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RESEARCH ARTICLE

First Record of the Little Gulper Shark, *Centrophorus uyato* (Rafinesque, 1810), in the Turkish Marine Waters of the North Aegean Sea

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Abstract

Objective: Gulper sharks, are small to medium-sized benthopelagic deep-water sharks that occur worldwide along the outer continental shelves and upper continental and insular slopes. *Centrophorus uyato* (Rafinesque, 1810) is a rare species that has only been recorded twice in Turkish marine waters. Our study provides the first record of the species in the Turkish waters of the North Aegean Sea and the third record from the Turkish waters.

Materials and Methods: In April 2019, the male specimen of *C. uyato* was caught at 401 m with trawl commercial fish vessels. The little gulper shark, *C. uyato* was collected off the Gökçeada coasts, North Aegean Sea. Measurements of the caught specimen are provided and the geographical distribution of the *C. uyato* in the Mediterranean Sea is documented.

Results: The male specimen of *C. uyato* was caught off the coasts of Gökçeada. It was measured as 775 mm in total length and weighed 3040 g in total weight.

Conclusion: In the Turkish marine waters of the Mediterranean Sea, data on the species is lacking because it is hard to find the genus. Their K-selected life strategy makes them vulnerable, so in the Mediterranean region, they have a declining trend. Therefore, identifying the species across its distribution range is an important step for future conservation efforts.

Keywords: First Report, North Aegean Sea, Gökçeada, *Centrophorus uyato*, Centrophoridae

Introduction

Order Squaliformes comprise an abundant and diverse group of sharks specifically living in deep-sea marine environments (Compagno, 1984). This order contains six families: Centrophoridae, Dalatiidae, Etmopteridae, Oxynotidae, Somniosidae, and Squalidae (Straube *et al*., 2015).

In the Mediterranean Sea, the following species represent most of the deep-sea sharks; kitefin shark *Dalatias licha* (Bonnaterre, 1788) is a medium-sized (maximum total length: 1820 mm) (Springer, 1990) shark belonging to the family of Sleeper sharks, Dalatiidae. *D. licha* can usually be found at depths of 300 to 600 m (Compagno, 1984). The species has been recorded in the Aegean Sea (Kabasakal & Kabasakal, 2002; Kabasakal & Kabasakal, 2004; Turetken, 2009; Eronat & Ozaydin, 2014; Gonulal, 2016), Levantine Sea (Dalyan, 2012; Erguden *et al.,* 2017), Mediterranean Sea (Guven *et al*., 2012) and Marmara Sea (Meriç, 1995). Smaller in length (common length: 450 mm) (Compagno, 1984), the velvet belly lantern shark

Etmopterus spinax (Linnaeus, 1758) is a shark belonging to the family Etmopteridae. *E. spinax* can usually be found at depths of 200 and 600 m (Weigmann, 2016), recorded in the Aegean Sea (Meriç, 1994; Kabasakal & Kabasakal, 2004; Ismen *et al.*, 2007, 2009; Turetken, 2009; Bilge *et al.,* 2010, Eronat & Ozaydin, 2014; Gonulal, 2016, Öz & İşmen, 2017), Mediterranean Sea (Guven *et al*., 2012, Bayhan *et. al*., 2018, Akbora *et al*., 2020), and Levantine Sea (Dalyan, 2012; Başusta, 2016) and has shown a relatively stable population trend, however, continued research is required (Guallart *et al.,* 2016a). Another research-required shark is the little sleeper shark *Somniosus rostratus* (Risso, 1827) since it is classified as data deficient in the Mediterranean Sea (Guallart *et al.,* 2016b). *S. rostratus* is a medium-sized (maximum total length: 1430 mm) (Cox & Francis, 1997) shark belonging to the family of Sleeper sharks, Somniosidae. *S. rostratus* can be usually found at depths of 200 to 1330 m (Goren & Galil, 2015), and has only been recorded in the Aegean Sea (Irmak & Ozden, 2021). Information about records of these species in the Turkish Seas is presented in Table 1.

Family Centrophoridae, also known as the gulper sharks, are small to medium-sized benthopelagic deep-water sharks that occur worldwide along the outer continental shelves and upper continental and insular slopes (Compagno, 1984; Ebert & Winton, 2010; Kyne & Simpfendorfer, 2010). Centrophoridae contains two genera, *Centrophorus* (Müller & Henle, 1837) and *Deania* (Jordan & Snyder, 1902). Both genera have a complex taxonomic history. This identification problem is firstly due to poorly defined characteristics (Muñoz-Chápuli & Ramos, 1989). Secondly, sampling for these specimens is hard to find (White *et al*., 2008). In the Mediterranean Sea, only the genus *Centrophorus* can be found (Compagno, 1984; Ebert & Dando, 2021) and it is represented by *C. granulosus* (Bloch & Schneider, 1801) and *C. uyato* (Rafinesque, 1810). Both the gulper shark *C. granulosus* and the little gulper shark *C. uyato* can be found at depths of 50 to 1400 m (Compagno, 1984). *C. granulosus* has been recorded in the Aegean Sea (Ismen *et al*., 2009, Cengiz *et al*., 2011) Marmara Sea (Benli *et al*., 1993), and the Mediterranean Sea (Güven *et al*., 2012). The only records of *C. uyato* in Turkish waters are from the Marmara Sea (Meriç, 1995) and the Gulf of Antalya (Kabasakal *et al*., 2022). Both sharks have been included in several taxonomic checklists (e.g., Kabasakal, 2002; Bilecenoğlu *et al*., 2002; Papaconstantinou, 2014; Haroun *et al.,* 2017). However, recent molecular and morphometric studies have shown that the small-sized *Centrophorus* species could have been misidentified as *C. granulosus* (Kousteni *et al.*, 2021). This taxonomic issue dates back to 1906 (Garman, 1906) and has historically generated confusion over the identification of two species (White *et al*., 2013; Veríssimo *et al*., 2014).

Presently, the nomenclatural validity of *C. uyato* vs *C. granulosus* stays unsettled (White *et al*., 2013; Veríssimo *et al*., 2014; Serena *et al*., 2020). However, according to Compagno (1984) and White *et al*. (2013), these species can be specified by following the main characteristics: *C. uyato* is smaller in maximum total length (1100 mm) than *C. granulosus* (1700 mm); the denticles in *C. uyato* are flat while denticles in *C. granulosus* are flat with tear-drop shaped crowns that give the skin more granular composition; the free tip of the pectoral fin of *C. uyato* is not in line with the apex of the 1st dorsal fin whereas in *C. granulosus* they are in line. Therefore, we use the following characteristics of *C. uyato* until this taxonomical issue is resolved.

According to the IUCN Red List, (Finucci *et al.,* 2020) *C. uyato* is listed as Endangered (EN) which makes it important to protect the species. The purpose of this study is to provide the first record of the poorly known *C. uyato* from the Turkish waters of the North Aegean Sea and to make a contribution to the literature.

Materials and Methods

The North Aegean Sea has interactions with the Mediterranean and Marmara Seas, thereby northern parts of the sea show richness of nutrients via Dardanelles and Black Sea currents (Öztürk, 2009). Gökçeada, located in the North Aegean Sea (40°17’49.56”-40°17’47.40”N; 24°53’45.84”-25°52’54.60”E) and has a 92 kilometers coastline and is Turkey’s biggest island (Fig. 1).

A male specimen of *C. uyato* was caught at 401 m depth in April 2019 in 3.6 miles off the Gökçeada coasts

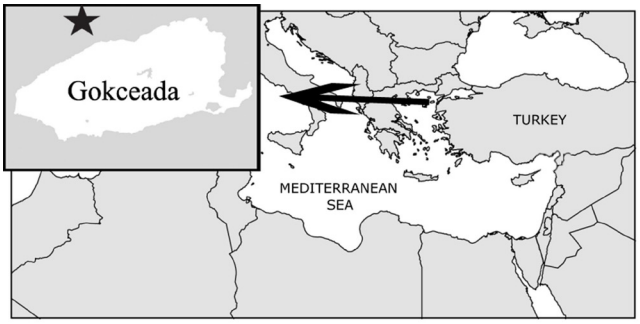

Figure 1. Map showing the coordinates of Gökçeada (40°17’49.56”-40°17’47.40”N; 24°53’45.84”-25°52’54.60”E).

(North Aegean Sea). Survey research is done with trawl commercial fish vessels. The necessary measurements were made in the laboratory, and the specimen was preserved in the freezer. All measurements and morphological features point to our specimen *C. uyato* (Fig. 2).

Figure 2. A male specimen of *C. uyato*, from Gökçeada, Turkey (TL. 775 mm).

C. granulosus; a black tip on dorsal fins and a second dorsal fin origin over the pelvic inner fin margin (Ebert & Dando, 2021).

The first two records of *C. uyato* in Turkish waters are from the Sea of Marmara (Meriç, 1995) and the Gulf of Antalya (Kabasakal, 2022) respectively. This paper provides the third record of *C. uyato* in Turkish waters and the first record of the species in the Turkish waters of the North Aegean Sea.

The taxonomic classification of *C. uyato* has been complicated throughout history (White *et al.*, 2013). Günther (1870) expanded the diagnosis of the genus *Centrophorus* to include six additional squaloid species,

Table 1. Records of Squaliformes deep water species in Turkey.

Familia	Species	Region	Depth Range	References
Centrophoridae	*Centrophorus granulosus*	Marmara Sea	-	(Benli *et al*., 1993)
Centrophoridae	*Centrophorus granulosus*	Aegean Sea (Saros Bay)	50-1400 m	(Cengiz *et al*., 2011)
Centrophoridae	*Centrophorus granulosus*	Aegean Sea (Saros Bay)	5-500 m	(Ismen *et al*., 2009)
Centrophoridae	*Centrophorus granulosus*	Levantine Sea (Antalya Bay)	200-800 m	(Güven *et al*., 2012)
Centrophoridae	*Centrophorus uyato*	Marmara Sea	-	(Meriç, 1995)
Centrophoridae	*Centrophorus uyato*	Levantine Sea (Antalya Bay)	140 m	(Kabasakal, 2022)
Dalatiidae	*Dalatias licha*	Aegean Sea (Gökçeada)	380 m	(Kabasakal, 2004)
Dalatiidae	*Dalatias licha*	Levantine Sea (İskenderun Bay)	40 m	(Ergüden, 2017)
Dalatiidae	*Dalatias licha*	Aegean Sea (Gökçeada)	500-800 m	(Gönülal, 2016)
Dalatiidae	*Dalatias licha*	Aegean Sea (İzmir and Sığacık Bay)	-	(Eronat & Özaydın, 2014)
Dalatiidae	*Dalatias licha*	Levantine Sea (Antalya Bay)	200-800 m	(Güven, 2012)
Dalatiidae	*Dalatias licha*	Marmara Sea	270 m	(Meriç, 1995)
Dalatiidae	*Dalatias licha*	Aegean Sea (Gökçeada)	380 m	(Kabasakal & Kabasakal, 2002)
Dalatiidae	*Dalatias licha*	Aegean Sea (Gökçeada)	-	(Türetken, 2009)
Dalatiidae	*Dalatias licha*	Levantine Sea (İskenderun Bay)	500-800 m	(Dalyan, 2012)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Gökçeada, Saroz Bay)	280 m	(Kabasakal, 2004)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Gökova Bay)	-	(Meriç, 1994)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Saros Bay)	5-500 m	(Ismen *et al*., 2009)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Saros Bay)	28-370 m	(Ismen *et al*., 2007)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Gökçeada)	500-1000 m	(Gönülal, 2016)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (İzmir and Sığacık Bay)	-	(Eronat & Özaydın, 2014)
Etmopteridae	*Etmopterus spinax*	Levantine Sea (Antalya Bay)	200-800 m	(Güven *et al*., 2012)
Etmopteridae	*Etmopterus spinax*	Levantine Sea (İskenderun Bay)	360-400 m	(Başusta, 2016)
Etmopteridae	*Etmopterus spinax*	Levantine Sea (Mersin Bay)	300-601 m	(Bayhan *et al*., 2018)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Gökçeada)	-	(Türetken, 2009)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Sığacık Bay)	200-600 m	(Bilge *et al*., 2010)
Etmopteridae	*Etmopterus spinax*	Levantine Sea (Northern Cyprus)	274-641	(Akbora *et al*., 2020)
Etmopteridae	*Etmopterus spinax*	Aegean Sea (Saros Bay)	200-500 m	(Öz, 2017)
Etmopteridae	*Etmopterus spinax*	Levantine Sea (İskenderun Bay)	500-800 m	(Dalyan, 2012)
Somniosidae	*Somniosus rostratus*	Aegean Sea (Muğla)	2500 m	(Irmak & Özden, 2021)

Results and Discussion

A male specimen of *C. uyato,* measuring 775 mm in total length and weighing 3040 g in total weight, was caught off the coasts of Gökçeada. All measured morphometrics characters indicated to *C. uyato* (Table 2). Besides, the little gulper shark shows different features than its congeneric as described by Barbosa du Bocage and de Brito Capello (1864). However, Garman (1906) argued that four distinct genera were involved, as originally designated by Barbosa du Bocage and de Brito Capello, and described two new species of *Centrophorus*. Garman also added *Squalus uyato* to the genus *Centrophorus*, in contrast to the previous classification by Müller and Henle (1839) and Bonaparte

Table 2. Morphometric measurements of male specimen of *C. uyato*, from Gökçeada.

Measurements mm	Present Specimen		Kabasakal (2022)		Kousteni *et al.* (2021)		Bellodi *et al.* (2022)	White *et al.* (2022)
	mm	% of TL	mm	% of TL (TL = 663 mm)	% of TL (TL= 522 mm)	% of TL (TL= 483 mm)	Mean values of body length measurements (mm)	% of TL (TL= 983 mm)
Pre-second dorsal-fin length (PD2)	550	70.98	431	65.01	63.51	63.69	69.72	64.6
Pre-first dorsal-fin length (PD1)	240	30.97	205	30.92	32.6	32.23	32.89	28.7
Head length (HDL)	170	21.93	150	22.62	24.82	23.82	21.93	22.5
Prebrancial length (PG1)	145	18.71	122.4	18.46	20.5	20.2	17.23	18.5
Prespiracular length (PSP)	85	10.97	86.9	13.11	14.66	14.1	-	12.1
Preorbital length (POB)	35	4.52	44.1	6.65	7.44	6.9	-	5.3
Prepectoral-fin length (PP1)	170	21.93	146	22.02	24.05	24.47	-	22.1
Prepelvic-fin length (PP2)	455	58.71	383	57.77	58.18	60.69	62.90	57.1
Interdorsal space (IDS)	205	26.45	161	24.28	20.27	20.04	31.28	23.2
Dorsal caudal-fin space (DCS)	55	7.10	53.5	8.07	7.89	6.9	-	6.4
Pectoral-fin pelvic-fin space (PPS)	260	33.55	211	31.83	28.49	29.82	-	31.3
Prenarial length (PRN)	30	3.87	21.5	3.24	4.7	4.29	-	3.7
Preoral length (POR)	70	9.03	63.7	9.61	10.33	9.29	-	9.5
Eye length (EYL)	40	5.16	31.6	4.77	6.3	6.54	-	5.3
Eye height (EYH)	20	2.58	15	2.26	1.73	1.77	-	1.4
Intergill length (ING)	25	3.22	34.1	5.14	4.32	3.62	-	-
First gill slit height (GS1)	20	2.58	13.8	2.08	1.82	1.8	-	-
Second gill slit height (GS2)	20	2.58	15.7	2.37	1.93	1.97	-	-
Third gill slit height (GS3)	20	2.58	18.1	2.73	2.07	2.07	-	-
Fourth gill slit height (GS4)	20	2.58	20.1	3.03	2.21	2.36	-	-
Fifth gill slit height (GS5)	30	3.87	20.2	3.05	2.38	2.57	-	-
Pectoral-fin anterior margin (P1A)	85	10.97	77.4	11.67	11.63	11.36	-	12.3
Pectoral-fin posterior margin (P1P)	85	10.97	59.7	9.00	10.46	10.53	-	-
Pectoral-fin height (P1H)	70	9.03	-	-	-	-	-	-
Pectoral-fin length (P1L)	115	14.84	-	-	-	-	-	-
Dorsal caudal-fin margin (CDM)	125	16.13	132.5	19.98	20.44	20.62	17.88	20.1
Preventral caudal-fin margin (CPV)	80	10.32	76.3	11.51	12.89	11.52	-	11.9
Subterminal caudal-fin margin (CST)	10	1.29	23.3	3.51	3.1	3.23	-	2.9
First dorsal-fin length (D1L)	120	15.48	119.2	17.98	17.39	16.7	-	19.0
First dorsal-fin anterior margin (D1A)	70	9.03	60.8	9.17	12.15	10.28	-	12.6
First dorsal-fin base (D1B)	75	9.68	69.4	10.47	11.54	11.49	-	13.5
First dorsal-fin height (D1H)	35	4.52	41.7	6.29	6.37	6.31	-	5.8
First dorsal-fin inner margin (D1I)	35	4.52	47.3	7.13	5.84	5.2	-	5.8
First dorsal-fin posterior margin (D1P)	70	9.03	64.7	9.76	8.68	8.31	-	9.3

Second dorsal-fin length (D2L)	70	9.03	75.4	11.37	12.36	12.69	-	12
Second dorsal-fin anterior margin (D2A)	50	6.45	45.9	6.92	9.23	9.13	-	8.6
Second dorsal-fin base (D2B)	40	5.16	42.9	6.47	8.1	8.53	-	8.3
Second dorsal-fin height (D2H)	30	3.87	32.9	4.96	3.86	4.28	-	4.7
Second dorsal-fin inner margin (D2I)	20	2.58	27.1	4.09	4.26	4.17	-	4.1
Second dorsal-fin posterior margin (D2P)	50	6. 45	43.6	6.58	6.36	5.44	-	6.3
Pelvic-fin length (P2L)	105	13.55	65.8	9.92	10.42	9.9	-	11.2
Pelvic-fin anterior margin (P2A)	55	7.10	40.7	6.14	6.52	6.71	-	-
Pelvic-fin base (P2B)	40	5.16	23.6	3.56	4.85	4.36	-	5.8
Pelvic-fin height (P2H)	35	4.52	-	-	-	-	-	-
Pelvic-fin inner margin (P2I)	75	9.68	49	7.39	5.84	5.86	-	5.8
Pelvic-fin posterior margin (P2P)	70	9.03	-	-	-	-	-	-
Head height (HDH)	90	11.61	150	22.62	24.82	23.82	21.93	22.5
Trunk height (TRH)	100	12.90	-	-	-	-	-	-
Abdomen height (ABH)	95	12.26	-	-	-	-	-	-
Tail height (TAH)	60	7.74	-	-	-	-	-	-
Caudal-fin peduncle height (CPH)	30	3.87	-	-	-	-	-	-
First dorsal-fin midpoint pectoral-fin insertion (DPI)	120	15.48	-	-	-	-	-	-
First dorsal-fin midpoint pelvic-fin origin (DPO)	165	21.29	-	-	-	-	-	-
Pelvic-fin midpoint first dorsal-fin insertion (PDI)	145	18.71	-	-	-	-	-	-
Pelvic-fin midpoint second dorsal-fin origin (PDO)	90	11.61	-	-	-	-	-	-
Mouth length (MOL)	10	1.29	-	-	-	-	-	-
Mouth width (MOW)	60	7.74	55	8.30	8.1	6.91	-	-
Upper labial-furrow length (ULA)	40	5.16	-	-	-	-	-	-
Lower labial-furrow length (LLA)	30	3.87	-	-	-	-	-	-
Nostril width (NOW)	55	7.10	-	-	-	-	-	-
Internarial space (INW)	30	3.87	-	-	-	-	-	-
Clasper outer length (CLO)	30	3.87	-	-	-	-	-	-
Clasper inner length (CLI)	86	11.10	-	-	-	-	-	-
Clasper base width (CLB)	10	1.29	-	-	-	-	-	-
Interorbital space (INO)	70	9.03	-	-	-	-	-	-
Spiracle length (SPL)	10	1.29	12.3	1.86	1.27	1.07	-	1.2
Eye spiracle space (ESL)	20	2.58	17.4	2.62	2	1.55	-	-
Head width (HDW)	90	11.61	-	-	-	-	-	-
Trunk width (TRW)	100	12.90	-	-	-	-	-	-
Abdomen width (ABW)	90	11.61	-	-	-	-	-	-
Tail width (TAW)	45	5.81	-	-	-	-	-	-
Caudal-fin peduncle width (CPW)	20	2.58	-	-	-	-	-	-

(1841). However, the original description and illustration of *S. uyato* by Rafinesque (1810) depict characteristics of a *Squalus* species rather than *Centrophorus*. Muñoz-Chápuli and Ramos (1989) also argued for the exclusion of *uyato* from the genus *Centrophorus*, while Böhlke (1984) regarded Bonaparte's treatment of *Spinax uyatus* as a new name proposal. It is clear that further investigations are needed to determine the validity of this classification.

A comprehensive synonymy analysis was conducted, revealing that *C. machiquensis*, *C. bragancae*, and *C. zeehaani* are junior synonyms of *C. uyato*. In order to maintain nomenclatural stability within the genus, the name *C. uyato* is retained for this species, with a neotype designated from the vicinity of the original type locality off Italy. (White *et al.*, 2013).

Further studies to clarify the taxonomic status of *C. uyato* are still being conducted (Bellodi *et al*., 2022, Kousteni *et al*., 2021, White *et al*., 2022). Bellodi *et al*. (2022) studied the genus through an integrated taxonomic approach including DNA sequencing and molecular analysis. Kousteni *et al*. (2021) provided the first record of *C. uyato* off the coast of Cyprus, examining both the mitochondrial and ribosomal DNA of the species. While White *et al*. (2022) focused more on detailed morphometric measurements providing a detailed synonym, aimed to persevere nomenclatural stability within the genus.

Deep sea habitats, characterized by their stability and isolation from human activity, provide a unique and fragile ecosystem that plays a vital role in the earth's biogeochemical processes (Ramirez-Llodra *et al*., 2010). These habitats are home to a diverse array of species, adapted to the extreme pressure and cold temperatures found at these depths. However, the long-life spans, slow growth rates, and low reproductive rates (Van Dover *et al.*, 2004) of deep-sea species make them particularly vulnerable to disturbances.

Information about these deep-sea sharks is still lacking (Simpfendorfer & Kyne, 2009; Pinte *et al*., 2020) even though they are apex predators (Heithaus *et al.,* 2008; Ferretti *et al*., 2010). It is known that sharks are, in general, slow-growing, late-maturing, and long-living beings (Musick, 1999) which potentially makes them vulnerable (Simpfendorfer & Kyne, 2009). This fact is not different for sharks that reside in the Mediterranean Sea since *D. licha*, *C. granulosus*, and *C. uyato* have shown a declining population trend.

The IUCN Red List assessment of the species for the Mediterranean Sea is as follows: *D. licha* is regarded as Vulnerable (VU), *E. spinax* is regarded as Least Concern (LC), *C. uyato* is regarded as Endangered (EN) while *C. granulosus* is categorized as Critically Endangered (CR). Although *S. rostratus* has been categorized as Least Concern (LC) globally, the Mediterranean population is considered Data Deficient (DD) for the species (Guallart *et al.*, 2016a; Finucci *et al.*, 2020).

The ongoing debate surrounding their definition and limited data availability regarding these endangered species in the Mediterranean highlights the precarious situation of these vulnerable animals. Accurately identifying the species across its distribution range may guide future conservation efforts by the IUCN to effectively protect their populations.

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