

## Review: Study on the Presence of Plastic Particles in the Mediterranean Sea

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### Abstract

The Mediterranean Sea, a semi-enclosed basin with high biodiversity and ecological significance, is increasingly threatened by plastic pollution. This review study examines the current understanding of plastic particles in the Mediterranean, including their sources, distribution, environmental impacts, and potential mitigation strategies. The review highlights the significance of both macroplastics and microplastics, their origins from land-based and maritime activities, and their widespread distribution across the water column, seabed, and coastal areas. The environmental and ecological impacts of plastic pollution are discussed, including ingestion by marine organisms, habitat degradation, and the potential transfer of plastic-associated toxins through the food web. Additionally, the review addresses the implications of plastic pollution for human health and outlines potential strategies for mitigation, including policy interventions, improved waste management, and public awareness campaigns. The study concludes with a call for urgent and coordinated action to address the growing problem of plastic pollution in the Mediterranean Sea.

*Keywords: Macroplastics, Microplastics, Pollution, Mediterranean Sea.*

### دراسة مراجعة حول وجود جزيئات البلاستيك في البحر الأبيض المتوسط

#### الملخص

يتعرض البحر الأبيض المتوسط، وهو حوض شبه مغلق يتمتع بتنوع بيولوجي كبير وأهمية بيئية، لتهديد متزايد بسبب التلوث البلاستيكي. تدرس هذه المراجعة فهم الوضع الحالي للجزيئات البلاستيكية في البحر الأبيض المتوسط، بما في ذلك مصادرها وتوزيعها وتأثيراتها البيئية واستراتيجيات التخفيف المحتملة. تسلط هذه المراجعة الضوء على أهمية كل من البلاستيك الكبير والدقيق، وأصولهما من الأنشطة البرية والبحرية، وانتشارهما على نطاق واسع عبر عمود الماء وقاع البحر والمناطق الساحلية. تتم مناقشة التأثيرات البيئية والبيئية للتلوث البلاستيكي، بما في ذلك ابتلاع الكائنات البحرية، وتدهور الموائل، والانتقال المحتمل للسموم المرتبطة بالبلاستيك من خلال شبكة الغذاء.

بالإضافة إلى ذلك، تتناول المراجعة آثار التلوث البلاستيكي على صحة الإنسان وتحدد الاستراتيجيات المحتملة للتخفيف، بما في ذلك التدخلات السياسية، وتحسين إدارة النفايات، وحملات التوعية العامة. وتختتم الدراسة بدعوة إلى اتخاذ إجراءات عاجلة ومنسقة لمعالجة مشكلة التلوث البلاستيكي المتنامية في البحر الأبيض المتوسط.

**الكلمات المفتاحية:** البلاستيك الكبير، البلاستيك الدقيق، تلوث، البحر الأبيض المتوسط

## 1. Introduction

The Mediterranean Sea, one of the most densely populated and industrialized regions in the world, is facing significant environmental challenges due to human activities (Baudena et al., 2022). Among these challenges, plastic pollution has emerged as a major concern in recent years. Plastic particles, ranging from macroplastics (larger than 5 mm) to microplastics (smaller than 5 mm), have been found in various marine environments, including the Mediterranean Sea (Thompson, 2015). The presence of plastic particles in the Mediterranean has raised concerns about their potential impacts on marine ecosystems, biodiversity, and human health (Cole et al., 2011; Huang et al., 2022; Romeo et al., 2015).

This review study aims to provide a comprehensive overview of the current knowledge on the presence of plastic particles in the Mediterranean Sea. The review will cover the sources and types of plastic pollution, their distribution and concentration in different marine environments, the environmental and ecological impacts, and potential mitigation strategies. The review will also discuss the implications of plastic pollution for human health and highlight the need for further research and policy interventions to address this pressing issue.

## 2. Sources and Types of Plastic Pollution in the Mediterranean Sea

### 2.1. Land-Based Sources

Plastic pollution in the Mediterranean Sea originates from both land-based and maritime sources (Baudena et al., 2022). Land-based sources include plastic waste from urban areas, industrial activities, and agricultural practices. Plastic debris from land is transported to the sea through rivers, wastewater discharge, and storm water runoff (Andrady, 2017). The Mediterranean Sea is bordered by 21 countries, many of which

have inadequate waste management infrastructure, leading to significant amounts of plastic waste entering the marine environment (Eriksen et al., 2014).

## 2.2. Maritime Sources

Maritime activities, including fishing, shipping, and tourism, also contribute to plastic pollution in the Mediterranean Sea (Equation, 2023). Fishing activities, in particular, generate a significant amount of plastic waste, including fishing nets, lines, and other fishing gear, which can be lost or discarded at sea. Shipping activities contribute to plastic pollution through the discharge of plastic waste from ships, as well as the loss of plastic containers and other materials during transportation.

## 2.3. Atmospheric Deposition

In addition to land-based and maritime sources, plastic particles can also be transported to the Mediterranean Sea through atmospheric deposition (Thompson, 2015). Microplastics can be carried by wind and deposited in the sea, contributing to the overall plastic pollution in the region (O'Brien et al., 2023).

## 3. Types of Plastic Particles

Plastic particles in the Mediterranean Sea can be classified into two main categories: macroplastics and microplastics. Microplastics are plastics less than 5 mm in their largest dimension; mesoplastics are between 5 mm and 2.5 cm in size; and macroplastics are larger than 2.5 cm in their smallest dimension (Jeyasanta et al., 2020; Zeri et al., 2018). Microplastics can further be categorized into primary microplastics, which are intentionally manufactured in small sizes (e.g., microbeads in personal care products), and secondary microplastics, which result from the degradation of larger plastic item (Gola et al., 2021)

## 4. Distribution and Concentration of Plastic Particles in the Mediterranean Sea

### 4.1. Surface Waters

The distribution of plastic particles in the Mediterranean Sea is influenced by various factors, including ocean currents, wind patterns, and coastal topography (Meijer et al., 2021; Zeri et al., 2018). Studies have shown that plastic debris is widespread in the surface waters of the Mediterranean, with higher concentrations observed in areas with high human activity and in convergence zones where plastic debris accumulates (Auta et al., 2017; Barnes et al., 2009).

#### 4.2. Seabed

Plastic particles have also been found in the seabed of the Mediterranean Sea, with higher concentrations reported in areas close to urban centers and industrial areas (Yılmaz et al., 2022). The seabed serves as a sink for plastic debris, particularly microplastics, which can be ingested by benthic organisms and enter the marine food web (Al Mamun et al., 2023; Zeri et al., 2018).

#### 4.3. Coastal Areas

Coastal areas in the Mediterranean are particularly vulnerable to plastic pollution due to their proximity to land-based sources of plastic waste. Beaches and coastal waters often serve as accumulation zones for plastic debris, which can have significant impacts on coastal ecosystems and tourism (Ali et al., 2021; Auta et al., 2017).

#### 4.5. Vertical Distribution

The vertical distribution of plastic particles in the Mediterranean Sea is influenced by factors such as buoyancy, wind-driven mixing, and biological interactions (Barnes et al., 2009). Microplastics have been found at various depths in the water column, with higher concentrations observed near the surface (Zayen et al., 2020). However, some studies have reported the presence of microplastics at deeper depths, suggesting that these particles can be transported to the deeper layers of the ocean through various mechanisms (Jambeck et al., 2015; Schmidt et al., 2018).

### 5. Environmental and Ecological Impacts of Plastic Pollution

#### 5.1. Ingestion by Marine Organisms

One of the most significant ecological impacts of plastic pollution is the ingestion of plastic particles by marine organisms. Marine species, including fish, seabirds, and marine mammals, have been found to ingest plastic debris, which can cause physical harm, such as blockage of the digestive tract, and chemical toxicity from plastic-associated pollutants (Fan et al., 2023; Reid et al., 2019; Romeo et al., 2015; Sussarellu et al., 2016). The ingestion of microplastics by small organisms, such as plankton and small fish, can lead to the transfer of plastic-derived chemicals through the food web, potentially affecting higher trophic levels, including humans (Al Mamun et al., 2023; Lehner et al., 2019; Pedrotti et al., 2016).

### **5.2. Habitat Degradation**

Plastic debris can also degrade marine habitats by altering the physical structure of ecosystems and affecting the availability of food and shelter for marine organisms. For example, the accumulation of plastic debris on coral reefs can lead to the smothering of corals and the reduction of habitat complexity, which can have cascading effects on the entire ecosystem (Bergmann et al., 2015).

### **5.3. Impact on Biodiversity**

The presence of plastic particles in the Mediterranean Sea can have significant impacts on biodiversity. Plastic debris can act as a vector for the introduction of invasive species, which can compete with native species for resources and alter ecosystem (de Souza Machado et al., 2018; Li et al., 2020). Additionally, the physical presence of plastic debris can lead to the entanglement and mortality of marine organisms, further threatening biodiversity in the region (Auta et al., 2017; Bergmann et al., 2015).

## **6. Human Health Implications of Plastic Pollution**

### **6.1. Food Safety Concerns**

The presence of plastic particles in the marine environment raises concerns about food safety, particularly in regions where seafood is a significant component of the human diet. The ingestion of microplastics by marine organisms can lead to the accumulation of plastic-derived chemicals in seafood, which may pose risks to human health (Al Mamun et al., 2023; Lehner et al., 2019). While the extent of these risks is still under investigation, the potential for plastic-associated toxins to enter the human food chain highlights the need for further research and regulation.

### **6.2. Economic Impacts**

Plastic pollution in the Mediterranean Sea also has significant economic implications, particularly for industries such as fishing, tourism, and shipping. The degradation of marine ecosystems due to plastic pollution can lead to declines in fish populations, affecting the livelihoods of fishermen and the sustainability of fisheries (Pedrotti et al., 2016). Additionally, the presence of plastic debris in coastal areas can negatively impact tourism, as beaches and coastal waters become unsightly and less attractive to visitors (Bergmann et al., 2015).

## 7. Mitigation and Management Strategies

### 7.1. Policy Interventions

Addressing the problem of plastic pollution in the Mediterranean Sea requires a combination of policy interventions, improved waste management practices, and public awareness campaigns. At the policy level, there is a need for the adoption of regulations to reduce plastic production and consumption, as well as to enhance the management of plastic waste. The European Union has taken steps to address plastic pollution through the implementation of the Single-Use Plastics Directive, which aims to reduce the consumption of single-use plastic items and improve the recycling of plastic waste (Zhao et al., 2025).

### 7.2. Improved Waste Management

Improving waste management practices is critical to reducing plastic pollution in the Mediterranean Sea. This includes the implementation of effective waste collection and disposal systems, particularly in countries with limited waste management infrastructure (Maes et al., 2015). Additionally, the development of recycling and recovery technologies can help to reduce the amount of plastic waste entering the marine environment.

### 7.3. Public Awareness and Education

Public awareness and education are essential components of any strategy to address plastic pollution (Liu et al., 2023). Raising awareness about the impacts of plastic pollution on the environment and human health can encourage individuals to reduce their plastic consumption and properly dispose of plastic waste (Hussain, 2022; Yadav et al., 2024). Education campaigns can also target specific sectors, such as tourism and fishing, to promote best practices for plastic waste management (Karim et al., 2023; Liu et al., 2023).

### 7.4. Innovation and Technology

Innovation and technology can play a key role in mitigating plastic pollution in the Mediterranean Sea. For example, the development of biodegradable plastics and alternative materials can reduce the environmental impact of plastic products (Edaes & Souza, 2020; Gannoruwa & Kelaniyagama, 2024; Kusumaningrum et al., 2024). Additionally, advanced technologies for the detection and removal of plastic debris from the marine environment, such as floating barriers and underwater drones, can help to reduce the accumulation of plastic pollution in the sea.

## 8. Conclusion

The issue of plastic particles in the Mediterranean Sea is an urgent environmental concern that demands immediate and collaborative action. The review underscores the importance of both macroplastics and microplastics, detailing their origins from both land-based and marine activities, and their extensive distribution throughout the water column, seabed, and coastal regions. The environmental and ecological consequences of plastic pollution, such as the ingestion of plastics by marine organisms, degradation of habitats, and the potential transfer of associated toxins through the food chain, highlight the necessity for swift intervention. Additionally, the implications for human health, particularly regarding food safety and economic effects, further stress the urgency of addressing this problem. Plastics and fishing nets are causing significant harm to marine life, including fish and turtles, in the Mediterranean Sea through entanglement, ingestion, and habitat destruction. To address this growing problem, it is essential to implement a range of mitigation strategies, such as policy interventions like bans on single-use plastics, improved waste management systems with enhanced recycling programs, public awareness campaigns to educate communities about plastic pollution, and technological innovations such as developing biodegradable alternatives and advanced cleanup technologies. However, these efforts must be supported by comprehensive research to better understand the sources, distribution, and impacts of plastic particles in the Mediterranean region, including studies on the pathways plastics take into the sea, the extent of pollution in different areas, the specific effects on various marine species, and the effectiveness of current mitigation measures. Ultimately, a coordinated and multi-stakeholder approach is essential to effectively protect the Mediterranean Sea from the harmful effects of plastic pollution and to ensure the long-term sustainability of its ecosystems and the communities that rely on them. By bringing together governments, industries, NGOs, and local communities, we can develop and implement comprehensive solutions that address the complex challenges of plastic pollution in the region.



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