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RESEARCH ARTICLE

Determination of fish diversity in the northern coasts of Cyprus (eastern Mediterranean) by visual census method

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ABSTRACT

The present study aims to determine fish assemblages spreading between 0 and 40 m depth on the northern coasts of Cyprus. During the study, Underwater Observations (UO) have been conducted in 54 locations and photographed the fish species. The hourly imaging figures of the recorded species were determined by using the Time-Transect Method (TTM). Also, dominance Analysis (DA) and Incidence Frequency Analysis (IFA) of the identified species were performed. As a result, 72 different fish species belonging to 26 families were found to occur in the studied area. After the evaluation of identified species, 56 of them were determined as native species of the Mediterranean and 14 of them as Indo-Pacific origin. Additionally, we provide two new records (*Dasyatis chrysonota* and *Gobius fallax*) from Cyprus.

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Introduction

Cyprus, the third largest island in the Mediterranean Sea, is located in the Levantine Sea. It is one of the keystone areas of the biological invasions of the Mediterranean Sea due to its location which is very close to the Suez Canal, and being exposed to heavy ship traffic (Iglésias & Frotté, 2015). Recent studies on marine biodiversity are mainly concentrated on the southern coasts of Cyprus (Moullec et al., 2019). In contrast, there are only a few studies from the north coasts of Cyprus.

The Suez Canal which connects the Mediterranean and the Red Sea is one of the most important and effective transit lines in the world. The canal was opened in 1869 with the initiatives of French Diplomat and engineer Ferdinand de Lesseps. After that, constructing the Aswan Dam on the Nile River have been removed the geographical barriers between the Red Sea and the Mediterranean, and then some Indo-Pacific species started fluxing the Mediterranean via the Suez Canal. As a result of the expansion and extension works on the Suez Canal from 1956 to

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2010, at the present time, the channel length reaches 193.3 km, with a depth of 24 m. Also, the 2nd channel was put into operation in parallel with certain parts of the existing channel on August 6, 2015 (Ergüden & Turan, 2013).

Thanks to its high endemism, the Mediterranean has become a hotspot of marine bio-invasions (Mannino et al., 2017). Although there are limited invasions from the naturally occurring Gibraltar Strait in the Mediterranean, most of the biological invasions in the region are carried out through the Suez Canal, which was formed artificially (Galil et al., 2015). In addition to the species that pass through the canal to the Mediterranean Sea, species that are carried by fouling and ballast waters through intensive ship traffic have also accelerated this invasion.

Benli et al. (1999, 2003) conducted studies in 1997 and 2003 with the aim of contributing to the determination of macro biodiversity with its dispersal in the North Cyprus coastal zone. Biotopes resulting from interaction of living and non-living parameters were evaluated ecologically. In the first study, a total of 82 fish species were determined during a bottom trawl operation between the depths of 20 and 600 m (Benli et al., 1999) and 84 fish species were caught between the depths of 25-840 m (Benli et al., 2003).

An investigation was carried out between 1995 and 1996 by Torcu et al. (2001) for the determination of fish species living on the coasts of Northern Cyprus. In this study, 49 fish species belonging to 2 classes and 32 families were collected. Çiçek (2006) conducted a study using the underwater visual census (UVC) technique and photography in Northern Cyprus.

The first project to record the spread of the Red Sea immigrants of Cyprus was initiated in 1967 during a joint program (Biota of the Red Sea and the eastern Mediterranean) by the Smithsonian Institution. A total of 140 alien species were listed which are known to reach to the Mediterranean Sea via the Suez Canal (Steinitz, 1970). Katsanevakis et al. (2009) presented an updated inventory of alien marine species from the coastal and offshore waters of Cyprus based on a thorough compilation of existing information, and provided a baseline information on the current situation of the island. A survey carried out around Cyprus during September 2014 documented the occurrence of 25 alien fishes, increasing the number of recorded alien fishes to 35 (Iglésias & Frotté, 2015).

The aim of this study is to provide an up-to-date list of the native and non-native fish species on the northern coast of Cyprus and to provide the opportunity to the relevant scientist to determine changes about the fish fauna of eastern Mediterranean.

Material and Methods

The study area is located in the northern part of the Cyprus Island (Levantine Sea – Eastern Mediterranean) between Koruçam and Esentepe (Figure 1). The survey was carried out from 0 to 2 nautical miles to the land, between the depths of 0 - 40 m. using the Time-Transect Method (TTM). Between 07.11.2015 and 28.09.2016, data were collected by completing the underwater observations (UO) with devices for an average of 70 hours of dives at 54 stations on the Northern Cyprus coasts (Figure 2).

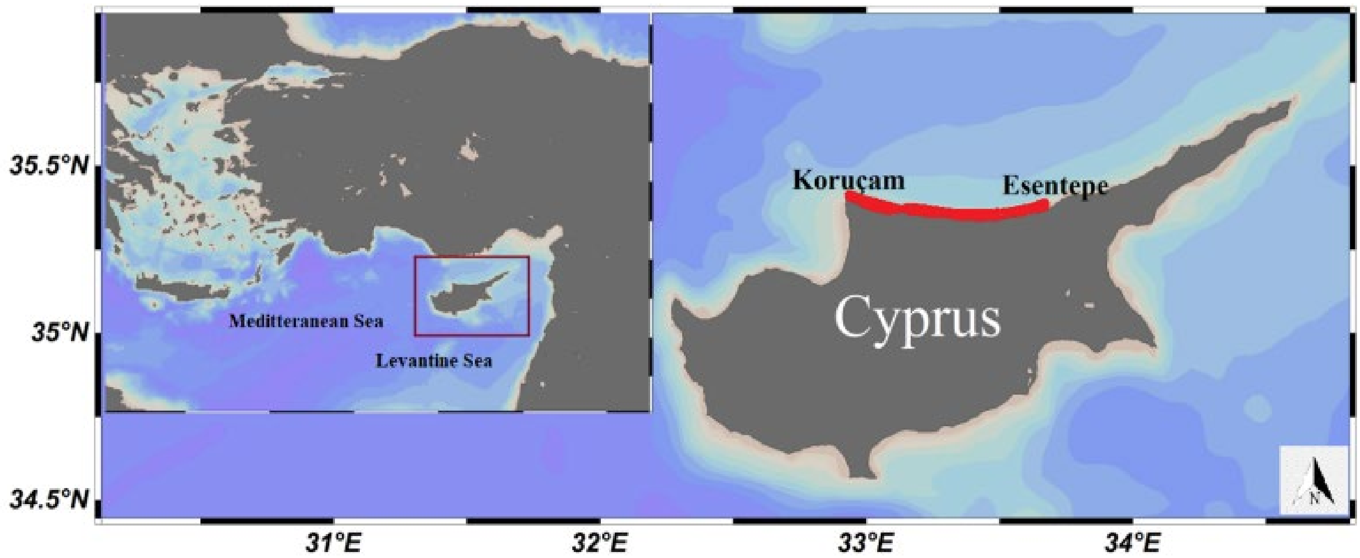

Figure 1. Study area

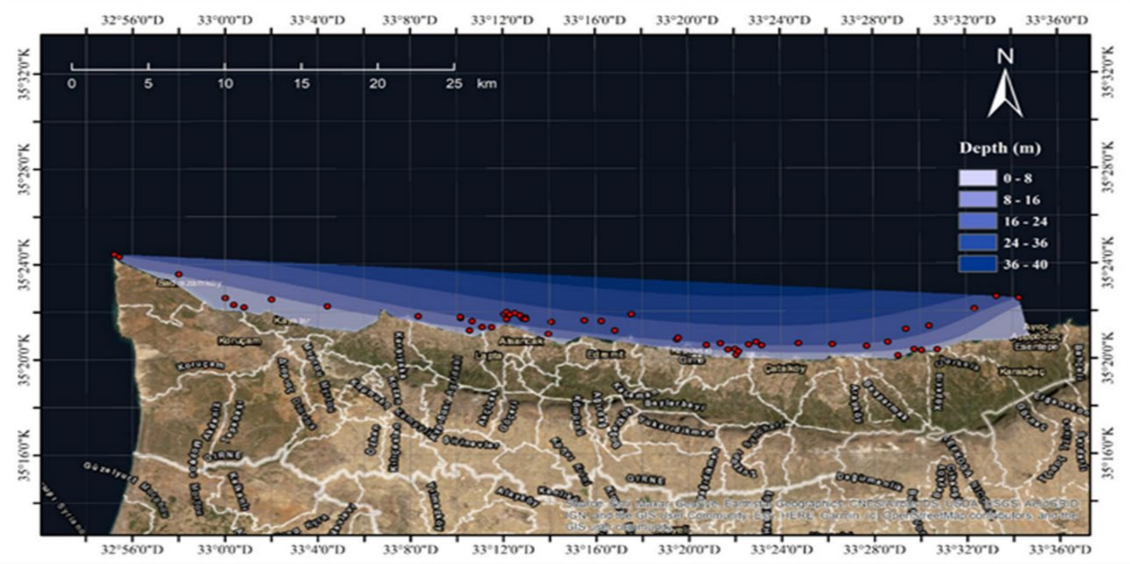

Figure 2. Sampling stations

The stations were determined according to the following items:

- Anthropological impact (the intensity of maritime traffic due to the presence of the harbour, the presence of a power plant, the supply of oil to the island from this point of the area and TRNC's hotels are out-numbered).
- The presence of underwater structures built to meet the water needs of the island in the study area.
- The distance of the mooring port of the boat to be used for field works to the stations.
- Sampling stations including areas where both anthropological effects are intense and not.

Special diving programs were formed for each sampling station. US NAVY and Deco 2000 dive tables were used for dive planning. The coordinates of the dives were determined using marine GPS or handheld GPS (Garmin GPSMAP 66s). And at every time, the first diving was performed around 10.00 and the second at 13.00. Table 1 provides detailed examinations conducted at the studied stations.

The shootings were performed by providing land and sea transportation to the pre-determined stations, divers were used the free diving and/or SCUBA diving method for shooting (Canon EOS Dd200 camera, Sea & Sea MDX-series housing, Sea & Sea YS-D2 J Flash and X-Adventurer 3000 Lumens and their components) and video-camera (Go–Pro Hero 3 and Go–Pro Hero 5) equipment.

Nevertheless, marine biodiversity based on UO are practically limited in terms of maximal depth and duration of diving because of physiological and technical constraints. In TTM using UO, the species recorded between the time when the underwater imaging starts and the time when the imaging ends are taken as basis. The aim was to complete the study without giving any damage to any of the habitats, using only imaging methods at the dive points in the designated stations. The field studies were based on the time-transect method following instruction by Engin et al. (2016). According to this method: descent from the surface and ascent to the surface times were subtracted from the total dive time. Number of individuals/species observed during a dive time was proportioned to an hour (60 min) (ind/hour). The abundances of each species were calculated at each station of the whole study area. After the dives, the images obtained were recorded digitally on a daily, weekly basis. The number of individuals in the stations and sight stations were recorded by analysing the obtained images. through the collected data, Imaging Frequency Analysis (IFA) and Dominance Analysis (DA) were performed. IFA is a method used to determine the incidence frequency of the detected species in different habitats. According to this method, it provides the expression of the observation frequency of the species percent (%) in the habitats (Kocataş, 1994). DA is a method used to determine the total ratio of individuals of a certain species to all the species determined (Kocataş, 1994).

The taxonomic classification of the species obtained from underwater imaging performed at the determined stations were based on Catalog of Fishes online database and validation of the scientific names of the species was done following Fricke et al. (2019).

Table 1. Study area station details (StN: Station Number; StCoo: Station Coordinates; BoT: Bottom time; ImT: Imaging time; DMax: Maximum depth; DAver: Average depth; BoStr: Bottom Structure; UnV: Underwater Vision; WT: Water Temperature)

Time	StN	StCoo	BoT (min)	ImT (min)	DMax (m)	DAver (m)	BoStr	UnV (m)	WT (°C)
7.11.2015	45	35°20’43.35” N 33°28’35.99” E	77	74	15.6	13	Sandy-Posidonia	12-15	24
7.11.2015	51	35°21’23.54” N 33°30’23.24” E	67	64	12.6	8.8	Sandy-Posidonia	10-12	24
8.11.2015	41	35°20’35.33” N 33°23’9.54” E	62	58	16.1	11.9	Rocky	10-13	24
14.11.2015	47	35°21’15.57” N 33°29’23.21” E	57	54	17.4	13.1	Posidonia	15-18	23
15.11.2015	12	35°21’14.26” N 33°10’33.27” E	87	85	4.1	2.1	Rocky-Posidonia	15-18	18
28.11.2015	35	35°20’24.88” N 33°21’42.10” E	43	41	37	25.3	Sandy-Posidonia	18-20	22
28.11.2015	36	35°20’26.19” N 33°22’0.23” E	67	65	7.8	5.7	Rocky	15-20	22
12.12.2015	49	35°20’23.97” N 33°30’44.61” E	-	-	Surface	Surface	Rocky-Posidonia	-	16
19.12.2015	48	35°20’21.97” N 33°30’3.39” E	-	-	Surface	Surface	Rocky-Posidonia	-	18
20.12.2015	15	35°21’22.26” N 33°11’30.61” E	57	55	7.6	4.3	Rocky-Posidonia	4-5	18
26.12.2015	15	35°21’22.26” N 33°11’30.61” E	68	66	11.2	5.8	Rocky-Posidonia	7-8	17
13.02.2015	46	35°20’9.01” N 33°29’2.61” E	23	21	4.2	2.9	Rocky-Posidonia	-	18
10.01.2016	50	35°20’24.43” N 33°29’44.30” E	57	55	5.3	2.1	Sandy	8-10	17
28.02.2016	37	35°20’12.00” N 33°22’3.08” E	76	74	6.4	2.8	Sandy-Rocky	5-7	17
2.04.2016	36	35°20’26.19” N 33°22’0.23” E	57	53	12.2	10.7	Rocky-Posidonia	8-10	18
2.04.2016	37	35°20’20.47” N 33°22’9.48” E	67	64	12.3	10.5	Rocky-Posidonia	8-10	19
3.04.2016	38	35°20’20.47” N 33°22’9.48” E	63	59	15.2	12.7	Rocky-Posidonia	8-10	19
3.04.2016	39	35°20’37.62” N 33°22’35.85” E	45	42	16.9	13.2	Rocky-Posidonia	8-10	18
3.04.2016	40	35°20’44.30” N 33°22’54.93” E	42	39	17.4	13.1	Rocky-Posidonia	8-10	18
16.04.2016	24	35°21’46.28” N 33°12’58.00” E	57	51	27.8	18.7	Rocky	12–15	20
16.04.2016	24	35°21’46.28” N 33°12’58.00” E	56	50	30.2	17.2	Rocky	12-15	21
17.04.2016	22	35°21’44.00” N 33°12’50.93” E	48	42	25.8	18.6	Rocky	12-15	20
23.04.2016	22	35°21’44.00” N 33°12’50.93” E	58	52	27.7	18.9	Rocky	8-10	20
24.04.2016	23	35°21’42.50” N 33°12’58.36” E	52	46	29.3	18.9	Rocky	7-8	21
24.04.2016	14	35°21’22.69” N 33°11’6.06” E	84	82	5.2	3.2	Rocky	10-12	20
30.04.2016	24	35°21’46.28” N 33°12’58.00” E	51	45	27.3	18.2	Rocky	-	-
30.04.2016	15	35°21’22.26” N 33°11’30.61” E	55	53	6.5	3.9	Rocky	5-8	21
1.05.2016	23	35°21’42.50” N 33°12’58.36” E	38	32	29	20.5	Rocky	8-10	22
1.05.2016	23	35°21’42.50” N 33°12’58.36” E	78	76	6.5	3.2	Rocky	8-10	21
4.06.2016	16	35°21’55.76” N 33°12’2.43” E	57	51	22.1	16.1	Rocky–Sandy-Posidonia	8-10	25
4.06.2016	26	35°21’35.80” N 33°14’4.77” E	62	59	13.6	9.7	Rocky-Posidonia	8-10	25
18.06.2016	16	35°21’55.76” N 33°12’2.43” E	52	46	21.8	14.2	Rocky–Sandy-Posidonia	12-14	26
18.06.2016	25	35°21’5.31” N 33°13’57.17” E	63	59	18	11.8	Rocky–Sandy-Posidonia	12-14	27
19.06.2016	23	35°21’42.50” N 33°12’58.36” E	43	37	31.4	19.6	Rocky-Posidonia	8-10	26
16.07.2016	27	35°21’39.22” N 33°15’30.69” E	47	41	23	16.3	Rocky–Sandy-Posidonia	8-10	29
16.07.2016	28	35°21’37.31” N 33°16’14.66” E	46	43	18.7	14.4	Rocky–Sandy-Posidonia	8-10	30
17.07.2016	29	35°21’13.51” N 33°16’49.28” E	47	41	28.9	20.2	Rocky–Sandy-Posidonia	6-8	26

Table 1. continued

Time	StN	StCoo	BoT (min)	ImT (min)	DMax (m)	DAver (m)	BoStr	UnV (m)	WT (°C)
17.07.2016	17	35°21'42.26" N 33°12'9.31" E	64	62	13.4	5.7	Rocky–Sandy-Posidonia	6-8	30
30.07.2016	21	35°21'52.51" N 33°12'43.34" E	46	40	28.6	18.7	Rocky-Posidonia	10-12	30
30.07.2016	17	35°21'42.26" N 33°12'9.31" E	77	75	3.8	2.5	Rocky-Sandy	10-12	30
31.07.2016	20	35°21'57.98" N 33°12'30.29" E	43	37	34.2	19.4	Rocky–Sandy-Posidonia	6-8	30
31.07.2016	14	35°21'22.69" N 33°11'6.06" E	54	51	19.2	15.8	Rocky–Sandy–Posidonia	6-8	30
6.08.2016	30	35°21'54.67" N 33°17'32.12" E	42	36	29.2	19.8	Posidonia	8-10	30
6.08.2016	15	35°21'22.26" N 33°11'30.61" E	65	59	20.9	15.5	Sandy-Posidonia	10-12	31
20.08.2016	34	35°20'40.85" N 33°21'22.80" E	57	52	19.5	13.5	Rocky–Sandy-Posidonia	10-12	33
20.08.2016	33	35°20'36.73" N 33°20'46.05" E	46	54	18.9	12.5	Rocky–Sandy-Posidonia	10-12	31
21.08.2016	53	35°22'37.35" N 33°33'18.13" E	75	43	20.5	7.4	Rocky–Sandy-Posidonia	10-12	30
21.08.2016	54	35°22'32.80" N 33°34'16.13" E	67	69	9.7	3.9	Rocky–Sandy-Posidonia	10-12	30
22.08.2016	18	35°22'0.37" N 33°12'9.59" E	54	64	25.6	17.4	Rocky–Sandy-Posidonia	12-15	30
22.08.2016*	19	35°21'54.04" N 33°12'17.13" E	62	48	24.8	16.9	Rocky	Night diving	30
23.08.2016	52	35°22'6.64" N 33°32'20.98" E	46	56	22.6	16.8	Rocky–Sandy-Posidonia	12-15	30
23.08.2016	44	35°20'33.41" N 33°27'41.26" E	52	40	22.6	13.4	Sandy-Posidonia	12-15	30
24.08.2016	31	35°20'50.68" N 33°19'29.96" E	59	46	30.6	18.4	Sandy-Posidonia	8-10	31
24.08.2016	32	35°20'54.85" N 33°19'33.35" E	43	53	19.6	14.6	Rocky–Sandy-Posidonia	10-12	33
25.08.2016	17	35°21'42.26" N 33°12'9.31" E	54	40	21.3	15.8	Rocky–Sandy-Posidonia	12-15	30
4.09.2016	43	35°20'38.20" N 33°26'12.64" E	47	48	30.8	20.2	Posidonia	10-12	30
4.09.2016	42	35°20'40.31" N 33°24'44.70" E	59	41	24.4	15.2	Posidonia	8-10	29
17.09.2016	11	35°21'45.60" N 33°10'10.14" E	48	53	24.9	19.3	Posidonia	8-10	28
17.09.2016	10	35°21'48.22" N 33°10'9.11" E	62	42	9.6	6.8	Posidonia	8-10	29
18.09.2016	13	35°21'37.51" N 33°10'39.58" E	54	59	27.3	19.4	Rocky-Posidonia	10-12	28
18.09.2016	9	35°21'50.36" N 33°8'20.40" E	73	48	8.4	4.1	Rocky–Sandy-Posidonia	10-12	30
26.09.2016	1	35°24'26.33" N 32°55'12.69" E	43	71	32.3	17.7	Sandy-Posidonia	10-15	28
26.09.2016	2	35°24'19.98" N 32°55'25.72" E	68	37	13.7	6.4	Rocky–Sandy-Posidonia	12-15	26
26.09.2016	3	35°23'35.92" N 32°58'0.18" E	59	65	6.8	2.3	Rocky–Sandy-Posidonia	12-15	26
27.09.2016	8	35°22'15.48" N 33°4'25.20" E	46	57	24.3	17.3	Sandy-Posidonia	10-12	26
27.09.2016	7	35°22'32.80" N 33°2'0.50" E	62	40	9.1	4.9.	Rocky–Sandy-Posidonia	12-15	27
28.09.2016	4	35°22'36.46" N 33°0'0.70" E	48	60	31.6	21.1	Sandy-Posidonia	10-12	27
28.09.2016	6	35°22'12.60" N 33°0'49.24" E	49	42	8.1	5.9	Rocky–Sandy-Posidonia	12-15	27
28.09.2016	5	35°22'19.36" N 33°0'22.74" E	46	47	7.8	4.9	Rocky–Sandy-Posidonia	12-15	27
19.08.2016	14	35°21'22.69" N 33°11'6.06" E	58	44	24.4	17.1	Sandy-Posidonia	6-8	30
10.12.2016	54	35°22'32.80" N 33°34'16.13" E	52	48	24.6	15.4	Rocky–Sandy-Posidonia	10-12	30
11.12.2016	15	35°21'22.26" N 33°11'30.61" E	68	66	11.4	7.8	Rocky	5-8	21

Note: *Night dive

Results

A total of 72 fish species belonging to 26 families has been identified at the sampled 54 stations. *D. chrysonota* and *D. pastinaca* were the cartilaginous fish species observed during the study. In detail, 56 species were determined as native species and 23% (13 species) of them were non-native species. As a result of this study, the list of the species observed in the stations and the total number of individuals sighted are showed in detail (Table 2).

When considered the minimum and maximum observed species according to biotopes, *C. chromis* was the most observed species in all biotopes except for Posidonia and Sandy-Rocky bottom type. *S. mediterraneus* (15 individuals) and *B. boops* (616 individuals) were mostly observed on sandy-rocky and *Posidonia* biotopes, respectively. In addition, the species mostly displayed in term of diving hours for all biotopes was *C. chromis*.

The results revealed that, aside from the species observed only once or twice during the whole field studies, other species were encountered 56 and 53 times during the 72 dives performed in 54 stations. The observed individuals in the stations were evaluated with the total observed species, the species living in schooling form and distributed in large areas showed dominant character in the dominance analysis. The frequency of observation was determined to be low and at a lower percentage, as a result of the dominance analysis made on the species that do not live in schools as expected. The IFA and DA results of the observed species are given in detail in Table 3.

In our study 14 non-native species (*A. forskalii*, *S. rubrum*, *F. commersonii*, *P. miles*, *P. forsskali*, *U. pori*, *P. vanicolensis*, *P. trispilus*, *T. pavo*, *O. petersii*, *S. luridus*, *S. rivulatus*, *S. diaspros* and *T. flavimaculosus*) were also observed. Considering these species according to the biotopes, more species were observed in the biotopes with hard ground. The numbers of native/ non-native species relative to biotopes, together with their trophic level, are given in Figure 3. Trophic levels were calculated for each species according to Fishbase (Froese & Pauly, 2000). Non-native species preferred living quarters in highly Sandy-local *Posidonia* biotopes. It is observed that the non-native species show similar distribution characteristics in the biotopes other than rock-sand (Figure 3).

First Records

During the dives made on the island of Cyprus; two new species have been reported with their detailed information given below.

Between the hours of 12:00 - 13:00 on December 11, 2016 in coordinates (35°22'37.35" N, 33°33'18.13" E), *G. fallax* (Figure 4) was observed in the SCUBA dive performed at 30°C at an average depth of 20 m. On December 10, 2016 between the hours of 15:00 - 16:00; in coordinates (35°22'32.80 "N, 33°34'16.13" E) *D. chrysonota* (Figure 5) was observed in the SCUBA dive performed at 30°C at an average depth of 15 m.

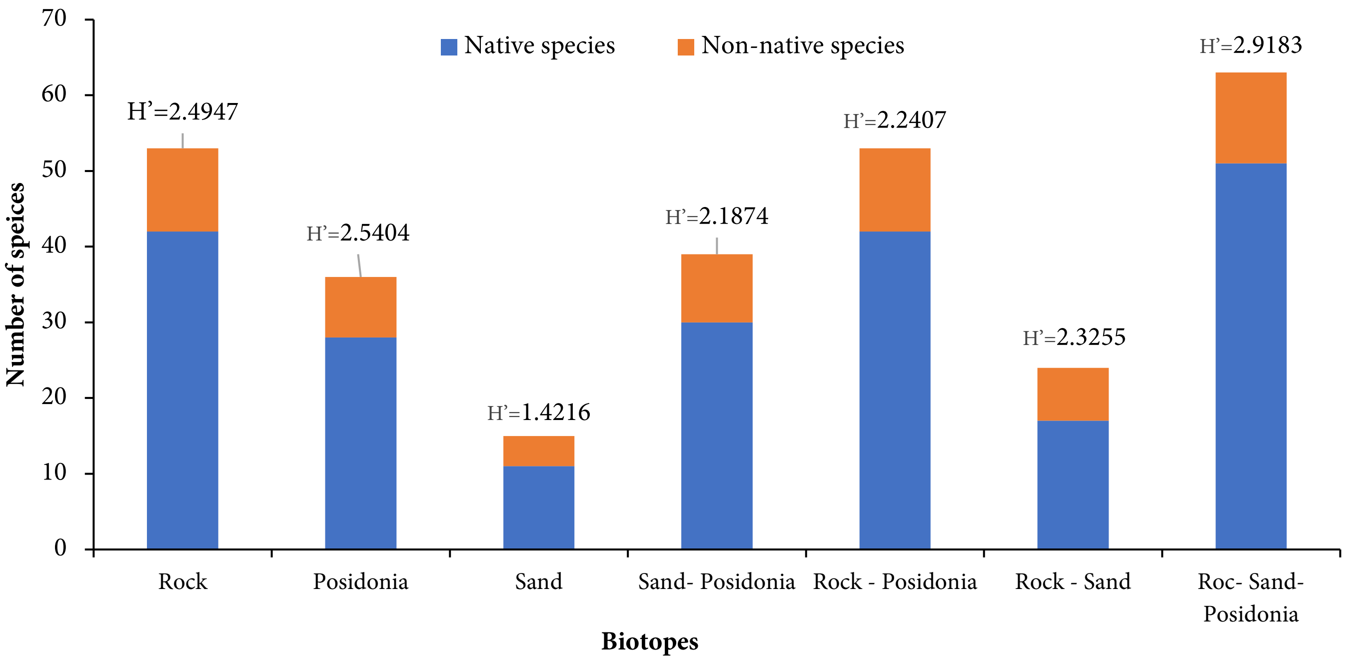

Figure 3. Number of native/lessepsian species according to biotopes with the Shannon diversity index value (H')

Table 2. The list of observed species in stations (TNIO: Total Number of Individuals Observed; DA: Dominance Analysis, NIS: Number of Imaging at the Station, IFA: Imaging Frequency Analysis, TL: Trophic Level, *: non-native species)

Species	Observed Stations	TNIO	DA%	NIS	IFA%	TL
Dasyatidae						
Dasyatis pastinaca	18,23	57	0.1	2	3.70	4.1
Dasyatis chrysonota	54	1	0.0	1	1.85	3,8
Muraenidae						
Gymnothorax unicolor	7,43,54	23	0.0	3	5.56	3.4
Muraena helena	10,20,44	74	0.2	3	5.56	4.2
Atherinidae						
*Atherinomorus forskalii**	9,11,12,14,15,17,18,23,25,30,35,45	3199	6.4	13	24.07	3.3
Holocentridae						
*Sargocentron rubrum**	2,7,10,16,19,21,22,23,24,27,29,30,32,33,36,38,39,41,43,54	1753	3.5	20	37.04	3.6
Fistulariidae						
*Fistularia commersonii**	2,15,16,19,23,33	169	0.3	6	11.11	4.3
Scorpaenidae						
**Pterois miles*	16,19,21	112	0.2	3	5.56	3.7
Scorpaena maderensis	2,7,21,54	171	0.3	4	7.41	4.1
Scorpaena scrofa	2,19,24,44	54	0.1	4	7.41	4.3
Serranidae						
Epinephelus aeneus	8,13,14,15,20,22,31,36,37,38	19	0.0	10	18.52	4.0
Epinephelus caninus	14,22,23,24,26	89	0.2	5	9.26	3.8
Epinephelus costae (Steindachner, 1878)	14,19,21,24,27,33,40,41,44,53	496	1.0	16	29.63	3.9
Epinephelus marginatus	4,5,8,10,14,16,17,20,27,31,33,41 ,54	441	0.9	19	35.19	4.4
Mycteroperca rubra	16,21,22,23,27	182	0.4	5	9.26	4.1
Serranus cabrilla	6,10,15,16,19,20,23,24,29,32,34,37,39,42,43,44,47,50,54	328	0.7	19	35.19	3.4
Serranus scriba	2,6,7,9,10,12,15,16,19,24,27,29,30,32,33,36,39,41,42,43,45,47,54	282	0.6	29	53.70	3.8
Apogonidae						
Apogon imberbis	3,5,8,9,10,14,15,17,19,22,23,27,31,32,33,38,39,41,43,44,53,54	468	1.0	22	40.74	3.4
Echeneidae						
Echeneis naucrates	23,36	8	0.0	2	3.70	3.7
Carangidae						
Caranx crysos	19,21,27,36,52	245	0.5	42	77.78	4.1
Pseudocaranx dentex	2,6,21,36,38	41	0.1	5	9.26	3.9
Trachinotus ovatus	2,6,7,22,23,24,36,43	36	0.1	6	11.11	3.7
Sparidae						
Boops boops	4,5,9,11,15,17,22,23,30,34,35,45 ,47,51	1580	3.2	14	25.93	2.8
Dentex dentex	22,23,30,42	28	0.1	4	7.41	4.5
Diplodus annularis	4,5,9,12,14,15,17,28,34,42,47,50	100	0.2	14	25.93	3.6
Diplodus puntazzo	1,8,14,15,22,23,52	32	0.1	7	12.96	3.2
Diplodus sargus	3,4,5,9,12,14,17,21,25,27,36,37,38 ,50	318	0.6	21	38.89	3.4
Diplodus vulgaris	1,3,4,5,8,10,14,15,16,17,20,22,23,24,26,32,33,36,37,39, 43,44,52	991	2.0	23	42.59	3.5
Lithognathus mormyrus	6,7,44	20	0.0	3	5.56	3.4
Oblada melanura	2,6,7,9,10,12,15,16,21,23,24,27,29,33,34,36,37,39,42,47,50,54	846	1.7	22	40.74	3.4
Pagellus bogaraveo	2,9,19,22,23,32,41	45	0.1	7	12.96	4.2
Sarpa salpa	2,6,7,9,10,12,23,44,50	395	0.8	9	16.67	2.0
Centracanthidae						
Spicara maena	7,9,10,15,16,22,23,24,29,41,42,47	841	1.7	12	22.22	4.2
Sciaenidae						
Spicara smaris	7,9,10,15,16,20,24,27,29,41,42,45 ,47	962	2.0	16	29.63	3.0
Sciaena umbra	15,21,22,35,44	90	0.3	5	9.26	3.8

Table 2. continued

Species	Observed Stations	TNIO	DA%	NIS	IFA%	TL
Mullidae						
Mullus barbatus	27,42,43	74	0.2	13	24.07	3.1
Mullus surmuletus	2,7,9,10,12,15,16,21,23,29,32,33 ,43	262	0.7	3	5.56	3.5
*Parupeneus forsskali**	2,6,10,21,33	72	0.1	5	9.26	3.5
*Upeneus pori**	10,15,23,27,44	169	0.3	5	9.26	3.5
Pempheridae						
*Pempheris vanicolensis**	2,9,15,44,50,54	445	0.9	6	11.11	3.5
Pomacentridae						
Chromis chromis	4,5,6,8,11,13,19,21,28,30,33,35,45 ,47,50,51,53	17703	37.7	43	79.63	3.8
Mugilidae						
Mugil cephalus	12,22,32	97	0.2	3	5.56	2.5
Labridae						
Coris julis	1,3,4,5,7,19,22,24,30,32,45,47,51 ,53 ,54	1293	2.6	5	9.26	3.4
Labrus mixtus	6,16,22,23,24	73	0.1	3	5.56	3.9
Labrus viridis	16,24,29	110	0.2	5	9.26	3.9
*Pteragogus trispilus**	15,23,29,30,34,36,45,47	11	0.0	8	14.81	3.4
Symphodus doderleini	6,7,10,12,15,19,23,24,32,35,36,38 ,47,50	127	0.3	14	25.93	3.4
Symphodus mediterraneus	2,5,6,7,9,10,15,16,19,21,24,27,29,32,33,36,39,41,43,45,47	621	1.3	25	46.30	3.2
Symphodus ocellatus	2,6,10,15,16,23,24,32,33,36,42,44 ,45,54	140	0.3	14	25.93	3.5
Symphodus roissali	7,12,19,21,23,24	202	0.4	6	11.11	3.5
Symphodus rostratus	2,6,9,12,15,16,23,24,36,41,42,47	60	0.1	12	22.22	3.5
Symphodus tinca	2,6,7,12,15,16,21,23,24,29,30,32,33,36,39,54	294	0.6	16	29.63	3.3
*Thalassoma pavo**	2,5,6,7,9,10,12,15,16,19,24,27,29,32,33,35,39,41,43,47,50	1684	3.4	28	51.85	3.5
Xyrichtys novacula	2,9,44,54	135	0.3	4	7.41	3.5
Scaridae						
Sparisoma cretense	2,6,7,9,10,12,14,15,16,19,24,27,29,30,32,33,36,39,42,43,44,50,54	2130	4.3	29	53.70	2.9
Tripterygiidae						
Tripterygion delaisi	22,23,24,36,43	104	0.2	5	9.26	3.4
Tripterygion melanurus	2,7,9,29,54	89	0.2	5	9.26	3.5
Tripterygion tripteronotus	6,10,16,20,33,43,50	93	0.2	7	12.96	3.4
Blenniidae						
Parablennius gattorugine	12,15,33	18	0.0	3	5.56	3.6
Parablennius rouxi	16,33	22	0.0	2	3.70	3.0
Gobiidae						
Gobius bucchichi	2,6,10,16,22,24,32,43,44,47,50,54	153	0.3	12	22.22	3.1
Gobius fallax	15	3	0.0	1	1.85	3.3
Gobius geniporus	2,7,9,10,15,21,22,24,33,36,37,38 ,47 ,50,54	212	0.4	15	27.78	3.3
Gobius paganellus	24	15	0.0	1	1.85	3.3
Gobius xanthocephalus	54	2	0.0	1	1.85	3.2
Gobius vittatus	33	2	0.0	1	1.85	2.9
*Oxyurichthys petersii**	6,24,32,44	39	0.1	4	7.41	3.7
Siganidae						
*Siganus luridus**	2,6,7,10,12,15,16,19,24,32,33,36 ,42 ,50,54	1913	3.8	19	35.19	2.0
*Siganus rivulatus**	2,6,7,9,10,12,15,16,19,24,27,32,33 ,36,39,42,43,44,50,54	6032	12.1	26	48.15	2.0
Balistidae						
Balistes capriscus	16,22,52	117	0.2	3	5.56	4.1
Monacanthidae						
*Stephanolepis diaspros**	19,21,22,27	231	0.5	4	7.41	2.8
Tetraodontidae						
*Torquigener flavimaculosus**	10,15,27,43,44	93	0.2	7	12.96	3.3

Figure 4. First record of *Gobius fallax* Sarato, 1889 in Cyprus

Figure 5. First record of *Dasyatis chrysonota* (Smith, 1828) in Cyprus

Discussion

In the study, UO method was performed in order to determine the fish species distributed from 0 to 2 miles, in the northern part of Cyprus Island. The UO method has advantages and disadvantages over other sampling methods. The method can provide detailed information about the biotope diversity of the studied region and these biotopes. Unlike the other methods (trawl, resistance and other fishing tools), the UO method allows us to make samples without giving any harm to the area. One more advantage is that hard substrata is difficult to sample by trawling or nets, and easier by UO. The UO method also allows us to have detailed information about the behaviours of the studied animals/organisms inhabiting the study area; it may be asserted that these are the most advantageous characteristics of the used method when compared to other methodologies. Considering the disadvantages of the UO method, it may be described as the limitation in the study area and working depth when compared to other sampling methods. The area and depth scanned with trawl and similar catching vehicles is incomparably large. In the studies carried out with such tools it is possible to perform sampling in much larger areas in a shorter period of time. Field surveys carried out by UO method may not be performed for various reasons (unsuitable weather conditions, sampling depth, etc.). Although the ratio of the imaging of species living in the coastal zone is high with the UO method, it remains insufficient in the detection of cryptic species. The UO method allows the identification of morphologically similar species at the genus level since the method is under the control of the individual performing the sample. Despite the disadvantages of the UO method, it is the one mostly used on biological inventory studies in the Mediterranean (Harmelin, 1987; Garcia & Zabala, 1990; Harmelin et al., 1995; Marconato et al., 1996; Borg et al., 1997; Fasola et al., 1997; Charton & Ruzafa, 1998; Mazzoldi & Girolamo, 1998; Vacchi & La Mesa, 1999; Condal et al., 2012). The UO method used in our study was applied to heterogeneous substrata. These substrata were categorized as Sandy-local *Posidonia,* Sandy, Sandy - Rocky, Rocky-*Posidonia*, Rocky, *Posidonia,* Rocky – Sandy -*Posidonia* and Sandy - *Posidonia*. O. petersii was reported frequently between 1982 and 2021 in the eastern Mediterranean region (Langeneck et al., 2022). In our study, in April, August and September 2016; it was recorded in 5 different dives in 4 different regions during dives between 6 - 30 m. D. pastinaca was observed multiple times from the coastal waters of Cyprus between 2015 and 2019 (Giovos et al., 2021). In our study, in April, May, June and August 2016; it was recorded 5 times during dives between 3 - 32 m in April, May, June and August. considering Mediterranean records of P. forsskali, it was recorded 5 times from 2014 to 2018 in South Cyprus and North West region of Cyprus Island (Evagelopoulos et al., 2020). In our study, in July, August and September 2016; it was recorded during dives between 6 - 19 m in 5 different regions. Çiçek (2006) determined a total of 83 fish species 37 different biotope types using the same method. the study was performed with, 400 SCUBA dives and snorkelling, at 31 stations along 70 km of coastline. Field research was conducted between July 2002 and July 2005. In addition, seven lessepsian fish migrant are reported in this study (*A. nigripinnis, F. commersonii, S.rubrum, S. luridus, S. rivulatus, S. diaspros* and *P. vanicolensis*). We observed all of these non-native fish species in our study except for *A. nigripinnis*. In order to determine the diversity of fish in the same region, Benli et al. (1999) identified a total of 82 fish species by using bottom trawl between 20 and 600 m depth. Also, a survey continuation of this study conducted by Benli et al. (2003) documented the occurrence of 84 fish species between 25-840 m depth. Torcu et al. (2001) conducted a study between the years 1995 and 1996. They determined a total of 49 fish species belonging to two classes and 32 families. *P. vanicolensis* which is a lessepsian immigrant is a new record for Northern Cyprus. Sampling in trawl studies can be carried out down to a depth of 840 m even though the field studies carried out with UO method are limited to 42 m so, when compared to the other studies, there are significant differences in depths. Although this the results are parallel to each other. The limited scientific activities on the coasts of the island of Cyprus, impose restrictions on the comparison of our available data. Benli et al. (1999, 2003) studies may be shown as a milestone of the scientific activities carried out in the Cyprus Island. Due to the prohibition of trawling and seine-haul fishing in the territorial waters of Northern Cyprus, the identification of alien species entering the region remains insufficient. Levant Basin, in which Cyprus Island is located, is considered as a species poor region due to its oligotrophy, high salinity and high sea water temperature. The deepening and widening studies carried out in the Suez Canal and the increasing shipping have gradually been increasing the number of alien species entering the Mediterranean (Galil et al., 2015). For these reasons, it is necessary to keep the current biodiversity inventory up to date the biodiversity inventory of systematic taxa performed in the region. Consequently, it would be more accurate to carry out these monitoring by using different methods in simultaneous to determine the biological diversity of the marine ecosystems.

Conclusion

In conclusion, due to the aforementioned reasons, it is necessary to keep the current biodiversity inventory date the biodiversity inventory of systematic taxa performed in the region. However, it would be more accurate to carry out these monitoring by using different methods simultaneously to determine the biological diversity of the marine ecosystems considering each fish species has a different distribution area and characteristic.

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Compliance With Ethical Standards

Authors' Contributions

FY, AT: Designed the study.
FY: Wrote the first draft of the manuscript.
FY: Carried out the proposal studies of the study.
AT: Directed the thesis in which the study was carried out.
FY, AT: Performed and managed statistical analyses.
Both authors read and approved the final manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

Data Availability Statements

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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