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Macrobenthic infaunal assemblage structure in nearshore and offshore seabeds of Ghana

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Abstract. *Commey NA, Armah AK, Lamptey E. 2021. Macrobenthic infaunal assemblage structure in nearshore and offshore seabeds of Ghana. Indo Pac J Ocean Life 5: 50-60.* This research aimed to compare and contrast the sediment properties and benthic macrofaunal assemblage composition of nearshore and offshore habitats. Also, the existing state of benthic macrofaunal assemblages in the Jubilee Fields, Ghana in 2015 is determined. A baseline is established for these communities before constructing a coal-powered plant in the nearshore area of Ekumfi Aboano, Ghana (deep-sea). The research was conducted in the shallower nearshore Ekumfi Aboano (average depth: 15 m) and deeper offshore portions of the Jubilee Fields (average depth: 1,250 m). A Van Veen grab was used to collect sediment samples from the nearshore area, while a box corer was used to collect samples from the deep water. PRIMER was used to look into the distribution of benthic macrofauna. Using GRADISTAT, it was determined that the nearshore sediment (mean grain size of 99.80 m) is fairly sorted with very fine sand. In contrast, offshore sediment (mean grain size of 109.79 m) was poorly sorted and comprised of extremely coarse silty fine sand. It was determined from studies of macrobenthic infauna that there were 11,131 individuals in the nearshore environment, with a density of 38 individuals/m^2, and 22,105 individuals in the deep-sea environment, with a density of 47 individuals/m^2. Data for the nearshore and offshore environments showed a total of 194 and 983 polychaetes, 827 and 696 crustaceans, 35 and 229 mollusks, 14 and 37 echinoderms, and 43 and 260 "others" (foraminiferans, nematodes, nemerteans, and sipunculids). Crustaceans > polychaetes > molluscs > others > echinoderms dominated the shallow Ekumfi seabed, whereas polychaetes > crustaceans > molluscs > others > echinoderms dominated the offshore Jubilee seabed. There were 116 species discovered close to shore, while 188 were discovered in the deep water. Both locations displayed a high level of diversity (H' > 4; 1-D > 0.9) and were evenly distributed (J' > 0.8). The nearshore was dominated by arthropods (74.30%), while the offshore was dominated by polychaetes (44.58%). A greater variety of macrobenthic infauna was found in the deep sea compared to the nearshore, with a difference of 75% between the two environments.

Keywords: Ghana, macrobenthic infauna, nearshore, offshore, seabeds

INTRODUCTION

Seventy percent of the Earth's surface is covered by water (Gray and Elliot 2009), making the marine environment the largest and most diversified biological community (Huston 1994; Garrison 2012). The marine ecosystem consists of continental shelf intertidal zones (0-200 meters), abyssal plains (2000-6000 meters), seamounts (> 1000 meters), and hadal troughs (6000-10000 meters) (Lalli and Parsons 2006). Its most essential characteristic is environmental heterogeneity; as a result, the ocean serves as the habitat for numerous animals found in the water column or connected to the seafloor (Lalli and Parsons 2006).

The two interdependent zones that make up the aquatic ecosystem are the water column (pelagic zone) and the sediment (benthic zone) upon which it rests. Regarding habitat size, the benthic zone is second to the pelagic environment but first in terms of geographical coverage (Bacci et al. 2009). These sediments are either autochthonous (originating where they are found) or allochthonous (originating elsewhere than where they are found) (FAO-FIGIS 2007). The benthic ecosystem is a community of bottom-dwelling creatures interacting with the sediment-water interface or environment. It is driven by the processes and variables of interdependent connections. Predator-prey relationships and competition are biological interactions (biology-biology relationships) that are capable of altering the biological community structure. Sediment morphology and chemistry can be affected by organism interactions (biology-environment relationships). In most instances, the extent of contact or modification is unknown but can be predicted (Gray and Elliot cit. Elliot et al. 2006). The activities of humans overlay these processes.

The devastation of natural environments (terrestrial and aquatic) has occurred over time as people have sought other energy sources to satisfy growing energy demands. Non-renewable resources (fossil fuels) are currently providing the majority of the world's energy, as reported by the International Energy Agency (IEA) Renewable Energy Working Party (2002). As we continue to mine for them, non-renewable resource quantities will continue to decline, driving up their prices and increasing environmental damage. Clean, renewable energy can meet or even exceed global energy demand while posing less danger to the planet's ecosystems.

Contrary to non-renewable resources, replenished over far longer timescales, renewable resources (such as wind, rain, sunlight, and geothermal heat) are constantly replenished on a shorter human timescale. Most of these renewable and non-renewable resources are overseen by governments located on continental shelves (Halpern et al. 2008). Submarine noise (Williams et al. 2015; Solan et al. 2016), gaseous emissions (Wilding et al. 2017), and electromagnetic fields are just some examples of the anthropogenic influences on the marine environment (Woodruff et al. 2013).

Human energy demands are concentrated on power generation, air and water cooling and heating, transportation, and rural energy services (REN21 2010).

Sufficient energy is based on energy security, limiting negative environmental effects, maximizing economic gains, and minimizing waste (International Energy Agency 2012). Biomass, hydropower, solar, wind, and geothermal energy contribute to the renewable 19% of world energy consumption (Ellabban et al. 2014; REN21 2016).

Hydropower, marine energy, solar energy, marine energy, and biomass energy are all significant options for energy generation that many African countries may use. For example, more than 30,000 extremely small solar panels are supplied annually in Kenya, making it the likely global leader in solar power system installations per capita. As a result, we save money on electricity while contributing significantly to environmental sustainability (Bullis 2012). In addition, liquid bioenergy (ethanol and methanol) from plant matter is used in several African countries as a domestic cooking stove fuel because it is clean, affordable, sustainable, and renewable. These countries include Ethiopia, Kenya, Mozambique, and Nigeria (REN21 2011). These efforts to use cleaner energy sources can help alleviate and even end poverty. Additionally, industrialization and urbanization can be accelerated (Wesseh and Lin 2016). Ghana's benthic environment has been subject to regular monitoring since the country's initial crude oil finding in 2007 when oil and gas drilling began on the country's continental shelf.

Shipping and maritime sector activities include oil and gas exploration and extraction, sonar systems, fishing methods (bottom trawling), dredging, and offshore mining (Coates et al. 2015; Hawkins and Popper 2016), have the potential to affect marine ecosystems and associated species. Species extinction, physiological modification (tissue damage, congenital disabilities due to chemical ingestion), behavioral modification, ocean acidification, and shifts in community structure and benthic species assemblages are all attributable impacts. However, it is unclear how much humans have an effect on the marine environment, especially the seafloor and related creatures (Halpern cit. Borowski 2001; Mesa et al. 2013). The need for regular assessment arises from the fact that shifts in the composition of marine benthic communities portend the disappearance of important services provided by this ecosystem (Tagliapietra and Sigovini 2010; MacDonald et al. 2012).

Maintaining a balanced maritime ecosystem depends on marine benthic communities and their supporting creatures. Indicator species are used to discover and determine the level of disruption to marine and aquatic habitats, and they play a role in elemental cycling, benthic remineralization, and eventually carbon sequestration (Pavithran et al. 2007; Jones et al. 2014). Acquiring macrobenthic baseline data will help direct environmental policy and biodiversity management in the deep seas of Ghana's EEZ (Froján et al. 2016). The main objectives include elucidating macrobenthic infaunal community structure and evaluating the connection between nearshore and deep-water seafloors.

MATERIALS AND METHODS

Study area

Ghana has a 550-kilometer (km) coastline. It was bordered by Guinea Current Large Marine Ecosystem (GCLME). Except for a 90 km extension off the coast of Takoradi, the continental shelf begins between 20 and 35 km out (ATFALCO 2012). The study focused on Ekumfi and Jubilee Fields, two major coastal locations in Ghana (Figure 1). Ekumfi Aboano was chosen because it is the intended location for the construction of a coal-fired power plant; as a result, baseline information on macrobenthic fauna is required for future comparisons and assessments of changes following production. Although the Jubilee research site has been operational for nearly a decade, the current status of the macrobenthic fauna within its operational area is unknown because historical reports cannot be used to monitor trends.

Ekumfi Aboano is located 78 kilometers west of Accra and 50 km east of Cape Coast (N 5°12'41.44", W 0°49'51.00"). This location experiences average temperatures of 28°C and approximately 70% relative humidity (Ghana Statistical Service 2014). The district's coastal boundary consists of rocky coasts and cliffs with short stretches of sandy beach. Within the Cretaceous-Eocene marine sands, the coastline contains some limestone and pebbly sand (Ghana Statistical Service 2014).

In 2007, the area between Deepwater Tano and West Cape, known as Jubilee Fields, was discovered. Three Points, which obstructs the Jubilee Fields (N 4°29'34.0", W 2°55'00.0"), is located 60 kilometers off the nearest coast at a depth of approximately 1400 meters (Tullow Ghana Limited 2009). Clays and silts range in hardness from soft to firm and make up most of the relatively smooth bottom (Tullow Ghana Limited ibid).

Data collection

Sampling took place at Jubilee Fields in November 2015 at a depth of 1,250 meters and Ekumfi Aboano in January 2016 at a depth of 15 meters. The sediments were sampled by lowering a Van Veen grab (used at Ekumfi Aboano) and a box corer (employed at the Jubilee Fields) to the seafloor using a winch. Both sampling devices had approximately 0.25 m^2 of surface area. When the descent rate neared the seafloor, precautions were taken to prevent damaging the epibenthos and the surface sediments. Samples were deemed acceptable after retrieval if they had a level surface, the grab or corer had been completely closed, or no significant leakage was seen. During the sampling process, random sediment samples were divided into two sections, one for biological (benthos) investigations and the other for sediment characterization. The sediment samples labeled for macrobenthic infaunal studies were emptied through a sieve with a mesh size of 0.5 millimeters (mm) and rinsed with seawater using a flotation technique that minimizes stress to the organisms and enables their separation from sediment (Tagliapietra and Sigovini 2010).

The macrobenthic organisms less than 0.5 mm were discarded, while fragile organisms or organisms remaining on equipment, such as ophiuroids, were collected using forceps and placed in labeled containers. In labeled storage containers, the leftover sample was backwashed with seawater.

The obtained specimens were subsequently treated with 10% buffered formaldehyde to preserve and harden some organism tissues. Date, location, sample type (macrobenthos or sediment grain size analysis), and preservation method were recorded on sample labels. Rose Bengal was applied to samples, 10 mL to $5.03*10^{-4}$ m^3 and 20 mL to $7.54*10^{-4}$ m^3, to stain the living tissues. Before usage at every sampling location, all equipment was inspected, cleaned, and rinsed.

For laboratory examination, sediment samples were labeled and stored in plastic containers for grain size analysis. Per sampling station, three replicate samples were collected due to the patchy distribution of benthos. There were a total of 64 samples taken, 29 from Ekumfi Aboano and 35 from Jubilee Fields.

Laboratory analyses

Macrobenthic infaunal analyses

The formaldehyde and other fine particles (lesser than 0.5 mm) were removed from macrobenthic samples by rinsing them with clean water on 0.50 mm-mesh sieves. The samples were equally distributed on a sorting tray with a white background and enough supply of clean water. Then, using fine forceps, the stained material was collected and placed into storage vials containing a 70:30 or 80:20 mixture of alcohol and glycerol. Alcohol permits short-term preservation, whereas glycerol lowers alcohol evaporation during solidification. During sorting, stained material or recognized species were classified into broad taxonomic groups, such as polychaetes, mollusks, and echinoderms (Eleftheriou and McIntyre 2007; Rumohr 2009).

Using a stereomicroscope, the identification of organisms was refined to the species level. As guides, acceptable taxonomic keys such as Nicklès (1950), Fauchald (1977), and Barnes (1994), as well as articles and manuals such as Tebble (1955), Rupert and Fox (1988), Branch and Branch (1998), Martin and Davis (2001), Rouse and Pleijel (2001), and Ardovini and Cossignoli (2004) were utilized.

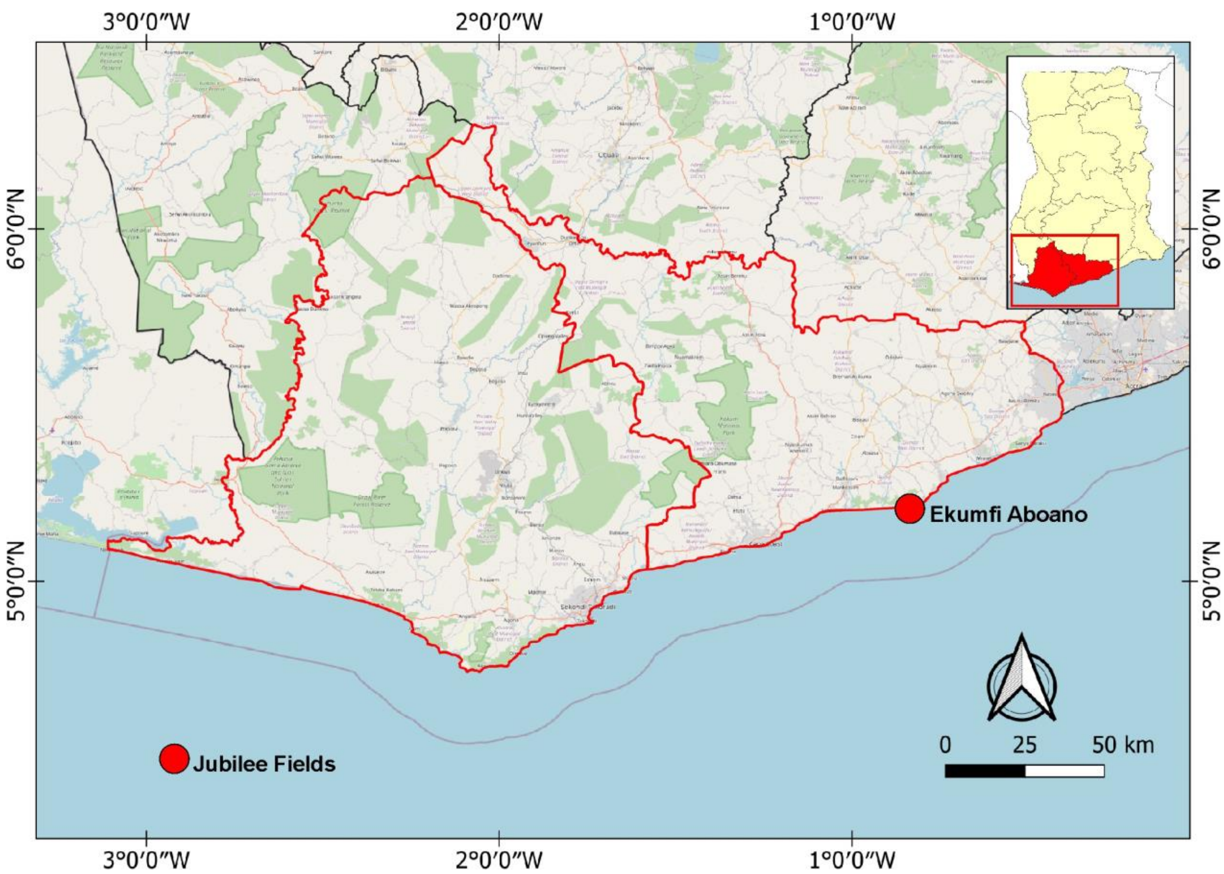

Figure 1. Map of Ghana showing sampling locations (Ekumfi Aboano and Jubilee Fields)

Sediment granulometry

In the Marine and Fisheries Sciences Post-Graduate Laboratory, sediment samples were oven-dried at 60°C for 8 hours at a constant weight of 120 grams (g) and analyzed with the Philip Harris A20002 weighing balance. Using a 63-micron (m) mesh filter, clumped sediment samples were rinsed with a dispersing reagent (1% NaOH(aq.)). Next, the residual sediment was oven-dried to constant weight at 60 degrees Celsius for six hours. The weight differences represented the silt-clay portion of the sediment. Next, 100 g of the dried sediment was weighed and sieved with the Octagon D200 Digital Sieve Shaker via stacked sieves. Following a diminishing geometric scale, the stacked sieves were positioned as follows: 1 mm, 0.5 mm, 0.355 mm, 0.125 mm, 0.063 mm, and the receiver. These sieve mesh sizes hold very coarse, coarse, medium, and fine sand particles. The retainer retains the silt and clay fractions of the sediment, respectively. Using the Philip Harris A20002 measuring scale, the weight of retained silt on each screen was calculated and recorded to the nearest 0.01 g. The collected sediment grain sizes were classified with the Wentworth scale (Blott and Pye 2001; Gray and Elliot 2009).

Diversity indices

Several indices can be used to measure diversity indicators that act as an indicator of community health on spatial and temporal scales (Magurran 2004). In this study, however, diversity indices such as Margalef's species richness, Pielou's evenness index, Shannon- Weiner, and Simpson's diversity index were utilized.

Margalef's species richness (d)

Species richness is the total number of different species found inside a sample without accounting for the proportion and distribution of each species. For example, the following equation represents the Margalef index (Margalef 1958):

$$d = \frac{(S-1)}{lnN}$$

Where:
S = the total number of species, and
N = the total number of individuals in the sample.

Pielou's evenness (J')

Pielou (1966, 1969) utilized the ratio of the expected number of species to the actual number of species as an indicator of evenness, assuming that all species were represented in the sample. It facilitates the determination of organism distribution among sampled assemblages. A higher score indicates a more even distribution of individuals within the species. Species evenness is based upon species abundance and diversity. The measure of evenness is the ratio of the observed diversity to the greatest that might exist in a sample with the same number of species. The equation used was:

$$I' = \frac{H'}{H'max} = \frac{H'}{\log S}$$

Where:
H' = the Shannon-Wiener diversity index
S = the total number of species

Shannon-Wiener's diversity index (H')

The Shannon-Wiener diversity index (or simply Shannon diversity) describes the condition of an assemblage in terms of the number of species present and the relative abundance of those species. It assumes that all species are represented in the sample and that random samples are taken from a large population. The diversity of a community is determined by the obtained value: 0 to 1.5 for low diversity, 1.5 to 2.5 for moderate diversity, and > 2.5 for great diversity. Shannon-Wiener diversity value typically ranges from 1.5 to 3.5 but can reach 4. The indicator rises as community wealth and distribution improve (Magurran 2004). The used equation is:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

Where:
pi = the proportion of individuals found in species i
ln = natural logarithm
s = the total number of species

Simpson's diversity index (D)

Simpson (1949) first proposed using this metric to quantify the level of species concentration in a given taxonomic group. Simpson's diversity index can take on values between 0 and 1, with 0 indicating no diversity and 1 indicating infinite diversity. The measure correlates positively with both species diversity and abundance. Therefore, the Simpson index ignores the small number of individuals belonging to rare species since it places more importance on more abundant species.

The equation used to measure it was:

$$D = \sum \left(\frac{n(n-1)}{N(N-1)}\right)$$

Where:
n = the total number of organisms of a particular species
N = the total number of organisms of all species

Since D measures predominance, a higher D results in less diversity (in the traditional sense). Because of this, the complement 1-D of Simpson's index is typically reported. It gives a proportionate, intuitive, and less species-richness-dependent measure of diversity.

Sediment granulometry assessment

Grain size is a key feature of sediment particle transit and deposition (Blott and Pye 2001), as it permits the assessment of sediment nature at sampling stations (Gray and Elliot 2009). Using modified scales from Udden (1914) and Wentworth (1922), sediment was classified.

Statistical analyses

Species abundance, species' relative abundance, frequency of occurrence (FOQ), the relative frequency of occurrence, and species diversity indices are performed as univariate analyses. The primary objective of the multivariate analysis was to evaluate the variability between sampled species, families, and sampling locations. Dendrograms were used to visualize macrobenthic assemblage patterns to determine the link between sampling sites. Using SIMPER (Similarity Percentage) tests, it was determined which species contribute to observed variations between and within sites. The grain size distribution was analyzed with the GRADISTAT tool, a Microsoft Excel-based statistical package. Univariate and multivariate analyses were conducted using the Microsoft Excel tool Pac and PRIMER (Plymouth Routines In Multivariate Ecological Research) version 6, respectively. In addition, version 23 of IBM SPSS (Statistical Package for the Social Sciences) was used to test hypotheses.

RESULTS AND DISCUSSION

Polychaetes, crustaceans, mollusks, echinoderms, and sipunculids were discovered and recognized within the collected samples. Figure 2 depicts a selection of these creatures.

Macrobenthic species abundance and relative abundance

Table 1 displays the variety of species found at Ekumfi and Jubilee. There were 1113 individuals with an average density of 38 individuals/m^2 in the nearshore habitat and 2205 individuals with an average density of 47 individuals/m^2 in the deep-sea environment. The analyses yielded polychaetes, crustaceans, mollusks, and "others" as taxa. Other species consisted of foraminiferans, nematodes, nemerteans, and sipunculids.

The numerical abundance of species in the nearshore habitat revealed that there were 194 polychaetes, 827 crustaceans, 35 mollusks, 14 echinoderms, and 43 other species. The respective average densities were 15, 62, 23, 28, and 57. There were 983 polychaetes, 696 crustaceans, 229 mollusks, 37 echinoderms, and 260 other species inside the deep-sea ecosystem. Their relative total densities were 36, 59, 42, 29, and 157 (Table 2).

Crustaceans > polychaetes > molluscans > others > echinoderms dominated the shallow Ekumfi seabed, whereas polychaetes > crustaceans > molluscans > others > echinoderms dominated the deep Jubilee seabed.

Macrobenthic species richness and diversity

Margalef's index (d) in the nearshore environment was 15.68, and Pielou's index (J') was 0.88. Shannon-Weiner and Simpson indices were 4.13 and 0.98, respectively, for the diversity. In the deep-sea benthos, Margalef's index (d) was found to be 24.16 while Pielou's index was 0.88. Shannon-index Weiner's diversity is 4.43, and Simpson's index is 0.98. It indicates that species richness and variety were greater in the macrobenthos of the deep sea (Table 3). The significance of the discrepancy was evaluated using the Mann-Whitney test (Table 4).

Cluster analysis

Dendrograms depicting a Bray-Curtis similarity cluster assessment between-site (Figure 3) and within-site (Figures 4 and 5) are provided. About 75% dissimilarity was found between-site. Across all of Ekumfi Aboano, the average degree of similarity was 40%. Within-site similarity for Jubilee Fields was measured at 35%.

Sediment characterization

Very fine sand, well sorted, was found in the Ekumfi sediment core, while very coarse silty fine sand, poorly sorted, was found in the Jubilee sediment core (Table 5). The average grain size of the sediments in the nearshore and offshore regions was determined to be 99.80 µm and 109.79 µm, respectively. At Ekumfi, the correlation between abundance and grain size was positive (0.82), whereas it was negative (-0.82) at Jubilee Fields (Table 6).

Species frequency of occurrence

The most common species of macrobenthic organisms at Ekumfi Aboano and Jubilee Fields are depicted in Figures 6 and 7, whereas the most common macrobenthic families are depicted in Figures 8 and 9.

Nineteen (19) out of 116 species were found to have the highest frequency of occurrence (> 20%) in the Ekumfi survey (Figure 6). Arthropods (13 species), polychaetes (2 species), mollusk (1 species), echinoderm (1 species), nemertean (1 species), and nematode (1 species) made up the majority of the 19 dominant species. Of the 188 species found in the Jubilee Fields, 14 were more common than the 50% threshold (Figure 5). Six annelids (polychaetes), six arthropods (crustaceans), one mollusk, and one nematode were among 14 species.

Similarity percentage (SIMPER)

To compare species richness between and within sites, the percentage of species contribution to the sample was calculated. Eleven (11) species accounted for 70.3% of the community structure in the Ekumfi samples, leading to an average similarity of 5.68% between them. In the Jubilee Samples, 24 species accounted for an average of 28.41% of the similarity and 70.4% of the community structure. Seventy-two species made up 70.3% of the difference in community structure between the Ekumfi and the Jubilee.

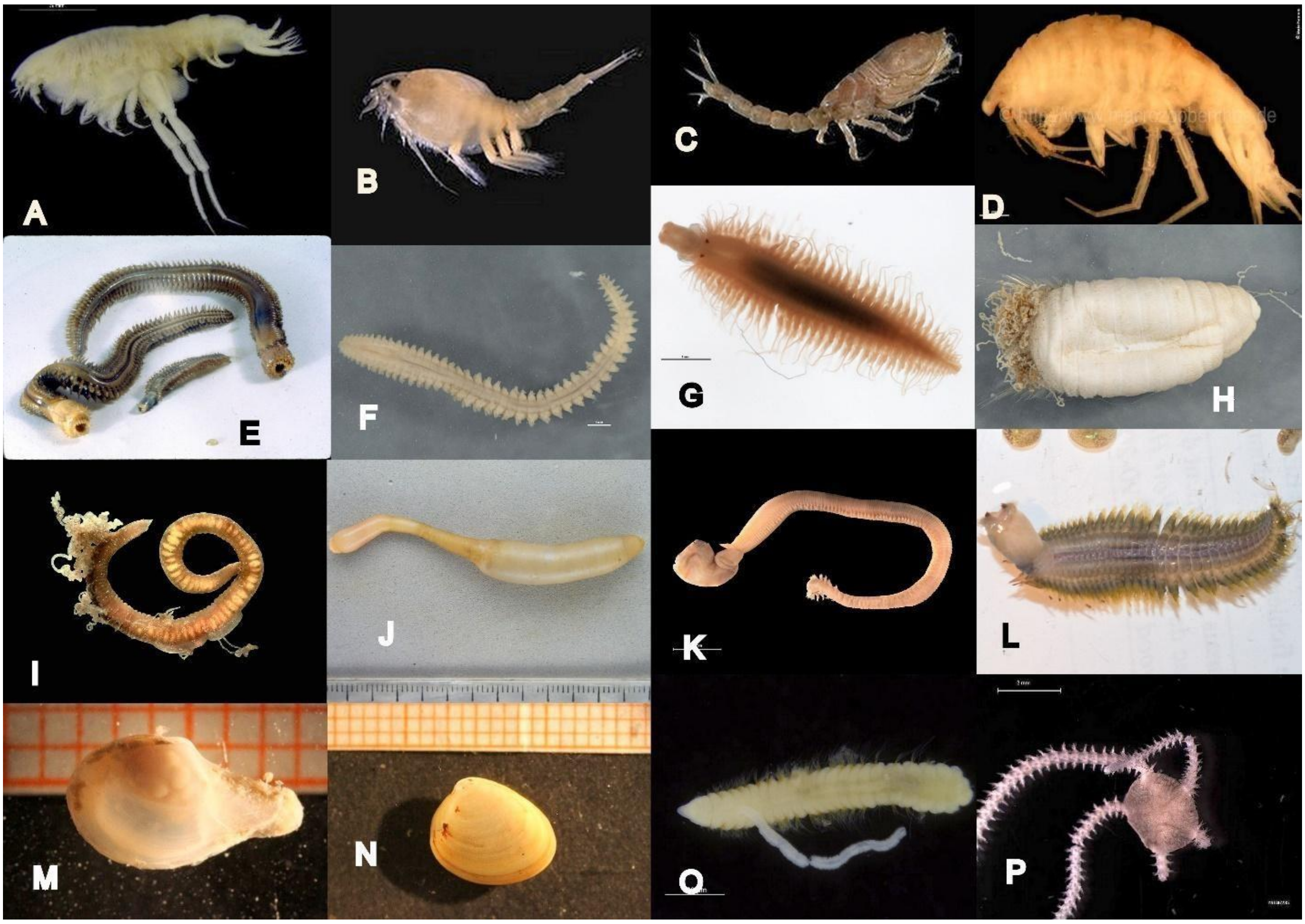

Figure 2. Photo documentation of some macrobenthic fauna found at the study sites; (A) *Harpinia* sp. [Crustacea], (B) Phyllocarida [Crustacea], (C) Diastylidae [Crustacea], (D) Oedicerotidae [Crustacea], (E) Nepthyidae [Polychaeta], (F) Paralacydonidae [Polychaeta], (G) Hesionidae [Polychaeta], (I) Cirratulidae [Polychaeta], (J) Sipuncula, (K) Goniadidae [Polychaeta], (L) Polynoidae [Polychaeta], (M) Cuspidaria [Mollusca], (N) Nuculidae [Mollusca], (O) *Cossura* sp. [Polychaeta] and (P) *Amphiura* sp. [Echinodermata] (Photo credit: https://creativecommons.org/)

Table 1. Abundance (No. of individuals) and relative abundance (%) of major macrobenthic faunal groups were identified at the study sites

Taxa	Ekumfi Aboano			Jubilee Field		
	No. of species	Abundance (No. of individuals)	Relative abundance (%)	No. of species	Abundance (No. of individuals)	Relative abundance (%)
Polychaetes	52	194	17.43	109	983	44.58
Arthropoda	53	827	74.30	47	696	31.56
Molluscans	6	35	3.14	22	229	10.39
Echinoderms	2	14	1.26	3	37	1.68
Others	3	43	3.86	7	260	11.79
Total	116	1113	100	188	2205	100

Table 2. Densities (individuals/m^2) of major macrobenthic faunal groups

Location	Major taxa					Total
	Polychaeta	Crustacea	Mollusca	Echinodermata	Others	
Ekumfi Aboano (nearshore)	15	62	23	28	57	38
Jubilee Fields (deep-sea)	36	59	42	29	157	47

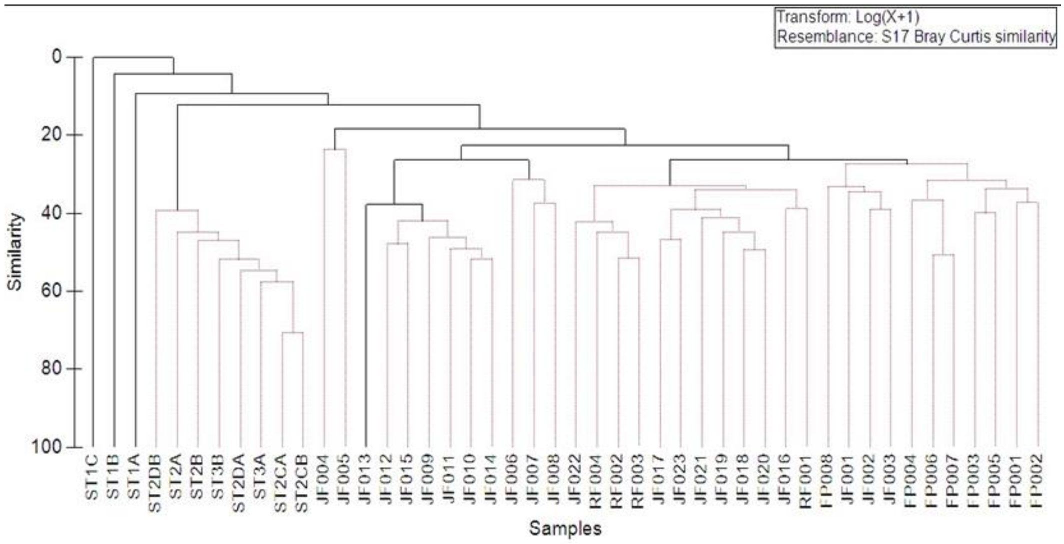

Figure 3. Significance test of the difference between sampling sites

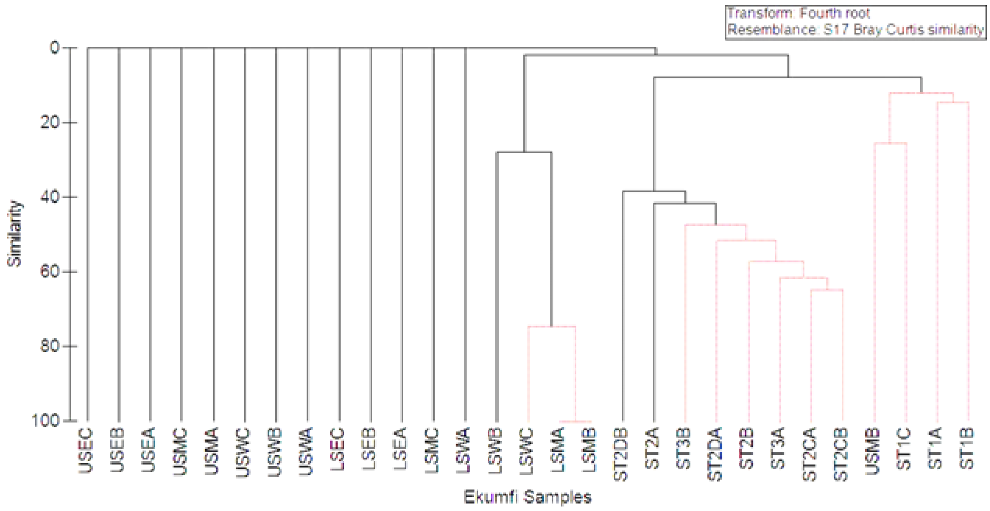

Figure 4. Bray-Curtis similarity (%) dendrogram within Ekumfi sites, Ghana

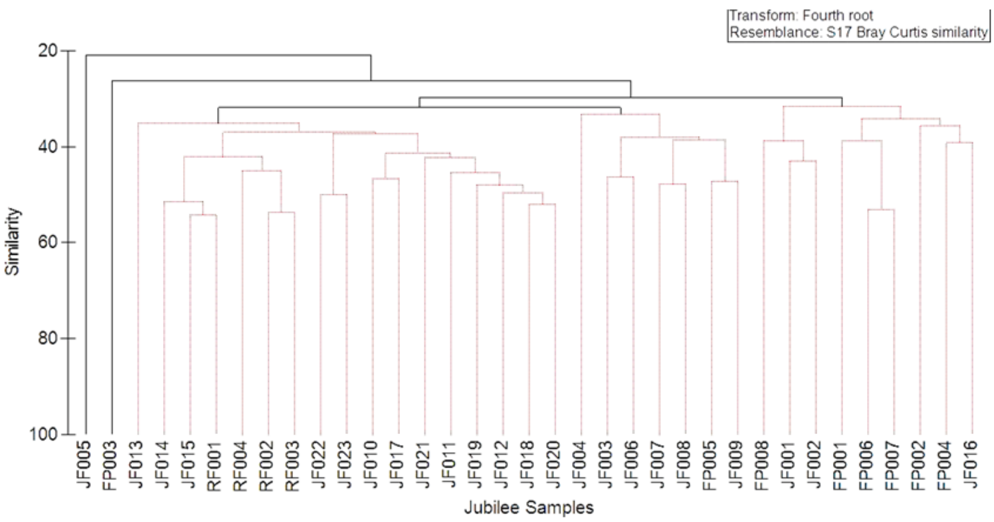

Figure 5. Bray-Curtis similarity (%) dendrogram within Jubilee sites, Ghana

Table 3. Between-site species richness and diversity indices

Diversity indices	Ekumfi Aboano	Jubilee Fields
Margalef's index (d)	15.68	24.16
Pielou's index (J')	0.88	0.85
Shannon-Weiner index (H')	4.13	4.43
Simpson's index (1-D)	0.98	0.98

Table 4. Significance test of the difference between sampling sites

α	0.05
P value	0.750

Table 5. Summary of sediment grain size results for Ekumfi Aboano and Jubilee Fields, Ghana

	Ekumfi Aboano	Jubilee Fields
Sieving Error	3.9%	2.6%
Sample Type	Bimodal, Moderately Sorted	Trimodal, Poorly Sorted
Sediment Name	Moderately Sorted Very Fine Sand	Very Coarse Silty Fine Sand

Table 6. Correlation between abundance and sediment grain size

	Abundance	Sediment grain size
Ekumfi Aboano		
Abundance	1	
Sediment grain size	0.816	1
Jubilee Fields		
Abundance	1	
Sediment grain size	-0.816	1

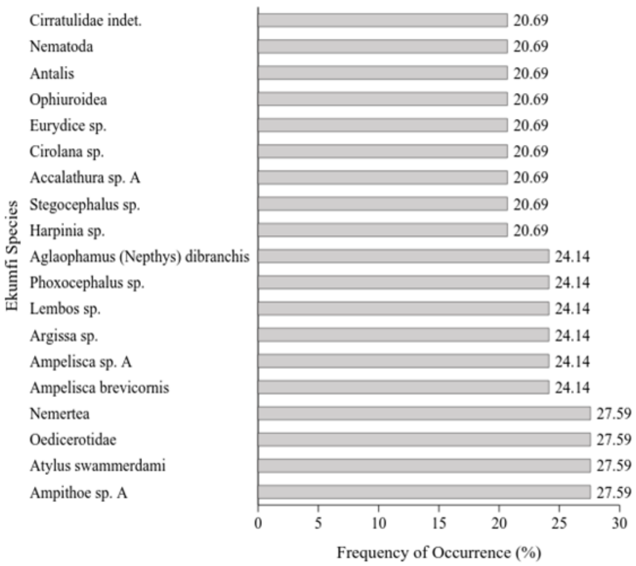

Figure 6. Frequency of occurrence for dominant (>20 %) macrobenthic species in Ekumfi Aboano, Ghana

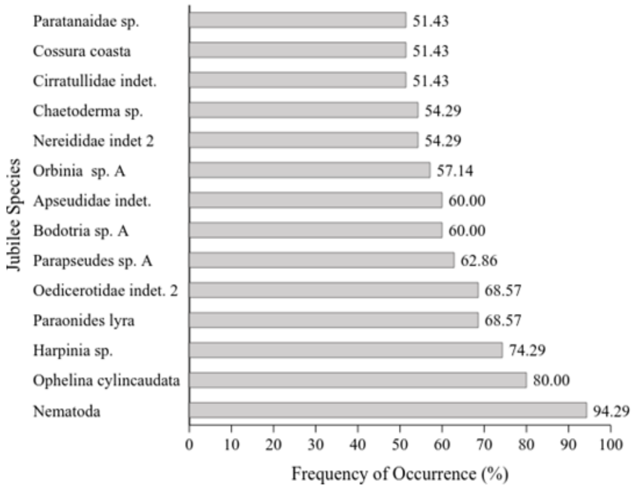

Figure 7. Frequency of Occurrence for dominant (>50 %) macrobenthic species in Jubilee Fields, Ghana

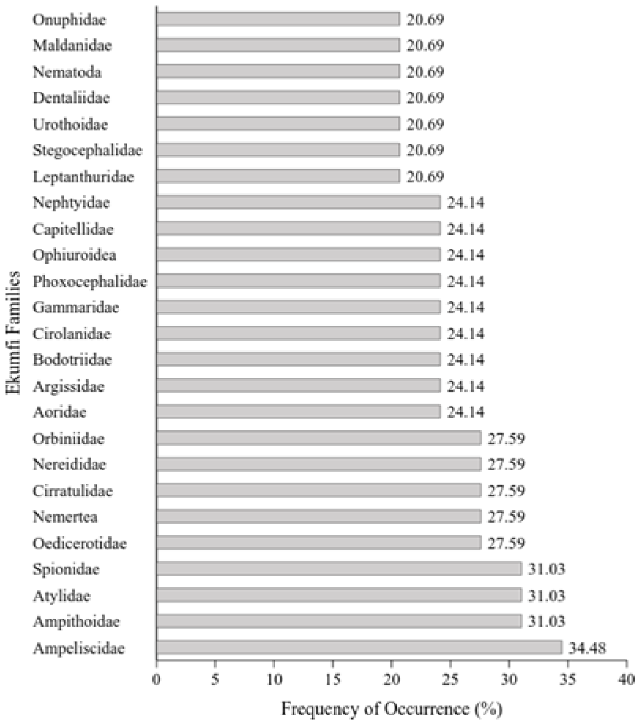

Figure 8. Frequency of Occurrence for dominant (>20 %) macrobenthic families in Ekumfi Aboano, Ghana

Discussion

According to Table 2, a healthy marine ecosystem would include 38 creatures per square meter in the Ekumfi Aboano area and 47 organisms per square meter in the Jubilee Fields area. However, it is not possible to achieve since benthic species are not evenly distributed. Species macrobenthic assemblage richness was higher in Jubilee (H' = 24.16; 2205 individuals) than in Ekumfi (H' = 15.68; 1113 individuals). It can only be explained by considering the scale and intensity of the perturbation in addition to the number of samples obtained, i.e., the relationship between species richness and sample size (Magurran 2004).

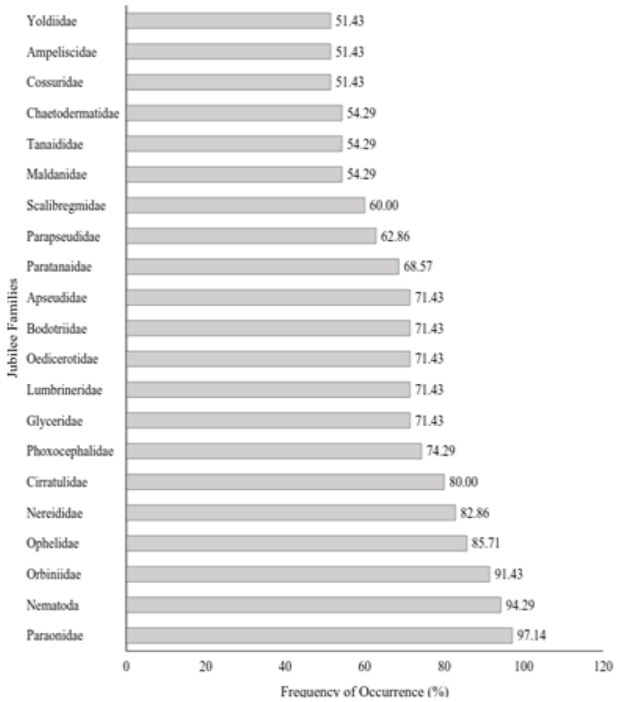

Figure 9. Frequency of occurrence for dominant (>50 %) macrobenthic families in Jubilee Fields, Ghana

The species diversity index was 0.90 in both cases. It suggests that macrobenthos patchiness, predators, underwater current, tidal, or wave movement all play a role in maintaining a somewhat even distribution of species throughout both sampling sites (Macdonald et al. 2012). The potential of an ecosystem to sustain a wide range of taxa and a robust community structure can be inferred from the species diversity present within sites (Erftemeijer et al. 2012) (Table 3).

The high numbers of nematodes indicated that both areas had abundant detritus, bacteria, and fungi, causing nematodes to be more common and abundant overall in both areas studied (Table 6). Changes in ratios measured over time can reveal whether the food chain is stable, developing, organized, or deteriorating (Krumins et al. 2013).

A substantial positive trend (0.82) was seen between abundance and grain size in the nearshore environment, while a large negative trend (-0.82) was seen in the deep-water environment. The activity of organisms (bioturbation, organic matter present, and feeding strategies), population density (number of species), diversity (types of organisms), and abundance (sizes of organisms) all have an impact on sediment composition (including sediment particle size) (Mermillod-Blondin et al. 2005; Wahl 2009). Benthic communities and sediment composition have been shown to have either no or a weak association in some research (Seiderer and Newell 1999; Arrighetti and Penchaszadeh 2010). According to the results, larger grain sizes in the average sediment contributed to fewer deep-water macrobenthos and more nearshore ones. It is common for the sediment properties of the nearshore seabed to change as a result of inland material being transported to the coast (Logan 2007).

The cluster analysis showed that nearshore and deep-water macrobenthic assemblages were 82% different. Dissimilarities like these can be attributed to a wide range of natural and anthropogenic factors, such as the composition of the sediment, the pressure at which it is held, the temperature at which it is maintained, the availability of food and water, and the proximity of trawling and anchoring grounds. Since the composition of the sediment and the availability of food are affected by the speed of the currents, the availability of food is the determining factor in the composition of the marine (Wieking and Kroncke 2005).

The distribution and abundance of macrobenthic animals are influenced by the distribution and composition of sediments, which differ between deep-sea and nearshore locations. The composition of the macrobenthic community is often dependent on depth (Allotey 2010). Sediment in the deep sea was said to be finer than that at the near coast. Variations in hydrodynamic regimes (wind velocity and direction, current and tide motions) influence weather patterns, physicochemical or biochemical processes, and the biological activities of different species, all of which contribute to the observed variations in sediment nature (Open University 2002).

About 90% dissimilarity was found using the Bray-Curtis similarity test amongst the sampled sites in Ekumfi Aboano (nearshore). The most prevalent families (>20%) were arthropods (14 families) and polychaetes (8 families). Within Jubilee Fields (deep-sea), Bray-Curtis similarity was approximately 70% dissimilar. The dominant families that occurred most frequently (> 50%) were polychaetes (10 families) and arthropods (8 families). As Patel and Desai (2009) discovered, the nearshore environment, which consisted primarily of very fine sand, was more dominated by arthropods than polychaetes. Still, the deep-sea environment of fine silty sand had more polychaetes than arthropods.

Using the SIMPER test at the species and family level, comparisons of contributing species and families to the respective community structure were established (Tables 7-11). Within the macrobenthic community structure of the nearshore seafloor, the polychaete family Pisionidae and the crustacean family Ampeliscidae contributed 18.71%. Pisionids are aggressive burrowers with a strong preference for soft, silty substrates and are frequently seen in interstitial groups, whereas Ampeliscids are tube-dwelling organisms that inhabit fine sand and mud. Both families are cosmopolitan and can survive in shallow to deep water. In Jubilee, polychaete families (Paraonidae [8.37%], Orbiniidae [6.59%], Opheliidae [6.22%], Nereididae [5.11%], and Cirratulidae [4.88%]) and nematodes contributed the most to the community structure. It was discovered that these polychaete groups are burrowers with a strong affinity for sandy mud substrate (Day 1967; Rouse and Pleijel 2001). Similar to Gray and Elliot's (2009) observations, the collected species were global and representative of the sediment's nature.

The Ekumfi macrobenthic community structure was dominated by crustacean species (including *Ampithoe* sp. [11.07%], *Argissa* sp. [9.64%], and *Lembos* sp. [8.4%]). It is identical to Gray's (2002) observation of crustacean dominance in sandy areas, especially nearshore. Nematodes, Ophelina cylincaudata, and Harpinia sp. contributed 21.15 % to the abundance and structure of the community. Due to their free-living or parasitic nature, nematodes outweigh the other species, particularly in an oxygen-depleted and organic-rich environment (Abbott and Murphy 2003). The average dissimilarity between Ekumfi and Jubilee was 95.52%, demonstrating the statistically significant difference (p= 0.05) between the macrobenthic infauna of nearshore and deep-sea habitats.

The 2015 sampling of the Jubilee Field macrobenthic assemblage structure revealed that polychaetes (44.58%) and arthropods (31.54%) comprised 76.14% of the community structure. Within the Jubilee Field, a polychaete complex including 109 species was discovered. Unexpectedly, it was determined that there is a greater likelihood of finding an arthropod (59 individuals/m^2) or mollusk (42 individuals/m^2) per square meter than a polychaete (36 individuals/m^2). During this survey, no exotic or invasive species were identified. The sediment is comprised of very coarse, silty, fine sand that is heterogeneous and characteristic of places with a low wave or current activity, as found in deep-sea environments (Cartes et al. 2002; Gray and Elliot 2009). Therefore, the abundance of creatures in the region can be related to exploratory operations.

Ekumfi Aboano, on the other hand, had a limited diversity of taxa, as polychaetes and arthropods made up 92% of the 116 species obtained (105 species). With a density of 62 individuals per square meter, arthropods comprised more than half of the total abundance. With the strong energy in the region from waves and currents, the predominant sediment nature was discovered to be well-sorted and homogeneous in grain size, presumably impacted by terrestrial runoff from inland waters, aeolian deposition, or meteorological activities.

In conclusion, compared to nearshore seabed sediment from Ekumfi Aboano (very fine sand), the study found that polychaetes were more common in deep-seabed sediment from Jubilee Fields (fine silty sand). There is a correlation between nearshore and deep-sea depth, sediment fineness, and the diversity of macrobenthic organisms, suggesting that deeper waters are home to more diverse and abundant macrofauna. The composition of the macrobenthic community is not noticeably different between the nearshore seafloor (Ekumfi Aboano) and the offshore seafloor (Jubilee Fields). From the Jubilee Field, this research found that I polychaetes (44.58%) and crustaceans (31.56%) made up the majority of the community structure, (ii) the macrobenthic fauna were evenly distributed (0.85) and highly diverse (H' - 4.43; 1-D - 0.98), and (iii) the taxa dominance order was polychaetes > crustaceans > molluscans > others > echinoderms. This study found that Ekumfi Aboano has: I a highly varied (H' - 4.13; 1-D - 0.98) and evenly distributed (0.88) macrobenthic community, (ii) the majority (91.73%) of the macrobenthic fauna abundance as polychaetes (17.43%), with crustaceans (74.30%) dominating, and (iii) the following taxonomic dominance order: crustaceans > polychaetes > molluscans > others > echinoderms.

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