Mariculture and Eutrophication in Jinhae Bay, Korea

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The contents of organic matters and sulfide in superficial bottom muds, and mass mortality of shellfish mainly due to red tides in the Jinhae Bay are reviewed. COD, ignition loss, and sulfide contents increased for the last decade from 1972 to 1982. Causative organisms of red tides also changed from diatom to flagelletes. A decerease of shellfish production or mass motalities of this area would be caused by a high level of eutrophication, which resulted from both waste discharge from an industrial complex and organic deposits from the aquaculture.

The Jinhae Bay was once a productive area of fisheries. It is, however, notorious for its red tides and eutrophication at present. Pollution of this area owing to operation of an industrial complex near Masan Bay(inner Bay of the Jinhae Bay) has making of dispute, since shellfish production is on decrease and mass mortality often occurs. Such a contradictory actually is like a rugged mountain to climb over once at least in a developing country. Accordingly, the pollution troubles of this area is a good model case shown frictions resulting from the industrialization in many places along the costal sea of Korea these days. Not only fisherman but also research institute and the fisheries authorities consider a counterplan. It is a serious problems around the Jinhae Bay area.

Description of the Jinhae Bay

The Jinhae Bay, a largest bay in Korea, is located in the southeastern part of the Korean Peninsula. The bay is composed of four subareas; Masan Bay, Haeng-am Bay, Gadok Waterway, and Jinhae Bay Proper. Total area of the bay is approximately 497km^2 with a mean depth of 20m. Sediments are composed mostly of slit. There are two mouths, one is the Gadok Waterway, a large mouth connected with the western channel of the Korea Strait and the other is a narrow and small Kyonaeryang Pass(Fig. 1). Seawaters exchange through the two mouths but most of them occurs through the Gadok Waterway. Major part of seawaters passing through the Gadok Waterway inflows into the Jinhae Bay Proper and a part of them into the Masan Bay through a long waterway(KORDI, 1980).

Eutrophication

Wastes influx from the land

A huge Masan and Chang-won Industrial Complex composed of some 270 plants is located in the vicinity of the Masan Bay. Populations of the two cities and their neighboring counties are about 750 thousand. From them, approximately 200m^3 waste per day discharges into the bay and about 75% of them comprises municipal sewages. In addition, 711kℓ night soils per day flows in and among them a half is untreated(Kim, 1989). In the vicinity of the Haeng-am Bay, a large chemical fertilizer plant lies and a great deal of phosphorus as waste discharges into the bay. So, nutrient contents in seawaters of these two bays are very high. It, especially phosphorus, has an effect on the Jinhae Bay Proper(Park,1975a,b), and it increases year by year(Cho, 1978).

Marine Pollution Bulletin, Vol. 23, pp. 275–279, 1991.
Printed in Great Britain
0025-326X/91 $3.00+0.00
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Deposits owing to aquaculture

Superficial bottom muds of this area contain high organic matters and sulfide(Cho et al., 1982a) compared to other bays(Cho, 1980; Cho et al., 1982b; Cho and Park, 1983). Chemical Oxygen Demand(COD) contents were from 9.7 to 38.5mg/g in dry base, phaeophytin from 7.6 to 48.2μg/g, ignition loss from 8.1 to 14.2%, and sulfide from 0.05 to 1.07μg/g in dry base in summer season of 1981(Cho et al., 1982a). In the further areas from the mouth of the bay, the more quantities of these materials were found. Such great quantities of organic matters and sulfide would be mainly due to excrements from shellfish and fouling organisms, but not owing to the influence of pollutants discharged from Masan, Chang-won and their adjacent counties.

Hypoxic state in the bottom water

Dissolved oxygen levels of the bottom water in September 1983 showed low though surface waters generally remained well-oxgenated. Oxygen concentration below 2mℓ/l in the bottom water covered an area of 55% of the bay. The most depleted(<1.0mℓ/l) areas were limited in inner areas of both the Masan and the Haeng-am Bays, and some parts of the Jinhae Bay Proper, where hydrogen sulfide was also observed. Oxygen saturation in the oxygen dificient(hypoxic) areas was less than 40% (Hong, 1987).

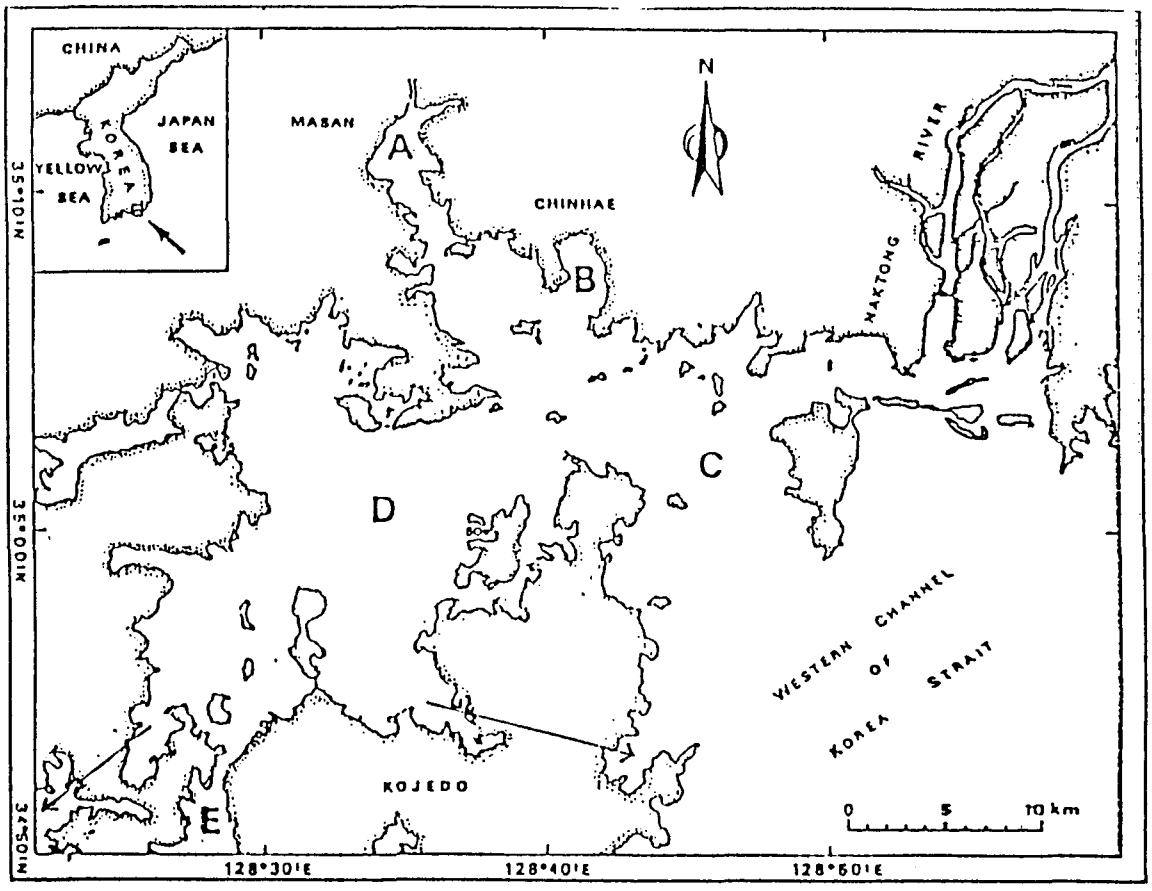

Fig. 1. Map showing the Jinhae Bay and subareas indicated; A=Masan Bay, B=Haeng-am Bay, C=Gadok Waterway, D=Jinhae Bay Proper, and E=Kyonnaeryang Pass. Arrow shows a desirable waterway.

Aquaculture

Shellfish culture

Productioin of mariculture in Korea increased about eightfold for the last two decades, 11.2 thousand tons in 1970 to 886.6 thousand tons in 1988, and the component ratio to total fisheries production also incremented from 11.6 to 27.6% at the same period. It means that mariculture in Korea made rapid progress in quantity. Major groups are seaweeds and shellfish(Table 1), and fish culture is disregard, say 0.3%. Most of mariculture grounds are located in the south coastal sea of the Korean Peninsula and the Chungmu area including the Jinhae Bay amounts to approximately 70% of total shellfish yield.

Table 1. Production and percentage of major groups produced from mariculture in Korea in 1988

Total	886,605M/T	100.00%
Oyster(*Crassostrea gigas)*	284,472	32.09
Brown algae(*Undaria pinnactifida)*	281,657	31.77
Laver *(Porphyra tenera)*	115,749	13.06
Short-necked clam(*Mactra veneriformis)*	51,245	5.78
Arkshell(*Anadara broughtonii)*	49.013	5.53
Subtotal	782,136M/T	88.22%

Decrease of shellfish production

Major culture species in the Jinhae Bay are oysters(*Crassostrea gigas)*, mussels(*Mytilus edulis)*, and arkshell(*Anadara broughtonii)*. Both oysters and mussels are cultured with a off-bottom and arkshell with a bottom system. Approximately 7.5% of this area is used for shellfish farms(KORDI, 1983).

Oysters have been cultured in a large scale in the Jinhae Bay Proper since 1970s. At the begining, oyster yield per raft(162㎡) was 4-5 tons in meat weight but it has decreased progressively, about 3 tons these days. It means that fatness of each oyster has continously down, and it causes that the harvest season is occasionally extended and passed the old year(Cho, 1980).

Culture density of shellfish in this area is about 12% and it is higher than the standard, 10%. It is important how much portion to total area is used as culture grounds, since density of organisms is closely related to food competition and water circultion.

Oyster damages

Red tides have frequently occurred. For eight years from 1972 to 1979 more than 50% of red tides in the southern coastal waters occurred in this area(Park, 1980). Causative organisms were mainly diatoms but flagellates appeared as dominant species since the late of 1970s(Cho, 1978, 1979; Park, 1980; KORDI, 1980).

Oysters were badly demaged due to red tides in this area. For example, it was estimated to US$4.45 million in 1978 and US$2.25 milloion in 1981(Cho, 1979, 1981). The red tide occurred in August, 1978 completely destroyed the oyster except the innermost part of the bay. In winter of 1978, 96% of an estimated

yield of 5,879 tons in shucked meat was lost.

For the last three years, shellfish culture in this area was in a bad condition due to mass mortalities.

Discussions

High contents of nutrients such as total nitrogen and phosphorus of seawaters(Park, 1975a, b; Cho, 1978), organic matters and sulfide in the superficial bottom mud(Cho et al., 1982) cause a low oxygen saturation of bottom waters in this bay(Hong, 1987). Such a high eutrophication(or contamination), caused by waste discharge from the land and pollution from the culture-self which results from a high density of farms and a continuous culture at same area with a same species, brings on red tides, as widely known.

Therefore, a deterioration and superannuation of the culture ground has been slowly advanced and it leads to a production decrease or mass mortalities of shellfish.

Conclusion

Frictions caused by pollution between shellfish farmers and factory owners are serious and this kind of disputes will grow more and more. Two ways to settle it down are proceeded; 1) A large scale dredging in the Masan Habor is in progress but many experts do not expect seawaters to be clean in a satisfactory way, and 2) Both shellfish farmers and the authorities concerned try to build a specially designed boat for cleaning of bottom deposits of culture grounds using by dredging or suction, and this plan takes a definits form before long.

My idea is like the following. The one is to reclaim a tract an inner-bay including the Masan Habor, and the other is to dig a waterway between the Jinhae Bay Proper and the open sea, for a good water circulation. It will be of no use due to an enormous expense and an ecological aspect, but this is worth a good deal more than the above two clauses, I believe. Although my proposal will be dangerous from an ecological point of view, tempory reliefs such as dredging will be unable to settle the problem down fundamentally, as long as an existance of the industrial complex and unless the Environmental Protection Act is thoroughly kept.

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