Online ISSN: 2588-3526
Journal of Wildlife and Biodiversity
DOI: 10.22120/jwb.2020.123579.1127
Special issue 6-12 (2020)
Challenges for Biodiversity and Conservation in the Mediterranean Region
(http://www.wildlife-biodiversity.com/)
Research Article

Distribution of vermetid reefs on the northern shores of Cyprus Island

Mehmet Fatih Huseyinoglu[1,2*], Gokhan Tari[1,2], Volkan Demir[3], Yaprak Arda[4], Mehmet Baki Yokes[5]

[1]Faculty of Maritime Studies, University of Kyrenia, Girne, Cyprus
[2]Biosphere Research Center, Istanbul, Turkey
[3]Glenelg Marine Research and Technology Center, Adelaide, Australia
[4]WWF-Turkey, Istanbul, Turkey
[5]AMBRD Research Center, Istanbul, Turkey
*Email: mehmetfatih.huseyinoglu@kyrenia.edu.tr

Received: 12 May 2020 / Revised: 13 June 2020 / Accepted: 17 June 2020 / Published online: 08 August 2020. Ministry of Sciences, Research, and Technology, Arak University, Iran.

Abstract
Vermetid reefs are among the very few reef-forming bio-constructions in the entire Mediterranean, supporting rich biodiversity and ecosystem services. Furthermore, they prevent coastal erosion, modulate the transportation of sediments, and act as carbon sinks. Since they build upon the formal reef builder organisms' fossilized skeletons, they are also invaluable assets to study some parameters of paleoclimatology. However, information about their basic features, distribution, and floral and faunal information is not sufficient. Between 2017 and 2019, a study demonstrated the distributions of the vermetid reefs, biodiversity investigation on selected reefs, and some livelihood evaluation was realized in the 200 km northern coastline of Cyprus. This paper demonstrates the distribution of the reefs with a fish biodiversity analysis recognized by the visual census.

Keywords: Biodiversity, GPS, vermetid reef

Introduction
Vermetid reefs are biological constructions by two species; a sessile marine gastropod, *Dendropoma (Novastoa) petraeum* (Monterosato, 1892), and the red algae *Neogoniolithon brassica-florida* ((Harvey) Setchell & Mason, 1943) common in the Southern Mediterranean coasts (Chemello 2009). In the Mediterranean, they can be found in latitudes with winter surface temperatures higher than 14^0C (Chemello and Silenzi 2011). Rugosity and structural rigidity of the reef bio-constructions are usually accompanied by the complexity of brown and red algae species, making them an extremely suitable habitat for many smaller species belonging to a variety of taxa, thus, creating a unique rich ecosystem. Vermetid reef developments can only be found in the lower mesolittoral and upper infralittoral sections on rocky coasts with increased exposition to wave activity, making them functionally similar to tropical fringing coral reefs (Milazzo *et al*. 2014). They are known to exist from the Middle Miocene epoch to the present, through an evolution of two different reef-building genera: while *Petaloconchus* was the major component of vermetid reefs until the Holocene, it was replaced by *Dendropoma* almost completely for reasons still unknown. Since $CaCO_3$ shells of *D. petraeum* and the

surrounding seawater are in isotopic equilibrium, the reefs are extensively used in paleoclimatology for the measurements of physical oceanographic parameters such as sea-level associated with the intertidal or immediate subtidal zone (Vescogni *et al*. 2008). Moreover, vermetid reefs prevent chemical and physical coastal erosion and the contribution of bioeroding species like grazers, micro, and macroborers. They also modulate sediment transport and act as carbon sinks (Milazzo *et al*. 2016).

An extensive abundance of vermetid reef formations of various sizes is found to be present in the northern shores of Cyprus island in the Eastern Mediterranean during this study, which revealed the locations of the reefs on the northern coast covering from East to West of almost all the island, and vitality of some selected reefs were evaluated. This paper aims to present the distribution of the vermetid reefs in the region without a thorough evaluation of the aliveness of *D. petraeum*, and to demonstrate fish biodiversity investigation on selected reefs by visual census method.

Material and methods

The study area covers more than 200 kilometers of coastline on the Northern shores of Cyprus island (Fig. 1). In 2017, the northern shores of the island were divided into 14 sections. Groups of two to three people instructed on vermetid reefs were assigned to each specific section, and they walked the shores. They took the reefs pictures they came across and recorded the coordinates with the free mobile phone application, "MyGPSCoordinates." However, it must be noted that some sections of the coastline were not accessible by walking, and those parts are not could not be evaluated. In situations where authors were doubtful about any of the reef pictures (Fig. 2), they visited the validation sites.

During the second leg of the project, the presence of the great abundance of vermetid reefs along the northern coast was confirmed. The livelihood of the vermetid reefs at the tip of the Rizokarpaso peninsula was evaluated by the visual census method.

Underwater visual census methods are scientifically based on in-situ visual counts of marine species. These methods can be designed in a variety of ways, and the most common of which is by either snorkeling or scuba diving conducted by specially trained researchers. A total of 4 scubas and two freediving sessions were carried out in the vermetid reefs at the tip of the Rizokarpaso peninsula. Two scientific divers on each group logged the data by swimming through a 300m transect line. Obtained data were noted on the tablets suitable for writing underwater. After each dive, all groups were gathered to write down a report based on the data collected underwater.

In this project, ESRI ArcGIS software was utilized for visualization and spatial data analysis and to specify geographic patterns in the distribution of abundance, subject to further statistical analyses. Marine categorization data was collected during the fieldwork following the Standard Data Format developed within the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean, an annex of the Barcelona Convention. The biodiversity database was prepared in a .mdb file format in the M.S. Access environment.

The abundance and range of the vermetid reef formations were shown on detailed maps suited to the ArcGIS 10.2 software during the fieldwork. For visualization purposes, reefs were mapped and interpolated to a grid surface of 20 seconds latitude x 20 seconds longitude cells with 30 meters depth contour. Raster data were transferred from Google Earth with KML format. Storing information on a layer basis with individual or collective manner is the critical process of illustrating spatial information of vermetid reefs. These layers have been produced in ArcGIS to identify the locations of the reefs. The last output data are shown on the Google Earth layer in ArcGIS.

Results

Locations for the vermetid reef formations are

given (Figs. 3-6). Since the study area is more than a 200 km patch distributed along East to West, the map is divided into four sections for visualization convenience.

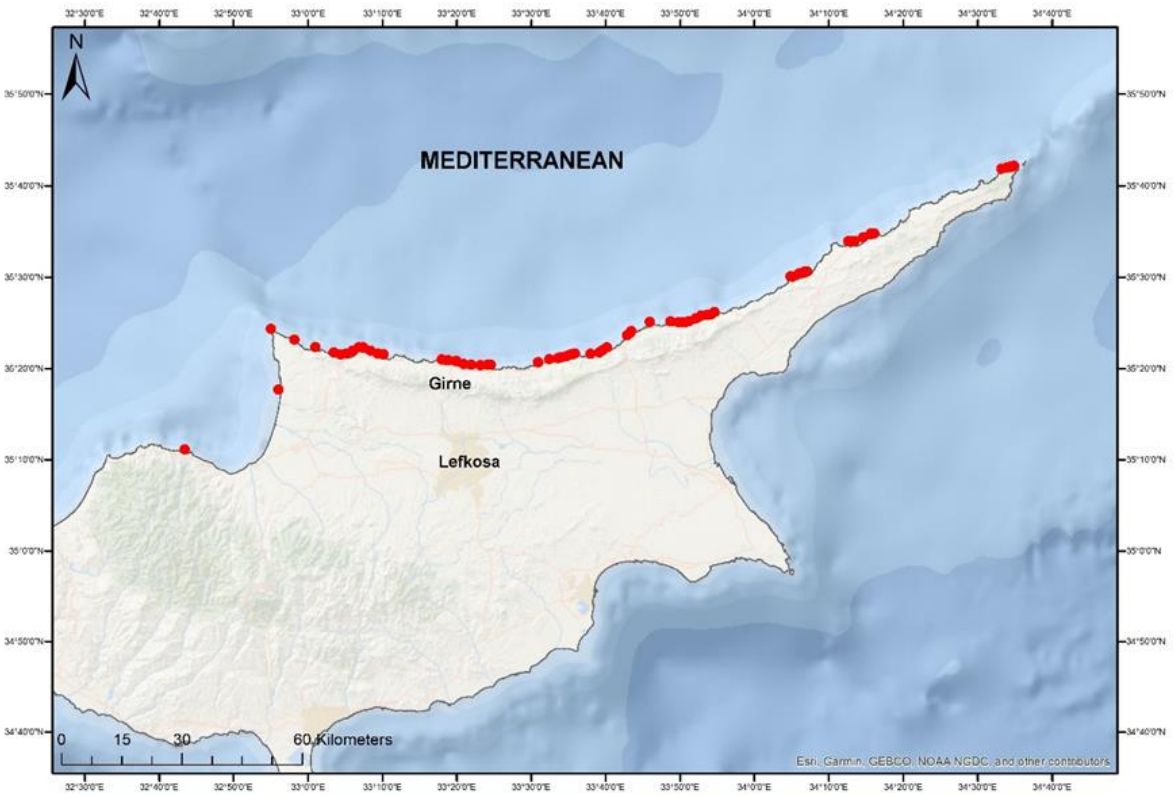

Figure 1. Study area with the presence of vermetid reefs indicated with red circles

Figure 2. Patches of vermetid reefs in Kyrenia, Cyprus

Dendropoma petraeum individuals. Furthermore, since some of the reefs could not be accessed by citizen scientists, they are not included in the results.

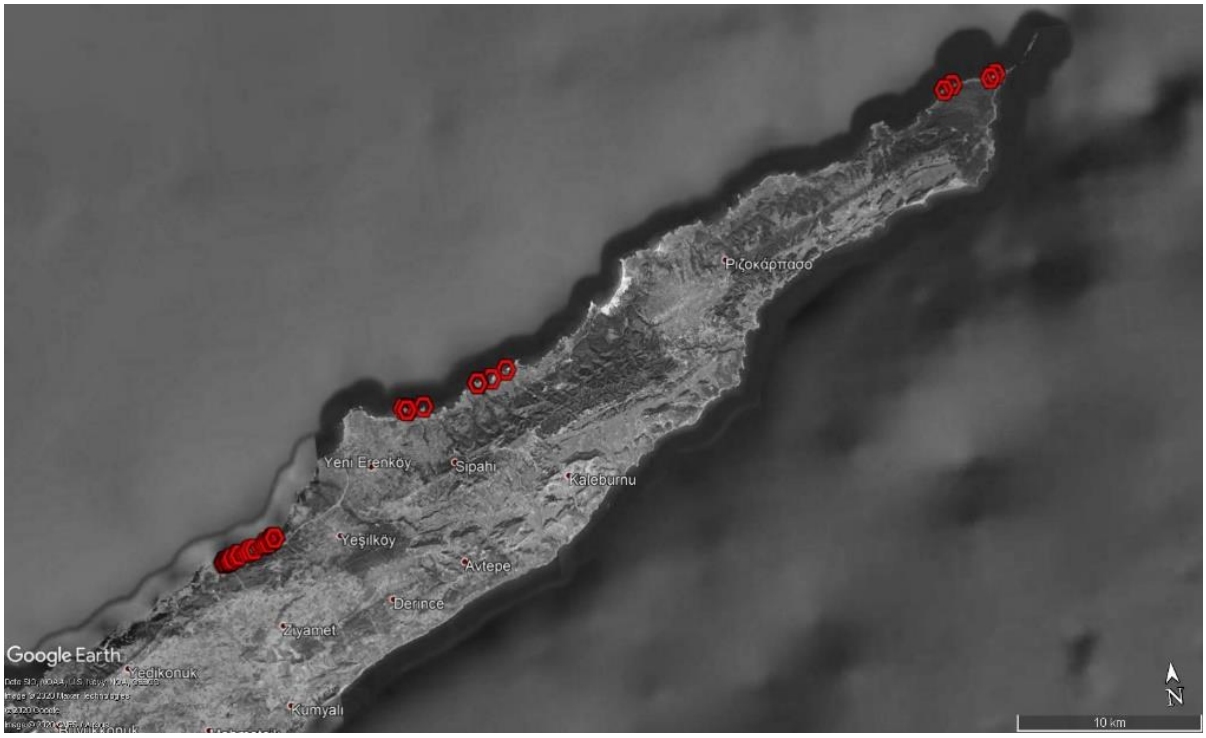

Figure 3. Locations of vermetid reefs, between 35°26' N, 33°58' E and 35°41' N, 34°35' E.

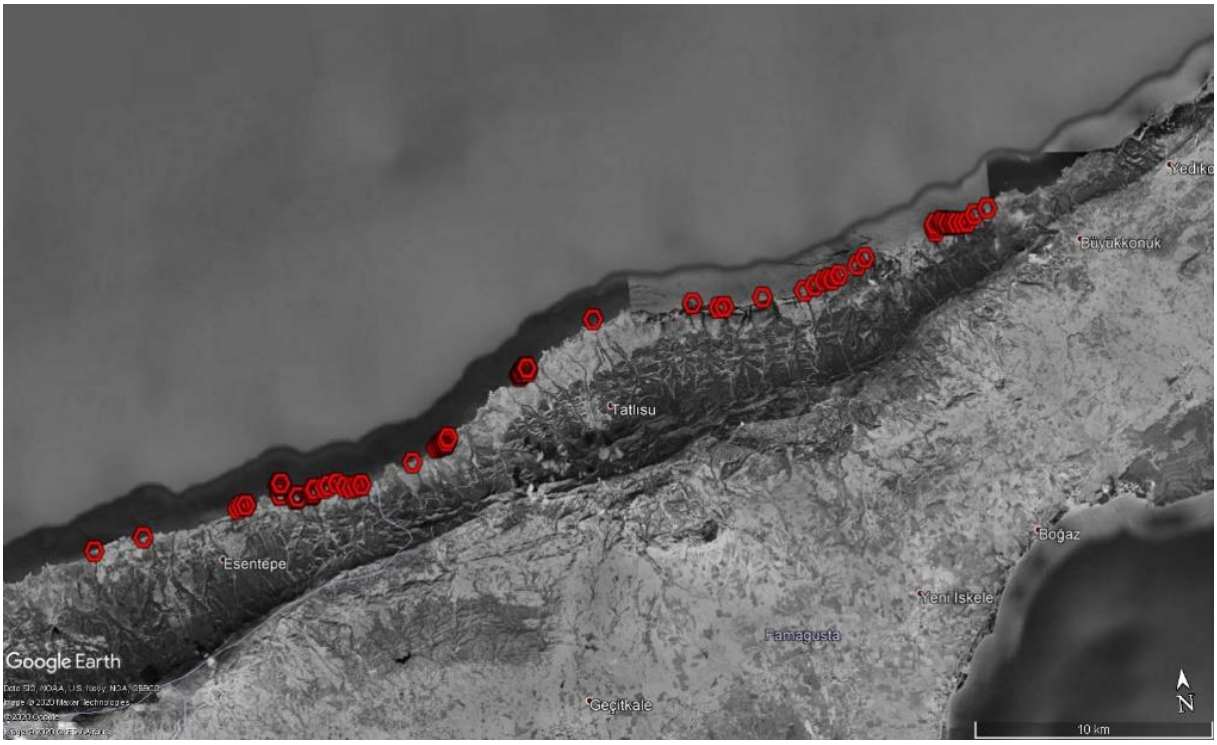

Figure 4. Locations of vermetid reefs, between 35°19' N, 33°28' E and 35°28' N, 34° 2' E.

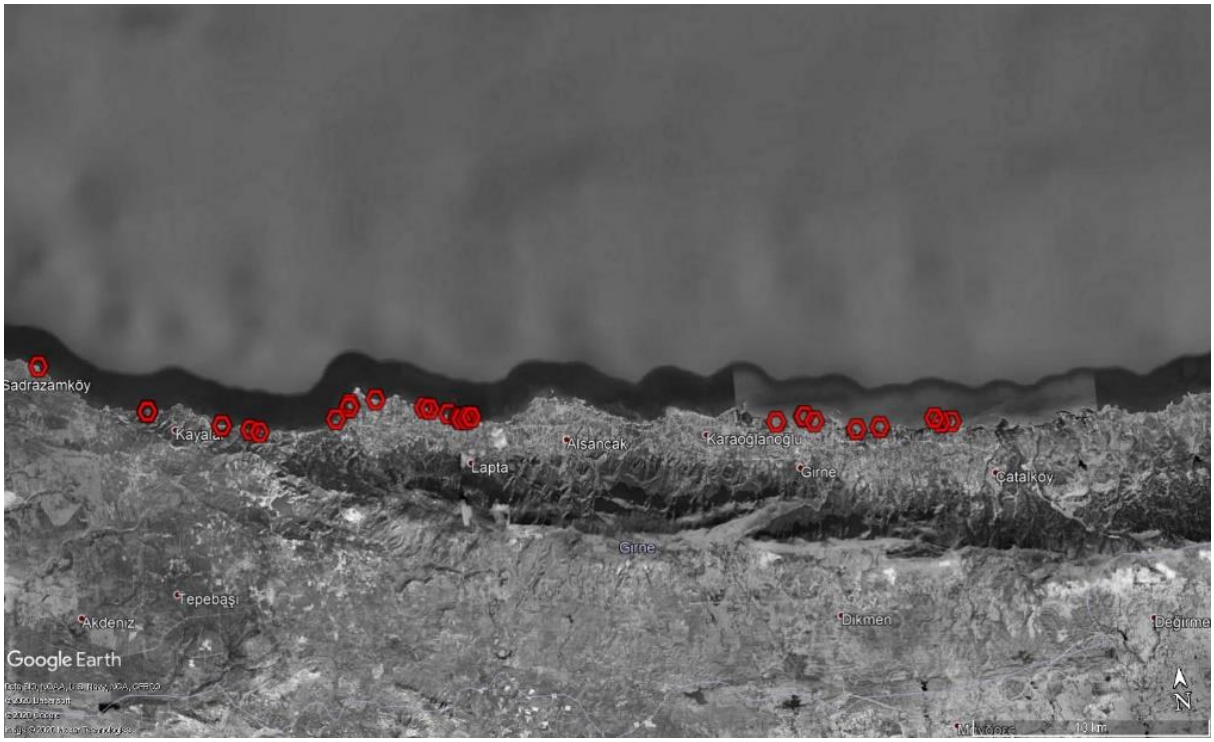

Figure 5. Locations of vermetid reefs, between 35°23' N, 32°57' E and 35°20' N, 33°30' E.

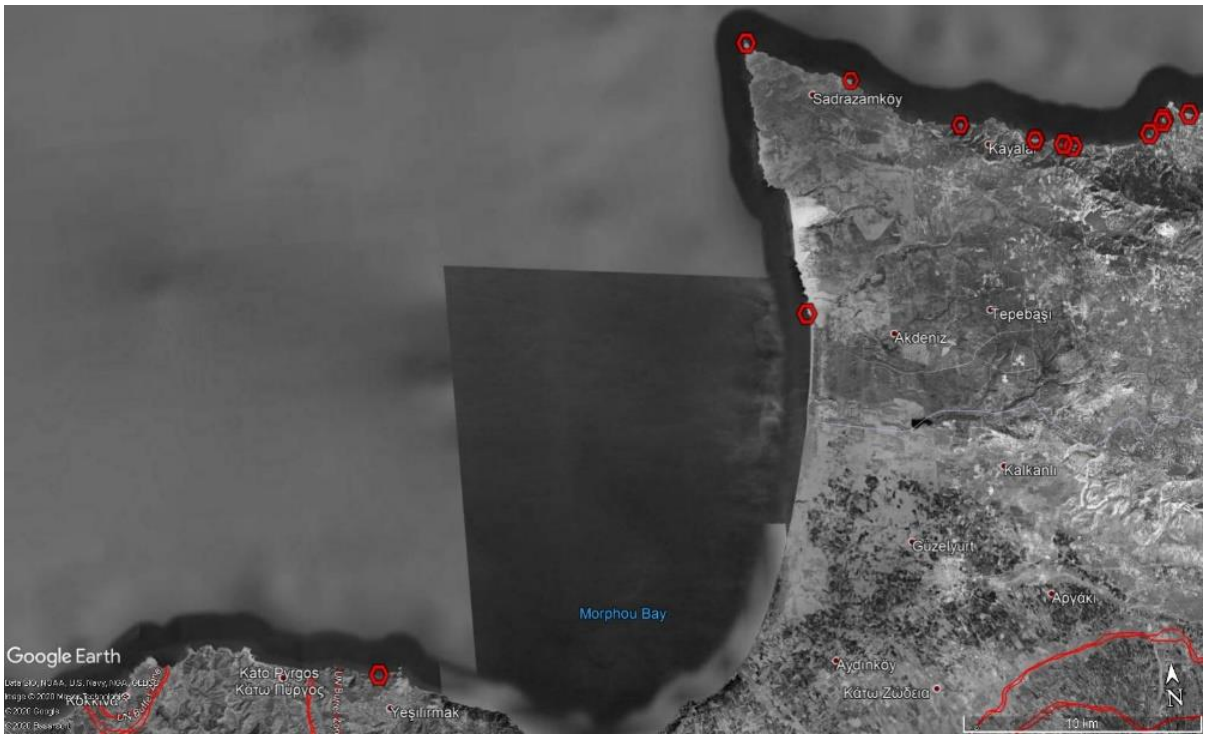

Figure 6. Locations of vermetid reefs, between 35°10' N, 32°42' E and 35°21' N, 33° 7' E.

In this project, GIS and satellite photos were used to analyze the distribution of vermetid reef data in situ surveys. A total of 65 vermetid reef patches were identified in the study area. The approximate area of detected vermetid reefs is 1,15 km^2. According to the satellite images, there are more vermetid reefs in the region, and its distribution reaches half of the northern coasts of Cyprus.

Vermetid reef forming a complex of bio-

constructor species are some of the only real reef-forming species in the Mediterranean, along with the antherozoid *Cladocora caespitosa*. Some other organisms, such as serpulid worms and red coralline algae, along with the contribution of bivalves, bryozoans, and corals, are also capable of building more than 22 different types of biogenic reefs along the Mediterranean coast (Milazzo *et al*. 2016). Vermetid reefs are an important habitat in terms of species biodiversity (Donnarumma *et al*. 2014, Milazzo *et al*. 2016); a study of the structure of the fish community associated with a vermetid reef at Shiqmona, Israel, revealed the highest fish biodiversity (36 species) of any habitat along the Mediterranean coast of Israel (Goren and Galil 2001). During the course of the project, the extensive emphasis was given to a 4 km long vermetid reef at the end of Rizokarpaso peninsula, the easternmost part of the island. Fish species determination by visual census method revealed the presence of 63 species (Table 1). During the preliminary evaluation of the aliveness of *D. petraeum* specimens, a great number of live mollusks could be observed on several portions of the reefs.

Table 1. Fish species recorded in Rizokarpaso vermetid reef

Acanthuroidei	***Callionymidae***	***Mugilidae***	***Serranidae***
Siganus luridus	*Clinitrachus argentatus*	*Mugil cephalus*	*Epinephelus costae*
Siganus rivulatus	*Tripterygion delaisi*		*Epinephelus marginatu*
	Tripterygion melanurus	***Percoidei***	*Mycteroperca rubra*
Atherinomorpha		*Apogon imberbis*	*Serranus cabrilla*
Atherina boyeri	***Carangoidei***	*Boops boops*	*Serranus scriba*
Atherinomorus forskali	*Caranx crysos*	*Cheilodipterus novemstriatus*	
Tylosurusacus imperialis	*Echeneis naucrates*	*Diplodus annularis*	***Scorpaeniformes***
	Pseudocaranx dentex	*Diplodus puntazzo*	*Pterois miles*
Anguilliformes	*Seriola dumerili*	*Diplodus sargus*	*Scorpaena maderensis*
Gymnothorax unicolor		*Diplodus vulgaris*	*Scorpaena scrofa*
Muraena helena	***Clupeiformes***	*Lithognathus mormyrus*	
	Sardinella aurita	*Mullus surmuletus*	***Sphyraenidae***
Beryciformes		*Oblada melanura*	*Sphyraena viridensis*
Sargocentronrubrum	***Gobiidae***	*Parupeneus forsskali*	
	Gobius bucchichi	*Pempheris mangula*	***Syngnathiformes***
Blenniidae	*Gobius cobitis*	*Sarpa salpa*	*Fistularia commersoni*
Aidablennius sphynx	*Gobius geniporus*	*Spicara maena*	
Coryphoblennius galerita	*Gobius paganellus*	*Spondyliosoma cantharus*	***Tetraodontiformes***
Lipophrys canevae		*Upaneus pori*	*Torquigener flavimacul*
Lipophrys trigloides	***Labridae***		
Parablennius incognitus	*Corisjulis*	***Pleuronectiformes***	
Parablennius zvonimiri	*Pterogogus trispilus*	*Bothus podas*	
	Sparisoma cretense		
	Symphodus mediterraneus	***Pomacentridae***	
	Symphodus tinca	*Chromis chromis*	
	Thalassoma pavo		
	Xyrichthys novacula		

Discussion

Vermetid reefs support a rich biodiversity and ecosystem services and other previously mentioned significant factors, making their imminent protection necessary. However, surprisingly, no detailed identification or coding for vermetid reefs is available in the well-established European Nature Information System (EUNIS). Since they are littoral biogenic reefs, they should be listed under A2.7, containing two biological subtypes; littoral *Sabellaria* reefs (A2.71) and mixed sediment shores with mussels (A2.72), encompassing the littoral biotope dominated by the honeycomb worm *Sabellaria alveolata*, and littoral *Mytilus edulis*- dominated communities (EUNIS 2020). Considering that A2.7 type habitats are protected by Council Directive (1992) on the

conservation of natural habitats and of wild fauna and flora, a new series of definitions should be introduced for this habitat type. Moreover, although both of the vermetid reef-forming species, *D. petraeum* and *N. brassica-florida* are included in the annexes of the Bern Convention (La Marca *et al*. 2015), and in Annex II (Endangered or Threatened Species) of the Protocol for Specially Protected Areas in the Mediterranean (SPAMI Protocol of the Barcelona Convention), there is no accepted protection status for vermetid reefs up to date. A quick action to protect the vermetid reefs in Cyprus should be taken as early as possible. A detailed study on the livelihood percentage of the reefs is necessary.

Acknowledgment

The authors hereby thank; Adil Berk Ayabakan, Ahmet Can Tekin, Altair Yilmaz Terzi, Asli Sen, Baran Kaan Oguzhan, Bulent Kaya, Caglayan Koc, Cem Yamaner, Durmus Bugrahan Dur, Efecan Acar, Enes Kara, Evren Ozturk, Fatih Durmaz, Fatima Gulsum Eroglu, Goktug Yilmaz, Gorkem Ozturk, Huseyin Can Tavzar, Ilhan Koray Akant, Luke Davut Dereli, Mert Findik, Ozgur Can Avci, Rasit Topaloglu, Salih Kulac, Serkan Ozdemir Ozdogdu, Umur Gumusbas, Uygar Yıldırım and Yagmur Irem Baybal for data collection. Authors also thank University of Kyrenia's Scientific Research Project numbered GRN-2019-1-510 004 for the evaluation of *D. petraeum* vitality and biodiversity investigation.

References

Vescogni A., Bosellini F.R., Reuter M., Brachert T.C. 2008. Vermetid reefs and their use as palaeobathymetric markers: New insights from the Late Miocene of the Mediterranean (Southern Italy, Crete). Palaeogeography, Palaeoclimatology, Palaeoecology 267(1–2): 89-101.

Chemello R. 2009. Marine bio-constructions in the Mediterranean Sea: A state-of-the-art on vermetid reef. Biologia Marina Mediterranea 16(1):2-18.

Chemello R., Silenzi S. 2011. Vermetid reefs in the Mediterranean Sea as archives of sea-level and surface temperature changes. Chemistry and Ecology 27(2):121-127.

Council Directive 1992. Council Directive 92/43/EEC (1992) https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:PDF. Downloaded on 06 May 2020.

Donnarumma L., Terradas M., Appolloni L., Di Stefano F., Sánchez-Lizaso J.L., Sandulli R., Russo G.F. 2014. Associated benthic fauna to the vermetid reefs along the Mediterranean Spanish coast. Biologia Marina Mediterranea 21(1):234-235.

EUNIS 2020. European Nature Information System https://eunis.eea.europa.eu/habitats/2681 Downloaded on 06 May 2020.

Goren M., Galil B.S. 2001. Fish Biodiversity in the Vermetid Reef of Shiqmona (Israel). Marine Ecology 22(4):369-378.

La Marca E.C., Franzitta G., Chemello R., Milazzo M. 2015. Conservation needs for the vermetid reefs in the Mediterranean Sea. Proceedings of the International Congress of Conservation Biology, Montpellier, France, 2-6 August 2015.

Milazzo M., Fine M., La Marca E.C., Alessi C., Chemello, R. 2016. Drawing the Line at Neglected Marine Ecosystems: Ecology of Vermetid Reefs in a Changing Ocean. In: S. Rossi (ed.), Marine Animal Forests, Springer International Publishing Switzerland.

Milazzo M., Rodolfo-Metalpa R., Bin San Chan V., Fine M., Alessi C., Thiyagarajan V., Hall-Spencer J.M., Chemello, R. 2014. Ocean acidification impairs vermetid reef recruitment. Scientific Reports 4:4189.