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Research Article

Short term temporal variation of mangrove fish assemblage in Chabahar Bay (Oman Sea)

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Abstract: This study aimed to assess the temporal variation in fish assemblage in Chabahar Bay mangrove habitat. Baited Remote Underwater Video (BRUV) sampling method was applied to record the fish presence. Fishes were sampled monthly from June 2017 to April 2018 at daylight time (9:00 to 14:00) during high tide. Water temperature, turbidity, and salinity were recorded at the time of sampling. During the study, a total of 17 species belonging to 12 families were identified. *Ambassis gymnocephalus* was found as the dominant fish throughout the year except in November and December. The most abundant fish fauna in numbers was characterized by the following five species: *Ambassis gymnocephalus* (53.38%), *Sardinella* sp. (17.13%), *Terapon jarbua* (4.79%), *Rhabdosargus sarba* (3.25%) and *Acanthopagrus berda* (2.9%). ANOSIM showed that significant differences in the assemblage structure occurred among months (R=0.613, $P< 0.001$), and the CLUSTER analysis, together with the SIMPROF test showed that December is significantly different in term of fish assemblage. Canonical Correspondence Analysis (CCA) on species-environment correlations revealed that temperature and turbidity were the main parameters influencing fish occurrence in the mangrove habitat of Chabahar Bay. The overall diversity (Shannon–Wiener, Simpson's Index of Diversity, and Pielou's evenness), as well as functional diversity indexes (FRic and FDis), was higher in autumn and spring pointing out that the diversity is higher when the temperature had the closest value to averaged value.

Keywords: Biodiversity, Oman Sea, Max N, Temporal variation, BRUV.

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Introduction

Chabahar Bay is located at the northeastern Oman Sea. The Bay is influenced by the Monsoon climate of the northern Indian Ocean (Ershadifar et al. 2020). Several habitats are found in the Chabahar Bay, including coral reefs, sandy and rocky shores, and mangrove swamps. The mangroves of the area have been planted by locals within the past 100 years to provide food for livestock. Now, with healthy and dense trees of the *Avicennia marina* (Forssk.) Vierh., the habitat has become a suitable living place for different species of birds, crustaceans, and fishes.

The importance of mangrove habitats as nurseries grounds for juvenile fishes in estuaries and nearshore marine environments is well documented by many studies (Tse et al. 2008; Kamrani et al. 2016; Whitfield 2017). As such, the mangrove ecosystem of the area may generate positive biodiversity effects of the fish stocks of the region. Despite the importance of mangroves in coastal ecosystems and their positive effects on fish biodiversity, there are only a few published studies that pertain to the ichthyofauna of mangrove ecosystems in the Oman Sea (e.g. Kamrani et al. 2016).

Sampling of fish communities in coastal and marine ecosystems can be done using a variety of techniques generally falling into two categories of observation- to extraction-based techniques. Fish nets are common sampling gears for studying mangrove fish assemblages (Faunce & Serafy 2006). However, they may be not appropriate for fish sampling within the densely vegetated areas with well-developed aerial roots (Wang et al. 2009). In such a shallow and complex habitat, it is only possible to catch fishes close to the mangrove fringe or in a main channel of the swamp using a net which might not reflect the real community of fish that live under or in between the aerial roots (Nagelkerken et al. 2000).

The Baited Remote Underwater Video (BRUV) technique is frequently used to investigate fish communities in tropical, sub-tropical, and temperate marine environments (Watson et al. 2005; Taylor et al. 2013; Ghazilou et al. 2016). The use of "bait" to attract fish species into the camera field-of-view (FOV) is a key element of this method. The BRUV technique is an affordable and non-destructive method and it has been used in different habitats and depths which are difficult for SCUBA divers to access (Willis et al. 2000). Both Mono and stereo setups can be used for surveying fish communities. Mono-BRUVs are smaller, lighter, cheaper, and less time-consuming to set-up (before and during field work) than the stereo-BRUVs (Whitmarsh et al. 2017). Using a single camera, the mono-BRUVs provide reasonable accuracy at FOV ranges from 1 to 5m (Harvey et al. 2002). The BRUV, as an alternative method, has several advantages over the visual census: (i) the pictures of the fish are clear even in low to moderate turbidity, (ii) fish escaping is not a problem, (iii) it can be used under the shadow of large trees (which many fish tend to get sheltered) while assessing such places is not possible during visual census method. Using a small BRUV unit can help with the latter two phenomenon especially in dense mangrove habitats as the cryptic species often rely on this habitat for protection from predators in mangroves (Rooker et al. 1996). Furthermore, compared to the extractive methods, the remotely operated underwater videos (e.g. BRUV) is more preferable approach for studying fish assemblages in clear-water mangroves (Reis-Filho et al. 2020).

The present study was carried out to investigate the structure of fish assemblage in a sub-tropical mangrove swamp as well as to study the temporal variations of fish abundance and diversity. We used classic biodiversity indices as well as two functional diversity indices (i.e. functional dispersion and Functional richness) to assess the temporal variations in the structure of the fish assemblages.

Materials and Methods

Study area: The Chabahar Bay is located in the northeast of the Oman Sea between Chabahar and Konarak ports (Southeast of Iran). It harbors different habitats such as coral reefs, sandy substrate, seaweeds and mangrove swamps and provides suitable breeding grounds for many fish and shellfish. Mangrove swamp of the Chabahar Bay is a newly planted forest, comprising of *A. marina*. The locals planted some parts of the swamp around 100 years ago to produce forage for their camels. Some parts also are planted by the Natural Resources and Watershed Management of Chabahar in recent years. Few rainfalls occur in the area, which may cause occasional freshwater runoff into the swamp. The swamp consists of the main channel and several sub-channels. The sub-channels are drained off during low tides, the connection between the main channel and the sea does not cut off. Surveys were carried out in mangrove habitats along the coasts of Chabahar Bay between June 2017 and May 2018 (Fig. 1). Samplings were conducted near the intersection of the main channel and one of the sub-channels. The depth of the water at the sampling site varied from 0.5 to 1.5 meters, depending on the tidal levels.

Sampling apparatus: We developed a small mono-BRUV system for this study. The BRUVS sampling apparatus included a Silver Edition GoPro Hero 4 full HD action camera covered with its waterproof

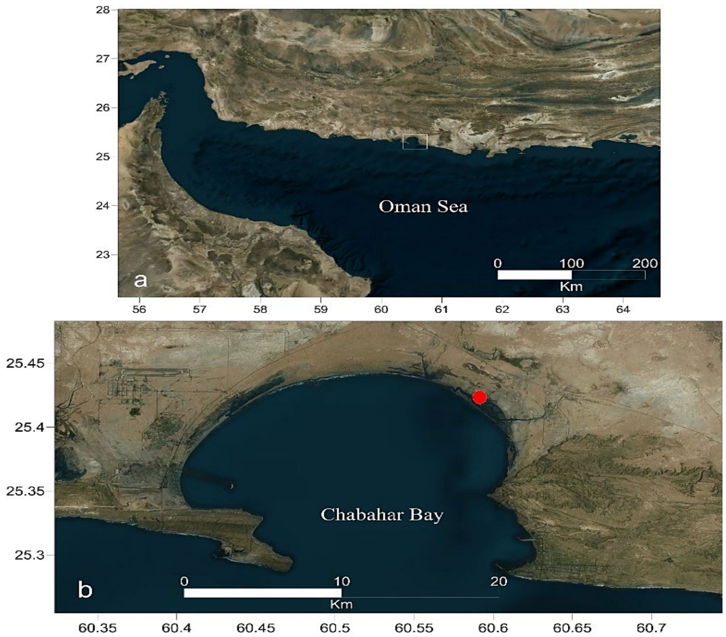

Fig.1. Sampling site (red dot) in Chabahar Bay, South east of Iran, north Coast of Oman Sea, during 2017–2018.

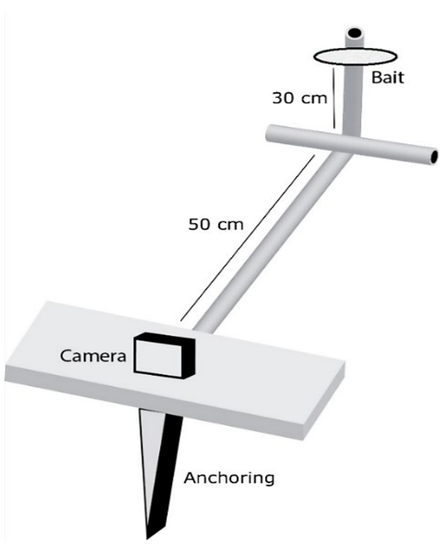

Fig.2. Schematics of mini BRUV setup.

housing fixed on a wooden board, a bait bag, a bait arm and two pieces of polyvinyl chloride (PVC) pipe. Pipes and bait arm were striped with power adhesives so that they could be used as scale bars. Each band was 10cm in length. A metal appendage was bolted beneath the board for anchoring the apparatus into the soft substrate. Further details of the apparatus are provided in Figure 2. We used mashed fresh *Sepia pharaonis* baits to attract fish to a field of view. The bait bag was fixed at approximately 50cm off the camera using a PVC bait rod which was dipped in the substrate so that the bait placed 30 cm above the seabed. The apparatus was directly deployed from the boat and baits were replaced before each deployment.

Data collection procedure: Monthly baited video recordings were done at daylight hours (9:00 to 14:00 h) during high tides. Three replicate deployments were done in each month. There were a >10m distance and 15min time-intervals among replicate castings. Each cast included 30 min of front-view video recording at 1080p-30fps quality and 170° viewing angle. The most cost-effective time frame has been found to be 30 minutes because it produces consistent estimates of relative abundances (Willis & Babcock 2000). During each sampling period, water temperature (°C) and salinity (psu) were measured using a portable multi-meter (HQ40D, HACH®-Germany) and turbidity (NTU) was measured using portable turbidity meter (2100Q, HACH®-Germany).

In the laboratory, recorded videos were observed by a single observer, using the VLC media player. Analysis of each video started 5min after the settlement of the filming apparatus and continued for 25min. Fish species were identified by illustrated fish guides (Carpenter et al. 1997; Psomadakis et al. 2015). The Max N (Cappo et al. 2006) was used as an abundance index for each fish species. Each video was split into short [i.e. 30 s or 1 min] segments and observed for estimating the Max N (i.e. the counts of the maximum number of individuals occupying the FOV within a moment) of each spices. Observations from the captured videos were made of Max N (the counts of the maximum number of individuals within particular short segments [usually 30 s or 1 min] or frames of video) (Cappo et al. 2006). The VLC screenshots were transferred to the ImageJ program to estimate the length of each fish is in which length-group using the scales.

Data Analysis: The fishbase database was used to determine the maturity or immaturity of observed length groups of each species (Froese & Pauly 2000). A Bray–Curtis similarity matrix was in PRIMER 6 (Clarke & Gorley 2006) was used to compare assemblage structures. Data were fourth-root transformed before calculation of Bray-Curtis coefficients. One-way analysis of similarity (ANOSIM; Clarke & Warwick (1999)) was used to compare significant differences in the structure assemblages among months. Cluster analysis, using group averages, was also conducted on the data. The significance of obtained groupings was assessed using a similarity profile (SIMPROF) test (Clarke & Gorley 2006). Species contributing the most to the average similarity within groups identified by the cluster analysis were identified using the similarities percentage (SIMPER) routine. For each video sample, species richness (S), Shannon's diversity index (H'), Pielou's evenness (J'), and Simpson diversity index (SID) were calculated.

Functional richness (FRic) is the amount of the functional space filled by a given fish assemblage on a given month irrespective of species' abundances, i.e it represents the amount of functional space occupied by a community (Mason et al. 2005; Schleuter et al. 2010). Functional dispersion (FDis) is a measure of the weighted mean distance of each species in multidimensional trait space to the centroid of all species in the community and is not correlated with species richness (Laliberté & Legendre 2010). For calculating functional diversity, a matrix of functional traits was created. Five traits were selected to define food acquisition, locomotion and biomass in each species (Villéger et al. 2008). The selected traits i.e., body form, length group (mean), food acquisition behavior, social foraging behavior, and caudal fin shape were used to create the matrix. As the fish communities in the mangrove habitat were mainly composed of juveniles and sub-adults, life stage were not considered. Matrices of functional traits and species abundances were used to evaluate community functional diversity using the indexes of FRic, and FDis. Analyzes were performed using the package 'FD,' (Laliberté & Legendre 2010) in R. As our functional traits were defined as categorical variables prior to analysis of FDis, the gowdis function was used to make a Gower dissimilarity matrix of the traits. Since biotic and environmental data did not follow normal distribution even after transformation, Kruskal-Wallis test was applied to test temporal variation of biodiversity, functional diversity and environmental data.

Canonical correspondence analysis (CCA) was used to examine the effects of environmental variables (explanatory variables) among different months on the transformed data (log X+1) of species abundance values (response variable). CCA was conducted using the software CANOCO v.5 (ter Braak & Šmilauer 2012) with forward selection model enabled to test the significance of environmental variables at a level of $P< 0.05$.

Results

Abundance and community composition: A heat map (Fig. 3) presents the abundance of fish species in the mangrove habitat of the Chabahar Bay. Overall, 17 species, belonging to 12 families were observed during the study period. The most commonly observed species was *Ambassis gymnocephalus* (Lacepède, 1802) (53.38% of total fish abundance) which was present in ten months, followed up by

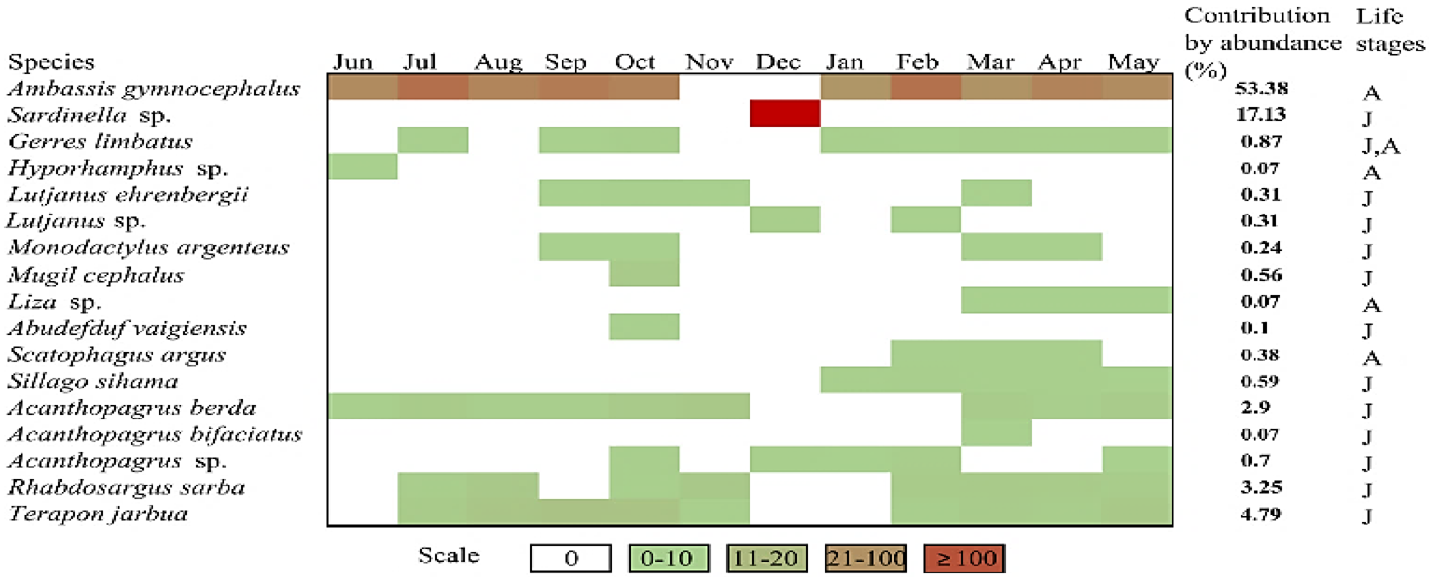

Fig 3. Heat map indicating the abundance of fish species in the mangrove habitat of the Chabahar Bay.

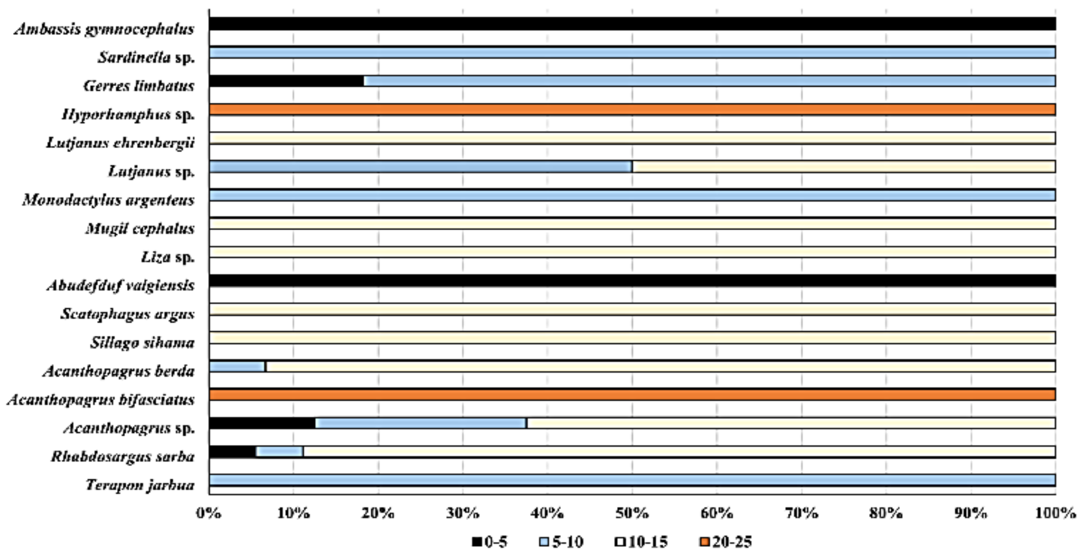

Fig 4. Length frequency groups of observed fish species in the mangrove habitat of the Chabahar Bay.

Sardinella sp. (17.13%), *Terapon jarbua* (Forsskål, 1775) (4.79%), *and Rhabdosargus sarba* (Forsskål, 1775) (3.25%). The latter two were observed in nine months. Meanwhile, *Sardinella* sp., *Hyporhamphus* sp., *Abudefduf vaigiensis* (Quoy & Gaimard, 1825), and *Acanthopagrus bifasciatus* (Forsskål, 1775) were recorded only once. The *A. gymnocephalus* was dominant in the months of its presence. In December (when the *A. gymnocephalus* was absent), *Sardinella* sp. was dominant species. Total fish abundance did not differ statistically among sampling months (Kruskal-Wallis, $P>0.05$).

The distribution of fish occurrence frequency in different length groups are shown in Figure 4. All *A. gymnocephalus* and *T. jarbua* belonged to 0-5 and 5-10cm length groups, respectively, which can be considered as juveniles. Five taxa have been identified to the genus level so it cannot be accurately stated about their length at maturity; however, of the taxa identified at species level (i.e. *Scatophagus argus* (Linnaeus, 1766) and *Gerres limbatus* (Cuvier, 1830)) were larger than their length at maturity.

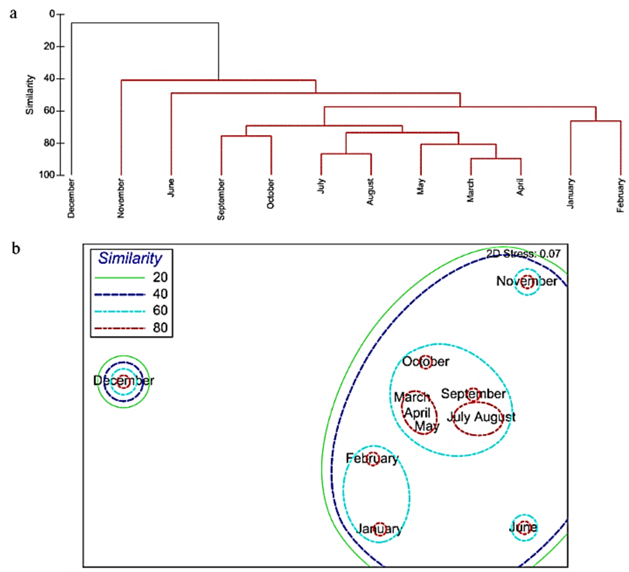

Fig 5. Dendrogram of hierarchical clustering (Above) and multidimensional scaling ordination plot (Below) of fourth root transformed abundance data of fish based on the similarity of the faunal composition at sampling months. SIMPROF separated December from other months which is presented in different color line.

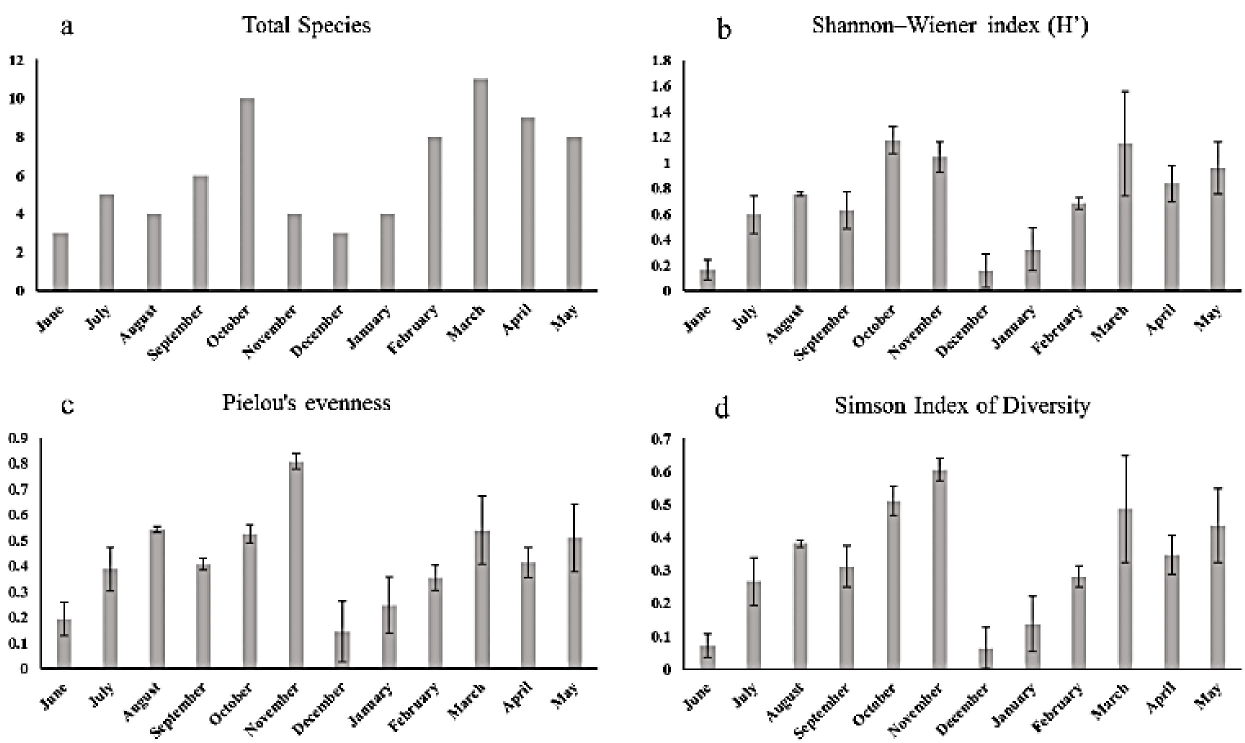

Fig 6. Monthly variations in diversity indices in mangrove habitat of the Chabahar Bay during one-year sampling period (2017-2018).

Other species such as *Acanthopagrus* sp. and *A. berda* observed in different length groups and all were smaller than 15cm, classified as juveniles. Overall, almost all recorded fish were under 15cm length and *A. bifasciatus* and *Hyporhamphus* sp. were the only species observed larger than 20 cm in size.

The results of ANOSIM showed that significant

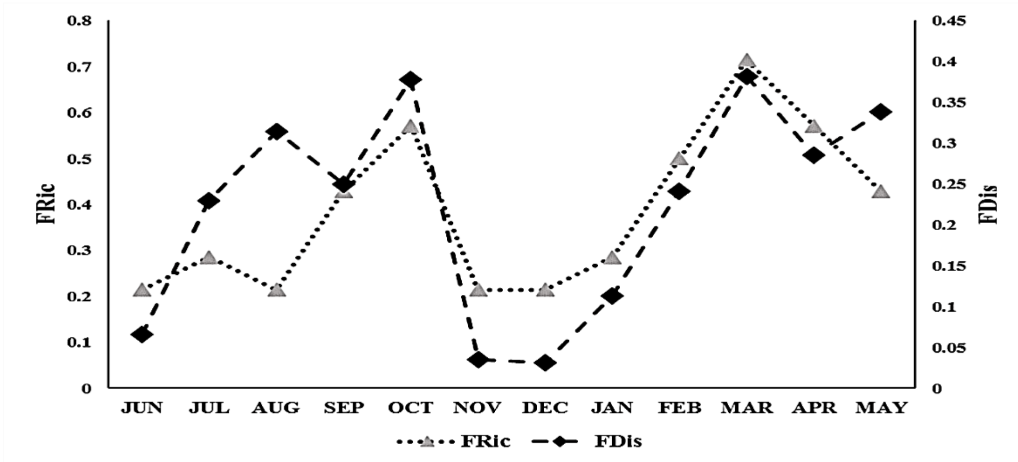

Fig 7. Short term variation in two indices of fish functional diversity (FDis and FRic).

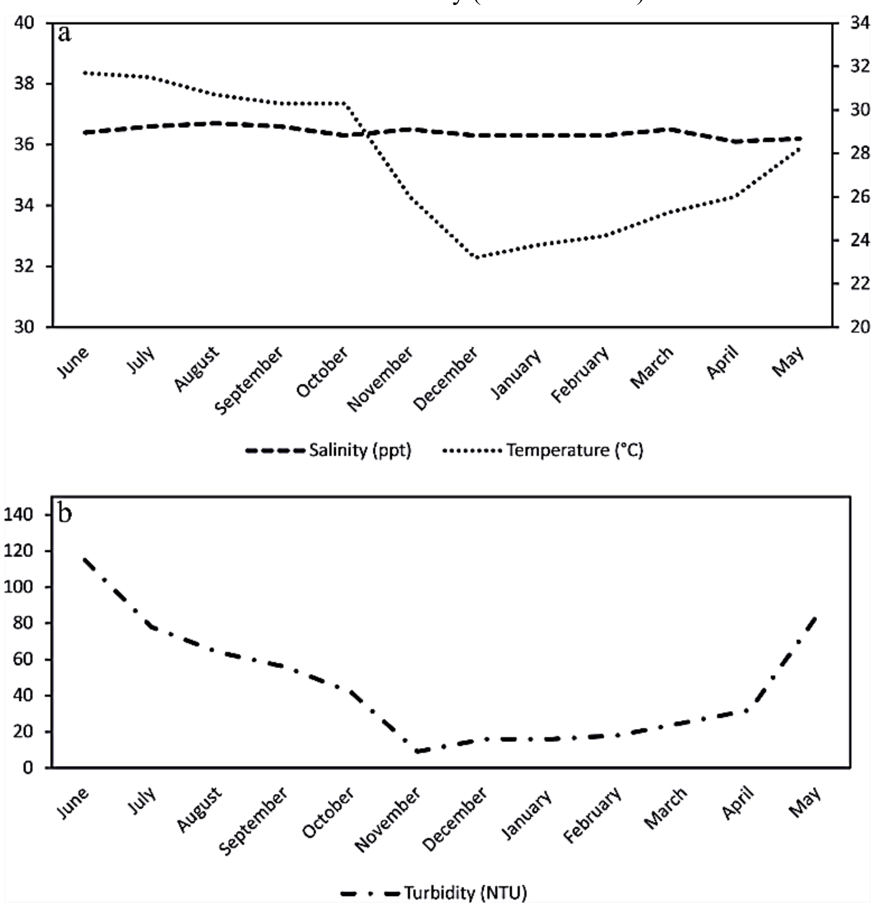

Fig 8. Variations in salinity, temperature and turbidity in mangrove habitat of the Chabahar Bay during the one-year sampling period (2017-2018).

differences in the assemblage structure occurred among months (R= 0.613, $P<0.001$). Cluster analysis of the Bray-Curtis similarity matrix based on fish species delineated two groups (SIMPROF test $P<0.05$) (Fig. 5). NMDS plot based on fish abundance data for all months showed a certain grouping of months from each season thus indicating some similarity in the fish community of that season (Fig. 5). SIMPROF analysis distinguished the 12 months into two main groups at a significance level

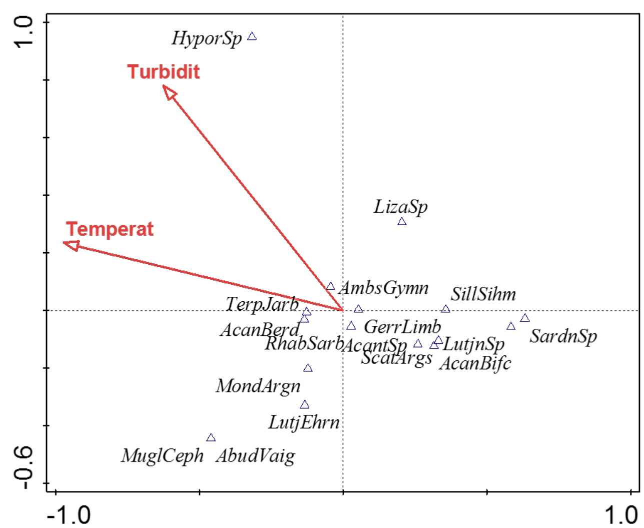

Fig 9. Canonical Correspondence Analysis (CCA) bi-plot showing the effect of environmental variables on the structure of fish assemblages (abundance data).

of 0.05 using Bray–Curtis similarity: all months except December as the bigger group and December as the second group. SIMPER analysis indicated *Sardinella* sp. and *A. gymnocephalus* contributed 26.33% and 18.01% correspondingly in the formation of group 1 (group average similarity 15.15).

Diversity metrics: The Shannon diversity of fishes was higher in autumn or spring as depicted in Figure 6. The October (H': 1.17±0.1) and March (H': 1.14±1.4) had the highest value of the Shannon-Wiener diversity index. In contrast, the lowest values were recorded in June (H': 0.16±0.08) and December (H': 0.15±0.13) with only three species observed in those months. Also, the highest value of the Simpson index of diversity values was recorded in October (1-D: 0.51±0.04) and March (1-D: 0.48±0.16), and the lowest values were observed in June (1-D: 0.07±0.03) and December (1-D: 0.06±0.06). The trend was nearly similar for the Pielou's evenness, the highest values were observed in November (J': 0.8±0.03) and August (J': 0.54±0.08) whereas December (J': 0.14±0.11) and June (J': 0.19±0.06) have the lowest values. The temporal variation of all four calculated indexes was significant (Kruskal-Wallis (KW) test, $P< 0.001$).

Functional diversity: Functional diversity of the fish community in Chabahar Bay showed short term temporal variation: FRic (0.21-0.71), FDis (0.03-0.38) (Fig. 7). FDis trend showed two peaks in October and March with the lowest value in June and December. While FRic almost shows similar trend it has contrasting trend in August and May with FDis (Fig. 7). Kruskal-Wallis test showed the variation of FRic and FDis is not significant between months.

Environmental parameters: All measured environmental parameters – salinity (ppt), temperature (˚C), and turbidity (NTU) are presented in Fig. 8. It indicates the monthly variations in temperature and turbidity in the mangrove habitat of the Chabahar Bay during the sampling period. The lowest and highest values of water temperature were recorded in December (23.2˚C) and June (31.7˚C), respectively and for water turbidity, the lowest and highest values were recorded in November (9 NTU) and June (115 NTU), respectively (Fig. 7). Salinity did not show sensible changes during the one-year sampling period and varied in the range of 36.1-36.7 ppt (Fig. 8). Temperature (Kruskal-Wallis test, H= 34.73, $P<0.001$) and Turbidity (Kruskal-Wallis test, H= 34.36, $P<0.001$) differed significantly between months.

Fish responses to environmental parameters: The relationships between temperature, and turbidity variables and structures of the fish assemblage are depicted in Fig. 9. All identified taxa were included in the final Canonical Correspondence Analysis (CCA) bi-plot (Fig. 8). The first two axes of CCA explained 15.64 and 21.40% of the variation in fish assemblages, respectively (total cumulative explained variation= 81.81%) and the eigenvalues of axes 1 and 2 were 0.215 and 0.079, respectively.

It was obvious that most species are located around the midpoint of the plot in the moderate temperature conditions. The same can be seen in the case of turbidity but it should be noted that turbidity were lower in cold months of the year and it can affect the results. However, the reaction of some taxa to the temperature and turbidity gradients are quite clear.

Sardinella sp. and *Lutjanus* sp. which are observed in the cold months of the year, are located along the negative temperature gradient and *Hyporhamphus* sp. are located at the positive temperature gradient. Considering the turbidity gradient, we can conclude that *Sardinella* sp. and *Lutjanus* sp. prefer clear and cold water and *Hyporhamphus* sp. prefer murky and warm water.

Discussion

Seventeen species, belonging to twelve families were observed in this study, and of these, three species (*A. gymnocephalus*, *Sardinella* sp., and *T. jarbua*) cumulatively contributed more than 75% of the total abundance demonstrating the low diversity of the mangrove swamp ichthyofauna. This can be seen in comparison to a study conducted in the northwest of the Oman Sea and Strait of Hormuz, with higher total number of observed species (108 species belonging to 54 families in Kamrani et al. (2016) and 29 fish species belonging to 22 families in Shahraki (2015). Despite the monsoon effects on the Chabahar climate, the biodiversity values showed that the observed fish species prefer more temperate conditions in spring and autumn. The lowest biodiversity values were observed in December (H':0.15, S:3) and June (H':0.16 S:3), which had the lowest and highest recorded temperature (23.2°C, 31.7°C), respectively. The highest biodiversity in terms of species richness was observed in March (H': 1.14, S:11) that the temperature had the closest value to the averaged value (27.6°C). FRic considers as filled a potential amount of functional space that is not occupied by any functional units in reality (Legras et al. 2018). They are usually interpreted by ecologists as an indicator for potentially used/unused niche space (Schleuter et al. 2010). October and March had generally higher FRic values suggesting a wider range of functions in those months. In winter (November and December) and summer (June, July and August) lower values of FRic were observed indicating that functionally similar organisms occurred in the community and/or potentially available resources to the community are unused (Mason et al. 2005). Functional dispersion is zero in one species community and it increases with an increasing diversity of traits in community, but is largely independent of species richness (Laliberté & Legendre 2010). Higher FDis values mean more individuals occupy the margins of the functional space concerning its more central part and it occurs because there is a higher number of extreme trait values in the community (de Arruda Almeida et al. 2018). October and March had generally higher FDis values, suggesting dissimilar functional traits and an expanded coverage of the trait space (due to increases in abundance and arrival of new species) which means lesser competition to use the resources. The lowest values of FDis were obtained in June, November and December. That is because *A. gymnocephalus* in June and November and *Sardinella* sp. in December were the most dominant species, resulting in relatively similar functional traits of the community and a low value of the average weighted distance of all species to the centroid. In addition, ordination analyzes revealed that December has significant difference in term of assemblage structure with other months (Fig. 5). Overall, in winter lowest values of functional and classic biodiversity indices were recorded. The results are consistent with Kamrani et al. (2016), in which the lowest biodiversity recorded in cold seasons. Hajisamae et al. (2006) stated that this trend is common in many mangrove habitats. In winter, owing to lower temperatures and lower availability of food items, the occurrence chance of some species can reduce in mangrove forests. Most of the observed species were demersal and were not mangrove associated. However, *A. gymnocephalus* were dominant species in ten months which is not a demersal fish. *A. gymnocephalus* is attracted to mangrove habitats, due to their complex nature (prop roots, pneumatophores, and branches). Laegdsgaard and Johnson (2001) and Tse et al. (2008) also stated that Ambassids prefer complex and sheltered habitats. Having better food conditions and habitat selection (due to avoidance of predators) can also be another reason for absorbing this species by mangroves habitats. Nagelkerken et al. (2008) reported that *T. jarbua* which is another abundant species in our study is an omnivores species and common in most mangrove habitats, which like other omnivores species spends the juvenile life stage in this habitat. The observed length groups of fishes in the mangrove region indicate that most of the observed species, such as the *A. berda*, *R. sarba*, *T. Jarbua*, *G. limbatus*, and *L. ehrenbergii* have not reached to length of maturity. Considering the non-dependency of their adults to mangrove ecosystem, it can be concluding that these species use the area as the nursery ground (lower risk of predation). Our finding is consistent with Nagelkerken et al. (2008); Tse et al. (2008); Mirera et al. (2010); Kamrani et al. (2016), who concluded that the mangroves habitat supports higher abundances of these species in juvenile stage and consistent with the view that mangroves are suitable habitats as nursery grounds for fish species. Although the nursery role of mangroves is well established (Laegdsgaard & Johnson 2001), most of the studies were carried out in tropical regions and estuarine swamps (Mumby 2006; Castellanos-Galindo et al. 2013). In addition, several authors believe that small fishes don't use mangrove as a nursery ground in the subtropical area and there is no advantage in mangrove area as compared to adjacent treeless habitats thus most of the species can be recognized as transient species (Wang et al. 2009; Shahraki et al. 2016). Therefore, despite what has been said about nursery grounds there is another explanation for this phenomenon that these species are transient species and their presence is mainly due to the high amount of food in the substrate (benthic fauna and detritus). The Chabahar Bay mangroves are low in rainfall and have the characteristics of Indo-pacific mangroves. However, due to the special topography and current pattern in the sampling area, in most cases, the connection of the main channel and the sea does not interrupt for long period and the main channel remains full of water even in low tides, therefore, fish can easily travel between mangrove and other regions which in turn, it can increase the presence of transient species. Yet, to estimate the importance of the Mangrove region to neighboring treeless areas, a study should be undertaken to compare these areas with each other in terms of biodiversity and ecological value.

This study also demonstrated that fish assemblages in Chabahar Bay were affected by environmental factors, temperature and turbidity. 81% of the observed variability in fish assemblages was explained by interactions between temperature and turbidity according to the CCA. Temperature is often considered to control the temporal variations of species occurrence in shallow habitats (Selleslagh & Amara 2008; Vilar et al. 2011). Turbidity (transparency) also playing a key role in distribution of fish taxa in coastal and marine ecosystem (Cocheret de la Morinière et al. 2004; Hossain et al. 2012). In areas with suitable food conditions it may protect juvenile fish taxa against predators, while the high values of turbidity indicated negative impacts on survival rate of fish eggs, hatching success, growth rate, and feeding efficiency (Whitfield 1999).

Overall, as stated in the results most species prefer near-average temperatures and are scattered throughout the center of the graph (Fig. 9). Abundant species like *A. gymnocephalus*, *T. jarbua,* and *R. sarba* are placed in the midpoint of the biplot. Species like *Sardinella* sp. and *S. sihama* has shown that they prefer cool and clear water. *Sardinella* sp. was only observed in December, a month that characterized by cold and transparent water, indicating that sufficient light is required to ensure that these planktivorous fish require transparent water to achieve sufficient food intake (Lazzaro 1987). *S. sihama* has been observed from January to May and was not present in the months when the temperature and turbidity have increased. In contrast, in this study *M. cephalus* and *Hyporhamphus* sp. preferred warm waters. However, since those species have been observed only once during the sampling period, it is not possible to comment on them with certainty on their suitable environmental conditions.

This study provides the knowledge base of the regional-scale fish community structure in a newly established mangrove swamp in the Chabahar Bay (north-east of Oman Sea) and it can contribute to our knowledge on the ecology of mangroves associated fishes in the Gulf of Oman and coastal ecosystems. The number of species observed in this study was low. High fishing pressure (Jamnia et al. 2015), lack of connectivity to coral and seagrass habitats (Mumby 2006), and the young foundation of Chabahar mangroves can be cited as the probable causes of low fish biodiversity in the swamp. Besides, the number of fish taxa varies from one study to another, which can be due to differences in sampling method, abiotic parameters, and type of habitat. Also, the type of prey used in this study might reduce the likelihood of the presence of herbivorous species to some extent. Finally, it can be concluded that the species which utilize the mangrove swamp are small and juvenile fish with higher diversity in spring and autumn. Moreover, temperature and turbidity can be considered as factors affecting the distribution and biodiversity of fish in the region.

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مقاله پژوهشی

تغییرات زمانی کوتاه مدت اجتماع ماهیان حرا در خلیج چابهار (دریای عمان)

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چکیده: این مطالعه با هدف بررسی تغییرات زمانی در ساختار جمعیت ماهیان در زیستگاه حرا در خلیج چابهار انجام شده است. برای ثبت حضور ماهی‌ها از روش تصویربرداری ویدئویی با کمک طعمه‌گذاری (BRUV) استفاده شد. تصویربرداری از تیر ماه ۱۳۹۶ تا خرداد ۱۳۹۷ در هر ماه در طی روز بین ساعت‌های ۹ الی ۱۴ در زمان مد کامل انجام شد. دمای آب، کدورت، و شوری در زمان نمونه‌برداری ثبت شد. در این مطالعه ۱۷ گونه متعلق به ۱۲ خانواده شناسایی شد. *Ambassis gymnocephalus* در تمامی ماه‌های سال به جز آذر و بهمن گونه غالب بود. فراوان‌ترین گونه‌ها به ترتیب *Ambassis gymnocephalus* (۵۳/۳۸٪)، *Sardinella* sp. (۱۷/۱۳٪)، *Terapon Jarbua* (۴/۷۹٪)، *Rhabdosargus sarba* (۳/۲۵٪) و *Acanthopagrus berda* (۲/۹٪) بودند. آنالیز ANOSIM نشان داد که تفاوت معنی‌داری در ساختار جمعیت بین ماه‌های مختلف وجود دارد (P<۰/۰۰۱ وR=۰/۶۱۳)، آنالیز دسته‌بندی خوشه‌ای همراه با آزمون SIMPROF نشان داد که ماه بهمن (دسامبر) به طور معنی‌داری از نظر ساختار جمعیت ماهی تفاوت دارد. آنالیز CCA نشان داد که دما و کدورت پارامترهای اصلی تاثیرگذار بر حضور ماهیان در زیستگاه حرا در خلیج چابهار بوده‌اند. شاخص‌های تنوع زیستی (Shannon–Wiener، Simpson's Index of Diversity و Pielou's evenness) و ویژگی‌های عملکردی (FRic و FDis) در بهار و پاییز بیشترین مقادیر را داشته‌اند زمانی که دما نزدیک‌ترین مقدار را به مقادیر میانگین داشته است.

کلمات‌کلیدی: تنوع زیستی، خلیج عمان، Max N، تغییرات زمانی، BRUV.