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Original article

Abundance of Meiofauna in the Surf Region of The Eastern Coast, Libya (Derna, Lathrun)

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Abstract
During the summer of 2024, two study sites in eastern Libya were used to establish meiofauna diversity in the Southern Mediterranean Sea's near-shore sandy bottom surf region. Six taxa of floatable meiofauna (extracted from sediment samples by flotation), Nematoda and Foraminifera, were the most abundant. The other available taxa were Bivalve, Platyhelminthes, Gastropoda, and Ostracoda. Four non-floatable meiofauna taxa were encountered (Foraminifera, Bivalve, Gastropod, and Ostracoda). This low diversity of floatable and non-floatable meiofauna was possibly due to the strong wave action prevailing in the region and the adjacent deleterious anthropogenic activities. Meiofaunal diversity was higher in Derna than in Lathrun, possibly due to the higher dissolved phosphorus concentration during this season. The causes of the between-site differences in meiofaunal diversity are unclear, but differences in adjacent coastal anthropogenic activities might have had more impact on the interstitial habitat. New practical techniques for collecting and identifying the smaller meiofauna are needed.
Keywords. Meiofauna, Surf Region Mediterranean Sea, Southern, Libya

Introduction

The water column is home to pelagic species in all aquatic environments. Like fish, whales, turtles, and cephalopods, they are either enormous swimmers or, with very few exceptions, tiny planktonic drifters. Living on the bottom are organisms called benthos. Three kinds of benthos live on the surface of the bottom, beneath the surface, and in between the sediment grains: epifauna, infauna, and meiofauna. Meiofauna, or interstitial organisms, are tiny organisms that range in size from 500 to 0.045 mm. Macrobenthos are infauna larger than 500 mm, while microbenthos are less than 0.045 mm each. In all aquatic habitats (fresh and marine) at all latitudes and depths, meiofauna are microscopic invertebrates that either reside continuously or sporadically between or are attached to soil grains.

In the upper 5 to 10 cm of the substratum, meiofauna are most prevalent, whereas their numbers decrease further down. Although they are less common farther out to sea, they are nevertheless common in shallow coastal waters. Zonation is widespread. They usually exist in very high biomass and abundance, often in the millions per square meter, and there is usually a great degree of diversity across species and individuals. The granulometry of the substratum, the physicochemical characteristics of the water immediately above it, particularly the inorganic nutrients, the dissolved oxygen content, temperature, salinity, the organic load of the substratum, waves and currents, and pollution are the primary determinants of their abundance.

The meiofauna aid in the cycling of nutrients and supply food for higher trophic levels due to their extensive distribution and great diversity throughout all aquatic settings [1-3]. When it comes to the horizontal distribution of meiofauna, latitudes frequently have little effect. Compared to surface-substrata habitats, subsurface-substrata ecosystems are more longitudinally and latitudinally stable because they are controlled by fewer, more stable characteristics.

With nematodes, copepods, oligochaetes, turbellarians, and protozoans as the principal species, meiofauna comprises the bulk of invertebrate taxa [3]. Many adaptations for interstitial living have been acquired by meiofauna. With their elongated, vermiform, or flat bodies, these tiny, usually active creatures may readily position themselves between grains of sand [2,4]. An epidermal cuticle, spines and spicules, and sticky glands that allow them to adhere to soil particles are all features that reinforce the body [4]. A few of the simple organs are left out. As solitary organisms, gonads are often copulated and either dioecious or hermaphrodite. Direct or indirect development takes place through either pelagic or benthic larvae, and some kind of parental care is typical [5-8]. All feeding modes are pursued.

Using two research locations on Libya's eastern coast, the current study sought to report important meiofauna traits in the southern Mediterranean Sea near-shore coastal water (surf region) in the summer of 2024.

Methods

The study sites

The study sites were: 1- Derna, 2- Lathrun, on the eastern coast of Libya (Fig. 1).

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

Collecting bottom substratum samples

In order to extract the contained meiofauna, samples of the bottom sediments were extracted from the upper 10 cm of the nearshore submerged substratum of each study site using a core and a shovel. The soil granulometry, bulk and actual density, porosity, and organic matter content were also determined using these samples in additional investigations.

Extraction of the Meiofauna

Each collected sediment sample was gently mixed well, then a 75 g subsample was obtained and handled as follows: The subsample was put in a measuring cylinder, and a 3.5% $MgCl2$ solution was applied to anesthetize the enclosed meiofauna, causing them to relax their hold on the sand particles. Water was added, the cylinder was vigorously shaken to suspend the sediment particles and meiofauna, a few seconds were allowed for the sediment particles, but not the meiofauna, to settle at the bottom of the cylinder, and the water (which now contained the majority of the floating meiofauna) was quickly decanted into a beaker. This method was performed numerous times to ensure maximal extraction. Three different approaches were used to separate the meiofauna from the water in the beaker based on [9, 10, 11] as follows:

Settlement

Half of the beaker's water was utilized. To kill the meiofauna, we added buffered formalin drops to the beaker. The beaker was left still for 24 hours to allow the meiofauna to settle at the bottom. The water above the meiofauna was carefully siphoned off, leaving only 5ml of water containing the meiofauna.

Flotation

Half of the water in the beaker was utilized. The sugar was added to the water in the beaker until it was nearly saturated. This procedure raised the density of the water, causing the enclosed meiofauna to float at the surface of the water within the beaker. After 12 hours, the water underneath the meiofauna was carefully drained off, leaving barely 5ml of water.

Filtration

Water extracted from beakers using the previous two processes was filtered using filter paper to remove any remaining meiofauna**.**

Identification of the extracted meiofauna

Floatable meiofauna

Meiofauna recovered using the three aforementioned methods were referred to as "floatable meiofauna" because flotation and decantation were employed in each of them. Based on the information available on the internet, the extracted meiofauna was identified under a microscope to the lowest taxa. One milliliter was extracted from each of the five milliliters, spread out on glass slides, and inspected under a microscope for this purpose. Next, a microscopic examination of the filter paper was conducted.

Relative abundance units (0): absent, +: low abundance, ++: medium abundance, +++: high abundance) were used instead of absolute numbers of individuals per taxon for each subsample and site.

Non-floatable meiofauna

Some shelled meiofauna, such as foraminifera, radiolarians, gastropods, and bivalves, were still present in the subsample (wet soil) that was left over after the meiofauna was extracted using the aforementioned techniques. These techniques were based on flotation at one point or another, and they were too heavy to

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be collected. Thus, to identify and count the included meiofauna, the remaining subsample was spread out on glass slides and inspected under a microscope. "Non-floatable meiofauna" was the designation given to these species. Relative abundance units (0: absent, +: low abundance, ++: medium abundance, +++: high abundance) are used to display meiofauna abundance by taxon. The identification process was based on online resources.

Results

Foraminifera, Nematoda, Platyhelminthes, Bivalve, Gastropoda, and Ostracoda are the six floatable meiofauna taxa that were found (to the lowest taxon) in the near-shore submerged sediments of the study sites during the summer (Table 1). Lathrun was the poorest taxonomic group in the meiofauna, with only two taxa (Table 1): Nematoda and Platyhelminthes. With six taxa, Foraminifera, Nematoda, Platyhelminthes, Bivalve, Gastropoda, and Ostracoda, Derna was the most abundant.
Based on the abundance of individuals per taxon, the most abundant taxa were nematode (with 6 stars). The least abundant were Bivalve and Foraminifera (with three stars each), followed by Platyhelminthes (with two stars each), then Gastropoda and Ostracoda recorded one star (Table 1).

Table 1. Relative abundance of floatable meiofauna in sediments of the study sites during summer 2024.

Taxa	**Derna**	**Lathrun**	**Relative abundance of individuals\ taxon**
Foraminifera	+++		3
Nematoda	+++	+++	6
Platyhelminthes	+	+	2
Bivalve	+++		3
Gastropoda	+		1
Ostracoda	+		1
Number of taxa\site	12	4	16

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

Foraminifera, Gastropoda, Bivalve, and Ostracoda are the four non-floatable meiofauna species that were found in the near-shore submerged sediments of the study locations during the summer (Table 2). The meiofauna was equally abundant in Derna and Lathrun.
Bivalve and foraminifera were the most abundant taxa (Table 4). Gastropoda was the least abundant, followed by Ostracoda.

Table 2. Relative abundance of non-floatable meiofauna in sediments of the study sites during summer 2024.

Taxa	**Derna**	**Lathrun**	**Abundance \ taxon**
Foraminifera	+++	+++	6
Gastropoda	+	+	2
Bivalve	+++	+++	6
Ostracoda	+	+	2
Abundance \ taxon	8	8	16

The effect of flotation on meiofauna abundance was low and not significant (Table 3).

Table 3. Statistical significance of the effect of flotation.

Flotation		
Floatable	**Non floatable**	**Sig.**
3.500±0.866	4.000±1.154	0.804

**There is no significance between Floatable and non-Floatable.*

Discussion

Because of their widespread occurrence, high species and individual diversity, large biomass, sensitivity to environmental degradation, and short life span, meiofauna rather than macrofauna have recently been favored by many scientists as a biological indicator in the assessment and monitoring of aquatic ecosystems. Meiofauna are "rr" choosing creatures. The challenges of meiofauna identification and sampling are the main reasons against this trend [12, 13, 14].

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In order to obtain a statistically representative distribution of the current meiofauna, many bottom samples must be collected spatiotemporally and vertically (from the surface of the bottom substrata and downwards). This is because the smaller meiofauna (0.045 mm) are difficult to isolate from collected sediment samples using the traditional techniques currently available. It is clear that the tiny meiofauna are harder to recognize.

These factors make it extremely challenging to compare the findings of various investigations. Nematodes, bivalves, and foraminiferans were the most prevalent among the six major taxa of floatable meiofauna and four major taxa of non-floatable meiofauna discovered in the current research. When comparing the meiofauna abundance by taxon and location found in the current study, it is important to keep in mind that the abundance was computed using relative units rather than absolute numbers. The taxa with the highest relative abundance, measured by the number of individuals per taxon, were nematodes, bivalves, and foraminiferans. Platyhelminthes, Gastropoda, and Ostracoda were the other taxa. Derna had a greater diversity of meiofauna than Lathrun. The higher concentration of total dissolved phosphorus in Derna may have contributed to the greater number of floatable meiofauna there compared to Lathrun, whereas the non-floatable meiofauna in Derna and Lathrun were equally plentiful.

The research locations had amounts of total nitrogen ranging from 0.18 to 0.16 parts per million. The current study may have overestimated the diversity of non-floatable meiofauna since deceased meiofauna shells may take a long time to decompose. The count of shells includes these. According to Balsamo *et al.* (www.intechopen.com), meiobenthic members of up to 24 of the 35 animal phyla reside in meiofauna, either permanently or only temporarily. Given this, it is impossible to conclude that the six floatable taxa (6 in Derna and 2 in Lathrun) and the four non-floatable taxa found in this study represent significant diversity, since each phylum has as many taxa as the parameters of the separate investigations determine.

Variation was seen in meiofauna abundance by taxonomic group or by number of individuals per location. The most prevalent and varied marine microorganisms are the shelled Nematoda and Foraminifera, according to several studies [14, 15]. Two variables can be considered to influence the richness and distribution of meiofauna: the interstitial habitat's natural spatiotemporal characteristics and anthropogenic habitat degradation.

The quantitative assessment of each of these components' separate contributions is sometimes impossible. The anthropogenic influence, however, could be more powerful for coastal meiofauna. Because the majority of Libyans live along the shore, human activities like mining, dredging, industry, agriculture, and dumping release large amounts of pollutants into the nearby sea, which has a negative influence on the marine ecosystems. The meiofauna used in this study were gathered from the surf zone, where year-round sustained waves lift, shift, and reset submerged sediments. Sand beaches form in these circumstances, and dissolved oxygen is constantly added to the interstitial environment. investigated the porosity, bulk density, actual (particle) density, and particle size fraction of the submerged bottom substrata of the research sites. Every research site's submerged substrata were largely sandy, and each site had a high porosity of between 35.25 and 37 percent. The meiofauna may therefore be comfortably housed in the interstitial gaps of the bottom sediments at all research locations. By carrying it out to sea, the waves lessen the organic burden on the sediment .

revealed that the submerged sediments of the research sites had extremely little oxidized organic matter, ranging from 5.34% to 0.14 %, with an average of 5.85% across all sites. Microorganisms and bacteria that feed on organic materials in turn feed the meiofauna. The meiofauna may be washed out to sea in large quantities by strong wave action. The observed low meiofaunal diversity in the current study may have been mostly caused by the low organic load in the study locations, the physical effects of the waves, and the detrimental anthropogenic activities. Since the surf zone was characterized by strong and turbulent wave activity that constantly changed the submerged substrata, microscopic analysis of the collected meiofauna did not show any signs of maimed or injured individuals. According to the study's findings, meiofauna are few in surf zones along exposed sandy shores. To determine if this is a general tendency for all coastlines that are comparable or if it is specific to our study region (the study sites), more research is required. If it is, it is necessary to determine why.

Conclusion

Meiofauna diversity in surf zones is low, according to the current study. Variations in meiofauna diversity by study location may be more the result of human activity than of variations in the interstitial habitat's intrinsic physico-biochemical characteristics. It is advised that future research make use of fresh methods and approaches for gathering, classifying, and tallying small-sized meiofauna. There are currently no practical methods of this kind available. It is extremely challenging to compare the findings of various research studies when there is no uniform approach in place.

Conflict of interest. Nil

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