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First record of *Trachipterus trachypterus* Gmelin 1789 (Lampriformes) in the Strait of Sicily

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*On July 7th 2018 a specimen of Mediterranean dealfish (*Trachipterus trachypterus *Gmelin 1789) was caught in the shallow waters of Selinunte (in the South-Western coast of Sicily) by trammel net. It was a female in maturing phase and the gonadosomatic index resulted as 1.1%. The specimen measured 1638 mm in total length and weighed about 2480 g. The estimated age through growth increments in vertebra was of 41 years. The finding of the Mediterranean dealfish in the Strait of Sicily might be linked to its spawning period during which it approaches the shallow waters. The present specimen represents the first record in the Strait of Sicily.*

Key words: Mediterranean dealfish; rare species; meristic features; vertebrae; otolith; fecundity

INTRODUCTION

The *Trachipterus Goüan*, 1770 genus, consists of six species, among which the *Trachipterus trachypterus* Gmelin 1789 and *Trachipterus arcticus* Brünnich 1771 have been reported in the Mediterranean. The latter was recorded only once in Spain (PLANAS & F. VIVES, 1956). Mediterranean dealfish *T. trachypterus* are widely found in subtropical and tropical seas of the Pacific Ocean (CORTES *et al.,* 1995), on both sides of the Atlantic Ocean (SMITH-VANIZ, 2015) and in the Mediterranean Sea (e.g. LIPEJ *et al.,* 2018) in the mesopelagic zone, at depths ranging from 200 to 1000 m (BORME, D. & F. VOLTOLINA 2006). Juvenile stages are frequently observed in the epipelagic zone (MACALI *et al.,* 2020). Mediterranean dealfish are an oviparous species and their diet is based on small fish and squid (PALMER, 1986).

This species does not possess swim bladders and it swims head-up, holding its position by undulating the dorsal fin (NISHIMURA, S. & Y. HIROSAKI 1964), and reduce drag with the numerous skin tubercles (WALTERS, 1963). Similarly, juveniles were observed adopting the same behaviour (i.e. swimming heads up)

and locomotion by undulating their long dorsal fin only, although the anterior prolonged dorsal fin rays showed limited oscillating movements (MACALI *et al.,* 2020). Conversely, BORME, D. & F. VOLTOLINA (2006) stated that juveniles use their elongated fins (dorsal, ventral and pectoral) like sails, drifting passively in the current. The Mediterranean dealfish, according to IUCN classification, is considered as a species with the status of least concern (SMITH-VANIZ, 2015). It is caught incidentally by purse seines, trawling nets and long-lines. It does not have any commercial value (FISHER *et al.,* 1987; GARIBALDI, 2015; TIRALONGO *et al.,* 2019). The species is sporadically recorded in all Italian waters, but it is mainly caught in the Adriatic Sea (JARDAS, 1980) and in the Messina Strait (COSTA, 1991). However, the mesopelagic habits of the species could lead to an underestimation of its abundance (TIRALONGO *et al.,* 2019). Most records deal with moribund or dead animals, stranded on the coast (DULČIĆ, J. & L. LIPEJ 1997; BORME, D. & F. VOLTOLINA 2006; FARIAS *et al.,* 2010; STIPA *et al.,* 2022). Nevertheless, *T. trachypterus* is still considered a poorly studied fish (LIPEJ *et al.,* 2018).

To date, *T. trachypterus* had never been recorded in the Strait of Sicily (Central Mediterranean). This research aims to increase knowledge of the spatial distribution of this rare fish and its reproductive aspects, as well as carry out the first age estimation in the Mediterranean basin. Furthermore, a biometric comparison with the other Mediterranean specimens is provided.

MATERIAL AND METHODS

On July 7th, 2018, a specimen of *T. trachipterus* was collected at 20 m depth off of Selinunte (in the South-Western Sicilian coast) using trammel net (Fig. 1), the most commonly used gear in the area (FALSONE *et al.,* 2020). The specimen was preserved in ice and delivered to the CNR-IRBIM laboratory in Mazara del Vallo, photographed with an Olympus Tough TG4 and weighed to the nearest 0.1 g (Sartorius LP 5200 P, Sartorius AG, Goettingen, Germany). Subsequently, morphometric measurements to

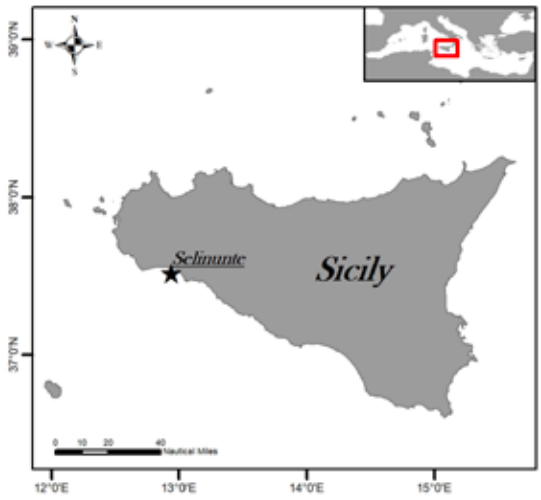

Fig. 1 - *Map showing the site of* T. trachypterus *finding (black star).*

the nearest 1 mm and meristic counts were taken and compared, in terms of percentage of standard length (SL), with specimens reported from Slovenia (BORME, D. & F. VOLTOLINA 2006) and the Gulf of Trieste (LIPEJ *et al.,* 2018). Sexual maturity was assessed using the MEDITS maturity scale (International Bottom Trawl Survey in the Mediterranean) and classified as follows: Stage 0 - undetermined; Stage 1 - immature; Stage 2a – virgin/developing; Stage 2b - recovering; Stage 2c - maturing; Stage 3 - mature/spawner; Stage 4a - spent; as well as Stage 4b - resting (ANONYMOUS, 2017). In addition, i) the whole gonad was weighted, ii) a small sub-sample of known weight was extracted, iii) placed in a petri dish under a stereoscope (Leica Mz12.5), and iv) the number of eggs were counted by three experts individually (some taking part in this research). The mean number of counted eggs were raised to the total for the purpose of obtaining an estimate of the specimen's fecundity. The eggs were also measured by Image J software (SCHNEIDER *et al.,* 2012). The gonadosomatic index (GSI) was computed as the ratio of fish gonads weight to eviscerated weight of the body. To estimate the age, two experts independently identified and counted the growth bands (annual growth rings that allow age estimation) by means of otoliths and vertebrae. Unfortunately, only one otolith was extracted because of its small size. A first attempt to read the otolith

as a whole, did not provide reliable age estimation due to its thickness. Therefore, the otolith was embedded in resin following the procedure of COLLOCA *et al.* (2019). Afterwards, a thin transversal section (about 0.5 mm) was carried out through the core (nucleus). To further support age estimation, the first two vertebrae after the skull were sectioned (KOROSTELEV *et al.,* 2020). Finally, the whole vertebrae, as well as the otolith and vertebrae sections, were viewed under a stereoscopic with 1.0x magnification (Leica Mz12.5) with reflected light and were then photographed (Leica Microsystems, DFC450 C). To assess the otolith morphometry two otolith

Table 1: Morphometric characters of the specimens recorded in the Strait of Sicily compared, in terms of Standard Length percentage (%SL), with those reported by LIPEJ et al., 2018, BORME, D. & F. VOLTOLINA 2006 and MACALI et al., 2020 (in bold the main differences).

Morphometric characters (mm)	**Abbreviation**	**Present study**		**LIPEJ *et al.*, 2018**						**BORME, D. & F. VOLTOLINA 2006***		**MACALI *et al.*, 2020****	
Total length	TL	1638		1363		403		427		1033		229	
			%TL		%TL		%TL		%TL		%TL		%TL
Standard length	SL	1486	91	1282	94	299	74	346	81	925	90	156	68.0
			%SL		%SL		%SL		%SL		%SL		
Preorbital length	PreO	49	3.3	NA	NA	9	3.1	8	2.3	23	2.5		
Eye horizontal diameter	ED	45	3.0	46	3.6	14	4.7	13	3.6	35	3.8	9	4.0
Head length	HL	156	10.5	167	13.0	42	13.9	43	12.5	98	10.6	28	12.0
Head height	**HH**	**146**	**9.8**	**NA**	**NA**	**50**	**16.9**	**52**	**15.1**	**105**	**11.4**		
Interorbital space	IOS	28	1.9	NA	NA	10	3.4	NA	NA	22	2.4		
Predorsal length	**LPD**	**96**	**6.5**	**158**	**12.3**	**11**	**3.8**	**19**	**5.5**	**55**	**5.9**		
Prepectoral lenght	LPP	140	9.4	174	**13.6**	40	**13.5**	44	**12.8**	99	10.7		
Preventral length	LPV	NA	NA	NA	NA	47	15.8	52	15.1	111	12.0		
Maximal body height	**MBH**	**198**	**13.3**	**NA**	**NA**	**51**	**17.1**	**63**	**18.2**	**108**	**11.7**	**40**	**17.0**
Preanal length	LPA	660	44.4	NA	NA	152	50.7	187	53.9	405	43.8		
Caudal peduncle height	**CPH**	**12**	**0.8**	**NA**	**NA**	**5**	**1.8**	**6**	**1.8**	**11**	**1.2**		
Dorsal fin rays maximal length	**MaxFR**	**78**	**5.2**	**NA**	**NA**	**35**	**11.8**	**32**	**9.2**	**68**	**7.4**		
Dorsal fin length	DL	1382	93.0	NA	NA	275	92.0	323	93.3	882	95.4		
Pectoral fin length	PL	49	3.3	NA	NA	17	5.6	15	4.4	33	3.6		
Caudal fin length (upper lobe)	**CUL**	**148**	**9.9**	**NA**	**NA**	**105**	**35.1**	**82**	**23.8**	**125**	**13.5**		
Caudal fin length (lower lobe)	CLL	NA	NA	NA	NA	1	0.3	NA	NA	1	0.1		
Ventral fin length	VL	NA	NA	NA	NA	59	19.6	39	11.2	0	0.0		
Sex		female		NA		NA		NA		male		NA	

**only the specimen with more accurate morphometric characters is reported; **only the morphometric characters of the bigger specimen are reported*

indices were computed: the ratio otolith length (OL)/otolith height (OH) and the OL/TL both expressed as percentage.

RESULTS

Meristic and morphometric data of the studied specimen are presented in Tables 1, 2 and 3.

The specimen of *T. trachypterus* was a female measuring 1638 mm in total length (TL) and weighed 2479.8 g (Fig. 2). The ovaries occupied about two-thirds of the abdominal cavity and appeared pinkish-yellow in color with granular aspect, indicating a 2c maturity stage (maturing phase). Gonad length and weight were 396 mm and 25.7 g, respectively.

The GSI estimate, widely used as a proxy of reproductive activity (RIZZO, E & N. BAZZOLI, 2020), has been estimated at 1.1%. The visual inspection of the eggs allowed us to assess their number, shape and size: i) the estimated number was about 206,000, ii) they were oval shaped and iii) the major axis was 0.54±0.15 mm (mean±sd) while the minor one was 0.44±0.10 mm (mean±sd). The stomach was empty with only gastric juice present. The number of ver-

Table 2: Organ weight of the specimen recorded in the Strait of Sicily compared with those reported by LIPEJ et al., 2018 and BORME, D. & F. VOLTOLINA 2006

Weight (g)	**Present study**		**LIPEJ *et al.*, 2018**				**BORME, D. & F. VOLTOLINA 2006**	
Total weight (TW)	2479.8		37.1		477.7		NA	
		%TW		**%TW**		**%TW**		**%TW**
Eviscerated weight	2293.4	92.5	NA	NA	NA	NA	NA	NA
Heart	1.0	0.0	<0.1	0.1	0.8	0.2	NA	NA
Stomach	29.5	1.2	4.5	12.1	22.5	4.7	1.4	NA
Empty stomach	21.6	0.9	1.1	2.9	20.9	4.4	0.6	NA
Liver	NA	NA	0.2	0.6	6.8	1.4	NA	NA
Pyloric caeca	18.8	0.8	0.8	2.2	8.0	1.7	NA	NA
Gonads	25.7	1.0	0.1	0.4	1.1	0.2	NA	NA

Table 3: Meristic characters of the specimens recorded in the Strait of Sicily compared with those reported by LIPEJ et al., 2018 and BORME, D. & F. VOLTOLINA 2006

Meristic characters	**Present study**	**LIPEJ *et al.*, 2018**		**BORME, D. & F. VOLTOLINA 2006**
Dorsal fin rays D	171	172	180	NA
Ventral fin rays V	NA	7	0	5
Pectoral fin rays P	10	10	11	10
Caudal fin rays (upper lobe)	NA	7	9	NA
Caudal fin rays (inferior)	NA	5	5	NA
Spines along lateral line	88	92	94	NA
Right lower jaw (dental) teeth	4	4	5	5
Left lower jaw (dental) teeth	3	3	4	5
Vomer teeth	4	2	1	1
Right upper jaw (praemaxillary) teeth	4	4	5	7
Left upper jaw (praemaxillary) teeth	4	5	4	4
Gillrakers (1st branchial arch)	13	13	13	12

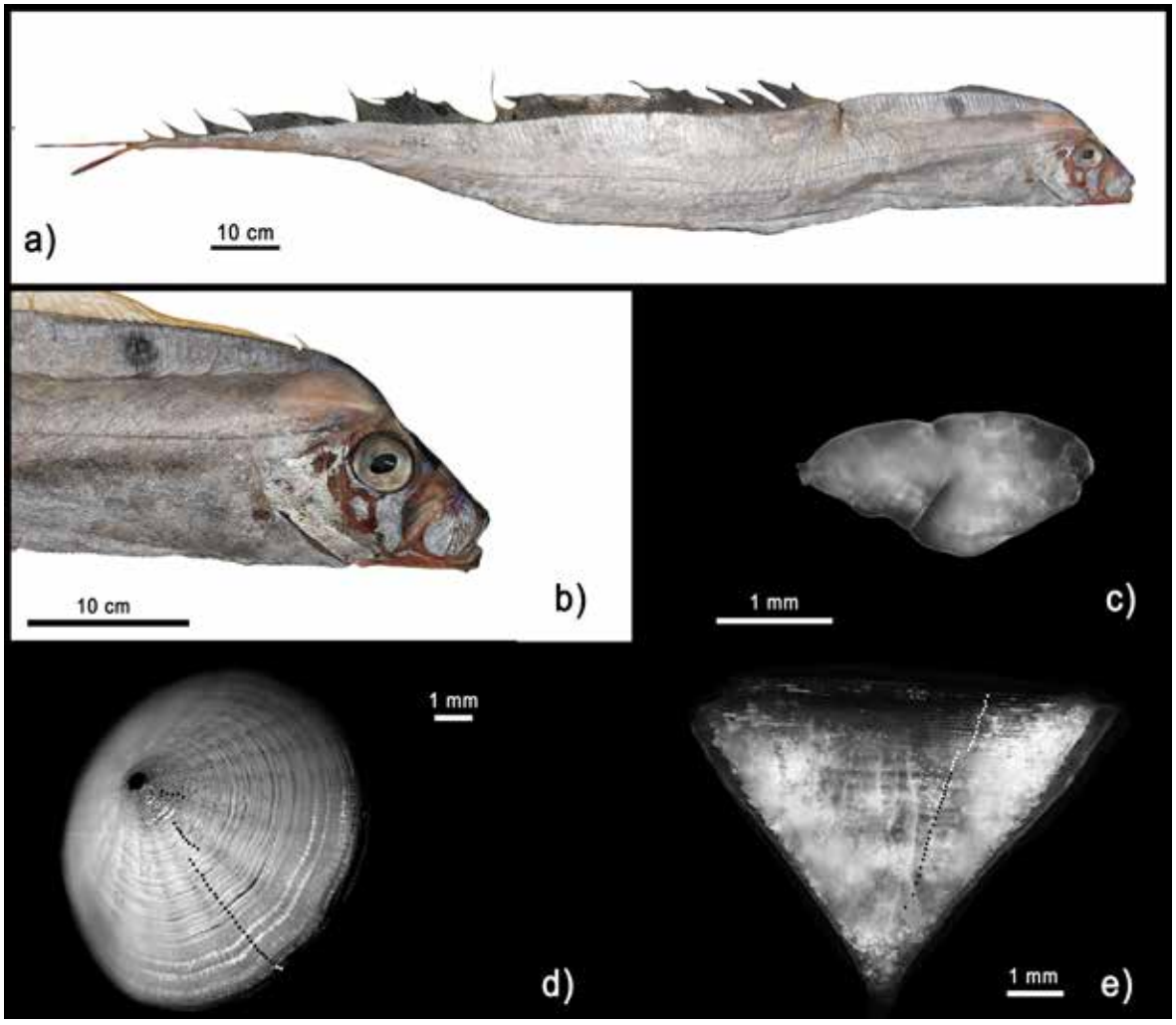

Fig. 2 - *Images of* T. trachypterus *presently reported; whole specimen (a), particular of the head (b), otolith (c), whole vertebra (d), transverse section of the vertebra (e). Black and white dots represent the growth rings.*

tebrae was 88. With regard to age estimation, the lack of reference points for this rare species, the absence of clearly visible annual rings in the sectioned and whole otolith, make estimation very difficult. Indeed, in the transverse section of the otolith, the annual rings of the specimen were not evident. Instead, the annual rings were much more visible both on the whole and sliced vertebrae; age was estimated at 41 years (Fig. 2). The ratios OL/OH and OL/TL were 49.6 and 0.15 respectively.

DISCUSSION

The specimen, according to FIGUEIREDO *et al.* (2007), was undoubtedly assigned to the *Trachypetrus* species as the number of vertebrae differs between the two species recorded in the Mediterranean with no overlap: 99–102 for *T. arcticus* and 84–96 for *T. trachypterus*. In addition, it is worth highlighting that genetic analyses (mitochondrial cytochrome oxidase subunit 1, mt-COI) suggested that *T. articus* grouped separately from its congeners, even if further studies are needed to better discriminate them (ALBANO *et al.,* 2022).

It is known that *T. trachypterus* reaches 3000 mm TL (TORTONESE, 1970; ŠOLJAN, 1975), but the biggest specimen recorded from the Adriatic Sea (Bakar Bay, Croatia) was 1600 mm long (JARDAS, 1980). Indeed, the TL of the 33 individuals measured in the Adriatic Sea from 1888 to 1979

ranged between 137 and 1600 mm (JARDAS, 1980). To the best of our knowledge, the Mediterranean dealfish caught in the Strait of Sicily was one of the biggest specimens ever recorded in the Mediterranean Sea. Most of the morphometric characters agreed with BORME, D. & F. VOLTOLINA (2006), LIPEJ *et al.* (2018) and MACALI *et al.* (2020) with the exception HH, LPD, MBH, CPH, MaxFR and CUL. These differences might be caused by either the specimens' state of preservation or the different phases of their life cycle they were in. Indeed, juveniles differ from adults in regard to general body shape, fin length and number and pigmentation patterns (STIPA *et al.,* 2022; MACALI *et al.,* 2020; MARTIN, 2015; JARDAS, 1980). In particular, the body in juveniles is higher and shorter whereas the anterior profile of the head is steeper. The eyes are located in the center of the head in juveniles, while in adults they are situated near the dorsal profile. In adults, some characters are drastically reduced and teeth are less abundant.

Regarding age estimates, the vertebra reading was a more suitable technique to estimate the age of the Mediterranean dealfish specimen. However, it should be pointed out that age reading herein provided should be taken with caution as age validation is lacking. The otolith showed a very dense structure with an oblong shape and a rounded *rostrum*. The ratios OL/OH, OL/TL and the shape of the otolith differed from those reported by TUSET *et al.* (2008), maybe because of the early life stage (VIGNON, 2012) of their specimen compared to the adult of the present study.

The absolute fecundity of the specimen from the Strait of Sicily is in line with the range (100,000-300,000) reported for its congeneric *Trachypterus ishikawae* Jordan & Snyder, 1901 in Japan (FROESE, R. & D., PAULY, 2021). The mean eggs size of *T. trachipterus* resulted smaller than the yolk size of its congeneric species *Trachypterus altivelis* Kner, 1859, 2.2-2.6 mm, and *Trachipterus fukuzakii* Fitch, 1964, 1.6-1.8 mm (CHARTER, S.R. & H.G. MOSER, 1996). These differences might be attributed to a specie-specific eggs size, the multiple environmental factors within their natural home range (JOHNSTON, T.A. & W.C. LEGGETT, 2002) as well as the different maturing phases.

Considering that Mediterranean dealfish was previously caught by purse seines, trawl nets, and long-lines (FISHER *et al.,* 1987; GARIBALDI, 2015; TIRALONGO *et al.,* 2019) or it was found stranded on the coast (DULČIĆ, J. & L. LIPEJ 1997; BORME, D. & F. VOLTOLINA 2006; FARIAS *et al.,* 2010; STIPA *et al.,* 2022; GÖKOĞLU, M. & M.R. ÖZEN, 2021), its finding in the Strait of Sicily through trammel net represents an anomaly.

The finding of Mediterranean dealfish in the Strait of Sicily might be related to the maturity stage supporting the suggestion of JARDAS (1980), for the Adriatic region, which reported that the higher frequency of this species during spring and summer months is correlated with the spawning period, during which, probably, it approaches the shallow waters making itself more vulnerable to fishing gear. However, LO BIANCO (1909) reported a prolonged spawning period of Mediterranean dealfish during the entire year.

CONCLUSIONS

The present note represents the first record of *T. trachypterus* caught in the Strait of Sicily. The paucity of records of some fish classified as rare might be due to many reasons: i) their local abundance and geographical displacement (GASTON, K.J. & LAWTON J.H., 1990; ARVEDLUND, 2009; MACALI *et al.,* 2020), ii) their preference for inhabiting habitats that aren't frequently studied (SARDO *et al.,* 2022), iii) the absence of suitable sampling techniques (FALSONE *et al.,* 2017; MYTILINEOU *et al.,* 2013), iv) the lack of a commercial interest (SARDO *et al.,* 2020), as well as v) the absence of dedicated research projects (SWABY, S.E. & G.W. POTTS 1990; GERACI *et al.,* 2019; GERACI *et al.,* 2021). The present study widens the spatial distribution of the species to the Mediterranean and sheds light on some biological aspects such as reproductive features and age estimation.

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Prvi nalaz mača srebrenjaka *Trachipterus trachypterus* Gmelin 1789 (Lampriformes) u Sicillijanskom tjesnacu

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SAŽETAK

Dana 7. srpnja 2018. uzorak mediteranskog dealfish (Trachipterus Trachypterus Gmelin 1789) je uhvaćen u plitkim vodama primorskog mjesta Marinella di Selinunte (na jugozapadnoj obali Sicilije) s troslojnom mrežom. Bila je to ženka u fazi sazrijevanja, a gonadosomatski indeks rezultirao je 1,1%.

Uzorak je izmjeren 1638 mm ukupne duljine i težio je oko 2480 g.

Procijenjena dob kroz povećanje rasta kralježaka bila je 41 godinu. Otkrivanje mediteranskog delfish u Sicilijskoj tjesnac mogao bi biti povezan s njegovim razdobljem mrijesta tijekom kojeg se približava plitkim vodama. Sadašnji uzorak predstavlja prvi zapis u Siciliji.

Ključne riječi: Mač srebrenjak; rijetke vrste; merističke značajke; kralježnjici; otolith; plodnost