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Vertical Distributions of Chemical Oceanographic Parameters in Jinhae Bay in July, 1983

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1983年 7月 鎭海灣의 海洋化學指數의 垂直分布에 관하여

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Abstract: Vertical and horizontal distributions of chemical oceanographic parameters were measured in Jinhae Bay in July, 1983. On the Masan-Gadeog section, high amounts of dissolved nitrates, ammonia, chlorophylla-a, and particulate carbon and nitrogen were observed in waters with low salinity.

In the inner Masan Bay, high concentrations of dissolved ammonia and phosphates were shown. The C/N ratio in the surface waters was higer in the outer bay. Concentrations of dissolved inorganic nitrogen and phosphates in the surface waters seemed to be sufficient for red tides to occur.

要約: 진해만에서 83년 7월의 장마직후에 수직적 및 수평적 해양화학적 환경을 조사하였다. 마산만—가덕수도의 종축면상에는 염분이 낮은 내만쪽의 표층수에서 높은 농도의 용존성 질산염, 암모니아, 클로로필 a, 입자성질소, 입자성탄소가 측정되었다. 입자성 C/N비는 내만쪽에서 낮고 외만에서 높은 값을 보였다. 이 해역에서 무기질소와 인의 양은 적조가 발생하기에 충분한 양으로 나타났다.

INRODUCTION

In recent years, rapid industrialization of the Korean coastal areas have imposed often severe problems on the water quality of coastal areas, damaging fishery resources and human health.

In Jinhae Bay frequent red-tide outbreaks damaging coastal fisheries have been reported (Cho 1979; Park 1980; Yoo and Lee 1980; Lee et al. 1980, 1981, 1982, 1983.)

Principal source of pollutants in this area is domestic and industrial wastewaters from Masan area. Since pollutants are transported from the inner Masan Bay to the open ocean through a narrow channel, it is of interest to understand the physical, chemical and biological oceanographic conditions in this area.

Many red tides have been reported in Jinhae Bay after heavy rainfall during which various nutrients and growth promoting substances can enter coastal waters from land runoff (Cho 1979; Park 1982).

Although various chemical parameters have been previously measured in Jinhae Bay (Lee et al. 1980, 1981, 1982, 1983; Yang and Hong 1982; Yang and Lee 1983), few works have been reported on their depth profiles. In this paper, vertical and horizontal distributions of chemical oceanographic parameters just after the rainy days were described in order to elucidate mechanism for red-tide outbreaks in Jinhae Bay.

MATERIALS AND METHODS

Sampling was done in July, 1983, just after the rainy days.

Seawater samples were collected at each 5m of depth on the water column at 11 stations

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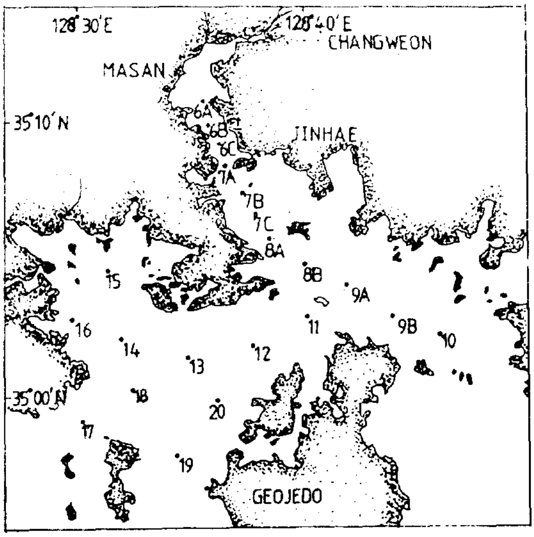

Fig. 1. Sampling stations of Jinhae Bay.

between the inner Masan Bay and Gadeog waterway (Fig. 1).

Methods of measurements for salinity and dissolved oxygen are described elsewhere (Lee et al. 1983). Analyses for dissolved nitrates, nitrites and phosphates were carried out with the Technicon Autoanalyzer II using the method of Zimmermann et al. (1977). The concentration of ammonia was determined by the indophenol blue method of Koroleff (1969). The extinction at 630nm was measured in 1 cm cuvettes in a perkin Elmer 552 spectrophotometer installed on board. Chlorophyll-a was determined on acetone extracts by the SCOR-UNESCO (1966) method. For the analysis of particulate carbon(PC) and particulate nitrogen (PN), seawater samples were filtered onto the proignited glass fiber filters(Whatman GF/C). Measurements were carried out with an elemental analyzer(Perkin Elmer 240B) by the method of Kerambrun and Szekielda(1969).

RESULTS AND DISCUSSSON

The low, surface salinity of less than 20‰ was shown from St. 6A to 7A and from St. 7B to the outer bay surface salinity was greater than 28‰ (Fig. 2). Salinity exceeded 31‰ at 5m depth regardless of distance from the inner Masan Bay. It appears that the influence of freshwater runoff was limited to the surface layer.

Dissolved oxygen contents in the surface waters of St. 6A to 7A were 9.1-10.1 ml/l (177.7-199.9%), reflecting the active photosynthesis of primary producers (Fig.3). In the outer part of the bay it was 5.7-8.4ml/l(112.4-168.8%). A sharp DO decrease in the vertical profile was observed in the inner bay. At Sts. 6A, 6B and 6C, the bottom waters contained 0.3 to 0.8ml/l of DO, showing nearly anoxic conditions. The low Do concentration in the inner bay was likely due to the oxidation of organic matters which was fallen down from the surface.

Extremely high concentrations of dissolved nitrates were observed in the inner bay, exceeding 1,200μg N/l at Sts. 6A and 6B(Fig.4). Surface nitrate contents decreased with increasing distance from the inner Masan Bay. Previous observation also indicated that high concentration of nirtates was mainly originated from the inner Masan Bay(Lee et al. 1981, 1982). Because of landwater influence limiting to the surface layer, dissolved nitrate contents at 5m depth ranged from 12 to 83μg N/l.

In the inner bay, nitrates were not detectable in the bottom waters. This may be due to denitrification processes eliminating nitrates from the bottom waters, where nearly anoxic conditions developed.

Dissolved nitrite concentration was high in the surface waters of the inner bay. Over 50μg N/l of nitrites could be detected from St. 6A to 7A.

Dissolved ammonia was abundant in the surface waters of the inner bay(Fig. 5). Oxygen-deficient bottom layer of the inner bay contained more than 400μg N/l of dissolved ammonia. This could be due to accumulation of ammonia

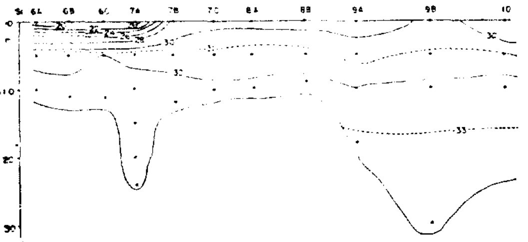

Fig. 2. Vertical distribution of salinity (‰).

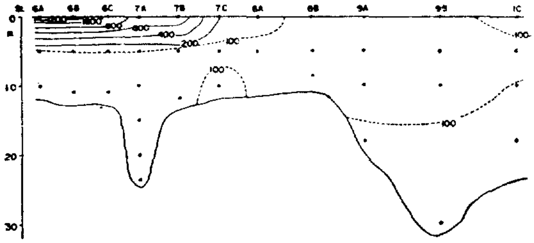

Fig. 4. Vertical distribution of nitrates(μg N/l).

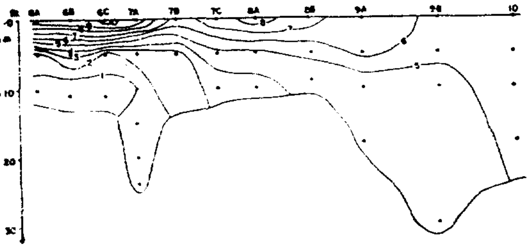

Fig. 3. Vertical distribution of dissolved oxygen (m/l).

Fig. 5. Vertical distribution of ammonia(μg N/l).

during denitrification processes (Goering 1968). In the outer bay, dissolved ammonia contents increased in the bottom waters due to the degradation of organic matters. Relationship between dissolved ammonia contents and dissolved oxygen concentration is shown in Fig. 6. Four points on the upper-left represent the surface waters of the inner bay with high contents of DO due to the photosynthesis and relatively high contents of ammonia introduced from landwater. Excluding these four points, good correlationship could be established between DO and ammonia contents with a correlation coefficient of 0.96.

Dissolved inorganic nitrogen (nitrates + nitrites + ammonia) in the surface waters of Masan-Gadeog section generally exceeded 100μg N/l which is the minimum level for large scale outbreaks of red tides (Japanese Association of Fishery Resources Protection 1972).

Surface phosphate concentrations varied from 21.8 to 41.5μg P/l and were not related to salinity, contrary to the nitrate distribution (Fig. 7). In the inner bay, intense degradation of organic matter in the bottom waters gave rise to phosphates reaching 128μg P/l at St. 6A. Leaching of phosphates from anoxic sediment may also account for the high concentrations of dissolved phosphates in the bottom waters, as was the case of Hakata Bay (Honjo 1974). Dissolved phosphate contents in the Masan-Gadeog section all exceeded 20μg P/l above which level phytoplankton growth is not limited by phosphate availability (Kuhl 1974).

Chlorophyll-a contents in the surface waters were high in nitrate-rich water with low salinity (Fig. 8). Highest concentration of chlorophyll-a (61μg/l) was measured at St. 6A which

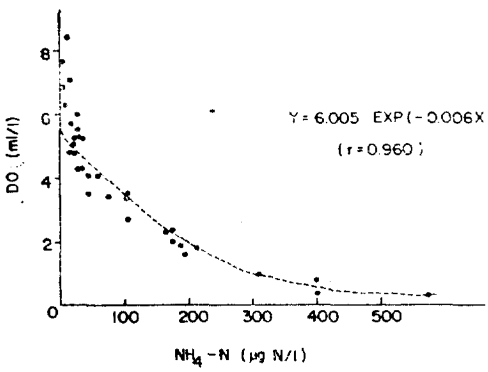

Fig. 6. Relationship between dissolved oxygen and ammonia.

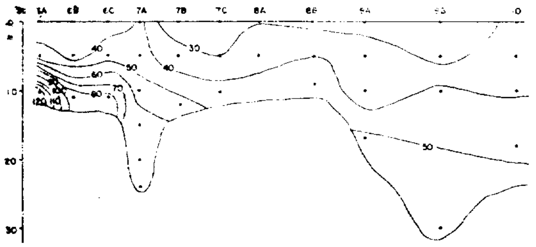

Fig. 7. Vertical distribution of phosphates(μg N/1).

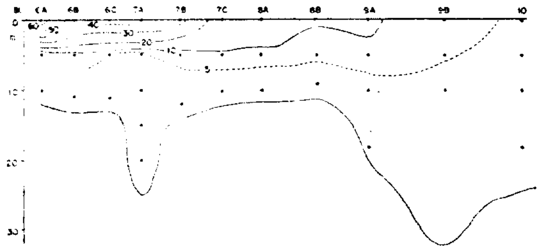

Fig. 8. Vertical distribution of chlorophyll-a(μg/1).

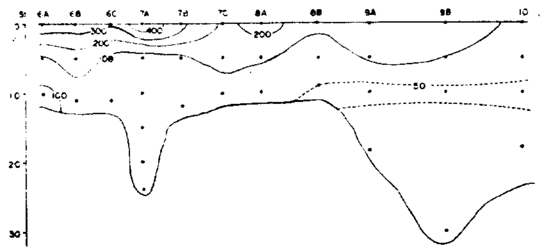

Fig. 9. Vertical distribution of particulate nitrogen (μg/1).

is located at the mouth of the inner Masan Bay. At 5m depth chlorophyll-a contents were less than 10μg/l, whereas in the bottom waters about 1μg/l of it was measured.

Particulate nitrogen(PN) contents in the surface waters exceeded 300μg/l from St. 6A to 7B(Fig. 9). PN contents generally decreased with increasing depth. At Sts. 9A, 9B and 10 the bottom waters contained more PN than 10 m depth.

Particulate carbon(PC) contents in the surface waters were also high in the inner bay(Fig. 10). Vertical distribution of PC showed a similar pattern as that of PN.

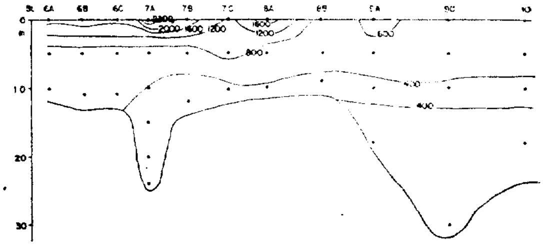

Fig. 10. Vertical distribution of particulate carbon (μg/1).

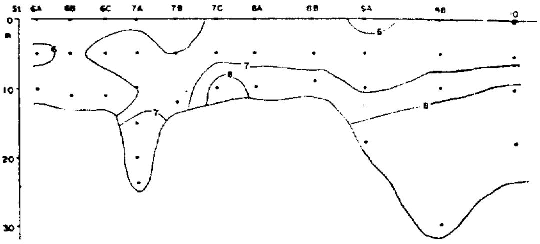

Fig. 11. Vertical distribution of the C/N ratio.

From St. 6A to 7B the C/N ratio in the surface waters varied from 5.1 to 5.9, whereas it was greater than 5.9 from St. 8A to the outer bay(Fig. 11). The horizontal variation of the C/N ratio may be due to high contents of nitrogenous compounds in the land-based organic matters. The C/N ratio increased with increasing depth reaching 6.7 to 8.6 in the bottom waters except in the inner bay where the C/N ratio was small ranging from 5.0 to 5.9.

Although PC and PN are not known to be good indicators of biomass in the ocean because of the difficulty in assessing the carbon content of living phytoplankton due to the presence of detritus and the variability of phytoplankton carbon to chlorophyll ratios, relationships in Jinhae Bay were established in the surface waters between PN and chlorophyll-a($r=0.894$, $n=11$) and between PC and chlorophyll-a($r=0.826$, $n=11$).

A more detailed study on the nutrient cycles and transports could provide useful information in studying the machanism sustaining high algal biomass in Jinhae Bay.

CONCLUSIONS

The influence of freshwater inputs with high contents of nutrients were distinctively shown in the Masan-Gadeog Section of Jinhae Bay. High amounts of dissolved nitrates, ammonia, chlorophyll-a, PN and PC were observed in the low-salinity surface waters. In the inner bay, nearly anoxic bottom waters contained high concentrations of ammonia and phosphates. A high C/N ratio was found in the outer bay and in the bottom waters, except in the inner bay.

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