The Potential Ecological Risk of Pb for Multi-phase Medium of Artificial Reefs

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***Abstract*—Using ICP-MS to detect Pb in the multi-phase mediumin the artificial reef .The results showed that: Pb of sediment is varied from0.138~0.470mg/Kg, mean0.273±0.106mg/Kg,The sediment distribution of Pb decreased in the order: lower> middle> upper layer in each station. Risk evaluation showed that potential ecological risk index of Pb is low in the reef sediments; accumulate partial index is belong to moderate pollution levels; enrichment factor is belong to the light~pollution-free . Pb of organisms is rang from 0.004-0.519 mg / Kg, mean 0.185 ± 0.170 mg / Kgin reef area; BCF value of Pb in organisms is generally higher than BAF value; its health risk factor is far less than 1, indicating that Pb has no obvious health risks on exposure population.**

Keywords-heavy metals; spatial distribution; ecological risk assessment

I. INTRODUCTION

Artificial reef areas is a special ecosystem, according to the survey, at the end of artificial reefs are three main types of quality concrete reefs serve different sediment after the dissolution of the hydration products if there are certain rules? Past, researchers concentrated on the surface sediments vertical distribution and pollution situation of heavy metals, Speciation and bioavailability, geochemical characteristics and influencing factors were studied [1-9]. But on the studies of heavy metals distribution of the multiphase medium in artificial reef rarely reported, based on this, the paper of heavy metals in artificial reef about multi-phase medium (sediments and organisms) in preliminary accumulation of Pb and other aspects of ecological risk to the reef area of scientific understanding of heavy metal pollution and its environmental safety for the protection of aquatic ecological effects of the area's ecological safety, scientific development and management of biological resources and the prevention and control risks provide a scientific basis.

II. MATERIALS AND METHODS

A. Sample Collection and Determination

Artificial reef areas selected for the survey area (Figure 1), in which the station is located in the 2010 1, 2,3 vote reef; 4,5,6 stations located in 2012 voted reef; stations 7,8,9 located in 2014 voted reef; nine were selected sampling stations. Field survey of all processes in strict accordance with "marine monitoring" (GB/T12763.6-2007) [10] carried out the job. Sediments and Synechogobius ommaturus (Richardson) in artificial reef as the object, after dissection, take the muscle was freeze-dried, and then by microwave digestion and then measured on the machine.

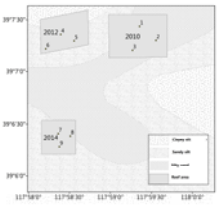

FIGURE I. SAMPLING SITES IN ARTIFICIAL REEFS

B. Potential Ecological Risk Index

$$C_f^i = C_o^i / C_n^i \tag{1}$$

$$E_r^i = T_r^i \times C_o^i / C_n^i \tag{2}$$

Cio is the measured content of heavy metals in sediments; C_n^i for the calculation of the required reference value (Pb 70) ; T_r^i (Pb toxicity response parameters were 5); wherein the potential ecological risk of heavy metal pollution index and the hierarchical relation in Table 1.

TABLE I. HEAVY METAL POLLUTION INDEX AND POTENTIAL ECOLOGICAL HARM HIERARCHICAL RELATION

E_r^i	**Ecological Risk**
E_r^i <40	low
40≤ E_r^i <80	intermediate
80≤ E_r^i <160	Heavier
160≤ E_r^i <320	weight
E_r^i ≥320	serious

C. Accumulate Index

$$I_{geo} = \log_2\left(C_n / 1.5B_n\right) \tag{3}$$

Cn is the measured content of heavy metals in sediments of n (mg/kg); Bn is geochemical background value of the element (mg/kg), Pb 25; 1.5 for the elimination of sediment diagenesis caused by natural effects of changes in the value of the background and the use of a correction coefficient matrix [11]. According Igeo value of heavy metal pollution will be divided into seven grades, as shown in Table 2.

TABLE II. INDEX OF GEOACCUMULATION AND CLASSIFICATION OF POLLUTION DEGREE

I_{geo}	≤0	0～1	1～2	2～3	3～4	4～5	＞5
series	0	1	2	3	4	5	6
Degree	No	Mild	Partial Moderate	Moderate	Lay particular stress	serious	Very heavy

D. Fish Health Risk Assessment

USEPA established objective risk evaluation system (THQ), evaluation of exposure to chemical pollutants on the population exposed to potential hazards that may exist THQ as a non-cancer risk assessment system, if the result of the calculation is greater than 1, indicating that the population may be exposed hazards; less than 1 indicates that there is no hazard to exposed populations affect [12].

$$THQ = \frac{E_F \times E_D \times F_{IR} \times C}{R_{FD} \times W_{AB} \times T_A} \times 10^{-3} \quad (4)$$

E_F is exposed frequency (365days / year); E_D is the time period of exposure is generally the average human life span (70years); F_{IR} exposed fish consumption amount of people (g/person/day); C for the heavy metals in fish the actual content (mg/kg); RFD oral reference dose; WAB is the average body weight (kg); TA non-carcinogenic average exposure time (365days /year × ED).

E. QC

The accuracy of the test method is close to 10% within a 95% confidence level, the standard material recovery of 90%.

F. Statistics and Analysis

All data are used Excel for data processing; SPSS10.0 statistical analysis; GraphPad Prism6and ArcGIS cartographic.

III. RESULTS

A. Distribution of Pb in Sediments of the Reef and Its Accumulation Characteristics

The sediment Pb of the vertical and horizontal distribution area in Figure 2. Range reef sediments Pb of 0.138-0.470mg/Kg, mean 0.273 ± 0.106mg /Kg;. The highest average content of Pb sediment appears in the 8th station, sandy silt bottom quality; the lowest value of station No. 2, silty sand sediment. Reef sediment vertical distribution shown in Figure 2 (A): lower> middle> upper layer.

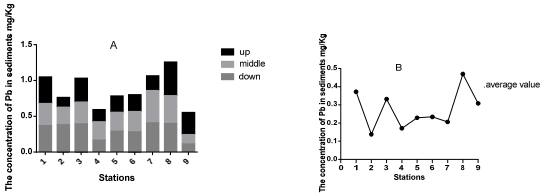

FIGURE II. THE DEPOSITS VERTICAL (A) AND HORIZONTAL DISTRIBUTION (B) OF PB IN SEDIMENTS （MG/KG）

Potential ecological risk index is a low ecological risk; accumulate partial index belong to moderate pollution levels; reef sediment enrichment factor belonging to no~light pollution. Reef enrichment factor is far less than 1.5, indicating that the main reef is a natural role.

B. Reef organisms Pb Content Distribution and Risk Assessment

Reef zone range organism Pb content is 0.004-0.519 mg/Kg, average 0.185±0.170mg/Kg. Figure 3 shows, organisms Pb BCF is generally higher than the value of BAF, BCF value difference nine stations were significantly ($P<0.05$), the maximum in 7 stations, the lowest value appears in the No. 1 station ; each station BAF values were not significant ($P>0.05$), the same trend.

According to USEPA standards [12], an oral reference dose RFD Pb element is 0.004mg / kg / day. The average adult body weight WAB is 60kg. The average daily amount of fish for human consumption is 36g. The health risk factor of 0.005, Pb is much less than 1, indicating that Pb exposed populations had no significant health risk.

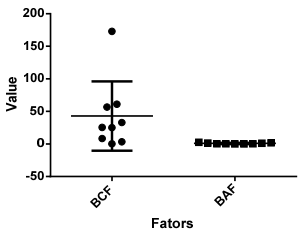

FIGURE III. THE BCF AND BAF OF PB IN ARTIFICIAL REEFS

IV. DISCUSSION

A. Ecological Risk of Pb in Sediments Reef

About ecological risk of heavy metals in surface sediment study more [1-3], the distribution of heavy metals in sediments due to the effect of hydrodynamic conditions, sediment particle size, organic matter in sediments and biological factors having differences, which so that different regions of the heavy metals also differences in the spatial distribution [11].

In coastal and estuary waters affected by tides, storms, ocean currents and coastal engineering facilities, the complex pattern of sediment transport, and vary in each estuary area. Surface sediments under the influence of tidal water power and other factors can easily make the surface sediments, especially fine particulate matter resuspension occurs [13]. As a result, on the one hand binds to heavy metals in sediments are released, that is, the sudden release of accumulated sediment

and pollutants; on the other hand, re-suspended fine particulate matter was brought water to other waters, heavy metals in more deposits over a wide range of reallocation.

In this study, sediment Pb is less than the average of each Sediments 2-3 orders of magnitude, indicating reefs Pb are within safe limits, sediments cleaner, lighter ecological harm, no enrichment, not the local waters ecosystem impact, this result and other findings are similar to the average of Liu. X. and blue waters of flood and other studies, although Pb is greater than the present study, but the results did not show Pb enrichment.

The results of each resulting difference may be related to the investigation area, investigation time, sample pretreatment method, select the value of the background and other factors, therefore, the investigation should strictly follow the "quality of marine sediments" (GB18668-2002) [14] carried out in order to provide basic data for marine sediment quality criteria.

B. Human Health Risk Assessment of Heavy Metals Pb

Goby is a fish benthic life camp, small-scale activity, contaminant levels in the body to some extent, reflect the pollution status of habitat [11-12]. According to the National Aquatic pollution-free food toxic harmful substances NY5073-2001 [24] and fresh marine fish quality standards GB / T 18108-2008 [15] (≤0.5mg / kg), this study tailed goby abdominal muscles the average content of Pb in addition to 7 stations exceeded 3.8%, the rest of the station Pb content is not exceeded, indicating that the reef area Bonasa belly goby basically meet the quality requirements of aquatic products, but heavy metal contamination of marine coastal affect the quality of fishery products should cause some concern. This Anritsu will wait [3] Wild multiplexing different goby Pb exceeded a result, human activities more frequently, so there are some differences in this study.

Aquatic organisms including fish is mainly absorbed through the gills and intestines of heavy metals in the water environment, and then transferred to other parts of the body such as the liver and muscle, and the exposure time and the environment is directly related to the dose of exposure [11]. Taking into account the goby are short growth type of fish (about 1a born), the paper Madarao belly goby muscle levels of heavy metals may reflect the recent heavy metal contamination of its habitat in accordance with the formula to get its health risk factor of 0.005, much less than 1, indicating that Pb exposed population without health risks. Investigation of heavy metal pollution risk another indicator that metallothionein levels, a biomarker that reflects the combined effect of the environment [3], can be used for early warning of potential ecological risk of heavy metals in sediments, Anritsu will wait [3] Research Complex goby liver metallothionein levels tended to increase, and with the potential risks of heavy metals in sediments consistent index. Given the reliability of the technical means, this topic will be further research in the indicators, with a view to evidence previously discussed.

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