Creation of a New Nonfeeding Aquaculture System in Enclosed Coastal Seas

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The modern civilization broke down a recycle system for human excrement, peculiar as it is in our country. As a result, eutrophication has occurred in the enclosed coastal seas, presenting a serious environmental problem. To prevent such a situation, we propose to create a new biogeochemical, recycle system whereby nutrients flow into the seas would be returned to land by means of a combined system of aquacultures of non-feeding type. The system consists of (1)culture of seaweeds, (2)culture of filter feeding animals, and (3)culture of mud feeding animals.

However, the development of culture in the enclosed coastal seas inevitably leads to overproduction. To promote and sustain the system, it is important not only to develop the industrial utilization of each of the cultured products, but also set up an organization of cooperations between the fishery cooperatives, local citizens and local governments.

In the past, organic matters in the human excrement had returned to the soil through an industry called agriculture. The nutrients decomposed by bacteria bred plants, and man utilized them. Thus, a local biogeochemical system was successfully established in Japan. However, such a recycle system was broken down owing to the modern civilization including the popularization of chemical fertilizers, the concentration of population towards the city, etc.

At present, nutrients such as N and P are finally flowed into the sea through sewage disposal plants as well as rivers. In the enclosed coastal seas especially, the eutrophication is promoted, and troublesome phenomena such as the red tide and the anoxic water frequently occure, causing a destruction of biota in the coastal seas. Consequently, the value of such areas as a fishing ground has diminished.

To prevent such a disastrous situation, we must build up a new biogeochemical system which recovers N and P accumulated in the sea. From the standpoint of aquaculture, however, there would be also a different point of view that rich nutrients in the sea can be precious resources. Through an industrial activity called aquaculture, therefore, it is possible to recycle N and P in the sea systematically and utilize these nutrients as food for mankind.

Present situation of treatment of domestic waste water and material circulation of nutrients

There are following three possible origins of nutrient load which flow into the sea, i.e. the domestic waste water, the industrial waste water and the agricultural-livestock waste water. Among them, the largest source of the nutrient is thought to be the domestic waste water (see Table 1 : after Hibino,1984). The estimated total load of nutrients per year in Japan is 45.6×10^4t/year for N and 7.5×10^4 t/year for P.

Table 1 Nutrients load per unit production of domestic waste water in Japan (g/man/day) (Hibino,1984)

	1955	1960	1965	1970	1975	1980
COD	17.0	18.0	18.0	20.0	20.0	20.0
T-N	8.5	9.2	9.8	10.1	10.4	10.4
T-P	1.2	1.4	1.7	1.9	1.8	1.7

The material balance of N and P in domestic waste water in Japan can be estimated as shown in Fig.1. About 40% of domestic waste water is treated at sewage disposal plants, but the remaining 60% flows into the sea through rivers. The volume of sluge produced at sewage disposal plants is estimated at 2×10^6 m^3 a year. Parts of

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the production activity can be carried out systematically under some controlling regulations.

Even at present, such non-feeding type aquacultures are conducted, but they are not carried out systematically as a matter of the policy aimed at the purification of the seawater. Here, we propose a special type of aquaculture objecting the purification of seawater as well as production of food.

The concept of such a culture system of non-feeding type is shown in Fig.2. The nutrients in the sea are absorbed by cultivated seaweeds. The seston, including phytoplankton, in the seawater is filtered and removed by the filter feeding animals, and finally, deposited their faeces and pseudofaeces on the seabed are eaten by mud feeding animals.

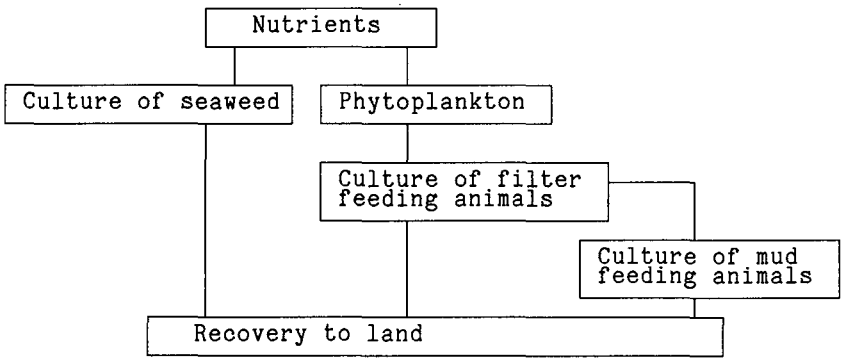

Fig.2 Aquaculture system of non-feeding type in enclosed coastal seas for the purification of the seawater

In the non-feeding type culture, the culture system mentioned above should be planned, taking the following matters into consideration:

1) Cultures should be carried out throughout the year.
2) Three-dimensional utilization of the area concerned should be planned.
3) Species matching regional environmental characteristics should be selected.
4) Culture species of pertinent ecological characteristics should be combined.

According to the rate of recovery of nutrients from the sea estimated from the catching rate in the coastal fishery, about 15% of the load of nutrients is recovered, but most of this is largely dependent on catching of fishes. The recovery rate by the non-feeding culture is less than 1% at the most. If we aim the recovery of phosphorous by the non-feeding culture at 10%, the amount of production of cultured seaweeds and filter feeding animals will be such figures as shown in Table 6. Assuming that the load recovery rate is 7% for seaweeds and 3% for filter feeding animals, then the scale is about 10 times as much as the present volume of cultures.

Table 6 Production in the case where 10% of phosphorous in the domestic waste water is recovered by the non-feeding cultures

Methods of recovery	Recovery of P		Production of aquaculture	
	Rate	Amount	Future	Present
Seaweed	7%	5.25×10^3 t	10^7 t	10^6 t
Filter feeding animals	3%	2.25×10^3	10^6	10^5

If we develop a new, non-feeding culture industry in the enclosed seas, the fishery production in coastal areas will be elevated too much. There must be a fear of excessive supply, which resulting in the collapse of the supply-demand balance in the country.

Improvement of social and economic factors for realization of the project

Creation of new usage and demand for culture products such as seaweeds

Applications and uses of the products from the culture system should be newly developed as follows:

1) Expansion of demand for food usage
2) Utilization of seaweeds for the culture of algae-eating marine animals
3) Supply of floating seaweeds to open-sea areas in order to help to protect fishery resources in the larval period of large-sized pelagic fish

4) Utilization as the agricultural fertilizer
5) Development of the utilization for the materials of chemical industries
6) Promotion of exports

Coordination for utilization of sea area concerned

The area of the sea are utilized in various ways such as navigation and harbor areas, areas of recreation (sportfishing, marine sports, etc.) as well as the fishing and culture grounds. Since the culture of the proposed type will be carried out in a vast area, the coordination between various organizations concerned must be made for the effective utilization of the area. Especially in Japan, the fishery right for a given area is strict and mighty all over the coastal waters except the harbor area, so that the coordination towards and among fishermen is a major problem to be solved.

Contributions from local citizens for operating expenses of a new aquaculture system

The luxurious and comfortable urban life of the present day depends on the sacrifice of marine environment. From the standpoint of the responsibility and duty for improving the marine environment, a certain amount of money should be contributed from the local citizens who discharge sewage.

Creation of a public aquaculture corporation realized by a close cooperation of fishery associations and local government

It is difficult to carry out this culture project only by fishermen. Efforts, therefore, should be made to create a public aquaculture corporation in which the local government and local citizens can work together in order to obtain a close cooperation of the local fishery cooperative association (Fig. 3).

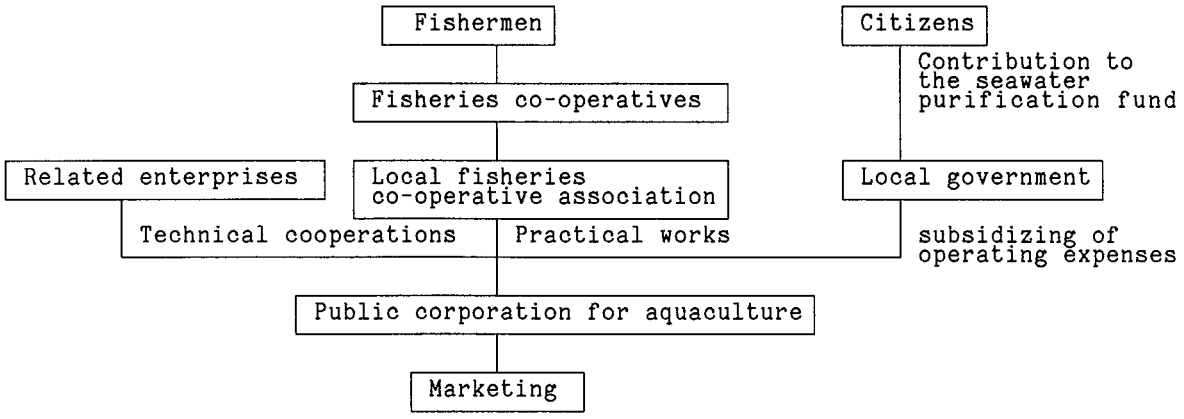

Fig. 3 Organization of a public aquaculture corporation

Improvement of species and development of culture technology and support technology

It is necessary to develop technologies for mass production and improvement of culture species, technologies that permit large-scale culture production, as well as support technologies for harvesting, transportation, storage, etc. To accomplish these purposes, the co-operation of companies concerned is also important.

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