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# *Antenna Potential of Crawfish to Monitor Hg^2+ Pollution in Water*

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***Keywords:*** Water Pollution, Antenna Potential of Crawfish, Mercury Ion, Water Monitoring

***Abstract:*** Water pollution is caused by harmful chemicals, so that the use value of water is reduced or lost. Heavy metal pollution, especially mercury ion pollution, is becoming more and more serious. The purpose of this article is to study the possibility of crayfish antennae potential monitoring of water Hg^2+ pollution. The current situation of water pollution and the experimental principles of this paper are briefly introduced through literature research and investigation, and the effect of different concentrations of mercury ions on the release of the tentacle potential of Kjeldahl with a body weight of 15g was analyzed experimentally. The results showed that the solution of 10 ppb mercury ion concentration had the most obvious inhibition on the release of tentacle potential of crawfish, with a slope of -0.1438. Followed by a mercury ion solution with a concentration of 1 ppb, the slope reached -0.0842. As a whole, the higher the concentration of mercury ions in the solution, the stronger the inhibitory effect on the release of antennae potential of crawfish. The method of monitoring the water body of the crawfish antennae potential has the possibility of application. However, under actual circumstances, the ions in the solution are diverse and extremely rich. It is difficult to ensure that other ions have no effect on the release of tentacle potential of crawfish. The experiments in this article have only been conducted on inorganic mercury ions. In fact, organic mercury still exists in water pollution. Organic pollution cannot be ignored either, and further research is needed.

## 1. Introduction

A survey of most lakes in China shows that China's waters are vast, but pollution is also more concerned. For example, heavy metal pollution is found in 80.1% of the mud at the bottom of rivers, lakes and reservoirs. Although there are few rivers seriously polluted by heavy metals, the pollution degree of over-standard sections in the river basin is relatively serious, basically all of which are of

inferior class V [1]. There are many sources of water pollution, which exist in all aspects of life and production (multi-source), which are generally not easy to be discovered (hidden) after the occurrence of pollution phenomenon, and heavy metal pollution, whether in water or soil, can realize long-distance transportation without weakening [2]. Once polluted by heavy metals, the consequences will be very serious. Heavy metals in gas-solid substances will generally enter the water body through sedimentation, rain and snow leaching, etc., and continue to pollute with the water flow. Even though the content of heavy metals in water is very small, through the food chain, when people drink contaminated water or contaminated food, heavy metals will accumulate in people's bodies, causing chronic poisoning to the human body and seriously damaging people's health [3].

Heavy metals present in water and soil will not disappear for no reason and cannot be degraded, but can only be transferred to each other in the system [4]. In China, there have been many cases of heavy metals causing human life safety and property losses. Heavy metal pollution has not only caused damage to individuals, but has now caused particularly great harm to society. Not only China, heavy metal pollution is a difficult problem facing the whole world. As early as the 1950s, a public nuisance event shocked the world occurred in Kumamoto Prefecture, Japan [5]. Many local residents suffer from such symptoms as dyskinesia, numbness of limbs, pain and treatise. People call it Minamata disease. And the disease can be passed on to children. According to a source, as of February 1976, 1,386 people were still suffering from Minamata disease. Why does Minamata disease occur? After examination, it was found that the waste water from a factory contained mercury ions, which polluted fish. People eat fish with high concentration of mercury ions for a long time, thus ingesting a large amount of mercury ions causes poisoning [6].

Hsu summarizes the research progress of various sensors based on colorimetry, electrochemistry and optical sensors. Sensors for estimating dissolved oxygen, nitrate, chlorine and phosphate contents are introduced, and the development direction of high-quality water monitoring sensors in this field is discussed [7]. Cloete has designed a water quality monitoring system to inform users of real-time water quality parameters. The system can measure physical and chemical parameters of water quality, such as flow rate, temperature, pH value, conductivity and redox potential [8]. Amaryllis has studied people's interest in some pollutants and believes that it is helpful to assess and predict the situation of water pollution in Britain [9]. Kovacs introduced a new water quality evaluation method and successfully applied it to water quality evaluation, proving the application potential of near infrared spectroscopy and water channel technology in water quality monitoring [10]. Christopher evaluated the eutrophication degree of water body through algae biomass, which proved the feasibility of algae in water quality evaluation [11]. Dibyendu selected a water area in India and studied the biological indicator effect in water quality detection [12].

In brief, this paper discusses the possibility of monitoring Hg 2+pollution by antennal potential of crayfish. Specifically, the main research content of this paper is roughly divided into six parts: The first part is the introduction part, aiming to make a systematic overview of the main research content of this paper from the research background, research purposes, research ideas and methods. The second part introduces the experimental principles and methods, and puts forward relevant suggestions. The third part introduces the technical methods of biological monitoring of water quality. The fourth part is the related research, through the inquiry data design related experiment, studies the different body weight Aonian shrimp to mercury ion sensitivity degree. The fifth part is the analysis of the data. Through the specific investigation data and research results, the influence of different concentrations of mercury ions on the electroantennogram release of crayfish weighing 15g was analyzed. The results show that the solution with 10ppb mercury ion concentration has the most obvious inhibition degree to the antennal potential release of crayfish weighing 15g, and the

slope reaches -0.1438. The second is mercury ion solution with a concentration of 1ppb, with a slope of -0.0842. On the whole, the higher the concentration of mercury ions in the solution, the stronger the inhibitory effect on antennal potential release of crayfish. The method of antennal potential monitoring of crayfish has the possibility of application. However, in reality, the ions in the solution are various and extremely rich, so it is difficult to ensure that other ions have no influence on the release of antennal potentials of crayfish. The sixth part is the summary and suggestion of this article, which is the summary and prospect of the article's achievements. The experiments in this paper only focus on inorganic mercury ions. In fact, there is still organic mercury in water pollution. Organic pollution cannot be ignored and needs further research.

## 2. Experimental Principle and Method

### 2.1. Experimental Principle

The experiment mainly uses electrophysiological principles and methods. Electrophysiology is a branch of physiology. It mainly studies electrical effects of objects and electrical phenomena in organisms. Since it is the most easily recorded phenomenon to take action potentials generated by excitation of organs and tissues such as nerves as its activity indicators, recording action potentials is often used for in-depth study of the functions of the nervous system, etc. The development of modern electrophysiology depends on the development of intracellular electrodes, electron tubes, transistors and other amplification technologies. Electrophysiology is an important part of physiology. Physiology takes the function of biological organism as the research object. The function of biological organism is all kinds of life phenomena shown by the whole organism and its parts. Most of these life phenomena are accompanied by bioelectric changes. Electrophysiology is based on bioelectricity. The task of electrophysiology is to study the mechanism and conditions of bioelectricity, the effects of various changes in the body's internal and external environment on these bioelectricities, the internal relations between bioelectricity and body functions, and the effects and mechanisms of electricity and magnetism on the body.

Electrophysiology is developed with the progress of electronic instruments and electrophysiology technology. It is specialized in studying the content of bioelectricity in life phenomena. Physiology was originally combined with anatomical description. In the early 17th century, physiological experimental research mainly used basic methods and techniques of physics and chemistry to observe organisms. However, it is different from general natural sciences such as physical chemistry and its experimental methods have their own characteristics. Engels pointed out at that time that physiology is of course the physics of living objects, especially its chemistry, but at the same time it is no longer chemistry, because on the one hand its range of activities is limited, and on the other hand it has reached a higher stage here. In the future, physiological methods will be improved with the development of basic science and its application technologies such as mathematics, physics and chemistry. With the development of electronic technology, especially the application of computers, bioelectricity research has become more and more extensive and in-depth and has become one of the fastest growing fields in physiological research.

Electrophysiology is divided into three levels. The first is the study of cellular and molecular mechanisms of bioelectric phenomena. The basic structure and functional unit of organism is fine nerve fiber. The main function of fine nerve fiber is to transmit information. Without nerve action potential conduction, it is impossible to complete. The functional contraction of muscles is caused by the shortening of the sarcomere that makes up each muscle cell. The shortening of the sarcomere is caused by the action potential on the sarcolemma. These electrical activities are all related to the opening and closing of channels on the membrane and the activities of ions. In order to understand

the laws and mechanisms of bioelectrical changes from the microscopic level, microelectrodes are used to guide the resting and active electrical changes in cells and to observe the single channel ion flow. The second is the mechanism research of tissue and organ level of bioelectricity phenomenon. Electrical activities of isolated organs and tissues under certain physical and chemical environment, such as heart, uterine muscle, digestive tract smooth muscle, skeletal muscle, nerve and brain slices. It can reduce the influence of the whole body and other organs on these tissues and organs and bioelectrical interference, and eliminate the influence of nerve and body fluid. It reflects the electrical activity of tissues and organs themselves and can directly observe the influence of various factors on them.

The last is the observation of the whole level of bioelectricity phenomenon and the mechanism research. The body is a volume conductor with three dimensions of up and down, left and right, front and back. The electrical activities of some tissues and organs can be guided at different parts of the body surface. Due to the influence of electric field, the magnitude of potential obtained from different guiding positions will be affected, and the waveform will also be different due to the change of position, which is the comprehensive electrical reflection of various bioelectricity of the body at a certain point. This bioelectricity reflects the electrical changes regulated by the body under the influence of internal and external environment. Different from the passive transport guided by ion channels, the trans-membrane transport of ions guided by ion transporters is an active transport mode with many unique biological characteristics. Using these biological characteristics can often solve many difficult problems.

The experiment in this paper is to make use of these characteristics. Different concentrations of mercury ion solution will theoretically have different effects on the antennal potential of crayfish. Through the difference of these influences, the concentration of mercury ions in the solution can be obtained reversely. However, the impact of multiple ions is extremely complex and unpredictable. In real life, water often contains not only mercury ions, but also other heavy metal ions.

## 2.2. Statistical Method

The analysis in this paper mainly adopts the method of linear regression, which is the first type of regression analysis that has been strictly studied and widely used in practical application. This is because the model linearly dependent on its unknown parameters is easier to fit than the model nonlinearly dependent on its position parameters, and the statistical characteristics of the resulting estimates are also easier to determine. Linear regression is used to find the linear relationship between the target and one or more predictive variables. There are two types of linear regression: univariate linear regression and multivariate linear regression. This article mainly uses the one-dimensional linear regression, which is very useful for finding the relationship between two continuous variables. One is a predictive variable or independent variable, and the other is a response or dependent variable. It looks for statistical rather than deterministic relationships. If one variable can be accurately expressed by another variable, the relationship between the two variables is considered deterministic. For example, using a temperature of degrees Celsius, the Fahrenheit temperature can be accurately predicted. Statistical relationships are not accurate in determining the relationship between two variables, for example, the relationship between height and weight. The core idea of linear regression is to obtain the straight line that can best fit the data. The straight line with the highest fitting degree is the straight line with the smallest overall prediction error (all data points) as possible.

Linear regression is a problem widely used in life. When solving linear regression equations, one should first judge whether the two variables are linearly related. If the linear correlation is followed

by the linear equation, one common and simple method to judge whether the two variables are related is to draw scatter plot. The other method is a quantitative test method, namely, correlation coefficient method. There is a lot of content in this article to analyze the correlation coefficient.

## 3. Principle and Technology of Biological Monitoring for Water Pollution

### 3.1. Principle of Biological Monitoring of Water Pollution

Under certain preconditions, aquatic communities and water environment are interrelated and mutually restricted, maintaining a very natural and temporary equilibrium system. The pollutants injected into the water environment will certainly affect the organisms themselves, their populations or their communities, and affect the inherent biological population, their quantity and species composition of the ecosystem. It will also affect more characteristics, inherent characteristics, productivity and physiological conditions, etc., causing some aquatic organisms to gradually disappear, while other aquatic organisms can continue to grow and the number of themselves and their populations will gradually increase. Using water quality testing instruments to monitor the degree of water pollution, from the biological manifestation of this change of water pollution, the change of water environmental quality is obtained, which is the concept and basis of biological monitoring of water pollution.

Biological monitoring refers to a water pollution monitoring method that uses the response of individual, population or community of aquatic organisms to water pollution or changes to judge the water pollution status. Biology and environment interact and influence each other. Environmental changes can affect the growth and living habits of organisms until their physiological functions are changed. The existence of living things can also affect and change the environment, such as the energy intake and metabolism of living things. This unity and coevolution between organisms and their environment is the biological basis for biological monitoring of environmental quality.

In general, biological monitoring has the characteristics of sensitivity, enrichment, long-term and comprehensive, and has certain advantages. Biological monitoring of water pollution has its own characteristics: firstly, the monitoring function is diversified. As there are many kinds of organisms that can be used for water pollution monitoring, and each organism can react to different pollutants and show different symptoms, the monitoring function is powerful. The second is to monitor the pollution objectively. Organisms that perform water pollution monitoring function generally live in fixed areas and have a stable period. Compared with physical and chemical monitoring, they can objectively reflect the long-term pollution status of a certain water area. Third, the monitoring results are reliable. Some monitoring organisms are very sensitive to some pollutants. They can react to trace pollutants that even precision instruments cannot detect and show corresponding damage effects. The fourth is to facilitate comprehensive evaluation. Physical and chemical monitoring can only detect the types and contents of pollutants in the water environment under specific conditions, while biological monitoring can reflect the comprehensive effects of various pollutants on organisms under natural conditions, thus making it possible to evaluate the water environment more objectively and comprehensively. Fifth, the monitoring cost is low. Monitoring instruments used in physical and chemical monitoring involve repair and maintenance, while biological monitoring does not involve such work, so the monitoring cost is relatively low.

### 3.2. Biological Monitoring Technology for Water Pollution

(1) Ecological monitoring method

Biological community method: living aquatic organisms, such as plankton, benthic organisms, microorganisms, bacteria and fish, etc., because changes in their community structure, quantity and species can reflect the state of water pollution. In accordance with the provisions of the sampling, inspection, counting methods to obtain a variety of groups and a variety of data, according to the biological sewage treatment system and biological index method to evaluate the status of water pollution.

Productivity measurement method: changes in chlorophyll content, photosynthetic capacity, nitrogen fixation and other indicators of aquatic plants show water pollution. The production capacity of aquatic plants will change with the pollution of water bodies. Water pollutants in water bodies are accumulated. Through physical and chemical testing methods to understand the distribution of pollutants accumulated in the body, the accumulation, distribution and transfer laws of accumulated pollutants can be conveniently understood.

(2) Toxicological methods

Aquatic biotoxicity test: algae and fish can be used for aquatic biotoxicity test, of which fish is widely used. A large number of studies show that crucian carp, zebrafish and swordtail fish are the most widely used and representative freshwater fishes.

Molecular Ecotoxicology Methods: Molecular Ecotoxicology uses modern molecular biology techniques and methods to study the interactions between pollutants and their metabolites and intracellular macromolecules, including enzymes, nucleic acids and proteins, to find out the target sites and target molecules of action, and to use its mechanism of action to make early warning at the individual, population, community and ecosystem levels in the future. At present, the most widely used method is to use enzyme as a biological marker to measure the activity of ATPase in vivo, and to judge the indicators of various pollutants stress according to the strength of its activity.

Toxicity test method: Luminescent bacteria test is a biological test technology that has been listed in German national standard (DIN38412) and international standard (ISO11348) and applied to toxicity test of environmental samples. Toxicity is a comprehensive biological parameter that measures the impact of samples on living organisms. Luminescent bacteria test uses natural microorganisms with luminous characteristics, while toxic substances will inhibit their luminescence, and the stronger the toxicity is, the more obvious the inhibition is. Luminescent bacteria are not harmful to themselves. This method has been proved to be fast, simple, sensitive and reliable.

Larval metamorphosis experiment: Studies on toxicity experiments of marine invertebrates at embryonic and larval stages show that toxicity experiment indexes of planktonic larval metamorphosis are more sensitive. The metamorphosis of larvae is easier to observe and is easily disturbed by environmental pollution. Compared with mortality rate, whether it can smoothly metamorphose becomes a more sensitive indicator for monitoring the toxicity of pollutants.

(3) Microbiological method

Bacteriological examination method: bacteria are ubiquitous in natural water bodies. When water bodies are polluted by domestic sewage or industrial wastewater, bacteria increase in large quantities. Therefore, the bacteriological examination of water, especially intestinal bacteria, is of great significance in hygiene.

Micro-biological monitoring: Artificial substrate (foam plastic block) is used to collect micro-biological communities existing in water body and measure various parameters of the community structure and function to evaluate water quality pollution, which is called

micro-biological community monitoring method (PFU method for short). In addition, indoor toxicity test method is used to determine the toxicity intensity of industrial wastewater and chemicals to microbial communities in the receiving water. Researchers from the Institute of Aquatic Sciences of Chinese Academy of Sciences applied PFU method to biological monitoring and provided a new standard method for biological monitoring in China. This monitoring method is suitable for field fresh water bodies, including streams, rivers, great rivers, lakes, etc. Indoor toxicity test is applicable to urban domestic sewage, wastewater discharged from factories, various hazardous chemicals and comprehensive water quality evaluation.

Nitrifying bacteria test method: nitrifying bacteria mainly include ammonia oxidizing bacteria and nitrite oxidizing bacteria, and they are specialized chemical energy autotrophic bacteria. The sensitivity of nitrifying bacteria to toxicity of various chemical substances is used to determine the influence of chemical substances on nitrification intensity of nitrifying bacteria, and to determine the toxicity of chemical substances and the degree of influence on nitrogen circulation capacity in nature. This method is uniquely sensitive, convenient, fast, cheap and quantitative in detecting the toxicity of pollutants.

(4)DNA monitoring method

Biosensors: Biosensors are based on immobilized cell nuclei and immobilized enzyme technology. Biological elements are used as functional identification elements to identify and sense the target object to be tested, and convert it into identifiable signal devices or devices according to certain rules. Its working principle is that biological components interact with the object to be tested, and the object to be tested is detected through electronic components and converted into measurable electronic signals.

DNA Biosensor: According to the principle of base pairing of DNA, using the very stable molecular recognition ability and super-strong specificity of nucleic acid molecules, the nucleic acid of the target sample and probe DNA are selectively reacted, and the highly specific DNA hybridization reaction is combined with the highly sensitive electrochemical detector, thus the DNA hybridization biosensor is formed, which has the characteristics of very high accuracy and sensitivity. Due to the uniqueness of DNA biosensor, it is distinguished from common biosensors to highlight its particularity.

Polymerase chain reaction technology: Polymerase chain reaction is a new technology widely used in molecular biology in recent years. The principle is an enzymatic DNA synthesis technology, i.e. a rapid and specific in vitro DNA biosynthesis technology. In environmental monitoring, it is applied to monitor the dynamic changes of specific microbial species, and to study the composition and population characteristics of microbial flora in specific environment.

## 4. Experiments

### 4.1. Experimental Content

Nowadays, with the rapid development of economy, people's life is more and more fast and convenient. People's food, clothing, housing and transportation are more and more diversified. Under this premise, it is the rapid development of light industry and heavy industry. But at the same time of rapid development, environmental problems are getting more and more serious. Among them, the random discharge of sewage is a very serious problem. According to WHO statistics, 80% of the world's diseases are caused by drinking contaminated water, and 50% of the world's child deaths are caused by drinking contaminated water. Heavy metal pollution is one of the most

difficult problems in water pollution control. Mercury is one of the common heavy metals. Mercury can exist in two forms of elemental substance and mercury compound under natural and artificial conditions. The elemental mercury or element is also called metallic mercury. Mercury compounds can be divided into two categories: organic mercury compounds and inorganic mercury compounds. So what harm does mercury in sewage exceed the standard? The impact of mercury on human body cannot be ignored. It can not only harm the kidney and immune system, but also threaten the nervous system and cardiovascular and cerebrovascular diseases.

In order to avoid the occurrence of excessive heavy metals in the water, it is necessary to monitor the water body. In this article, we will conduct research on the monitoring of mercury ion water pollution, and use electrophysiological methods to observe the effects of different concentrations of mercury ion solutions on the release of action potentials of the medial branch nerve of the first antennae of crayfish. The selected crawfish were from Xiyu County, Huai'an City, Jiangsu Province, and were divided into 4 groups for screening. The crawfish of the first group weighs about 15g, the crawfish of the second group weighs about 25g, the crawfish of the third group weighs about 35g, and the crawfish of the fourth group weighs about 45g. The selected crawfish are males, not females, and the body length is about 7 to 13cm (due to the structure of crawfish, there may be some errors in the measurement of body length). Because the price of crawfish is low, the number is large, and each group has more than 30 animals to prevent accidents in the experiment, but not all of them will be used in the experiment. Before the experiment, the crawfish were kept in clear water for 12 hours.

In this experiment, HgCl2 is selected as the solute of the solution and deionized water is used as the solvent. Because the standards of mercury ion content in different liquids are different and often quite different. For this reason, we chose a solution with a concentration of 1ppb as the experimental concentration. Because the sensitivity of the tentacles of crayfish to the solution cannot be determined, the experiment is mainly based on qualitative judgment, and whether the tentacles of crayfish can be used for detecting mercury ion content is observed through experiments.

### 4.2. Experimental Results

The recording electrode is made of insect needles, tungsten wire or silver sheet is used as a reference electrode, and the inner branch is cut off at the base of the first antenna on one side of crayfish. The recorder electrode is inserted into the inner branch and immersed in the test solution together with the reference electrode. The above-mentioned device is placed in the constant temperature shielding box, and the antennal potential is guided into the bioelectrical preamplifier. The amplifier parameters are respectively 200 times of gain, 0.001s of time constant and 1kHz of high-frequency filtering, which are monitored by the oscilloscope and simultaneously input into the electrophysiological experiment intelligent instrument. The amplitude, duration and distribution frequency of the antennal potential in various test solutions are respectively measured by using the memory oscillograph and sequence density histogram programs, and the experimental data are calculated by the averaging method with small samples for oscillography. Examining the difference between relevant data by inspection method. The regression coefficient and the regression linear equation are directly obtained through the software program, and then the regression linear is drawn.

Attention in the experiment: during the experiment, the temperature in the screen cabinet is controlled within the range of 20-25℃. HgCl2 test solution was prepared during the experiment to prevent adsorption. In the experiment, the antenna was stabilized in deionized water for 5 minutes, and then tested. After the recording electrode is inserted into the antenna, the antenna incision is

sealed with medical vaseline to prevent tissue from drying. In the first experiment, 5 crayfish were selected from each crayfish weight group. Relevant data of linear regression in the experimental process were collated and recorded, and the results are shown in Table 1.

*Table 1. Linear regression correlation data at 1ppb concentration*

| Weight (g) | 15 | 25 | 35 | 45 |
|---|---|---|---|---|
| Regression Equation | Y=1.0941-0.0842X | Y=1.0019-0.0724X | Y=1.0863-0.0558X | Y=1.0319-0.0523X |
| Correlation Coefficient | -0.9954 | -0.9682 | -0.9601 | -0.9573 |

## 5. Discussion

### 5.1. Effect of Mercury Ions on Crayfish of Different Weight

Experiments were carried out on four different weight groups of crayfish at a concentration of 1ppb in order to explore the sensitivity of crayfish of different weights to mercury ions. In theory, the more sensitive crayfish is, the better the detection effect of mercury ion concentration is. However, before analyzing the sensitivity of crayfish with different weights to mercury ions, it is necessary to judge the correlation and study whether the differences between different weights have significant influence on the experiment. The judgment of correlation depends on the absolute value of correlation coefficient. In order to understand the correlation of variables, we plot the absolute value of correlation coefficient into a bar graph, as shown in Figure 1.

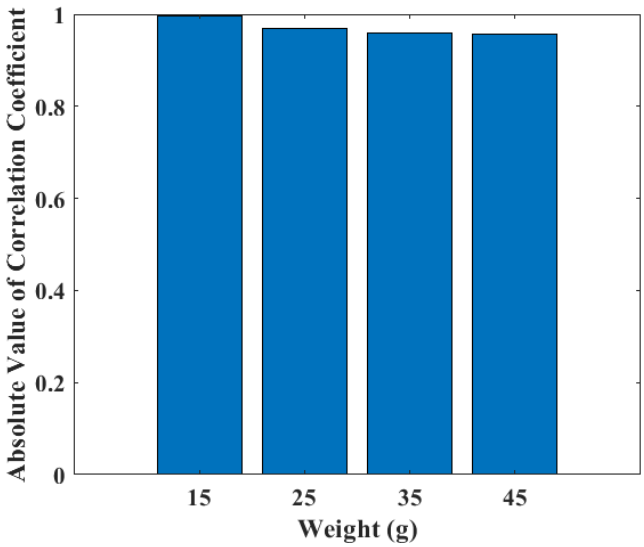


*Figure 1. Absolute value of correlation coefficient at 1ppb concentration*

From the data in the above figure, it can be seen that the absolute values of the correlation coefficients at the concentration of 1ppb mercury ions are relatively high, proving that they have certain correlation. The correlation of the data from the group of 15g crayfish is the highest, and the absolute value of the correlation coefficient reaches 0.9954. However, because the correlation of other groups is not low, the sensitivity can be compared. For this reason, we need to analyze the regression straight line graph at 1ppb concentration drawn by computer software. The abscissa is selected as the time, and the ordinate is the ratio of the distribution frequency. In short, it is the ratio of the distribution frequency of each time period to the distribution frequency of the first time period. The related regression line is shown in Figure 2.

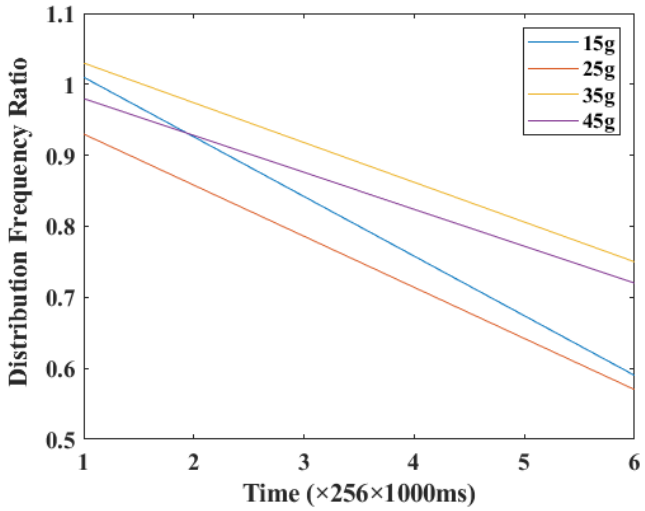


*Figure 2. Regression line at 1ppb concentration*

From the data in the above figure, it can be seen that mercury ions have different effects on the release of antennal potentials of crayfish with different weights, and the inhibition degree on the release of antennal potentials of crayfish with a weight of 15g is the most obvious, with the slope reaching -0.0842. The second is crayfish weighing 25g, with a slope of -0.0724. The slope of crayfish in 35g and 45g experimental groups was -0.0558 and -0.0523 respectively. From this, we can see that in the experimental group selected in this paper, the smaller the body weight, the higher the sensitivity of crayfish tentacles to mercury ions. The possible reasons are as follows: during the growth and development of crayfish, the degree of ossification of the outer skin of tentacles is deepening and its resistance to the outside world is increasing. During the growth and development of crayfish, the tentacle cells may age, resulting in a decrease in sensitivity. After comprehensive analysis, it was decided to select the crayfish of 15g weight group for the following experiment.

## 5.2. Effect of Different Concentrations of Mercury Ions on Crayfish

In the above experiments, the experimental concentration we selected was 1ppb. Since the experiments in this paper are mainly qualitative rather than quantitative, the span of concentration selection should be larger to reduce the negative effects brought by experimental errors. In addition, in the above experiments, we also observed that the change of data is not large and the concentration difference is large, which is more conducive to experimental exploration. The concentrations of mercury ions we selected were 0ppb, 0.5ppb, 1ppb and 10ppb. Among them, the solution with mercury ion concentration of 0ppb is chloride-free water. In the same way as the above experimental steps, only 15g crayfish were selected as the experimental objects, and 5 crayfish in each group were selected to carry out experiments on the concentration of the remaining 4 mercury ions. The regression coefficient and regression line equation are directly obtained through software program, and then the regression line is drawn. The relevant data of linear regression in the experiment were collated and recorded, and the results are shown in Table 2.

*Table 2. Linear regression correlation data under different concentrations*

| Concentration (ppb) | 0 | 0.1 | 1 | 10 |
|---|---|---|---|---|
| Regression Equation | Y=1.0162-0.0157X | Y=1.0317-0.0498X | Y=1.0941-0.0842X | Y=1.1446-0.1438X |
| Correlation Coefficient | -0.8165 | -0.9628 | -0.9954 | -0.9982 |

The judgment of correlation depends on the absolute value of correlation coefficient. In order to understand the correlation between the distribution frequency ratio and time under different mercury ion concentrations, we plot the absolute value of correlation coefficient into a bar graph, as shown in Figure 3.

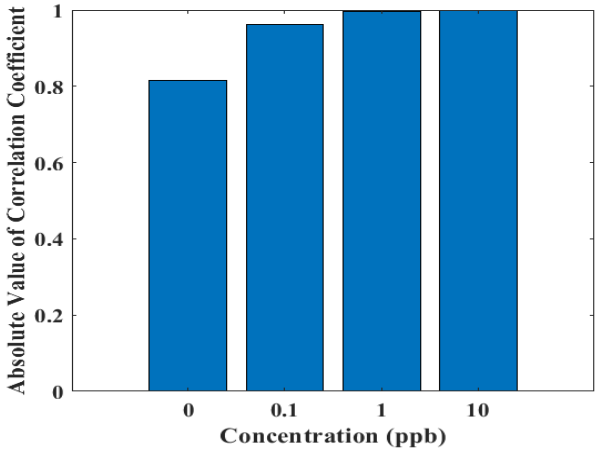


*Figure 3. Absolute value of correlation coefficient at different concentrations*

From the data in the above figure, it can be seen that the absolute values of the correlation coefficients under various mercury ion concentrations are all greater than 0.8, which proves that there is a certain correlation. The absolute value of correlation coefficient at 0ppb mercury ion concentration is the smallest, 0.8165. When the concentration of mercury ions in the solution rises to 0.1ppb, the absolute value of the correlation coefficient increases obviously, reaching 0.9628. On the whole, the higher the concentration of mercury ions in the solution, the greater the correlation. At a concentration of 10ppb, the absolute value of the correlation coefficient reaches 0.9982. It can be inferred from this that there is a certain relationship between the change of antennal potential release frequency of crayfish and the change of mercury ion concentration in the solution. In order to accurately study the effect of mercury ion concentration in solution on the release frequency of antennal potential of crayfish, we will analyze the relevant regression straight line diagram, as shown in Figure 4.

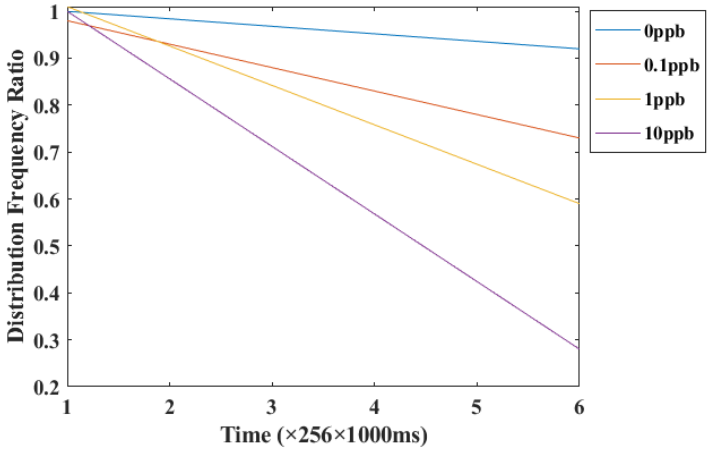


*Figure 4. Regression line at different concentrations*

From the data in the above figure, it can be seen that different concentrations of mercury ions have different effects on the antennal potential release of crayfish weighing 15g. The solution with

10ppb mercury ion concentration has the most obvious inhibition on the antennal potential release of crayfish weighing 15g, with the slope reaching -0.1438. The second is mercury ion solution with a concentration of 1ppb, with a slope of -0.0842. On the whole, the higher the concentration of mercury ions in the solution, the stronger the inhibitory effect on antennal potential release of crayfish.

Therefore, it can be seen that the method for monitoring water body by antennal potential of crayfish has the possibility of application. However, in reality, the ions in the solution are various and extremely rich, so it is difficult to ensure that other ions have no influence on the release of antennal potentials of crayfish. In addition, the effects of different ion combinations may be reduced or increased, and the situations to be discussed vary with different concentrations and ion types. Therefore, the antennal potential monitoring water body of crayfish is more likely to be applied in the solution with less solute species or the solution with smaller species concentration change, which is not suitable for application under the condition of complex changes. Moreover, the experiments in this paper only focus on inorganic mercury ions. In fact, organic mercury still exists in water pollution, and organic pollution cannot be ignored.

## 6. Conclusion

(1) The introduction of water pollution, the purpose and significance of the research and the current research situation, and the introduction of experimental principles and methods. The experiment mainly uses electrophysiological principles and methods. Electrophysiology is a branch of physiology. It mainly studies electrical effects of objects and electrical phenomena in organisms. In this paper, different concentrations of mercury ion solution will theoretically have different effects on the antennal potential of crayfish. Through the difference of these influences, the concentration of mercury ions in the solution can be obtained reversely.

(2) Through literature research and investigation, the technical methods of biological monitoring of water quality are introduced. The technical methods of water quality biological monitoring mainly include: biological community method, bacteriological test method, aquatic biological toxicity test, productivity test method, micro biological monitoring, molecular ecotoxicology method, nitrifying bacteria test method, larval metamorphosis test, toxicity test method, biosensor, DNA biosensor, polymerase chain reaction technology, etc. The classification can be divided into ecological monitoring method, toxicological method, microbiological method and DNA monitoring method.

(3) Experiments and data analysis show that different concentrations of mercury ions have different effects on the antennal potential release of crayfish weighing 15g. The solution with 10ppb mercury ion concentration has the most obvious inhibition on the antennal potential release of crayfish weighing 15g, with a slope of -0.1438. The second is mercury ion solution with a concentration of 1ppb, with a slope of -0.0842. On the whole, the higher the concentration of mercury ions in the solution, the stronger the inhibitory effect on antennal potential release of crayfish. The method of antennal potential monitoring of crayfish has the possibility of application. However, in reality, the ions in the solution are various and extremely rich, so it is difficult to ensure that other ions have no influence on the release of antennal potentials of crayfish. The experiments in this paper only focus on inorganic mercury ions. In fact, there is still organic mercury in water pollution. Organic pollution cannot be ignored and needs further research.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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