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THE CONFIRMED OCCURENCE OF SERPENT EEL *Ophisurus serpens* IN SAROS BAY (NORTHERN AGEAN SEA), TURKEY

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ABSTRACT

One mature female specimen of serpent eel *Ophisurus serpens* (Linnaeus, 1758) was caught by long line by a professional fisherman at a depth of about 45 m from Ece Bight, Saros Bay, north Aegean Sea on 15 February 2016. The species was previously reported without any morphometric and meristic characters from Saros Bay. Some biological characters, such as age and diameters of otolith and oocytes, are also given. In this study, the detailed morphomeristic features, which can contribute to the taxonomic studies of serpent eel from Turkish Seas, are presented.

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INTRODUCTION

Serpent eel *Ophisurus serpens* (Linnaeus, 1758) is a member of the family Ophichthidae which has over 250 species worldwide; *O. serpens* has been recorded in the northern Adriatic Sea, Italy, Alboran Sea, Tunisian Coasts, Algarve Coast, Gibraltar Strait, northwestern Ionian Sea, Galician Waters and the central Aegean Sea in the Mediterranean Sea, the Saronikos Gulf in the Ionia Sea (Cappetta et al., 1985; Tortonese, 1970; Bauchot, 1986; McCosker and Castle, 1986; Papaconstantinou and Tsimenidis,1979; Biagi et al., 2002; Borges et al., 2003; Dulcic et al., 2005; Golani et al., 2006; Abad et al., 2007; Ben Amor et al., 2009; Banon et al., 2011; Kousteni and Christidis, 2019). *O. serpens* is benthic on the shelf or the upper slope up to 300 m, burrowing in sand or mud with only its head exposed, and is also found in estuaries (Bauchot, 1986; Froese and Pauly, 2016). Despite a worldwide distribution, *O.serpens* was reported in Turkish Seas by Geldiay and Mater (1968), Mater and Bilecenoğlu (1999), Bilecenoğlu et al., (2002) and Bilecenoğlu et al. (2014), with only area information. While Cengiz et al. (2011) and Torcu Koç and Erdoğan (2015) reported the species the first time from different localities of the northern Aegean Sea. Ergüden et al. (2016) mentioned the occurrence of the species in Mersin Bay.

In this study, some morphometric and meristic characteristics of the species are investigated. Besides, biological characteristics as age determination, diameters of otolith and oocyte are also given from a single specimen.

MATERIALS AND METHODS

One mature female of *O.serpens* (2026 mm TL) (Fig. 1) was caught at 45 m depth from Ece Bight (40°22'11''N, 26°19'16''E), Saros Bay (Fig. 2). Saros Bay is an inlet of the northern Aegean Sea located north of the Gallipoli Peninsula in northwestern Turkey. The bay is roughly "V" shaped; its length is about 61 km and the width that connects it to Lemnos basin (Aegean Sea) is about 36 km long, reaching a depth of 700 m. For most of the year, the bay is under the influence of northerly winds which cause upwelling over the area (Tokat and Sayın, 2007).

Previous and present capture records of distributions of *O. serpens* in the northern Aegean Sea are given in Fig. 2. All measurements, including counts and weights, were carried out on fresh fish, using a digital caliper of 0.05 mm accuracy and digital balance of 0.01 g. Meristic characteristics included counts such as fin rays in dorsal, pectoral and anal fins, and counts of pores in the lateral line. All diagnostic characters of the species were recorded and then stored in the collections of the Piri Reis Museum, University of Çanakkale.

For age determination, sagittal otoliths were removed from one individual and cleaned by appropriate procedures (Chugunova, 1963) and then photographed with a Nikon D800 digital camera fixed on a tripod. Sectioning method was used to calculate the ages of the individuals. Age was estimated using both of otoliths (Fig. 3A, 3B) to test the congruity in the annual opaque rings counted on the whole otolith. The complete alternate opaque and translucent zones were considered "true" age-related zones. On the base of the external margin feature of the otolith, the age was assigned with a +. Two otoliths were examined in a black Petri dish containing glycerol under reflected light, using a binocular microscope at 40X magnification for counting annual growth increments from the nucleus to the otolith edge. The age was estimated by counting the complete translucent zones by two readers, three times independently (Lagler, 1966; Panfili et al., 2002 and Vitale et al., 2016). Diameters of otoliths [otolith length (OL) and width (OW)] were defined as the longest dimension between the posterior edges of otolith and otolith width (OW) as the dimension from the dorsal to the ventral edge, and measured with the aid of 10µ micrometric ocular on the Olympus CX21 stereo microscope.

For obtaining fresh (unpreserved) oocytes, three wet samples, each of 0.5 g (±0.001 g), were taken once from the middle, front and back of the ovary of the female in order to homogenize the oocytes, and were thoroughly washed and spread on a blotter to dry and then onto a microscope slide (Holden and Raitt, 1974; Sokal and Rohlf, 1981), After removing extracellular coats of a sample size of 50 oocytes, their diameters were measured, using a millimetre slide under an objective 40X. Measurements were taken along the median axis of the oocyte, parallel to the horizontal micrometer gradations (Macer 1974, DeMartini and Fountain, 1981).

Fig 1. *Ophisurus serpens* from Saros Bay; 2026 mm TL (photo by Tuncer and Zilifli)

Fig 2. Distributions of the sampled specimen of *Ophisurus serpens* in the northern Aegean Sea

RESULTS AND DISCUSSION

Total length of one specimen was 2026 mm (Table 1). Its body is very elongate and cylindrical, snout long and conical with the upper jaw projecting. Jaws elongate and slender, Teeth large caniniform and more or less curved enlarged on premaxillae, small and biserial on maxillae. Small and uniserial teeth on the lower jaw. Vomerine teeth uniserial, enlarged anteriorly. Anterior nostril small at midsnout. Posterior nostril a long opening covered by an upper flap, located on the outer lip at midway between the anterior nostril and anterior edge of the eye. Eyes relatively small. As for the colour, the body is brownish-olive dorsally, silvery with yellow iridescences ventrally, both dorsal and anal fins have grey edges, and the pores are blackish. *O. serpens* has an extremely elongate and cylindrical body, anus in the anterior half of the body, snout long and slender, jaws elongate and extending posteriorly beyond the eye.

Table 1. Historical and present records of serpent eel *Ophisurus serpens* at various depths in the Mediterranean Sea

References	Location	Year	N	Depth (m)	Gear	Bottom type	Size (mm)
Geldiay and Mater(1968)	Aegean Sea	1966	1	35-40	-	-	-
Papaconstan-tinou and Tsi-menides (1979)	Aegean Sea, Greece	1979		94	-	muddy	1380
Stergio et al.(1997)	Aegean Sea, Greece	1994		73–210	-	-	-
Karakulak et. al.(2006)	Aegean Sea	2004	2	< 30	Gill net		
Trammel net	-	1692					
Sangun et. al.(2007)	N.Eastern Mediterrane-an	2001 - 2003	41	100	Bottom trawl	-	121-501
Relini et al. (2007)	Ligurian Sea	1989-2004	-	-	-	Artificial reefs	-
Ben Amor et al. (2009)	Tunusia	2006	1	2.10	Dragnet	Sea grass bed	333
Cengiz et. al.(2011)	N. Aegean Sea	2004-2005	1	< 30	Bottom trawl	-	-
Bettoso and Comisso(2015)	Adriatic Sea	2015	1	3.0	Hydraulic dredge	Sandy bottom	500
Ulaş and Akyol, 2015	Aegean Sea	2014	1	32	handline	sandy	1917
Torcu Koç and Erdogan(2015)	Edremit Bay	2014	1	40	longline	sandy and muddy	2000
Filiz et. al.(2015)	Gökova Bay	2004	1	55	Purse seine	sandy-muddy	1212
Rafrafi-Nouira et al.(2015)	Tunusia	2014	1	45	Trammel net	rocky-sandy	1850
Öztekin et al.(2016)	N. Aegean Sea	2012	1	400	-	-	1195
Ergüden et. al.(2016)	Mersin Bay	2014	1	492	-	-	1902
Ben Amor et al. (2017)	Tunusia		1	1	dragnet	-	1890
Kousteni and Christidis, 2019	Saranikos Gulf	2017	1	206.5	Bottom trawl	sandy-muddy	2100
This study	Saros Bay	2016	1	45	long line	sandy-muddy	2026

The presence of *O. serpens* at different depths in the Mediterranean Sea have been pointed out in Table 1. *O. serpens* was captured in a sandy muddy bottom, which is commonly supported by relevant studies (Bettosa and Comisso, 2015; Filiz et al., 2015; Torcu Koç and Erdoğan, 2015). The depth of capture (45 m) is in accordance with the range of previously reported depths where this species is found (Rafrafi-Nouira et al., 2015; Torcu Koç and Erdogan, 2015). The unexpected occurrence of *O. serpens* in Saros Bay can be due to catching it only by the long line and burrowing of specimens in sandy and muddy bottoms (Dulcic et al., 2005; Filiz et al., 2015; Kousteni and Christidis, 2019). Owing to the scarceness of *O. serpens*, the fact that Sangun et al. (2007) caught 41 specimens by using bottom trawl in the Turkish eastern Mediterranean was amazing. It may be related to the fishing tools with which the recorded specimens in the area were caught, as seen in Table 1. Some relevant studies (Başusta and Erdem, 2000; Beğburs and Kebapçıoğlu, 2007) in the same area indicated that *O. serpens* had been absent among the fishes of Antalya and İskenderun Bays (NE Mediterranean) before. However, after recording from Aliağa (Çandarlı Bay), where it was first reported 48 years ago by Geldiay and Mater (1968), the present study reports a distribution of the new rare species with its biological aspects northward to Saros Bay in the north Aegean Sea. This phenomenon can be supported by global heating and different trophic environment conditions.

With special regard to maximum body size, Kousteni and Christidis (2019) reported the largest specimen in the Mediterranean Sea reaching 2100 mm in TL. The present study reports the largest specimen (2026 mm) in the north Aegean Sea where the previously recorded largest specimen reached 2000 mm in TL (Torcu Koç and Erdoğan, 2015). The proportional body measurements were also expressed as a percentage of total length in Table 2. Descriptions, measurements and percentages in total length recorded in the northern Aegean Sea are in agreement with some previous descriptions of the species (Dulcic et al., 2005; Torcu Koç and Erdoğan, 2015; Banon et al., 2017) (Table 2).

Table 2. Morphometric (mm) and meristic data of serpent eel *Ophisurus serpens* specimen captured in February 2016 at 45 m depth, Saros Bay. Morphometric measurements given as proportions of total and head lengths

	Ophisurus serpens													
Morpho- meristic characters	Castle (1984)	Bauchot (1986)	Dulcic et al. (2005)	Golani et al. 2006	Ben Amor et al. (2009)	Banon et al. (2011)	Torcu Koç and Erdoğan (2014)	Rafrafi-Nouira et al.(2015)	Ulaş and Akyol (2015)	Ergüden et al (2016)	Ben Amor et al. (2017)	Banon et al. (2017)	Kousteni and Chiris-tis (2019)	This study
Total length (L_T)	-	2400	2130	2400	333	1680	2000		1850	1902	1890	1850	2100	2026
Body depth (%L_T)	-	-	65 (3.1% LT)	-	8 (2.4% LT)	46 (2.7% LT)	35 (1.8% LT)	51.00(2.76)	735.00(38.34	39.61 (2.08% LT)	35.00 (1.85% LT)	51 (2.8% LT)	44.46(2.12% LT)	69 (3.4% LT)
Head length, (%L_T)	-	-	155 (7.3% LT)	-	42 (12.6% LT)	125 (7.4% LT)	152 (7.6% LT)	118.00(6.38)	158.00(8.24)	148.51 (7.8% LT)	149.00 (7.88% LT)	138 (7.5% LT)	172.00(8.20)	150 (7.4% LT)
The length of lower jaw	-	-	83	-	20	-	96 (48.0%)	83.00(70.34)	-	-	92.00 (6.17% LT)	-	-	-
Oocyte diameter	210-220	-	-	-	-	-	-	-	-	-	-	-	-	98-720 (433.68±188.74)
Pectoral fin rays	-	-	-	-	-	-	-	14	-	-	15	-	-	15
Otolith length (OL)	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1 – 5.47
Otolith width (OW)	-	-	-	-	-	-	-	-	-	-	-	-	-	2.75 – 2.83
The number of pores in linea lat-eralis	-	199-215	202	-	149	195	206	202	191	205	201	198		200
Lateral line (prepectoral)	-	7-10	-	-	-	9	8-9	-	-	-	9	9	8	7-10
Weight (g)		-	-	-	-	-	-	-	-	1320	-	-	1653	1800
Gonad weight (g)		-	-	-		-	-	-	-	-	-	-	9.50	30.9

Regarding the maximum size of *Ophisurus serpens*, Bauchot (1986) reported 2400 mm for the Mediterranean specimens, and McCosker & Castle (1986) 2500 mm for the south African ones as maximum total length, while the Tunisian longjaw snake eel 333 mm TL for a juvenile specimen. Variations in fish length can be explained as an adaptive response to different ecological conditions such as the temperature of the water system in which the fish live (Nikolsky, 1963; Wootton, 1992).

The number of pores in linea lateralis counted in the specimen in this study was 200, while Torcu Koç and Erdoğan (2015) reported 206 pores in a specimen in the northern Aegean Sea. However, Ben Amor et al. (2009) mentioned 149 pores in Tunisian waters and Jardas (1996) and Dulcic et al. (2005) noted 173 pores in the Adriatic Sea. The causes of variation in the morphometric and meristic characters can be partly attributed to intraspecific variability, which is under the influence of environmental parameters (Wimberger, 1992). On the other hand, sufficient data are not available to state if there is a relationship between the number of pores in linea lateralis and total length in *O. serpens*; however, such hypothesis could not be totally ignored.

As for otoliths, they are calcified structures involved in hearing and balance system, and are used to determine the taxon, age and size of fishes. They contain reliable fingerprints as an invaluable source of information for reconstructing a fish's entire life cycle (Campana and Thorrold, 2001; Özpiçak et al., 2019). To know the relationship between otolith length and fish length is useful for determining stock management, archaeological research and stomach of the predators, ageing studies and mainly for the back-calculation of the length of such rare species as serpent eel (Harver et al., 2000; Panfili and Tomás, 2001; Kasapoğlu and Düzgüneş, 2011).

Lengths (OL) and widths (OW) of sagittal otoliths ranged between 5.31 – 5.47 mm and 2.75 – 2.83 mm. Diameters of sagittal otoliths removed from serpent eel could not be evaluated with the relevant literature. The age of the individual was estimated as 10 (Figure 3A, 3B). Because of no studies on ageing of serpent eel, the age of the specimen could not be compared with other studies.

In this study, oocytes belonging to one female were measured in the diameters of 98-720 µm. (Table 2). It seems that a partial spawning occurred due to small oocytes and hydrated oocytes which are seen together in the same ovary. Harchouche (2006) mentioned that some fish can spawn several times during a single spawning period. According to Kartas and Quignard (1984), the number of oocytes issued annually by a female, in the majority of species, is generally between a few thousand and a few hundred thousand. Castle (1984) gave the shape of the eggs from the species (Froese and Pauly, 2016). The sizes of eggs which were measured in this study are not in harmony with those given by Castle (1984) probably because of different maturity stages.

Fig 3A. Age determination on sagittal otoliths of *Ophisurus serpens* (40X)

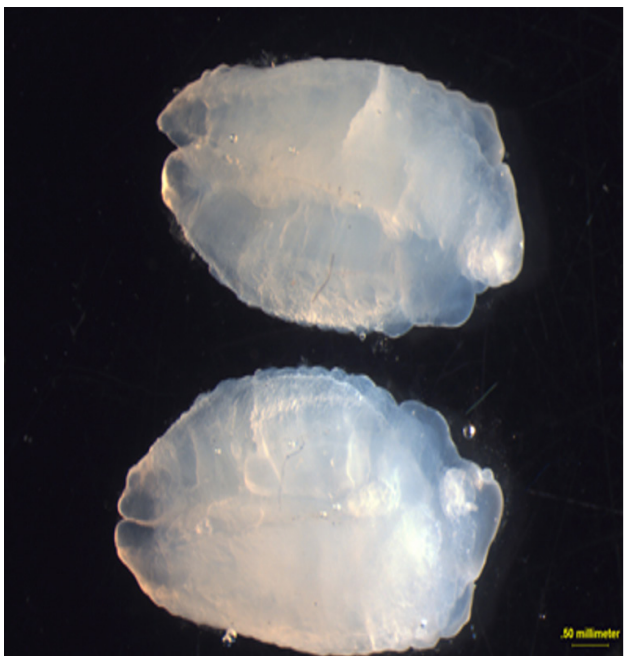

Fig 3B. Right and left sagittal otoliths

The ichthyological records show *O. serpens* as a new rare species in the eastern part of the Mediterranean Sea. Akşiray (1987), Jardas (1996) and Louisy (2002) support the conclusion of the rarity of the species in the Mediterranean Sea and Turkish Seas. The fact that serpent eel has an extremely elongate and cylindrical body and lives buried with only its head exposed (Jardas,1996 in Dulcic et al., 2005) makes it difficult to obtain. Moreover, it has no commercial value but as a gamefish.

CONCLUSION

The species might be less rare than previously thought and its presence may be probably ignored. However, the

northward distribution of the thermophile species such as *O. serpens* from the Atlantic to the Mediterranean Sea is not a single event and may be an ongoing process. This spread can be correlated to an increase in seawater temperatures and changing trophic conditions because of global heating; this phenomenon needs detailed research. Although the species has no economical value and is likely caught as a by-catch, it represents a new species in fish diversity of northern Aegean Sea ichthyofauna. The effective presence and abundance of *O. serpens* in Saros Bay might be monitored to check the establishment of serpent eel in the area continuously, and thus to understand its stock management in the locality.

SAŽETAK

POJAVA ZMIJE ZUBUŠE *Ophisurus serpens* U ZALJEVU SAROS (SJEVERNO EGEJSKO MORE), TURSKA

Zreli primjerak ženke zmije zubuše *Ophisurus serpens* (Linnaeus, 1758) ulovljen je parangalom na dubini od oko 45 m blizu mjesta Ece Bight, zaljev Saros, u sjevernom Egejskom moru 15. veljače 2016. Navedena vrsta je prethodno zabilježena u zaljevu Saros ali bez unesenih morfometrijskih i merističkih karakteristika. Biološka svojstva vrste, kao što su dob, promjer otolita i oocita, navedeni su u radu. Također, u ovom radu su predstavljena detaljna morfomeristička obilježja koja mogu pridonijeti taksonomskim istraživanjima zmije zubuše iz turskih mora.

Ključne riječi: *Ophisurus serpens*, morfo-meristička mjerenja, otolit, dob, oocit

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