Mediterranean Marine Science

Vol 24, No 1 (2023)

VOL 24, No 1 (2023)

Range expansion of the Atlantic fish Zenopsis conchifer (Lowe, 1852), family Zeidae, in the western Mediterranean Sea

CECILIA PINTO, GIOVANNI ROPPO VALENTE, NICOLA RASORE, EDOARDO OLMI, LUCA LANTERI, FULVIO GARIBALDI, CLAUDIO VIVA, ALESSANDRA NERI, ANDREA MASSARO, FRANCESCO DE CARLO, ALESSANDRO LIGAS, PAOLO SARTOR

doi: 10.12681/mms.31409

Short Communication

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net
www.hcmr.gr
DOI: http://doi.org/10.12681/mms.31409

Range expansion of the Atlantic fish *Zenopsis conchifer* (Lowe, 1852), family Zeidae, in the western Mediterranean Sea

Cecilia PINTO[1], Giovanni ROPPO VALENTE[2], Nicola RASORE[1], Edoardo OLMI[2], Luca LANTERI[1], Fulvio GARIBALDI[1], Claudio VIVA[3], Alessandra NERI[3,4], Andrea MASSARO[5], Francesco De CARLO[5], Alessandro LIGAS[3] and Paolo SARTOR[3]

[1] DISTAV, University of Genova , Corso Europa 26, 16132 Genova, Italy
[2] CoNISMa, Piazzale Flaminio 9, 00196 Roma, Italy
[3] CIBM, Viale Nazario Sauro 4, 57127 Livorno, Italy
[4] DSFTA, University of Siena, Via Mattioli 4, 53100 Siena, Italy
[5] APLYSIA, Via Menichetti, 35, 57121 Livorno, Italy

Corresponding author: Cecilia PINTO; cecilia.pinto@edu.unige.it

Contributing Editor: Stelios SOMARAKIS

Received: 19 September 2022; Accepted: 21 December 2022; Published online: 30 January 2023

Abstract

Three specimens of Silver John dory, *Zenopsis conchifer*, (Lowe, 1852) were observed for the first time in the Ligurian Sea and northern Tyrrhenian Sea (western Mediterranean), one in 2020 and two in 2021. This is the fifth record (up to ten individuals) of *Z. conchifer* in the Mediterranean Sea, which occurred 11 years after the last observation in 2010 in the southern Tyrrhenian Sea. The present study reports the northernmost record of the species in the western Mediterranean Sea, indicating a potential range expansion of the distribution of this Atlantic species across the area. Morphometric, meristic and biological data of the three specimens are provided and compared with previous published records.

Keywords: Alien species; Atlantic immigrant; Ligurian Sea; Northern Tyrrhenian Sea; Silver John dory; *Zenopsis conchifer.*

Introduction

The Mediterranean Sea is a basin characterised by a high biodiversity and a high rate of endemism (Quignard & Tomasini, 2000). It is the basin that presents the highest number of records of non-indigenous species in the world (Streftaris *et al.*, 2005; Costello *et al.*, 2021), due to its semi-enclosed structure connected both to the Atlantic Ocean (through the Strait of Gibraltar) and the Indo-Pacific Ocean (through the Suez Canal and the Red Sea) (Galil *et al.,* 2015; Zenetos *et al.,* 2018). At present, 1,050 non-indigenous taxa have been recorded; of these, 751 taxa result as "established" in the Mediterranean Sea and 97 are represented by fishes (Zenetos *et al.,* 2022). From a literature review, Ben Rais Lasram *et al.* (2008) estimated that 63 non-indigenous species were of Atlantic origin, 29 of which could be considered colonisers, and the colonising success of Atlantic alien species seems to be correlated with the depth range of their original habitat, favouring species inhabiting waters shallower than 300 m of depth. Evans *et al.* (2020) identified 70 species of Atlantic origin recorded overall in the Mediterranean Sea considering alien, vagrant, range-expanding or cryptogenic records. The most recent estimations, available on the CIESM (Commission Internationale pour l'Exploration Scientifique de la Méditerranée) Atlas of exotic fish species (Golani *et al.*, 2021), report 53 species of Atlantic origin (both Tropical Atlantic and Boreal Atlantic); specifically, 26 are reported as established and 27 as not established (Golani *et al.*, 2021).

Worldwide, the Family *Zeidae* is represented by two main genera, *Zeus* and *Zenopsis.* The genus *Zeus* is represented within the Mediterranean Sea only by the native species, *Zeus faber* (Linnaeus, 1758) (John dory), a highly valuable bycatch of bottom trawling and set net fisheries (Quigley & Flannery, 1995; Dunn, 2001; STECF, 2015). The genus *Zenopsis,* instead, is distributed in the Atlantic Ocean, Indian Ocean and the Indo-Pacific area (Froese & Pauly, 2022). The Silver John dory, *Zenopsis conchifer* (Lowe, 1852), is distributed across the Indian Ocean, except the northern Red Sea (Froese & Pauly, 2022), in the Atlantic Ocean (western and eastern) and in the north-east Atlantic (Quigley & Flannery, 1995). The main morphological features distinguishing *Z. conchifer* from *Z. faber* are the following: 1) the head profile is concave over the eyes in *Z. conchifer*, while is flat or convex

in *Z. faber*; 2) a set of scutes after the pelvic fin origin, and large bony bucklers are present at the basis of the dorsal and anal fins in *Z. conchifer*, which are absent in *Z. faber*; 3) the caudal peduncle is longer than deep in *Z. conchifer*, while it is as long as it is deep in *Z. faber*; 3) a silver grey colour of the skin in *Z. conchifer*, which is golden-green with the presence of a large yellow-edged black spot on the side, under the lateral line, in *Z. faber* (Whitehead *et al.,* 1989; Golani *et al.,* 2021).

In the last 20 years, the presence of *Z. conchifer* was reported several times in the Mediterranean Sea (Fig. 1); the species was first recorded near the Gibraltar Strait (Spain) in 2002 (Fernández *et al.,* 2012), but it was only reported in the literature later, as it was considered at that time an occasional vagrant that had entered from the western side of the strait. Then, it was observed further inside the Mediterranean Sea, off the northern Tunisian coast in July 2006 (Ragonese & Giusto, 2007) (recorded as the first observation in the Mediterranean Sea) and again along the Levantine Spanish coast in 2007, 2008 and 2009 (Fernández *et al.,* 2012). The last reported catches in the Mediterranean Sea were two specimens caught in June 2010 by a bottom trawler targeting deep-water red shrimp off the Cilento coast (Italy, southern Tyrrhenian Sea) (Psomadakis *et al.,* 2012).

This study reports information on three new records of *Z. conchifer* in the Mediterranean Sea, caught for the first time once in the western Ligurian Sea and twice in the northern Tyrrhenian Sea (Fig. 1).

Material and Methods

The specimen found in the Ligurian Sea (Fig. 2) was caught by a trawler off Imperia on the 19th of February 2020 at 250 m depth; it was recovered by researchers from the Department of Earth, Environment and Life Sciences of the University of Genova (DISTAV) and is now part of the collection of the Zoological Museum of DISTAV with number: IZUG - 16112. The two specimens found (Fig. 3) in the northern Tyrrhenian Sea were caught by two different trawlers working on fishing grounds targeting Norway lobster, *Nephrops norvegicus,* on muddy bottoms around the Montecristo Island in February and September 2021 at 400 m depth; they were collected by the researchers from the Centre of Marine Biology in Livorno (CIBM). The three specimens were classified following the description provided by Whitehead *et al.* (1989). The weight of the fishes was recorded, and morphometric and meristic data were gathered using measuring boards and callipers (0.5 mm and 0.1 mm precision level).

Results

All measurements recorded for the three new individuals are reported in Table 1 together with measurements recorded in previous studies reporting records of *Z. conchifer.* Macroscopic examination of the gonads revealed that the fish caught in the Ligurian Sea was a male, while the two specimens found in the northern Tyrrhenian Sea were a male and a female; both specimens were adults with gonads at the immature stage (Table 1). The stomach of the Ligurian specimen was empty, while that of the male specimen found in the northern Tyrrhenian Sea contained 23 specimens of the pelagic fish, *Maurolicus muelleri*, found in different stages of digestion; they were identified through the otoliths, according to Tuset *et al.* (2008). The stomach of the female contained otoliths of 5 specimens of the pelagic fish, *Notoscopelus* sp., remains

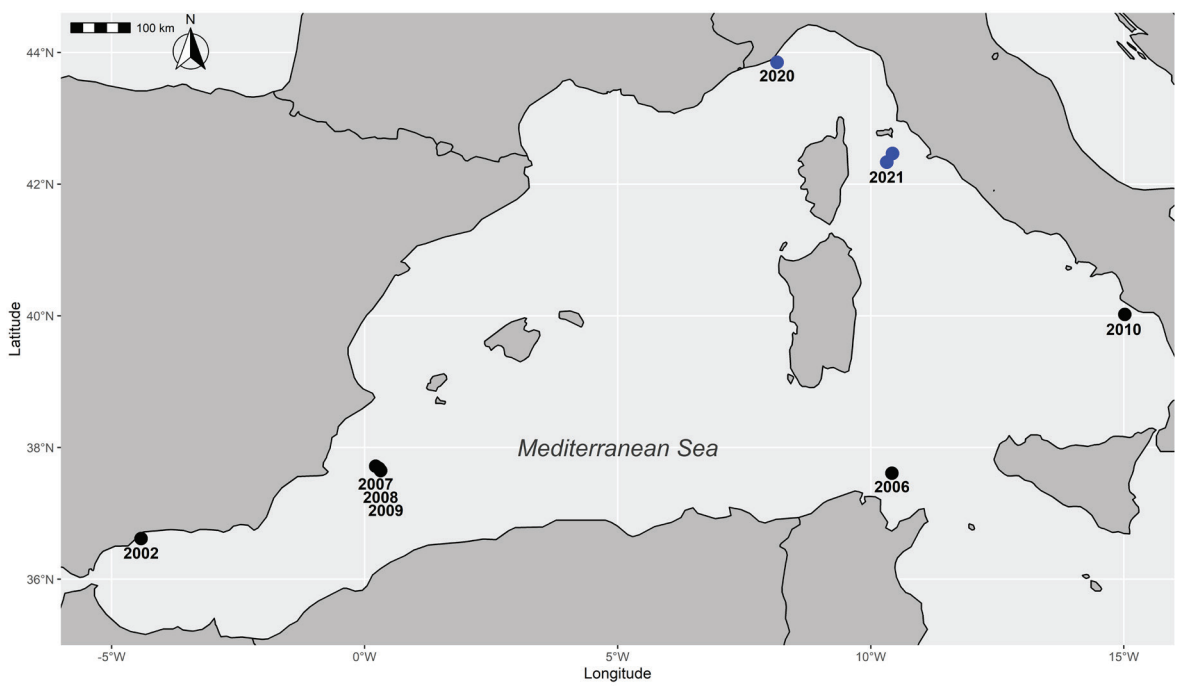

Fig. 1: Records of *Z. conchifer* in the Mediterranean Sea. Black points are historical records, blue points new records (present study). The scaling bar corresponds to 100 km.

Fig. 2: The specimen of *Z. conchifer* caught in the western Ligurian Sea on 19/02/2020.

of 1 unidentified crustacean and suckers of cephalopods (Table 1). The specimens found in the northern Tyrrhenian Sea also had parasites in the stomach, while the Liguria specimen only showed ectoparasites on the skin and fins. Samples of all parasites were taken and sent to the Veterinary Department of the University of Pisa for taxonomic identification (Macchioni, unpublished data).

Discussion

The comparison of the morphometric and meristic data of the new and historical specimens collected in the western Mediterranean Sea shows consistency confirming the species identification. There is, nevertheless, some intra-specific variability in the number of plates (both bucklers and scutes) present at the base of the fins (Table 1), which could be related to the size of the fish but does not show any linear relationship within the available data. The three specimens of *Z. conchifer* were caught for the first time in the Ligurian Sea and the northern Tyrrhenian Sea in 2020 and 2021, respectively, by professional demersal trawlers. All individuals were caught alone and were immature (two males and a female). As reported by Fernandez *et al.* (2012), who observed three mature females, there is still no evidence for the presence of a self-sustaining population in the Mediterranean Sea, as neither juvenile individuals nor aggregations of mature females and males were observed yet. The 10 individuals recorded in the last 15 years could be vagrants entering through the Strait of Gibraltar and were not able to reproduce in the Mediterranean Sea. However, following the CIESM criteria (Golani *et al.,* 2021), since the species was observed more than three times in three different areas in the last 20 years (Tunisia in 2006; Spain in 2002, 2007, 2008 and 2009; Italy in 2010, 2020 and 2021), it should be considered as "established" in the Mediterranean Sea although there is no evidence of a self-maintaining population. We acknowledge though that the specimens caught in the Ligurian and northern

Fig. 3: The two specimens of *Z. conchifer* caught in the northern Tyrrhenian Sea in 2021; the top individual is a female (06/09/2021), the bottom individual a male (18/02/2021). The scaling bar corresponds to 2 cm.

Tyrrhenian Seas are the northernmost caught specimen from the Strait of Gibraltar, confirming that *Z. conchifer* is a range-expanding species within the western Mediterranean Sea, as already categorised by Evans *et al.* (2020).

Quero *et al.* (1998) suggested that *Z. conchifer* spread from the central Atlantic Ocean to the northeast Atlantic due to the increase in seawater temperatures. Quigley & Flannery (1995) observed a seasonal pattern with individuals found in northern waters (off Ireland) during late summer and early autumn, and in southern waters (NW coast of Spain) in the winter months. As two out of the

Table 1. Morphometric, meristic and biological data collected on the three specimens of *Z. conchifer*. Measurements from Psomadakis et al. 2012 were not available from the publication.

Measurements (mm) or counts								
	Present study			Ragonese & Giusto, 2007	Fernandez *et al.*, 2012 (IIPB150/2002)	Fernandez *et al.*, 2012 (IIPB 68/2007)	Fernandez *et al.*, 2012 (#3)	Fernandez *et al.*, 2012 (#4)
Fishing area	Imperia (Ligurian Sea)	Off Montecristo Island (Northern Tyrrhenian Sea)	Off Montecristo Island (Northern Tyrrhenian Sea)	Capo Farina (Sicilian Channel)	Alboran Sea	Cabo de Palos (Levantine Spanish Sea)	Cabo de Palos (Levantine Spanish Sea)	Cabo de Palos (Levantine Spanish Sea)
Depth	250 m	400 m	400 m	183 m - 290 m	69 m	200 m	390 m	270 m
Gear	bottom trawler	bottom trawler	bottom trawler	bottom trawler	bottom trawler	bottom trawler	bottom trawler	bottom trawler
Date	19/02/2020	18/02/2021	06/09/2021	07/2006	05/2002	01/2007	11/2008	12/2009
Total Length	533	639	570	645	130	605	525	545
Standard Length	474	527	475	550	-	-	-	-
Fork Length	511	485	430	-	-	-	-	-
Total weight (g)	1530	1936,3	1730,5	3296	28	3500	1913	2137
Sex	M (immature)	M (immature)	F (immature)	F (spent)	Undet.	F (maturing)	F (maturing)	F (maturing)
Gonad weight (g)	3.5	5.0	1.4	245	-	531.6	154.9	270.9
Body depth	207	234	222	280	-	-	-	-
Head length	149	198	183	215	43.3	169	153.9	153.8
Preorbital space	82	90	78	100	-	-	-	-
Prepectoral length	104	-	-	-	-	-	-	-
Preventral length	81	-	-	-	-	-	-	-
Predorsal length	143	-	-	-	-	-	-	-
Preanal length	239	-	-	-	-	-	-	-
Postorbital space	48	80	69	-	-	-	-	-
Upper jaw length	63	-	-	82	-	-	-	-
Lower jaw length	93	-	-	120	-	-	-	-
Interorbital space	27	28	30	30	7.5	29.5	27.7	27.3
Horizontal eye diameter	31	28	27	35	8.8	30.1	28.1	24.3
Vertical eye diameter	26	27	25	36				
Snout length	-	-	-	-	17.6	92	71.7	68.9
Snout-anus lenght	-	-	-	290	-	-	-	-
Caudal peduncle height	21	22	24	24	-	-	-	-
Caudal peduncle length	46	55	54	53	-	-	-	-
Snout-dorsal fin length	143	-	-	192	-	-	-	-
Snout-anal fin length	239	-	-	333	-	-	-	-
Snout-tip of pectoral fin length	104	-	-	166	-	-	-	-
Snout-tip of pelvic fin length	81	-	-	194	-	-	-	-

Continued

Table1 continued

Measurements (mm) or counts								
	Present study			Ragonese & Giusto, 2007	Fernandez *et al.*, 2012 (IIPB150/2002)	Fernandez *et al.*, 2012 (IIPB 68/2007)	Fernandez *et al.*, 2012 (#3)	Fernandez *et al.*, 2012 (#4)
Fishing area	Imperia (Ligurian Sea)	Off Montecristo Island (Northern Tyrrhenian Sea)	Off Montecristo Island (Northern Tyrrhenian Sea)	Capo Farina (Sicilian Channel)	Alboran Sea	Cabo de Palos (Levantine Spanish Sea)	Cabo de Palos (Levantine Spanish Sea)	Cabo de Palos (Levantine Spanish Sea)
Maximum body width	24	-	-	38	-	-	-	-
Dorsal fin height	123	-	-	150	-	-	-	-
Dorsal fin base length	291	-	-	350	-	-	-	-
Pectoral fin length	59	-	-	70	16.1	60.2	63.8	60.1
Pectoral fin base length	16	-	-	220	-	-	-	-
Pelvic fin length	97	-	-	112	34.5	106.8	97.5	90.7
Anal fin length	216	-	-	233	-	-	-	-
Caudal fin length	88	-	-	103	-	-	-	-
Number of dorsal fin rays	X-25	IX-25	IX-26	IX-26	IX-24	IX-26	IX-26	IX-26
Number of pectoral fin rays	12	12	12	12	-	-	-	-
Number of pelvic fin rays	I-5	I - 6	I - 6	I-6	I-5	I-6	I-8	I-7
Number of caudal fin rays	14	14	14	14	-	-	-	-
Number of anal fin rays	III-26	III - 25	III - 25	III-26	III-25	III-25	III-25	III-25
Number of bucklers along dorsal fin base length	7	8	8	8	7	9	7	6
Number of scutes anterior to pelvic fin	2	2	2	2	12[1]	7[1]	8[1]	7[1]
Number of scutes between pelvic and anal fin	8	7	7	7				
Number of bucklers along anal fin base length	5	6	6	5	6	6	5	5
Total number of gill arches per side	4	4	4	3+1/2	-	-	-	-
Body mass without viscera (g)	-	1653.5	1559.7	2524	-	-	-	-
Liver weight (g)	-	43.4	61.2	-	-	-	-	-
Stomach weight (g)	-	103.1	44.9	-	-	-	-	-
Stomach content weight (g)	0	22.1	1.0	-	-	-	-	-
Food in the stomach	empty; signs of suckers of cephalopod on ventral right side	at least 23 specimens in different digestion stage of *Maurolicus muelleri* identified from the otholits	at least 5 specimens of *Notoscopelus* sp. (only otholits, 5 right and 4 left); fragments of 1 unidentified crustacean, remain of suckers of cephalopod	-	-	-	-	-

1 Fernandez *et al.*, 2012 report the total number of scutes of the ventral area (belly scutes).

three individuals were caught in February, there seems to be no seasonal effect related to temperature, which would push the species into the northern part of the western basin. All individuals were caught between 200 and 500 m of depth, within their native range of depth distribution (Vaz-dos-Santos *et al.*, 2014). Such depths, in the western Mediterranean Sea, maintain temperatures around ~13°C across the whole year, with variations depending on the water mass circulation (Migon *et al.*, 2020). Atlantic species that cross the Strait of Gibraltar have been observed to follow two alternative paths: one following the dominant current along the North African coast, and one counter-current path which instead follows the Spanish and French coasts (Ben Rais Lasram *et al.*, 2008). In fact, the same species can alternatively follow both paths, probably depending on the environmental conditions present at the time of entrance, as observed in the case of *Pomadasys incisus* (Bowdich, 1825) by Bodilis *et al.* (2013). Individuals following the dominant current along the North African coast could be pushed northward by the Levantine Intermediate Water (LIW) which divides at the Corsica channel and reaches both the southern Tyrrhenian Sea and the western Ligurian Sea (after flowing along the coasts of western Sardinia and Corsica).

Acknowledgements

The authors would like to thank the crew of the fishing boats Padre Pio (Liguria), Angela Madre and Folgore (Tuscany) for reporting the catches of *Zenopsis conchifer* to DISTAV (University of Genoa) and CIBM. The authors would also like to thank two anonymous reviewers for their insightful comments that improved the manuscript.

References

Ben Rais Lasram, F., Tomasini, J. A., Romdhane, M.S., Do Chi, T., Mouillot, D., 2008. Historical colonization of the Mediterranean Sea by Atlantic fishes: do biological traits matter? *Hydrobiologia*, 607 (1), 51-62.

Bodilis, P., Crocetta, F., Langeneck, J., Francour, P., 2013. The spread of an Atlantic fish species, Pomadasys incisus (Bowdich, 1825) (Osteichthyes: Haemulidae), within the Mediterranean Sea with new additional records from the French Mediterranean coast. *Italian Journal of Zoology*, 80 (2), 273-278.

Costello, M.J., Dekeyzer, D., Galil, B.S., Hutchings, P., Katsanevakis, S. *et al.* 2021. Introducing the World Register of Introduced Marine Species (WRiMS). *Management of Biological Invasions,* 12, 792-811.

Dunn, M.D., 2001. The biology and exploitation of John dory, *Zeus faber* (Linnaeus,1758) in the waters of England and Wales. *ICES Journal of Marine Science*, 58, 96-105.

Evans, J., Arndt, E., Schembri, P.J., 2020. Atlantic fishes in the Mediterranean: using biological traits to assess the origin of newcomer fishes. *Marine Ecology Progress Series*, 643,133-143.

Fernández, A.M., Lloris, D., Pérez Gil, J.L., Esteban, A., 2012. On the occurrence of *Zenopsis conchifer* (Lowe, 1852) (*Osteichthyes, Zeidae*) in the Mediterranean Sea. *Arxius de Miscellània Zoològica*, 10, 50-54.

Froese, R., Pauly, D., 2022. FishBase. http://www.fishbase.org (Accessed 15 June 2022).

Galil, B.S., Boero, F., Campbell, M.L., Carlton, J., Cook, E. *et al.,* 2015. "Double trouble": The expansion of the Suez Canal and marine bioinvasions in the Mediterranean Sea. *Biological Invasions,* 17 (4), 973-976.

Golani, D., Azzurro, E., Dulcic, J., Massutí, E., Orsi-Relini, L., 2021. *Atlas of Exotic Fishes in the Mediterranean Sea.* 2nd edition. CIESM Publishers, Monaco, 365 pp.

Migon, C., Nival, P., Sciandra, A. (Eds.), 2020. *The Mediterranean Sea in the Era of Global Change 1. 30 Years of Multidisciplinary Study of the Ligurian Sea.* ISTE, London, UK and John Wiley & Sons, NJ, USA, 234 pp.

Psomadakis, P.N., Giustino, S., Vacchi, M., 2012. Mediterranean fish biodiversity: an updated inventory with focus on the Ligurian and Tyrrhenian seas. *Zootaxa*, 3263, 1-46.

Quero, J.C., 1998. Changes in the Euro-Atlantic fish species composition resulting from fishing and ocean warming. *Italian Journal of Zoology*, 65 (S1), 493-499.

Quigley, D.T.G., Flannery, K., 1995. Sailfin Dory *Zenopsis conchifer* (Lowe 1852): Further records from Irish waters and a review of north-west European records. The Irish Naturalists' Journal, 25 (2), 71-76.

Quignard, J.P., Tomasini, J.A., 2000. Mediterranean fish biodiversity. *Biologia Marina Mediterranea*, 7, 1-66.

Ragonese, S., Giusto., G.B., 2007. *Zenopsis conchifera* (Lowe, 1852) (Pisces, Actinopterygii, Zeidae): a new alien fish in the Mediterranean Sea. *Journal of Fish Biology*, 71, 1853-1857.

Scientific, Technical and Economic Committee for Fisheries (STECF), 2015. Landing Obligation - Part 6 (Fisheries targeting demersal species in the Mediterranean Sea) (STECF-15-19). *Publications Office of the European Union*, Luxembourg, EUR 27600 EN, JRC 98678, 1-268.

Streftaris, N., Zenetos, A., Papathanassiou, E., 2005. Globalization in marine ecosystems: the story of non-indigenous marine species across European seas. *Oceanography and Marine Biology,* 43, 419-453.

Tuset, V.M., Lombarte, A., Assis, C., 2008. Otolith atlas for the western Mediterranean. North and central eastern Atlantic. *Scientia Marina* 72 (S1), 7-198.

Vaz-dos-Santos, A.M., Rossi-Wongtschowski, C.L.D.B., Honji, R.M., Bannwart, D., 2014. Reproduction of the silver John dory *Zenopsis conchifer* (Actinopterygii: Zeiformes) based on virgin stock condition. *Biota Neotropica*, 14 (3), e20130069.

Whitehead, P.J.P., Bauchot, M.-L., Hureau, J.-C., Nielson, J., Tortonese, E. (Eds.), 1989. *Fishes of the North-eastern Atlantic and the Mediterranean.* Vol. I, II & III. United Nations Educational, Paris, France, 1473 pp.

Zenetos, A., Corsini-Foka, M., Crocetta, F., Gerovasileiou, V., Karachle, P. *et al.* 2018. Deep cleaning of alien and cryptogenic species records in the Greek Seas. *Management of Biological Invasions*, 9 (3), 209-226.

Zenetos, A., Albano, P.G., López Garcia, E., Stern, N., Tsiamis, K. *et al.* 2022. Established non-indigenous species increased by 40% in 11 years in the Mediterranean Sea. *Mediterranean Marine Science,* 23, 196-212.