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Original article

Some Traits of Meiofauna in the Surf Region of the Southern Mediterranean Sea Coast (Alhamama - Susa)

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Abstract
In the winter of 2022, meiofauna diversity in the near-shore sandy bottom surf region of the Southern Mediterranean Sea was established using two study locations in eastern Libya. The most abundant taxa among the seven floatable meiofauna (extracted from sediment samples by flotation) were Foraminifera and Nematoda. Bivalve, Copepoda, Ostracoda, Nemertea, and Turbellaria were the additional taxa that were available. There were four non-floatable meiofauna taxa found: Ostracoda, Bivalve, Gastropod, and Foraminifera. Possible causes of this low diversity of floatable and non-floatable meiofauna include the region's high wave activity and the nearby harmful human activities. Differences in neighboring coastal anthropogenic activities may have had a greater influence on the interstitial habitat, but the reasons for the between-site variations in meiofaunal diversity remain unknown. Susa had a higher level of meiofaunal diversity than Alhamama. There is a need for new, useful methods for gathering and classifying the smaller meiofauna.
Keywords: meiofauna, surf region Mediterranean Sea, southern, Libya

Introduction

In all aquatic habitats, pelagic animals live in the water column. They are either huge swimmers or, with rare exceptions, small planktonic drifters, like fish, whales, turtles, and cephalopods. Bentos are creatures that live on the bottom. Epifauna, infauna, and meiofauna are the three types of benthos that inhabit the bottom's surface, under it, and between the sediment grains. Interstitial organisms, or meiofauna, are microscopic creatures with sizes ranging from 500 to 0.045 mm. Microbenthos are infauna smaller than 0.045 mm, and macrobenthos are infauna greater than 500 mm. Meiofauna are tiny creatures that live intermittently or consistently between or connected to the soil in all aquatic ecosystems (fresh and marine) at all latitudes and depths.

Meiofauna are minute creatures that live constantly or intermittently between or attached to soil grains in all aquatic ecosystems (fresh and marine) at all latitudes and depths. Meiofauna are most common in the top 5 to 10 cm of the substratum, whereas their numbers decline below. Despite becoming less prevalent further out to sea, they are nonetheless widespread in shallow coastal waters. There is widespread zoning. There is typically a significant degree of diversity across species and individuals, and they typically exist in very high biomass and abundance, often in the millions per square meter. The main factors influencing their abundance are the granulometry of the substratum, the physicochemical properties of the water directly above it, especially the inorganic nutrients, the dissolved oxygen content, temperature, salinity, the organic load of the substratum, waves and currents, and pollution.

Because of their wide distribution and high variety throughout all aquatic environments, meiofauna contribute to the cycling of nutrients and provide food for higher trophic levels. [1-3]. Latitudes often have minimal impact on the horizontal distribution of meiofauna. Because subsurface substrata ecosystems are governed by fewer, more stable traits than surface substrata habitats, they are more longitudinally and latitudinally stable. The majority of invertebrate taxa are classified as meiofauna, which includes nematodes, copepods, oligochaetes, terbillarians, and protozoans as the main species [3].

Meiofauna have developed numerous adaptations for interstitial residence. According to [2, 4], these small, typically active organisms can easily place themselves between sand grains thanks to their elongated, vermiform, or flat bodies. The body is reinforced by features such as epidermal cuticle, spines and spicules, and sticky glands that enable them to bind to soil particles [3]. Some basic organs are omitted. As solitary organisms, gonads are frequently dioecious or hermaphrodite and copulate. Parental care of some sort is common, and either benthic or pelagic larvae can develop directly or indirectly [5-8]. All feeding modes are pursuit. The current study aimed to identify significant meiofauna features in the southern Mediterranean Sea near-shore coastal water (surf region) in the winter of 2022, using two research sites on Libya's eastern coast.

Methods

The study sites

The research locations were: 1-Alhamama, 2-Susa, located on Libya's eastern coast (Fig. 1).

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Figure 1. The study sites (2 sub-sites).

Collecting bottom substratum samples

Samples of the bottom sediments were taken using a core and a shovel from the top 10 cm of the nearshore submerged substratum of each study site in order to extract the contained meiofauna. These samples were also used in other studies to measure the bulk and real density, porosity, and granulometry of the soil.

Extraction of the Meiofauna

After thoroughly mixing each sediment sample that was collected, a 75g subsample was taken and treated as follows: After the subsample was placed in a measuring cylinder, the encased meiofauna were anesthetized with a 3.5% MgCl2 solution, which caused them to loosen their grip on the sand particles. After adding water, the cylinder was shaken vigorously to suspend the sediment particles and meiofauna. The sediment particles, but not the meiofauna, were allowed to settle at the bottom of the cylinder for a few seconds. The water, which now contained the majority of the floating meiofauna, was then rapidly decanted into a beaker. To guarantee the maximum extraction, this procedure was carried out multiple times. Based on [9, 10, 11], three distinct methods were employed to extract the meiofauna from the water in the beaker:
- Settlement: Half of the water in the beaker was used. We put drops of buffered formalin into the beaker to destroy the meiofauna. To allow the meiofauna to sink to the bottom, the beaker was left motionless for a whole day. Only 5 mL of water holding the meiofauna remained after the water above it was carefully skimmed off.

Flotation: The beaker's water was used to fill half its capacity. Until the water in the beaker was almost saturated, the sugar was added. By increasing the water's density, this process made the confined meiofauna float at the water's surface in the beaker. Only around 5 milliliters of water remained when the water beneath the meiofauna was carefully drained out after 12 hours. Filtration: Water collected from beakers using the two methods described above was filtered using filter paper to get rid of any meiofauna that remained. The extracted meiofauna's identification: Floatable meiofauna**:** Meiofauna recovered via the three previously stated procedures were called "floatable meiofauna" because each of them used flotation and decantation. Under a microscope, the extracted meiofauna was categorized to the lowest taxa using the information that was accessible online. From each of the five milliliters, one milliliter was taken out, spread out on glass slides, and examined under a microscope. After that, the filter paper was examined under a microscope.

For each subsample and location, relative abundance units ((0): absent, +: low abundance, ++: medium abundance, +++: high abundance) were utilized in place of absolute numbers of individuals per taxon. Non-floatable meiofauna, the subsample (wet soil) that remained after the meiofauna was recovered using the previously indicated methods, contained some shelled meiofauna, including foraminifera, radiolarians, gastropods, and bivalves. They were too heavy to be gathered, and these methods relied on flotation at one point or another. Therefore, the remaining subsample was spread out on glass slides and examined under a microscope to identify and count the contained meiofauna. These species were classified as "non-floatable meiofauna". Meiofauna abundance by taxon is shown using relative abundance units (0: absent, +: low abundance, ++: medium abundance, +++: high abundance). Online resources served as the foundation for the identification procedure.

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Results

According to Table 1, the seven floatable meiofauna taxa that were discovered (to the lowest taxon) in the near-shore submerged sediments of the research locations throughout the winter were Foraminifera, Turbellaria, Nemertea, Nematoda, Bivalve, Copepod, and Ostracoda. With just five species (Table 1), the Alhamama group was the weakest in the meiofauna. These taxa included Bivalve, Turbellaria, Foraminifera, and Nemertean Nematoda. The six taxa in Susa, the most prevalent were Foraminifera, Nemertea, Nematoda, Bivalve, Copepod, and Ostracoda.
Considering individual abundance by taxon, Nematodes (with six stars) were the most prevalent taxon. With four stars, Bivalve and Foraminifera were the least abundant, followed by Nemertean (two stars), Turbellaria, Copepod, and Ostracoda (one star) (Table 1).

Table 1. Relative abundance of floatable meiofauna in sediments of the study sites during winter 2022.

Taxa	Alhamama	Susa	Relative abundance of individuals\ taxon
Foraminifera	+	+++	4
Turbellaria	+		1
Nemertean	+	+	2
Nematoda	+++	+++	6
Bivalve	+++	+	4
Copepod		+	1
Ostracoda		+	1
Number of taxa\site	**9**	**10**	**19**

0: absent, +: low abundance, ++: medium abundance, +++: high abundance.

Non-floatable meiofauna abundance in winter: The near-shore submerged sediments of the research sites contained four non-floatable meiofauna species: Foraminifera, Gastropoda, Bivalve, and Ostracoda (Table 2). In both Susa and Alhamama, the meiofauna was equally prevalent. According to Table 4, the most prevalent taxa were foraminifera and bivalves. Gastropoda was the most prevalent, followed by Ostracoda.

Table 2: Relative abundance of non-floatable meiofauna in sediments of the study sites during winter 2022.

Taxa	Alhamama	Susa	Abundance \ taxon
Foraminifera	+++	+++	6
Gastropoda		+	1
Bivalve	+++	+++	6
Ostracoda	+	+	2
Abundance \ taxon	**7**	**8**	**15**

Meiofauna abundance was not significantly impacted by floating. (Table 3).

Table 3. Statistical significance of the effect of flotation.

Flotation		
Floatable	**Non floatable**	**Sig.**
2.800±0.969	3.400*±0.871	0.553

**There is no sig. between Floatable and Non-Floatable*

Particle size fractionation by stacked sieves revealed that bottom deposits in all the study sites were made of sand (Figures 5 & 6); silt and clay fractions were essentially absent. Deposits of all sites passed completely through the 5 mm sieve and almost completely through the 2 mm sieve. Most particles were retained by the 1mm sieve, followed by the 0.5 mm sieve (the sand range) and the 0.250 mm sieve. Small fractions were retained by the 0.125 mm sieve; almost no fractions were retained by the 0.075 mm sieve and the pan.
Susa had the finest sediments: percent passing through the 0.5 mm sieve was 75.30. Alhamama had the coarsest sediments: percent passing was 21.65. Bulk density values ranged from 0.97 in Alhamama to 2.21 in Susa, respectively. ascending order of their real particle density: 1.34 and 1.86. Porosity values recorded the minimum in Alhamama, 27.5 %, and the maximum value in Susa 35 %. Percent porosity in ascending order.

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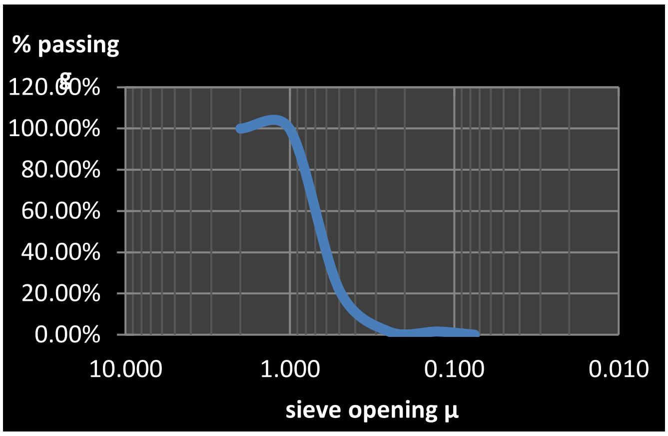

Figure 1. Particle size fraction of Alhamama marine bottom sediments.

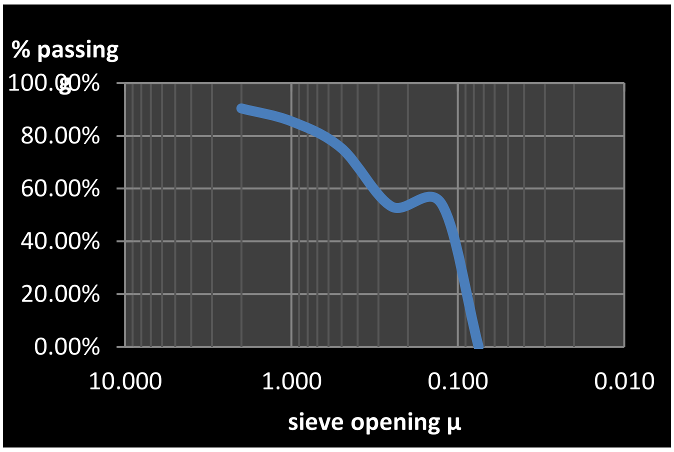

Figure 2. Particle size fraction of the Susa marine bottom sediments.

Discussion

Numerous scientists have recently favored meiofauna over macrofauna as a biological indicator in the assessment and monitoring of aquatic ecosystems due to their widespread occurrence, high species and individual diversity, large biomass, sensitivity to environmental degradation, and short life span. Meiofauna are creatures that "rr" choose. The primary causes of this tendency are the difficulties in identifying and sampling meiofauna. [12, 13, 14]. Many bottom samples must be taken both vertically (from the surface of the bottom substrata and downwards) and spatiotemporally to establish a statistically representative distribution of the current meiofauna. This is because it is challenging to separate the tiny meiofauna (0.045 mm) from sediment samples that have been obtained using the conventional methods that are now available. The little meiofauna are more difficult to identify. Comparing the results of different studies is quite difficult because of these characteristics. The present study identified four major taxa of non-floatable meiofauna and seven major taxa of floatable meiofauna, with nematodes, bivalves, and foraminiferans being the most common. It is crucial to remember that the abundance was calculated using relative units rather than absolute numbers when comparing the meiofauna abundance of the current study by taxon and region. According to the number of individuals per taxon, the taxa with the highest relative abundance were Ostracoda, Bivalve, Copepod, Nemertean, Turbellaria, and Foraminifera. Meiofauna diversity was higher in Susa than in Alhamama. The diversity of non-floatable meiofauna may have been exaggerated in this study because the shells of dead meiofauna might take a long time to break down. These shells are included in the count. Meiobenthic individuals of up to 24 of the 35 animal phyla either permanently or intermittently inhabit in meiofauna, according to Balsamo et al. (www.intechopen.com). Therefore, it is hard to draw the conclusion that the four non-floatable taxa and the seven floatable taxa (five in Alhamama and six in Susa) in this study indicate substantial variety since each phylum has as many species as the conditions of the individual investigations dictate.

The number of individuals by site or by taxonomic category showed change in meiofauna abundance. The shelled Nematoda and Foraminifera are the most common and diverse marine microorganisms, according to many studies. [14, 15]. Anthropogenic habitat degradation and the natural spatiotemporal features of the interstitial habitat are two factors that may affect the diversity and distribution of meiofauna. Sometimes the individual contributions of each of these components cannot be quantitatively evaluated. However, the anthropogenic impact on coastal meiofauna may be stronger. Human activities like as mining, dredging, manufacturing, agriculture, and dumping discharge significant amounts of pollutants into the neighboring

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sea, which has an adverse effect on the marine ecosystems, because most Libyans reside around the coast. The surf zone, where year-round persistent waves lift, move, and re-set submerged sediments, is where the meiofauna used in this study were collected. These conditions lead to the formation of sand beaches and the continuous addition of dissolved oxygen to the interstitial environment. The porosity, bulk density, actual (particle) density, and particle size fraction of the submerged bottom substrata of the study locations were examined. The submerged substrata of all the research sites were mostly sandy, and their high porosity ranged from 27.5 to 35 percent. Therefore, at all research sites, the meiofauna may be comfortably accommodated in the interstitial spaces of the bottom sediments. The waves reduce the biological burden on the sediment by transporting it out to sea. Microscopic examination of the collected meiofauna revealed no evidence of maimed or damaged individuals since the surf zone was associated with vigorous and turbulent wave action that continuously altered the submerged substrata.
Meiofauna are few in surf zones along exposed sandy coasts, the study found. Further research is needed to ascertain whether this is a general trend for all comparable coasts or if it is unique to our study region (the study sites). If so, the reason must be ascertained.

Conclusion
Based on the current study, meiofauna diversity in surf zones is low. Human activities may have a greater impact on meiofauna diversity at the study site. Future studies are encouraged to employ new techniques and strategies for collecting, categorizing, and counting small-sized meiofauna. There aren't any useful techniques of this type at the moment. Without a standard methodology, comparing the results of different studies is quite difficult.

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