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New and confirmed records and rare occurrences of some deep sea fishes in the Turkish waters of the northern Aegean Sea (Mediterranean Sea)

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Abstract

There are very few locations in the Turkish waters which are suitable for deep sea investigations and the northern Aegean Sea is one of them. The study was conducted in the Turkish territorial and adjacent waters of the northern Aegean Sea between the years of 2011 and 2019, providing information on the distribution of some deep sea fishes, with their rare occurrences in the area. The results revealed range expansions of some of the deep sea teleosts as well as the first and the second record of some species for the Turkish waters of the northern Aegean Sea. This study provides the first record of *Mora moro* (Risso, 1810) for the Aegean Sea. The study also includes the confirmed records of *Lestidiops sphyrenoides* (Risso, 1820) and *Epigonus denticulatus* Dieuzeide, 1950 from the Aegean Sea, *Stomias boa* (Risso 1810) in the Turkish waters of the northern Aegean Sea as well as the second records of *Nemichthys scolopaceus* Richardson, 1848, *Ceratoscopelus maderensis* (Lowe, 1839), *Lepidion lepidion* (Risso, 1810) and *Epigonus constanciae* (Giglioli, 1880).

Keywords: Deep Sea Teleosts, Deepest Record, Rare Fish, Myctophiidae.

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Introduction

Human activities such as fishing and oil, gas and mineral exploration and exploitation has started to move into deeper waters. However, deep sea ecosystems are highly vulnerable considering their exclusive features and low turn-over rates. A large part of the Mediterranean basin can be classified as deep sea (Coll et al. 2010), harbouring unique ecosystems within. Anthropogenic effects combined with the relative lack of data on deep seabed ecosystems and biodiversity, makes it difficult to predict and control their impacts (Haedrich 1996, Merrett and Haedrich 1997). Greater efforts are required to compile and review existing knowledge which can lead us one step further to understand the deep sea life (Gjerde 2003). Focusing on the Aegean Sea, the unique topography of the area (i.e. small islands and semi-enclosed bays adjacent to the open seas) and intense artisanal fishery activities complicate fisheries management, since the catches and exploitation status varies locally (Papaconstantinou 2005; Tsagarakis et al. 2010).

The Aegean Sea represents one of the northern extremities of the eastern Mediterranean, surrounding the coasts of Greece and Turkey. It is divided into two sub-basins by the Cyclades Plateau: The northern and the southern Aegean Sea (Ignatiades et al. 2002). Despite the oligotrophic Mediterranean waters, the northern Aegean Sea is much more productive with its higher faunal densities due to the incoming Black Sea current which is characterized by higher nutrient concentrations and colder temperatures (Siokou-Frangou et al. 2002). The average depth of the northern part is greater than the southern part as in the example of the northern Aegean Trough which is the deepest area of the whole basin (Zervakis et al. 2000).

Even though its bottom has many deep trenches and troughs, the knowledge on the deep sea fish fauna of the northern Aegean Sea is inadequate (Papaconstantinou 2014; Gönülal and Dalyan 2017). Froese and Pauly (2018) designated the depth ranges of the deep sea fishes in the Aegean Sea. Despite the small differences between the lists of deep sea fishes, Turkish and Greek waters have nearly the same number of species (512 and 510,

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respectively) (Bilecenoğlu et al. 2014; Papaconstantinou 2014). Only a few studies have been focused on this fauna (Kaya 1993; Labropoulou and Papaconstantinou, 2000; Türetken 2009; Gönülal 2016; Gönülal 2017) and the depth range in several ones extended down to 200 m (Filiz and Bilge 2004; Ismen et al. 2007; Cengiz et al. 2011). Despite small differences between the lists of deep sea fishes, Turkish and Greek waters have nearly the same number of species (512 and 510, respectively) (Bilecenoğlu et al. 2014; Papaconstantinou 2014) with only a few studies focusing on its fauna (Kaya 1993; Labropoulou and Papaconstantinou 2000; Türetken 2009; Gönülal 2016; Gönülal 2017; Filiz and Bilge 2004; Ismen et al. 2007; Cengiz et al. 2011). However, the depths in which the species were collected have not been explicitly mentioned in any of these studies.

Fifty-three deep sea fish species have been found from depths greater than 200 m in the Turkish waters of the northern Aegean Sea since the second half of the 20th century (Table 1). Recently, Gönülal and Dalyan (2017) listed the deep sea species reported from Aegean Sea that inhabits deeper than 200 m. The present findings, along with nineteen species are rare in the northern Aegean Sea, contribute to the knowledge on the temporal and bathymetric distribution of these deep sea fishes.

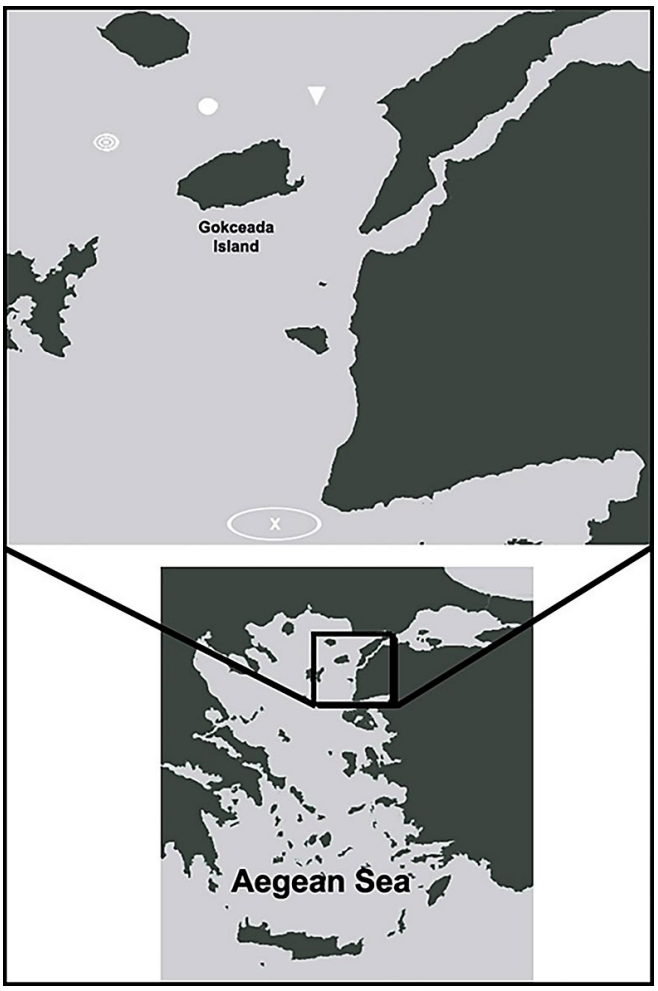

Figure 1. Study area in the northern Aegean Sea.

Material and Methods

All fish samples were obtained in the Turkish territorial and adjacent waters of the northern Aegean Sea (Fig. 1) by rented fishing vessels and "FIRTINA IU" (Boat of the Gökçeada Marine Research Department, Istanbul University - Faculty of Aquatic Sciences). Trawl (44 mm mesh size), ring net (3 m in diameter and 7 mm mesh size), long line and baited trap were used for sampling between 2010 and 2017.

Morphometric (Total length, standard length, body depth, head length, snout length, eye diameter, dorsal fin base length, anal fin base length, first dorsal spine length) and meristic characteristics (Gill rakers, first and second dorsal fin rays, anal fin rays, pectoral fin rays, post-orbital pores, preopercular pores) of the specimens were determined. All samples were preserved in 4% formalin or 50% ethanol solution and deposited in the Istanbul University, Science Faculty, Hydrobiology Museum (IUSHM). Eschmeyer et al. (2019) was followed for the scientific names of fishes while taxonomic classification is in accordance with Nelson et al. (2016).

Results and Discussion

This paper includes six species of *C. maderensis, L. crocodilus, L. dofleini, B. glaciale* and *H. benoiti, M. punctatum*) of Myctophids. All species of the family are considered as rare in the Aegean Sea due to lack of deep sea research. *Chimaera monstrosa, C. braueri, A. hemigymnus, L. crocodilus, M. punctatum* and *T. scabrus* are also considered as rare species, both in the Turkish waters and the northern Aegean Sea. Among them, *C. monstrosa, L. crocodilus* and *M. punctatum* are known from all seas of Turkey except for the Black Sea,

Table 1. The deep sea fishes obtained and previously reported down to 200 m in the Turkish waters of the northern Aegean Sea.

Species	Depths (m)	Fishing Device	Reference
Arctozenus risso	630	Trawl	Cihangir et al. 2003
Argentina sphyraena	150-500	Trawl	Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Sever et al. 2013
Argyropelecus hemigymnus	329-750	Ring Net; Trawl	Kaya 1993, Türetken 2009, PS
Bellottia apoda	210	Beam Trawl	Kaya and Bilecenoğlu 2000
Benthosema glaciale	201-640	Ring Net; Trawl	Kaya 1993, Türetken 2009, PS
Capros aper	150-473	Trawl	Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Sever et al. 2013
Centrolophus niger	500-900	Longline	Gönülal 2016, Gönülal 2017
Centrophorus granulosus	200-500	Trawl	Cengiz et al. 2011
Ceratoscopelus maderensis	201-419	Ring Net; Trawl	Türetken 2009, PS
Chimaera monstrosa	200-500	Ring Net; Trawl	Filiz and Bilge 2004, Türetken 2009, Cengiz et al. 2011, PS
Chlopsis bicolor	273-419	Ring Net; Trawl	Türetken 2009
Chlorophthalmus agassizi	150-473	Trawl	Ünsal and Kabasakal 1998, Kabasakal 1999, Filiz and Bilge 2004, Türetken 2009, Sever et al. 2013
Coelorinchus caelorinchus	200-500	Trawl	Ünsal and Kabasakal 1998, Kabasakal 1999, Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011
Conger conger	500-900	Longline	Gönülal 2017
Cyclothone braueri	590-850	Ring Net	Demir 1958, Kaya 1993, PS
Dalatias licha	201-900	Trawl	Kabasakal and Kabasakal 2002, Türetken 2009, Gönülal 2016, 2017
Diaphus holti	570-585	Ring Net; Trawl	Kaya 1993, Türetken 2009
Dipturus oxyrinchus	200-900	Longline; Trawl	Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Echiodon dentatus	156	Trawl	Filiz et al. 2007
Epigonus constanciae	150-450	Trawl	Özaydın et al. 2007, PS
Epigonus denticulatus	401	Trawl	PS
Etmopterus spinax	200-1000	Longline; Trawl	Kabasakal and Ünsal 1999, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Gadella maraldi	210	Beam Trawl	Kaya and Bilecenoğlu 2000
Gadiculus argenteus	200-500	Beam Trawl; Trawl	Kaya 1993, Kabasakal 1999, Filiz and Bilge 2004, Türetken 2009, Cengiz et al. 2011
Galeus melastomus	200-1000	Longline; Trawl	Kabasakal 2002, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Glossanodon leioglossus	150-473	Trawl	Sever et al. 2013
Helicolenus dactylopterus	200-900	Longline; Trawl	Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Hexanchus griseus	200-1000	Longline; Trawl	Kabasakal 2004, Kabasakal and Kabasakal 2004, Ismen et al. 2007, Cengiz et al. 2011, Gönülal 2016, 2017
Hoplostethus mediterraneus	150-580	Ring Net; Trawl	Kaya 1993, Ünsal and Kabasakal 1998, Kabasakal 1999, Filiz and Bilge 2004, Türetken 2009, Sever et al. 2013
Hygophum benoiti	201-850	Ring Net; Trawl	Türetken 2009, PS
Hygophum hygomii	640	Ring Net	PS
Hymenocephalus italicus	200-685	Beam Trawl	Kaya 1993, Türetken 2009, Cengiz et al. 2011
Lampanyctus crocodilus	600-850	Ring Net	Kaya 1993, PS
Lepidion lepidion	580-1480	Trawl, Baited Trap	Bilecenoğlu et al. 2014, PS
Lepidorhombus boscii	200-500	Beam Trawl; Ring Net; Trawl	Kaya 1993, Ünsal and Kabasakal 1998, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011
Lestidiops sphyrenoides	200	Trawl	PS
Lobianchia dofleini	273-850	Ring Net	Kaya 1993, Türetken 2009, PS
Lophotus lacepede	329	Trawl	PS
Macroramphosus scolopax	200-500	Trawl	Filiz and Bilge 2004, Cengiz et al. 2011

Maurolicus muelleri	200-500	Trawl	Cengiz et al. 2011
Micromesistius poutassou	200-500	Trawl	Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011
Molva macrophthalma	200-500	Trawl	Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011
Mora moro	880	Longline	PS
Myctophum punctatum	326-600	Ring Net, Trawl	Kaya 1993, PS
Nemichthys scolopaceus	230 -600	Trawl	Filiz et al. 2007, PS
Nezumia sclerorhynchus	396-419	Trawl	Türetken 2009
Notoscopelus elongatus	201-347	Ring Net; Trawl	Türetken 2009
Notoscopelus kroyeri	350-475	Trawl	Keskin and Eryılmaz 2010
Ophidion barbatum	200-500	Beam Trawl; Trawl	Kaya 1993, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011
Peristedion cataphractum	200-500	Trawl	Filiz and Bilge 2004, Cengiz et al. 2011
Phycis blennoides	200-1000	Beam Trawl; Longline; Trawl	Kaya 1993, Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Polyprion americanus	500-900	Longline	Gönülal 2016, Gönülal 2017
Pteroplatytrygon violacea	500-900	Longline	Gönülal 2016, Gönülal 2017
Scyliorhinus canicula	200-1000	Longline; Trawl	Kabasakal 2002, Filiz and Bilge 2004, Ismen et al. 2007, Türetken 2009, Cengiz et al. 2011, Gönülal 2016, 2017
Stomias boa	316	Trawl	PS
Symphurus nigrescens	200-500	Trawl	Cengiz et al. 2011
Synchiropus phaeton	201-279	Trawl	Türetken 2009
Trachyrincus scabrus	329-685	Beam Trawl; Trawl	Kaya 1993, Türetken 2009, PS
Vinciguerria attenuata	450-500	Ring Net	Kaya 1993

while *C. braueri* and *T. scabrus* are found only in the Levantine and the Aegean waters.

The record of *M. moro* is the second report for the Turkish seas and the first report in the Turkish waters of the Aegean Sea. Also, in this study, the confirmed records of *L. sphyrenoides* and *E. denticulatus* from the Aegean Sea are provided. In addition, *S. boa* is the first record in the Turkish waters of the northern Aegean Sea while the second records are *N. scolopaceus*, *C. maderensis*, *L. crocodilus*, *L. lepidion* and *E. constanciae*.

Chimaeridae Rafinesque, 1815

Chimaera Linnaeus, 1758

Chimaera monstrosa Linnaeus, 1758

Material examined: Çanakkale [1 spc, TL:174 mm]; north of the Gökçeada Island; 40°19'08"N- 25°58'26"E; 468 m depth; 13 Apr 2016, Trawl; IUSHM 2017-1174 (Fig. 2a).

Identification: The species is diagnosed by the following morphological features: body tapering from a large head to a whip-like caudal filament. Snout short. First dorsal fin with a strong spine, the upper half free from the front margin of the fin; second dorsal fin long, continuous to upper caudal fin; caudal fin ending in a filament (nearly always incomplete). Total length 174 mm; body depth 8.8 times, head length 10.2 times, dorsal fin base length 5.7 in total length; eye diameter 56.2 times, snout length 65.7 times in head length. First dorsal spine length 14.5 mm. The morphological description and colour of the specimens agree with Stehmann and Bürkel (1984).

Distribution: The family Chimaeridae, also known as rabbitfishes, contains two genera and thirty-seven species (Nelson et al. 2016) and has a wide vertical range starting from the near surface to deep waters (Stehmann and Bürkel 1984). The rabbitfish *C. monstrosa* is a benthopelagic species occurring in the depths between 300 and 1250 m (Eronat 2016). The species is found along the continental slope of the eastern Atlantic from Norway to Morocco, Madeira and Azores and Mediterranean Sea (Stehmann and Bürkel 1984). The first record of *C. monstrosa* in the Turkish waters of the Aegean Sea was given by Geldiay (1969). It has been previously recorded in the Sea of Marmara (Dalyan 2010) and in the southern Aegean Sea (Filiz and Bilge 2004). However,

it is still considered as a rare species for the eastern Mediterranean Sea.

Nemichthyidae Kaup, 1859
Nemichthys Richardson, 1848
Nemichthys scolopaceus Richardson, 1848
Material examined: Çanakkale [1 spc, TL: 787 mm]; north of the Gökçeada Island; 230 m depth; 22 Feb 2017; Trawl; IUSHM 2018-1399 (Fig. 2b).
Identification: The species has a relatively black skin while congeneric *N. curvirostris* (Strömman, 1896) has a pale skin with large melanophores on belly. Also, two species are separated by *N. scolopaceus* having fine and numerous teeth than *N. curvirostris* (Nielsen 1986). Total length 787 mm; standard length 780 mm; body depth 1.7 times, head length 7.8 times, dorsal fin base length 94.5 times, anal fin base length 91 times in standard length and eye diameter 14.8 times in head length. Post-orbital pores 17; preopercular pores 9. Because the upper jaw was damaged, snout length measurements could not be taken.
Distribution: *Nemichthys scolopaceus* can be found in tropical and subtropical zones throughout the world seas. The species is distributed from Canada to Brazil in the west and from Iceland to South Africa in the east of Atlantic, including the Mediterranean Sea. Also, it disperses from Japan to the Arafura Sea in the west and from Alaska to Chile in the east Pacific Ocean. *N. scolopaceus*, as a bathypelagic species, scatters at depths of 100-4337 m (usually 100 - 1000 m) (Froose and Pauly 2018). The first record of the *N. scolopaceus* was reported by Bilecenoğlu et al. (2006) and the following year by Filiz et al. (2007) from the Aegean Sea. Lately, Bayhan et al. (2020) has confirmed the occurrence of *N. scolopaceus* from the Eastern Mediterranean coasts of Turkey.

Gonostomatidae Cocco, 1838
Cyclothone Goode and Bean, 1883
Cyclothone braueri Jespersen and Tåning, 1926
Material examined: Çanakkale [1 spc, TL:27 mm]; north of the Gökçeada Island; 40°21'88"N- 25°52'45"E; 850 m depth, 19 Sep 2015; Ring net; IUSHM 2018-1385 (Fig. 2c).
Identification: The species is distinguished from its Mediterranean congenerics by its gill rakers that are 3 (4) on hypobranchial of first arch. The membrane of branchiostegal rays is transparent or it has a stellate melanophore between each pair of rays. The first dorsal fin rays 14; anal fin rays 18. Total length 26.6 mm; standard length 21.8 mm; body depth 16.1 times, head length 22.5 times, dorsal fin base length 17.4 times, anal fin base length 14.7 times in SL; eye diameter 6.1 times, snout length 19.6 times in head length.
Distribution: The family Gonostomatidae has five species belonging to two genera in the Mediterranean Sea; *C. braueri* Jespersen and Tåning, 1926, *C. microdon* (Günther, 1878), *C. pygmaea* Jespersen and Tåning, 1926, *Gonostoma denudatum* Norman, 1930 and *Sigmops elongatus* (Günther, 1878) (Quignard and Tomasini 2000; Roman et al. 2000) and three of them (*C. braueri*, *C. pygmaea* and *G. denudatum*) are found in the Turkish waters (Bilecenoğlu et al. 2014). Among those, *C. braueri* is the only species reported from the Turkish waters of the Aegean Sea (Jespersen and Tåning 1926). It is widely distributed in temperate and sub-temperate zones of the Atlantic, Indian and South Pacific Oceans and the Mediterranean Sea (Froose and Pauly 2018).

Sternoptychidae Duméril, 1805
Sternoptychinae Duméril, 1805
Argyropelecus Cocco, 1829
Argyropelecus hemigymnus Cocco, 1829

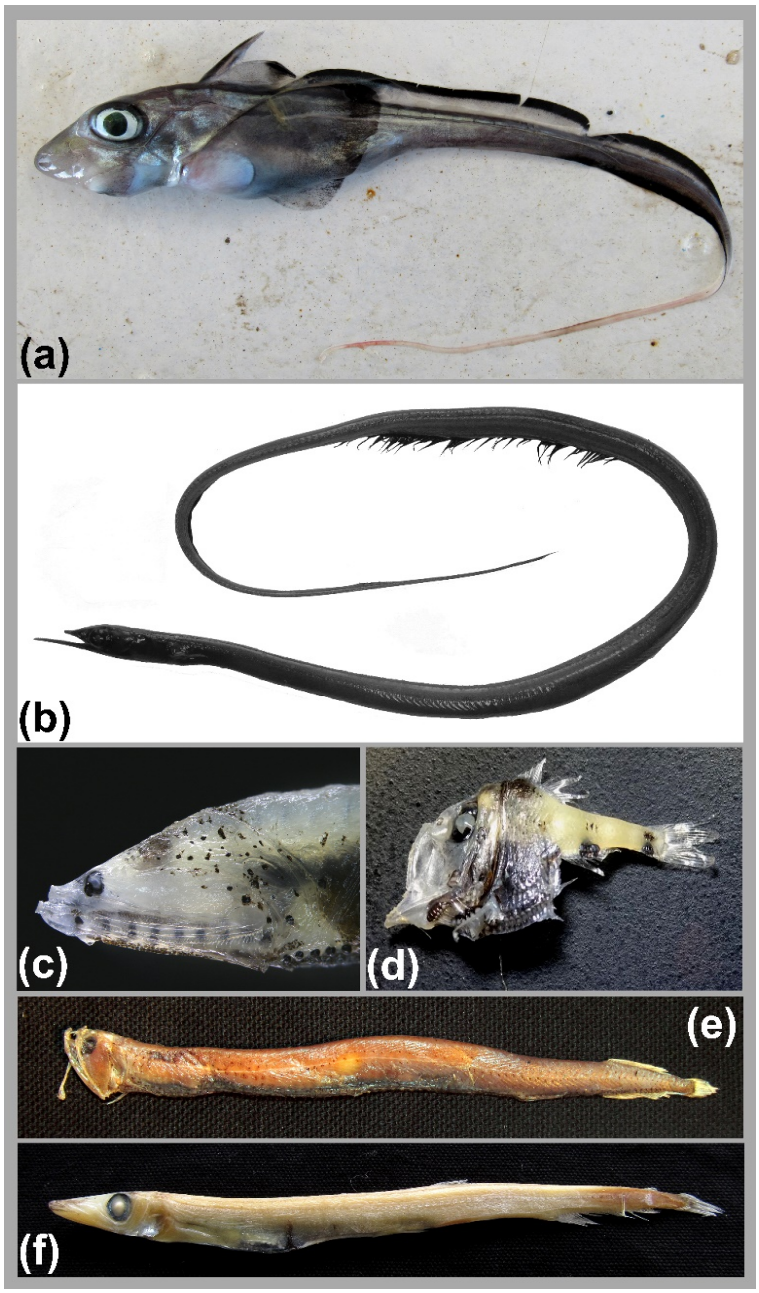

Figure 2. (a): *Chimaera monstrosa* (TL 174 mm); (b): *Nemichthys scolopaceus* (TL 787 mm); (c): Head of *Cyclothone braueri* (TL 27 mm); (d): *Argyropelecus hemigymnus* (TL 18 mm); (e): *Stomias boa* (TL 134 mm); (f): *Lestidiops sphyrenoides* (TL 192 mm).

Material examined: Çanakkale [1 spc, TL: 18 mm]; north of the Gökçeada Island; 750 m depth; 04 Mar 2016; Ring net; IUSHM 2018-1391 (Fig. 2d).

Identification: *Argyropelecus hemigymnus* can be distinguished from the other Atlanto-Mediterranean congeneric by having a single post-abdominal spine and having well separated photophore groups of VAV, AC_1 and AC_2. Dorsal fin rays 8, followed with an adipose fin; pectoral fin rays 10; anal fin with 2 distinct group of fin rays separated by AC_1 photophore; first group consist of 6, second group 6 fin rays. Total length 18 mm; standard length 14 mm; body depth 50 times, head length 35.7 times, dorsal fin base length 21.4 times and anal fin base length 21.4 times in standard length; eye diameter and snout length 40 times in head length.

Distribution: The subfamily Sternoptychinae has a single species in the Mediterranean Sea; *A. hemigymnus* (Psomadakis et al. 2012). This bathypelagic species is known from all tropical and subtropical waters of the

world. It is distributed in the east of Atlantic from the north of British Isles to South Africa and in the west of Atlantic from the Canada to Argentina. The species can be found at depths down to 2400 meters, however, it usually prefers a depth range of 100-700 m (Froese and Pauly 2018). Although Badcock (1984) mentioned the occurrence of the species, Kaya (1993) firstly reported *A. hemigymnus* with four specimens in the Turkish waters of the Aegean Sea. Türetken (2009) gave the second record of the species and recently, Daban and İşmen (2020) has reported the species larval occurrence off the coasts of the Gökçeada Island.

Stomiidae Bleeker 1859
Stomiinae Bleeker 1859
Stomias Cuvier 1816
Stomias boa (Risso 1810)
Material examined: Çanakkale [1 spc, TL:134 mm]; north of the Gökçeada Island; 40°16'53"N-25°51'08"E; 316 m depth; 09 June 2015; Trawl; IUSHM 2018-1400 (Fig. 2e).
Identification: *Stomias boa* can be confused with *Chauliodus sloani* Bloch & Schneider, 1801 that lives in the same depth ranges and habitat. The species is separated from *C. sloani* by its barbels and relatively small teeth. Dorsal fin rays 23; anal fin rays 18; pectoral fin rays 4. Total length 134 mm; standard length 121 mm; body depth 9.1 times, head length 10.7 times, dorsal fin base length 9.1 times and anal fin base length 9.9 times in standard length; eye diameter 30.8 times and snout length 23.1 times in head length
Distribution: The genus *Stomias* Cuvier, 1816 is only represented with the boa dragonfish, *S. boa*, in the Mediterranean Sea and can be considered as extremely rare in the Turkish waters of the Mediterranean Sea. Although *S. boa* has records in both western and eastern Mediterranean Seas, it has not been reported in the Turkish waters of the northern Aegean Sea (Kaya, 1993; Türetken, 2009). In the Turkish waters, the species was recorded in the sea of Marmara by Demir (1958), in the South Aegean Sea by Kaya (1993) and in the eastern Mediterranen Sea by Bayhan et al. (2015). Daban and İşmen (2020) have obtained larvae of *S.boa* off the Gökçeada coasts.

Paralepididae Bonaparte, 1835
Lestidiops Hubbs, 1916
Lestidiops sphyrenoides (Risso, 1820)
Material examined: Çanakkale [1 spc, TL:192 mm]; north of the Gökçeada Island; 200 m depth; 06 Nov. 2015; Trawl; IUSHM 2017-1179 (Fig. 2f).
Identification: The characteristics of the species are: the anal and caudal fin separate with a notch; body elongate and snout length is a little less than the head length. Dorsal fin is short and positioned slightly behind the middle of the body. Body is naked except for lateral line scales. Dorsal fin rays 9, anal fin rays II + 27, pectoral fin rays 11. Total length 192.2 mm; standard length 182.4 mm; body depth 7.2 times; head length 16.4 times, dorsal fin base 4.7 times and anal fin base 16.3 times in standard length; eye diameter 2.7 times and snout length 62 times in head length.
Distribution: Barracudinas are small to medium sized fishes (15-50 cm) known from all oceans from Arctic to Antarctic but they are most abundantly found in the tropics (Post 1984). The family Paralepididae consists of 7 genera (Nelson et al. 2016) and most of them are found in the Mediterranean Sea. *Lestidiops sphyrenoides* inhabits in depths between 50 - 600 m (Post 1984). The distribution of the species is confined to the eastern Atlantic; France to Mauritania, including the Mediterranean Sea (Fischer et al. 1987). Although *L. sphyrenoides* was reported in the Aegean Sea by Ege (1930), there is no available information on its occurrence in both Turkish and Greek waters ever since. Also, Cihangir et al. (2003) mentioned that the occurrence of

L. sphyrenoides needs confirmation. This specimen caught in the "north" of Gökçeada Island provides confirmation of the occurrence of *L. sphyrenoides* in the Aegean Sea and the Turkish waters.

Myctophidae Gill, 1893
Lampanyctinae Paxton, 1972
Ceratoscopelus Günther, 1864
Ceratoscopelus maderensis (Lowe, 1839)
Material examined: Çanakkale [1 spc, TL: 65 mm]; north of the Gökçeada Island; 40°17'49"- 25°53'09"; 390 m depth; 14 Jan 2015; Trawl; IUSHM 2018-1392 (Fig. 3a).
Identification: *Ceratoscopelus maderensis* is the only species in the Mediterranean Sea belonging to the genus *Ceratoscopelus*. It is distinguished from *C. warmingii* (Lütken 1892), the Atlantic congeneric, with the presence of supraorbital spine (Hulley 1986). Dorsal fin rays 13; anal fin rays 13; pectoral fin rays 13. Gill rakers 5 + 1 + 16. Total length 65 mm; standard length 58 mm; body depth 20.7 times, head length 34.5 times, dorsal and anal fin base length 17.2 times in standard length; eye diameter 35 times and snout length 20 times in head length.
Distribution: *Ceratoscopelus maderensis*, a species native to the Atlantic Ocean and Mediterranean Sea, lives mainly in the northern hemisphere (Froese and Pauly 2018). This bathypelagic species is found at depths of 51 - 1480 m. *C. maderensis* was reported for the first time by Tåning (1918) from the Aegean Sea. Türetken (2009) confirmed the occurrence of the species in the Turkish Seas.

Lampanyctus Bonaparte, 1840
Lampanyctus crocodilus (Risso, 1810)
Material examined: Çanakkale [1 spc, TL: 36 mm]; north of the Gökçeada Island; 40°21'88"N- 25°52'45"E; 850 m depth; 19 Sep. 2015; Ring net; IUSHM 2017-1180 (Fig. 3b).
Identification: The jewel lanternfish is distinguished from other species of *Lampanyctus* by the pattern of its photophores and by its short pectoral fins which are located behind the gill opening (Hulley 1986). Dorsal fin rays 13; anal fin rays II + 16; pectoral fin rays 14. Gill rakers 5 + 1 + 11. Total length 35.6 mm; standard length 29 mm; body depth 21 times, head length 29.7 times, dorsal fin base length 14.8 times, anal fin base length 23.4 times in standard length; eye diameter 27.9 times and snout length 19.8 times in head length.
Distribution: Members of the genus *Lampanyctus* inhabit in warm, temperate and cool waters of all three oceans and the Mediterranean Sea (Hulley 1986). The jewel lanternfish, *L. crocodilus,* is a mesopelagic species, inhabiting merely in the northern Atlantic Ocean and the Mediterranean Sea. The Mediterranean population of the species exhibits diurnal migrations; while small juveniles migrate from 200 m to 100 m during the day, adults migrate from 1000 m to 700 m. The occurrence of this species in the Aegean Sea was first mentioned by Taning (1918) and afterwards confirmed by Kaya (1993) and Daban and İşmen (2020). *L. crocodilus* is also known from the eastern Mediterranean (Bayhan et al. 2020) and Sea of Marmara (Tåning 1918).

Diaphinae Paxton, 1972
Lobianchia Gatti, 1904
Lobianchia dofleini (Zugmayer, 1911)
Material examined: Çanakkale [1 spc, TL: 41 mm]; north of the Gökçeada Island; 40°21'88"N- 25°52'45"E; 850 m depth; 19 Sep. 2015; Ring net; IUSHM 2018-1393 (Fig. 3c).

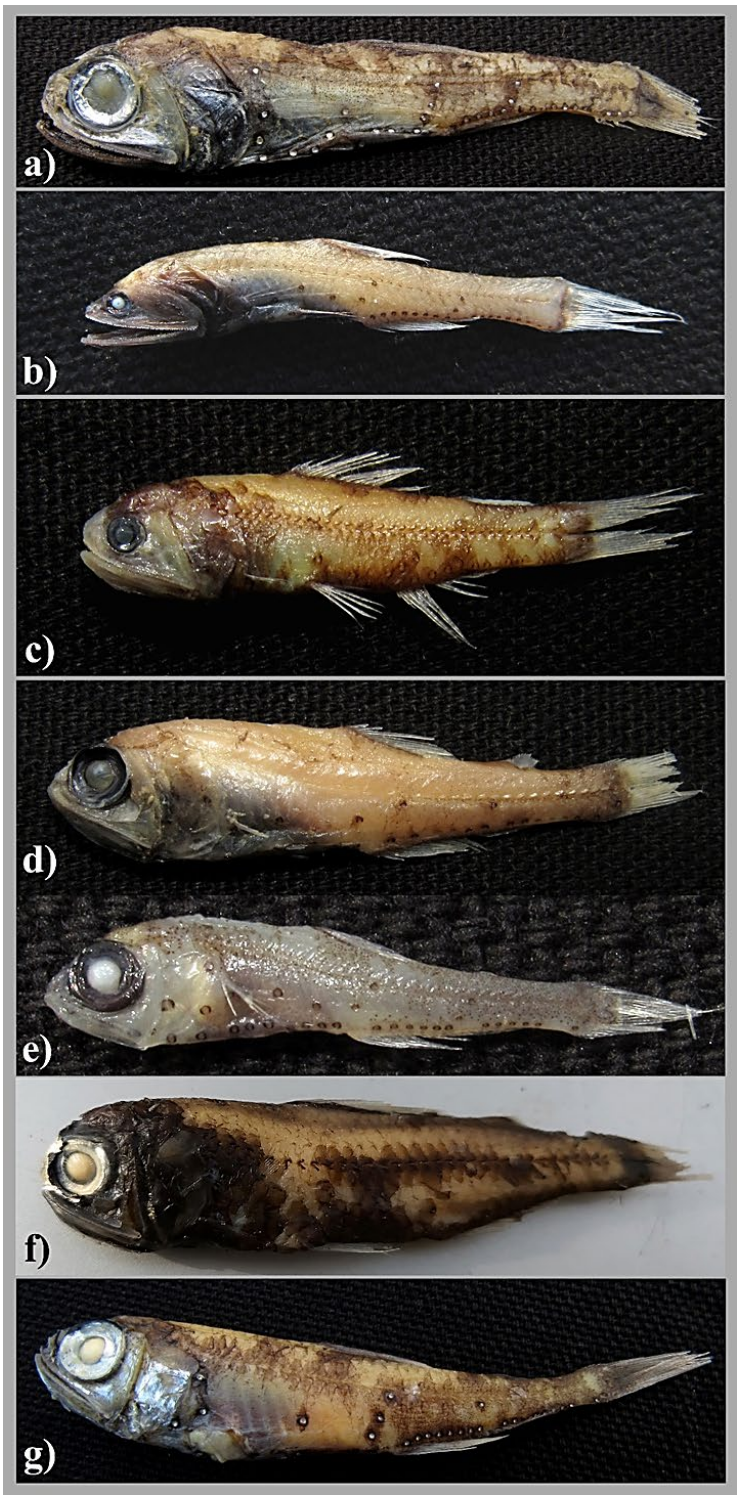

Figure 3. (a): *Ceratoscopelus maderensis* (TL 65 mm); (b): *Lampanyctus crocodilus* (TL 36 mm); (c): *Lobianchia dofleini* (TL 41 mm); (d): *Benthosema glaciale* (TL 50 mm); (e): *Hygophum benoiti* (TL 18 mm); (f) *Diaphus metopoclampus* (TL 81 mm); (g): *Myctophum punctatum* (TL 71 mm).

Identification: In this genus, individuals have infra and supracaudal luminous glands which are the secondary sexual characters. The distance of Prc_4 and Prc_3 is greater than the distance between Prc_3 and Prc_1 on caudal pedoncule, while the opposite is observed in *L. gemellarii* (Hulley 1986). Dorsal fin rays 16; anal fin rays 13; pectoral fin rays 13. Gill rakers 6 + 1 + 14. Total length 41 mm; standard length 33 mm; body depth 24.2 times, head length 33.3 times, dorsal fin base length 24.2 times and anal fin base length 21.2 times in standard length; eye diameter 27.3 times and snout length 18.2 times in head length. Supracaudal luminous gland present.

Distribution: The genus *Lobianchia* has two species in the Mediterranean Sea; *L. dofleini* and *L. gemellarii*

(Quignard and Tomassini 2000). Both species are in the check list of marine fishes of Turkey (Bilecenoğlu et al. 2014). *Lobianchia dofleini* is widely dispersed in tropical and subtropical zones of the Atlantic and Mediterranean Sea, it is also known to be a southern circumglobal species. The species mainly lives in the mesopelagic zone, however it has been found at depths down to 4000 m (Froose and Pauly 2018). *L. dofleini* was obtained by Tåning (1918) in the Aegean Sea and by Kaya (1993) in the Turkish waters. Türetken (2009) also reported the species from the northern Aegean Sea with 5 specimens and Daban and İşmen (2020) has obtained larvae of the species in the region.

Myctophinae Gill, 1893
Benthosema Goode and Bean, 1896
Benthosema glaciale (Reinhardt, 1837)
Material examined: Çanakkale [1 spc, TL: 50 mm]; north of the Gökçeada Island; 40°17'07"N-25°45'55"E; 640 m depth; 20 Jan. 2016; Ring net;]; IUSHM 2018-1394 (Fig. 3d).
Identification: In this genus, individuals have infra and supracaudal luminous glands which are the secondary sexual characters. This species can be easily distinguished from its congenerics by the presence of So photophore which is located beneath the eye. The number of gill rakers is 17-20 in total while its congeneric has 13-15 (Hulley 1986). Dorsal fin rays 12; anal fin rays 18; pectoral fin rays 11. Gill rakers 5 + 1 + 13. Total length 50 mm; standard length 43 mm; body depth 23.3 times, head length 30.2 times, dorsal fin base length 14 times and anal fin base length 25.6 times in standard length; eye diameter 38.5 times and snout length 15.4 times in head length. Infra-caudal luminous gland present.
Distribution: *Benthosema glaciale* is an epi- and bathypelagic species, it disperses horizontally from the surface to 1407 m depth (Coad and Reist 2004). Most of its distribution area takes part in the northern hemisphere to 81°N (Froose and Pauly 2018). The first record of *B. glaciale* from the Sea of Marmara was given by Tåning (1918) and its occurrence was confirmed by Demir (1958). The first record of this rare species in the Aegean Sea was reported by Kaya (1993), while the second was reported by Türetken (2009) from the northern Aegean Sea. Daban and İşmen (2020) collected larvae of the species from the Gökçeada coasts.

Myctophidae Gill, 1893
Diaphus Eigenmann & Eigenmann, 1890
Diaphus metopoclampus (Cocco, 1829)
Material examined: Çanakkale [1 spc, TL: 81 mm]; northeast of the Gökçeada Island; 40°20'18"N - 25°59'53"E, 520 m depth; 01 Aug. 2019, Trawl; IUSHM 2020-1424 (Fig. 3f).
Identification*: D. metopoclampus* can easily be distinguished from its Mediterranean congenerics by the absence of the So photophore. Dorsal rays 14, anal rays 14, pectoral rays 11. Gill rakers 17 + 1 + 9. Total length 81 mm. Standard length 71 mm. AO 6 + 6. Head length 3.9 times in SL. Lateral line organs 34. Snout length 2. Eye diameter 6. The head is almost as deep as long (1.06 times). Vn very large, extending along the lower orbital border to beyond the midline of snout.
Distribution: The genus *Diaphus* is the most speciose genus in the family Myctophidae and includes over 70 species throughout world's oceans. Three species of the genus Diaphus are known to inhabit the Mediterranean Sea: *D. holti, D. metopoclampus* (Cocco, 1829) and *D. rafinesquei* (Hulley, 1986). Among them, *D. metopoclampus* is considered to be a rare species in the Mediterranean. It is a bathypelagic myctophid (Froese & Pauly 2011), distributed worldwide in the temperate and tropical waters of all oceans and the Mediterranean Sea (Hulley 1984). The species is found in the northern Aegean Sea (Papaconstantinou, 2014) however the only record of the species from the Turkish waters was given by Kaya and Bilecenoğlu (2000). This is the second

record of the species from the Turkish waters and the first record from the Turkish waters of the northern Aegean Sea.

Hygophum Bolin, 1939
Hygophum benoiti (Cocco, 1838)
Material examined: Çanakkale [1 spc, TL: 18 mm]; north of the Gökçeada Island; 40°21'88"N- 25°52'45"E; 850 m depth; 19 September 2015; Ring net; IUSHM 2018-11395 (Fig. 3e).
Identification: Dorsal fin rays 14; anal fin rays 19; pectoral fin rays 14. Body measurements of the species are as follows: Total length 18 mm; standard length 15 mm; body depth 26.7 times, head length 33.3 times, dorsal fin base length 13.3 times and anal fin base length 20 times in standard length; eye diameter 40 times and snout length 20 times in head length.
Distribution: The genus *Hygophum* is represented in the Mediterranean by two bathypelagic species; *H. benoiti* and *H. hygomii*. *H. benoiti* is endemic to the Mediterranean Sea and the Atlantic Ocean and its distribution is restricted to the parallels 48°N - 16°N (Hulley 1986). This bathypelagic Myctophid lives at a depth range of 51-700 m. There are mostly larval records of the species in the Aegean Sea (Daban and İşmen 2020) as well as a few adult records (Papaconstantinou 2014). The second documented record of *H. benoiti* in the Turkish waters of the Aegean Sea is reported with this paper, while the first one was given by Türetken (2009).

Myctophum Rafinesque, 1810
Myctophum punctatum Rafinesque, 1810
Material examined: Çanakkale [1 spc, TL: 71 mm]; north of the Gökçeada Island; 40°17'54"- 40°17'47"N; 25°56'44"-25°55'40"E; 326 m depth; 13 Apr 2016; Trawl; IUSHM 2018-1387 (Fig. 3g).
Identification: In this genus, individuals have infra and supracaudal luminous glands which are the secondary sexual characters. The most crucial diagnostic character of the species is the fairly rounded posterodorsal margin of operculum (Hulley 1986). Dorsal fin rays 13; anal fin rays 19; pectoral fin rays 14. Gill rakers 27. Total length 70.7 mm; standard length 58.5 mm; body depth 25.7 times, head length 20.2 times, dorsal fin base length 8.4 times and anal fin base length 12 times in standard length; eye diameter 67 times and snout length 22 times in head length. Infra-caudal luminous gland present.
Distribution: The spotted lanternfish *M. punctatum* is a mesoplegaic and nyctoepipelagic species most abundantly found in the depths between 700-800 m during the day and migrates up to 40-45 metres at night (Hulley 1986). *Myctophum punctatum* is the only species among the genus *Myctophum* that inhabits in the Mediterranean Sea. It is distributed both in the eastern and western parts of the Atlantic and is endemic to the Mediterranean Sea (Hulley 1986). The first record of *M. punctatum* in the Turkish waters of the Aegean Sea was given by Kaya (1993) and by Daban and İşmen (2020). The species was also recorded from the Levantine Sea and the Sea of Marmara by Erazi (1942).

Lophotidae Bonaparte, 1845
Lophotus Giorna, 1809
Lophotus lacepede Giorna, 1809
Material examined: Çanakkale [1 spc, TL: 650 mm]; off Babakale Cape, 329 m depth; 28 July 2017; Trawl; IUSHM 2018-1388 (Fig. 4a).
Identification: Body of the species is elongated and compressed and becomes pointed to the caudal fin. Head with an occipital crest which extends forward to the level of mouth or beyond. The dorsal fin is long-based and

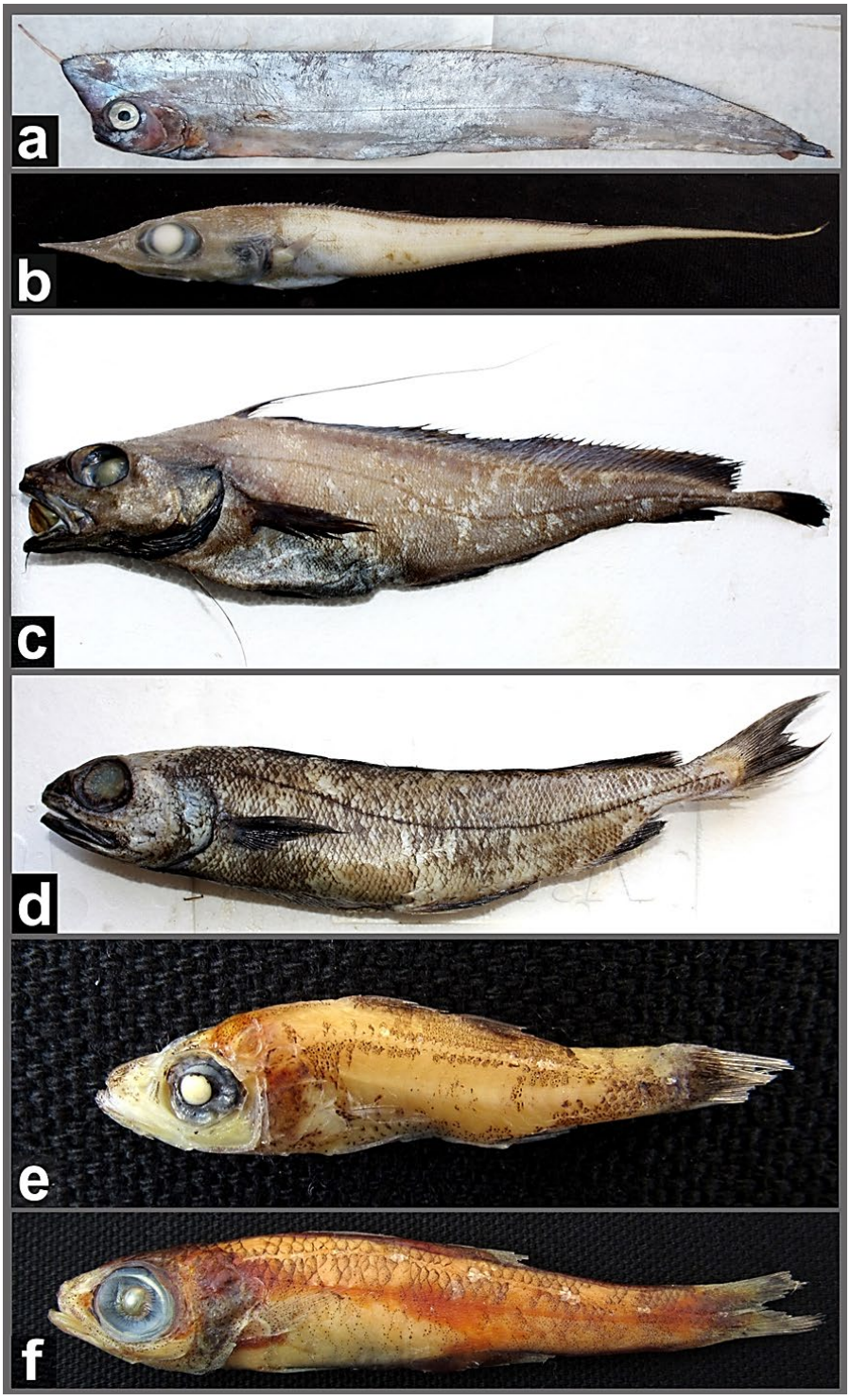

Figure 4. (a): *Lophotus lacepede* (TL 650 mm); (b): *Trachyrincus scabrus* (TL 156 mm); (c): *Lepidion lepidion* (TL 298 mm); (d): *Mora moro* (TL 372 mm); (e): *Epigonus constanciae* (TL 35 mm); (f): *Epigonus denticulatus* (TL 101 mm).

the anterior ray elongates. Pelvic fins of this species are very small with only 5 – 6 fin rays. The cycloid scales of *L. lacepede* are very thin and oblong. The lateral line is present with smooth plates (Palmer 1986). Dorsal fin longbased and low with 235 fin rays; anal fin rays 18; pectoral fin rays 14. Gill rakers 4 + 8. Standard length 650 mm; body depth 15.9 times, head length 12.3 times in standard length; eye diameter 33.2 times and snout length 31.3 times in head length.

Distribution: The family Lophotidae, also known as ribbon-like fishes, includes 4 species but only a single species inhabits in the Mediterranean Sea; *L. lacepede* (Quignard and Tomasini, 2000). *Lophotus lacepede* is a poorly known mesopelagic fish of the Mediterranean. According to Fischer et al. (1987), the species is found at depths of 1000 m and its maximum length can reach up to 1.80 meters (Palmer 1986). It was previously known from the western Mediterranean. The first record of *L. lacepede* in the Turkish waters was given by Bilecenoğlu et al. (2001) and Yapıcı (2019) from the Southern Aegean Sea. Also, Minos et al. (2015) reported the first record of the species in the Greek waters of the northern Aegean Sea. Consequently, the first record of the fish was given by Tuncer and Kanat (2019) from Turkish waters of the northern Aegean. This obtained specimen represents the second record of the species in the Turkish waters of the northern Aegean Sea and the fourth documented record in the Aegean Sea.

Macrouridae Bonaparte, 1831
Trachyrincinae Goode & Bean, 1896
Trachyrincus Giorna, 1809
Trachyrincus scabrus (Rafinesque, 1810)
Material examined: Çanakkale [1 spc, TL: 156 mm]; north of the Gökçeada Island; 40°17'24"- 40°17'06"N; 25°51'35"-25°50'35"E; 406 m depth; 08 Apr. 2017; Trawl; IUSHM 2017-1176 (Fig. 4b).
Identification: *Trachyrincus scabrus* is distinguished from its congenerics by the number of enlarged dorsal scales (23-42) and the absence of ventral scales before anus. The species is diagnosed by the following morphological features: head length about 32% of body length; snout long and pointed with a ridge on side which extends to operculum; eyes are large, covering 31% of head length. First dorsal fin is short with 11 fin rays and second dorsal fin begins close behind the first one and is longer than anal fin; pectoral fin with 21 fin rays. First dorsal fin rays 10; second dorsal fin rays 124 anal fin rays 105; pectoral fin rays 21. Total length 156.2 mm; standard length 153.9 mm; body depth 13.2 times, head length 32.7 times, first dorsal fin base length 5.6 times and anal fin base length 67.6 times in standard length; eye diameter 31.4 times and snout length 43.6 times in head length.
Distribution: The subfamily Trachyrincinae involves 6 species (Nelson et al. 2016) and 2 of them are found in the Mediterranean Sea. The rough snout grenadier, *T. scabrus,* is distributed in the Atlantic Ocean, northwards to the Irish continental shelf and also in the Mediterranean Sea (Geistdoerfer 1986). According to D'onghia et al. (2003), the distribution of the species shows the lowest abundance between 300 - 750 m depths in the Western Ionian Sea. In addition, D'onghia et al. (2004) indicated that the species is found at depths between 800 and 1200 m in the Balearic Sea. *T. scabrus* was reported by Kaya (1993) for the first time in the Turkish waters of the Aegean Sea. The second record of the species was given by Türetken (2009), from the area.

Moridae Moreau, 1881
Lepidion Swainson, 1838
Lepidion lepidion (Risso, 1810)
Material examined: Çanakkale [1 spc, TL: 298 mm]; West of the Gökçeada Island; 40°13'29"- 25°16'55"; 1480 m depth; 19 Sep. 2010; Baited trap; IUSHM 2017-1175 (Fig. 4c).
Identification*:* *L. lepidion* is diagnosed by the following morphological features: Posterior nostril located immediately anterior to eye; orbit diameter 3.1 times in head length. Second dorsal fin rays 54; anal fin rays 48 lateral line system on head with pit organs but no pores (Cohen 1986). First dorsal fin rays 4; second dorsal fin rays 54 anal fin rays 48; pectoral fin rays 23. Gill rakers 6 + 14. Body measurements of the species are as follows: Total length 298.1 mm; standard length 283.2 mm; body depth 21.6 times, head length 22.2 times, first

dorsal fin base length 2.8 times and anal fin base length 44 times in standard length; eye diameter and snout length 7.2 times in head length.

Distribution: The family Moridae, showing a circumglobal distribution, consists of 18 genera with 108 species. The Mediterranean codling, *L. lepidion*, is a benthopelagic member of the family Moridae, previously known in the northern-western Mediterranean Sea between the depths of 500 and 2230 m (Cohen 1986). Bilecenoğlu et al. (2014) reported the first record of this Mediterranean Sea endemic fish in Turkish waters of the northern Aegean Sea. Our report presents the deepest capture and the second record of the species in the Turkish waters.

Mora Risso, 1827

Mora moro (Risso, 1810)

Material examined Çanakkale [1 spc, TL: 372 mm]; northwest of the Gökçeada Island; 40°15'28"N - 25°30'46"E, 880 m depth; 05 Feb. 2011, Long line; IUSHM 2017-1178 (Fig. 4d).

Identification: The characteristic features of the species: eye diameter greater than snout length; first dorsal fin with 7 fin rays; second dorsal fin with 47 fin rays. Anal fin originates near mid length of the body and appear as two; first anal fin rays 7 second anal fin rays 47; pectoral fin rays 20; pelvic fin rays 5 and one of them is moderately elongated (but not reaching anal fin origin); ventral light organ absents. First dorsal fin rays 7; second dorsal fin rays 47; anal fin sometimes appearing as two; pectoral fin rays 20. Gill rakers 4 + 13. Body measurements of the species are as follows: Total length 372.3 mm; standard length 322.1 mm; body depth 20 times, head length 24.9 times, first dorsal fin base length 8.4 times and first anal fin base length 20 times in standard length; eye diameter 34 times and snout length 25 times in head length.

Distribution: *Mora moro* (Risso, 1810) is one of the four representatives of the family Moridae in the Aegean Sea and has few records from the Greek waters (Papaconstantinou 2014). It has an Atlanto-Mediterranean origin and it is known to be most common between 500 – 800 m, as it is seldomly found in the shallow littoral zone (Bilecenoğlu et al., 2002). From the Turkish waters, the only record of the species was given by Bilecenoğlu et al. (2002) from the Levantine coasts. The current study provides the second record of *M. moro* in the Turkish waters and the first record in the Turkish waters of the Aegean Sea.

Epigonidae Poey, 1861

Epigonus Rafinesque, 1810

Epigonus constanciae (Giglioli, 1880)

Material examined: Çanakkale · [1 spc, TL: 35 mm]; north of the Gökçeada Island; 40°17'54"- 40°17'47"N; 25°56'44"-25°55'40.14"E; 326 m depth; 13 Apr. 2016; Trawl; IUSHM 2018-1389 (Fig. 4e).

Identidication: The species is distinguished from its congeners by having a well ossified, pungent opercular spine (Tortonese 1986). Meristic characteristics of the species are as follows: first dorsal fin rays 7; second dorsal fin rays I + 9; anal fin rays II + 8; pectoral fin rays 17-18. Gill rakers 31 on first arch. Body measurements of the species are as follows: Total length 34.5 mm; standard length 29.1 mm; body depth 25.8 times, head length 28.5 times, first dorsal fin base length 12.4 times and first anal fin base length 11 times in standard length; eye diameter 47 times and snout length 40 times in head length.

Distribution: The genus *Epigonus*, also known as deep water cardinal fishes, are found in the continental and insular slopes and seamounts at depths from 75 to 3700 m (Paramo et al. 2017) and occur in all oceans from subantarctic to tropical latitudes (Krupp et al. 2009). While the genus consists of 36 species, three of them are known in the Mediterranean Sea; *E. constanciae, E. denticulatu*s and *E. telescopus,* (Nelson et al. 2016). *E. constanciae* mainly occurs on the upper parts of the continental slopes; most abundantly between the depths of 200-400 meters. It is frequently observed in the eastern Atlantic and the western Mediterranean (Froose and

Pauly 2018), and less frequently in the eastern Mediterranean (Mytilineou et al. 2005; Özaydın et al. 2007). This paper provides the second record of the species in the Turkish waters of the Aegean Sea.

Epigonus denticulatus Dieuzeide, 1950

Material examined: Çanakkale (1 spc, TL: 101 mm); north of the Gökçeada Island; 40°17'50"- 40°17'47"N; 25°53'46"-25°52'55"E; 401 m; 11 Nov. 2015; Trawl; IUSHM 2017-1177. (Fig. 4f).

Identification: The species is distinguished from *E. constanciae* by the lack of a fully ossified spine on the opercule and by the number of gill rakers on the first arch (Tortonese 1986). First dorsal fin rays 7; second dorsal fin rays I + 9; anal fin rays II + 8; pectoral fin rays 19-20. Gill rakers 30 on first arch. Total length 100.7 mm; standard length 87.2 mm; body depth 20.3 times, head length 23.9 times, first dorsal fin base length 14.1 times and first anal fin base length 7.6 times in standard length; eye diameter 54.3 times and snout length 27.9 times in head length.

Distribution: Among all three species which are widespread in the western Mediterranean and the eastern Atlantic, *Epigonus denticulatus* is the only cosmopolitan species within the genus (Ergüden et al. 2017). This bathydemersal species prefer the upper continental slope such as the other *Epigonus* species in the Mediterranean Sea. Two specimens of *E. denticulatus* have been reported recently as the first record of the northern Levantine Sea by Ergüden et al. (2017). Also, Fischer et al. (1987) mentioned the occurrence of *E. denticulatus* in the Aegean Sea but there has not been any confirmation up to date. This paper provides a confirmed record of the species in the Turkish waters of the Aegean Sea.

Conclusion

There are few areas in the Turkish waters that are suitable for deep zone investigations, and one of them is the northern Aegean Sea. A significant amount of deep sea research has been carried out in this area. Yet, there are very few comprehensive studies on its biodiversity (Labropoulou and Papaconstantinou 2000; Gönülal and Dalyan 2017). The present study contributes to the faunistic and biogeographic data on the northern Aegean Sea ichthyofauna. Finally, future research should ensure a better understanding of the biodiversity and correspondingly, the community structure of the deep zone of the northern Aegean Sea.

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Authors' Contributions

The all of authors performed fieldwork and analysed the data. CD and NBK identified the specimens, CD, OG and NBK took the photographs and wrote the manuscript. LE and SE revised and corrected the manuscript.

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