

Assessment of Amphipoda communities in Chabahar Bay using species richness and Taxonomic distinctness indices

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Abstract

In most ecological studies, traditional biodiversity indices such as the Shannon have generally been used in assessing species diversity. New taxonomic distinctness indices have been considered phylogenetic relatedness of species and provide more information for ecologists. In the present contribution traditional species richness index along taxonomic distinctness indices were used to evaluate amphipods communities of Chabahar Bay. Sampling was carried out in 19 stations during December 2016. We identified 21 species belong to 14 genera and 12 families. Amphisidae was the most abundant family. Shannon index was 0-2.9 with average value of 1.2. The highest distribution of amphipod communities was on the east, northeast and southwest coasts of the bay. The highest average taxonomic distinctness index (AvTD) was calculated for west, southwest and southeast. Therefore, considering that higher taxonomic distinctness indices indicate more suitable ecological conditions, it can be concluded that the middle part of Chabahar Bay has more unfavourable ecological conditions for amphipods and other macrobenthos.

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1. Introduction

The biodiversity and variations in the macrobenthos community are some of the most important indexes in environmental impact assessment studies that could be revealed the habitat health status (Borja et al., 2009; Van Hoey et al., 2010). The amphipod assemblages are one of the main parts of macrobenthos community. The density and composition of amphipod assemblages were affected by environmental conditions, geography and history of distribution (Ellis et al. 2000; Guerra-García & GarcíaGómez 2009). Annually multi environmental impact assessment studies was carried out in the Iranian coastal waters. Usually, traditional biodiversity indices was used for defining the ecological condition of ecosystems.

In the last two recent decades, several formulas have been proposed in the ecological literature to measure species diversity based on the number of species and their relative frequency. One of the main problem of species richness indices (such as Shannon-Wiener, Simpson, Margalf and Brillouin) is the high correlation between them and the sampling size without pay attention to the taxonomic diversity in the community. For example, it is clear that a population with 10 species of one genus has lower biodiversity than a population with 10 species of different

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genera, but because these indicators are only sensitive to species level of biodiversity, therefore, unable to differentiated two communities (Ashori et al., 2016). Recently, Clark and Warwick (2001) proposed further biodiversity index, based on taxonomic (or phylogenetic) relatedness of species, namely the variation in taxonomic distinctness' (VarTD, Δ^+) between every pair of species recorded in a study. It complements the previously defined 'average taxonomic distinctness' (AvTD, Δ^+), which is the mean path length through the taxonomic tree connecting every pair of species in the list. VarTD is simply the variance of these pairwise path lengths and reflects the unevenness of the taxonomic tree. However, these indices was used in terrestrial ecology of Iranian studies but generally ignored in marine biodiversity projects.

Chabahar crenulated shape bay (Ω) is part of the Makran area in the southeast of Iran (Oman Sea, north-western part of Indian Ocean). It has 13.5 km wide entrance and 17 km length in south-north direction. Several habitats are found in the Chabahar Bay, including coral reefs, sandy and rocky shores, and mangrove swamps (Maghsoudlou & Momtazi, 2017).

In the present study, for the first time the taxonomic indices associated with traditional indices was used for detecting the biodiversity status of Chabahar Bay.

2. Materials and Methods

Quantitative sampling was done with tree replicates by 0.25 m Ekman grab, in 16 subtidal stations and three intertidal stations in November 2016 (Fig 1). Stations was organized in three transect perpendicular to coastal line. In subtidal stations amphipod community was collected via Van veen grab (0.025 m²) and in coastal stations via quadrat (0.25*0.25 m²) with three replicate. The contents of each grab or quadrat were sieved by 0.5 mm mesh and after relaxing with MgCl₂, the material was fixed in 75% ethanol. Macrobenthic organism was sorted and identified with Stereo Microscope (Nikon SMZ 1500) and valuable Intkey (Dallwitz, 2002).

Taxonomic and biodiversity indices was calculated with PRIMER Ver. 6.1.12 and PERMANOVA ver.1.0.2 (Clarke & Gorley, 2006). The results was mapped with Arc GIS 10.6.1 software (Esri & GeoEye, 2018).

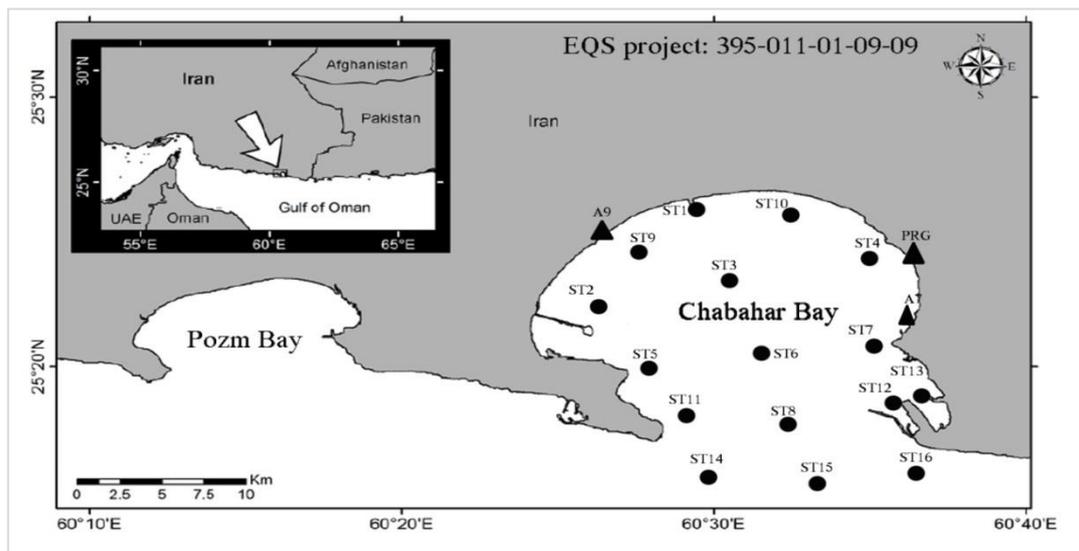


Fig. 1: Map of the study area and locality of different stations.

3. Results and Discussion

The amphipod macrobenthic community in the current study was composed of 21 species belong to 14 genus and 12 family. The most frequent family are Ampeliscidae with eight identified species from 2 genera (Table 1). Also, the most relevant species in the studied area was *Ampelisca persicus* that was reported from 14 stations.

Table 2: The amphipod assemblages in the Chabahar Bay

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	ST15	A7	A9	PRG	ST16
<i>Ampelisca cyclops</i>	-	-	-	-	+	+	+	+	-	-	+	-	-	+	+	-	-	-	+
<i>A. Persicus</i> Momtazi, 2020	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+
<i>Ampelisca</i> sp.1	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Ampelisca</i> sp.2	-	-	-	-	+	+	-	+	+	-	+	+	-	-	+	-	-	-	-
<i>Ampelisca</i> sp.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Ampelisca</i> sp.4	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>A. zamboangae</i>	-	-	-	-	-	-	-	+	+	-	+	-	-	-	+	-	-	-	+
<i>Byblis</i> sp.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ceradocus</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
<i>Indischonopus herdmani</i>	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	-	+	+	-
<i>Latigammaropsis</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>Leptocheirus</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
<i>Leucothoe</i> sp.	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Metatiron brevidactylus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Monoliropus kazemii</i>	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
<i>Photis</i> sp.	+	+	+	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-
<i>Rhinoecetes brevipodus</i>	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
<i>Tryphosella</i> sp.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Urothoe grimaldi</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	+	-	-	-
<i>Urothoe platydactyla</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>Xenocheria</i> sp.	-	-	-	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	-

Figure 2 was shown the spatial pattern of total amphipod abundance in the Chabahar Bay. It could be seen the lower frequency of amphipods is in the center of the Bay.

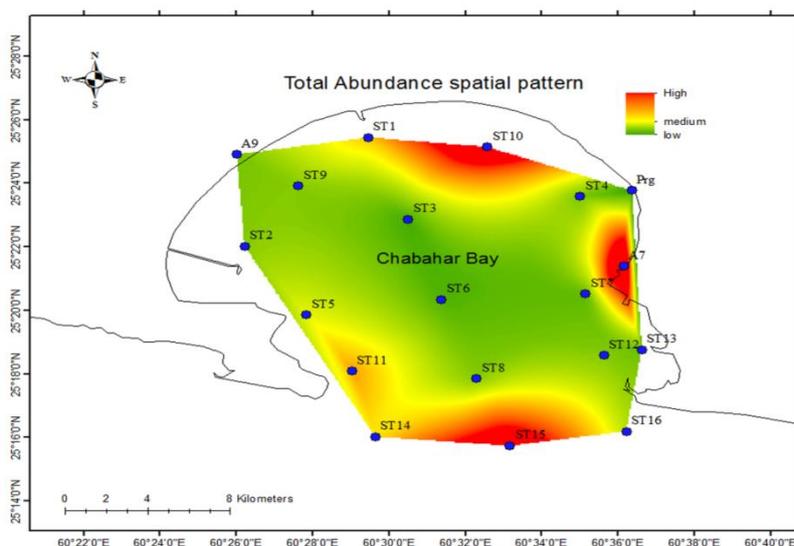


Fig. 2: Spatial distribution of amphipod abundance in Chabahar Bay

The biodiversity indices in this study was shown that Shannon index was different from 0 to 2.9 in the Chabahar Bay. The mean value of Shannon index was 1.2 in the studied area. The results of spatial pattern of calculated Shannon index in each station was observed in the Figure 3. The highest distribution of amphipod communities was on the east, northeast and southwest coasts of the Bay.

The results of Taxonomic distinctness index (AvTD) was mapped in the Figure 4. The highest average taxonomic distinctness index (AvTD) was calculated for west, southwest and southeast. The average taxonomic distinctness was differentiated from 0 to 2.9 with mean 1.2.

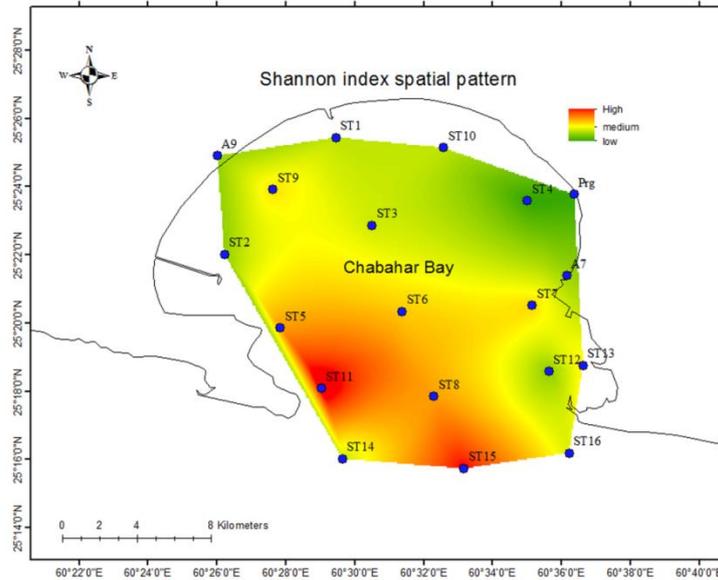


Fig. 3: The spatial pattern of Shannon index in the Chabahar Bay

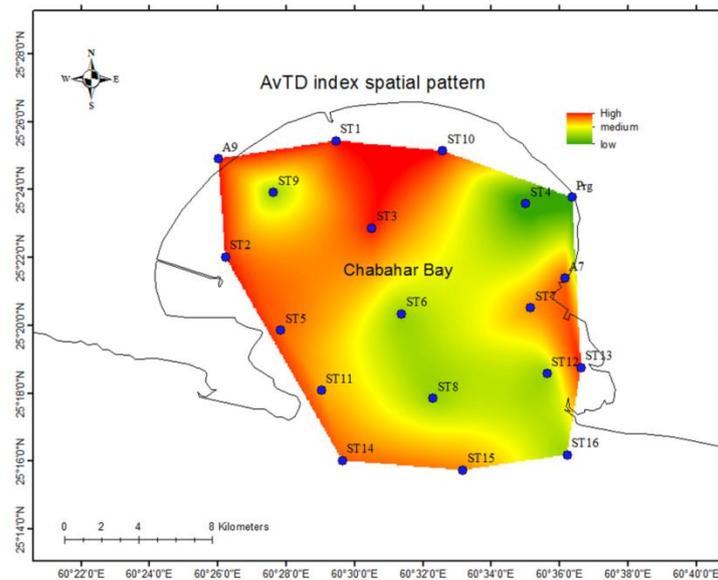


Fig. 4: The spatial pattern of average taxonomic distinctness in the Chabahar Bay

The result of variation taxonomic distinctness was demonstrated in Figure 5. The higher value of Λ^+ was recorded in western coast and the southeast of the Bay.

Funnel plots of the Δ^+ and Λ^+ for the studied stations and the elliptical plot of their combination, based on the presence and absence data, at 95% confidence level (continuous line) and mean value (dashed line), is shown in Fig. 6A–C. As indicated in Fig. 6, except for St16,12, 9, 8, 6, 4 in other stations Δ^+ is very close to the community average. The variance of Λ^+ is more than Δ^+ and all stations show irregular distribution around mean value (dash line).

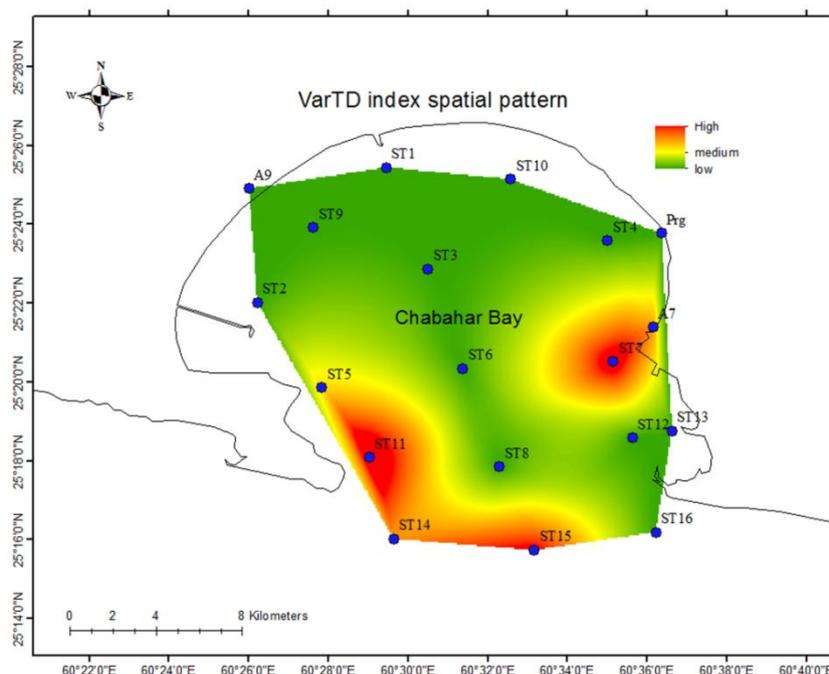


Fig. 5: The spatial pattern of variation in taxonomic distinctness in the Chabahar Bay

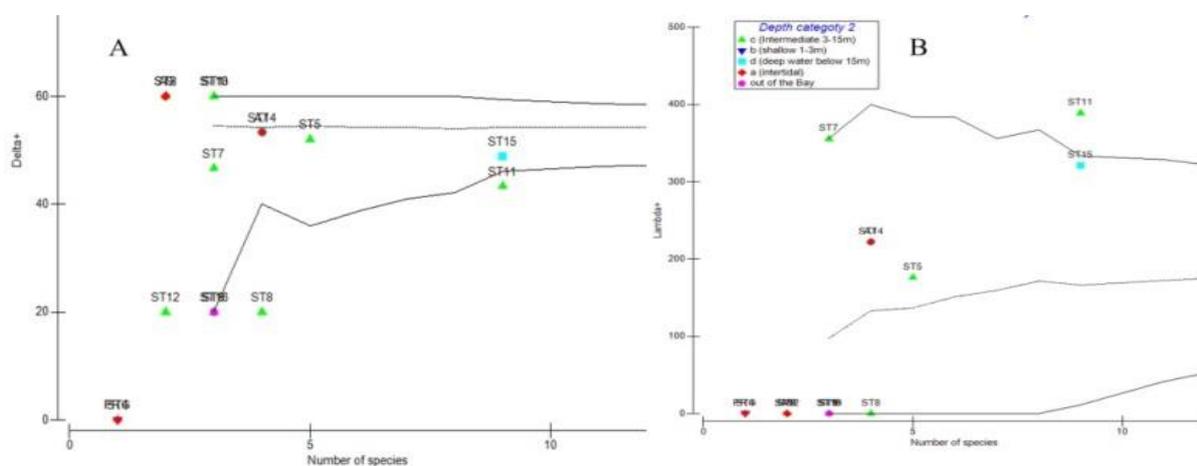


Fig. 6: Funnel plot of Average taxonomic distinctness (A) and Variation in taxonomic distinctness (B) in the studied stations

4. Conclusions

The response of species richness index to environmental changes in different habitats is not uniform due to the dependence of these indicators on habitat type and complexity (Warwick, R.M., 2008; Warwick & Clarke 1995;1996;1998).

For example, after an environmental disturbance, most species in a community that all belong to the same genus are replaced by species of different genera but with the same frequency, traditional diversity indices will not be able to detect the effects of environmental disturbances on species diversity (Ashori et al., 2016). Using of phylogenetic relationship could be improve the insight of ecosystem function on disturbance environment (Maghsoudlou et al., 2020).

However, the result of Shannon index in the region represent the low amphipod species diversity in the Chabahar Bay, but the average taxonomic index value show the high diversity expect for stations 16, 12, 9, 8 and 6.

The same results for numbered stations was seen in $\Delta+$ value. Warwick and Clarke (1995) were mentioned that with increase on pollutants in the ecosystem, the variation on taxonomic distinctness decreases. Therefore, stations that located under the mean line in the figure 6 (B) have not a safe ecological conditions. As amphipods known as sensitive organisms to pollution in marine environment (De-la-Ossa-Carretero, 2012), this is the early warning point for managements.

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