10 km north of Tel-Aviv. Additional records were reported, as *Ambassis* sp. by Abd Rabou *et al.* (2024) from the Gaza strip, Palestine, 70 km south of Tel-Aviv. Due to the poor quality of the photographs (A1 and A2), it is difficult to identify the specimens at specific level. This species has a wide Indo-Pacific distribution, including the Red Sea (Golani & Fricke, 2018), hence it can be considered a Lessepsian migrant.

LEIOGNATHIDAE

Equulites leuciscus (Günther, 1860)

A single specimen was hooked at a depth of 28 m in September 2022 in Antalya Bay, Turkey (Kebapcioglu & Cinbilgel, 2022). This species has a wide Indo-Pacific distribution, including eastern Africa but it was not recorded from the Red Sea (Golani & Fricke, 2018), hence it is reasonable to consider it a Lessepsian migrant.

HAEMULIDAE

Pomadasys argeneus (Forsskål, 1775)

A single specimen was captured and photographed near the city of Misrata, Libya (Fitori *et al.,* 2023). This species has a wide Indo-Pacific distribution, including the Red Sea (Golani & Fricke, 2018), hence it can be considered a Lessepsian migrant.

NEMIPTERIDAE

Scolopsis ghanam (Forsskål, 1775)
A single specimen was collected in August 2020 by trammel net at a depth of two meters in Bahirei Lagoon, Tunisia (Ben Souissi *et al.,* 2021). The original distribution of this species is in the western Indian Ocean, including the Gulfs of Aqaba and Suez in the Red Sea (Golani & Fricke, 2018).

LABRIDAE

Cheilinus lunulatus (Forsskåin Niebuhr, 1775)

A single specimen of ca. 300 mm (TL) was speared on 16 May 2022 at Gaza port, Palestine (Abd Rabou *et al.,* 2024). Originally the distribution of this species is the western Indian Ocean including the Red Rea. It is certainly a Lessepsian migrant.

GOBIIDAE

Hazeus ingressus Engin, Larson & Irmak, 2018

This species was first described from Turkey (Engin *et al.,* 2018) but was not included in the CIESM Atlas of Exotic Fishes, 2nd Edition (Golani *et al.,* 2021). Later it was reported from the northern Red Sea (Bogorodsky and Goern, 2023). Mavruk *et al*. (2024) reported an established population from Iskenderun Antalya Bay.

Cryptocentrus steinhardti Goren & Stern 2021

This species was first described based on several specimens caught by trawlers along the coast of Israel, indicating an established population in the Mediterranean (Goren & Stern, 2021). This species is considered to be a Lessepsian migrant, although it has not yet been recorded in the Red Sea, probably due to its external similarity to four congeneric species in the Red Sea (Golani & Fricke, 2018).

Oxyurichtys keiensis (Smith, 1938)

An established population was documented from the northern Levantine coast of Turkey (Özden *et al.,* 2022). The identification of the other co-generic *Oxyurichtys petersii* (Klunzinger, 1871) was determined by morphological and genetic studies. *Oxyurichtys keiensis* is known from the western Indian Ocean, but there is no record from the Red Sea (Golani & Fricke, 2018). It is likely that this species was overlooked hitherto from the Red Sea and the Mediterranean due to its external similarity to *Oxyurichtys petersii.*

SCOMBRIDAE

Thunnus albacares (Bonnaterre, 1788)

Michalidis *et al.* (2021) reported the capture of a single specimen of Yellowfin Tuna from Potima Bay, Pafos, Cyprus, based on photographs taken in October 1993. It is worth noting that since then, over three decades later, no specimen of this species has been recorded in the Mediterranean.

ACANTHURIDAE

Acanthurus gahham (Forsskål, 1775)

A single specimen was reported as *Acanthurus* cfr. *gahham* from Agios Georgios Salamina, Greece, on 24 August 2019, based on a photograph of an individual caught by commercial trammel at a depth of 11 m (Karachle *et al.,* 2020). This species has a north-western Indian Ocean distribution, including the Red Sea (Golani & Fricke, 2018), hence it can be considered a Lessepsian migrant

Acanthurus xanthopterus Valenciennes, 1835

A single specimen of this species measuring 356 mm (TL) was speared along the shore of Alexandria, Egypt on 28 August 2021 (Adel *et al.,* 2022). This species has a wide Indo-Pacific distribution including east Africa but it has not yet been recorded from the Red Sea (Golani & Fricke, 2018). Based on its distribution pattern, it is reasonable to assume that the lack of a record of its presence in the Red Sea is due to overlooking.

Naso annulatus (Quoy & Gaimard, 1825)

A single specimen of this species was speared, photographed, but not saved along the southern coast of Malta on 27 October 2021 (Nour *et al.,* 2022). This species has a wide Indo-Pacific distribution including the Red Sea; hence it can be considered a Lessepsian migrant.

TRIACANTHIDAE

Triacanthus biaculeatus Bleeker, 1859

A single specimen was hooked by simple line over shallow sandy substrate on 22 April 2021 (Abd Rabou *et al.,* 2024). This species has a wide Indo-Pacific distribution, including the Red Sea. (Goutham-Bharathi *et al.,* 2024).

Substantial distribution expansion in the Mediterranean

BREGMACEROTIDAE

Bregmaceros nectabanus Whitley, 1941

This species has expanded its distribution to the Sea of Marmara (Tunçer & Dalyan, 2021) from the Ionian and Adriatic Sea (Vrdoljak *et al.,* 2021; Palermino *et al.,* 2022).

BELONIDAE

Ablennes hians (Valenciennes, 1846)

Two specimens of this species were collected from Malta, central Mediterranean (Deidun *et al.,* 2021); this species was previously known from Israel and Syria (Golani *et al.,* 2019).

FISTULARIDAE

Fistularia petimba Lacepède, 1803

This species was reported from Southern Samos Island, Aegean Sea, the Sea of Marmara and the Cretan Sea, respectively (Uyan & Turan, 2021; Metaxakis & Kosoglou, 2024). This species was known hitherto in the eastern Mediterranean from Israel, Cyprus, and Turkey (Golani *et al.,* 2021).

SCORPENIDAE

Pterois miles (Bennett, 1828)

A single specimen was filmed in August 2022 at Corralete beach near Cabo de Gatu, Alboran Sea (Belmonte-Gallegos & Báez, 2023). This species expanded its distribution from the eastern and central Mediterranean.

SERRANIDAE

Epinephelus fasciatus Forsskål, 1775

A single specimen was speared at 8-10 m depth in September 2020 in the Gulf of Antalya, Turkey (Gökoğlu & Biçer, 2022). Previously, this species was known in the Mediterranean only from Lebanon (Bariche & Heemstra, 2012).

APOGONIDAE

Cheilodipterus novemstriatus (Rüppell, 1838)

Swarms of individuals of this species were observed and photographed in Rhodes in August 2020 (Miliou & Loudaros, 2020) This species was previously known only from the eastern coast of the Levant, Israel to Iskenderun, Turkey (Golani *et al.,* 2021).

TERAPONIDAE

Terapon puta Cuvier, 1829

Based on photographs posted on Facebook, several specimens were reported from the Venetian lagoon, Italy. The specimens were caught in November 2021 by trap net at a depth of 2 m (Tiralongo & Ulman, 2022). Previously, this species was reported from Egypt, Israel, Lebanon, and Turkey (Golani *et al.,* 2021).

PEMPHERIDAE

Pempheris rhomboidea Kossmann and Räauber, 1877

A single specimen was reported from the Sea of Marmara in June 2017 (Yapici & Yalgin, 2020). According to Golani *et al*. (2021), the distribution of this species in the Mediterranean includes Tunisia to Egypt, the southern coast, and Israel and Lebanon to Greece on the northern Mediterranean coast.

SPARIDAE

Acanthpagrus bifasciatus Forsskål, 1775

A single specimen was caught by trammel net at a depth of 3 m at Karaburum, Izmir Province, Turkey (Şensurat-Genç *et al.,* 2022). In the Mediterranean, this species was only recorded hitherto from Tunisia (Ben Souissi *et al.,* 2014)

ISTIOPHRIDAE

Istiompax indica Cuvier, 1832

This species was first recorded in the Mediterranean Sea by a single specimen from Camogli, Ligurian Sea. (Orsi-Relini & Costa, 1987) A second record of this species from the Mediterranean was reported from Tripoli, Lebanon on 23 January 2021 (Michailidis *et al.,* 2021).

Doubtful record

Tylosurus crocodilus (Péron & Lesueur, 1821)

This species was first mentioned from the Mediterranean by George *et al.* (1964) and later by Sinis (2005). In both cases, and see also Borme *et al.* (2023) the specimens were not saved and no characteristics distinguishing the Mediterranean specimens from their co-generic species were given.

Excluded species

Sargocentron spinosissimum (Temmink & Schlegel, 1843)

Sargocentron tiereoides (Bleeker, 1853)
Both species were reported from the Mediterranean coast of Egypt (Deef, 2021). However, from the photographs (Fig. 1), it is clear that both are misidentifications of the co-generic *Sargocentron rubrum* (Forsskål, 1775), which is known to be a Lessepsian migrant in the Mediterranean. In both *S. spinosissimum* and *S. tiereoides,* the white stripes are very narrow, their width is subequal to one quarter of that of the red stripes (Randall, 1998). Both species lack dark upper and lower margins in the caudal fin. Golani (1987) showed that the spines on the upper operculum varied within *S. rubrum.* Both species do not occur in the Red Sea (Golani & Fricke, 2018). Keskin & Atar (2013), Tikochinski *et al.* (2014) and Bariche *et al*. (2015) who studied the DNA sequence of *Sargocentron rubrum* found a high intraspecific genetic level of the Mediterranean and Indo-Pacific populations and suggested that most likely there is a species complex within *S. rubrum* having more than one cryptic species.

TETRAODONTIDAE

Lagocephalus spadiceus (Richardson, 1844)

Based on a molecular study, Turan *et al.* (2024) reported this species as occurring in the Mediterranean together with *Lagocephalus guentheri* Miranda Ribero, 1915. However, Matsuura *et al*. (2011) showed clearly that these are two distinct species; *L. spadiceus* does not occur in the Red Sea and the Mediterranean. The confusion may stem from the high genetic variability of some of the Lessepsian migrants or the misidentification of some of the studied samples.

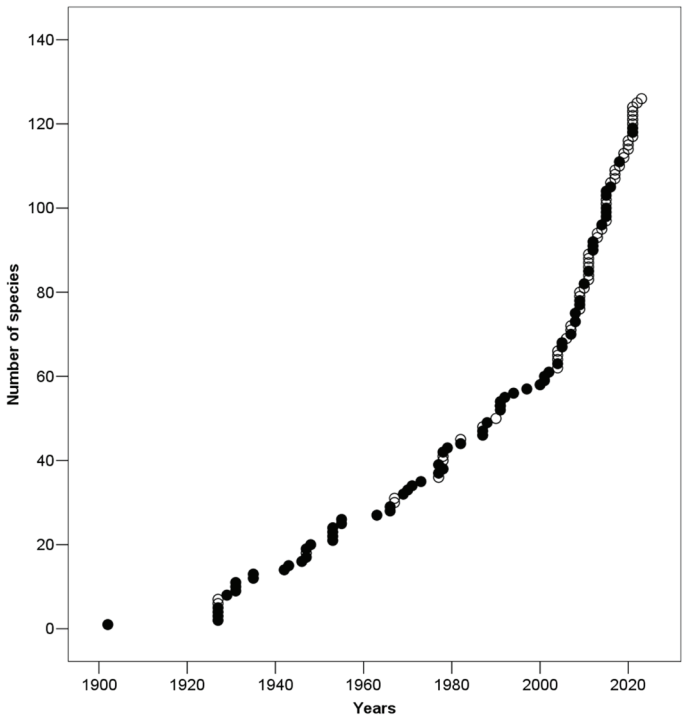

Fig. 1: Cumulative number of Lessepsian fishes. Full dots – established species; empty dots – non-established species.

First records of 18 Lessepsian fish were considered in this study; three of them, namely *Hazeus ingressus, Thunnus albacares*and *Acanthurus gahham*, were documented in the Mediterranean prior to the 2nd edition of the CIESM Atlas (Golani *et al.,* 2021). One species was first recorded in 2020, in 2021, 8 species, in 2022, 4 species and 2 species in 2023. Five first recorded Lessepsian migrants have established populations in the new region (*Neoniphon samara, Ambassis dussumieri, Hazeus ingressus, Oxyurichtys keiensis* and *Cryptocentrus steinhardti*), while out of the 13 non-established species, four were recorded and identified from photographs provided by the authors (*Rhincodon typus, Pomadasys argeneus, Thunnus albacares* and *Acanthurus gahham*).

The rate of increase of Red Sea fish arrivals in the Mediterranean is accelerating and consists of three stages. During the first stage, the first Lessepsian fish, *Aterinomorus forskali*, was documented at the beginning of the 20th century as *A. lacunosus* (Forester, 1801) (Tillier, 1902). By the end of the 1950s, an average of 0.47 Lessepsian species were recorded per year. During the second stage and until the end of the 20th century, the number increased to an average of 0.94 species per year. During the third stage, since the beginning of the 21st century, the average rate of increase has reached 2.80 species per year (see Fig. 1). Another difference between the three stages is the percentage of established Lessepsian fish, which was high during the first stage, but slowly decreased during the second stage, and dropped dramatically during the third stage.

Postscript: After submission, Ali *et al*. (2024) reported the first record of *Odunus niger* (Rüppell,1836) from the Mediterranean coast of Syria.

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