Effects of Heavy Metals on Phytoplankton Genetic Material in Jiaozhou Bay

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Abstract. Jiaozhou Bay as a semi-closed bay, its heavy metal pollution phenomenon has attracted extensive attention of scholars in recent decades. Heavy metals are a unique category due to their persistent pollution, biogeochemical cycling and ecological harmfulness. In addition, there are a large population and abundant phytoplankton species in the vicinity of Jiaozhou Bay. Therefore, this paper focuses on the influence of heavy metals on phytoplankton genetic material in the nearby sea area, and puts forward corresponding suggestions.

Keywords: Jiaozhou Bay · Heavy Metal Pollution · Phytoplankton

1 Introduction

The offshore area is a dynamic and complex environmental system where a large number of land-based pollutants converge. Among the numerous pollutants, heavy metals are unique because of their persistent pollution, biogeochemical cycling and ecological harmfulness [1]. Heavy metals are typical cumulative pollutants, which cannot be degraded by microorganisms. They can be transferred and enriched step by step through the food chain, and can be converted into more toxic metal-organic compounds under certain conditions [2]. In recent years, through the investigation and research of heavy metal pollution, revealing the pollution status of Marine environment and Marine sediments has become a hot and difficult problem in the research of Marine science and technology.

Jiaozhou Bay, located in the south of Shandong Peninsula, is a typical semi-closed bay. Since the 1970s, the population of Qingdao city around Jiaozhou Bay has increased rapidly, and the domestic sewage and industrial and agricultural waste water brought by this have been flowing into Jiaozhou Bay through the runoff of the surrounding rivers, causing the rapid destruction of the ecological environment in Jiaozhou Bay, and posing a serious threat to the Marine ecological environment and human health. As an important "sink" of heavy metals and a "source" of seawater secondary pollution, Marine sediments play an important role in the transport, storage and research of heavy metals. Some scholars have done a lot of work on heavy metal pollution in Jiaozhou Bay, but the ecological environment quality of Jiaozhou Bay needs to be re-evaluated due to a long time.

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Phytoplankton are tiny and diverse. Therefore, the phytoplankton community structure, such as species composition and abundance, may change under the influence of environmental factors. Phytoplankton, as the main primary producer in the ocean, plays an important role in the Marine ecosystem. Phytoplankton are very sensitive to heavy metal pollution in water, and have the effects of accumulation and transfer [3]. Phytoplankton can respond quickly in terms of population density and species diversity, and directly reflect the health status changes of water ecosystems [4]. Phytoplankton play an important role in ecotoxicology and water environmental protection. Therefore, the study on the evolution and direction of phytoplankton community structure caused by long-term environmental changes has become one of the hot topics in Marine scientific research. Therefore, the combination of the two has strong theoretical value and practical significance.

2 Research Design

Based on surface sediment samples obtained in Jiaozhou Bay in recent years and combined with some existing literature data, this paper analyzed seven heavy metal elements (Cu, Pb, Zn, Cr, Cd, As and Hg), and revealed the distribution characteristics of heavy metal elements in surface sediments of Jiaozhou Bay. The potential ecological risk of heavy metals in Jiaozhou Bay was evaluated by using geological accumulation index method and potential ecological risk index method in order to provide support for the comprehensive management of natural resources and ecological restoration in Jiaozhou Bay. As for phytoplankton, we used the phytoplankton survey results in Jiaozhou Bay in recent years, combined with the long-term environmental change data caused by natural factors and human activities to conduct a comprehensive analysis, and discussed the response of phytoplankton genetic material to the long-term change of heavy metals [5]. Some of the hydrometeorological and seawater chemistry data were obtained from the Jiaozhou Bay Ecosystem Research Station database of CERN.

3 Distribution of Heavy Metals

From the statistical analysis of heavy metal elements in surface samples, it can be found that the average content of heavy metal elements in sediments in the study area does not exceed the national marine sediment quality standard of class I, and the overall content of heavy metal pollutants is not high [6]. According to the Jiaozhou bay surface sediment distribution of heavy metal element can be found, in addition to the elements of Hg, the remaining six kinds of heavy metal elements distribution overall characteristics is similar to that of high value area is mostly distributed in bay from the west side of Yang River estuary to southeast port terminal line of inshore areas, low distribution in bay Midwest offshore waters, more uniform distribution. The content of Hg is not high on the whole, and it is high in the estuary of Baisha River and Ink River on the east side of the bay from Dagang wharf to Baisha River and Ink River [7].

It is worth noting that the variation range of different heavy metal elements is large, and the extreme difference and standard deviation of Pb, Zn, Cu and Cr elements are obviously larger than those of other elements, and the contents of Pb, Zn, Cu and Cr

elements in some stations reach the national standard of Class II or even Class III in marine sediments. It can be found that the sediments in most areas of Jiaozhou Bay belong to the first class, the concentration of heavy metals is generally low, and the sedimentary environment quality is good [8]. The type 2 sediments were mainly distributed in the coastal areas near the mouth of Dagu River in the northwest of the Bay and the coastal areas in the east of the Bay, and the concentrations of Pb, Zn, Cu and Cr elements increased in these areas. The three types of sediments mainly concentrated in Dagang wharf, Ink River and Baisha River estuary, which were the maximum distribution areas of heavy metal content in sediments in this study [9].

In addition, compared with the offshore waters of Jiaozhou Bay, the contents of seven heavy metals in the bay are obviously higher. Compared with other bays at home and abroad, the contents of most heavy metals (Hg, Pb, Zn, Cr) in this study area are higher than those in Beibu Gulf and Gulf of California, but lower than those in Quanzhou Bay and Aegean Sea (Lesbos Island). In general, the distribution of heavy metals in surface sediments of Jiaozhou Bay gradually decreases from shore to sea, and the eastern region is higher than the western region. This is mainly due to the fact that Qingdao industrial zone is located in the eastern coast of Jiaozhou Bay, and the heavy metal content in sediments in the bay is affected by terrestrial material input, industrial pollution and human activities. Since the 1980s, the discharge of industrial and agricultural wastewater, domestic sewage and solid waste into Jiaozhou Bay has gradually increased, and human activities have become the main factor affecting the distribution of heavy metal elements in surface sediments of Jiaozhou Bay.

4 Changes in Phytoplankton Genetic Material

Phytoplankton are primary producers of Marine ecosystems and the base of the food chain [10]. Marine phytoplankton converts inorganic matter into organic matter through photosynthesis to provide material and energy for Marine life activities. At the same time, their community structure changes with the different Marine environment, which can indicate the state of the Marine environment. Therefore, it is of great significance to the study of phytoplankton [11].

As more and more domestic sewage and industrial and agricultural production, including Marine aquaculture wastewater flowing into the bay, and water heavy metal content has increased in recent decades, and coastal zone development, shrinking, Jiaozhou bay waters decreased tide, water environmental capacity and self-purification ability is abate, these factors lead to the Jiaozhou bay environment towards the direction of heavy metals and transformation.

Under the influence of heavy metals, dominant species of phytoplankton in Jiaozhou Bay changed obviously, and heavy metal tolerance genes became more prominent. Some formerly dominant species have declined in number and are no longer dominant. At the same time, under the drive of eutrophication, the number of more fertilizing-loving species, such as E. codonis, increased significantly and became the most important dominant species, and their genetic material also changed to some extent, but the reason should not be from the influence of heavy metals, but the “survival of the fittest” natural selection. Similarly, some warm-water genetic material, such as lymphadenia undulata, appeared in the bay, and the number increased greatly.

The phytoplankton diversity index in Jiaozhou Bay decreased in the past 50 years, reflecting the changes of phytoplankton species quantity and population abundance under the background of increasing heavy metal content, indicating that the phytoplankton community structure in Jiaozhou Bay is in the process of evolution.

Due to the rapid increase of nutrient content and the genetic changes of phytoplankton caused by heavy metals, the formation and development of red tide has a rich material basis. A small scale red tide outbreak caused by Mesoconstriction rubrum was first recorded in Jiaozhou Bay in 1990. Since the mid-1990s, the red tide has developed rapidly in Jiaozhou Bay, and the frequency and area of the outbreaks have become larger, and the species causing the disaster have also increased. Especially since 1997, red tides of different sizes have broken out almost every year, and the trend of development has become more and more intense, and this abnormality may be caused by heavy metals pollution. However, in recent years, the Chinese government has intensified efforts to protect Jiaozhou Bay. In the latest report (2020), the regional biodiversity, species richness and evenness of Jiaozhou Bay are at a good level. Compared with previous years, the stability of phytoplankton community structure was significantly improved, and the stability of biological community structure and biodiversity were well maintained [12].

5 Conclusion

It can be seen that heavy metal pollution in the waters near Jiaozhou Bay has a certain degree of influence on phytoplankton genetic material. Therefore, the trend of heavy metalization should be paid attention to, and the following aspects should be started to improve the local Marine ecology.

Raise awareness of environmental protection, strengthen propaganda of heavy metal pollution. At present, the pollution of heavy metals in seawater is very serious, because it is closely related to People's Daily life and industrial production, so we should start to improve people's environmental awareness. It is everyone's responsibility to protect the Marine environment. Reasonable treatment of domestic sewage should be done to improve the utilization rate of water resources, especially for people living near the ocean. Dumping domestic sewage into the sea is forbidden.

We should optimize industrial production and strictly deal with industrial waste. Industrial waste water and waste from industrial production are the main sources of heavy metals in seawater. Industrial production, involving a large number of chemical components and drugs, or even chemical reactions between each other will produce toxic or harmful substances. If these toxic substances are discharged into the sea with industrial wastewater, the higher the pollution coefficient of heavy metals in the sea water will be, posing a serious threat to people's health. Therefore, to strengthen the treatment of heavy metal pollution in seawater, we should also start from the industrial field, strengthen the control of industrial emissions, and use laws to restrict them.

Establish a monitoring platform for offshore ecosystems. Through long-term observation and research of Jiaozhou Bay ecosystem, a perfect offshore ecosystem monitoring and research platform was constructed to study the long-term changes, system evolution, driving mechanism, development trend and response measures of the gulf and offshore ecosystems [13].

We should strengthen the strict detection of pollutant emissions, once there is excessive phenomenon, government departments should deal with and punish it, to achieve effective constraints on the industrial sector. In addition, we should strengthen the continuous innovation of industrial wastewater and waste treatment technology, use modern and advanced sewage treatment technology to carry out clean sewage treatment work, remove heavy metals and toxic substances in sewage in time, and then discharge them into the ocean.

At the same time, improve treatment technology to alleviate heavy metal pollution. In order to deal with the problem of heavy metal pollution in seawater more effectively, it is necessary to innovate the heavy metal treatment technology in time, starting from the aspects of physics, chemistry, biology and membrane separation technology, etc., to ensure the scientific and normative implementation of heavy metal treatment technology. The application of physical methods is mainly that the wastewater contains heavy metals. Physical methods can be used to adsorb, concentrate and separate heavy metals. In the field of chemistry, heavy metal ions should be removed by means of chemical reaction, and treated by chemical precipitation, coagulation, REDOX, electrolysis and other methods. From the biological field, biological adsorption, plant remediation and flocculation are applied to the treatment of heavy metal ions.

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