The stability of pH value in the waters of Jiaozhou Bay

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Abstract: According to the survey materials in the waters of Jiaozhou Bay in May and October 1979, this article presents the pH value and horizontal distribution in the surface waters of Jiaozhou Bay. The results indicate that the pH value in the waters of Jiaozhou Bay ranged within 7.55-8.79 in May and October. The pH value in the seawater was all greater than 7.50 in May and October. In addition, the interval length of the changes of pH value in the seawater was 1.24, which indicated that the overall pH value of the water body was within the normal range of variation in May and October. In May, the pH value ranged within 7.55-8.07. In Jiaozhou Bay, the pH value of seawater was relatively low. In the northeastern coastal waters, the pH value ranged within 8.02-8.07, which presented that the content of carbon dioxide and hydrogen ion in the surface seawater of this area was decreasing, causing the pH value of northeastern coastal waters to reach the highest value. In the waters inside of the bay, in the mouth of the bay, and outside of the bay, the variation range of pH value was 7.55-7.89, with the interval length of 0.05. It presented that the pH value in this area had reached the low value and was very stable. In October, the pH value ranged within 8.28-8.79. In Jiaozhou Bay, the pH value of seawater was relatively high, which presented that the content of carbon dioxide and hydrogen ion in the entire surface seawater of Jiaozhou Bay was very low, causing the pH value of entire waters to reach the highest value. Moreover, in the waters inside of the bay, in the mouth of the bay, and outside of the bay, the interval length of the variation of pH value was 0.05. It presented that the variation of pH value in this area was very small and stable.

1. Introduction
pH is an indicator of the potential of hydrogen in the seawater. To understand the environmental changes in the ocean, it is necessary to know the changes in the pH value of seawater. When the pH value of seawater is greater than 7, the seawater is weakly alkaline. The changes in the content of carbon dioxide and hydrogen ion concentration in seawater are just the opposite of the changes in pH [1-8]. Therefore, studying the changes of pH in coastal waters and its high-and-low-value water areas can be used to show the environmental conditions of the waters. Based on the survey data in 1979, the author determined the pH value, horizontal distribution, and source changes in the waters of Jiaozhou Bay, and obtained the pH level, source variation process and source quantity of the waters of Jiaozhou Bay, providing a scientific theoretical basis for the environmental changes in the waters of pH sources.

2. Survey waters, materials and methods
2.1 Natural environment of Jiaozhou Bay
Jiaozhou Bay is between 120°04′-120°23′E and 35°58′-36°18′N, locating in the southern part of Shandong Peninsula, whose strait is composed of the line connecting Tuan Island and Xuejia Island. The bay represents a typical semi-enclosed one and has an area of about 446km² and an average water depth of about 7m. Such as the Dagu River, Yang River and the Haibo River, Licun River and Loushan River near Qingdao, more than a dozen rivers around Jiaozhou Bay go into it [8].
2.2 Materials and methods

The survey data of pH values in the waters of Jiaozhou Bay in May and October 1979 used in this study are provided by the North Sea Monitoring Center of the State Oceanic Administration. In May and October, taking water samples from 8 stations: H34, H35, H36, H37, H38, H39, H40, H41 (Figure 1). Water samples were taken three times in May and October 1979 according to the water depth (surface and bottom layers were taken when the depth >10m, and only the surface layer was taken when the depth <10m). The survey of pH value in Jiaozhou Bay water body was carried out according to the national standard method, which was recorded in the national “Marine Monitoring Code” (1991) [9].

3. Results

3.1 pH value

In May and October, the variation range of pH value in the waters of Jiaozhou Bay was 7.55-8.79, with the interval length of 1.24. In May, the variation range of pH value was 7.55-8.07, which was relatively low. In October, the pH value in the water body increased significantly, with a variation range of 8.28-8.79, relatively high. Therefore, in May and October, the pH value in the water body of Jiaozhou Bay ranged within 7.55-8.79, above 7.50. It presented that in terms of the changes of pH value, the pH value in the entire waters of Jiaozhou Bay was relatively high (Figure 1) in May and October.

| Time       | May       |          | October  |
|------------|-----------|----------|----------|
| pH content | 7.55-8.07 |          | 8.28-8.79|

3.2 Horizontal distribution in the surface

In May, in the northeast of Jiaozhou Bay, at station H40, the estuary of Laoshan River, the pH value reached relatively high, 8.07. A high pH zone was formed around the coastal waters of the estuary of Loushan River, and a series of parallel lines with different gradients were formed from the north to the south of the bay. The pH value decreased from a high value of 8.07 in the center along the gradient to 7.60 in the eastern waters of the bay, and decreased along the gradient to 7.55 in the waters outside the bay (Figure 2).
In October, in the northeast of Jiaozhou Bay, the high pH value appeared at station H39 in the water area between the mouth of Loushan River and Licun River in Jiaozhou Bay, reaching 8.79. A high pH zone was formed centered with the northeastern coastal waters, and a series of parallel lines with different gradients were formed from the north to the south of the bay. The pH value decreased from a high value of 8.79 in the center along the gradient to 8.34 in the mouth of the bay, and decreased along the gradient to 8.29 in the waters outside the bay (Figure 3).

4. Discussion

4.1 Regional changes of pH

The pH value in the waters of Jiaozhou Bay ranged within 7.55-8.79 in May and October. The pH value in
the seawater was all greater than 7.50 in May and October. In addition, the interval length of the changes of pH value in the seawater was 1.24, which indicated that the overall pH value of the water body was within the normal range of variation in May and October.

In May, the variation range of pH value in the waters of Jiaozhou Bay was 7.55-8.07. The pH value in the seawater of Jiaozhou Bay was relatively low. There were two areas where the pH value changed small: northeastern coastal water area and the area inside of the bay, in the mouth of the bay and outside of the bay. In the northeastern coastal waters, the pH value ranged within 8.02-8.07, with the interval length of 0.05. In the area inside of the bay, in the mouth of the bay and outside of the bay, the pH value ranged within 7.55-7.89, with the interval length of 0.34.

In October, the variation range of pH value in the waters of Jiaozhou Bay was 8.28-8.79. The pH value in the seawater of Jiaozhou Bay was relatively high. From the waters inside of the bay to the mouth of the bay and the waters outside the bay, the pH value changed relatively small, ranging from 8.28 to 8.79, and the length of the interval for pH changes was 0.51. This showed that in the entire waters of Jiaozhou Bay, including the waters inside of the bay to the mouth of the bay and the waters outside the bay, the changes of pH value of the seawater was very little.

4.2 Regional structure of pH
The increase in pH was mainly due to warming and strong photosynthesis, which reduced the content of carbon dioxide and hydrogen ion concentration in the upper seawater.

In May, there were two regional characteristics of pH changes in the waters of Jiaozhou Bay: in the northeastern coastal waters and the waters inside of the bay, in the bay mouth and outside of the bay. In the northeastern coastal waters, the pH value varied from 8.02 to 8.07, which indicated that the pH value of this water area had reached the highest value. This was because in the northeastern coastal waters, the water temperature rose and photosynthesis was strong, resulting in the vigorously grew of phytoplankton. The content of carbon dioxide and hydrogen ion concentration in the surface seawater decreased, which caused the pH value of the northern coastal waters to reach the highest value. In the waters inside of the bay, in the bay mouth and outside of the bay, the pH value varied from 7.55 to 7.89, and the length of the interval for pH value variation was 0.05. This showed that the pH value of this water area reached a low value and was very stable. Therefore, the changes in the content of carbon dioxide and hydrogen ion concentration in the surface seawater of this area were also very stable.

In October, there was only one regional characteristics of pH changes in the waters of Jiaozhou Bay: in the entire waters of Jiaozhou Bay, including the waters inside of the bay, in the bay mouth and waters outside of the bay, where the pH value varied from 8.28 to 8.79, reached a very high value. This was because in the entire waters of Jiaozhou Bay, the content of carbon dioxide and hydrogen ion concentration were very low, causing the pH value of entire waters to reach the highest value. In addition, in the waters inside of the bay, in the bay mouth and outside of the bay, the length of the interval for pH value variation was 0.51. This showed that the pH value of this water area changed little and was very stable. Therefore, the content of carbon dioxide and hydrogen ion concentration in the surface seawater of this area kept the stable low value.

5. Conclusion
The pH value in the waters of Jiaozhou Bay ranged within 7.55-8.79 in May and October. The pH value in the seawater was all greater than 7.50 in May and October. In addition, the interval length of the changes of pH value in the seawater was 1.24, which indicated that the overall pH value of the water body was within the normal range of variation in May and October.

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In October, the pH value ranged within 8.28-8.79. In Jiaozhou Bay, the pH value of seawater was relatively high, which presented that the content of carbon dioxide and hydrogen ion in the entire surface seawater of Jiaozhou Bay was very low, causing the pH value of entire waters to reach the highest value. Moreover, in the waters inside of the bay, in the mouth of the bay, and outside of the bay, the interval length of the variation of pH value was 0.05. It presented that the variation of pH value in this area was very small and stable.
References

[1] Yang Dongfang, Zhang Jing, Lu Jibin, Gao Zhenhui, Chen Yu. Examination of Silicate Limitation of Primary Production in the Jiaozhou Bay, North China I. Silicate Being a Limiting Factor of Phytoplankton Primary Production[J]. Chin. J. Oceanol. Limnol. 2002, 20(3): 208-225.

[2] Yang Dongfang, Zhang Jing, Gao Zhenhui, Chen Yu, Sun Pei-yan. Examination of Silicate Limitation of Primary Production in the Jiaozhou Bay, North China II. Critical Value and Time of Silicate Limitation and Satisfaction of the Phytoplankton Growth[J]. Chin. J. Oceanol. Limnol. 2003, 21(1): 46-63.

[3] Yang Dongfang, Gao Zhenhui, Chen Yu, Zhang Jing, Wang Pei-gang. Examination of Silicate Limitation of Primary Production in the Jiaozhou Bay, North China III. Judgment Method, Rules and Uniqueness of Nutrient Limitation among N, P, and Si[J]. Chin. J. Oceanol. Limnol. 2003, 21(2): 114-133.

[4] Yang Dongfang, Chen Yu, Gao Zhenhui, Zhang Jing, Wang Fan. Silicon limitation on primary production and its destiny in Jiaozhou Bay, China IV. Transect offshore the coast with estuaries[J]. Chin. J. Oceanol. Limnol. 2005, 23(1): 72-90.

[5] Yang Dongfang, Gao Zhenhui, Wang Pei-gang, Sun Pei-yan, Liu Shuang. Silicon limitation on primary production and its destiny in Jiaozhou Bay, China V. Silicon deficit process[J]. Chin. J. Oceanol. Limnol. 2005, 23(2): 169-175.

[6] Yang Dongfang, Gao Zhenhui, Zhang Jing, Cui Wenlin, Shi Qiang. Examination of Daytime Length’s Influence on Phytoplankton Growth in Jiaozhou Bay, China[J]. Chin. J. Oceanol. Limnol. 2004, 22(1): 70-82.

[7] Yang Dongfang, Gao Zhenhui, Chen Yu, Wang Pei-gang, Sun Pei-yan. Examination of Seawater Temperature’s Influence on Phytoplankton Growth in Jiaozhou Bay, North China[J]. Chin. J. Oceanol. Limnol. 2004, 22(2): 166-175.

[8] Dongfang Yang, Fan Wang, Zhenhui Gao, et al. Ecological Phenomena of Phytoplankton in Jiaozhou Bay[J]. Marine Science, 2004, 28 (6): 71-74.

[9] State Oceanic Administration. The Specification for Marine Monitoring [Z]. Beijing: China Ocean Press, 1991.