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A study on polychaetes in the yellow sea and Bohai Sea: Biodiversity perspective

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Abstract
The marine flora and fauna of the China seas are characterized by high biodiversity, including both the yellow sea and Bohai Sea. Among various flora and fauna, marine Polychaetes are known to play an important ecological role in the marine environment. In marine benthic communities, the most dominant group considered is the Polychaetes. Various species are used as an indicator organism for environmental quality assessment of marine sediments and Polychaetes are often considered as the most dominant group in marine benthic communities. Based on comprehensive investigation in certain areas the species distribution pattern of benthic Polychaetes can provide an ecological oriented environmental assessment and overall theoretical support for the protection and management of marine benthic ecosystems. This review determines (a) the marine biodiversity in Yellow Sea and Bohai Sea (b) ecological features of Polychaetes including diversity, relationship between Polychaetes and environment. (c) Effects of water quality on Polychaetes including Effects of temperature, Spatio-temporal change on community. (d) Significance of Macrobenthic ecology in China seas.

Keywords: polychaetes, diversity, yellow sea, bohai sea

1. Introduction
The ocean covers 70% of the Earth's surface and marine sediments provide habitat to variety of oceanic organisms. Marine sediments can be classified into two broad categories according to their sources, namely, called lithogenious and oceanic sediments according to Guoying and Shi, 2002. Majority of the marine organisms are found along the intertidal zone, continental shelf, deep sea, and some Polychaetes species are predominantly found in hydrothermal ecosystem. The most and common among marine benthic communities are Polychaetes. The Polychaetes are found in both fresh and marine waters [1]. Early research focused on marine sediments in the discovery of new species and species classification. The most famous Swedish biologist Carl von Linnaeus (1707-1778), studied the Linnaean classification system developed to now have also been followed. Following the study of early biology, 1872-1876, the British "Challenger" was the world's first sea adventure. It was the first systematic study of marine sediments, which was mostly descriptive research focused on the taxonomy and aspects of life history. Rise of ecology as a discipline in the late 1890s, was first proposed by German scientist Ernst Haeckel (1834-1919). Ecology is a multidisciplinary describes the relationship between organisms and their living environment.

Most studies have focused on ecology, land ecology, knowing the 1950s; research on the ecology of marine organisms began together as per Guoying and Shi, 2002. The most commonly used classification is the benthic fauna by sorting mesh pore size, the animals were divided into large benthic macrobenthos, small meiobenthos and micro-benthic macrobenthos that macrobenthos, usually refers to the screening 0.5mm aperture sieve interception of benthic fauna [2]. At present, benthic research focuses on four typical habitats: intertidal, subtidal, brackish estuaries and Deep Ocean. Benthic invertebrate ecosystems play an important intermediary role in benthic food by filtering phytoplankton and larger organisms such as fish food sources, that the primary productivity and higher trophic level biological link. Benthic fauna through its effects on sediment deposits further remodeling and improve sediment

oxygen permeability. Benthic sediment can break down organic matter, for the bacteria play a fundamental role to play again, [3]. The British scientists Forbs during the first quarter of the 18th century began to study benthic ecology. In 19th-century, Wester Western European countries carried out several large-scale Community Structure and Biodiversity of Sublittoral Polychaetes in the Yellow Sea and Bohai Sea marine biological surveys to collect a certain number of benthic form description and classification and identification data, such as the "Challenger" global survey.
A google search strategy for the review was utilized using the terms “Marine Polychaetes”, “Marine biodiversity in Yellow Sea and Bohai Sea,”, “Characteristics and changes in marine biodiversity” and “Conservation of endangered species and effective management”. Overall the study consists of total 95 articles. The searched articles were then separated for both China seas i.e., Yellow Sea and Bohai Sea.

1.1 An overview of Polychaetes

In marine invertebrates the Polychaetes are present in a wide range of habitats and are separated from the bottom of the rock to the muddy sediments, estuarine environments, abyssal plains [4-8] and even in extreme environments such as hydrothermal vents [9]. Polychaetes are the most dominant creatures in abundance and biomass and are often diverse [4, 10, 11]. They have an amazing range of means of living freely in stone and algae, creeping to the surface, being buried in the bottom material or swimming, and they may sit and live in a tube or cage [4]. They may also fall in the whale of the bones [12-14]. Basically, they are marine invertebrate organisms living in freshwater sediments [15, 16]. Typically, they are less common Polychaetes living in groundwater, river and plants [1, 17, 18]. In addition, they can become special symbiotic from parasites, living in connection with many marine taxa (including other Polychaetes) [19]. The Polychaetes are vital in the marine food chain as an important prey for many crustaceans, mollusks, fish, migratory birds and other creatures, and serves as a predator in marine food chain. They play an important role in the decomposition, subduction and incorporation of organic matter into sediment. Because of their ubiquitous distribution the species composition of the Polychaetes in the *zoobenthos* community indicates the healthy ecosystem. Moreover, Polychaetes are the source of pollution indicators [20]. Some species are used as serious contaminants or as insects of commercial shellfish such as suspended oysters *Crassostrea gigas* cultures [21]. In addition, some Polychaetes animals are consumed by humans and are known primarily as "palolo" worms [22]. Polychaetes are also economically important because of increasing commercial activities and the international market by tapping or produced as a food project in aquaculture [23]. Field introduction of alien species and associated pathogens or other non-natural organisms were implied into wildlife [24, 25].
The other Polychaetes contain the presence of toxins or venom glands in certain populations like *Amphionomidae*, *Glycera*, *Metaxypsamma*, and other groups is chemically protected, opening up the possibility of new research and application in pharmacology and drugs [26]. The first classification for the taxonomic purposes of accepting the Polychaetes was described by Linne in 1758. Acknowledged class Vermes for soft body worm-like creature in addition to organisms currently recognized as Polychaetes and shellfish. They also include various molluscs and several crustaceans, nematodes, sea urchins, starfish [27]. Other descriptive and taxonomic tasks of great importance were described by Cuvier *et al*. (1817) and Lamarck (1818). This phase of annelid classification ended with *Audouin* and Milne-Edwards (1834), and outlined the French fauna. *Errantia* was the only new name for the importance introduced in the higher classification. Previously it was called "*Antenneed"* or "*Dorsibranchiata*" and was a member of *Sedentaria* [4]. Firstly a unified group of Polychaetes was recognized by Grube in 1850. He presented a new classification of Annelida as (*Annulata*). The *Appendiculata* order is still called the Polychaetes and *tomopteris* was placed in a different order of *Gymnocopa*. At that time *Peripatus* was also considered as annelid and arranged into the order of *Onychophora* as Audouin & Milne Edwards in 1834. The *Oligochaeta* and *Discophora* order included taxa related to earthworms and the serpent. Both *clitellate* groups were separated for the first time by Grube in 1850 [20, 27]. Later, two series of worms Versique and Veronique were divided by Quatrefages (1865). All Polychaetes were included in Annelids. As in sedentariness, Polychaetes were recognized possessing a clearly localized body as the thorax and abdomen and errands were missing. Recently, in 1878 Hatschek added *Archiannelida* as a separate class containing two families *Polygordiidae* and *Dinophilidae*. Until the 1990s, the most commonly used system was derived from *Quatrefages* (1865) and compiled in a widely used monograph by [28, 29]. The concept of *errantia* and *sedentaria* was used even complaining about the system inadequacy. The finding of stomodal modification in 1863 was important in order to understand the phylogeny of Polychaeta [30]. The other features that were also considered in his previous publications such as *Nephilida*, Musculature and Chaeta have important implications for phylogenetic interpretation. A key Polychaeta class that directly led to families was presented with no reference to a key order by Pettibone (1963). After 1982 identified 25 orders, including 5 traditional *archiannelidan* and six super families. The diagnosis on 17 orders was not focused on single morphological features for the characteristics of the front end of the main branch [31]. After arguing with Annelida systematic studies [32], unless an *Articulata's* internal relationship is resolved, indicating that it is single taxa it should not be used. They also suggest that the classification group name *Articulata*, originally formulated includes Annelida and *Arthropoda* by Cuvier. They are defined as branches derived from the first ancestors that show homologous structure repeats, through *cotyledonous* growth zones and longitudinally divided into strips band. In addition, they showed the historical background of the current unsatisfactory system of Polychaetes lacking consistent morphological information as a major source of uncertainty [31]. They also showed that Polychaeta was a monophyletic group, but there was no evidence about a group of *Clitellata* in the Polychaetes. They also pointed out that *pogonophora* was a member of Polychaeta. On the other hand, the uses of sequence of nuclear genes, elongation factor-1 of phylogenetic analysis by simple and adjacent ligation methods, there was no evidence of a single system of Polychaetes [33]. On the contrary, the *clitellates*, *pogonophorans* and *echiurans* placement were made in the paraphyletic for the Polychaetes. In the same way, based on *hennigian* reasoning, their character weights were based on diversification, mainly functional considerations [34].They took into account habitat, body size, reproductive biology and fossil records. Their annelid tree showed the *Clitellata* was

highly evolved mono phylum and many Polychaetes were as paraphyletic. Special emphasis on the description of *Clitellata* was on the earth.

Thus future methods using morphological and molecular data were used to analyze higher levels of relationships for Annelid, but this was also further required to study of specific problems at lower classification levels [35]. The number of currently accepted Polychaetes was about 9000, although thousands have been named are considered invalid [36]. Currently, the Mediterranean Polychaetes fauna includes 1122 species, out of them 946 are known from the western Mediterranean region, belonging to the 452 genera and of 72 families [37]. Some of them are still not classified in the world or endemic species [38]. Taking this trend into account the 72 different Polychaetes family level for practical comparison purposes was not described [27].

1.2 General ecological features of Polychaetes

All Polychaetes were included in *Annelides.* As in sedentariness Polychaetes were recognized to have a clearly localized body as the thorax and abdomen and errantes were missing. Recently, in 1878 Hatschek added *Archiannelida* as a separate class containing two families *Polygordiidae* and *Dinophilidae*. Until the 1990s, the most commonly used system was derived from Quatrefages (1865) and compiled in a widely used monograph by [28, 39]. The concept of errantia and sedentary was used even complaining about the system inadequacy [40]. The finding of stomodal modification in 1863 was important in order to understand the phylogeny of Polychaeta [4]. The other features that were also considered in his previous publications such as *Nephilida,* Musculature and Chaeta have important implications for phylogenetic interpretation. A key Polychaeta class that directly led to families was presented with no reference to a key order by Pettibone (1963). After (1982) she identified 25 orders, including 5 traditional *Archiannelidan* and six super families. The diagnosis on 17 orders was not focused on single morphological features for the characteristics of the front end of the main branch [4]. After arguing with Annelida systematic studies [32], unless an *Articulata's* internal relationship is resolved, indicating that it is single taxa, it should not be used. They also suggest that the classification group name *Articulata*, originally formulated includes Annelida and *Arthropoda* by Cuvier. They are defined as branches derived from the first ancestors that show homologous structure repeats, through *Cotyledonous* growth zones and longitudinally divided into strips band. In addition, they showed the historical background of the current unsatisfactory system of Polychaetes by lacking consistent morphological information as a major source of uncertainty [32]. They also showed that Polychaeta was a monophyletic group, but there was no evidence of a sister group of *Clitellata* in the Polychaetes. They also pointed out that *pogonophora* was a member of Polychaeta. On the other hand, the uses of sequence of nuclear genes, elongation factor-1 of phylogenetic analysis by simple and adjacent ligation methods, but there was no evidence of a single system of Polychaetes [33]. On the contrary, the *cliellates, pogonophorans* and *echiurans* placement were made in the paraphyletic for the Polychaetes. In the same way, based on *hennigian* reasoning, their character weights were based on diversification, mainly functional considerations [34]. They took into account habitat, body size, reproductive biology and fossil records. Their showed the annelid *Clitellata* was highly evolved mono phylum and many Polychaetes were as paraphyletic. Special emphasis on the description of *Clitellata* was on the earth. Thus future methods, using morphological and molecular data were used to analyze higher levels of link relationships for Annelid, but this was also further required to study of specific problems at lower classification levels [35]. The number of currently accepted Polychaetes was about 9000, although thousands have been named and are considered invalid [36]. Currently, the Mediterranean Polychaetes fauna includes 1122 species, out of them 946 are known from the western Mediterranean region, belonging to the 452 genera and of 72 families [37]. Some of them have still not classified in the world or endemic species [38]. Taking this trend into account the 72 different Polychaetes family level for practical comparison purposes was not described [27].

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1.3 Research on Polychaetes diversity

Biodiversity refers to the sum of the complexity at a time and in a specific area of biological species, ecosystems and genetic variation, including three levels of genetic diversity, species diversity and ecosystem diversity (Yunlin, 1994). Biodiversity and spatial scales are related therefore unified within a range of diversity is described [41, 42]. According to the spatial scale study of diversity can be divided into α, β, γ three levels [43]. α-diversity is confined in a small-scale homogeneous habitats which may exist due to the interaction between biodiversity species, also known as biological diversity (within-habitat diversity) within the habitat; β-diversity means on the larger scale, species composition between different habitats community dissimilarity, the sampling range and more in the community boundaries intersect, this biological diversity is called biodiversity (between- habitat diversity) between habitat; γ - diversity is in a larger scale, the factors controlling the evolution of total species diversity measure within a certain area, also known as landscape biodiversity “landscape diversity” [44, 45]. Most research on benthic fauna diversity of levels of biodiversity is still stuck in the habitat, the study of diversity between habitats and biological landscape appears to be meager. Community and ecosystem diversity index is usually the basis for evaluation of the diversity of research which not only refers to the number of all species within a region, but also includes abundance and abundance of species within a single individual, within the species combination. Early research focused on the diversity of the community description, such as the abundance of (A), biomass (B) and number of species (S) of the study, therefore gave rise to a variety of community structure to represent the average of the ratio (A/S) abundance and number of species, and (B / A) biomass and abundance. The large number of biological diversity is the number and variety of data to summarize mathematically in order to describe the community structure [46]. Diversity indices, including the total number of species richness, Shannon-Wiener diversity index [47] and evenness index J [48], they are generally used to assess the degree of interference and the protection of the marine environment of offshore marine biodiversity. The index is not only that there is a problem that the community of each species harmonization failed to take into account the evolution of differences between species exist, and the index there are a lot of problems [49, 50]. To be able to contain more information richness, Clarke and Warwick made four "category diversity index" [51]. They were classified diversity index (Taxonomic Diversity), classification difference index (Taxonomic Distinctness), the average taxonomic distinctness index (Average Taxonomic Distinctness) and classification of the degree of difference variability index (Variation in Taxonomic Distinctness). After the class index obtained in the proposed macro-benthos analysis was in a wide range of marine applications [52-54].

1.4 The relationship between polychaetes and environment

There were significant differences in the growth, reproduction, species composition, community distribution in different seasons, different water bodies and regions. The environmental factors, including sediment, water quality and temperature had significant effects on the Polychaetes a variety of effects. The study of species composition and quantity, composition of Polychaetes is an indispensable part in the study of environmental factors. There were significant differences in the number and types of Polychaetes in different types of sediments. Generally believed that the sandy or sand, Polychaetes type of individual size and the thickness of the substrate particles are also in direct proportion to the relationship between the distribution of Polychaetes and the type of nutrition is also related to the substrate.

1.5 Effects of water quality on polychaetes

Benthic Polychaetes live at the bottom of the water body for a long time. The water quality directly affects their survival, growth and reproduction. The dissolved oxygen level, suspended matter concentration, nutrient level, pH, salinity and flow velocity which determines the species composition, biomass and macroscopic distribution of Polychaetes. In general, Polychaetes have low demand for dissolved oxygen, but low levels of dissolved oxygen have a negative effect on Polychaetes. For example, low levels of Polychaetes biomass in Peru's Anken Bay are caused by low dissolved oxygen (Yang, 1996). Some Polychaetes species live only in a certain range of dissolved oxygen in order to lead a normal life [55]. Studies have shown that the dissolved oxygen between (3.4-40mg /L), small Polychates *(Capitella capitata)* can impact normal growth and reproduction, when less than or above this range cannot be normal growth and reproduction. The biomass of benthic macroinvertebrates were negatively correlated with the concentration of suspended sediment in the ocean bottom. For example, the material composition of the suspended sediment in the Bohai Sea mainly consisted of classic minerals and clay minerals. The macrobenthos biomass, including the Polychaetes, water suspension concentration was negatively correlated [56]. It may be because suspended particles in the high concentration of water, hindering the light, so that the primary productivity of water reduced affecting the growth of large animals.

1.6. Effects of temperature on Polychaetes

Any living organisms in a certain temperature range, its growth, reproduction and all life activities are greatly affected by temperature constraints. The effect of temperature on Polychaetes is more common in food and other environment suitable conditions, in the appropriate temperature range; and increased temperature can speed up the growth and development of benthic animals and shorten the turnover rate of Polychaetes, thereby increasing its productivity [57, 58]. Excessively high or low temperatures are particularly detrimental to the growth of Polychaetes species, such as Peru's Ankeny Bay, experiencing short-term increases in El

Nino water temperature, the biomass of the Polychaetes increased markedly, but the density of the *Sigambra bassi* in this bay showed a completely different situation for water temperature increase in three different *El* Niño phenomena [59].

1.7. Spatio-temporal change of Polychaetes community

The spatial distribution of benthic Polychaetes is mainly caused by interference [60], interference includes not only physical disturbance, further comprising a variety of biological interference caused by changes in benthic fauna. Bottom trawling is recognized ecological impact on the global marine benthic Polychaetes of the most serious interference activities. Statistics show, that the North Sea bottom trawling United States twice a year, in some places 3 to 4 times while the number of China's annual trawl can reach 10 to 20 times. Trawl consequences are dramatic cited in Norwegian scientists [61], article in its metaphor of marine exploitation. In addition to bottom trawling in recent years hugely extreme and anomalous temperature changes on benthic fauna also caused a great impact. There has been many studies have focused on temperature changes in the benthic fauna by Solan *et al*., 2003. In addition to external factors, the interaction between biological also has a huge impact [62] on the spatial distribution of the benthic Polychaetes. Time distribution of benthic animals will often alternate with the change of seasons change. Most benthic Polychaetes species are of the larval stage, the larvae more camp planktonic life, the use of water diffusion. Most benthic animal species release gametes eggs in the spring or early summer, also choose autumn or winter spawning [63]. Marine environment (temperature, light and primary productivity) seasonal cycle, even shallow water has a significant impact on benthic animals, and this effect is more obvious deep sea than in coastal benthic [63].

2. Overview on yellow sea and Bohai Sea waters (China)

Yellow Sea in the western Pacific Ocean, is a marginal sea in the east of the Eurasian continent and located between mainland China and the Korean peninsula. Yellow Sea is shallow in depth, with average depth of 44 m; the seabed is gentle, all located on the continental shelf of East Asia. Customarily between Shandong Peninsula and Korea, the Yellow Sea wires into the northern Yellow Sea and southern Yellow Sea in two parts by Chengshan Jiao and Changshan string. In the central portion of the Yellow Sea deep water (Yellow Sea trough), water depth is generally 50-80m, under the combined effect of this unique terrain and heat, power factor, and in the summer quarter, the Yellow Sea at a depth of 40-50 m of the emergence of a unique Yellow Sea cold water mass (YSCWM): winter sea water mixed into the outer coast of the Yellow Sea, due to the cooling effect of the sea and sink to the bottom of the deep. In summer, the upper water due to warming down salt layers, the lower its water remains low temperature (6-12 ℃) high salt (31.6-33.0) characteristics, thus forming a cold water mass by He, 1959. Not only affected hydrological factors, nutrients, chlorophyll distribution of zooplankton, bacterio-plankton, and distribution of benthic organisms were affected [64]. The YSCWM, hindering the majority of tropical origin of warm water species northward distribution, but such environmental conditions are extremely conducive to the development of a large number of species of the temperate northern origin. Yellow Sea cold water mass has a south and north central South Yellow Sea cold water mass in comparison with the North Yellow Sea cold water mass, due to the south geographical, which were slightly higher temperature and salinity. Compared to the northern Yellow Sea, Yellow Sea warm current are presence at the southeast edge of the South Yellow Sea Cold Water Mass. The Yellow Sea Warm Current (Tsushima Warm Current) of the sub-tropical zone carry high temperature and salinity along the Yellow Sea waters sink into the Yellow Sea [65, 66], some of the warm water species with the arrival of the warm region. Therefore, the southern Yellow Sea, in the same qualitative sampling network was eligible, and often at the same time cold and subtropical species of warm-water species of different nature [67].

Bohai Sea surrounded by land is China's only inland sea, also China's largest inland sea nearly closed east to the Yellow Sea and the Bohai Strait. The average depth of the Bohai Sea is only 18m, flat seabed, mostly soft sand and shale. The Bohai Sea is an estuaries of nutrients and variety of food organisms the natural formation in northern China an important economic fisheries by Dong *et al*., 1992. There are three bays in the Bohai Sea i.e. Bohai Bay, Laizhou Bay, Liaodong Bay. Laizhou Bay in the south of Bohai Sea, with a total area of 9530 km², monotonous flat seabed topography, water depth at most within 10 m. Compared with the Yellow Sea, Bohai Sea fauna and flora are poor, monotonous, low biodiversity, the predominant species are mainly salt, eurythmic warm water species [68]. The Bohai Sea coastal region is rich in resources, economic development, China is a major economic center. The study of the Yellow Sea and Bohai Sea, macrobenthos is still characterized by Polychaetes species, they plays an important role in the Yellow Sea and Bohai Sea macrobenthos communities, which represent and reflect the changes in the composition variation throughout the community. On the other hand, polychaete highlight changes in the status of benthic animal communities, but also reflect the changes in the Yellow Sea and Bohai Sea trophic levels.

2.1. Marine environment in the Yellow Sea and Bohai Sea

Marine benthic organisms (benthos), also known as underwater organisms, live in the intertidal zone to the seabed from the surface and sediments in the benthic life of all organisms, is the most species of marine organisms in the group, and has an important ecological learning function. Macrobenthos, as an important part of the food chain of marine ecosystem, can make full use of organic detritus in sedimentation of the aquatic layer through nutrient relations of benthic animals and promote the decomposition of nutrients. In marine ecosystem, energy flow and material circulation, it plays an important role. Macrobenthos can also reduce the concentration of contaminants in the water and sediment by filtering food or by incorporating contaminants on the surface. The biotype of benthic organisms and the sedimentation of sediments are the main and basic contents of benthic ecology and sedimentary dynamics. The research on marine benthic organisms was carried out in the world, as early as the 1870s, the British investigated the benthic organisms in the world's three oceans. At present, the research on benthic organisms has entered the stage of quantitative research [69] Warwick, 1997), biological community research [70, 71] and biological diversity research [72] and [73], through long-term investigation of benthic community for environmental monitoring. Compared with developed countries such as Europe and the United States, China's benthos ecology research started relatively late. Before the founding of New China, the research on macro benthos was scant. After the founding of the People's Republic of China, the systematic investigation and research were carried out. The large-scale comprehensive survey of marine science, such as the comprehensive survey of marine science in China from 1958 to 1959 (i.e. the national marine survey) 1959- 1962 Sino-Vietnamese Beibu Gulf Marine Science Joint Investigation, 1980-1985 national coastal zone and tideland comprehensive resource survey, 1989-1993 national island survey, 1999-2004, the Yellow Sea ecosystem dynamics and the sustainable use of biological resources, 2004 to 2009 of China's coastal ocean comprehensive survey and evaluation (i.e. 908 special surveys, the second national marine survey) and in progress the key process, mechanism and ecological environmental effect of the offshore jellyfish outbreak in China, as an important content of the ecological investigation of macrobenthos, and the regional or local marine ecological survey and environmental quality in the investigation and evaluation. The early marine macrobenthos ecology work mainly focused on intertidal biota, species composition and distribution of the study. The regional environmental fauna species composition, structure, biodiversity, secondary productivity, trophic level and the coupling of bio and abiotic environmental factors were present. The ecological characteristics of macrobenthos were investigated and studied systematically, under the positive efforts of the national marine scientists, the species, distribution, resource utilization and main ecological and biological diversity characteristics of major macrobenthos assemblages in China's seas and estuaries have been basically dominated.

The late 1980s, under the influence of international research programs, China's macro fauna ecology research in design methods, research methods, information exchange began to change qualitatively, macro benthos in the water layer - benthic coupling, and biogeochemical cycling have also been incorporated into the scope of the Chinese GLOBEC study. The bio turbation experimental system has made possible the experimental study of the aquifer-benthic interface [74].

3. Survey of marine environment in the Yellow and Bohai Sea (China)

3.1 Yellow Sea

The Yellow Sea is a semi-enclosed water body, bordering the western part of the Chinese mainland, east of the Korean Peninsula, and from the north bank of the Yangtze River estuary (Yangtze River) to the south side of Cheju Island, an area of about 400,000 km^2. It has an average depth of 44 m and most of its sea surface area has shallower as 80 m [75] (GEF/UNDP 2000) (figure 1). It connects to the Northern Bohai Sea and the Southern East Sea, forming a continuous circulation system between the three oceans. The Yellow Sea receives large amounts of sediment about (1.6 billion tons) annually, mainly from the northern Yellow River and the Southern Yangtze River and these two rivers form a delta in their mouths. The biological community of the Southeast Yellow Sea is complex in terms of species composition, spatial distribution and community structure, and may be due to the complex oceanographic conditions of the ocean. The animal community consists of warm water and cold water as well as various taxonomies of international metropolitan and pacific species. However, the diversity and abundance of fauna are relatively low. All the components of the biotic community show significant seasonal changes. Turbidity and sedimentary types appear to be the main parameters affecting the distribution of planktonic and benthic organisms in the Yellow Sea coastal waters [76, 77]. It was reported that there are about 1600 species of marine and coastal habitats in the Korean side of the region. These include 70 phytoplankton, 300 species of benthic diatoms, 300 species of seaweed, 50 species of algae, 500 species of marine invertebrates, 150 species of fish, 230 species of water birds and 10 species of marine mammals were reported (GEF/UNDP 2000 [75]. Over the past few decades, the total tidal unit in the area has suffered a loss of about 25 percent. Coastal industrial complexes and municipal waste and pollutants, as well as coastal tourism visits, have also contributed to reducing habitat (GEF/Department of 2000) [75].

Fig 1: Yellow and Bohai Sea (China)

The region was in a high degree of biological diversity and suffered from a high level of losses. For example, about 80 species of birds were classified as threatened by both China and South Korea in the region [78]. The main threats are: (i) the introduction of lien for competing endemic species, (ii) habitat destruction, (iii) hunting, (iv) over exploitation, (v) sometimes deliberately wiped out. The habitat destruction in the area was particularly important because of the conversion to other uses, removal of vegetation or erosion and / or debris, and reduced habitat in areas where local species could not be supported. In addition, future changes in global climate may further emphasize the habitat of the region [79].

3.2 Bohai Sea

The Bohai Sea is the large inland sea of China. It is the most inland sea in the northeast of China, with an area of about 823,000 km^2, bordering the Eastern part of Liaoning Peninsula and the Southern part of Shandong Peninsula. Bohai Sea consists of three bays: the southern part of Laizhou Bay; northern part of Laiodong Bay and western part of Bohai Bay. The three largest rivers the Yellow River, the Liao River and the Hai River run out into the Bohai Sea. The Shandong, Laioning, Hebei and Tianjin provinces and cities are bordered to the Bohai Sea. The main port cities Dalian, Yingkou, Jinzhou, Qinhuangdao, Tanggu, Longkou and Yantai are around to the Bohai Sea. Over the past two to three decades, oil and gas deposits have been discovered and developed around the Bohai Sea and around it (Wikipedia). The Bohai Sea is an ecologically important and stressed water body. Its marine resources are important to China, Japan, North and South Korea. The physical processes that mainly control the changes of the ecosystem of the Bohai Sea include the tide-warm salt circulation, deep summer seasonal stratification, winter mixing and river discharge [80]. More than 17 rivers enter into the Bohai Sea. One of the largest of the Huanghe River (Yellow River). The flood season (July-September) the water and sediment flux accounted for 70-80% of the annual value [81].

4. Significance of macrobenthic ecology study in China seas

The Yellow Sea is the edge of the sea, often in accordance with the characteristics of natural geography, the Shandong Peninsula into the Korean mountains to the Korean mountains between the strings as a line between the Yellow Sea will be divided into the southern Yellow Sea and the northern Yellow Sea. Southern Yellow Sea refers to the south of this connection. The Yellow Sea Shelf and the East China Sea Shelf form one of the widest shelves in the world. In the South Yellow Sea there are many small rocky reefs. Jeju Island, South Korea is the connection between the Yellow Sea and the East China Sea line. The Yellow Sea Cold Water Mass is formed in the water depth of 40-50 m in summer. The formation of the cold water mass is due to the low temperature water sinking and strong mixing in the winter surface. The vertical convection in summer is higher than the winter [74]. The Yellow Sea cold water mass has a very important effect on the biomass and productivity of phytoplankton [82], zooplankton distribution and density in the Yellow Sea [83-86]. However, there are very few studies on the community structure of cold water mass and macrobenthic fauna, reported the cold-water benthic community in cold water mass for the first time. Yellow Sea cold water group summer bottom water temperature north in 4-8ºC south no more than 8-12ºC this provides suitable survival, breeding conditions [87], for the cold water species from the north, especially the cold temperate species. Many important fisheries are distributed in the waters, such as the southwestern part of the waters are young eel farms and anchovy spawning grounds. It is the South Yellow Sea this special for the marine life research provides excellent research sites. Benthic organisms and sedimentary environments have a clear distribution gradient with water depth, coupled with the mixing of cold and warm water, and have become the best place to study the response of benthic ecosystems to climate change, and all the continental shelf of the sea, the South Yellow Sea is also the human activities, the most frequent economic development of the region, but also land factors, ocean factors, atmospheric factors more intense interaction zone. The average of South Yellow Sea shallow water is about 46 meters. The South Yellow Sea is rich in biodiversity, food network structure is complex, biological resources, large reserves, dominant species for fishery resources and related research provides a good place. Along with the recent decline in the basic productivity of marine ecosystems in recent years, the green tide of Enteromorpha proliferates frequently and the biodiversity of the southern Yellow Sea is declining. Biodiversity in our waters has been seriously threatened.

Benthic fauna is an important part of the marine food chain, especially in the food chain, especially in coastal and estuaries. Organic debris in the sea, after the deposition in the coastal waters, cannot be directly used, only through the microbial and swallow-type benthic organism’s related role can be further used. In these areas, benthic organisms play an extremely important role in fish and shrimp foods because of the low primary productivity of phytoplankton. In addition to the important role of marine benthic ecosystem energy flow, macrobenthic play an important role in the material cycle, so macrobenthic fauna is widely used to monitor the marine environment and has been confirmed by many studies [88]. In the marine environmental pollution control and monitoring, the seabed depositional environment is regarded as a secondary pollution source, is an important indicator of marine environmental monitoring. Although many researchers have been previously studied the macrobenthic fauna in the South Yellow Sea. A low number of environmental factors were involved. Therefore, in-depth m study of macrobenthic fauna, combined with advanced statistical methods was carried out, especially the combination of environmental factors on the South Yellow Sea macrobenthic species composition characteristics, dominant species, abundance, biomass plane distribution, multi-sex, secondary productivity, community structure and so on, and it summarizes the characteristics of macrobenthic fauna in the South Yellow Sea, and compares with historical data and adjacent sea area data, and analyzes the response mechanism of macrobenthic fauna to environmental change. Further study of benthic ecology in China was to provide a corresponding reference as well.

5. Conclusion

The study reveals the benthic biodiversity in both the Yellow Sea and Bohai Sea. The results determined in this research reveals the community structure and biodiversity of Polychaetes. It exclusively shows that in Yellow Sea and Bohai Sea the dominant group is the Polychaetes. Moreover, the study also explains the ecological role and importance of Polychaetes in the marine environment. Hence, the research reveals that Polychaetes can be a major factor as an indicator organism for environmental quality assessment of marine sediments.

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