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Standard Classification of Intertidal Habitats in North Qeshm Island (Persian Gulf)

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As a new approach to ecological classification, the "Coastal and Marine Ecological Classification Standard (CMECS)" was applied to 141 km of the northern intertidal stretch of Qeshm Island during 2010. Biotic Cover and Surface Geology as the two components of the classification were used. Considering the extent and geomorphology of the area, 9 sites were designated using GPS. Density and distribution of biotic community were determined using 0.5×0.5 m quadrate and sediment was sampled up to 15 cm below the surface. Totally 32 codes were determined for 40 habitats (biotopes), and their positions were displayed on map by GIS. *Acar* spp., *Barbatia* sp. (molluscs), and *Zoanthus* sp. (cnidarian) can be regarded as the rocky substrates' specific biotopes, while *Stichodactyla* sp. (cnidarian) and *Halophia* sp. (seagrass) can be regarded as the sandy substrates' specific biotopes.

[**Key words**: Biotope, Classification, CMECS, Intertidal Habitat, Qeshm Island]

Introduction

The part of the coast that lies between the highest high and the lowest low tides is intertidal zone[1]. Considered among the most productive ecosystems, coastal area are vital to sustained fisheries for having the distinctive shallow water environmental conditions[2]. Marine environmental assessment and conservation require understanding the habitats distribution, extension and quality condition[3]. Marine benthic habitat, synonymously referred to as "biotope", is the sum of physical, chemical and biological factors[4]. The primary characteristic of the biotope is the "high fidelity" relationship between the physical habitats and strongly associated diagnostic taxa[5]. Biotope is not only regarded as a convenient structural unit for coastal zone mapping, but also a sub-unit of the ecosystem emphasizing its own processes, which change according to the type of biotopes[6]. Biotope also can be used as indicators of changes due to various pressures, including human impact[6]. In other words, it is at the habitat scale that anthropogenic impact may be most appropriately monitored. Nevertheless, little is known about the distribution and extent of habitats[2]. Ecosystem modeling, monitoring and conservation planning, and also human activities that impact the sea floor can be assessed with the help of benthic habitats or biotope mapping. On the other hand, habitat classification is necessary for the coherence of habitat data report and their management, habitat mapping, and also to identify the information gaps about them.

Coastal and Marine Ecological Classification Standard (CMECS) has recently been regarded as a new and comprehensive approach to habitat classification that has reviewed and incorporated many habitat classification systems[7]. CMECS was developed to classify all recognized marine ecological units within a simple standard format that uses a common terminology[5]. It divides the coastal and marine environment into various units and sub-units[5], of which the Biotic Cover Component (BCC) and the Surface Geology Component (SGC) have been used in this work to describe the intertidal benthic environment. Using the biotope as a unit for management is a success of CMECS. Also, by incorporating the various components information and sharing a common coding system, it allows mapping these components. Codes uniquely describe classification concepts, and so are searchable[5].

As the biggest island in the Persian Gulf and being a free zone area, Qeshm Island is expected to develop rapidly[8]. Therefore, assessing the island's ecosystems against the impacts of human activities seems necessary. No such work about the intertidal habitat classification and mapping in this island has been conducted so far. In this paper, we attempt to apply the CMECS at two levels of BCC and SGC in order to classify the intertidal habitats, using data acquired at representative sites in the north of Qeshm Island. The main objectives of this study were to (1) determine the biotopes of each intertidal geological structure, (2) give each habitat a CMECSs' code, and (3) represent the habitat borders by map.

Materials and Methods

Qeshm Island (26-27˚N, 55-56˚E) with an area of 1491 km^2 is situated in the Strait of Hormoz along Hormozgan province. Weather is characterized by a long warm and a short temperate season. There is no permanent river in the island, but some seasonal streams flow to the coastal area. Tidal regime is mixed semidiurnal, and its range (at north) is noticeably high[9]. Because of the sheltered condition of the northern coast of the island, the currents' energy is low and allows the fine sediment to settle. The sediment origin is both continental, and also rapid and high benthos growth in the Persian Gulf[10-11]. Mangrove forest with an area about 9200 hectares is located in the north-west between the mainland and the island[12].

Nine intertidal sites between Qeshm city to the Basaeidu port (QB) were so selected to cover the various available substrates within the entire 141 km northern coastal stretch of the island (Fig. 1, Table 1).

Site 1 is situated in an urban area between two harbors. Site 2 included two cliffs and a seasonal river. Sites 3 and 4 included man-made mangrove beds, some traditional shipyards and villages between the sites. Site 5 included rocky and rocky-sand shores with algae covered tidal pools. Site 6 included vast mangrove forests (Harra) that received freshwater from the mainland (Mehran River). Site 7 included some small mangrove forests together a few shipyards, and Sites 8 and 9 included oyster beds and some cobble in upper intertidal and also low sand shoreline. Shoreline and intertidal habitats adjacent to the study sites included a mix of mangrove beds (natural and man-made), creeks, sand flats and mudflats. Traditional shipyards, village settlements and tidal fish traps are the major anthropogenic features of the study area.

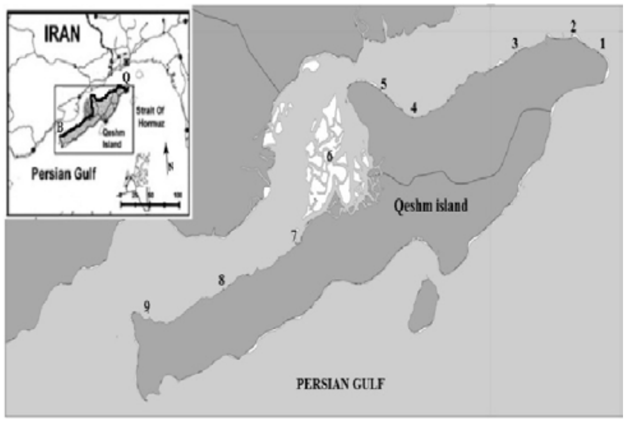

Fig. 1— Map of Qeshm Island, showing the designated sites in the northern coastal stretch.

Table 1—Names and locations of sites where benthic sediment and biota data were collected

Site Number	Site Name	Latitude	Longitude	Coastline length [a] (km)
1	Zakeri port	N 26˚58´07″	E 56˚15´44.8″	6
2	Saresur	N 26˚59´37.6″	E 56˚12´28.7″	15
3	Dargahan	N 26˚58´29.7″	E 56˚05´18.3″	25
4	Laft east junction	N 26˚53´48.3″	E 55˚51´59.8″	7
5	Laft Desalination Plant	N 26˚55´36.5″	E 55˚48´46.7″	11
6	Harra (Mangrove)	N 26˚56´41.9″	E 55˚45´08.2″	39
7	Gouran	N 26˚44´16.3″	E 55˚36´51.5″	18
8	Doulab	N 26˚40´53.2″	E 55˚27´31.2″	20
9	Basaeidu	N 26˚39´24.4″	E 55˚17´01.2″	_

[a] Coast line length represents distance between 2 continuous sites

Sampling was conducted seasonally in three replicates between March and November 2010, to observe sediment size and benthic (crustaceans, mollusks, echinoderms, cnidarians and algae) biodiversity and population, using 0.5×0.5 m quadrates. Photos of the samples were also taken before collecting and preserving them in 4% formalin solution for further identification, which was carried to the lowest possible level using reliable identification keys[13-16]. Identification of motile benthic fauna (observed out of the quadrate) was done using photos taken at various sites. Sediment sampling was also conducted up to 15 cm below the surface for particle size. Sediment was sieved with a mechanical shaker[17]. In addition to data gathering from the present work, all other biotic information from the earlier works in the same area were also taken into consideration.

Field data discussed above were used to evaluate several levels of SGC and BCC, to categorize habitats (Fig. 2).

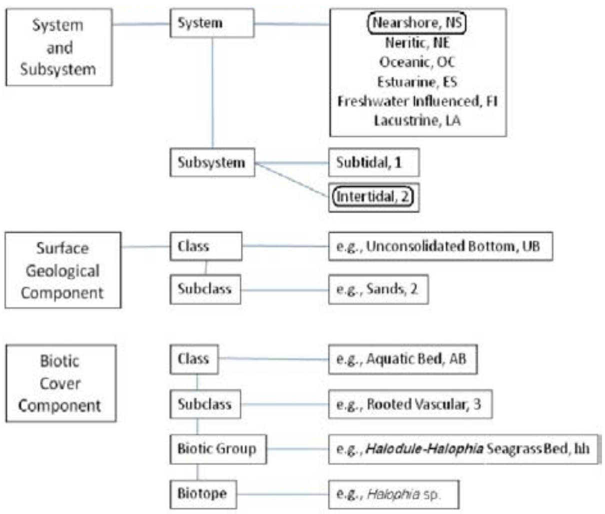

Fig. 2— Example structure of the SGC and BCC in CMECS classification.

Geographical positions of the habitats were transferred from GPS to computer using Mapsource ver.: 6.13.7 (1999-2008). Field delineations and observations were incorporated into the final GIS database.

Results

According to CMECS category for System and Subsystem (Fig. 2), the Persian Gulf having up to 100 m depth and 37-40 ppt salinity will, therefore, fall in Neritic [NE] System. The areas covered in this study should, however, be categorized in the Nearshore [NS] System for having a low steep and a low tidal line occurring below 30 m. Subsystem is also categorized according to the position to tidal line, so all sampling sites fall under "intertidal [2]".

Table 2 shows the substrate types at various sites. Based on the composition and particle size of the substrate, the 141 km intertidal area of northern Qeshm Island was divided into 3 substrate types of sandy (65% or 92 km), muddy sand (28% or 39 km) and rocky-sand (7% or 10 km), (Fig 3, b, c and a, respectively).

Table 2— Types of substrate and their SGC codes at various sites along the northern coastal stretch of Qeshm Island

Site Number	TOM (%Mean±S.D.)	Sand content (%Mean±S.D.)	Intertidal structure	CMECS code
1	2.3±1	88.2±9.1	Sandy	s:US.2
2	4.2±1.6	78.4±14	Sandy	s:US.2
3	7.7±0.3	83.6±8.6	Sandy	s:US.2
4	3.1±1.2	77.7±3.2	Sandy	s:US.2
5	3.2±1.3	87.5±5.3	Sandy & Rocky-Sandy	s:US.2 & s:RS.1
6	5.4±0.9	67.1±8.1	Muddy sand	s:US.2[Muddy Sand]
7	4.1±2.2	68.8±5.3	Muddy sand	s:US.2[Muddy Sand]
8	6±1.5	81.7±16.2	Sandy	s:US.2
9	4.9±1.1	81.3±19.8	Sandy	s:US.2

Unconsolidated substrate, encoded "US", constituted the major part (up to 90%) of the northern coastal stretch of Qeshm Island, while the Rocky substrate, encoded "RS" constituted the rest (Table 2). The unconsolidated substrate was further separated into sand flat in the east and west parts (totally 92 km), and muddy sand in the central part (39 km). Rocky-sand substrate was observed only at 5. Sand [2] and Rock Bed [1] Subclasses were defined by composition and particle size of their related substrates. Muddy sand substrate, which is considered as a division of sandy subclass with no special code in CMECS, was considered as a modifier in sites 6&7.

3.2. Habitat diversity based on biotic cover component (BCC)

Totally 42 faunas and 4 floras were identified. Mollusk constituted the highest diversity, while echinoderms and cnidarians constituted the least (Table 3).

Fig. 3— Rocky sand (a), sandy (b) and muddy sand (c)

Table 3— Seasonal presence of the observed intertidal biotic communities of north Qeshm Island

Family	Species	Winter	Spring	Summer	Fall
Ocypodidae	*Ocypode* sp.	√	√	-	-
	Uca sp.	-	√	√	√
	Macrophtalmus sp.	-	-	-	√
Leucosiidae	*Pyrhila* sp.	-	-	-	√
	Philyra sp.	-	√	-	-
Dotillidae	*Dotilla* sp.	-	√	-	√
Portunidae	*Portonus* sp.	√	-	-	-
	Charybdis helleri	√	-	-	√
Alpheidae	*Alpheus lobidens*	√	√	√	√
Porcellanidae	*Pisidia dehaanii*	-	√	-	-
	Petrolisthes sp.	√	√	√	√
	Petrolisthes rufescens	-	-	-	√
Xanthidae	*Leptodius exaratus*	-	√	√	√
	Eurycarcinus sp.	-	√	-	-
Grapsidae	*Grapsus* sp.	-	-	-	√
Majidae	_	-	-	-	√
Arcidae	*Acar* sp.	√	√	-	√
	Acar plicata	√	-	√	√
Mytiloidae	*Brachiodontes variabilis*	-	√	-	√
Trapezidae	*Trapezium sablavigatum*	-	√	√	√
Isognomonidae	*Isognomon legumen*	-	√	-	√
Veneridae	*Amiantis umbonella*	-	-	√	√
	Marcia marmorata	-	√	-	√
Ostreidae	*Saccostrea cucullata*	√	√	√	√
Arcidae	*Barbatia* sp.	√	√	√	√
Potamididae	*Cerithidea cingulata*	√	√	-	√
Trochidae	*Trochus erythroaeus*	√	√	√	√
Muricidae	*Thais* sp.	-	√	-	√
Bursidae	*Bufonaria rana*	-	-	-	√
Columbellidae	*Mitrella blanda*	-	-	-	√
Planaxidae	*Planaxis* sp.	-	-	-	√
Babyloniidae	*Babylonia spirata*	-	-	-	√
Cerithiidae	*Cerithium* sp.	√	√	√	√
Turbinidae	*Turbo bruneus*	-	-	√	√
Chitonidae	*Chiton lamyi*	√	√	√	√
Nassariidae	*Nassarius* sp.	√	-	-	√
Onchididae	*Onchidium peronii*	√	√	√	√
Zoanthidae	*Zoanthus* sp.	√	√	√	√
Stichodactylidae	*Stichodactyla* sp.	-	√	√	√
Asterinidae	*Aquilonastra* sp.	√	√	-	√
Ophiothricidae	*Ophiothrix* sp.	-	-	-	√
Gobiidae	*Periophtalmus waltoni*	√	√	√	√
Hydrocharitacae	*Halophila* sp.	-	-	√	√
Potamogetonaceae	*Halodule* sp.	-	-	-	√
Dictyotaceae	*Padina* sp.	√	√	-	√
Ulvaceae	*Ulva* sp.	√	-	-	-

The highest and lowest numbers of biotic groups were observed in sandy and muddy-sand substrates, respectively (Table 4).

Permanent and dominant intertidal faunas and floras of north Qeshm Island were categorized into 3 Classes, 6 Subclasses and 13 Biotic Groups (Table 5). BCC Classes and Subclasses are categorized based on dominant biotic cover (percent).

Table 4— Biotic groups (frequency and percent) based on substrate in the intertidal area of north Qeshm Island

Surface geology	Crustacean	Mollusc	Cnidarian	Echinoderm	Fish	Algae & seagrass	Total
Sandy	12 37.5%	14 43.8%	1 3.1%	1 3.1%	1 3.1%	3 9.4%	32 100%
Muddy sand	2 28.6%	4 57.1%	- -	- -	1 14.3%	- -	7 100%
Rocky-sand	8 33.3%	11 45.9%	2 8.3%	2 8.3%	- -	1 4.2%	24 100%

Table 5—BCC codes for north intertidal habitats of Qeshm Island

CMECS Biotic Cover Component			Site Number									BCC code
Class	Subclass	Biotic Group	1	2	3	4	5	6	7	8	9	
Faunal Bed [FB]	Mobile Epifauna [2]	Mobile Crustaceans[mc]	√	√	√	-	√	√	-	√	√	b:FB.2.mc
		Mobile Mollusk[mm]	√	√	√	-	√	√	√	√	-	b:FB.2.mm
		Tunneling megafauna[tm]	-	-	-	-	-	√	√	-	-	b:FB.2.tm
	Sessile Epifauna [1]	Attached Mollusk[am]	-	-	-	-	√	-	-	√	√	b:FB.1.am
		Attached Anemone[aa]	-	-	-	-	√	-	-	-	-	b:FB.1.aa
		Burrowing Anemones[ba]	-	√	-	-	-	-	-	-	-	b:FB.1.ba
		Oyster Bed [ob]	-	-	-	-	-	√	-	√	√	b:FB.1.ob
	Infauna [3]	Small Surface Burrowing Fauna[sb]	√	√	-	-	-	-	-	-	√	b:FB.3.sb
		Clam Bed[cb]	-	√	√	√	-	√	-	-	-	b:FB.3.cb
		Larger Deep-Burrowing Fauna [db]	-	-	-	-	-	√	-	-	-	b:FB.3.db
Aquatic Bed [AB]	Rooted Vascular [3]	Halodule - Halophila Seagrass Bed[hh]	-	√	-	-	-	-	-	-	-	b:AB.3.hh
	Macroalgae [1]	Attached Algae[aa]	√	-	-	-	√	-	-	-	-	b:AB.1.aa
Forested Wetlands [FO]	Mangrove [2]	Forested Mangrove[fm]	-	√	√	-	-	√	√	-	-	b:FO.2.fm

In this research, 32 biotopes were determined for 40 intertidal habitats (Table 6; Fig. 4). Biotopes were determined based on communities' seasonal distribution and density. These communities were observed in 3 or 4 seasons of the year with high density (Table 3).

Table 6—Biotope codes based on CMECS in northern stretch of Qeshm Island

CMECS code	Site Number								
	1	2	3	4	5	6	7	8	9
NS.2_s:US.2_b:FB.2.mc.*Alp lob/ petr* sp.	√	-	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mm.*Nass* sp./*Thai* sp	√	-	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.3.sb.Lep/Pro	√	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:AB.1.aa.*Pad* sp.	√	-	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.1.ba.*Stic* sp.	-	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mc.*Uca sp./ Alp lob/ Ocy* sp.	-	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mm.Vitr/*Moni* sp.	-	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.3.cb.*Dosi* sp./ *Tell* sp.	-	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:FO.2.fm.*Avi mar*	-	√	√	-	-	√	√	-	-
NS.2_s:US.2_b:AB.3.hh.*Halo* sp.	-	√	-	-	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mc.*Uca* sp.	-	-	√	-	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mm.*Cer cing*	-	-	√	-	-	-	√	-	-
NS.2_s:US.2_b:FB.3.cb.*Mar mar*	-	-	√	-	-	-	-	-	-
NS.2_s:US.2_b:FB.3.cb.*Amia umb*	-	-	-	√	-	-	-	-	-
NS.2_s:US.2_b:FB.2.mc.*Alp lob*	-	-	-	-	√	-	-	-	-
NS.2_s:RS.1_b:FB.2.mc.*Petr* sp.	-	-	-	-	√	-	-	-	-
NS.2_s:RS.1_b:FB.2.mm.*Onch per*	-	-	-	-	√	-	-	-	-
NS.2_s:RS.1_b:FB.1.am.*Bar fus/ Acar pli*	-	-	-	-	√	-	-	-	-
NS.2_s:RS.1_b:FB.1.aa.*Zoa* sp.	-	-	-	-	√	-	-	-	-
NS.2_s:RS.1_b:AB.1.aa.*Pad* sp.	-	-	-	-	√	-	-	-	-

NS.2_s:US.2_b:FB.2.tm.*Peri wal*	-	-	-	-	-	√	√	-	-
NS.2_s:US.2_b:FB.2.mc.Ocyp	-	-	-	-	-	√	-	-	-
NS.2_s:US.2_b:FB.2.mm.*Cer cing/ Plan sul/Clyp bifa*	-	-	-	-	-	√	-	-	-
NS.2_s:US.2_b:FB.1.ob.*Suc cuc*	-	-	-	-	-	√	-	√	√
NS.2_s:US.2_b:FB.3.cb.*Dos cey/Eury nat*	-	-	-	-	-	√	-	-	-
NS.2_s:US.2_b:FB.3.db.Cirr/ Euni	-	-	-	-	-	√	-	-	-
NS.2_s:US.2_b:FB.2.mm.*Cer cing/Per per*	-	-	-	-	-	-	-	√	-
NS.2_s:US.2_b:FB.2.mc.*Alp lob/Dot* sp.	-	-	-	-	-	-	-	√	-
NS.2_s:US.2_b:FB.1.am.*Bra vari*	-	-	-	-	-	-	-	√	-
NS.2_s:US.2_b:FB.2.mc.*Dot* sp.	-	-	-	-	-	-	-	-	√
NS.2_s:US.2_b:FB.1.am.*Trap sab*	-	-	-	-	-	-	-	-	√
NS.2_s:US.2_b:FB.3.sb.Lep	-	-	-	-	-	-	-	-	√

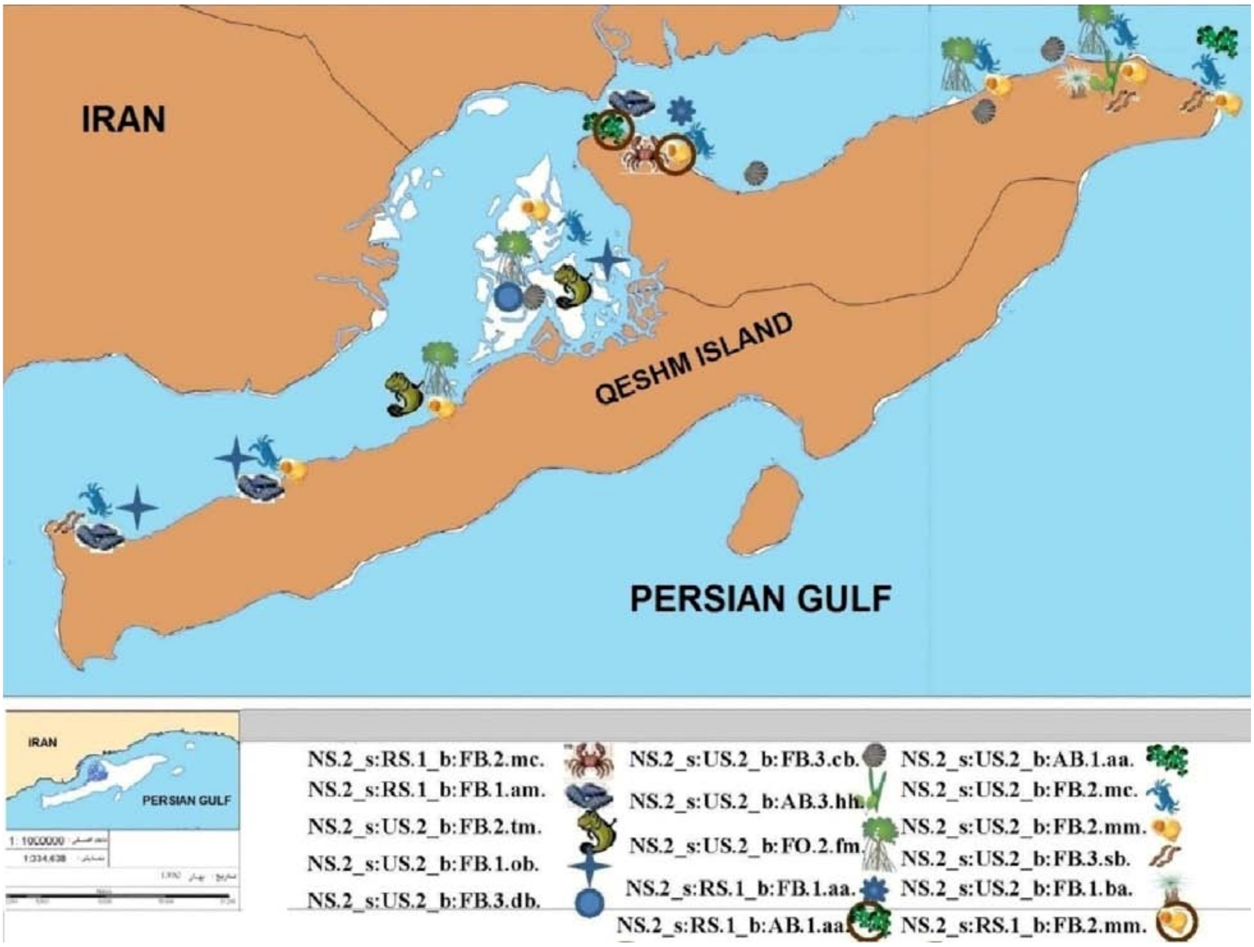

Fig. 4— Biotope distribution in northern intertidal stretch of Qeshm Island

Discussion

According to Cotton (1954)[18], all the world coasts are divisible into unstable (Unconsolidated) and stable (Rocky) ones. Although this division is regarded as primary and non-specialist, it is necessary to coastal management[19]. Unconsolidated substrate constituted up to 90% of the northern coastal stretch of Qeshm Island. It's due to the fact that the northern coasts of Qeshm Island are tidal dominant with high sedimentation rate[20]. On the other hand, high growth of benthos in the Persian Gulf, sediment transmitted by wind and numerous seasonal streams originated from Zagros Mountains[10] have, in general, resulted in the formation of unstable coast in the Persian Gulf, as well as very low current velocity at north of Qeshm Island, in particular, has contributed to the formation of vast unconsolidated substrate. Grain size and total organic matter content- used in SGC subclass definition and also as modifiers for habitats (Table 2) - proved to be effective factors in faunal distribution (Table 4).

Since the Qeshm coasts entail both natural and man-made structures, their effects on the physical and biological features of the substrates have to be dealt with, accordingly. Some parts of substrates between sites 1 & 2 appeared to be muddy, which could be attributed to the reduction of current speed by the harbors. Separate cliffs were observed in site 2, which were alternated by sandy and muddy sediments or both, providing suitable grounds for mangrove transplantation. Such complex structures have, probably, been formed by change of sedimentation rates as the result of speed fluctuations in tidal current and/or settlement of very fine sediment. Westward to the 5, average steep cliffs with intermittent sandy patches were observed along the coast. Rock and sediment of the site 5 have formed a complex structure, showing alternative sequence in parallel to the coast line (Fig. 3, left). Tide pool (on upper limit of intertidal) and algal mat were permanent features in this site.

Since muddy- sand substrate is not dealt separately in CMECS but categorized under sandy substrate, we considered it as a modifier in sites 6 & 7. Our results do not correspond with those of earlier works[12-21], in which the mangrove swamps of the area have been introduced as muddy land. This can be explained by the fact that the substratum in the upper tidal zone of mangrove swamp is often found to be more sandy, while the lower part is more muddy[22]. Upper intertidal in site 8 was covered with dispersed stones (≤ 60 mm) that could have, probably, been formed as the result of villagers' activity. These stones provided suitable habitat to some bivalves.

The highest and lowest numbers of biotic groups in the northern coastal stretch of Qeshm Island were observed in sandy and muddy-sand substrates, respectively (Table 4). In spite of the fact that the sandy shore possesses lower biota[1], the higher number of biotic groups in sandy shore in this study is merely related to the extent of sandy shore (Table 2). On the other hand, intertidal area of the northern Qeshm Island have low steep (<5°) and average tidal range (2-3 km), that provide suitable condition to sandy benthic communities.

About site 6, biotic data was based on previous information. Mangroves in general have high biodiversity in their soft (sediment) and hard (roots and pneumatophores) habitats[22], and Qeshm Island's mangrove is no exception[23]. However, the low biodiversity in the site 6 encountered in this work might be due to short monitoring period. Low diversity in site 7 with similar substrate structure as site 6 could be attributed to the anthropogenic activities such as human traffic and shipyards.

Rocky-sand structure constituted only about 7% (10 km) of the intertidal length but represent high biotic diversity. Physically, rocky substrates provide more shelter and nourishment opportunities for mobile fauna. Besides, rocky substrate organisms live right on the rock's surface and are easily observable[1-24].

Comparing the eastern, central and western parts of the northern Qeshm's intertidal zone, the eastern part represent higher species diversity. Substrate heterogeneity and some manmade features such as port and harbor (shelter opportunity), tidal flat trap (feeding opportunity) and higher organic matter from inshore in the eastern part might have attributed to the higher diversity. Homogeneity in substrate content might have caused lower diversity of species at western part. Although substrate features in this work are considered as the main factor in biodiversity, other physical factors such as current velocity or waves could have also played roles in faunal diversity and distribution[25].

Crustacean: Hermit crabs and *Alpheus lobidens* were observed in more than 50% of sites, in all seasons and all substrates. *Uca* sp., *Leptodius exaratus* and *Philyra* sp. were observed only in eastern part, and *Macrophtalmus* sp. and *Eurycarcinus* only in western part. *Uca* sp. needs unconsolidated substrate with high organic matter content, like sites 2 & 3 where they live in high density. *L. exaratus* and Porcellanidae family were found only in site 1 and site 5. *L. exaratus* is often herbivorous and higher density of macroalgae and seagrass may limit it to these sites. Porcellanidae family is scavenger, so high biodiversity in the site can provide them a suitable feeding opportunity.

Mollusc: *Saccostrea cuculata, Cerithidea cingulata and Onchidium peronii* were found in higher distribution and density than other mollusks. *S. cuculata* were observed on the stones and lower parts of mangrove shrubs throughout the central and western parts of the island. Current direction (counter-clockwise) may spread their larvae from the site 6 to westward. Oyster beds found in western part provided a hard substrate for other species and, therefore, increased habitats. Very fine substrate with microalgae cover and also mangrove habitats in western part supported high density of *C. cingulata*. *O. peronii* was found only in stone covered substrate. *Brachidontes variabilis* was found only in upper intertidal of site 8 on the oyster bed. They prefer protected brackish water and live with *S. cuculata,* sympatrically[26]. Cnidarian: *Stichodactyla* sp. was present in two thirds of sandy substrate and in rocky-sand as well, but higher density (1-2 individuals per quadrate) was encountered in site 2. *Zoanthus* sp. was found only in rocky-sand substrate (site 5) in high density.

Application of CMECS to the northern intertidal area of Qeshm Island resulted in recognition of 32 codes within 40 habitats; 22 codes for eastern, 10 codes for central and 7 codes for western intertidal habitats (Fig. 4). Results indicate the substrate heterogeneity descend westward. Heterogeneity of seabed type and other physical factors is associated with increased habitat[27]. Biotope concept combines the physical environment and its distinctive and dominant assemblage of conspicuous species[28]. Most of biotopes were observed at their expected specific habitats. *Petrolisthes* sp., *Zoanthus* sp., *Barbatia* sp. and *Acar* spp. were only observed in rocky-sandy substrate, while *Uca* sp. and *Halophia* sp. were only found in sandy substrate, which could be regarded as rocky substrate and sandy substrate specific biotopes, respectively. In some instances, specific biotopes were found on substrates other than their natural ones, such as the manmade structures.

Conclusion

Based on CMECS, 40 intertidal habitats with 32 codes were determined, of which 56.5% were recorded for the eastern, 25.5% for the western and 18% for the central coastal stretch of the Island. Westward decrease in habitat may be due to increased substrate homogeneity. It seems that habitats distribution is mainly determined by the substrate type, but other factors can also affect this distribution.

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