Q. 100 – R. 29

COMMISSION INTERNATIONALE
DES GRANDES BARRAGES

VINGT SIXIÈME CONGRÈS
DES GRANDS BARRAGES
Vienne, Juillet 2018

NEW DEVELOPMENT OF TECHNOLOGY FOR COUNTERMEASURES AGAINST BARREN GROUND BY LAKE BOTTOM SEDIMENTS (SUPER FULVIC ACID IRON)*

Takashi TOYODA
Former President, JCOLD

Junya TAKIMOTO
Former Executive Director, JCOLD

Tetsuya SUMI
Professor, KYOTO UNIVERSITY

Shigekazu HORIYA
Professor, AICHI INSTITUTE OF TECHNOLOGY

Yuji SAKAI
Professor, KOGAKUIN UNIVERSITY

Mitsuru SUEYOSHI
Manager, ASIA AIR SURVEY CO., LTD.

JAPAN

SUMMARY

This time, our research group focused on the effect of high concentrations of fulvic acid produced at the bottom of the dam, using a high concentration fulvic acid iron elution unit, in a real sea area where barren ground is progressing.

** Nouveau développement de technologies pour les contre-mesures contre les fonds dénudés par dépôt de sédiments en fond de lac (fer super-fulvique)*

By conducting demonstration experiments on the algae field recovery of the dam reservoir, it is going to develop for the practical application of technological development for effective utilization of lake bottom deposits.

We have used steelmaking slag made from blast furnace as a material to promote dissolution of divalent iron ions in the past development process, but from this time we have found more effective materials, we have manufactured from electric furnace converter A material containing high concentration divalent iron ions was adopted. This is a material containing high concentrations of divalent iron ions which is 100 times higher than the steelmaking slag that has been adopted so far.

Regarding the commercialization of this research and development overseas, it is scheduled to apply in Korea the first time in East Asia.

In addition, we propose a new calculation formula for CO_2 absorption (carbon conversion) by seaweed bed construction, and the annual fixing by the algae of Japan is estimated to be about 3 million tons.

It is expected that future development of research and development utilizing this technology will be commercialized in areas such as tidal banks as a port conservation technology and construction for forming seaweed bed and seawall maintenance etc. Research and development in this area has attracted attention as a technique for improving the quality of cultured laver as application technology in recent years, technology for restoring seaweed beds and improving the production of agricultural products in recent years.

Keywords: Biological Effect, Dam, Ecology, Mainternance, Reservoir, Reservoir Capacity, Slag, Soil, Soil Investigation, Water Qality, Ichifusa Dam, Iwamoto Pond, Takahara Pond, Akasegawa Pond.

RÉSUMÉ

Cette fois-ci, notre groupe de recherches s'est concentré sur l'effet des hautes concentrations d'acide fulvique produites au pied du barrage, en utilisant un dispositif d'élution de fer d'acide fulvique à haute concentration, dans une zone réelle où le sol dénudé progresse. En conduisant des expériences de démonstration sur le champ d'algues du réservoir du barrage, nous visons à développer des applications pratiques technologiques pour l'utilisation effective des dépôts en fond de lac.

Nous utilisions dans la procédure jusqu'ici des mâchefers de hauts fourneaux pour faciliter la dissolution d'ions de fer bivalents, mais désormais nous avons trouvé des matériaux plus efficaces : nous avons fabriqué à partir d'un convertisseur de fourneau électrique un matériau contenant une forte concentration d'ions de fer bivalents. Cette concentration est 100 fois plus importante que celle des mâchefers adoptés jusqu'ici.

La commercialisation de ces résultats de recherches à l'étranger va commencer en Corée, pour la première fois en extrême orient.

Par ailleurs, nous proposons une nouvelle formule de calcul pour l'absorption du CO_2 (conversion du carbone) par la formation d'un lit d'algues, et la fixation annuelle par l'algue du Japon est estimée à 3 millions de tonnes.

Nous espérons que les résultats de la recherche et du développement utilisant cette technologie seront commercialisés dans des zones de marnage comme technologie de conservation des ports, afin de former des lits d'algues pour la maintenance des digues, etc. Ces dernières années, ces techniques ont attiré l'attention pour améliorer la qualité des lits d'algues ainsi que la production agricole.

1. INTRODUCTION

The area of the seaweed bed as a "cradle of the sea" has declined by an average of 20% in all coasts of Japan compared with the 1990s, and has decreased by nearly 40% especially in the waters of western Kyushu from the Pacific coast of southern Honshu. As causes of this phenomenon, it is pointed out that animals feeding seaweed such as sea urchin and rabbitfish, seawater temperature rise, and shortage of nutrient salt including iron ion etc. Our research group has conducted demonstration experiments to confirm its effect in real sea areas where barren ground is progressing, focusing on the high concentration of fulvic acid iron produced at the bottom of the dam. Based on these results, we have developed technologies for effective utilization of lake sediments in the dam and are conducting research on its practical application. [1] [2]

This report is a development of the research results so far. Here, we describe the contents of development of a high-concentration fulvic acid iron elution unit in which a high-concentration iron fulvic acid-containing substance as a lake sediment or a regional biomass is mixed with a high-concentration divalent iron-containing substance and filled in a coconut tube, it presents the effect of this basic technology. By applying this basic technology to the coastal waters, by strengthening the relationship between marine algae and animals feeding seaweed by reinforcing the deficient nutrient salt, it is necessary to improve the biodiversity by creating seaweed communities on a large scale, should be originally. We are aiming to restore balanced rocky reef ecosystem.

The principle of utility in the high concentration fulvic acid iron elution unit is derived from iron complex in general humic acid structural model. As this high concentration fulvic acid iron-containing substance, lake bottom sediments and local biomass fermented products (wood chips, bamboo shoots bark compost etc.) were selected. In this report, we selected a gradual chelating iron oxide containing a high concentration of divalent iron ions of natural organic acid, mixed it with a high concentration fulvic acid-containing substance and anaerobically ferment it to make it high. It is the first attempt to aim at practical application of basic theory to form a complex structure model of concentration fulvic acid iron.

Many unknown parts of the mechanism and process of recovering barren ground by humic acid iron are demonstrated, but by demonstrating these in the actual sea area, by effective utilization of sediments at the bottom of the dam and CO_2 fixation by promotion of algae growth in the ocean, we consider it to contribute greatly to the global environment, so we will report on its research results.

2. BACKGROUND OF DEVELOPMENT OF SUPER FULVIC ACID IRON

2.1. OUTLINE OF DEMONSTRATION EXPERIMENT

2.1.1. Artificial Humic Substances

Humic substances are fractions extracted from soil with alkali such as caustic soda, or fractions eluted with dilute alkaline aqueous solution by adsorption on DAX resin with natural water (International Humic Substances Society, Abbreviation Defined in IHSS). Furthermore, among humic substances, a fraction precipitated by acid is called humic acid and a fraction which does not precipitate is called fulvic acid. Fig.1 shows the chemical structure model of fulvic acid and humic acid in humic substances.

As a humic substance, conditional anaerobic fermentation decomposition of organic matter is promoted by mixing a fermentation promoter with a waste wood chip, and a humic substance (fulvic acid) is produced. Fulvic acid has a carboxyl group (-COOH) or a carbonyl group (-CO-).

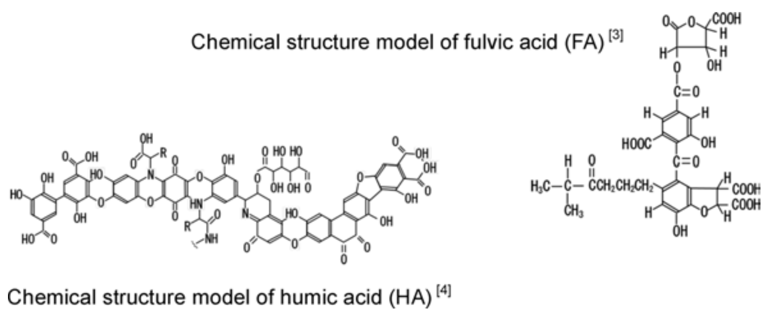

Fig. 1
Chemical structure model of fulvic acid (FA), humic acid (HA)
Modèle de structure de l'acide fulvique (FA), de l'acide humique (HA)

For artificial humic substances, by using useful microorganisms such as actinomycetes as a fermentation promoter, decomposing organic matter of crushed chips such as harvested trees, cutting roots, and selected branches by conditional anaerobic fermentation, it is possible to obtain humic substances in a relatively short period of time it can be manufactured. By this method, organic compounds such as fulvic acid and humic acid can be produced by lowering composted organic matter.

2.1.2. About Artificial Fulvic Acid Iron

Fulvic acid (corrosive substance), which is a water-soluble organic matter produced by decomposition of dead leaves etc. in humus soil under forests binds quite stably with iron in an oxygen-free state, and even in seawater flowing down, the form of divalent iron ions is retained without being oxidized, while seaweed incorporates it into the living body and promotes its own growth. The chemical structure of this ionic form is as shown in Fig.2.

The mechanism of artificially producing iron fulvic acid iron (humic acid iron oxide) by mixing this iron-containing substance and humic substances in sea water is the “study of eluted ferrous iron” by Kogakuin University and others. It has been confirmed quantitatively. [2]

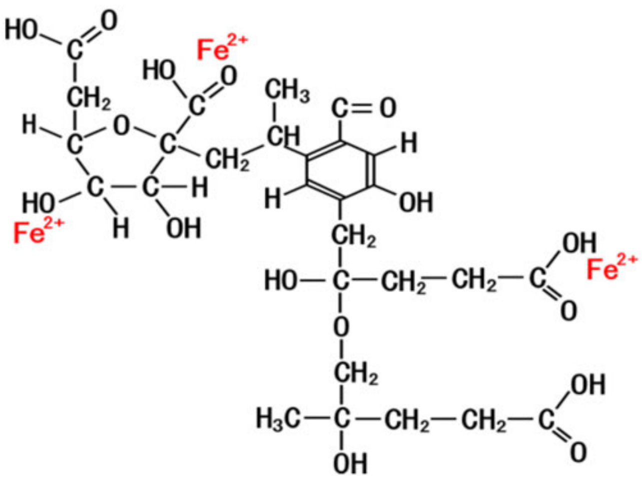

Fig. 2
Structural diagram of chelating compound of divalent iron and fulvic acid
Schéma structurel du composé chélatant du fer divalent et de l’acide fulvique

2.1.3. Production of Fulvic Acid Iron Elution Unit and Confirmation of its Effectiveness (From 1st stage to 2nd stage of development)

According to the present construction method, when an elution unit packed with a mixed substance of a humic substance and an iron-containing substance is buried in the shoreline, the artificial fulvic acid iron (divalent iron) produced in the bag elutes, Growth of zoospores released from sporophytes of algae surviving around the shoreline is promoted and it becomes nutrients for further growth. Besides, since the bag is the palm fiber which has the slowest degeneration rate among natural fibers, it allows elution of divalent iron ions while retaining the iron-containing substance for over 5 years.

In the two-step research process shown in Fig.3, it was demonstrated that the amount of elution of divalent iron was improved by selecting the iron-containing substance to be placed in the bag, and the growth of seaweed was promoted accordingly, and development of an elution unit it was able to improve its performance through the stage as well.

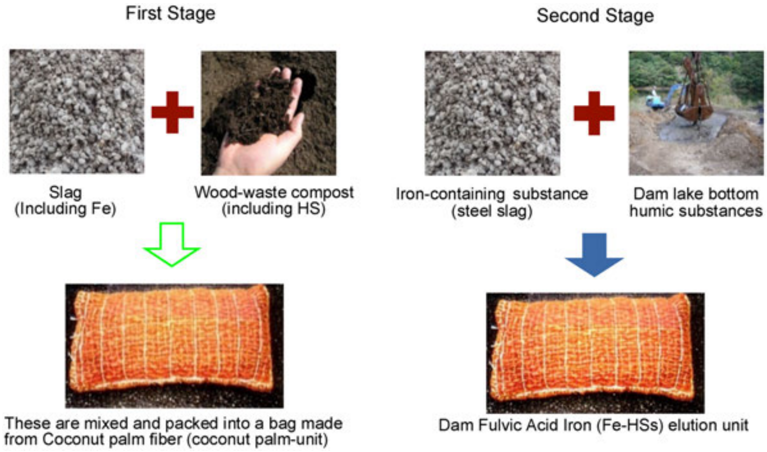

Fig. 3
Development process
Processus de développement

2.1.4. Super Fulvic Acid Iron Elution Unit (The Third Stage of Development)

As the third stage of commercialization, we utilize the following four special materials and technologies owned by the Dam fulvic acid Iron Research Group.

1) Coconut Palm Fiber Tube
The standard specification of the palm fiber tube is as shown in the photograph, with a size of 500mm × 1,000mm, tolerance ± 50mm

2) High Concentrated Divalent Iron-Containing Material
A natural organic acid substance containing a large amount of divalent iron ions constituting the chelate complex prevents the Fe from becoming unacceptable and becomes a transporter of divalent iron ions effective for plant growth. This concept is shown in Fig.4.

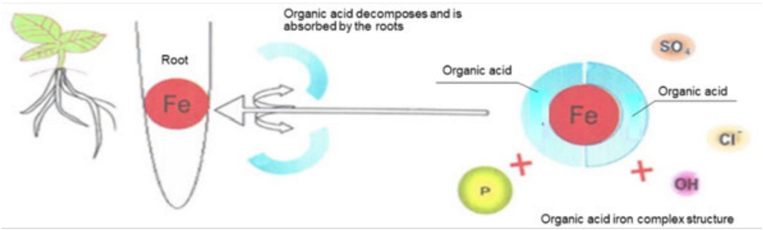

Fig. 4
Schematic diagram of iron absorption
Schéma d'absorption de fer

3) High Concentration Fulvic Acid Iron-Containing Substance

Dam lake sediments

In this research group, in Japan, we have collected lake bottom deposits of 21 dams and other reservoirs nationwide over the 8 years from 2007 to 2015, and this component analysis is carried out. The situation of the collection is shown in Fig.5.

Fig. 5
Sampling of lake bottom sediments from the prefectural Nita dam, Tsushima-City, Nagasaki prefecture
Échantillonnage des sédiments du fond du lac du barrage préfectoral de Nita, Tsushima-City, préfecture de Nagasaki

Regional biomass fermented substance 1 (Bamboo shoots bark compost)

Component analysis of bamboo shoots bark compost produced in 2011 showed that it contained high concentration of humic acid. Fig.6 shows the manufacturing process of bamboo shoots bark, and Table 1 shows the component analysis result of bamboo shoots bark compost.

Digging bamboo shoots Bamboo shoots bark

Fig. 6
Digging bamboo shoots and bamboo shoots bark
Creuser des pousses de bambou et des pousses de bambou peau

Table 1
Bamboo shoots skin raw material analysis result (2001 in production)

Analysis method	unit	Measurements		Analysis method
		As-collected state	Dried state	
pH [Liquid temperature]	°C	7.4 [18]		Glass electrode method "fertilizer analysis method"
Electric conductivity (EC)	ds/m	1.51		Electrical conductivity measurement method "fertilizer analysis method"
Total amount of Carbon (C)	%	13.62	40.21	Dry combustion method "Organic matter analysis method such as compost"
Total amount of Nitrogen (N)	%	0.57	1.68	
C / N			24	
Humic acid content	%	2.04	6.02	NaOH extract fraction-nichromic acid colorimetic method
Fulvic acid content	%	1.30	3.85	NaOH extract fraction-nichromic acid colorimetic method
[Special mention matter] The indication of C/N is a ratio of carbon gross quantity/nitrogen gross quantity				

Regional biomass fermented substance 2 (wood chip)

Fig.7 shows the flow of production by conditional anaerobic fermentation of wood chips compost. As a result of analyzing this compost, it was found that the plate had a high concentration of humic acid as shown in Table 2.

Fig. 7
Production process of wood chips compost
Processus de production du compost de copeaux de bois

Table 2
Analysis result of wood chips compost

Analysis items	Measurements (%)	Analysis method
Total amount of Carbon (C)	36.93	Dry burning method "organic matter analysics method shch as compost"
Total amount of Nitrogen (N)	0.69	
(C) / (N)	54.00	
Humic acid	7.56	
Fulvic acid	7.92	Humic acid • Fulvic acid extraction fraction Nichromic acid colorimetric method

4) High concentration fulvic acid elution unit

Our research group developed a fulvic acid elution unit which was made into a product by mixing a high concentration divalent iron-containing substance and high concentration fulvic acid iron oxide and filling it into the palm tube of 1). Fig.8 shows this manufacturing process and product.

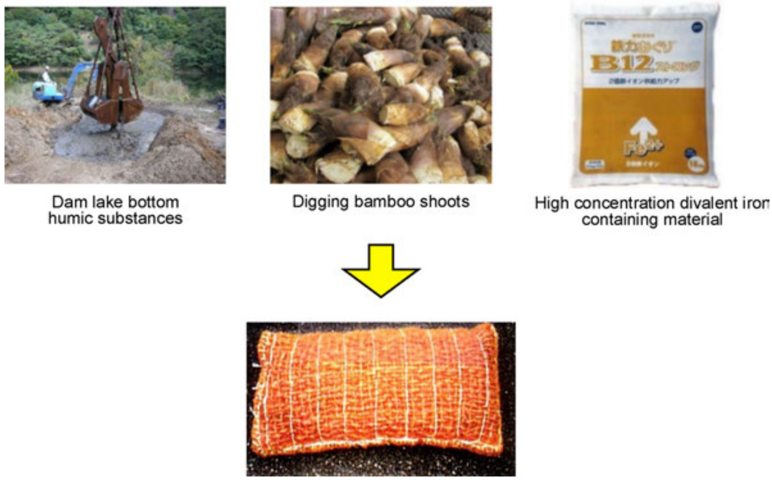

Fig. 8
Productization of high concentration fulvic acid iron elution unit
Production de l'unité d'élution du fer acide fulvique à haute concentration

3. DEMONSTRATION EXPERIMENT ON THE EFFECTIVENESS OF SUPER FULVIC ACID ELUTION UNIT

3.1. DEMONSTRATION SITE

With the cooperation of the Sado Fishery Cooperative Association Koizumi branch office in Niigata Prefecture, the coastal area of the northern Ebisu district on the Aikawa coast was selected as the experiment site to demonstrate this effectiveness. Fig.9 shows its location and its coast scene.

Fig. 9
Field of demonstration and whole view of the embedment coast
Champ de démonstration et vue d'ensemble de la côte d'embedment

3.2. The fulvic acid elution unit to be used

3.2.1. Outline of Elution Unit

Dam fulvic iron elution unit used for this sedimentation construction is a unit developed by our research group based on know-how accumulated through field demonstration experiment based on the research result so far. This unit is mainly composed of the following four members.

3.2.2. Main unit members

① Dam lake bottom sediment
② Regional biomass (bamboo shoots bark etc.)
③ High concentration divalent iron containing substance
④ Coconut palm fiber tube

3.2.3. Dam lake sediment (Akasegawa Reservoir lake bottom sediment)

As a result of collecting and analyzing the lake sediments of Akasegawa Reservoir (Fig.10) in Akune City, Kagoshima Prefecture, we have confirmed the presence of high concentration of humic acid iron, it is confirmed that the content of (Table 3) is extremely high.

Akasegawa pond Construction Monument | Akasegawa swamp Overview Photos | Collection | Lake sediments

Fig. 10
Akasegawa Reservoir
Réservoir Akasegawa

3.2.4. Analysis result of sampled soil

Comparative analysis of sampled soil from the reservoir in various parts of Kyushu showed that the fluctuation range of the fulvic acid iron content contained by the site conditions and history differed as shown in Table 3.

Table 3
Fulvic acid iron content in the Akasegawa Reservoir sediment

	Fulvic acid Iron(FA)	Humic acid Iron(HA)	C=FA+HA Iron-humates (Fe-HSs)	Fulvic acid iron content ratio FA / C(%)
Ichifusa dam	7.1	21.8	28.9	24.6%
Iwamoto pond No.1	16.3	31.5	47.8	34.1%
Iwamoto pond No.2	9.9	33.7	43.6	22.7%
Iwamoto pond Ave.	13.1	32.6	45.7	28.7%
Takahara pond	68.7	103.0	171.7	40.0%
Akasegawa pond	67.0	0.0	67.0	100.0%

3.2.5. High concentration divalent iron containing substance

This research group has been using steel slag manufactured from a blast furnace in the iron making process as an inexpensive high concentration divalent iron containing material in the past two research stages, but when used in a large amount, the average hydrogen ion index of seawater 8.1 was pushed up, and the divalent iron ion concentration by this was only a stage where it can only be expected to be less than about 10 ppm.

The feature of the third stage of this development is the introduction of a new high concentration divalent iron-containing material that can be replaced with blast furnace slag as conventional industrial waste. Even with the slag generated in the same steelmaking process, the iron oxide slag produced from the electric furnace converter does not receive treatment of industrial waste, but also it can be used as a plant for supplying iron ions for agriculture an active agent is present. It is a gentle iron oxide solution containing a high concentration of divalent iron ions of a natural organic acid or a granular iron oxide solution, or granular, and its effect on the environment has been verified, so extremely effective divalent iron for plants Ion transporter (IRT) is considered.

This research group improved this material to ocean type, and confirmed the high concentration of 5,000ppm divalent iron ion concentration at the laboratory institute in Akune city in Kagoshima prefecture. In the actual sea area, we succeeded in the creation of a sea forest at Mine Town in Tsushima City, Nagasaki prefecture.

3.2.6. Regional biomass fermented substance

In this research, we will discuss regional biomass limited to one kind of garbage generated in the process of agricultural and marine products processing. Even raw garbage if thrown away as it is, if you add hands such as fermentation, it will be composted into useful items. In the same way as fermenting cow dung and so forth to make compost of terrestrial crops, if you digest it by fermenting garbage generated in the area, it is rich in seaweeds such as nitrogen, phosphoric acid and potassium. Pathway to utilize regional biomass containing nutrients can be opened.

The super fulvic acid elution unit developed by us contributes to effective utilization of resources which are normally disposed of as garbage, including bamboo shoots bark, shochu residue, fish cake, etc. as a raw material for regional biomass it will help to a resource recycling society.

3.3. Outline of demonstration experiment method

So far, the method of countermeasures against barren ground in Japan has eliminated sea urchin and rabbitfish of sea vegetable animals and planting of seaweed seedlings by a diver was common, but there was little point of view on improving the qualitative environment of sea water components in coastal waters. Based on the findings of fundamental research so far [1] [2], our research group has adopted a method of directly embedding the super fulvic acid iron elution unit described in the previous section on the shoreline of the set coast so that the area of the island burn It is to demonstrate the effect of countermeasures.

3.3.1. Embedding plan of fulvic acid elution unit

The embedding plan of the elution unit are shown in Fig.11.

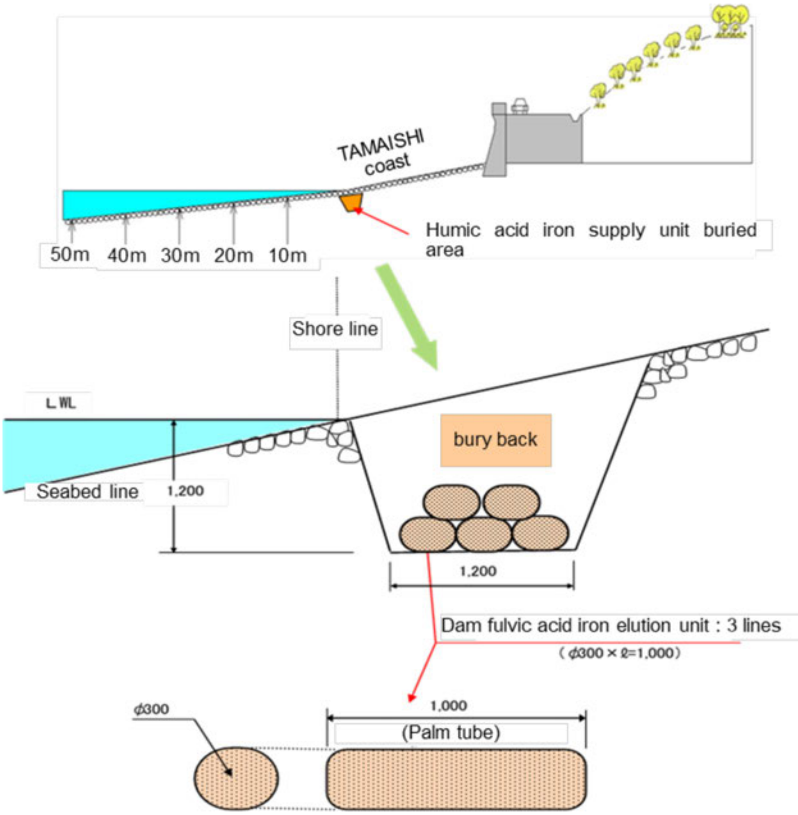

Fig. 11
Embedment plan of elution unit
Plan d'incorporation de l'unité d'élution

3.3.2. Work procedure for embedding fulvic acid elution unit

The work procedure is explained in Fig.12, and the implementation situation is shown in Fig.13.

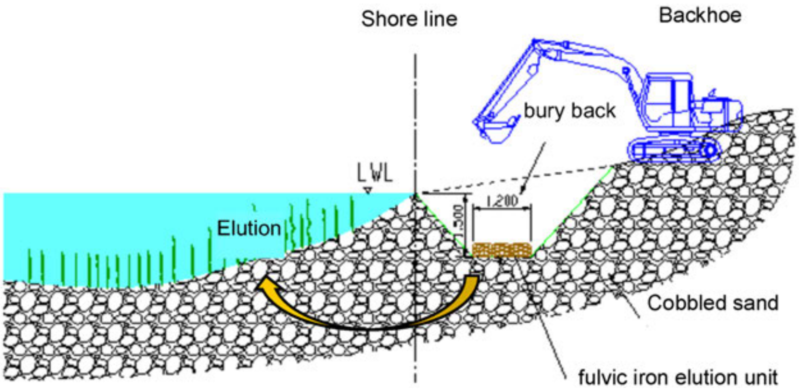

Fig. 12
Embedding procedure of elution unit
Procédure d'incorporation de l'unité d'élution.

Fig. 13
Excavating of coast and embedding of unit
Excavation de la côte et encastrement de l'unité

3.4. Water quality survey and soil investigation

3.4.1. Seabed survey

In the intertidal reef zone, the topography is rich in general and the environmental gradient is remarkably large. Therefore, as the method for investigating various seaweed community structures within a narrow range, the most basic collard method (Fig.14)

The survey was carried out by the submarine by the glory frame of 1.0 m × 1.0 m and the aquatic environment of aquatic animals and plants.

After photographing, record and record the growth quantity for each seaweed type. The survey position was set for each line In 5 places, 10 m, 20 m, 30 m, 40m, 50m from the shoreline. Survey on the seabed-Based on the materials, arrange the seaweeds and the seasoning etc. by class, make a drawing and make a report to form.

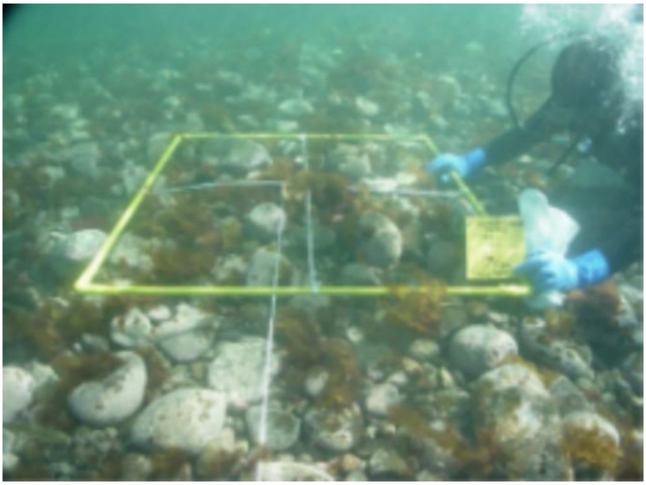

Fig. 14
Collard method using square frame
Méthode Collard utilisant un cadre carré

Contents of investigation

Degree:	The ratio of the perpendicular projected area to the collard area is expressed as a percentage or classified degree.
Density:	Number of individuals per collard (unit area)
Frequency:	Number of collards / total number of collards × 100%
Height:	in communities the natural state height, or length
Group degree:	It is a qualitative rate showing various degrees of aggregation in the entire community, not in collards, brown - blanket community class (1: unity, 2: growth in ultramarine, 3: patchy growth, 4: Growth in a colony state, 5: form a large group).

3.4.2. Water quality survey

Determination of the concentration of divalent iron ions in sea water and inflowing river water (only when present) and content measurement of nutrient salt were carried out in each sinking and embedding section and in each control section where nothing was added It is carried out twice in advance and after.

3.4.3. Soil investigation

We investigate and analyze the humus soil of the forest department on the land side in the embedded area and the control zone.

3.4.4. Location map of water quality survey and soil investigation (schematic)

A specific investigation position is shown in the map of Fig.15.

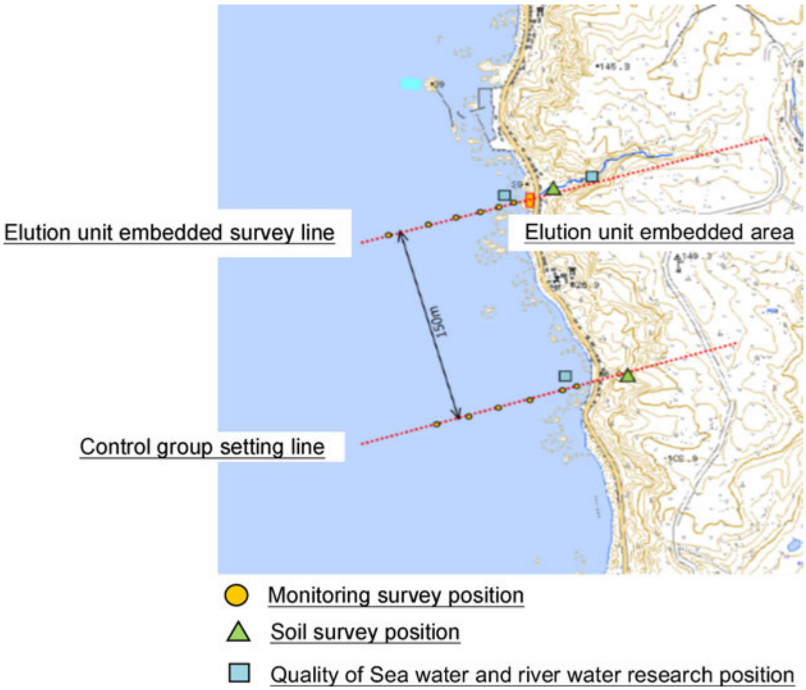

Fig. 15
Various survey position chart
Tableau de position de l'enquête variée

4. APPROACH OVERSEAS ON THIS RESEARCH

4.1. TECHNICAL EXCHANGE MEETING BETWEEN KOREA AND JAPAN ON MEASURES AGAINST BARREN GROUND

4.1.1. 1st technical exchange meeting in december 2008

The research group participated in field survey on Korea's measures against barren ground. Due to the shortage of nutrient salt etc. in the South West coast region, degradation of quality is a problem due to loss of color of laver and red spoilage, so the research group cooperated as a part of Korea's implementation of measures to counter barren ground.

4.1.2. 2nd technical exchange meeting in april 2016

As a part of South Korea's Barren Ground Measures Project, our research group participated in the survey of Jeju Island. On this occasion, we were able to observe changes in the growth condition of algae up to 20 m in depth using a submarine craft.

4.1.3. 3rd technical exchange meeting in december 2016

We invited four key people related to fisheries resources in Korea to Japan and introduced research achievements on measures against barren ground in Japan. After a series of technical exchanges, we introduced Sado Island which is a demonstration experiment site on the effectiveness of super fulvic acid elution unit.

4.1.4. WANDO seaweed international EXPO

In April 2017, as part of "Wando Seaweeds International EXPO" at the Wand of Korea, international symposium on sustainable seaweed industry and "green carbon" was held. This research group was invited and gave a lecture entitled "Case study of success of proliferation of marine algae by conducting demonstration experiment using lake bottom sediment etc. on coast such as Hokkaido, Tsushima, Sado Island etc."

This symposium is hosted by the Korea Algae Industry Development Association, organized by the organizing committee, and all the university professors who are participating in our series of technical exchanges as the chairman and committee are in office. The co-host of this symposium is Korea Fisheries Department National Fisheries Research Institute, Korea Marine Science and Technology

Agency (KIMST) Korea Fisheries Resources Agency (FIRA), Korea Seoul Medical Association, Wando Town.

Green carbon is a term that emphasizes that seaweed contributes not only to improvement of the marine environment but also to carbon absorption, which is the cause of global warming, with carbon stored in seaweed.

It was reported in Korea in 1992 that the first barren ground phenomenon was confirmed in Jeju Island and some deterioration phenomenon occurred in 21,600 ha corresponding to 45.6% of all coasts in 2016 in this symposium. The Korea Fisheries Resources Agency will take budget measures to implement this measure at 260 locations and 35,000 ha between 2009 and 2020. And, by 2016, 111 plants, 12,206 ha are already undergoing seedling transplants.

5. PROPOSAL OF CALCULATION FORMULA OF CO_2 ABSORPTION AMOUNT BY SEAWEED BED CONSTRUCTION

This research group proposes the following calculation formulas in the ocean as a method to quantify the amount of CO_2 fixation by algae growth in the ocean. We observe the growth situation of seaweed for 1 year in 4 sea areas, measure the change in growth amount different for each kind, and measure the change in carbon content by chemical analysis of this seaweed, and derived this calculation formula.

5.1. Calculation equation of CO_2 fixed amount

Calculation formula of annual carbon fixed amount by seaweed bed recovery is shown below.

Carbon fixing amount = α × current weight of seaweed (dry weight) × P/B ratio × β × carbon content percent o be measured

α : Increment factor for the production amount to change depending on the denseness of seaweed in the measurement area

β : Increment rate derived by the change in the carbon content of annual

P/B ratio : Annual production of algae and ratio of existing volumes

5.2. ANNUAL CO_2 FIXATION BY SEAWEED BED

Japan's land area is 375,631km^2, coastal area less than 20 m in depth is about 34,482km^2. If the reef to become seaweed bed is 10%, the area of rocky seaweed bed in Japan will be 3,448km^2. Therefore, the trial calculation of carbon fixed amount by seaweed bed construction,

Carbon fixed amount (ton/Y) = area of reef seaweed bed area × abundance × P/B ratio × carbon content percentage
= $3.448 \times 10^9 m^2 \times 3.0\ kg/m^2 \times 1.0 \times 0.3$
= 3,103,200,000 kg/Y
= 3,000,000 ton/Y

However, the existing amount in this calculation formula is a trial calculation with 3.0 kg/m^2 in terms of the growth amount of Eisenia bicyclis growing all over Japan, P/B ratio 1, carbon content 0.3.

6. CONCLUSION

Our research group newly found a high concentration fulvic acid iron-containing substance as a lake sediment in the dam and regional biomass, confirmed its effectiveness, mixed with a high concentration divalent iron-containing substance of iron oxide slag, We developed a high concentration fulvic acid iron elution unit (super fulvic acid iron) filled in a tube.

As a high concentration divalent iron ion-containing substance, instead of the steelmaking slag produced from the blast furnace which has been used up to now, after confirming the characteristics of the iron oxide slag produced in the electric furnace converter, it is adopted There. This high concentration divalent iron-containing substance is a gentle chelating iron oxide containing a high concentration of divalent iron ion of a natural organic acid, and it is also environmentally friendly divalent iron ion transporter (IRT) for safety and Possible (divalent iron ion concentration about 5000 ppm).

This technology was also introduced at the International Symposium held in South Korea, and it was decided to consider the first commercialization in East Asia.

We think that CO_2 fixation by promoting the growth of algae in the ocean contributes greatly to the global environment, and this research group proposes a new calculation formula for CO_2 absorption amount (converted to carbon) by seaweed bed construction, the fixed annual rate was calculated to be about 3 million tons.

ACKNOWLEDGMENTS

We are grateful for the cooperation of many stakeholders concerned with facility management when collecting nationwide dam reservoir for this research. Also, when carrying out demonstration experiments at the beach, we would like to express our deep gratitude to the local administrators for proper guidance and for receiving assistance from the local fishery cooperatives.

REFERENCES

[1] TOYODA T., KOMAI. T, FUKUSHIMA. M, SAKAI. Y, HORIYA. S. Investigation of Seaweed at Barren Ground by Deposition on Bottom of Dam Reservoir, *Journal of the Japanese National Committee on Large Dams*, 214, pp. 93-105, 2011 (In Japanese)

[2] SAKAI. Y, T TOYODA T., H HORIYA. S. Investigation of the Recovery of Seaweed at Barren Ground by Deposition on Bottom of Dam Reservoir in Japan, *Journal of the Japanese National Committee on Large Dams*, 232, pp. 110-106, 2015 (In Japanese)

[3] Miyajima,T., Mori, M., Bumseki kagaku, 45,369(1996).

[4] George R. A. et al. Eds. *Humic substances in soil. Sediment and water-geochemistry. Isolation and characterization.* p. 4, 1985