

Research Article.

Inventory, Abundance and Distribution of Mega Benthos in the Trawlable fishing areas along Algerian coast (South western Mediterranean Sea)

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ABSTRACT

This study focuses on the inventory and distribution of mega benthos in trawlable fishing areas along the Algerian coast. Sampling was conducted on board the research vessel Belkacem Grine during the cruise ALDEM 2021. 532 Species belong to six main taxa were recorded. The Shannon index ranged from 0 to 1.09, indicating low overall biodiversity. The highest equitability index was recorded at station T12 Skikda ($E=0.87$), while station T9 Annaba showed complete dominance by single species ($E=0$). Results show a dominance of molluscs and echinoderms, with species richness and abundance showing notable variation between stations. The ecological indices indicate low species richness and uniform distribution of species. The sampling method deployed in the present study may affect the inventory results. Therefore, deployment of adequate sampling methodologies can improve the quality of species inventory, abundance and distribution findings.

KEYWORDS

Inventory;
Abundance;
Trawling fishing
areas;
Macrobenthos.

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1 INTRODUCTION

The Mediterranean is recognized as one of the world's biodiversity hotspots due to its high species richness and significant number of endemic species (Coll *et al.*, 2010), with exceptional biodiversity estimated at nearly 15,000 to 20,000 marine species (Bianchi *et al.*, 2012). The distribution of marine biodiversity in the Mediterranean Sea is quite uneven, with its flora and fauna varying in their distribution across the different basins (UNEP-MAP-RAP/SPA, 2010).

Megabenthic communities of the continental margins and deep basins of the Mediterranean Sea, dominated by fishes, mollusks and crustaceans in terms of abundance and biomass (Sardà *et al.*, 1994). Currently, a total of 1,797 taxa of megabenthic species have been documented from the trawled soft bottom areas of the Mediterranean (Stamouli *et al.*, 2022).

This megabenthic diversity present a strong biomass reduction that follow the gradients of productivity and food arrival at the seafloor (Tecchio *et al.*, 2011), by fluvial inputs, surface productivity and other mesoscale oceanographic events (Margalef, 1985; Company *et al.*, 2008). The megabenthic communities play critical roles in energy and material transfer within marine food webs (Dauvin *et al.*, 2006). In parallel, they receive the adverse effects of all deposit materials, as well as other environmental features such as temperature, oxygen, pH and bottom trawling impacts (Sebbih *et al.*, 2024; Jennings *et al.*, 2001; Puig *et al.*, 2012; Korpinen *et al.*, 2019). Therefore, these communities can serve as effective indicators of pollution impacts and ecosystem health due to their ecological

significance and sensitivity to disturbances (Beldi *et al.*, 2012; Li *et al.*, 2016).

Bottom trawling and dredging are the most prevalent causes of human-induced disruption to benthic habitats, affecting extensive areas of the continental shelf (Hiddink *et al.*, 2017; Stamouli *et al.*, 2022). Bottom trawling decreases the biomass and diversity of benthic ecosystems, leading to a decline in abundance of most megabenthic taxa as trawling intensity rises (Buhl Mortensen *et al.*, 2016) and this could result in a reduction of the complexity of benthic habitats (Kaiser *et al.*, 2006) and the condition of the seabed (Pitcher *et al.*, 2022).

The present study contributes to the inventory of megabenthic communities in fishing grounds along the Algerian coast by analyzing their abundance, composition and spatial distribution. Through the use of biodiversity indices and multiregional comparisons, this study aims to assess the ecological status of coastal ecosystems and to highlight spatial patterns related to environmental and anthropogenic influences.

2 MATERIALS AND METHODS

2.1 Study area

Like other Mediterranean coastal areas, the northern fringe of the African continent is bordered by a relatively narrow and discontinuous continental shelf (Leclaire, 1972). The Algerian coastline, stretching for approximately 2148 km, is located in the southwestern part of the western Mediterranean and features a diverse geomorphology including rocky shores, sandy beaches, dunes, cliffs, bays, and gulfs.

The continental shelf is narrow and fragmented, particularly near mountainous areas, and shows a steep bathymetric profile, with rapid transitions from shallow to deep waters. The seabed is composed of heterogeneous substrates such as gravel, sand, sandy mud, and pure mud, with an increasing fine sediment gradient offshore (Bakalem, 2008; Inal *et al.*, 2018).

Hydrodynamically, the Algerian coast is influenced by the inflow of Atlantic-origin surface waters through the Strait of Gibraltar, generating predominantly eastward surface currents and

westward undercurrents. This circulation is characterized by local turbulence, particularly along the continental margin, which promotes vertical mixing and the redistribution of nutrients, thus supporting the marine food web (Millot, 1987; Millot *et al.*, 1990). However, certain coastal zones, such as the Gulf of Oran and the industrial region of Arzew, are increasingly affected by anthropogenic pressures and pollutant inputs, resulting from urbanization and socio-economic activities (Remili and Kerfouf, 2013; Guendouzi *et al.*, 2021; Inal *et al.*, 2025).

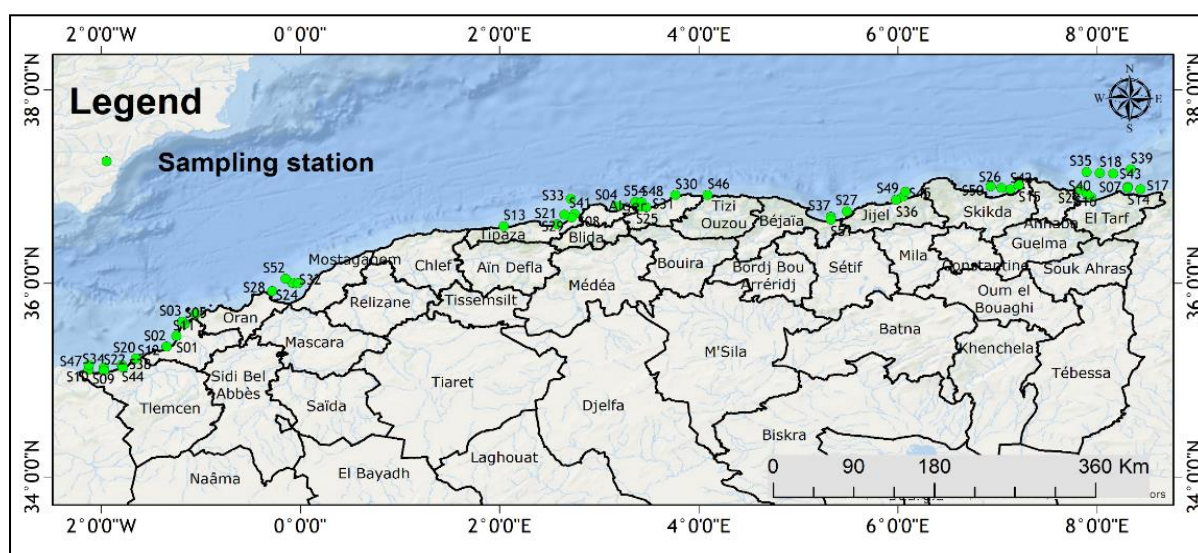


Figure 1. Geographical location of the Algerian coast and sampling stations

2.2 Samples collection

Sampling was conducted during the ALDEM 2021 scientific cruise, carried out between August 24th and September 16th, 2021, on board the research vessel *Belkacem Grine*. A total of 68 fishing hauls (S1 to S68) were sampled along the Algerian coast (Fig. 1), covering three main regions: Western (Mostaganem, Arzew, Beni Saf, Ghazaouet), Central (Bou Ismail, Aïn Benian, Cherchell, Boumerdes, and Cap Djenet), and Eastern (El Kala, Annaba, Skikda, Jijel).

Following the MEDITS (Mediterranean International Trawl Survey) Protocol (Bertrand *et al.*, 2002), the fishing hauls were performed between 20 and 800m of depth, they were distributed across five bathymetric strata: A (0–50 m), B (50–100 m), C (100–200 m), D (200–300 m), and E (>300 m), to ensure a representative coverage of depth-related habitats. The fishing hauls took 30 min when depth is under 200 m and 60min when depth is over 200 m. The trawler gear used type GOC73 was equipped with either 20 mm square mesh netting in the cod end.

Bathymetry and position coordinates for fishing hauls were obtained directly from the vessel and all sampling was conducted during daylight.

At each fishing haul, the entire catch from each haul was sorted. Benthic species were separated from the total catch, identified to the lowest possible taxonomic level, weighed (biomass), and counted to assess abundance. Non-identified species were preserved for later identification.

2.3 Data Analysis

The data collected from each sampling station were used to evaluate the distribution and faunal structure of benthic communities, focusing on parameters such as abundance, species richness, and species frequency. In order to assess these aspects, the Shannon and Weaver diversity index (H') and the equitability index (E) were calculated (Shannon and Weaver, 1963; Pielou, 1966). The following ecological indices were computed:

Species Richness (S): total number of species recorded at each station.

Abundance (A): number of individuals per species.

Dominance (D): percentage of total biomass represented by the most abundant species.

Shannon Diversity Index (H'): calculated using the formula:

$$H' = -\sum p_i \log(p_i) \quad (\text{Eq. 1})$$

Equitability Index (E): measures how evenly individuals are distributed across species and is expressed as:

$$E = \frac{H'}{\log S} \quad (\text{Eq. 2})$$

3 RESULTS AND DISCUSSION

3.1 Megabenthic taxa diversity

The study identified 532 species and 11178 individuals; the taxonomic evaluation of the species collected during the ALDEM 2021 survey revealed a high level of zoological diversity across several benthic groups. The fauna composition shows a distinct predominance of certain taxa, as illustrated in the (Fig. 2).

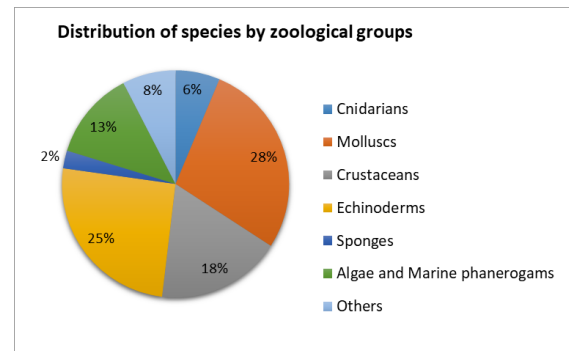


Figure 2. Taxonomic distribution of benthic species recorded during ALDEM 2021

The following benthic groups were found in order of decreasing diversity: Mollusca with 149 taxa covering 28% of the recorded taxa, Echinodermata (25%), Crustacea (18%), Algae and Phanerogams (13%), Cnidaria (6%), and Sponges (2%). Others including various small groups, represented 8% of the total megabenthic diversity. This distribution reflects the heterogeneous nature of the substrates found along the Algerian continental shelf, which consists of a mosaic of sand, mud, and gravel, offering a wide range of ecological niches.

The dominance of mollusks particularly bivalves and gastropods are commonly linked to the organic enrichment of coastal sediments and the high trophic resources available. Echinoderms, especially sea urchins and holothurians, indicate a degree of habitat stability in soft-bottom environments, while the presence of crustaceans

such as decapods suggests structurally complex habitats that support mobile benthic fauna.

3.2 Regional Distribution of Species Diversity

The analysis of benthic species richness and abundance across the Algerian coastline reveals notable spatial variations in community structure and dominance patterns. A total of 16 regions were surveyed, with species richness ranging from as low as 4 species in Cap Djenet to as high as 86 species in Ghazaouet. In terms of abundance, Beni Saf recorded the highest number of individuals (5038), while Cap Djenet again reported the lowest (9 individuals).

These disparities are visually represented in the pie chart illustrating the distribution of individual counts by region (Fig. 3) which highlights the dominance of Beni Saf and Bouzedjer in terms of total benthic individuals.

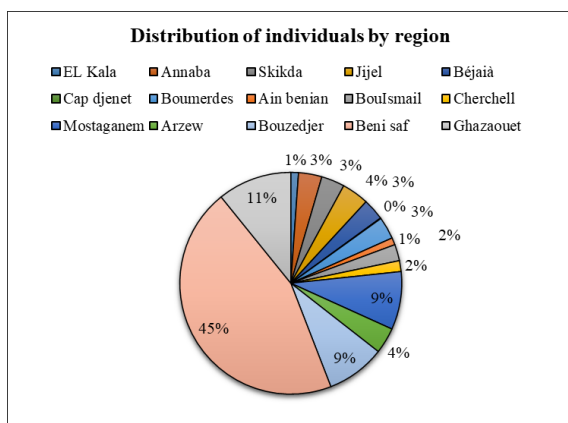


Figure 3. Distribution of individuals by region recorded during ALDEM 2021

Additionally, the bar chart combining species richness and individual abundance per region (Fig. 4) provides a comprehensive comparison, demonstrating that Ghazaouet, Skikda, and Jijel not only host a large number of species but also support considerable population densities.

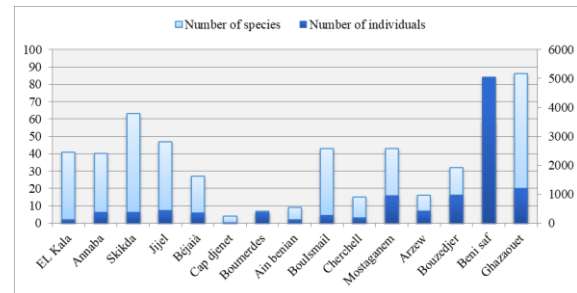


Figure 4. Species richness and individual abundance per region during ALDEM 2021

Ghazaouet stands out as the most taxonomically rich region, harboring 86 species and 1208 individuals, with *Venus verrucosa* as the dominant species. Similarly, Skikda and Jijel exhibited high richness (63 and 47 species, respectively), both dominated by *Ophiura ophiura*, a species indicative of stable soft-bottom habitats.

In the western sector, Beni Saf showed exceptional dominance by *Neopycnodonte archealar*, contributing significantly to its biomass and indicating the presence of complex benthic substrates such as biogenic concretions. This species was also dominant in Bouzedjer, supporting the west coast's reputation for high biodiversity and structural heterogeneity.

In contrast, Cap Djenet and Boumerdes exhibited low diversity but relatively high abundance in the latter, dominated by hermit crabs (*Pagurus prideauxi*), which are often associated with disturbed or organically enriched sediments. *Pagurus excavatus* was the most common species in Bou Ismail and Ain Benian, reflecting uniform sediment conditions in these areas.

3.3 Diversity and evenness indices

To better understand the structure and distribution of benthic communities along the Algerian coastline, the Shannon diversity index

(H') and the equitability index (E) were calculated for each sampling station. The study area was subdivided into three main coastal regions eastern, central, and western to facilitate comparative analysis.

Bar charts were generated for each region to compare the diversity (H') and equitability (E) values across individual trawl stations. These graphical representations allow for a clear visualization of spatial trends in species richness and community balance.

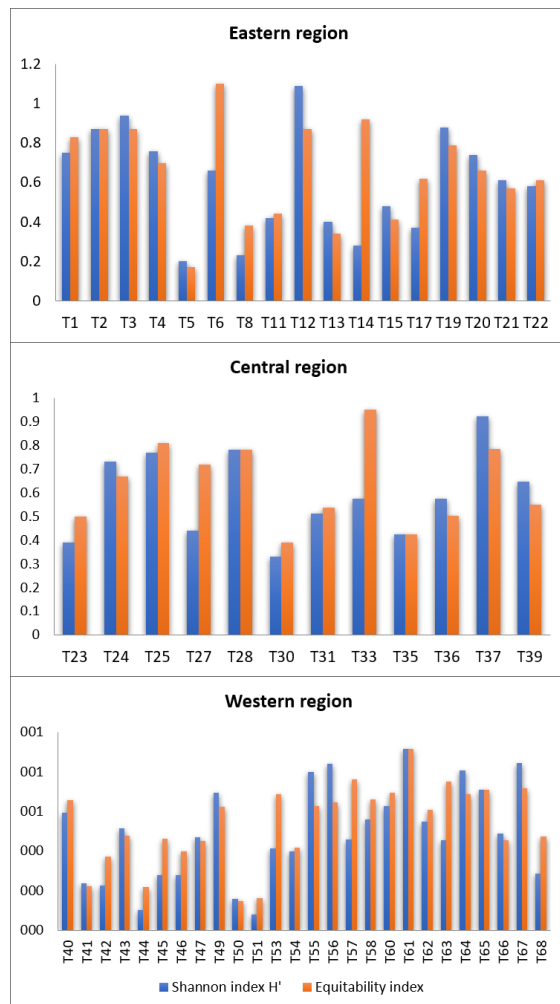


Figure 5. Shannon index and Equitability index in the Eastern, Central and Western region (during the ALDEM 2021 scientific cruise)

The eastern region (Fig. 5), encompassing stations from El Kala to Béjaïa, generally exhibited higher diversity indices, particularly at stations such as El Kala T3 ($H' = 0.94$) and Skikda T12 ($H' = 1.09$), suggesting more heterogeneous and stable benthic assemblages.

Conversely, several stations in the central and western regions (Fig. 5), such as Mostaganem T44 ($H' = 0.10$) and Bouzedjer T51 ($H' = 0.08$), displayed low diversity values, indicating a dominance of few taxa or a possible anthropogenic influence. Equitability values showed similar trends, with some stations like Annaba T6 ($E = 1.1$) suggesting a nearly even distribution of individuals among species, while others like Bouzedjer T50 ($E = 0.15$) revealed a strongly unbalanced community structure.

This regional comparison highlights distinct ecological patterns that may be linked to environmental heterogeneity, sediment types, or anthropogenic pressures across the Algerian shelf. The use of both diversity and equitability indices provides a more nuanced interpretation of benthic community dynamics and their spatial variation.

The results of the present study can be compared to those obtained from other regions of the Algerian coastline, notably the Gulf of Oran (Kerfouf *et al.*, 2022), the Bay of Beni Saf (Allaili and Kerfouf, 2015), and the eastern coastal zone (El Kala, Skikda, and Annaba) (HR Mahcene *et al.*, 2022). In the Gulf of Oran, benthic communities were analyzed in relation to sediment types and environmental gradients (Kerfouf *et al.*, 2021; Bakalem *et al.*, 2020). Four groups of stations were identified based on sediment composition ranging from gravel to fine sand with polychaetes such as *Aponuphis bilineata* and *Eunice vittata*

dominating most of the assemblages. Although relatively high individual abundances were observed in sanded gravel (116 individuals) and fine sands (113 individuals), overall species richness was reported to be lower compared to the eastern Algerian coast, particularly in El Kala and Skikda, where higher Shannon-Weaver diversity indices were recorded ($H' = 1.09$ in Skikda-T12).

This reduced diversity in the Gulf of Oran may be attributed to anthropogenic pressures such as port activities and untreated urban wastewater discharges (Remili and Kerfouf, 2013; Dilem *et al.*, 2014). In contrast, the eastern coast showed higher ecological balance and evenness, with elevated Pielou's evenness values ($E = 0.87$ in El Kala-T2 and T3), likely due to reduced human impact and the existence of protected natural areas. Additionally, the Bay of Bou-Ismaïl (central Algeria) is reported to host the richest macrobenthic community on the national scale, with 723 species (Bakalem *et al.*, 2020), reinforcing the idea that habitat heterogeneity and lower environmental stress favor higher biodiversity.

The structure of echinoderm assemblages observed in the present study also shows both similarities and differences with previous findings from the Bay of Beni Saf and Oran region (Kerfouf *et al.*, 2021). In this study, *Paracentrotus lividus* was the most dominant echinoid, being present at all sampled stations (100 %), followed by *Arbacia lixula* which was recorded at (60 %) of the stations. These species were often associated with holothurians such as *Holothuria tubulosa*

(60%) and *H. forskali* (40%). Notably, *H. tubulosa* and *H. polii*, although common in the Mediterranean, were *H. tubulosa* was present in our study in Beni Saf, Ghazaouet and Mostaganem and also *H. poli* was found in Ghazaouet, Aïn Benian and Bou Ismail.

In both studies, echinoid and holothurians diversity appeared higher in relatively undisturbed areas such as Sbiaat Beach (Station 3), whereas more urbanized or polluted stations (Les Andalouses and Aïn El Turk) exhibited reduced species richness and diversity. This pattern aligns with our findings, where stations close to urban or port zones showed lower Shannon indices and a decrease in echinoderm diversity, suggesting a strong influence of anthropogenic stressors such as sewage discharge, habitat degradation, and tourism pressure.

Furthermore, the occasional presence of predatory starfishes such as *Coscinasterias tenuispina* and *Echinaster sepositus* known predators of *P. lividus* and *A. lixula* in both studies illustrates the ecological interactions and top-down control mechanisms within echinoderm communities. In our case, these species were observed less frequently, possibly due to local ecological conditions or variations in predator density.

Additionally, marine litter, common in Algerian fishing areas, may alter benthic communities, favoring dominant, disturbance-tolerant taxa (Inal *et al.*, 2025).

4 CONCLUSIONS

This study highlights the dominance of mollusks and echinoderms within the megabenthic communities of trawlable fishing areas along the Algerian coast. The ecological indices calculated across the different sampling stations reveal significant spatial variations in species richness, abundance, and dominance.

Despite this variability, all surveyed areas are characterized by relatively low specific richness. This pattern can be attributed to the continuous overexploitation of these fishing grounds by trawlers, which tends to reduce biodiversity and favor opportunistic or resistant species.

In light of these findings, we recommend reducing fishing pressure in trawlable zones and exploring alternative sampling methods better adapted to benthic biodiversity assessment. Such approaches would help produce a more representative inventory of megabenthic species, while also accounting for the complex seabed structure characteristic of this region.

Consequently, it is essential to conduct research aimed at recognizing components, assemblages, structures, and functions of megabenthic communities in trawlable benthic ecosystems, rather than solely examining the presence of particular taxa. In this scenario, access to time series data on megabenthos distribution is crucial for applying the ecosystem-based approach to fisheries in the waters along the Algerian coastline.

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