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DISTRIBUTION EXTENSION OF *LUTJANUS ARGENTIMACULATUS* (LUTJANIDAE) AND *PSENES PELLUCIDUS* (NOMEIDAE) TO THE WATERS OF MALTA, CENTRAL MEDITERRANEAN SEA

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ABSTRACT

The recent first findings of the Lessepsian migrant Lutjanus argentimaculatus (Forsskål, 1775) *and of the Atlantic range-expanding* Psenes pellucidus Lütken, 1880 *in the waters of Malta, central Mediterranean, are described. The current distribution in the basin of these two fish species is briefly discussed.*

Key words: Non-Indigenous species, Lessepsian migration, range-expanding species, Mediterranean Sea, citizen science

ESPANSIONE DELLA DISTRIBUZIONE DI *LUTJANUS ARGENTIMACULATUS* (LUTJANIDAE) E DI *PSENES PELLUCIDUS* (NOMEIDAE) VERSO LE ACQUE DI MALTA, MEDITERRANEO CENTRALE

SINTESI

Nell'articolo vengono segnalati i primi recenti ritrovamenti nelle acque di Malta, Mediterraneo centrale, del migrante lessepsiano Lutjanus argentioomaculatus (Forsskål, 1775) *e di* Psenes pellucidus Lütken, 1880, *una specie di origine atlantica, il cui areale è in espansione. L'attuale distribuzione di queste due specie nel bacino è brevemente discussa.*

Parole chiave: Specie non-indigene, migrazione Lessepsiana, specie di origine atlantica in espansione, Mediterraneo, citizen science

INTRODUCTION

In the Mediterranean Sea, most of the Non-Indigenous Species (NIS) of fishes are of Indo-Pacific origin, introduced via the Suez Canal (Lessepsian migrants); other species, of diverse origins, have entered into the basin via human-mediated activities (ship-transport, mariculture, aquarium trade) (Golani *et al.*, 2021). Furthermore, a number of fishes of Atlantic origin, named range-expanding, newcomers, neonative species, entered naturally into the basin through the Strait of Gibraltar (Evans *et al.*, 2020).

Four species of Lutjanidae have been detected in the Mediterranean, *Lutjanus argentimaculatus* (Forsskål, 1775), *Lutjanus fulviflamma* (Forsskål, 1775), and *Lutjanus sebae* (Cuvier, 1816), all native to the Red Sea and the Indo-West Pacific (Vella *et al.*, 2015; Deidun & Piraino, 2017; Golani & Fricke, 2018; Akyol, 2019) and *Lutjanus jocu* (Bloch & Schneider, 1801) originating from the western and eastern Atlantic (Vacchi *et al.*, 2010).

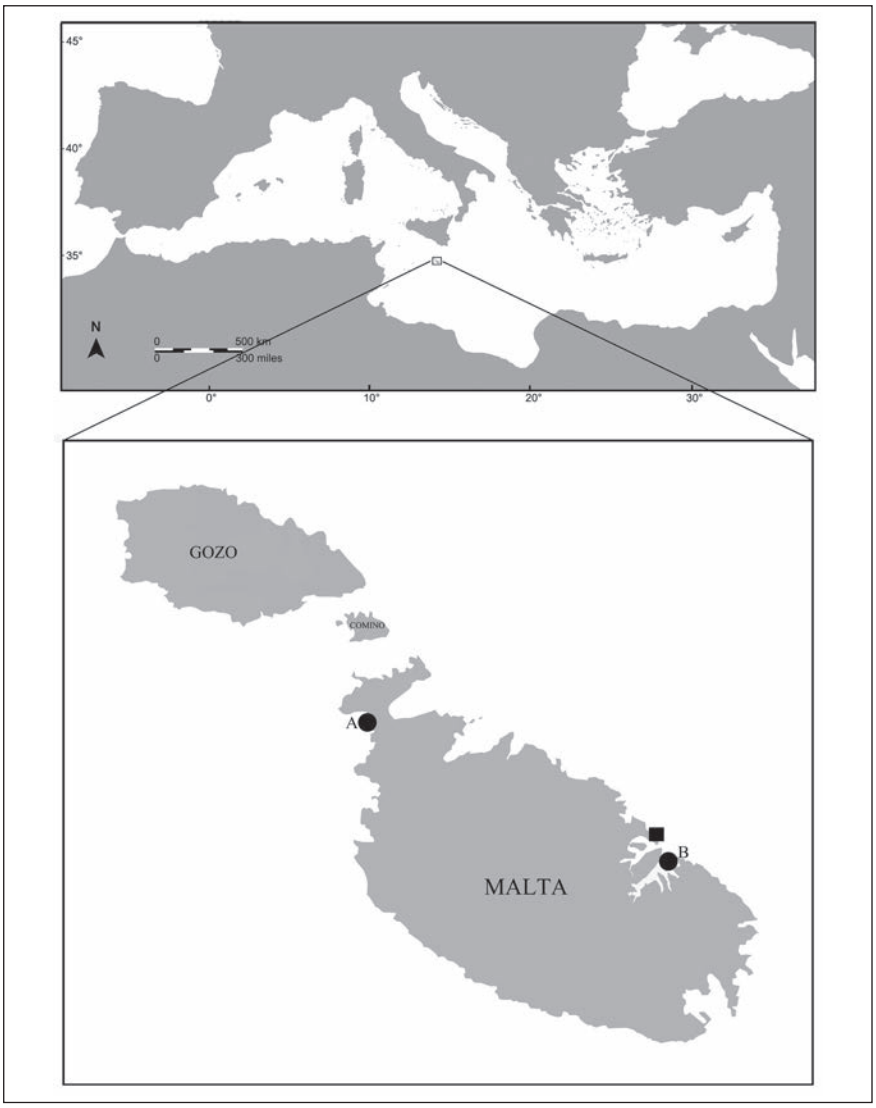

Fig. 1: Maps of the Mediterranean Sea and the Malta Archipelago, showing the finding locations of *Lutjanus argentimaculatus* ***at Sliema (square), and*** *Psenes pellucidus* ***at Anchor Bay (A) and Grand Harbour, Valletta (B), in Malta Island (circle). Sl. 1: Zemljevid Sredozemskega morja in malteškega arhipelaga z označenimi lokalitetami na Malti, kjer sta bili najdeni vrsti*** *Lutjanus argentimaculatus* ***na lokaliteti Sliema (kvadratek) in*** *Psenes pellucidus* ***na lokalitetah Anchor Bay (A) in Grand Harbour, Valletta (B) (krogca).***

Fig. 2: *Lutjanus argentimaculatus* ***spearfished in Malta (photo: R. Mizzi).***
Sl. 2: *Lutjanus argentimaculatus* ***ulovljen s podvodno puško na Malti (foto: R. Mizzi).***

According to Kovačić *et al*. (2021), the family Nomeidae is represented in the Mediterranean by *Cubiceps capensis* (Smith, 1845), *Cubiceps gracilis* (Lowe, 1843) and *Psenes pellucidus* Lütken, 1880, all circumglobal species in warm and temperate seas. Among the above named nomeids, the latter one, *P. pellucidus*, is generally considered as a recent, naturally range-expanding species from the Atlantic (Evans *et al*., 2020; Golani *et al*., 2021).

The first findings of the Indo-Pacific NIS *L. argentimaculatus* and of the Atlantic range-expanding *P. pellucidus* in the waters of the island of Malta are described and the distribution of their records in the Mediterranean is briefly discussed.

MATERIAL AND METHODS

Photographic material and capture data of fishes were obtained from the "Spot the Alien" platform, a citizen science campaign implemented since 2017 by the Oceanography Malta Research Group within the Department of Geosciences at the University of Malta.

On 12 January 2021 a specimen of the Mangrove red snapper *Lutjanus argentimaculatus*, 43.0 cm of total length, weighing 1.63 kg, was speared at Sliema (Malta) (35.911958°N, 14.509129°E) at 12 m of depth (Fig. 1). The sample was not preserved.

On 13 February 2022 a small specimen of the Bluefin driftfish *Psenes pellucidus*, approximately 50 mm in total length (TL) (specimen A), was collected at Anchor Bay, Malta (35.959923° N, 14.340031° E) (Fig. 1) from the shore with a hand-net, next to a specimen of *Pelagia noctiluca*. The sample was photographed alive and released, while another similar individual (about 100 mm in length) was only observed. On 12 March 2022, a second small specimen (specimen B), about 40 mm in total length, was collected at the Grand Harbour, Valletta, Malta (35.893415° N, 14.525980° E) (Fig. 1) from the shore through rod-fishing, using common shrimps as bait, at an estimated depth of 4-5 m. The specimen was photographed, but not collected. It is to be stressed that a large-scale bloom of jellyfish, primarily consisting of salps, *P. noctiluca* and of ctenophores, has been observed in the waters of Malta since December 2021 (AD, personal observation).

RESULTS

Lutjanus argentimaculatus (Forsskål, 1775)

The specimen was identified as *L. argentimaculatus* following Allen (1985) and Anderson & Allen (2001), on the basis of the available photo (Fig. 2): body moderately deep, pointed snout and terminal mouth, a notch in the lower margin of the oper-

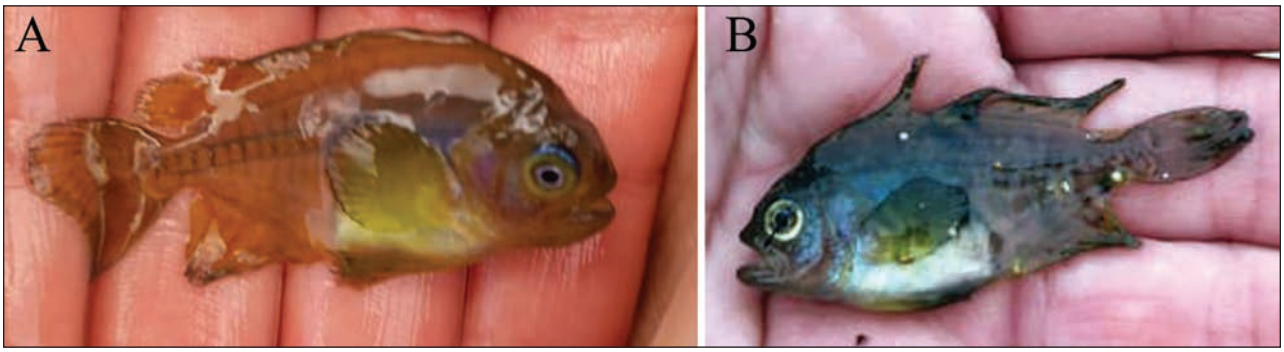

Fig. 3: Juveniles of** Psenes pellucidus **from Malta. A: live specimen collected in February 2022 (photo: A. Misfud), B: specimen collected in March 2022 (photo: M. Etienne).
Sl. 3: Mladostni primerki vrste** Psenes pellucidus **iz Malte. A: živi primerek, ulovljen februarja 2022 (foto: A. Misfud), B: ujeti primerek iz marca 2022 (foto: M. Etienne).

culum, scale rows on back parallel to lateral line, apart the last rows rising obliquely posteriorly under the end of soft dorsal, caudal fin nearly truncate. Colour: body reddish, darker on back and sides, lighter on belly; silver shadings are visible; dorsal and anal fins dusky brownish, caudal fin dusky brownish with the outer margin paler, pectoral and pelvic fins reddish.

***Psenes pellucidus* Lütken, 1880**

The fishes were identified as juveniles of *P. pellucidus* on the basis of the photos available (Fig. 3A, B), following Lütken (1880), Haedrich (1967), Ahlstrom *et al*. (1976), Costa (1999), Lamkin (2005), Fahay (2007), Hata & Motomura (2017), Cabebe & Motomura (2019) and Bray (2020). The body of the *P. pellucidus* juveniles (Fig. 3A, B) appears moderately high and compressed with a flabby consistence; the head shows a concavity over the eye; two dorsal fins, the origin of the first over the posterior end of the gill opening, the origin of the second over the end of the upper margin of the pectoral fin; the posterior end of the dorsal fin base is located just above the posterior end of the anal fin base; the pectoral fin has round margin, the upper origin of its base is under the posterior end of the gill opening; the caudal fin is lightly emarginated, with rounded lobes; the pelvic fin origin is under the pectoral fin base. Anal fin appears high. The mouth is small, with the upper jaw ending about below the middle of the lower margin of the eye. As observed by the persons who collected the specimens, the fishes were almost transparent, acquiring, during photography, a reddish translucent coloration in specimen A, alive (Fig. 3A) and a bluish-violet translucent colouration in specimen B, dead (Fig. 3B). The ventral part, between pectoral and pelvic fins, appears whitish, not translucent; a bluish curved shadow from the upper gill opening to the origin of anal fin is visible in the live specimen (Fig. 3A); the pectoral fin is prevalently golden; the outer margin of dorsal, anal, pelvic and caudal fins appears darker than the remaining fin; the iris appears silvery around the crystalline, with a posterior darker shadow, then golden with a lunate dark blue band at the superior margin (Fig. 3A). From Fig. 3A it was possible to obtain a limited number of approximate ratios: head length 34.9, pectoral fin length 28.5, body depth 43.4, caudal peduncle height 7.4, eye diameter 10.8, maxillary length 13.1, all expressed as % of standard length.

DISCUSSION

The description of the *Lutjanus argentimaculatus* specimen from Malta was in agreement with that provided by Allen (1985) and Anderson & Allen (2001) for the species.

The mangrove red snapper *L. argentimaculatus* is a large fish of a common size to 80 cm (maximum 120 cm), with a wide Indo-West Pacific distribution extending from the Red Sea and eastern Africa to Australia and Samoa (Allen, 1985; Sonin *et al*., 2019; Golani *et al*., 2021). It was first recorded in the Mediterranean by Mouneimné (1979) from Lebanon, considered to have been introduced via the Suez Canal (Lessepsian migrant) (Golani & Fricke, 2018). A second record was reported again from Lebanon, in 2014 (Crocetta & Bariche, 2016), after a time interval lasting about four decades and widely discussed in Sonin *et al*. (2019). From 2018 to date, other findings in the eastern Mediterranean followed: east Aegean, Turkey (Akyol, 2019), Israel (Sonin *et al*., 2019), southwest Aegean, Greece (Tiralongo *et al*., 2019) and Cyprus (Langeneck *et al*., 2022).

The Maltese record of the Lessepsian migrant *L. argentimaculatus* described in the present paper is the first for the central Mediterranean Sea and could constitute a first indication that the species, already established in the eastern basin (Sonin *et al.*, 2019), is expanding its population westward. The quick succession of new Mediterranean records of the species in recent years suggests that this expansion is happening rapidly.

Concerning *Psenes pellucidus*, the description of the young specimens from Malta agreed with that of similarly-sized specimens described for example in Costa (1999), Hata & Motomura (2017) and Cabebe & Motomura (2019). The approximate ratios obtained for our specimen were comparable to the correspondent ratios for *P. pellucidus* given by Hata & Motomura (2017), except for that of body depth. The transparence and the lack of bands and spots of our young *P. pellucidus* allowed to differentiate them from the early stages of other *Psenes* species, unrecorded in the Mediterranean, such as *P. maculatus* Lütken, 1880, *P. cyanophrys* Valenciennes, 1833 and *P. arafurensis* Günther, 1889 (Fahay, 2007; Myoung *et al*., 2001; Cabebe & Motomura, 2019). Furthermore, our samples were distinguishable from the juvenile stages of the Mediterranean Centrolophidae *Centrolophus niger* (Gmelin, 1789), *Schedophilus ovalis* (Cuvier, 1833) and *Schedophilus medusophagus* (Cocco, 1839), because these latter have a single dorsal fin, their young stages are pigmented with dark spots or bands, and *Schedophilus* species have denticulate preoperculum (Tortonese, 1959; Ahlstrom *et al*., 1976; Aboussouan, 1983; Costa, 1999; Fahay, 2007; Akyol, 2008; Milana *et al*., 2011; Dulčić *et al*., 2012; Rafrafi-Nouira *et al*., 2015). The *P. pellucidus* samples from Malta were also distinguishable from juveniles of the other nomeids known in the Mediterranean, *C. gracilis* and *C. capensis*, having these latter a more elongated body (Fahay, 2007).

The Bluefin driftfish *P. pellucidus* reaches a length of 60-80 cm and is widely distributed in the temperate and warm waters of the Atlantic, Indian and western Pacific oceans (Golani *et al*., 2021). It is an oceanic species with epipelagic or mesopelagic juveniles, often associated with jellyfish and floating objects, while large adults are prevalently demersal on the continental slope (Golani *et al*., 2021). In the Mediterranean, *P. pellucidus* was first recorded in Algeria (Dieuzeide & Roland, 1955) and, as mentioned above, it is considered a range-expanding species introduced via the Strait of Gibraltar (Evans *et al*. 2020; Golani *et al*., 2021). Subsequent records were reported in the western and central basin, from Morocco (Maurin, 1962, 1968), Spain (Riera *et al*., 1995), France (Quignard & Tommasini, 2000), Italy, in the Strait of Messina since 1992 and later (Costa & Fanara, 1994; Berdar *et al*., 1995; Spalletta *et al*., 1995; Costa, 1999; Navarra *et al*., 2007; Orsi-Relini, 2010), and Sardinia (Follesa *et al*., 2006), as well as from Tunisia (Ghanem *et al*., 2016). Although it is a fish not frequently caught in the basin, *P. pellucidus* is considered as established in northeastern Sicilian waters (Sperone *et al*., 2015); in particular, the collection of juveniles of this species is probably correlated to the abundance of ctenophores and cnidarians along the coasts of the Strait of Messina (Navarra *et al*., 2007) as in the case for juvenile fishes of other medusivorous species in the same area (Battaglia *et al*., 2014).

The first record of *P. pellucidus* from Malta is currently the easternmost one for the whole Mediterranean and could anticipate that the species is facing a further extension of its distribution toward the eastern part of the basin. It is known that the diet of *P. pellucidus*, at least during its juvenile stages, includes the jellyfish *Pelagia noctiluca* (Navarra *et al*., 2007). The current winter bloom of *Pelagia noctiluca* observed in Malta could have played a role in the dispersal of juveniles *P. pellucidus* to the waters of the island, as hypothesized in the case of the juvenile specimen found in Tunisian waters (Ghanem *et al*., 2016).

The findings from this study further reinforce the significance of the Strait of Sicily, east of which the Malta archipelago is located, as an ecological corridor for the east-west and west-east dispersion of exotic species and Atlantic range-expanding species within the Mediterranean basin respectively, i.e., as a biogeographical crossroads between the two parts of the basin (Guidetti *et al*., 2010; Deidun *et al*., 2011, 2021a, b; Azzurro *et al*., 2014).

Constant monitoring of biodiversity in this region is fundamental for the anticipation of new arrivals from east toward the west and vice versa, so as to alert and inform environmental managers and policy-makers of the possible expansion of their populations in the contiguous areas.

Citizen science is giving an important contribution to the enhancement of knowledge on marine biodiversity and for the monitoring of species (native, NIS and neonative species) distributions. Fully in agreement with Karachle *et al*. (2020), it is nevertheless essential to verify species identification through the scientific examination of samples reported by citizens in platforms and social media, given that the submission by the public of photographic material or videos, the quality of which is often poor, is clearly insufficient to enable the correct taxonomic identification of species and could lead to approximate or incorrect conclusions on their occurrence in the basin. There is no doubt that social media and new technologies are powerful instruments for the rapid exchange of information

and photos on biota, but there is a dire need to improve the collaboration between citizen scientists and scientists (Roy *et al*., 2018). This collaboration, for example, could lead scientists to provide clear guidance to the public on how to correctly position samples pursuant to taking good-quality photos as well as on sound specimen preservation.

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ŠIRJENJE AREALA VRST *LUTJANUS ARGENTIMACULATUS* (LUTJANIDAE) IN *PSENES PELLUCIDUS* (NOMEIDAE) V MALTEŠKE VODE (OSREDNJE SREDOZEMSKO MORJE)

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POVZETEK

Avtorji poročajo o recentnem prvem zapisu o pojavljanju lesepske selivke Lutjanus argentimaculatus (Forsskål, 1775) in širjenju areala atlantske vrste Psenes pellucidus Lütken, 1880 *v malteške vode (osrednje Sredozemsko morje). Nadalje na kratko razpravljajo o sedanji razširjenosti obeh vrst.*

Ključne vrste: tujerodne vrste, lesepska selitev, vrste, ki širijo areal, Sredozemsko morje, ljubiteljska znanost

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