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On the occurrence of two lessepsian fishes in the southern Tyrrhenian Sea: filefish *Stephanolepis diaspros* and goatfish *Upeneus pori*

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Received: 28.03.2024

Accepted/Published Online: 10.07.2024

Final Version: 05.11.2024

Abstract: The reticulated leatherjacket *Stephanolepis diaspros* and the Por's goatfish *Upeneus pori* occur as lessepsian migrants in the eastern and central Mediterranean Sea. This article reports on the findings of one reticulated leatherjacket and two Por's goatfishes in the Gulf of Castellammare, southern Tyrrhenian Sea, which suggest a possible westbound expansion of the Mediterranean distribution for the latter species. The specimens were three adults collected by professional fishermen on inshore sandy bottoms with a trammel net. The main meristic characteristics of both species, the identification issues of *S. diaspros*, and the potential impact of *U. pori* on the native biota and artisanal fisheries are briefly discussed.

Key words: Nonindigenous species; alien fishes; fisheries; range expansion; Osteichthyes; Mediterranean

1. Introduction

The Mediterranean Sea is considered a hotspot of biological invasions as it has the greatest number of introduced species among all marine regions of the world (Costello et al., 2021). The eastern sector in particular hosts a vast number of nonindigenous species due to the presence of the Suez Canal, one of the main pathways of introduction of marine nonindigenous species (Servello et al., 2019) that gave rise to the so-called lessepsian migration of organisms from the Red Sea (Por, 1978; Golani, 2010). Among the approximately 190 nonindigenous fishes occurring in the Mediterranean, 106 of them are now considered established (Golani et al., 2021). The abundance of lessepsian fishes has increased so much that it has brought about a dramatic change in the Levantine infralittoral ecosystem, where they represent up to 90% of the total fish biomass in shallow soft-bottom areas (Goren and Galil, 2005; Arndt et al., 2018). The reticulated leatherjacket *Stephanolepis diaspros* Fraser-Brunner, 1940 (Tetraodontiformes: Monacanthidae) and the Por's goatfish *Upeneus pori* Ben-Tuvia and Golani, 1989 (Perciformes: Mullidae) are two

lessepsian fishes widely distributed in the eastern and central Mediterranean Sea (Golani et al., 2021; Azzurro, 2023¹).

Stephanolepis diaspros was recorded for the first time in the Mediterranean from the Palestinian coast in 1927 as *Monacanthus setifer* Bennett, 1831 (Steinitz, 1927). Its native distribution includes the northwestern Indian Ocean from the Persian Gulf to the Red Sea, where it is apparently neither particularly abundant nor widespread, considering that until the early 1980s it was known only from Iran and the eastern Arabian Peninsula (Fischer and Bianchi, 1984). This species also occurs along the coasts of eastern and central Mediterranean areas (Golani et al., 2021) where it is considered established (Zenetos et al., 2010; see also Tiralongo et al., 2020 for recent records from SE Sicily). The northernmost record comes from the northern Adriatic (Kapiris et al., 2014), and the westernmost from off the Tunisian-Algerian border (Katsanevakis et al., 2020). The only other monacanthid recorded from the Mediterranean is *Aluterus monoceros* (Linnaeus, 1758), also a nonindigenous species (Crocetta et al., 2021).

¹Azzurro E. (2023). Occurrence Records of Mediterranean Exotic Fishes, ORMEF [online]. Website www.ormef.eu [accessed 1 February 2024]. This footnote applies to all other occurrences of this reference.

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Upeneus pori, originally known from the northern Red Sea and Madagascar (Uiblein et al., 2020), was recorded for the first time in the Mediterranean in 1942 by Kosswig (1950), albeit misidentified as *Upeneoides tragula* (= *Upeneus tragula* Richardson, 1846), from the Iskenderun Bay, southeastern Turkey. Since its first appearance, and like many other lessepsian species (Golani, 2010), after its colonization of the eastern Mediterranean, *U. pori* spread westwards to the Aegean Sea as far north as the Thermaikos Gulf (Kampouris et al., 2020) and to the central-western Mediterranean in Tunisia (Azzouz et al., 2010; Ragkousis et al., 2023), the Strait of Sicily (Geraci et al., 2018), and eastern Sicily (Deidun et al., 2018; Katsanevakis et al., 2020). Along with the congeneric lessepsian *U. moluccensis*, this species shows the characteristics of an invader. Ranked fourth among all Levantine demersal species in 2010–2011 Turkish trawl surveys with a 5 kg/h catch per unit effort (Yemisken et al., 2014), this species has given rise to concern about a displacement effect over the two autochthonous goatfishes of the genus *Mullus* (Otero et al., 2013). *U. pori* currently represents an important fishery resource in the Levant Sea (Yemisken et al., 2014).

The preferred habitat of *S. diaspros* includes inshore rocky substrates and seagrass meadows, but trawl catches from both the Indo-Pacific and the eastern Mediterranean suggest that it also lives on soft bottoms (Fischer and Bianchi, 1984; El-Ganainy and Sabra, 2008; Erguden et al., 2009). Shaiek et al. (2019) have reported its presence from brackish water habitats (Bizerte Lagoon, northern Tunisia). *U. pori* lives preferentially on sandy and muddy substrates to a depth of 50 m (Golani et al., 2021).

This paper reports the finding of one individual of *S. diaspros* and two of *U. pori* from the western part of their Mediterranean distribution.

2. Materials and methods

One individual of *Stephanolepis diaspros* and two of *Upeneus pori* were collected with a trammel net by professional fishermen in the Gulf of Castellammare, northwestern Sicily (southern Tyrrhenian Sea, Figure 1).

S. diaspros (Figure 2) was caught on 21 November 2023 off Alcamo Marina, approximately 38°033'N, 12°920'E, at a depth of about 15 m. The area is characterized by soft bottoms with interspersed patches of the seagrass *Cymodocea nodosa* and sparse submerged artificial reefs, with the closest natural rocky habitats and *Posidonia oceanica* patches at a distance of about 2 km. The identification was carried out at the CNR-IAS laboratory in Castellammare del Golfo and was based on Bauchot (1987) and Golani et al. (2021). Tortonese (1986) warned against possible misidentification due to the lack of an updated identification key and the need for a revision of the genus.

Two individuals of *U. pori* were caught in July 2023 close to the aforementioned location, approximately 38°030'N, 12°910'E (Figure 3) on a sandy bottom at a depth of about 10 m. The fisherman noticed the unusual aspect of the two fishes compared with the locally abundant and well-known native goatfishes, the red mullet *Mullus barbatus* and the striped mullet *M. surmuletus*. For specimen 1, only the photo taken by the fisherman before selling the fish is available, while specimen 2 was delivered to the CNR-IAS laboratory and frozen. Their identification was confirmed after checking the description and taxonomic key provided

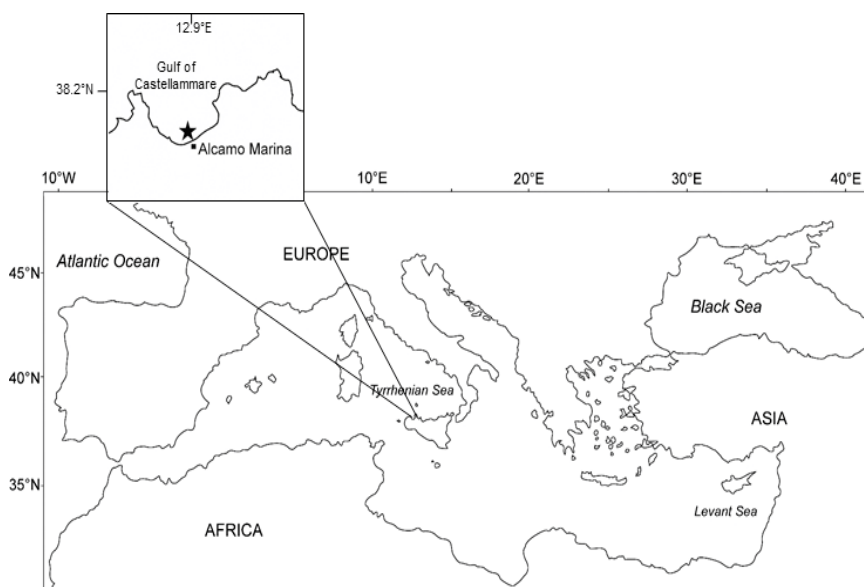


Figure 1. Map of the collection area of *Stephanolepis diaspros* and *Upeneus pori*.



Figure 2. Reticulated leatherjacket, *Stephanolepis diaspros* collected in the Gulf of Castellammare. Scale bar: 2 cm.



Figure 3. Por's goatfish, *Upeneus pori* collected in the Gulf of Castellammare. (a) Specimen 1, photographed by the fisherman at the harbor dock. (b) Specimen 2, photographed after preservation in freezer in the CNR-IAS lab.

by Uiblein et al. (2020). The acquired specimens of *S. diaspros* and *U. pori* were preserved in 70% ethanol and added to the CNR-IAS collection.

3. Results

Table 1 shows the measurements taken on *Stephanolepis diaspros*. According to Zouari-Ktari et al. (2008) and

Zouari-Ktari and Bradai (2011), its size suggests that the specimen is an adult and likely male. The only other morphologically similar fish present in the Mediterranean is the grey triggerfish *Balistes capricus* Gmelin, 1789 (Tetraodontiformes: Balistidae), which is characterized by a larger maximum size, a uniform light-grey coloration, three spines in the first dorsal fin instead of one, and hard,

Table 1. Morphometric measurements and meristic counts recorded for *Stephanolepis diaspros* collected in the Gulf of Castellammare.

Morphometrics	Measurement (mm)	Percentage of total length (%TL) or head length (%HL)
Total length	152	
Standard length	129	85 (%TL)
Body depth*	58	38 (%TL)
First predorsal fin length	36	24 (%TL)
Second predorsal fin length	70	46 (%TL)
Preanal fin length	68	45 (%TL)
Head length	36	24 (%TL)
Eye diameter	8	22 (%HL)
Preorbital length	25	16 (%TL)

Meristics	Count
First dorsal fin rays	1
Second dorsal fin rays	30
Anal fin rays	31
Pectoral fin rays	15
Total wet weight (g)	62

*Measured between the origins of the soft dorsal and anal fins (Fraser-Brunner, 1940).

plate-like scales on the skin instead of the smoother skin with minute scales that *S. diaspros* has (Bariche, 2012). Nevertheless, the similarity between *S. diaspros* and juvenile *B. capricus* is pronounced, and misidentification during underwater observation is highly probable. Furthermore, many triggerfishes and filefishes hide below floating debris as juveniles (Fricke et al., 2009; Carpenter and De Angelis, 2016), so tentative underwater identifications by nonspecialist observers may be incorrect.

The size of *Upeneus pori* specimen 1 was estimated at about 100 mm total length by the fisherman. The measurements of specimen 2 are shown in Table 2. After macroscopic examination of the gonads, specimen 2 was sexed as a recovering female, corresponding to stage 2b of the maturity scale proposed by Follesa and Carbonara (2019) for *M. barbatus* and *M. surmuletus*.

4. Discussion

Assessment of the impacts of invasive alien species, including possible positive ecological and socioeconomic effects, is key to the implementation of management measures and mitigation initiatives (Katsanevakis et al., 2014; Corrales et al., 2017; Vimercati et al., 2020). Such impacts may be driven by niche overlap and competition for space and food (Arndt et al., 2018). In the case of *Upeneus pori*, although a diet overlap with the indigenous goatfishes was observed, differences in habitat and spawning period have been suggested as niche separation mechanisms in the Levant Sea (Golani, 1994). In fact, it

is not clear whether a competitive exclusion exists in that area between native and alien goatfishes. Even though a decrease in the abundance of *Mullus* spp. and an increase of *Upeneus* spp. was recorded, which could be due to factors such as fishing pressure and temperature raise (Arndt et al., 2018), overall, the increased catches of *Upeneus* spp. in the Levant Sea and its expansion at higher depths (Keskin et al., 2011) did not seem to occur at the expense of *Mullus* spp.

To our knowledge, this is the first record of *U. pori* from the Tyrrhenian Sea and the fourth from Italian waters, after those from the Strait of Sicily (Geraci et al., 2018) and from eastern Sicily (Deidun et al., 2018; Katsanevakis et al., 2020). Judging from the consistent catches in the Strait of Sicily (Geraci et al., 2018), the north Tunisian records (Azzouz et al., 2010), and those from northwestern Sicily (this paper), it seems that *U. pori* is gradually expanding its distribution range to the western Mediterranean. Considering the global warming trend and the general northward and westward shift of isotherms observed in this area (Geraci et al., 2018), the Strait of Sicily should no longer be seen as a barrier to the expansion of marine species, as already highlighted by Guidetti et al. (2010).

The Gulf of Castellammare has been subject to a trawling ban since 1990 (Pipitone et al., 2014), and the native goatfish *M. barbatus* showed a massive increase that remained consistent in the following years (Agnetta et al., 2019; Pipitone et al., 2023). The conditions in the Gulf of Castellammare, which are very different from the Levant

Table 2. Measurements of *Upeneus pori* specimen 2 in the Gulf of Castellammare.

TL	SL	HL/HH	SL/HL	SL/BH	HL/BH
117	95	1.7	4.0	4.8	1.2

TL = total length, SL = standard length, HL = head length, HH = head height through eye, BH = body height at anal fin origin. Measurements in mm. Size ratios after Uiblein et al. (2020).

Sea where both native and alien goatfishes are subject to intense trawling, prevent prediction of the possible dynamics of potentially competing species. Although shallow sandy bottoms appear to be the preferred Mediterranean habitat for *U. pori* (Golani, 1994), the ability of this species to overlap with the deeper muddy habitat of the native goatfishes (Keskin et al., 2011; Geraci et al., 2018) and their partial diet overlap (Golani, 1994; Sergiwa et al., 2017) represent a potentially worrisome scenario to be monitored in the coming years. This also relates to the economic returns of artisanal fishermen in the Gulf of Castellammare due to the smaller average size of *U. pori* compared to native goatfishes. Moreover, the sizes of both examined specimens correspond to length at first maturity (Ramadan and El-Halfawy, 2014), with one of them being a recovering female, and this suggests the possibility of further spread in the area.

Stephanolepis diaspros has been recorded numerous times from the eastern and central Mediterranean, where it is considered one of the worst invasive species and seen as a pest by fishermen (Zenetos et al., 2005). The most numerous and frequent records are from the eastern and southern Mediterranean and from the southern Aegean Sea (Golani et al., 2021; Azzurro, 2023). The first finding in Italian waters occurred in the northern Ionian Sea in 1967 (Tortonese, 1967), followed by 11 more records concentrated in Sicilian and adjacent waters (Tiralongo

et al., 2020; Azzurro, 2023). This reported finding is the second from the southern Tyrrhenian Sea, 40 years after the collection of two specimens in the Gulf of Palermo in 1983 (Catalano and Zava, 1993).

The Gulf of Castellammare is the finding locality of several nonindigenous algae and invertebrates (Katsanevakis et al., 2020; Pipitone et al., 2020; Ragkousis et al., 2023) and one nonindigenous fish, *Fistularia commersonii* Rüppell, 1838 (Azzurro, 2023), found as one or two individuals although it was considered already established in the central Mediterranean (Zenetos et al., 2010). *S. diaspros* is among the most widely spread lessepsian fishes, and in the Mediterranean, it reaches a size even larger than in its native range (Metin and Akyol, 2021). It is still too uncommon in the southern Tyrrhenian to foresee a range expansion, and its occurrence is probably the result of vagrant movements (Deidun et al., 2015).

Acknowledgments

We thank the fishermen, Vincenzo Agnello and Leonardo Russo, for providing the specimens of *U. pori* and *S. diaspros*, respectively. We acknowledge the precious support of Gianna Innocenti and Annamaria Nocita of the La Specola Natural History Museum (Florence, Italy) for retrieving the details of a specimen of *S. diaspros* kept at the museum.

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