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First record of the Fang tooth moray eel *Enchelycore anatina* (Lowe, 1838) and the diagnostic features of three fish species and a decapod crab from southeastern Mediterranean Sea, off Alexandria (Egypt)

Evelyn Ragheb[1,*] and Samir I. Rizkalla[2]
[1, 2] National Institute of Oceanography and Fisheries Alexandria, Egypt

[*]Corresponding Author: evelynragheb@yahoo.com.

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ABSTRACT

In the present study the fang tooth moray eel *Enchelycore anatina* is recorded for the first time from the Egyptian Mediterranean Sea off Alexandria. The diagnostic features of three fish species comprising *Gobius cobitis*, *Auxis rochei*, *Dentex macrophthalmus* and a crustacean species, *Eriphia verrucosa* were given. All the recorded species are Atlantic origin and naturally extended into the Mediterranean Sea. *E. anatina*, *A. rochei* and *D. macrophthalmus* are listed in the IUCN Red List for threatened species and rarely found in the Egyptian waters. The giant goby, *G. cobitis* is distinct with its brownish body color with black batches and white spots, thick lips, small well-spaced eyes and the disc-shaped sucker of fused ventral fins. The bullet tuna, *A. rochei* is characterized by large space between the first dorsal and the second dorsal fins, and its dark blue color above and white color below. The large-eye dentex, *D. macrophthalmus* is known by its large eye diameter, the strongest four anterior fang teeth on the upper jaw and the light rosy body with the white abdomen. The warty crab, *E. verrucosa* is characterized by the presence of frontal teeth on each side of deep U-shaped notch. Its body has five appendages; the first right one is larger than the left, both having black dactylus (claw) and each segment of the first appendage (cheliped) covered with numerous rounded tubercles. The last four preiopods are covered with numerous hairs.

INTRODUCTION

The Atlantic fang tooth moray eel *Enchelycore anatina* (Lowe, 1838), belongs to Family Muraenidae, is a tropical species distributed in the eastern Atlantic from St. Helena Island to the Azores **(Golani *et al.*, 2002)**. It extended into the Mediterranean waters and was first recorded on the coast of Israel in 1979 **(Ben-Tuvia and Golani, 1984)**. Now this species was recorded in the eastern Mediterranean at several localities along coasts of Croatia; Cyprus; Greece; Lebanon; Syria and Turkey, in addition to its occurrence in the western Mediterranean along coasts of Spain and Malta and its record in the eastern Atlantic along Portugal **(Katsanevakis *et al.*, 2009; Kalogirou, 2010;**

Lipej *et al.*, 2011; Guidetti *et al.*, 2012; Erguden *et al.*, 2013; Deidun *et al.*, 2015; Papaconstantinou and Karmovskaya, 2015 and Bartulović *et al,* 2017).

The giant goby, *Gobius cobitis* (Pallas, 1814) of Family Gobiidae, is the largest goby native to coastal waters of the eastern Atlantic, extends in distribution from western English Channel to Morocco, and into Mediterranean, Black Sea (except north-west) and Gulf of Suez **(Miller, 1986; Saad, 2005; Kovacic and Golani, 2007; Froese and Pauly, 2013 and Papaconstantinou, 2014)**.

The bullet tuna, *Auxis rochei* (Risso, 1810) of Family Scombridae, is a tuna species found in tropical regions of Atlantic, Indian and Western Pacific oceans, including the Mediterranean Sea **(Collette, 1986; Froese and Pauly, 2018)**. It is abundant in the Strait of Gibraltar and along the north coast of Africa, especially, the Spanish Mediterranean coasts **(Collette and Nauen, 1983; Sabatés and Recasens, 2001)** and in the eastern Mediterranean in the Turkish waters **(Kahraman *et al.*, 2011)**.

The large-eye dentex, *Dentex macrophthalmus* (Bloch, 1791) of Family Sparidae, distributes in the eastern Atlantic off Portugal and Strait of Gibraltar to Namibia. It is also found in most of the Mediterranean regions **(Louisy, 2002)**, but rare from the Egyptian Mediterranean waters and absent from the northwestern coast and northern Adriatic **(Pollard *et al.*, 2014)**.

The decapod species, warty crab, *Eriphia verrucosa* (Forsskål, 1775) was firstly included in Family Xanthidae **(Fischer *et al.*, 1987)**. But now genus *Eriphia* is represented within the Family Eriphiidae and has eight species which is identified with its distinct a hexagonal carapace **(Koh and Ng, 2008 and Ng *et al.*, 2008)**. *E. verrucosa* is the only species of family Eriphiidae which distributes in the eastern and the western parts of the Mediterranean Sea and reported regularly from the Turkish coasts **(Fischer *et al.*, 1987; Özcan *et al.*, 2005; Bakır *et al.*, 2014 and Harlıoğlu *et al.*, 2018)**, occasionally on the Ligurian coasts and Yugoslavia, rarely on the Adriatic, Black Sea, Italy, Greece and Egypt **(Fischer *et al.*, 1987; Fouda, *et al.*, 2015)**. This species is also distributed in the eastern Atlantic, from Brittany to Mauritania and the Azores **(Manning and Holthuis, 1981; Fischer *et al.*, 1987; Stevcic and Galil, 1994; Koh and Ng, 2008; Bakır *et al.*, 2014 and Harlıoğlu *et al.*, 2018)**. This species has no economic importance in the Egyptian market.

The gill net is a type of single net which is designed to catch not a specific fish species but a specific fish size range depending on the number of the meshes in the half meter and the level of its putting in the sea. The operated gill nets in the coastal area of Egyptian Mediterranean waters off Alexandria are with different mesh numbers (6, 10, 11, 14, 17, 18, 20, 23, 24, 28, 30, 32, 33 and 36) and there are pelagic (mesh with numbers from 28 up to 36) and demersal gill nets are operated. The net has about 30 meters in length and from 5 to 10 meters in height. It is limited from upper side by a robe of floats and has a robe of sinkers at lower side, makes it vertical in the water column.

The importance of studying *E. anatina* (First record), *A. rochei* and *D. macrophthalmus* are not only because they are listed in the IUCN Red List for threatened species **(IUCN, 2019)** but also because of those with *G. cobitis* and *E. verrucosa* haven't any diagnostic studies in the Egyptian waters.

MATERIALS AND METHODS

A total of 55 specimens of fish species, *E. anatina* (only one), *G. cobitis* (2), *A. rochei* (10), *D. macrophthalmus* (40) and a decapod species, *E. verrucosa* (2) were obtained during studying the catches of gill fishing nets operated in the coastal regions of Alexandria, Egypt (Figure 1) at depths: 2 – 20 m, during the period from March to May 2018. The operated gill nets in the coastal area of Egyptian Mediterranean waters off Alexandria with different mesh numbers (6, 10, 11, 14, 17, 18, 20, 23, 24, 26, 28, 30, 32, 33 and 36) were used for sample collection. The date of collection, mesh number of gill net, depth (m), number of collected specimens, total length range (cm) and weight range (g) of different species are shown in Table 1.

Figure 1. Map of the Mediterranean Sea showing Alexandria (Egypt) at the south-eastern part where the samples recorded.

Table 1. Date of collection, mesh number of gill net, depth (m), total length range (cm) and weight range (g) of different species obtained during the period from March to May 2018.

Species	Date of collection	Mesh number	Depth (m)	No. of specimen	TL range (cm)	Wt. range (g)
Enchelycore anatina	02/04/2018	20	20	1	51.0	170.0
Gobius cobitis	16/04/2018 22/04/2018	23	2	2	16.7	52.0
Auxis rochei	23/03/2018	11	20	10	33.0 – 36.0	471.5 – 588.5
Dentex macrophthalmus	22/05/2018	17,18,20	20	40	14.0 – 18.0	48.5 – 83.0
Eriphia verrucosa	01/04/2018 22/04/2018	23	2	2	4.0 – 5.0 (carapace length)	63.0 – 98.0

The samples were freshly examined in the laboratory. Total lengths (cm) as well as total weight (g) of each fish were obtained. The biometric characters (morphometric measurements and meristic formula) were recorded. The morphometric measurements related to total length (TL) or standard length (SL) were: head length (HL), pre-first dorsal length (PrD1), pre-second dorsal length, (PrD2), pre-pectoral length (PrP), pre-ventral length (PrV), pre-anal length (PrA), first dorsal fin base length (D1L), second dorsal fin base length (D2L), anal fin base length (AL), pectoral fin length (PL), ventral fin length (VL), head depth (HD), body depth (BD), caudal depth (CdD) and body girth (BG). Other morphometric measurements related to head length were: pre-orbital length (PrO), postorbital length (PoO), inter-orbital width (IO), eye diameter (ED), upper jaw (UJ) and lower jaw (LJ). The morphometric index of each morphometric character was calculated as the percentage to total length, standard length or head length. Meristic characters were the number of spines and/or rays in dorsal, pectoral, ventral and anal fins as well as the lateral line scale number.

The samples were photographed and preserved in 10% formalin in the lab. The data of all material examined are listed for each species in Table 1.

It is clear that:

On 2nd April 2018, one specimen of *E. anatina*, having 51.0 cm length and 170 g was obtained by gill net having mesh number 20 (Mesh size =2.5 cm) operated at 20 meter depth in the coastal area of Mediterranean water off Alexandria.

On 16/4/2018 and 22/4/2018 two specimens of *G. cobitis* (Pallas, 1814) were captured by gill net having mesh number 23 operated at 2 meter depth in the Eastern Harbor of Alexandria.

On 23/3/2018, 10 specimens of *A. rochei* (Risso, 1810) have total length ranged 33.0–36.0 cm (averaged 34.15 ± 1.075 cm) and total weight 5358 g (mean weight 531.94 ± 55.086 g) were captured by gill net having mesh number 11 operated in the coastal region off Alexandria.

On 22/5/2018, a total number of 40 *D. macrophthalmus* have total length ranged 14.0–18.0 cm (averaged 15.55 ± 1.1391cm) and total weight 2431 g (averaged 60.78 ± 9.251 g) with weight range 48–83 g were collected by gill net having mesh numbers 17, 18 and 20 operated off Alexandria at 20 meter depth.

On 1/4/2018 and 22/4/2018 two specimens of *E. verrucosa* (Forsskal, 1775) were obtained by a gill net having 23 meshes in the half meter and operated in the Eastern Harbor of Alexandria at 2 meter depth.

RESULTS AND DISCUSSION

Family: Muraenidae
***Enchelycore anatina* (Lowe, 1838)**
Fang tooth moray

Description (Figure 2 a, b):

During this study, only one specimen of *E. anatina*, has 51.0 cm length and 170 g was recorded in the coastal area of Mediterranean water off Alexandria (31º 13' 12" N and 29º 53' 15" E). The body is elongated and moderately compressed. Pre-dorsal fin is

7.84% TL, originates above branchial opening; the fin is in continuous with caudal and anal fin, forming together long fin. Pectoral and pelvic fins are absent. Anal opening lies slightly in front of midpoint of total length (PrA 47.06% TL). Head is pointed and represents 6.67% TL, with elevated occipital region carrying a pair of nasal tubes. Body depth is 9.80% TL. Mouth is large, with cleft extending back behind eyes. Upper jaw (UJ) length equals 67.65% HL. Lower jaw (LJ) length is 100.0% HL. Eyes are small and represent 16.18% HL, situated above the center of the upper jaw, PrO is 29.41% HL and PoO equals 52.94% HL. Inter-orbital (IO) is 8.82% HL. Gill slit length represents 0.98% TL, pre-gill slit is 11.96% TL. Jaws carry sharp teeth; about 18 sharp canine teeth arranged in one row along the inner edge of the upper jaw. There are three long teeth situated on the roof of the front portion of this jaw. Lower jaw has about 18 teeth arranged in one row. Teeth appeared when the mouth is closed. No scales on body.

Color: Body has reticulate brown net enclosing white large ocelli within which few small brown dots are present. The small round gill opening is black in color.

Remarks:

The record of the fang tooth moray, *E. anatina* in the coastal waters of the southeast Mediterranean Sea off Alexandria during this study, indicates to establishment of this species in Egyptian waters. According to the Mediterranean Sea map of **Lipej *et al.* (2011)**, that is showing the different records regions of *E. anatina*, and up to now there isn't any record in the southern Mediterranean waters and this considers the first record from the Egyptian Mediterranean water. The description of the present specimen of *E. anatina* is in accordance with that given by **Bauchot (1986), Smith and Bohlke (1990) and Golani *et al.* (2002)**. The description of *E. anatina* body color of the present specimen are in agreement with **Kalogirou (2010)** and it's different from that was described underwater observation by **Guidetti *et al.* (2012), Erguden *et al.* (2013)** and **Deidun *et al.* (2015)**. It is yellowish and the color changed after a few hours of capture. On the other hand, this species caught between 15m depth **(Bartulović *et al.*, 2017)** and 50m depth **(Ben-Tuvia and Golani, 1984)**, whereas it captured at 20 m depth in the present study.

Figure 2. a- The fang tooth moray eel, *Enchelycore anatina* (Lowe, 1838) from Mediterranean Sea off Alexandria, Egypt (51.0 cm TL). b- The arrangement of teeth on both jaws of the eel.

Family: Gobiidae
***Gobius cobitis* (Pallas, 1814)**
Giant goby

Description (Figure 3 a, b, c and Table 2):

The two specimens obtained have the same total length (16.7 cm), total weight (52 g) and a standard length (12.8 cm). All morphometric and meristic characters are given in Table (2). The meristic formula is: D1 (VI), D2 (I+14), A (I+12), P 20. The morphometric measurements were varied. PrD1 is 35.94%, increased in PrD2 to 54.69%. The distance between D1 and D2 is 5.47%, while D1L base is 13.28%, increased in D2L base to 29.69%. The pre-fin distances represents in PrP 31.25%, declined in PrV to 28.13%, but increased in PrA to 60.16%, while AL base is 20.31%. These ratios were also varied represent in HD 14.84%, increased in BD to 20.31% and in HL to 25.78%. All ratios were taken in relation to standard length. On the other hand, PrO recorded 27.27%, PoO 45.45%, IO, 9.09%, ED, 24.24%, Upper jaw (UJ) length 48.48% and Lower jaw (LJ) length 57.58% in relation to head length.

Anal fin is situated behind the beginning of the 2nd dorsal fin rays. First dorsal spines are situated on the vertical line between it and ventral fin. Ventral fins are fused forming a disc-shaped sucker. Both jaws are provided with thick lips. Caudal fin is rounded. Eyes are small and well-spaced.

Color: Body has brownish molted color with black batches and white spots. Pectoral fin rays are free. Edge of caudal fin is black and rounded.

Remarks:

The description of the goby coincides with **Miller (1986)** and **Kovacic and Golani (2007)**. The fused ventral fins form a disc-shaped sucker. Most distinctive aspects of all members of family Gobiidae adhere themselves on rocks.

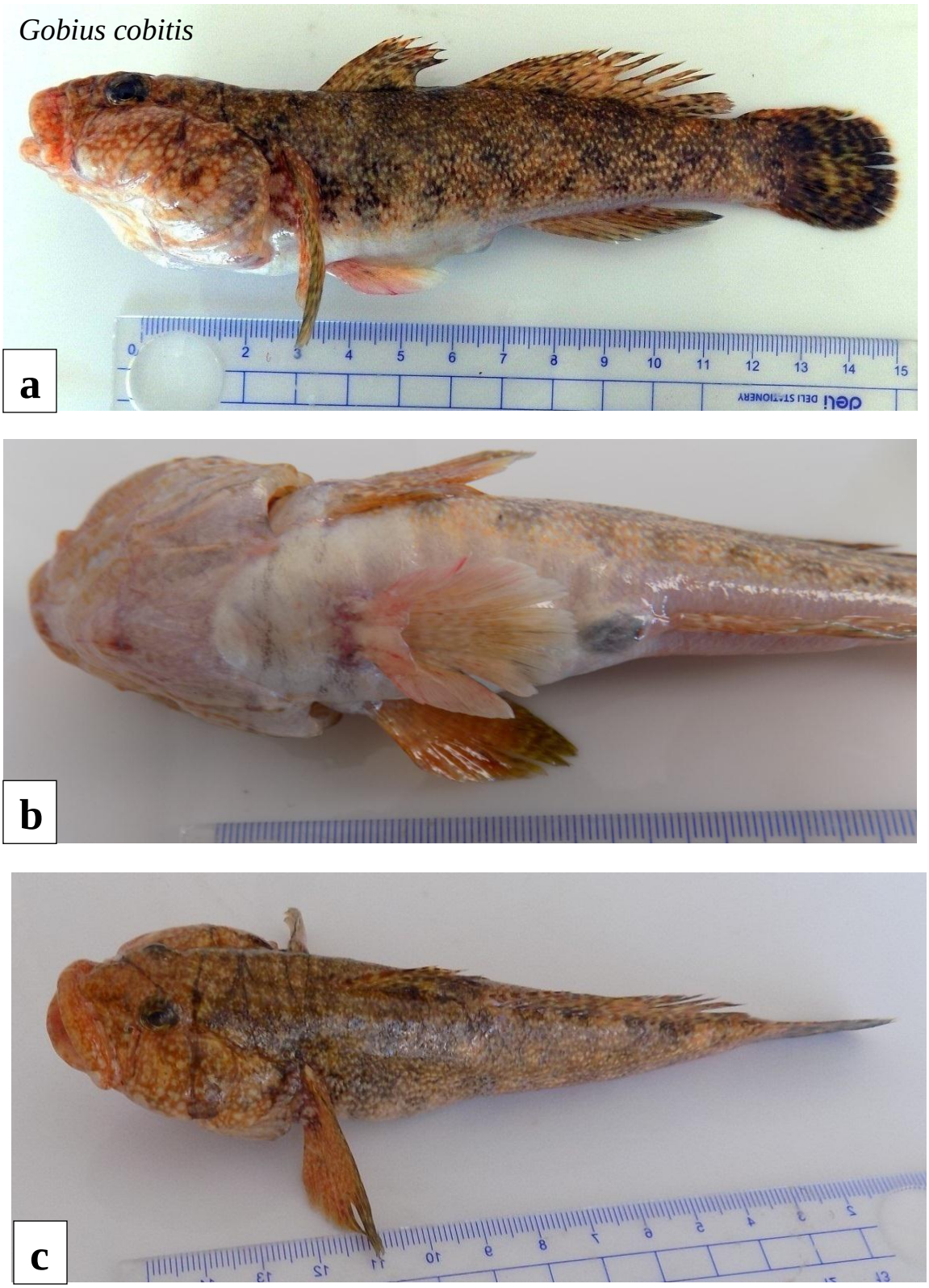


Figure 3. a- The Giant goby, *Gobius cobitis* (Pallas, 1814) from Mediterranean Sea off Alexandria – Egypt (16.7 cm TL). b- Ventral view showing the fused ventral fins (disc-shaped suckers). c- Dorsal view showing the thick lips and the small well-spaced eyes**.**

Table 2. Morphometric and meristic characters of fish species obtained from Alexandria Mediterranean Sea waters, Egypt) during the period from March to May 2018.

Biometric characters	*Gobius cobitis*		*Auxis rochei*		*Dentex macrophthalmas*	
	Length (cm)	%	Aver. Length (cm)	%	Aver. Length (cm)	%
Morphometric characters:						
***In Standard Length* (SL):**						
TL	16.7		34.15		16.24	
FL			32		14.66	
SL	12.8		29.4		12.7	
HL	3.3	25.78	6.65	22.62	4.14	32.60
PrD1	4.6	35.94	9.7	32.99	5.4	42.52
PrD2	7	54.69	20.15	68.54		
PrP	4	31.25	8.4	28.57	4.44	34.96
PrV	3.6	28.13	8.65	29.42	4.72	37.17
PrA	7.7	60.16	21.4	72.79	8.32	65.51
D1L	1.7	13.28	3.9	13.27	6.48	51.02
D2L	3.8	29.69				
AL	2.6	20.31			2.23	17.56
PL	2.9	22.66			4.49	35.35
VL	2.6	20.31			2.86	22.52
Distance bet. D1, D2	0.7	5.47	6.8	23.13		
Distance bet. V, A			13.1	44.56		
Height of D1 spine			3.5	11.90		
HD	1.9	14.84	4.75	16.16	3.94	31.02
BD	2.6	20.31	6.2	21.09	4.73	37.24
CdD	1.3	10.16	0.4	1.36	1.11	8.74
BG	8.3	64.84			11.5	90.55
***In Head Length* (HL):**						
PrO	0.9	27.27	1.65	24.81	1.24	29.95
PoO	1.5	45.45	3.1	46.62	1.19	28.74
IO	0.3	9.09	1.5	22.56	0.96	23.19
ED	0.8	24.24	1.6	24.06	1.64	39.61
UJ	1.6	48.48	2.55	38.35	1.72	41.55
LJ	1.9	57.58	3.1	46.62	1.79	43.24
Meristic characters:						
D1	VI		X		XII	
D2	I+14		11		10_ 11	
V			I+6		I+5	
A	I+12		I+14		III+9	
P	20		24		14 – 16	
Dorsal finlets			8			
Ventral finlets			7			
Lateral line scale no.					40 – 53	

Family: Scombridae
***Auxis rochei* (Risso, 1810)**
Bullet tuna

Description (Figure 4 and Table 2):

A total of all caught 10 specimens of *A. rochei* were females. The morphometric and meristic characters are given in Table (2). The meristic formula is: D1 (X), D2 (11), A I+14, P (24), V (I+6). The dorsal spines base (D1L) is 13.27% and beings widely separated from the second fin rays. The height of the first spine of D1 is 11.90%. PrD1 represents 32.99%, increased in PrD2 to 68.54%. The distance space between the end of first dorsal fin spines and the beginning of the second dorsal fin rays is 23.13%. PrP is 28.57%, and very close to Prv (29.42%). PrA is 72.79%, while HL was 22.62%, decreased in HD to 16.16% and increased in BD to 21.09%; while the distance between ventral and anal fins increased to 44.56%. All measurements are in relation to standard length. The following measurements are taken in relation to head length and comprised PrO (24.81%), PoO (46.62%), IO (22.56%), Upper jaw (38.35%) and lower jaw (46.62%) and ED (24.06%).

It was noticed that, the pectoral fin is short, while the space between the first dorsal and second dorsal fin is large. There is a scale-less area above the lateral line extending posteriorly along the lateral line and situated under the origin of the second dorsal fin. This species have eight dorsal and seven anal fin-lets for each.

Color:

The body is dark blue from above and white below. The scale-less area is provided with dark vertical lines.

Remarks:

The description of *A. rochei* in the present work is in accordance with that given by **Uchida (1981)**, **Collette and Nauen (1983)**, **Collette (1986)** and **Collette *et al.* (2011)**. **Sabatés and Recasens (2001)** mentioned that *A. rochei* have a spawning migration from the Atlantic Ocean to the Western Mediterranean waters (spawning area) through the Gibraltar Strait. So, this species is rare in the Eastern part of the Mediterranean, especially in Egypt.

Figure 4. The bullet tuna, *Auxis rochei* (Risso, 1810) from Mediterranean Sea off Alexandria, Egypt (33.3 cm TL).

Family: Sparidae
***Dentex macrophthalmus* (Bloch, 1791)**
Large-eye dente

Description (Figure 5 and Table 2):

Seven specimens out of 40 collected fish ranged from 14–17 cm with a mean TL of 16.24 cm and mean total weight of 64 g were biometrically studied (Table 2). Dorsal fin has XII spines; the first four dorsal spines are increasing in length and then decreasing gradually to the last one. Dorsal fin rays 10 - 11 with an average of 10.86 ± 0.38. Pectoral rays 14–16, with an average of 14.86 ± 0.69. Ventral has I+5, while anal has III+9. Lateral line scales number varied from 40–53 and averaged 47.29 ± 4.39. Pre-dorsal length is 42.52% SL, while length of dorsal fin base increased to 51.02% SL. Pre-pectoral length is 34.96% SL, increased slightly in pre-ventral to 37.17%, and reached the maximum in pre-anal (65.51% SL), but declined in body depth to 37.24% and reached the minimum in head length (32.6% SL). Eye diameter represented 39.61% HL; while PrO declined to 29.95% HL and PoO to 28.74% HL and showed further decline in IO to 23.19% HL, while Upper jaw (UJ) represents 41.55% HL and Lower jaw (LJ) was 43.24% HL. Teeth are canine-form in several rows, with 4 strongest anterior fangs on the upper jaw. From above, length of dorsal base and pre-anal length are larger than half of the standard length. Eyes are large, with their diameter of 39.61% HL, larger than the length of snout (29.95% HL). Scales are present on the body and operculum.

Color: Body is light rosy with white abdomen. Pectoral, ventral, anal and caudal fins are transparent; with light red color on the base of pectoral fin.

Remarks:

The description of *D. macrophthalmus* is based on that given by **Bauchot and Hureau (1990)** and **FAO Species Fact Sheets (2007)**. This species is distributed in Eastern Atlantic and rarely found in the Egyptian Mediterranean waters **(Pollard *et al.*, 2014)**.

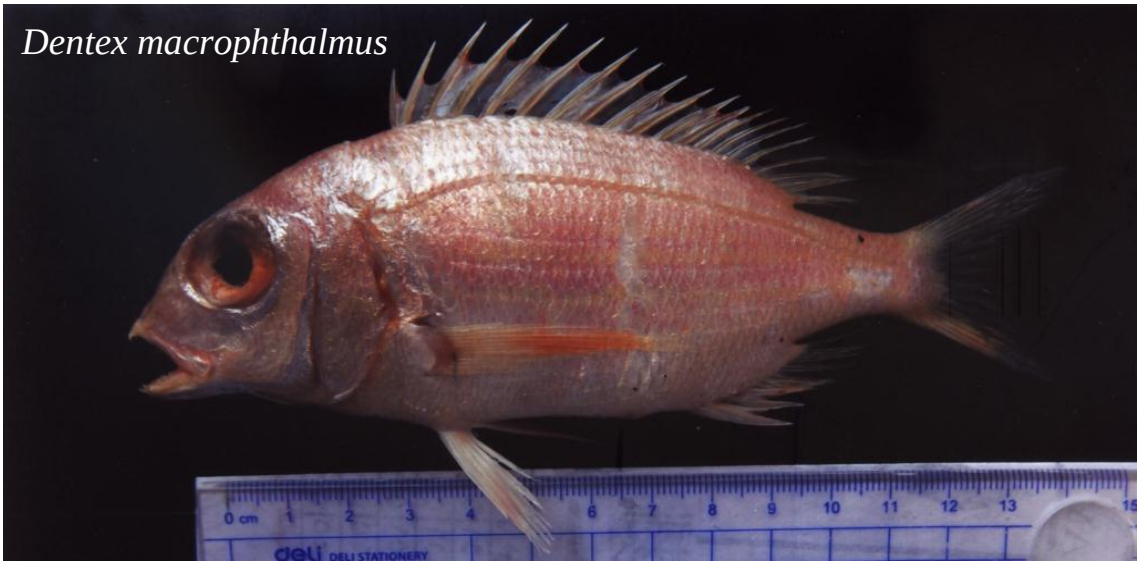


Figure 5. The large-eye dentex, *Dentex macrophthalmus* (Bloch, 1791) from Mediterranean Sea off Alexandria – Egypt (15.7 cm TL).

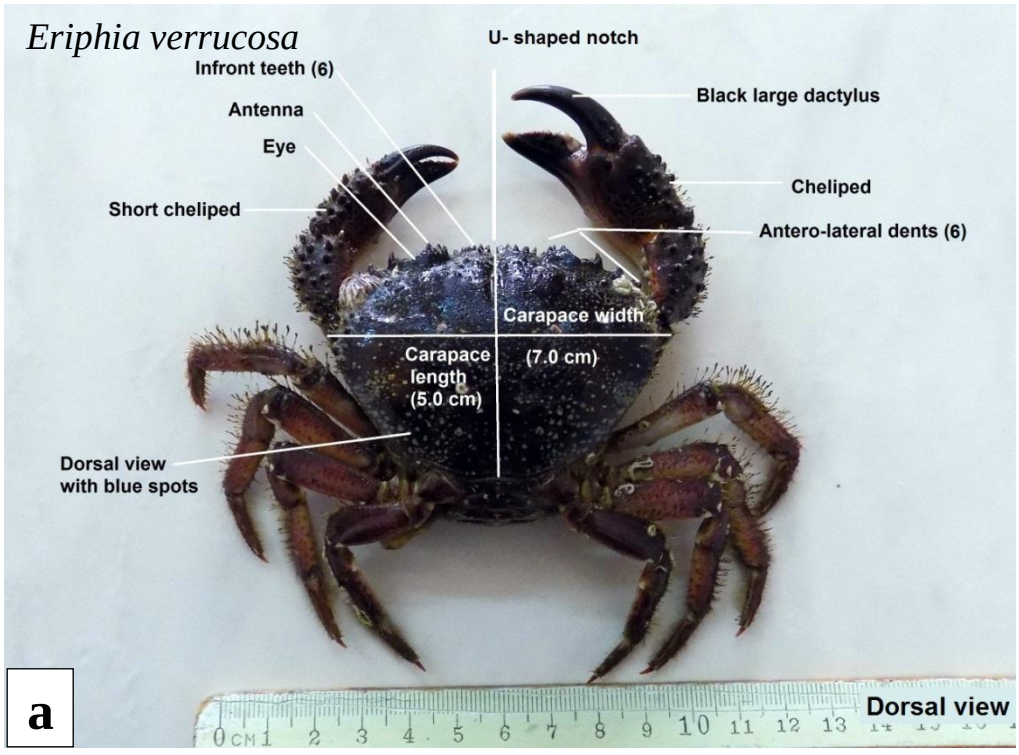
Order: Decapoda
Family: Eriphiidae
***Eriphia verrucosa* (Forsskâl, 1775)**
Warty crab

Description (Figure 6 a, b):

Two ovigerous females of *E. verrucosa* were obtained with mean carapace length 4.5 cm and mean weight 80.5 g. The carapace is black-brown with blue spots on its lower part. Body has four relatively shorter walking legs or preiopds behind the first longer, unequal and massive chelipeds (right is larger than the left). Both cheliped has black dactylus or movable finger moves against fixed thumb. Each segment of chelipods is covered with numerous rounded tuberculus. In contrast, the four walking legs are covered with numerous hairs. The abdomen is white showing a female specimen carrying black fertilized eggs attached to the abdominal female uropods.

Remarks:

The description of warty crab, *E. verrucosa* is based mainly on **Fischer *et al.* (1987)** and **Koh and Ng (2008)**. **Moussa *et al.* (2016)** mentioned that **Balss (1936)** recorded *E. verrucosa* for the first time around Alexandria as *Eriphia spinifrons*. **Monod (1938)** recorded this species at the entrance of Suez Canal and was listed among Suez Canal's list of true crabs by **Holthuis (1956)**. **Dumitrache and Konsulova (2009)** mentioned that *E. verrucosa* migrates to shallow water, less than 1 meter depth in spring time for spawning. **Fouda *et al.* (2015)** collected *E. verrucosa* specimens monthly from the rocky supra-littoral, intertidal and uppermost borders of the sub-tidal zones varied from 1 to 5 meters at Alexandria (Egypt). In the present study, the two female specimens were collected in April at 2 meters depth carrying fertilized black eggs in late stage of maturation.



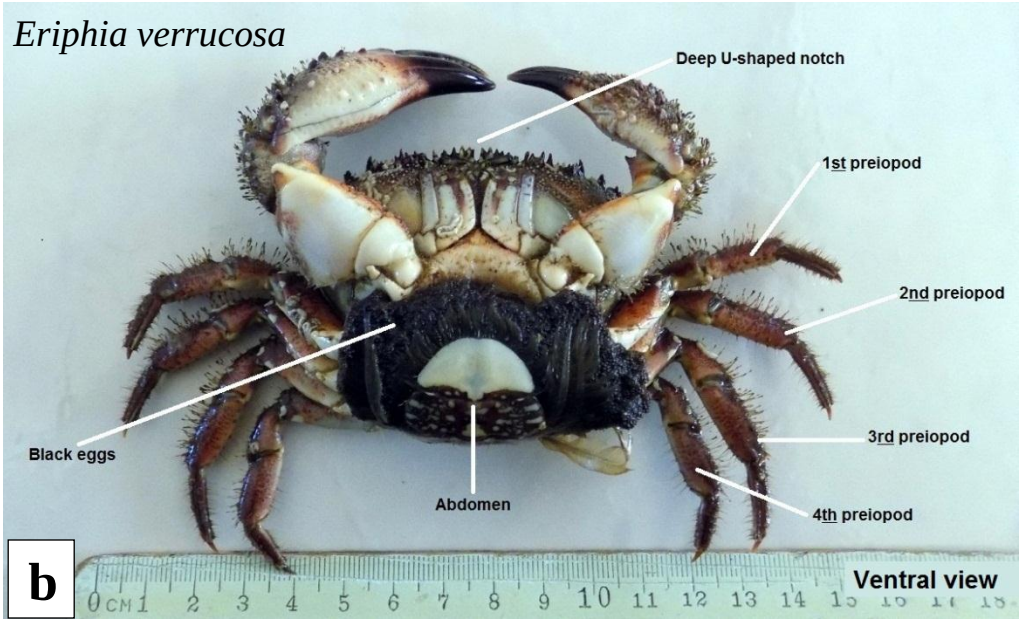


Figure 6. a- Dorsal view and b- ventral view of the warty crab ovigerous female, *Eriphia verrucosa* (Forsskâl, 1775) from the Egyptian Mediterranean waters of Alexandria.

CONCLUSION

The present study deals for the first records of the Atlantic Fang tooth moray eel, *Enchelycore anatina* (Lowe, 1838) Family Muraenidae, in the southeastern Mediterranean Sea off Alexandria (Egypt) and the characteristic features of three species of fish comprised Giant goby, *Gobius cobitis* (Pallas, 1814), Family Gobiidae; Bullet tuna, *Auxis rochei* (Risso, 1810), Family Scombridae; Large-eye dentex, *Dentex macrophthalmus* (Bloch, 1791), Family Sparidae and a crustacean decapod species, Warty crab, *Eriphia verrucosa* (Forsskal, 1775) Family Eriphiidae. These species were collected from the catch of gill nets operated from March to May 2018.

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