Bloom of *Coscinodiscus wailesii* and DO Deficit of Bottom Water in Seto Inland Sea

T. MANABE* and S. ISHIO†
*Hyogo Pref. Fish. Exp. Stn., 1-6-8, Nakasaki, Akashi, 673 Japan
†Kyushu University, 6-10-1, Hakozaki, Higashi-ku, Fukuoka, 812 Japan

Relationships among high values of Secchi disc visibility, DO deficit in bottom layer and bloom of a giant diatom *Coscinodiscus wailesii* in eastern Seto Inland Sea were examined.

***C. wailesii* appeared in autumn when water temperature went down, developed to bloom absorbing much amounts of nutrients. Decline of the bloom occurred with quick deposition onto the bottom mud. Consequently, Secchi disc visibility became very high in this area and the decayed giant diatom was sedimented. During low temperature of water, the diatom was kept as organic matter in the sediment and decomposed as the temperature of water went up. The cause of the recent DO deficit of the bottom water in Seto Inland Sea was attributed to the decomposition of this giant diatom in the sediment accelerated by raise of bottom water temperature.**

DO deficit of bottom water in eutrophicated shallow waters exerts adverse effects on marine organisms. Blooming, decline and anaerobic composition of phytoplankton seemed to be the cause of this DO deficit. The DO deficit of bottom water in the eastern Seto Inland Sea still proceeds resulting in devastation of bottom fauna, whereas the eutrophication of this waters has been strictly controlled, by acts of water pollution abatement. Authors intend to clarify the causes of this DO deficit.

Methods and Materials

Cell counting of *C.wailesii* was continued over 6 years from 1984 to 1989, and water temperature, DO, Secchi disc visibility and content of chlorophylls were investigated over 17 years from 1973 to 1989 in waters of 1930 km^2 where is shadowed in Fig.1. Moreover, Secchi disc visibility was measured over 64 years from 1926 to 1989 in such a area shown within the radius of 10km centering around a point of 34° 33′ N, 134° 35′ E marked with ■ in Fig.1.

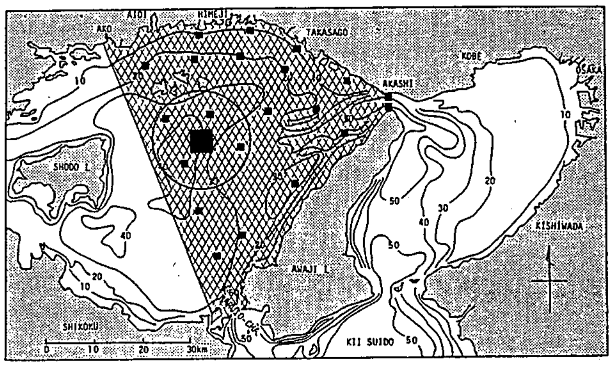

Fig.1 Location of sampling stations and aspects of their depth(m) in Harima-nada.■ : 34° 33′ N, 134° 35′ E.

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Results and Discussion

In Fig.2, frequency of phytoplankton red tides occurred over 17 years from 1973 to 1989 in all of Seto Inland Sea is indicated.

The frequency reveals the tendency of decrease of phytoplankton blooms since 1977.

In Fig.3, annual Secchi disc visibilities in central Harima-nada from 1926 to 1989 are shown which were treated by 5-year moving average process.

The Secchi disc visibilities decrease gradually from 1926 to 1976 probably by increase in discharge of organic wastes, but increase since 1977 likely due to water pollution control by laws.

In Fig.4, the Secchi disc visibilities from 1973 to 1989 in Harima-nada are demonstrated which were treated by 12-month moving average process.

The visibilities are indicated to increase gradually in accordance with probably by the effect of the program of the water pollution abatement, but the outstanding increase in Secchi disc visibilities from 1982 to 1984 can not be explained by only such a water pollution control.

In Fig.5, DO saturation indexes of water of surface, middle and bottom layers of Harima-nada are shown which were treated by 12-month moving average process.

The DO saturation indexes of water of surface and middle layers are shown to decrease gradually as if they converge to 100 % of the index probably by the effect of ceasing of phytoplankton red tides in this area, but the indexes of water of bottom layer decrease far below 90% of index.

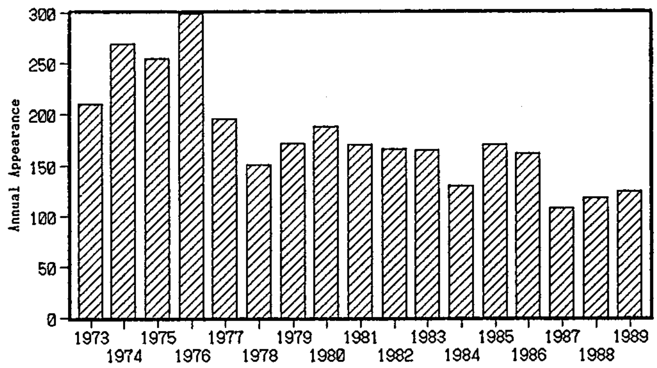

Fig. 2 Frequency of usual phytoplankton blooming in Seto Inland Sea.

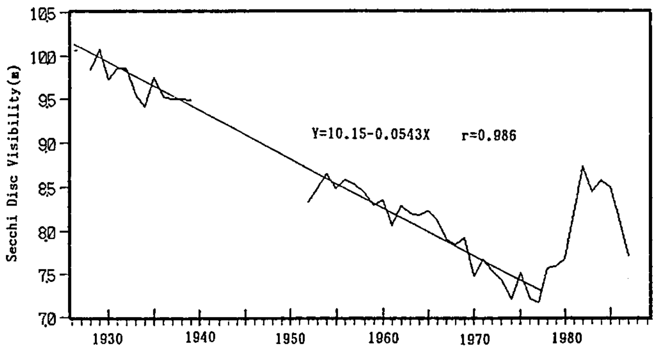

Fig. 3 Annual Secchi disc visibilities in the central area of Harima-nada. Data were treated by 5-year moving average process.

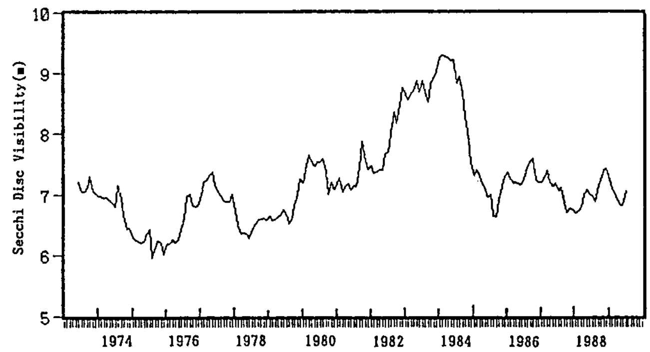

Fig. 4 Monthly Secchi disc visibilities in central area of Harima-nada. Data were treated by 12-month moving average process.

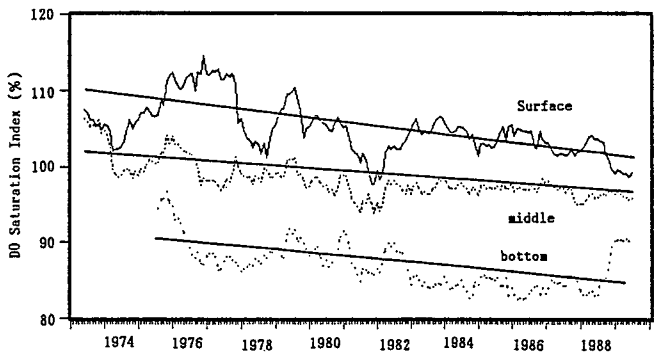

Fig. 5 DO Saturations indexes of surface, middle and bottom water in central area of Harima-nada. Data were treated by 12-month moving average process.

In Fig.6, changes of areas where DO deficit occurs in bottom water in Harima-nada are shown over 15 years from 1975 to 1989.

There can be seen the tendency of increase in area of DO deficit. Decrease in DO saturation indexes shown in Fig.5 tells us that it exerts not only to deplete DO concentration but also enlarge the bottom area of DO deficit. Such high values of Secchi disc visibilities as shown in Fig.4 and lowered DO concentration areas indicated in Fig.6 can not be explained by the effects of the water pollution control alone , but by the effect of bloom of a certain species of phytoplankton.

Recently, a giant disc diatom *C.wailesii* is observed abundantly in Seto Inland Sea during low water temperature from autumn to spring.

In Fig.7, a microphotograph of *C. wailesii* is shown.

This diatom possesses 300 μ m in diameter and 200 μ m in height, very large in sizes. It was also well known that this plankton has a large specific gravity of 1.060 and great sedimentation rate as large as 6m/hr(MANABE, unpublished).

In Fig.8, relationship between cell numbers of *C. wailesii* and Secchi disc visibilities, which were observed from autumn of 1984 to spring of 1990, is shown.

When *C. wailesii* can be observed abundantly in water, Secchi disc visibilities of the water become large. This phenomenon is strange, because the Secchi disc visibility of water becomes small in general when phytoplankton develops to bloom in water.

In Fig.9, the relationship between the cell densities of *C. wailesii* and

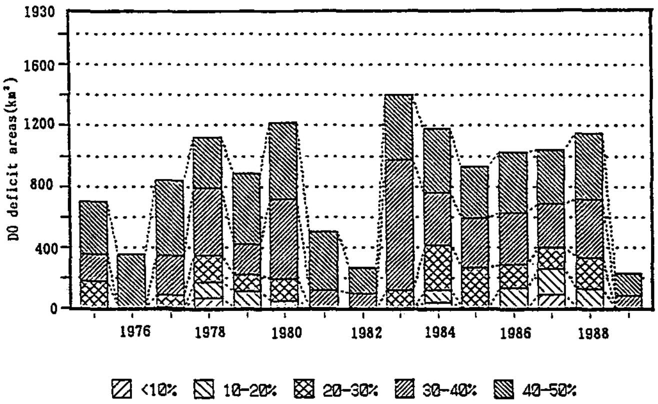

Fig. 6 DO deficit areas of bottom water observed from 1975 to 1989 in Harima-nada.

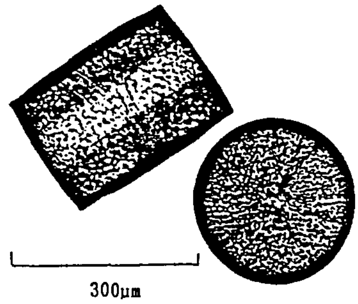

Fig. 7 Micrographs of *C.wailesii* .

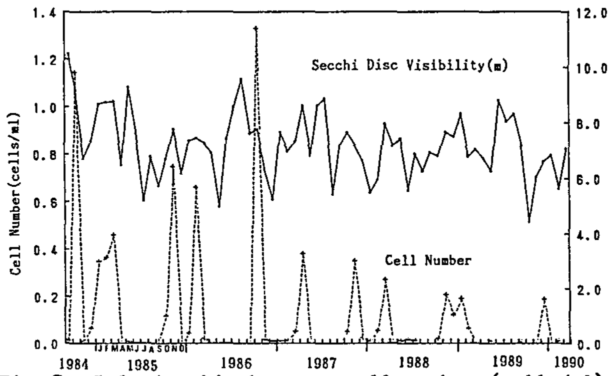

Fig. 8 Relationship between cell numbers(cells/ml) of *C.wailesii* and Secchi disc visibility(m) in Harima-nada.

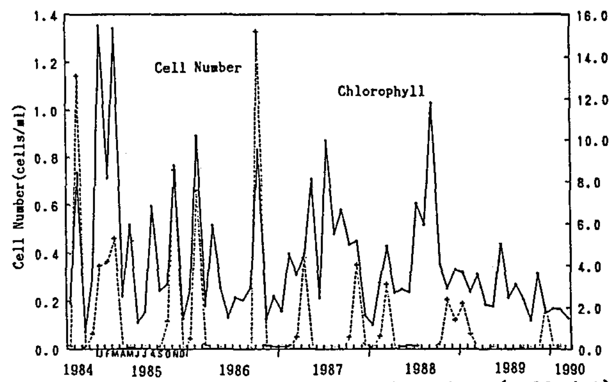

Fig. 9 Relationship between cell numbers(cells/ml) of *C.wailesii* and contents(µg/l) of chlorophylls in water of bottom layer in Harima-nada.

the concentrations of chlorophylls in water of bottom layer is indicated.

When *C. wailesii* is blooming, the concentrations of chlorophylls in water of bottom layer become high suggesting their high aggregation abilities and quick deposition.

In Fig.10, there is indicated the relation between the cell densities of *C. wailesii* and the temperature of ambient water.

C. wailesii can be seen from September when water temperature decreases to 25 ℃, to May of next year when it increases to 17℃.

In Harima-nada, vertical mixing of water occurs on September. Thus, blooming of *C. wailesii* is surmised to be accelerated by utilizing abundant nutrients from bottom layer carried by upwelling.

In Fig.11, aggregation of *C. wailesii* and their sedimentation are illustrated by copying a series of photographs.

C. wailesii is capable of aggregating themselves including other species of phytoplankton forming either filamentous or globular detritus and sink with large sedimentati on rates.

Conclusively, with the reason of a large cell size, *C. wailesii* can seldom be observed as exemplified by large values of Secchi disc visibility even if they may bloom. However, their deposition onto the bottom mud give the same magnitude of bottom eutrophication causing to DO deficit of bottom layer as well as blooms of phytoplankton with common size which give visual blooms.

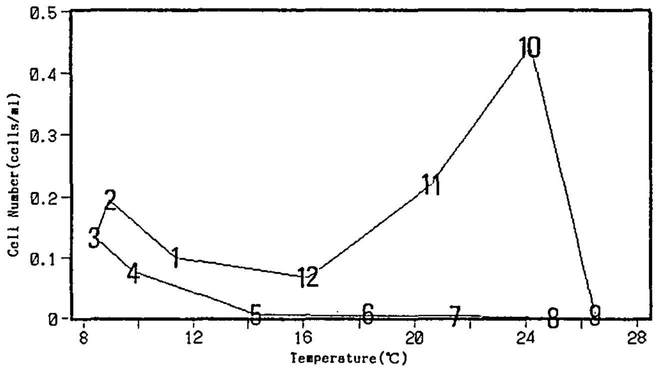

Fig.10 Relationship between cell numbers(cells/ml) of *C.wailesii* and water temperature(℃) in Harima-nada. Numbers on the line show month. Data were treated by 6-year average process.

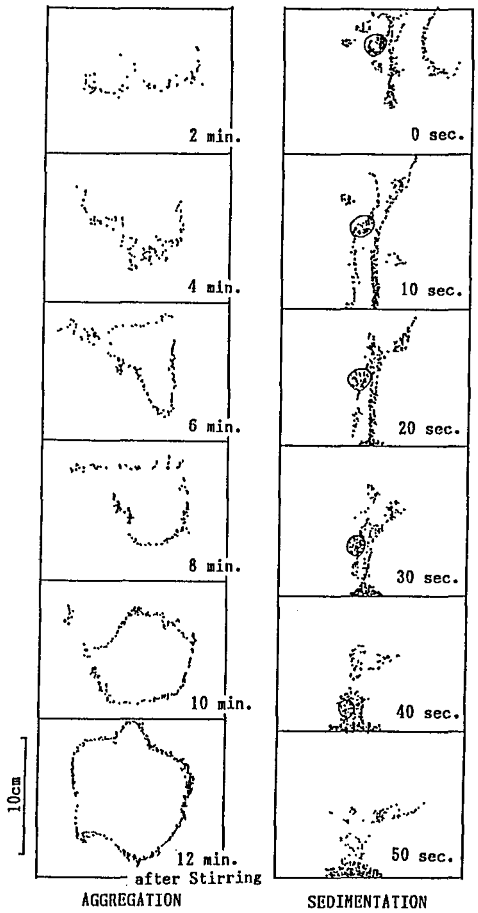

Fig.11 Illustrations of filamentous and globular aggregation and sedimentation of cells of *C.wailesii* including other species of phytoplankton.